Appendix H1

Document: *Management Plan*

MEADOWBANK GOLD PROJECT

Landfarm Design and Management Plan

In Accordance with Water License 2AM-MEA0815

Prepared by:
Agnico-Eagle Mines Limited – Meadowbank Division

Version 3
February 2013

EXECUTIVE SUMMARY

General Information

The Landfarm Design and Management Plan (LDMP) describes the design features and operational procedures for the landfarm constructed at the Meadowbank Gold Project site for the storage and treatment of petroleum hydrocarbon contaminated soil.

Annual Review

The LDMP will be reviewed and updated at least annually if necessary. Completion of the annual review of the LDMP will be documented through signatures of the personnel responsible for reviewing, updating and approving the LDMP.

Record of Changes

A record will document all significant changes that have been incorporated in the LDMP subsequent to the latest annual review. The record will include the names of the persons who made and approved the change, as well as the date of the approval.

Distribution List

Agnico-Eagle Mines Limited (AEM) will maintain a distribution list for the LDMP providing information about all parties that receive the plan including mine personnel, departments, and outside agencies.

IMPLEMENTATION SCHEDULE

As required by Water License 2AM-MEA0815, Part B, Item 16, the proposed implementation schedule for this Plan is effective immediately (February 2013) subject to any modifications proposed by the NWB as a result of the review and approval process.

DISTRIBUTION LIST

AEM - Environmental Superintendent

AEM – Environmental Coordinator

AEM – General Mine Manager

AEM – Site Services Superintendent

AEM – Field Services Supervisor

AEM – Engineering Superintendent

DOCUMENT CONTROL

Table 1 – Document Control

Version	Date (YMD)	Section	Page	Revision
1	08/10/08	2		Remediation guidelines used and the parameters measured
		7		Details on storage and treatment options for metals, solvents, glycol and heavy oils; Measures to prevent damage to the liner during mechanical operation
		4		Contingency plans for exceedances in the amounts of contaminated soil and/or snow/ice
		5		Details describing the design components/specifications of the spillway
		8		Contingency planning and monitoring of sump volumes during the snowmelt period
2	12/10/22	All	All	Comprehensive revision to original plan
3	13/02/28	All	All	Further detail and rationale provided

Version 3

Prepared By: Meadowbank Environment Department

Approved By: _____

Kevin Buck

Environmental Superintendent

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1 INTRODUCTION

1.1 PROJECT HISTORY

Agnico-Eagle Mines Limited (AEM) Meadowbank Division (Project) currently operates an open pit gold mine located on Inuit-owned land in the Kivalliq Region of Nunavut, approximately 70 km north of the hamlet of Baker Lake. In 2008 the Landfarm Design and Management Plan was developed by AEM in accordance with Water License 2AM-MEA0815 to describe the handling and remediation of petroleum hydrocarbon (PHC) contaminated soil at the Meadowbank site. During construction and initial operations (2008-2011, prior to construction of the landfarm facility), soil potentially contaminated with PHCs, as a result of spills, was deposited in two quarries (Q5 and Q22) along the All Weather Access Road (AWAR). The majority of this soil was from a transport tanker spill in 2010 and from the contractor camp used for roadway construction in 2007 and 2008. In 2012 the transport of this soil back to the minesite for treatment/storage began. Landfarm design and management plan modifications (Version 2) were submitted by AEM to the Nunavut Water Board on October 22, 2012. This new plan focuses on minimizing the waste footprint onsite, and maximizing remediation potential through implementation of a pilot bioremediation project. The revisions in this document (Version 3) provide further rationale for the designs presented in Version 2, as well as additional details on the management of contaminated soils onsite. This includes spill prevention and contingency planning.

1.2 OBJECTIVES

Onsite storage and remediation has been established as the preferred method for treatment of petroleum hydrocarbon-contaminated soil that may be generated on the Meadowbank site and Exploration Camp. Specifically, remediation through landfarming has been identified as the primary treatment option and, as such, is the focus of this contaminated soil management plan. A pilot project to enhance rates of bioremediation through addition of a nutrient source is also described. Alternate contingency options in the event that landfarming is not successful or as efficient as planned are also discussed.

This plan is a component of the Meadowbank Environmental Management System. The objectives of this plan are:

1. To provide an overview of contaminated soil management at Meadowbank
2. To describe the physical setting, location and design criteria of the landfarm
3. To define acceptable types of contaminated soils to be placed in the landfarm and conditions for removal of treated soil

4. To define operating procedures and monitoring requirements for the landfarm, including the pilot bioremediation project
5. To describe contingency options for alternate treatment/storage of PHC contaminated soil

2 SPILL PREVENTION

2.1 SPILL MANAGEMENT DOCUMENTATION

Spill prevention is the first stage in contaminated soil management at the Meadowbank site. Three documents describe spill prevention, management and response at this facility: the Spill Contingency Plan, the Emergency Response Plan, and the Oil Pollution Emergency Plan. Specifically, Section 2.1 of the Spill Contingency Plan describes spill prevention measures and can be referred to for further detail. All were updated in July or August of 2012, and spill prevention programming was reviewed.

General spill prevention methods include:

- Daily inspections of fuel/chemical storage areas for leaks
- Training in safe handling procedures
- Keep containers sealed
- Use methods of secondary containment
- Keep overpack drums nearby to contain leaking drums
- Keep storage area secure from unauthorized access, and protected from weathering and damage
- Segregate incompatible materials
- Regular meetings with site departments

2.2 DECREASING SPILL SEVERITY

In 2011, spills of landfarmable materials (fuel and hydraulic oil) at Meadowbank totaled 5338 liters. In 2012, Meadowbank Division Environment Department increased delivery of spill prevention programing. This included more departmental information sessions to maintain awareness about spill prevention methods and reporting procedures. In 2012, spills of fuel and hydraulic oil have been reduced to 3012 liters. In 2013, the Environment Department will be incorporating a site wide training session for every employee on site. In addition, the Emergency Response Team as well as Environment and Road Maintenance staff will have extensive training in spill response by a consultant specializing in spill training (January, 2013). Training will pertain to spill response on the tundra as well as surface water. In addition, AEM will begin use of a new hydraulic fluid (Hydrex^{TM} Extreme; Petro-Canada) that contains no heavy metals and is 40% biodegradable in 28 days. It is therefore estimated that any soil contaminated with the new fluid will be more rapidly remediated in the landfarm than soil contaminated with the previously used fluid.

3 LANDFARM DESIGN

3.1 BACKGROUND

When spills do occur, onsite storage and remediation is the most practical and efficient method of handling contaminated soil, particularly in an isolated location like Meadowbank. For PHC contamination, bioremediation through landfarming has been identified as a viable remedial technique. This method involves spreading, mechanical mixing, and placing the contaminated soil in windrows within a containment area and promoting conditions favourable for the volatilization and aerobic microbial degradation of hydrocarbons. A number of environmental factors and physical properties of the soil affect microbial growth and rates of biodegradation, including temperature, soil moisture, nutrient content, salinity and soil particle size.

Previously, a landfarm options analysis prepared for AEM by Golder (2007a) identified some of these factors, and presented the following information from the literature on landfarming in the north. Although rates of biodegradation decline with temperature, landfarming is still a feasible technique in arctic climates (Reimer et al. 2005). Microbial activity stops between 0 – -5°C (although volatilization continues at this temperature), so degradation in the north is typically restricted to the months of June – September. Nevertheless, degradation was reported at 70% after one year in a study in Alert, NU (Greer et al. 2007), and 90% over two summers on Resolution Island (Paudyn et al. 2005).

3.2 LOCATION

The overall site plan for the Meadowbank Gold Project and the location of the landfarm facility are shown in Figure 3-1. This central location was chosen to minimize the waste footprint on site and the transport distance of contaminated material from spill locations. All of the waste generated at Meadowbank in the form of tailings, wasterock and the site landfill is in close proximity. The location of the new facility is directly north of the future South Cell Tailings Facility (2015). This location will facilitate closure and possible contingency plans (Section 5), because all waste will be located in the same area, and not spread out around the mine site.

3.2.1 Proximity of Surface Water

The facility is located 300 m from the nearest water body, Third Portage Lake (TPL) and immediately adjacent to the current North Cell Tailings Storage Facility (TSF). Surface drainage in this area is easterly, towards the TSF and away from TPL.

3.2.2 Proximity of Groundwater

In the Meadowbank area, the shallow groundwater is estimated to be 1.5 m below surface (active layer July – October), at the average depth of thaw. In order to prevent movement of contaminants from the landfarm facility into groundwater and the surrounding environment, Environment Canada (SAIC, 2006) recommends implementation of a barrier with 10^{-7} cm/s hydraulic conductivity at a thickness of 0.6 m. The Meadowbank facility pad is constructed of 2.7 m of compacted till with a hydraulic conductivity of 10^{-7} m/s. Therefore, no impacts to groundwater are anticipated.

3.3 DESIGN

The landfarm facility is designed with one soil remediation/storage cell. The design volume of the cell is based on allowances for the materials to be treated. This calculation is described in the following section.

3.3.1 Soil Volume Requirements

Between 2008 and 2010, the Meadowbank Gold Mine stored 5,320 m^3 of soil potentially contaminated with hydrocarbons in two quarries along the AWAR (Q5 and Q22), as a contaminated soil storage facility had not yet been built onsite. As discussed above, the majority of this contamination was the result of an overturned tanker in 2010, and spills during the construction and initial operations. A delineation of contamination in the quarries (Qikiqtaaluk Environmental, 2010) indicated approximately 1,000 m^3 of contaminated soil above Government of Nunavut (GN) guidelines in Q22, and 250 m^3 in Q5. In 2011, an additional 250 m^3 of PHC contaminated soil was generated onsite, and placed in Q22. Actual hydrocarbon contaminated soil from January - October 2012 was 400 m^3, and the projected total for 2012 at that time was 480 m^3. The total volume of contaminated soil generated at Meadowbank to date is therefore approximately 1730 m^3, for an annual average of 346 m^3. Currently production will continue through 2017 for an expected additional required landfarm capacity of 1,725 m^3 (5 years x 346 m^3/year). With an additional 20% for contingency, and conservatively assuming that no soil will be remediated and removed before closure, the total capacity of the landfarm should therefore be a minimum of 4,146 m^3.

3.3.2 Design Specifications

Specifications of the landfarm design are shown in Figure 3-2. As built, the landfarm area is constructed with a 1.5 m high berm and a 2.7 m deep compacted till base with hydraulic conductivity of $1x10^{-7}$ m/s. The slope of the base is 1.5%.

The useful landfarm area is 3,712 m^2. Based on landfarm specifications of other northern mines (Ekati Diamond Mine – in Golder, 2007a), contaminated material can be stockpiled up

to 4 m high. Accounting for a 25% loss of area due to sloping at that windrow height, the landfarm area will allow for the storage of a maximum of 11,136m^3. This will readily accommodate the estimated total of 4,146 m^3 of contaminated soil, should all of it need to be stored until closure. In addition, ample room will be available to accommodate a designated area for spreading of contaminated coarse-grained material that cannot be bioremediated (see Section 4.2.2).

Based on the available area, maximum windrow size will be 15 m wide at base x 4 m high x 50 m long, but smaller piles will be used as space allows tomaximize rates of biodegradation and volatilization.

4 LANDFARM OPERATION AND MANAGEMENT

The following presents the operational procedures for the landfarm facility.

4.1 MANAGEMENT RESPONSIBILITY

AEM will be responsible for managing and implementing the operation plan. Operation and monitoring of the facility will come under the responsibility of the Environment Superintendent. Designation of training requirements is the responsibility of Meadowbank Environment Department.

4.2 ACCEPTABLE MATERIAL

4.2.1 Contaminants

The landfarm facility will only treat and/or store petroleum hydrocarbon contaminated soils that have been generated through mine-related activities at the Meadowbank Gold Project and the Meadowbank exploration camp. Material from other sites will not be accepted without approval from the Nunavut Water Board, AANDC Water Resources Officers and the Kivalliq Inuit Association.

The following products may be treated in the landfarm if used onsite and spilled on soil:

- Diesel fuel
- Gasoline
- Aviation fuel (Jet A)
- Hydraulic oil
- Other light oil e.g. engine oil, lubricating oil

In the event that the contaminant source is unknown, soil samples will be analyzed for petroleum hydrocarbons and possibly additional contaminants prior to placement in the landfarm. These additional parameters could include total metals, oil and grease, and volatile organic compounds. Analysis for additional compounds will be determined by the Environment Department on a case-by-case basis. Concentrations of contaminants will be compared to the site background values (for metals) and/or criteria in the GN Guidelines for Contaminated Site Remediation (March, 2009). If this analysis indicates soil contamination above background or GN guidelines with any substances not described in Section 4.2.1 (i.e. non-PHC contaminants), it will not be placed in the landfarm facility. This is to ensure PHC contaminated soil is not contaminated with other products.

Spills of > 100 L of non-PHC material (e.g. solvents, glycol) will be placed in drums and stored in the site Hazmat area for shipment south to approved facilities during barge season. Spills of non-PHC material < 100 L will be placed in the TSF.

4.2.2 Grain Size

While very coarse-grained larger soil material does not readily retain moisture and nutrients, inhibiting bioremediation, volatilization will occur more rapidly (SAIC, 2006). It has been noted that this material likely contains lower concentrations of contaminants due to a lower volume:surface area ratio, and can typically be screened out prior to landfarming (SAIC, 2006). A 2010 study at Meadowbank (Qikiqtaaluk Environmental, 2010) indicated increasing concentrations of PHC with decreasing grain size in one group of samples with soil fractions of 0.5, 0.5-1 and >1" (two other groups sampled were below detection at all grain sizes). Soils and rock material with grain size <1" will be separated from larger-grained material as best as possible. This will occur at the spill location or in the landfarm. If necessary, a screen sieve will be used. The two soil fractions will be treated separately in the landfarm (see Section 4.3.1).

4.3 CONTAMINATED SOIL ADDITIONS

4.3.1 Spill Excavation

Soil contaminated with the above-described petroleum hydrocarbon materials will be excavated from the source and transported to the landfarm facility in dump trucks or by roll-off containers. Care will be exercised to ensure that the entire spill is excavated (verified by olfactory and visual assessment or sampling if necessary) and that none of the contaminated material is lost during transport.

4.3.2 Placement in the Landfarm

As above, larger coarse material (> 1") will be separated from the finer material in the landfarm and assessed visually for PHC staining and product. If the material is saturated it will be spread out for volatilization in the designated area of the landfarm.

Fine-grained materials identified as acceptable in the landfarm should be placed in windrows with dimensions ~15 m wide at base x 2.5 m high x 50 m long. Windrows may be piled higher as space permits. A record will be kept by the on-site Environmental Coordinator of the amount of contaminated soil placed in the landfarm and the location of each load within the facility.

Although Qikiqtaaluk Environmental (2010) indicated 250 m^3 of contaminated soil in Quarry 5, all soil previously deposited in there (1200 m^3) has been removed to the landfarm facility and placed in two windrows (see Photo 1, Appendix B). Including contaminated soil

produced onsite in 2012, the landfarm currently contains approximately 1680 m^3 of contaminated soil. Contaminated soil historically deposited in Quarry 22 (up to a maximum of 1,000 m^3, as delineated in Qikiqtaaluk Environmental, 2010) will be moved to the landfarm in 2013. Coarse, uncontaminated material will be left in Q22 for rehabilitation purposes.

4.4 CONTAMINATED SNOW

For spills < 100 L, PHC-contaminated snow will be placed in a designated area of the landfarm and treated as contact water after snowmelt.

For spills > 100 L, PHC-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 PHC residue. The treated water will be sampled per Part F, Item 6 of the Water License, and discharged to the Stormwater Management Pond if criteria are met. If criteria 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.

4.5 REMEDIATION

Remediation of fine-grained PHC-contaminated soil in landfarms occurs naturally through volatilization and aerobic microbial degradation. Soil aeration and nutrient amendment are recognized as methods of improving rates of remediation. To this end, remedial operations at the Meadowbank site include soil mixing (aeration) and a pilot project utilizing onsite nutrient additions. While it is recognized that pH, salinity, moisture content and microbial population density also contribute to rates of degradation, these factors will not be explicitly investigated or managed unless remediation rates are too slow to meet the site closure time period (see Section 5.2).

4.5.1 Absorbent Materials

Coarse-grained soils are not readily bio-remediated, but concentrations of PHC contaminants may still be reduced through volatilization. Oil absorbent pads will be used to help remove visible product from coarse-grained material. Used absorbent materials will be incinerated.

4.5.2 Aeration

In order to promote aerobic conditions throughout the windrows, soil will be mixed mechanically with earth-moving equipment. This turnover of soil piles will occur two to four times per year, during the summer months.

4.5.3 Soil Moisture

Prior to turning, site personnel will ensure that soil is not so dry as to generate significant dust, nor overly saturated. If soil is dry, water from within the landfarm containment area will be used as a moisture source and sprayed on the piles. If no accumulated water is available, a freshwater supply will be used. If the windrows are saturated, aeration will be conducted at a later date.

4.5.4 Nutrient Amendment – Pilot Project

A number of studies have indicated that amendment with nutrients may increase rates of biodegradation in PHC contaminated soils, but the effectiveness of this practice is not well defined in northern climates. For example, in a Resolution Island study by Paudyn et al. (2008), aeration alone reduced concentrations of diesel fuel by 80% over three summers, almost entirely due to volatilization (not biodegradation). One-time amendment with nutrients (C:N:P of 100:7.5:0.5) in combination with aeration resulted in 90% reduction of TPH concentrations over this time, with significant (but undefined) contributions from microbial degradation.

In order to determine effectiveness of nutrient additions, a pilot project has been undertaken at Meadowbank to examine rates of biodegradation with and without nutrient amendment. Two pilot piles in the landfarm facility were treated in 2012 with 400 gallons of sewage sludge as a nutrient source. Sewage sludge was mixed into the pilot piles on October 8th 2012. Each pile consisted of approximately 140 m^3 of soil. Representative composite samples of the non-treated piles were taken in November 2012 (surface and 1 m depth – see Photo 2; Appendix B), and further samples will be taken in spring 2013 of the treated and non-treated piles to determine if this method of nutrient amendment significantly affects rates of PHC degradation. If degradation occurs more rapidly with additions of sewage sludge and it is estimated that sufficient degradation will be achieved through this method before mine closure, the pilot project will be extended to include all soil placed in the facility.

The use of sewage sludge as a nutrient amendment has precedent in the north. This method has been used at Diavik Diamond Mine, as reported in the BSc thesis of Brenda Lee Bailey, Carleton University (in Golder, 2007). It was found in this study that with sewage sludge amendment (12.6 gallons on a 6 m^3 soil pile), aeration by perforated pipe and clear polyethylene covers to retain heat and moisture, TPH concentrations declined from 15,000 mg/kg to less than 2,000 mg/kg in 88 days. Sewage sludge as a nutrient source has also been proposed for the Milne Inlet Mary River Project (EBA, 2010). This material not only provides the benefit of nutrients, but adds organic matter to help retain moisture, and is a source of microorganisms. Furthermore, the re-use of this material produced onsite helps to reduce the waste footprint of the mine by re-directing this material from disposal facilities and avoiding the import of chemical fertilizer.

4.6 REMOVAL OF SOIL FROM THE LANDFARM

When PHC odours are no longer detected, coarse-grained material will be removed to the site waste rock disposal area and disposed of as potentially acid generating (PAG) material. PAG will be covered with a minimum of 2 m of non-potentially acid generating (NPAG) material at closure, such that freeze-back occurs and any potentially remaining contaminants are not mobile in the environment.

Prior to removal of the finer grained soil from the landfarm, soil samples will be analyzed to ensure they meet Government of Nunavut guidelines, as described below.

4.6.1 Remediation Guidelines

In assessing the remediation success of PHC contaminated soils being treated in the landfarm facility, AEM will use the Government of Nunavut (GN) Department of Environment, Environmental Guidelines for Site Remediation (March, 2009) to determine if the soil has been suitably treated. A copy of the guideline document has been included as Appendix A.

The following parameters will be measured and compared with the GN industrial remediation criteria in order to determine whether PHC contaminated soil has been adequately remediated:

- Benzene, toluene, ethylbenzene and xylene (BTEX)
- Petroleum hydrocarbon fractions 1 - 4

GN remediation criteria are characterized for agricultural/wildland, residential/parkland, commercial and industrial land uses. At the Meadowbank site, remediation to agricultural/wildland criteria is targeted. However, if these criteria cannot be met efficiently, industrial criteria will be followed and soil disposed of accordingly (see Section 4.6.3). Remediation criteria for coarse-grained (>75 um) soils will be applied. Table 2 presents the applicable Tier 1 criteria for coarse-grained soil, assuming agricultural/wildland or industrial land uses. For contaminated sites, a Tier 1 analysis involves the most conservative criteria, and may be applied when the proponent does not wish to establish site-specific criteria.

Table 2 - Summary of relevant Government of Nunavut Tier 1 soil remediation criteria for surface soil for industrial land uses.

Parameter	Criteria (mg/kg)	
	Agricultural/ Wildland	*Industrial*
Benzene	0.03	0.03
Toluene	0.37	0.37
Ethylbenzene	0.082	0.082
Xylene	11	11
PHC Fraction 1	30	320
PHC Fraction 2	150	260
PHC Fraction 3	300	1700
PHC Fraction 4	2800	3300

4.6.2 Sampling and Analysis

Landfarm windrows will be sampled annually at the end of the summer season to determine if remediation objectives have been met. Representative composite samples will be taken of each windrow to estimate remaining PHC concentrations. For each 10 m of windrow length, one composite sample will be collected, each consisting of three surface sub-samples and three sub-samples at 1 m depth. Sub-samples will be taken approximately 3.3 m apart, and will be taken from both sides of the windrow.

After two seasons of treatment in the landfarm (Fall 2013), degradation rates will be assessed to estimate the total remediation time required for PHC-contaminated soil under these conditions. If remediation to GN guidelines is feasible within the life-of-mine timeframe, landfarm operations will continue, with aeration and possible nutrient amendments as described above. If rates of TPH degradation are not sufficient through this method, alternate options will be further investigated (see Section 5).

4.6.3 Soil Removal

Coarse-grained material will be assessed near the end of the summer season by Environment Department technicians for PHC product and odour. A PID monitor may be employed to assist in petroleum-based vapour detection . When PHC odours are no longer detected, this material will be removed to the PRSF and disposed of as PAG material.

When sample analysis of fine-grained material at the end of a season indicates that concentrations of contaminants are below Government of Nunavut guidelines, a soil pile or

the appropriate section of a pile will be deemed acceptable for removal from the facility. Interim monitoring may be conducted through measurements of head-space with a portable instrument (e.g. flame ionization detector), but samples will be confirmed by an accredited laboratory prior to soil removal.

Soil remediated to agricultural/wildland criteria will be appropriately delineated by Environment Department staff, and stockpiled outside the landfarm for use in site works or reclamation activities.

Soil remediated to industrial-use criteria will be removed from the landfarm and placed in the Portage Rock Storage Facility (PRSF) as PAG material. This material will be capped with a minimum of 2 m of NPAG at closure, allowing freeze-back and permanent encapsulation to occur.

4.7 WATER MANAGEMENT

Since the landfarm facility is uncovered to facilitate natural weathering, water accumulating inside the bermed area may come into contact with contaminated material. The management plan for handling this potentially contaminated water is described below.

4.7.1 Snow Management

Snow will be removed as much as possible during winter to minimize the quantity of spring melt water inside the berm. Care will be taken to ensure contaminated snow/soil is not disturbed by leaving a base layer of snow (no less than 10 cm) in place. After snowmelt any contaminated product left from winter spill clean-up operations will be padded up. The base soil in these areas will be excavated and added to existing remediation windrows as soon as possible after snow melt to minimize migration into the facility substrate.

4.7.2 Water Management

Monitoring will be conducted for seepage of contact water through the perimeter berm, or accumulation of water within the containment berm through visual inspection by the Environment Department. This will be conducted on a weekly basis, after freshet, from July through October when water is likely to be present. In the event of water accumulation or seepage, the ponded water will be analyzed for BTEX, lead, oil and grease, as described in Part F, Item 6 of the Water License prior to discharge to the adjacent Tailings Storage Facility. Alternatively, ponded water will be sprayed on the windrows to increase moisture content, as required. Water accumulating in the landfarm will not be discharged to the environment.

4.8 LANDFARM ABANDONMENT

After removal of all remediated soil and prior to abandonment/closure of the landfarm, the berm and base will be sampled on a 10 m grid, including at a depth of 1 m in representative locations, to determine if these soils are free from PHC contamination. Results of this analysis will be compared to GN criteria. Since this area will form part of the TSF at closure, no excavation is necessary if industrial criteria are not met. AEM's Closure Plan notes that the tailings facilities will be capped with at least 2 m of NPAG to ensure freeze-back encapsulation. Monitoring of tailings freeze-back is ongoing at the site, and to date the results indicate that tailings are already freezing as planned.

4.9 SUMMARY OF ACTIVITIES

A summary of landfarm activities including monitoring of the physical condition and potential environmental impacts of the landfarm facility is provided in Table 3. A report will be prepared annually, indicating the volume of material added to the facility, amount of material removed and disposal or reuse location, all analysis results, volume and type of nutrient addition, visual inspection results and volume of contact water pumped. This information will be appended to AEM's NWB Annual Report.

Table 3 - Summary of landfarm activities, analyses and records to be kept.

Activity	Analysis	Frequency of Analysis	Record
Excavation of spill and transport of contaminated material	If unsure of full excavation - F1-F4, BTEX	As needed	Date and time of excavation; estimated quantity of excavated soil; storage/disposal location of excavated soil, if applicable; any evidence of remaining product
Contaminated soil additions to landfarm	If contaminant source unknown, F1-F4, BTEX, metals, oil and grease, VOCs (at discretion of Environment Department)	Prior to soil addition at facility	Date and time; quantity of soil; original location; landfarm location; spill/excavation record # or storage container label
Soil aeration	N/A	Two to four times during summer	Date and time; location; soil condition (moisture, odour, etc.)
Soil treatment with sewage sludge as nutrient supplement	Visual inspection to ensure proper incorporation	At least once during summer on selected windrows	Date and time; type of treatment (aeration or nutrient amendment); location in landfarm; any odour noticed during aeration
Sampling for progress of remediation	Hydrocarbon vapour in headspace (by PID); F1-F4, BTEX (laboratory)	Vapour – as needed; Laboratory - annually	Date and time; location; odour; laboratory report;
Soil removal from landfarm	Removal subject to meeting GN criteria	N/A	Date and time; location; quantity of soil removed; final location
Ponded contact water	BTEX, oil and grease, lead – as per Part F, Item 6 of Water License	Prior to any dewatering; if re-used in landfarm, no sampling necessary	Date and time, location, laboratory report, Annual Report
Seepage	Visual inspection; BTEX, oil and grease, lead – as per Part F, Item 6 of Water License	Weekly during summer	Location, extent, approximate depth, evidence of sheen
Identification of maintenance requirements	Visual inspection of facility	Twice annually during summer	Inspected areas; condition of berm and base; previously unidentified safety concerns

5 CONTINGENCY OPTIONS

The following sections describe the contaminated soil management plan, should a large spill event occur, and if landfarm treatment is not successful.

5.1 LARGE SPILL EVENT

Considering that the landfarm is built to hold nearly 3x as much contaminated soil as is expected to be produced, a large spill event producing a quantity of soil that cannot be contained in the landfarm is unlikely. Nevertheless, in this event, soils will be placed in a temporary storage area. A temporary stockpile area would be set up in the PRSF or at another location as approved by the NWB and AANDC. The soil would then be placed in the landfarm as soon as practical. Through extensive spill prevention measures discussed earlier in this Plan AEM is minimizing the probability of this scenario occurring.

5.2 ALTERNATE TREATMENT OPTIONS

Should landfarm treatment not perform as anticipated and it is evident that rates of degradation are not sufficient to meet GN Tier 1 criteria within the life-of-mine and the anticipated closure period (to 2025) the following alternative treatment options will be considered. Implementation will be after development of a more detailed protocol and approval of a revised plan by the NWB.

5.2.1 Soil Amendment

Since pH, salinity, moisture content and microbial population density all affect rates of biodegradation by microbes, these factors may be monitored and adjusted through soil amendments if they are not found to be optimal (see SAIC, 2006). In addition, the height of soil windrows could be reduced to maximize air exposure if space in the facility allows.

5.2.2 Tier 2 – Modified-Criteria Approach

According to the Government of Nunavut Environmental Guideline for Contaminated Site Remediation (Appendix A), in cases where site conditions, land uses, receptors or exposure pathways are different from those assumed in the development of the Tier 1 criteria, modified criteria may be permitted. This process requires the collection of site-specific information on exposure and risk estimates, and is subject to GN approval. In the case of the Meadowbank site, landfarmed soils are to be encapsulated in the PRSF rather than used in surface applications, as assumed in Tier 1, reducing the likelihood of exposure to any remaining contamination. Therefore, the Tier 2 approach could be warranted if Tier 1 criteria cannot be met. Any consideration for this approach would be based on soil sampling results and science based information.

5.2.3 Thermal Desorption

In the thermal desorption process, excavated soils are heated in a chamber to rapidly volatilize PHCs. Gases produced are consumed in an oxidation unit, and particulate matter removed (baghouse). Soil, free of any contamination, can then be replaced, or used in site reclamation or construction processes. The other advantage of this approach is that this equipment is mobile and could be brought to any spill site for remediation activities (e.g. spills along the AWAR). This method is described by Environment Canada (2002). The purchase or rental of a portable thermal desorber unit is under consideration by AEM as a contingency option.

5.2.4 Direct Placement in TSF or PRSF

Another option for management of contaminated soil would be the direct placement of this material in the Tailings Storage Facility or Waste Rock Storage Facility, if bioremediation is not effective. Although the consumption of space in these storage areas is not optimal, the quantity of PHC-contaminated soil created onsite is small in comparison to the quantity of tailings or waste rock. While this method would not result in the treatment of soil, it is a viable contingency option because it would allow for the safe disposal of the contaminated material. The final cover with NPAG will be a minimum of 2 m deep (current closure plan is 4 m of NPAG cover). Total encapsulation and freeze-back would occur, eliminating any movement of contaminants. Over time, this material would undergo natural degradation. Consideration of this option would also include a suitable monitoring program for PHCs, which would be incorporated into the Meadowbank Closure Plan.

6 PLAN REVIEW AND CONTINUAL IMPROVEMENT

The Landfarm Design and Management Plan will be reviewed annually by the Meadowbank Environmental Superintendent in consultation with the Mine General Manager, and updated, if necessary, at least every two years of operation.

A final proposal will be submitted in regards to the feasibility of the pilot project within the next four years. Before submitting the final proposal, time is needed to estimate rates of remediation, and analyze the effectiveness of treatment with and without sewage sludge amendments.

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LIST OF ACRONYMS

AEM Agnico-Eagle Mines Ltd.

CCME Canadian Council of Ministers of the Environment

GN Government of Nunavut

NPAG Non-potentially Acid Generating

PAG Potentially Acid Generating

PPE Personal Protective Equipment

PRSF Portage Rock Storage Facility

SPL Second Portage Lake

TPL Third Portage Lake

TSF Tailings Storage Facility

FIGURES

Figure 3.1 – Location of the landfarm on the Meadowbank site

Figure 3.2 – Specifications of the landfarm design

FORMAT ANSI B – LANDSCAPE

NORTH

RF2

TSF - NORTH TAILING CELL

WASTE DUMP

RF1

TSF - FUTURE SOUTH TAILING CELL

ENVIRONMENT PAD ELEVATION 138

TITLE	# DWG
REFERENCE DRAWINGS	

REV	DESCRIPTION	DATE	BY
REVISIONS			

AGNICO-EAGLE

DRAWN BY	Y.SIMARD	DATE	2012-12-09
CHECKED BY	E.VOYER		
APPROVED BY	K.BUCK		
PROJECT NO.			
DATE			

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TITLE
AGNICO–EAGLE – MEADOWBANK DIVISION
ENVIRONMENT PAD
AREA VIEW

SCALE	FILE
N.T.S.	.DWG

DRAWING NO.	REVISION	SHEET
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FORMAT ANSI B – LANDSCAPE

STORMWATER DIKE

N

7215225N 637675E 637700E 637725E 7215250N 637750E 637775E 637800E 637825E

A — A'

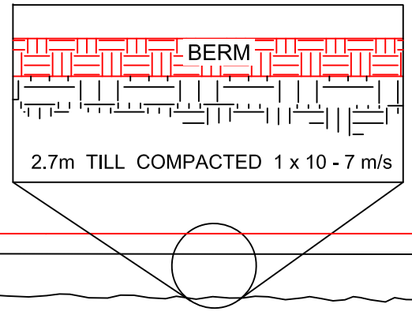
SECTION A-A'
GRADE 1.0% ->

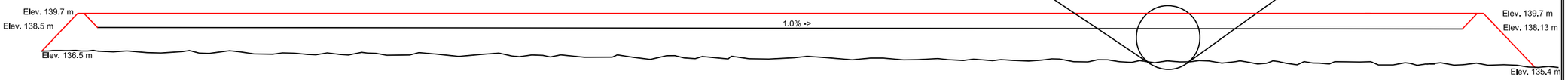
AVG. ELEVATION 138.5 m
VOLUME 3 712 m³

7215200N 7215250N

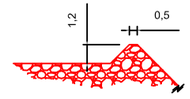
BERM

PLAN VIEW





SECTION A-A'



SECTION B-B'

TITLE	# DWG	REV	DESCRIPTION	DATE	BY

REFERENCE DRAWINGS

REVISIONS

AGNICO-EAGLE

DRAWN BY	P. DAUDELIN	DATE 20/10/2012
CHECKED BY	T.Lépine	20/10/2012
APPROVED BY	J.Bélanger	20/10/2012
PROJECT NO.		
DATE		

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TITLE
AGNICO–EAGLE – MEADOWBANK DIVISION
ENVIRONMENT
LANDFARM

SCALE	FILE	
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Figure 3–2		1 / 1

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Appendix A

Environmental Guideline for Contaminated Site Remediation
Government of Nunavut
March, 2009

Environmental Guideline for

Contaminated Site Remediation

Department of Environment
Government of Nunavut

GUIDELINE: CONTAMINATED SITE REMEDIATION

Originally Approved on April 1999
Revised January 2002
March 2009

This Guideline has been prepared by the Department of Environment's Environmental Protection Division and approved by the Minister of Environment under authority of Section 2.2 of the *Environmental Protection Act.*

This Guideline is not an official statement of the law and is provided for guidance only. Its intent is to increase the awareness and understanding of the risks and hazards associated with contaminated sites and to assist in the management and remediation of these sites. This Guideline does not replace the need for the owner or person in charge, management or control of the contaminated site to comply with all applicable legislation and to consult with Nunavut's Department of Environment, other regulatory authorities and qualified persons with expertise in the management of contaminated sites.

Copies of this Guideline are available upon request from:

Department of Environment
Government of Nunavut
P.O. Box 1000, Station 1360, Iqaluit, NU, X0A 0H0
Electronic version of this Guideline is available at http://www.gov.nu.ca/env/environment

Cover Photos: GNU Department of Environment

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Introduction

In Nunavut and across Canada, contaminated sites can pose a threat to human health, safety and the environment. Petroleum hydrocarbon contamination in soil is a concern for several reasons. To differing degrees, petroleum hydrocarbons are toxic to plants and animals, and are mobile and persistent in the environment. Petroleum hydrocarbons can also pose a fire or explosion hazard and can create aesthetic problems such as offensive odours and tastes. In some cases the concern may also be financial, because of the loss of property value and the cost of remediating the property.

The intent of this Guideline is to help effectively manage contaminated sites. It helps to provide a consistent approach by describing the process used to manage (e.g. identify, assess, plan and remediate) contaminated or potentially contaminated sites on Commissioner's Land, including private land within municipalities, and by providing soil remediation criteria for petroleum hydrocarbons and other contaminants.

The *Environmental Protection Act (EPA)* gives the Government of Nunavut authority to take measures to ensure the preservation, protection and enhancement of the environment, with the goal of long-term sustainability and stewardship. Section 2.2 of the *EPA* provides the Minister of Environment with authority to develop, coordinate, and administer this Guideline (see Appendix 1).

The Department of Environment is the key territorial agency concerning the management of contaminated sites on Commissioner's Land. In Nunavut however, Indian and Northern Affairs Canada (INAC) retains responsibility for the management of inland waters, including surface water and groundwater. If contaminated water is encountered, INAC should immediately be consulted.

1.1 Definitions

CCME	The Canadian Council of Ministers of the Environment (CCME) is the major intergovernmental forum in Canada for discussion and joint action on environmental issues of national, international and global concern. The 14 member governments work as partners in developing nationally consistent environmental standards and practices (see Appendix 8).
Closure Report	The final report prepared by a qualified person and provided to the Environment Department following successful implementation of the Remedial Action Plan. The report generally includes a description of all site activities conducted, quantity of contaminated material treated or removed, treatment and disposal methods used, and analytical data generated.
Commissioner's Land	Lands that have been transferred by Order-in-Council to the Government of Nunavut. This includes roadways and land subject to block land transfers. Most Commissioner's Land is located within municipalities.

Contaminant	Any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment, (a) endangers the health, safety or welfare of persons, (b) interferes or is likely to interfere with normal enjoyment of life or property, (c) endangers the health of animal life, or (d) causes or is likely to cause damage to plant life or to property.
Contaminated Site	Areas of land, surface water, groundwater, or sediments that have levels of contaminants exceeding the remediation criteria. Contaminant sources can include on-site burial of wastes, small or frequent drips and spills, stockpiling and storage of materials, major spills, and releases during fires. Contamination may also be caused by illegal dumping of contaminated soil. Contaminated sites may have short or long term consequences to the health and safety of people and the quality of the environment.
Discharge	Includes any pumping, pouring, throwing, dumping, emitting, burning, spraying, spreading, leaking, spilling, or escaping.
Environment	Means the components of the Earth and includes (a) air, land and water, (b) all layers of the atmosphere, (c) all organic and inorganic matter and living organisms, and (d) the interacting natural systems that include components referred to in paragraphs (a) to (c) above.
Inspector	Means a person appointed under subsection 3(2) of the *EPA* and includes the Chief Environmental Protection Officer.
Phase I Environmental Site Assessment	The process, as outlined in the Canadian Standards Association's (CSA) Standard Z768, by which a qualified person determines whether a property is, or may be, contaminated.
Phase II Environmental Site Assessment	The process, as outlined in the CSA Standard Z769, by which a qualified person characterizes and delineates concentrations and quantities of contaminants on a site and compares those levels to acceptable remediation criteria.
Qualified Person	A person who has an appropriate level of knowledge and experience in all aspects of contaminated site investigation, remediation and management.
Remedial Action Plan	A plan that identifies Site-Specific Remedial Objectives for a site, identifies remedial options and outlines their feasibility, and describes a preferred conceptual remediation plan, a performance monitoring plan, and, if appropriate, requirements for ongoing site management.

Remediation	The process to restore a site's environmental condition and reduce any existing hazards to human health and safety to an acceptable level. Remediation involves the development and application of a planned approach that removes, destroys, contains or otherwise reduces the availability of contaminants to people and the environment.
Remediation Criteria	The numerical limits or narrative statements pertaining to individual substances or chemicals in soil, water or sediment which are recommended to protect and maintain the specified uses of the site. When measurements taken at a contaminated site indicate that the remediation criteria are being exceeded, the need for management and remediation is indicated.
Responsible Party	The owner or person in charge, management or control of the contaminant before it is discharged or owner of the contaminated site.

Additional definitions can be found in Appendix 2.

1.2 Roles and Responsibilities

1.2.1 Environment Protection Division, Department of Environment

The Environmental Protection Division of the Department of Environment is the key environmental agency responsible for ensuring the proper management of contaminated sites on Commissioner's Land. Responsibilities include confirming the required level of remediation using the remediation criteria cited in this document, reviewing the submitted Remedial Action Plan, monitoring the progress of the project and issuing a letter of confirmation when no further remedial action is required.

Authority is derived from the *Environmental Protection Act*, which prohibits the discharge of contaminants to the environment and enables the Minister to undertake actions to ensure appropriate management measures are in place. Although programs and services are applied primarily to activities taking place on Commissioner's and municipal lands and to Government of Nunavut undertakings, the *Environmental Protection Act* may be applied to the whole of the territory where other controlling legislation, standards and guidelines do not exist. A complete listing of relevant legislation and guidelines can be obtained by contacting the Environmental Protection Division or visit the web site at http://www.gov.nu.ca/env/environment.

The Environmental Protection Division will provide advice and guidance on remediation measures. However, it remains the sole responsibility of the polluter, facility operator and landowner to provide adequate site management and remediation and to ensure all applicable statutes, regulations, standards and guidelines are fully complied with.

1.2.2 Responsible Party

If the polluter, facility operator or landowner is notified or otherwise has reason to believe that a site is contaminated, or is potentially contaminated, that person must immediately report the incident and ensure an appropriate evaluation of the potential environmental effects and risks is completed to

determine what action, if any, is required under the *EPA* and this Guideline. Exercising timeliness in all matters related to the contaminated site is critical.

The responsibilities of a Responsible Party include the following:

- Reporting the incident to the NWT/Nunavut 24-Hour Spill Report Line (867-920-8130);
- Contacting EPD and other relevant regulatory agencies including the Regional Environmental Health Officer, Office of the Fire Marshal, local fire department, local government, landowner, affected adjacent landowners, 'Designated Inuit Organization', or other parties regarding health and safety concerns;
- Notifying members of the public who may be adversely affected by the contamination;
- Retaining a qualified person (see Section 1.1) to assess the site to determine the presence and extent of contamination; and
- Developing and implementing a Remedial Action Plan.

1.2.3 Other Regulatory Agencies

As there may be other environmental or public and worker health and safety issues to consider, other regulatory agencies may have to be contacted regarding the management of a contaminated site. Some of the other agencies include:

Department of Community and Government Services

The Department of Community and Government Services is responsible under the *Commissioners' Lands Act* for the issuance of land leases, reserves, licenses and permits on Commissioner's Lands. The Department is also responsible for, in cooperation with communities, the planning, funding, operation and maintenance of municipal solid waste and sewage disposal facilities in most Nunavut communities. Emergency planning responsibilities under the *Emergency Measures Act* include developing territorial emergency response plans, coordinating emergency operations at the territorial and regional levels and supporting community emergency response operations.

The Office of the Fire Marshal is responsible for ensuring the safe storage, handling and use of flammable and combustible liquids and the withdrawal of fuel storage tanks from service. The Office of the Fire Marshal derives its authority from the *Fire Prevention Act*, National Fire Code and National Building Code.

Department of Health and Social Services

Contaminated sites may impact adjacent properties, residences or other buildings thereby potentially affecting the health and safety of the public. The Office of the Chief Medical Officer of Health and Regional Environmental Health Officers should be consulted regarding legislated requirements under the *Public Health Act.*

Department of Economic Development and Transportation

The Motor Vehicles Division is responsible for ensuring the safe transport of contaminated soil and other hazardous waste through administration of the *Transportation of Dangerous Goods Act*. The Department is also responsible under the *Motor Vehicles Act* for driver licensing and various other vehicle and load safety matters.

Workers' Safety and Compensation Commission

The Workers' Safety and Compensation Commission is responsible for promoting and regulating worker and work place health and safety in Nunavut. The Commission derives its authority from the *Workers' Compensation Act* and *Safety Act*, which require an employer to maintain a safe work place and ensure the safety and well being of workers. The Work Site Hazardous Materials Information System, or WHMIS, requires information be provided to workers on the safe use of any hazardous materials used in the work place. All responsible parties should consult the Prevention Services Division for further information and guidance.

Local Municipal Governments

The role of local municipal governments is important in the management and safety of contaminated sites. Remediation standards are determined, in part, by how the property is used and how the property may be designated under local government development plans (e.g. land use zoning). Contaminated soil may be deposited for treatment and disposal at municipal landfill sites only with the consent of the local government. The local fire department may also be called upon if a fire or other public safety issue is identified.

Indian and Northern Affairs Canada

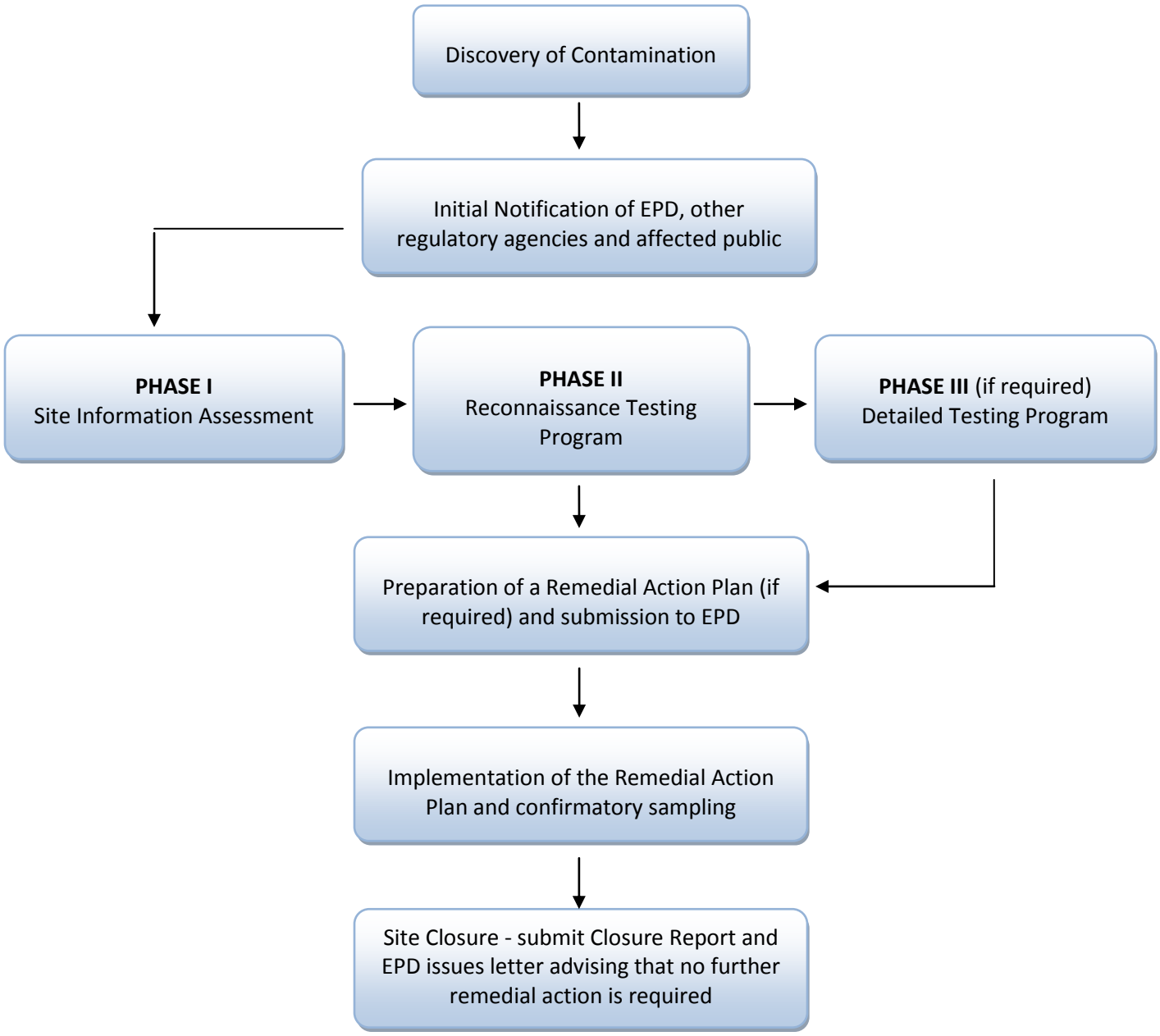
Indian and Northern Affairs Canada is responsible under the *Territorial Lands Act* and *Nunavut Waters and Nunavut Surface Rights Tribunal Act* for the management of federal lands and inland waters. Indian and Northern Affairs should be consulted if contaminated surface water or groundwater is encountered.

Co-management Boards and Agencies

Co-management boards and agencies established under the Nunavut Land Claim Agreement have broad authority for land use planning, impact assessment and the administration of land and water in settlement areas located outside of municipalities. The remediation of contaminated sites may be controlled through the setting of terms and conditions in plans, licenses and permits issued by these boards and agencies.

Contaminated Site Management Process

The management and remediation of a contaminated site consists of a phased approach starting with discovery of the contamination. A well-considered and comprehensive work plan will enable the Responsible Party to make informed decisions, which will result in the safe, effective and cost-efficient remediation of the site. The following flow chart describes the general steps in the overall management process.



2.1 Initial Notification

When a person discovers the presence of contamination, or has reason of believe a site is contaminated, they should immediately notify the Department of Environment and the owner of the facility or property. This discovery may occur as a result of a spill or other accident, an investigation completed for the sale or refinancing of a property, or other actions that identify contamination impacts to the environment.

Section 5.1 of the *EPA* states that where a discharge of a contaminant occurs, or is likely to occur, the owner or person in charge, management or control of the contaminant must immediately:

- report the discharge to the NWT/Nunavut 24-Hour Spill Report Line at (867) 920-8130;
- take all reasonable measures to safely stop the discharge and repair damages; and
- make reasonable efforts to notify any affected public.

Once this notification has occurred, EPD will assess the significance of the reported contamination by having an Inspector conduct a site visit or by reviewing other relevant information (e.g. site assessment report). If it is determined that contamination is present, or may be in the future, and that it poses a risk to human health, safety or the environment, the responsible party must undertake actions to repair the damages in a timely manner. These actions may include identifying the nature and extent of contamination, preparing a Remedial Action Plan and implementing the plan.

If it is determined that the problem cannot be resolved with limited remedial action, the responsible party may be instructed to obtain the services of a qualified person (e.g. environmental engineer or consultant). Obtaining the services of a qualified person is mandatory if there is evidence of groundwater contamination, if explosive vapours are present, or if a neighbouring property is affected. In all cases, the responsible party or its representative must consult the appropriate regulatory agencies (see section 1.2) and notify any affected members of the public. EPD may require the responsible party to provide proof of such consultation and notification.

Issues not related to public health, safety or the environment that arise between the responsible party and affected parties are civil matters, which are to be settled by the parties outside of this management process.

2.2 Site Assessment

Assessing, or characterizing, a contaminated site is a critical phase in the site management process. A well-planned and comprehensive assessment will enable the responsible party to make informed decisions about potential remediation actions.

There are normally up to three phases to an Environmental Site Assessment (ESA). These phases depend on the size and complexity of the contaminated site, and range from the general to the specific. While there are advantages with a phased approach, there may also be economies realized by combining information gathering and testing into a single investigation, particularly at remote locations where mobilization costs are significant.

2.2.1 Phase I: Site Information Assessment

The overall objective of the Phase I ESA is to identify whether actual or potential contamination exists at a site. At a minimum, the Phase I ESA must meet or exceed the Canadian Standards Association (CSA) Standard Z768-01, *Phase I Environmental Site Assessment*.

All available and relevant current and historical information pertaining to the site should be assembled when completing a Phase I ESA. This information will be used to estimate the likelihood, types and locations of contamination that may be present and help to develop a field-testing program, should one be required. Reports and information prepared for legal, transactional or environmental reasons (e.g. spill reporting, ESAs if already conducted) should be reviewed. Phase I ESAs do not involve the carrying out of a sampling plan.

The review frequently includes three broad aspects:

Facility Characteristics - A current and historical description of the site and its facilities is developed, particularly as it relates to the areas of concern (e.g. contaminant sources and potential discharge points). Reviewing facility records and discussions with past and present employees should also be used to gather relevant information. Additional information can be obtained by reviewing above and below ground structures (using blueprints, if available) as possible sources of contamination, as well as considering prior site and surrounding land uses.

Phase 1 - The initial actions undertaken to determine whether a property is, or is not, contaminated. A Phase I site information assessment involves reviewing all available reports, studies and other relevant documents on a site, but does not involve sampling, analysis and measurement of soil and water.

Phase II - Builds upon results of the Phase 1 assessment by sampling soil and water, and sometimes air, on a site to characterize and delineate the concentration of contaminants, and compare those levels to approved remediation criteria. A Remedial Action Plan may be developed following the Phase II reconnaissance testing program if all necessary information about the site has been obtained.

Phase III - The most detailed level of assessment that is intended to address any outstanding issues and information gaps following a Phase II assessment.

Contaminant Characteristics - Hydrocarbons, chemicals and other contaminants that may be stored at the site are identified. Their quantities and concentrations are estimated by visual inspections, reviewing documentation and interviewing past and present employees.

Physical Site Characteristics - The geology, hydrology and hydrogeology of the site and surrounding area are examined using available data. The objective is to develop a comprehensive understanding of local site characteristics and a current and historical description of the area.

Other sources of information can include aerial photographs, geology and groundwater reports; topographical, geological and other maps; the Government of the Northwest Territories' Hazardous Materials Spill Database (this database includes spills that have occurred in Nunavut) and previous site assessment reports.

The review should include a visual inspection of the site and discussions with local residents who may have knowledge of the site and its history. The site inspection will identify signs of contaminant discharge (e.g. leaks and drips, discoloured soil or discoloured building foundation walls), vegetation stress and examine local sensitive habitats (e.g. beaches, ponds, streams) for the presence of hydrocarbons. The proximity of the site to surrounding buildings, surface water bodies and sensitive habitats (e.g. wetlands) should also be identified.

2.2.2 Phase II: Reconnaissance Testing Program

The overall objective of the Phase II ESA is to confirm the presence and characterize the contaminants of concern at the site. At a minimum, the Phase II ESA must meet or exceed the CSA Standard Z769-00, *Phase II Environmental Site Assessment*.

Characterization of the contamination and site conditions require the carrying out of a sampling plan. The plan usually involves one or more field screening methods to identify suitable locations for more intrusive sampling and analysis. Overall, the sampling plan should enable the qualified person to confirm the presence of any contamination, provide an understanding of the nature of the contamination (e.g. location, quantity and direction of movement) and provide an understanding of the relevant site conditions (e.g. soil type, groundwater flow, exposure pathways). This information is necessary in order to develop a Remedial Action Plan or to identify the need for a more specific Phase III assessment, including human health and ecological risk assessments. It may also enable the qualified person to determine that no further action is required.

The Phase II testing program should include the adoption of recognized sampling procedures, quality assurance/quality control procedures and laboratory analytical protocols (see Appendices 5 and 6).

Environmental quality remediation criteria will need to be selected in consultation with EPD during the Phase II ESA. The data collected during the testing program will be compared to the applicable criteria to determine if, and where, exceedances exist on the property. See the CCME *Guidance Document on the Management of Contaminated Sites in Canada, April 1997* for further information.

2.2.3 Phase III: Detailed Testing Program

The results of the Phase II ESA will determine whether a Phase III ESA is required. If sufficient data has been obtained at Phase II to characterize the site and any potential risk to human health, safety and the environment, then the process may move directly to developing a Remedial Action Plan (if it is required).

Alternatively, a detailed Phase III ESA may be necessary if Phase II testing indicates that significant and wide-spread contamination exists. A Phase III ESA will address outstanding issues and information gaps with a view to obtaining enough information to enable development of a Remedial Action Plan. Specifically, the Phase III ESA will:

- target and delineate the boundaries of identified contamination;
- define site conditions and possible contaminant pathways in greater detail, particularly with respect to possible risk assessment;

- provide contaminant and other information necessary to finalize environmental quality remediation criteria or risk assessment; and
- provide all other information that is required in order to develop a Remedial Action Plan and enable contract specifications and tender documents to be prepared.

The Phase III detailed testing program will focus on areas identified in the Phase II program and involves a similar systematic process of sampling, analysis and evaluation. However, a greater number of samples are usually collected and a smaller suite of chemical substances may be analyzed as the program converges on the outstanding environmental issues. Field screening techniques are not usually employed in this testing.

Once the environmental condition of the site has been thoroughly assessed, the qualified person will be able to develop a site-specific Remedial Action Plan.

2.3 Land Use

Remediation criteria (see section 2.4) are presented in the context of four types of land use: agricultural/wildland, residential/parkland, commercial and industrial. The criteria are considered generally protective of human and environmental health for the 'normal' activities associated with each land use. It is important to note that it is the *current and intended future* land use that governs the decision on the level of remediation to be performed at a site. Identifying the appropriate land use will help to assess the extent of human and ecological exposure to contaminants in the soil, and is essential for preparing a Remedial Action Plan. The type of land use found adjacent to the contaminated site may also affect the remediation criteria to be achieved.

Agricultural/Wildland	Land on which the primary activity is related to the productive capability of the land. This includes lands that provides habitat for transitory wildlife and birds as well as greenhouses.
Residential/Parkland	Land on which dwelling, on a permanent, temporary or seasonal basis, is the primary activity. Institutions (e.g. hospitals, schools, daycares) and playgrounds are included under this land use. This land use also includes activity that is recreational in nature and that requires the natural or human designed capability of the land to sustain that activity. Residential/Parkland lands are normally readily accessible to the public.
Commercial	Land on which the primary activity is the commercial buying, selling, or trading of goods or services. Members of the public, including children, normally have free access to these lands.
Industrial	Land on which the primary activity is the production, manufacture, construction or storage of goods. Public access is restricted and children are not permitted continuous access or occupancy.

2.4 Application of Remediation Criteria at Contaminated Sites

There are three basic approaches that may be utilized for the development of site-specific remediation criteria and objectives:

Tier 1 Direct adoption of remediation criteria (Criteria-Based Approach).

Tier 2 Adoption of remediation criteria with modifications based on site-specific information (Modified-Criteria Approach).

Tier 3 Use of site-specific risk assessment (Risk-Based Approach).

The criteria-based approach (Tier 1) is designed to require fewer resources while providing a scientifically defensible basis for protection that is sufficiently flexible to account for certain site-specific factors. In most cases this approach provides an effective alternative to the modified-criteria (Tier 2) or detailed risk-based (Tier 3) approaches. The Tier 2 and Tier 3 approaches can be more complex and costly, and are utilized when the criteria-based approach is not suitable for a site (e.g. large, complex or remote industrial sites).

Regardless of the approach that is ultimately chosen, the level of human health, safety and environmental protection provided by each approach does not change, only the manner in which the level of protection is achieved.

The responsible party should consult with EPD before deciding which approach to take.

Tier 1 - Criteria-Based Approach

Under this approach, the remediation criteria selected for a site are adopted as the remediation objectives. In most cases this approach would involve either the reduction of petroleum hydrocarbon (PHC) concentrations in soil to achieve Tier 1 criteria or the removal and replacement of soil containing PHC concentrations in excess of the criteria. Factors that may bear weight on the decision of whether or not to directly adopt Tier 1 criteria include cost, time, simplicity and other practical and technical considerations (e.g. cost of obtaining additional data to support Tier 2 or Tier 3 approaches, risks associated with residual contamination, cost and commitment to long-term management and monitoring).

The Tier 1 criteria-based approach is applicable only where site conditions, receptors, and exposure pathways are similar with those assumed in the development of the criteria.

A summary of Tier 1 remediation criteria (mg/kg) for PHC in 'surface' soil is provided in Table 1.

Tier 1 criteria may also be used for the remediation of 'subsoil' even though PHC contaminated subsoil usually has a lower level of risk associated with direct human contact, vapour inhalation and ecological soil contact. The responsible party should balance the benefits associated with using Tier 1 criteria for the remediation of subsoil with the additional commitments associated with undertaking a Tier 2 modified-criteria approach. EPD must be consulted in all cases where PHC concentrations in 'subsoil' exceed Tier 1 criteria.

Table 1.

Land Use	Soil Texture	Fraction 1 (C6-C10)	Fraction 2 (>C10-C16)	Fraction 3 (>C16-C34)	Fraction 4 (>C34)
Agricultural/Wildland	Fine-grained soil	210 (170[a])	150	1300	5600
	Course-grained soil	30[b]	150	300	2800
Residential/Parkland	Fine-grained soil	210 (170[a])	150	1300	5600
	Course-grained soil	30[b]	150	300	2800
Commercial	Fine-grained soil	320 (170[a])	260 (230[a])	2500	6600
	Course-grained soil	320 (240[a])	260	1700	3300
Industrial	Fine-grained soil	320 (170[a])	260 (230[a])	2500	6600
	Course-grained soil	320 (240[a])	260	1700	3300

a = Where applicable, for protection against contaminated groundwater discharge to an adjacent surface water body or for protection of potable groundwater.
b = Assumes contamination near residence.

Additional Tier 1 criteria for PHC in soils can be found in Appendix 3. Remediation criteria for other contaminants in soil (e.g. BTEX, metals, PAHs) can be found in Appendix 4.

If the remediation of soil to Tier 1 criteria for the associated land use is not practical from a cost, logistical or technological perspective, then the responsible party will have to move to Tier 2 or Tier 3 site management.

Tier 2 - Modified-Criteria Approach

In certain circumstances, remediation criteria may be modified, within specified limits, and adopted for use as the site-specific remediation criteria when site conditions exist that modify human and ecological exposure to PHC contamination relative to the generic conditions used to derive Tier 1 criteria. In general, this modified-criteria approach is utilized in situations where site conditions, land use, receptors or exposure pathways differ only slightly from those assumed in the development of Tier 1 criteria. However, as pointed out above, the decision to undertake Tier 2 adjustments implies a commitment to increase the accuracy of information on site-specific factors, including exposure and risk estimates.

The acceptability of a Tier 2 approach for evaluation of site-specific impacts is subject to review by EPD. If the impacts also extend off-site, then the responsible party must seek the acceptance of other affected parties before proceeding with a Tier 2 approach.

Specific guidance on situations where modifications are allowed to the Tier 1 criteria, as well as details concerning implementation of the modified-criteria approach are provided in the *Canada-Wide Standard for Petroleum Hydrocarbons in Soil User Guide (CCME 2008).*

Tier 3 - Risk-Based Approach

In certain circumstances, neither the criteria-based or modified-criteria approach may be suitable for a site because pathways of exposure, target chemicals, receptors or other site characteristics differ significantly from those used to develop these more generic approaches. If this is the case, risk assessment procedures may be required to develop site-specific remediation objectives that correspond to an acceptable level of risk to human or ecological receptors. The Tier 3 approach involves completion of a site-specific risk assessment and development of a risk management plan, including long-term monitoring.

A contaminated site is a candidate for the risk-based approach when there are:

- significant ecological concerns (e.g. critical or sensitive habitats for wildlife; rare, threatened or endangered species; parkland or ecological reserves; special hunting or trapping resources);
- unacceptable data gaps (e.g. exposure conditions are particularly unpredictable or uncertain; lack of information about receptors; high degree of uncertainty about hazard levels); or
- special site characteristics (e.g. site is large or remote; the contamination is complex; estimated cost of remediation is prohibitive; site conditions, receptors and/or exposure pathways differ significantly from those assumed in the derivation of Tier 1 and Tier 2 criteria).

Further guidance on human health and ecological risk assessment is beyond the scope of this document. If the reader wishes to proceed with a risk-based approach to site remediation, they are encouraged to contact EPD and professionals competent in the field of human health and ecological risk assessment.

2.5 Preparation of a Remedial Action Plan

At this point the responsible party will review the results of the site assessment and determine whether to remediate the site to the generic Tier 1 criteria or develop site-specific remediation criteria using either a modified-criteria or risk-based approach. The selection should take into consideration factors such as effectiveness in achieving the remediation goals, practicality, safety and cost.

Once remediation criteria have been determined, the responsible party must prepare a Remedial Action Plan for the site which reflects the preferred remediation method. Where practical, the plan should favour permanent remediation solutions, and not solutions that require long-term management and monitoring. The Remedial Action Plan should:

- include names and contact information of all key personnel, consultants and contractors;
- summarize all data collected on contaminants identified during the site investigation(s);
- identify contaminants of concern and the media (e.g. soil, water) affected;
- identify the remediation criteria and the method(s) by which they have been derived;
- identify, quantify and characterize the materials to be treated, removed and disposed;
- summarize remedial options evaluated and the method used to select the preferred remedial strategy;
- describe the selected remediation method and its technical feasibility;
- detail an implementation plan, including a schedule for implementing the plan;

- discuss control measures to minimize fugitive air emissions, surface water control, and worker health and safety;
- identify the fate of any residual contaminants that may remain on-site following remediation; and
- identify remedial verification and long-term monitoring plans (if required).

The Remedial Action Plan should be submitted to EPD, and other regulatory agencies as appropriate, for review prior to the plan being implemented in order to confirm all regulatory requirements are being met.

2.6 Implementation of a Remedial Action Plan

Once all necessary approvals have been obtained, the responsible party shall implement the Remedial Action Plan in a timely manner and submit monitoring reports to EPD on the pre-determined schedule. The responsible party must advise EPD if any activities deviate from the approved Remedial Action Plan. In these cases, EPD will assess the significance of any deviations and advise accordingly.

The completion of remediation activities should be validated by comparing the results of confirmatory samples to the selected remediation criteria. Where the remediation criteria fail to be achieved, the responsible party would be required to re-evaluate the Plan and implement alternative remediation activities.

2.7 Site Closure

When the responsible party and is satisfied that all the requirements of the Remedial Action Plan have been met, a closure report should be prepared and forwarded to EPD. The closure report includes a description of all site activities conducted and remediation methods used, the quantity of contaminated material treated or disposed, and all analytical data generated.

Provided the remediated site complies with all appropriate criteria, management to Tier 1 or Tier 2 would normally enable unrestricted future use of the land within the particular land use designation. This is referred to as ‘unconditional closure’. Where a Tier 3 risk-based approach is used, land use controls and restrictions and long-term monitoring would likely be required to ensure human health, safety and environmental risks do not increase. This is referred to as ‘conditional closure’.

In the case of unconditional closure, EPD will conclude the management process upon receipt and acceptance of the closure report by issuing a letter advising the responsible party that no further remedial action is required. In the case of conditional closure, the letter would state that the management process remains on-going and confirm what land-use controls and restrictions and long-term monitoring is required.

Conclusion

This is a brief introduction to the contaminated site remediation process and is intended to inform the reader about the basic issues involved in contaminated site management. Once a contaminated site has been discovered or verified, the Environmental Protection Division of the Department of Environment must be contacted before proceeding though the contaminated site management process.

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Department of Environment
Inuksugait Plaza, Box 1000, Station 1360
Iqaluit, Nunavut, X0A 0H0

Phone: (867) 975-7729;
Fax: (867) 975-7739
Email: EnvironmentalProtection@GOV.NU.CA
Website: http://www.gov.nu.ca/env/environment

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APPENDICES

APPENDIX 1 - *ENVIRONMENTAL PROTECTION ACT*

The following are excerpts from the *Environmental Protection Act*

1. "Contaminant" means any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment,
   (a) endangers the health, safety or welfare of persons,
   (b) interferes or is likely to interfere with normal enjoyment of life or property,
   (c) endangers the health of animal life, or
   (d) causes or is likely to cause damage to plant life or to property;

   "Discharge" includes, but not so as to limit the meaning, any pumping, pouring, throwing, dumping, emitting, burning, spraying, spreading, leaking, spilling, or escaping;

   "Environment" means the components of the Earth and includes
   (a) air, land and water,
   (b) all layers of the atmosphere,
   (c) all organic and inorganic matter and living organisms, and
   (d) the interacting natural systems that include components referred to in paragraphs (a) to (c).

   "Inspector" means a person appointed under subsection 3(2) and includes the Chief Environmental Protection Officer.

2.2 The Minister may
   (a) establish, operate and maintain stations to monitor the quality of the environment in the Territories;
   (b) conduct research studies, conferences and training programs relating to contaminants and to the preservation, protection or enhancement of the environment;
   (c) develop, co-ordinate and administer policies, standards, guidelines and codes of practice relating to the preservation, protection or enhancement of the environment;
   (d) collect, publish and distribute information relating to contaminants and to the preservation, protection or enhancement of the environment:

3. (1) The Minister shall appoint a Chief Environmental Protection Officer who shall administer and enforce this Act and the regulations.

   (2) The Chief Environmental Protection Officer may appoint inspectors and shall specify in the appointment the powers that may be exercised and the duties that may be performed by the inspector under this Act and regulations.

5. (1) Subject to subsection (3), no person shall discharge or permit the discharge of a contaminant into the environment.

   (3) Subsection (1) does not apply where the person who discharged the contaminant or permitted the discharge of the contaminant establishes that
   (a) the discharge is authorized by this Act or the regulations or by an order issued under this Act or the regulations;
   (b) the contaminant has been used solely for domestic purposes and was discharged from within a dwelling house;
   (c) the contaminant was discharged from the exhaust system of a vehicle;

(d) the discharge of the contaminant resulted from the burning of leaves, foliage, wood, crops or stubble for domestic or agricultural purposes;
(e) the discharge of the contaminant resulted from burning for land clearing or land grading;
(f) the discharge of the contaminant resulted from a fire set by a public official for habitat management of silviculture purposes;
(g) the contaminant was discharged for the purposes of combating a forest fire;
(h) the contaminant is a soil particle or grit discharged in the course of agriculture or horticulture; or
(i) the contaminant is a pesticide classified and labelled as "domestic" under the *Pest Control Products Regulations* (Canada).

(4) The exceptions set out in subsection (3) do not apply where a person discharges a contaminant that the inspector has reasonable grounds to believe is not usually associated with a discharge from the excepted activity.

5.1. Where a discharge of a contaminant into the environment in contravention of this Act or the regulations or the provisions of a permit or license issued under this Act or the regulations occurs or a reasonable likelihood of such a discharge exists, every person causing or contributing to the discharge or increasing the likelihood of such a discharge, and the owner or the person in charge, management or control of the contaminant before its discharge or likely discharge, shall immediately:
(a) subject to any regulations, report the discharge or likely discharge to the person or office designated by the regulations;
(b) take all reasonable measures consistent with public safety to stop the discharge, repair any damage caused by the discharge and prevent or eliminate any danger to life, health, property or the environment that results or may be reasonably expected to result from the discharge or likely discharge; and
(c) make a reasonable effort to notify every member of the public who may be adversely affected by the discharge or likely discharge.

6. **(**1) Where an inspector believes on reasonable grounds that a discharge of a contaminant in contravention of this Act or the regulations or a provision of a permit or license issued under this Act or the regulations has occurred or is occurring, the inspector may issue an order requiring any person causing or contributing to the discharge or the owner or the person in charge, management or control of the contaminant to stop the discharge by the date named in the order.

7. (1) Notwithstanding section 6, where a person discharges or permits the discharge of a contaminant into the environment, an inspector may order that person to repair or remedy any injury or damage to the environment that results from the discharge.

(2) Where a person fails or neglects to repair or remedy any injury or damage to the environment in accordance with an order made under subsection (1) or where immediate remedial measures are required to protect the environment, the Chief Environmental Protection Officer may cause to be carried out the measures that he or she considers necessary to repair or remedy an injury or damage to the environment that results from any discharge.

APPENDIX 2 - GLOSSARY

Accreditation	Formal recognition of the competence of an environmental analytical laboratory to carry out specified tests. Formal recognition is based on an evaluation of laboratory capability and performance. Site inspections are utilized in the evaluation of capability.
Adverse Effect	An undesirable or harmful effect to an organism, indicated by some result such as mortality, altered food consumption, altered body and organ weights, altered enzyme concentrations or visible pathological changes.
Assess or Assessment	Investigations, monitoring, testing and other information-gathering activities to identify: (1) the existence, source, nature and extent of contamination resulting from a release into the environment of a hazardous material or chemical substance; and (2) the extent of danger to the public health, safety, welfare, and the environment. The term also includes studies, services, and investigations to plan, manage, decommission and clean up a contaminated site.
Background	An area not influenced by contaminants released from the site.
Background Samples	Matrices minus the analytes of interest that are carried through all steps of the analytical procedure. They are used to provide a reference for determining whether environmental test sample results are significantly higher than "unpolluted" samples, which contain "zero", low, or acceptable levels of the analytes of interest. All matrices, sample containers, reagents, glassware, preparations, and instrumental analyses are included in the analysis of background samples.
Blank	The measured value obtained when a specified component of a sample is not present.
Borehole	A hole drilled into the earth, and into which casing or screen can be installed to construct a well.
Chemical	Any element, compound, formulation or mixture of a substance that might enter the environment through spillage, application or discharge. Examples of chemicals are insecticides, herbicides, fungicides, and agents for treating oil spills.
Clean up	The removal of a chemical substance or hazardous material from the environment to prevent, minimize or mitigate damage to public health, safety or welfare, or the environment that may result from the presence of the chemical substance or hazardous material. The clean up is carried out to attain specified remediation criteria.

Concentration	The amount of chemical or substance in a given environmental medium. Concentration is typically expressed as milligrams per litre (mg/L) in water, milligrams per kilogram (mg/kg) in soil and food and micrograms per cubic metre (µg/m^3) in air. Concentrations may also be expressed as parts per million (ppm) or parts per billion (ppb). 1 mg/litre = 1 ppm or 1000 ppb 1 mg/kg = 1 ppm or 1000 ppb
Criteria	Numerical standards that are established for concentrations of chemical parameters in various media to determine the acceptability of a site for a specific land use.
Detection Limit	The smallest concentration of a substance that can be reported as present with a specified degree of precision and accuracy by a specific analytical method.
Environmental Analytical Laboratory	A laboratory engaged in the physical, chemical or biological measurements of either the receiving environment or discharges to the receiving environment.
Ground Penetrating Radar	A geophysical method in which bursts of electromagnetic energy are transmitted downward from the land surface, to be reflected and refracted by velocity contrasts within the subsurface.
Groundwater	All subsurface water that occurs beneath the water table in rocks and geologic formations that are fully saturated.
Guidelines	Statements outlining a method, procedure, process or numerical value which, while not mandatory, should be followed unless there is a good reason not to do so, and includes the numerical limits or narrative statements that are recommended to protect and maintain the specified uses of water, sediment, soil or air. Guidelines also assist in clarifying the intent of the *Environmental Protection Act* and regulations.
Hazardous Material	Material that, because of its quality, concentration, chemical composition or corrosive, flammable, reactive, toxic, infectious or radioactive characteristics, constitutes a present or potential threat to human health and safety or the environment, when improperly stored, treated, transported, disposed of, used or otherwise managed.
Headspace	The empty volume in a container between the cap and the solid or liquid level of the sample.
Migration	The movement of chemicals, bacteria and gases in flowing water or vapour in the subsurface.

Monitoring	The routine (e.g. daily, weekly, monthly, quarterly) checking of quality or collection and reporting of information.
Monitoring Well	A well that is used to extract groundwater for physical, chemical or biological testing, or to measure water levels.
Objective	A numerical limit or narrative statement that has been established to protect and maintain a specified use of water, sediment or soil at a particular site by taking into account site-specific conditions. Objectives may be adopted directly from generic criteria or formulated to account for site-specific conditions.
Quality Assurance/Quality Control (QA/QC)	Those procedures and controls designed to monitor the conduct of a study in order to ensure the quality of the data and the integrity of the study.
Receptor	A person or organism subjected to chemical exposure. An ecosystem component that is, or may be, adversely affected by a pollutant or other stress emanating from a contaminated site. Receptors may include biological or abiotic (e.g. air or water quality) components.
Risk	Risk is a measure of both the severity of effects arising from exposure to a substance and the probability of its occurrence.
Risk Assessment	Procedure designed to determine the qualitative aspects of hazard identification and usually a quantitative determination of the level of risk based on deterministic or probabilistic techniques.
Screening	Rapid analysis to determine if further action (e.g. detailed analysis or clean up) is warranted.
Site-Specific Remedial Objectives	The objectives established for a specific site to be met by implementation of a Remedial Action Plan and, if appropriate, ongoing site management.
Subsoil	Soil which is 1.5 metres (approximately 5 feet) or deeper from the surface.
Surface Soil	Soil which is less than 1.5 metres (approximately 5 feet) from the surface.
Surface Water	Natural water bodies, such as rivers, streams, brooks and lakes, as well as artificial water courses, such as irrigation, industrial and navigational canals.
Test Pit	A shallow pit made to characterize the subsurface.

APPENDIX 3 - REMEDIATION CRITERIA FOR PETROLEUM HYDROCARBONS

The term 'Petroleum Hydrocarbons' (PHC) describes a mixture of organic compounds found in and derived from oil, bitumen and coal. Petroleum products typically contain thousands of compounds in varying proportions, composed predominantly of carbon and hydrogen, with minor amounts of nitrogen, sulphur and oxygen. The properties of PHC contamination in soils varies with the soil type, petroleum source and composition, degree of processing (crude, blended or refined) and the extent of weathering caused by exposure to the environment. Such factors complicate the assessment of the human health, safety and environmental risks associated with PHC contamination. This complicated assessment of risk makes it necessary to evaluate PHC as four fractions: F1, F2, F3, and F4. This differs from the previous guideline (2002) where PHC contamination in soil was assessed using one parameter - Total Petroleum Hydrocarbons.

PHCs are subdivided according to specified ranges of equivalent carbon number (ECN). Each fraction is, in turn, made of subfractions. These subfractions are described according to their relevant physical and chemical properties and toxicological characteristics. These divisions between the fractions have been established in consideration of analytical factors, physical and chemical properties, the expected relevance to biological response in soils and the ability to utilize the definitions and associated properties.

Fraction 1 (F1) The range of ECN from C6 to C10. It includes gasoline and represents the volatile fraction of most hydrocarbon mixtures. The F1 fraction consists of aromatic subfractions in the range C8 to C10, as well as aliphatic subfractions in the ranges of C6 to C8 and >C8 to C10. The fraction is generally considered to be high in mobility, volatility and solubility

Fraction 2 (F2) The range of ECN from >C10 to C16. It includes kerosene, jet fuel and light fuel oils (No. 2 fuel oil, Arctic diesel) and represents the semi-volatile fraction of petroleum hydrocarbons. The F2 fraction is comprised of aromatics and aliphatic subfractions in the ranges >C10 to C12 and >C12 to C16.

Fraction 3 (F3) The range of ECN from >C16 to C34 and includes medium fuel oils (No. 4 fuel oil, Bunker B), heavy fuels oils (Bunker C) and lubricating and motor oils. It is comprised of both aromatics and aliphatics in the ranges >C16 to C21 and >C21 to C34.

Fraction 4 (F4) The range of ECN from >C34 to C50+. PHC within this range often make up a significant proportion of crude oils. The fraction is generally considered to be of low mobility, volatility and solubility.

Some specific aromatic compounds found within the F1 fraction are managed separately from PHC. Benzene ("B") has been excluded because of its carcinogenic properties while toluene, ethylbenzene and xylene ("TEX") have been excluded because of the relatively long history of managing these compounds. Collectively these compounds are referred to as "BTEX".

Tier 1 and Tier 2 remediation criteria are prescribed for coarse-grained and fine-grained soils. As a result, sufficient textural information needs to be obtained through environmental site assessments to permit classification of the soils as either coarse or fine. These classifications are defined as follows:

Fine-grained soil — Soil having a medium grain size of <75 µm as defined by the American Society for Testing and Materials, and includes silts and clays.

Course-grained soil — Soil having a median grain size of >75 µm as defined by the American Society for Testing and Materials, and includes sands and gravels.

Tier 1 remediation criteria for PHC in soils are presented in Tables A3-1, A3-2 and A3-3. Remediation criteria for BTEX are identified separately in Appendix 4.

Table A3-1
Summary of Tier 1 Criteria (mg/kg) for PHC for Surface Soil.*

Land Use	Soil Texture	Fraction 1 (C6-C10)	Fraction 2 (>C10-C16)	Fraction 3 (>C16-C34)	Fraction 4 (>C34)
Agricultural/Wildland	Fine-grained soil	210 (170[a])	150	1300	5600
	Course-grained soil	30[b]	150	300	2800
Residential/Parkland	Fine-grained soil	210 (170[a])	150	1300	5600
	Course-grained soil	30[b]	150	300	2800
Commercial	Fine-grained soil	320 (170[a])	260 (230[a])	2500	6600
	Course-grained soil	320 (240[a])	260	1700	3300
Industrial	Fine-grained soil	320 (170[a])	260 (230[a])	2500	6600
	Course-grained soil	320 (240[a])	260	1700	3300

* EPD must be consulted if PHC concentrations in 'subsoil' exceed these criteria.
a = Where applicable, for protection against contaminated groundwater discharge to an adjacent surface water body or for protection of potable groundwater.
b = Assumes contamination near residence.

Table A3-2. Pathway-Specific Tier 1 Levels (mg/kg) for PHC for Fine-Grained Surface Soils.

Land Use	Exposure Pathways*	F1 (C6-C10)	F2 (>C10-C16)	F3 (>C16-C34)	F4 (>C34)
Agricultural/ Wildland	Direct Contact (Ingestion + Dermal Contact)	12 000	6800	15 000	21 000
	Vapour Inhalation (indoor, basement)	710	3600	NA	NA
	Vapour Inhalation (indoor, slab-on-grade)	610	3100	NA	NA
	Protection of Potable GW	170	230	NA	NA
	Protection of GW for Aquatic Life[a]	RES	RES	NA	NA
	Protection of GW for Livestock Watering	4200	10 000	NA	NA
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	210	150	1300	5600
	Eco Soil Ingestion	NC	NC	NC	NC
	Produce, Meat and Milk Ingestion	NC	NC	NC	NC
	Management Limit[b]	800	1000	3500	10 000
Residential/ Parkland	Direct Contact (Ingestion + Dermal Contact)	12 000	6 800	15 000	21 000
	Vapour Inhalation (indoor, basement)	710	3600	NA	NA
	Vapour Inhalation (indoor, slab-on-grade)	610	3100	NA	NA
	Protection of Potable GW	170	230	NA	NA
	Protection of GW for Aquatic Life[a]	RES	RES	NA	NA
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	210	150	1300	5600
	Produce Ingestion	NC	NC	NC	NC
	Management Limit[b]	800	1000	3500	10 000
Commercial	Direct Contact (Ingestion + Dermal Contact)	19 000	10 000	23 000	RES
	Vapour Inhalation (indoor)	4600	23 000	NA	NA
	Protection of Potable GW	170	230	NA	NA
	Protection of GW for Aquatic Life[a]	RES	RES	NA	NA
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	320	260	2500	6600
	Offsite Migration	NA	NA	19 000	RES
	Management Limit[b]	800	1000	5000	10 000
Industrial	Direct Contact (Ingestion + Dermal Contact)	RES	RES	RES	RES
	Vapour Inhalation (indoor)	4600	23 000	NA	NA
	Protection of Potable GW	170	230	NA	NA
	Protection of GW for Aquatic Life[a]	RES	RES	NA	NA
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	320	260	2500	6600
	Offsite Migration	NA	NA	19 000	RES
	Management Limit[b]	800	1000	5000	10 000

NA = Not applicable. Calculated value exceeds 1,000,000 mg/kg or pathway excluded.
RES = Residual PHC formation. Calculated value exceeds 30,000 mg/kg and solubility limit for PHC fraction.
NC = Not calculated. Insufficient data to allow derivation.
a = Assumes surface water body at 10 metres from site.
b = Includes additional considerations such as free phase formation, explosive hazards, and buried infrastructure effects.

Table A3-3. Pathway-Specific Tier 1 Levels (mg/kg) for PHC for Course-Grained Surface Soils.

Land Use	Exposure Pathways*	F1 (C6-C10)	F2 (>C10-C16)	F3 (>C16-C34)	F4 (>C34)
Agricultural/ Wildland	Direct Contact (Ingestion + Dermal Contact)	12 000	6800	15 000	21 000
	Vapour Inhalation (indoor, basement)	40	190	NA	NA
	Vapour Inhalation (indoor, slab-on-grade)	30	150	NA	NA
	Protection of Potable GW	240	320	NA	NA
	Protection of GW for Aquatic Life[a]	970	380	NA	NA
	Protection of GW for Livestock Watering	5300	14 000	NA	NA
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	210	150	300	2800
	Eco Soil Ingestion	NC	NC	NC	NC
	Produce, Meat and Milk Ingestion	NC	NC	NC	NC
	Management Limit[b]	700	1000	2500	10 000
Residential/ Parkland	Direct Contact (Ingestion + Dermal Contact)	12 000	6800	15 000	21 000
	Vapour Inhalation (indoor, basement)	40	190	NA	NA
	Vapour Inhalation (indoor, slab-on-grade)	30	150	NA	NA
	Protection of Potable GW	240	320	NA	NA
	Protection of GW for Aquatic Life[a]	970	380	NA	NA
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	210	150	300	2800
	Produce Ingestion	NC	NC	NC	NC
	Management Limit[b]	700	1000	2500	10 000
Commercial	Direct Contact (Ingestion + Dermal Contact)	19 000	10 000	23 000	RES
	Vapour Inhalation (indoor)	320	1700	NA	NA
	Protection of Potable GW	240	320	NA	NA
	Protection of GW for Aquatic Life[a]	970	380	NC	NC
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	230	260	1700	3300
	Offsite Migration	NA	NA	4300	RES
	Management Limit[b]	700	1000	3500	10 000
Industrial	Direct Contact (Ingestion + Dermal Contact)	RES	RES	RES	RES
	Vapour Inhalation (indoor)	320	1700	NA	NA
	Protection of Potable GW	240	320	NA	NA
	Protection of GW for Aquatic Life[a]	970	380	NC	NC
	Nutrient Cycling	NC	NC	NC	NC
	Eco Soil Contact	320	260	1700	3300
	Offsite Migration	NA	NA	4300	RES
	Management Limit[b]	700	1000	3500	10 000

NA = Not applicable. Calculated value exceeds 1,000,000 mg/kg or pathway excluded.
RES = Residual PHC formation. Calculated value exceeds 30,000 mg/kg and solubility limit for PHC fraction.
NC = Not calculated. Insufficient data to allow derivation.
a = Assumes surface water body at 10 metres from site.
b = Includes additional considerations such as free phase formation, explosive hazards, and buried infrastructure effects.

APPENDIX 4 – REMEDIATION CRITERIA FOR OTHER CONTAMINANTS

Table A4-1. Canadian Soil Quality Guidelines (mg/kg soil).

	Land Use and Soil Texture							
Substance[y]	**Agricultural/ Wildland**[*]		**Residential/ Parkland**[*]		**Commercial**[*]		**Industrial**[*]	
	Course	Fine	Course	Fine	Course	Fine	Course	Fine
Arsenic (inorganic)	12[b]		12[b]		12[b]		12[b]	
Barium	750[c]		500[c]		2000[c]		2000[c]	
Benzene								
Surface[w]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]
Subsoil[w]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]
Surface[x]	0.0095[t,u]	0.0068[t,u]	0.0095[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]
Subsoil[x]	0.011[t,u]	0.0068[t,u]	0.011[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]	0.03[t,u]	0.0068[t,u]
Benzo(a)pyrene	0.1[e]		0.7[f]		0.7[f]		0.7[f]	
Cadmium	1.4[b]		10[g]		22[b]		22[b]	
Chromium								
Total chromium	64[b]		64[b]		87[b]		87[b]	
Hexavalent chromium (IV)	0.4[h]		0.4[h]		1.4[h]		1.4[h]	
Copper	63[b]		63[b]		91[b]		91[b]	
Cyanide (free)	0.9[b]		0.9[b]		8.0[b]		8.0[b]	
DDT (total)	0.7[i]		0.7[i]		12[i,j]		12[i,j]	
Diisopropanolamine (DIPA)[z]	180[b]		180[b]		180[b]		180[b]	
Ethylbenzene								
Surface	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]
Subsoil	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]	0.082[t]	0.018[t,u]
Ethylene glycol	960[k]		960[k]		960[k]		960[k]	
Lead	70[b]		140[b]		260[b]		600[b]	
Mercury (inorganic)	6.6[b]		6.6[b]		24[b]		50[b]	
Naphthalene	0.1[d]		0.6[h]		22[h]		22[h]	
Nickel	50[l]		50[l]		50[l]		50[l]	
Nonylphenol (and its ethyloxylates)	5.7[p]		5.7[p]		14[p]		14[p]	
Pentachlorophenol	7.6[b]		7.6[b]		7.6[b]		7.6[b]	
Phenol	3.8[b]		3.8[b]		3.8[b]		3.8[b]	
Polychlorinated biphenyls (PCB)	0.5[m]		1.3[l]		33[j,l]		33[j,l]	
Polychlorinated di-benzo-p-dioxins/dibenzofurans (PCDD/Fs)	4 ng TEQ/kg[q]		4 ng TEQ/kg[q]		4 ng TEQ/kg[r]		4 ng TEQ/kg[s]	
Propylene glycol	Insuff Info[v]		Insuff Info[v]		Insuff Info[v]		Insuff Info[v]	
Selenium	1[b]		1[b]		2.9[b]		2.9[b]	
Sulfolane[z]	0.8[b]		1[b]		1[b]		1[b]	
Tetrachloroethylene	0.1[e]		0.2[f]		0.5[f]		0.6[f]	
Thallium	1[n]		1[o]		1[o]		1[o]	
Toluene								
Surface	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]
Subsoil	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]	0.37[t]	0.08[t]
Trichloroethylene	0.01[b,u]		0.01[b,u]		0.01[b,u]		0.01[b,u]	
Uranium[z]	23[t]		23[t]		33[t]		300[t]	
Vanadium	130[l]		130[l]		130[i]		130[i]	
Xylenes								
Surface	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]
Subsoil	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]	11[t]	2.4[t]
Zinc	200[l]		200[l]		360[l]		360[l]	

Notes (Table 4A-1):

Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health are published in "Canadian Environmental Quality Guidelines (CCME, 1999, updated 2007).

SQG_E = Soil Quality Guideline for Environmental Health
SQG_{HH} = Soil Quality Guideline for Human Health

* For guidelines derived prior to 2004, differentiation between soil texture (coarse/fine) is not applicable.

[a] Guidelines released in 1997 were originally published in a working document entitled "Recommended Canadian Soil Quality Guidelines" (CCME 1997) and have been revised, edited and reprinted here. Guidelines revised/released in 1999 are published here for the first time.
[b] Data are sufficient and adequate to calculate an SQG_{HH} and an SQG_E. Therefore the soil quality guideline is the lower of the two and represents a fully integrated *de novo* guideline for this land use, derived in accordance with the soil protocol (CCME 1996; 2006).
[c] Data are insufficient/inadequate to calculate an SQG_{HH}, a provisional SQG_{HH}, an SQG_E or a provisional SQG_E. Therefore, the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use.
[d] Data are sufficient and adequate to calculate only a provisional SQG_E. It is greater than the corresponding interim soil quality criterion (CCME 1991). Therefore, in consideration of receptors and/or pathways not examined, the interim soil quality criterion is retained as the soil quality guideline for this land use.
[e] Data are sufficient and adequate to calculate an SQG_{HH} and a provisional SQG_E. Both are greater than the corresponding interim soil quality criterion (CCME 1991). Therefore, in consideration of receptors and/or pathways not examined, the interim soil quality criterion is retained as the soil quality guideline for this land use.
[f] Data are sufficient and adequate to calculate an SQG_{HH} and a provisional SQG_E. Both are less than the corresponding interim soil quality criterion (CCME 1991). Therefore, the interim soil quality guideline supersedes the soil quality criterion for this land use.
[g] The soil-plant-human pathway was not considered in the guideline derivation. If produce gardens are present or planned, a site-specific objective must be derived to take into account the bioaccumulation potential (e.g. adopt the agricultural/wildland guideline as objective). The off-site migration check should be recalculated accordingly.
[h] Data are sufficient and adequate to calculate only a provisional SQG_E, which is less than the existing interim soil quality criterion (CCME 1991). Therefore, the provisional soil quality guideline supersedes the interim soil quality criterion for this land use.
[i] Data are sufficient and adequate to calculate only an SQG_E. An interim soil quality criterion (CCME 1991) was not established for this land use therefore, the SQG_E becomes the soil quality guideline.
[j] In site-specific situations where the size and/or the location of commercial and industrial land uses may impact primary, secondary or tertiary consumers, the soil and food ingestion guideline is recommended as the SQG_E.
[k] Data are sufficient and adequate to calculate only a provisional SQG_E.
[l] Data are sufficient and adequate to calculate only an SQG_E, which is less than the interim soil quality criterion (CCME 1991) for this land use. Therefore the SQG_E becomes the soil quality guideline for this land use.
[m] Data are sufficient and adequate to calculate only an SQG_E, which is greater than the interim soil quality criterion (CCME 1991) for this land use. Therefore the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use.
[n] Data are sufficient and adequate to calculate a provisional SQG_{HH} and an SQG_E. The provisional SQG_{HH} is equal to the SQG_E and to the existing interim soil quality criterion (CCME 1991) and thus becomes the soil quality guideline for this land use.
[o] Data are sufficient and adequate to calculate a provisional SQG_{HH} and an SQG_E. The provisional SQG_{HH} is less than SQG_E and thus becomes the soil quality guideline for this land use.
[p] Data are sufficient and adequate to calculate only an SQG_E. An interim soil quality criterion (CCME 1991) was not established for these substances therefore, the SQG_E becomes the soil quality guideline.
[q] Data are sufficient and adequate to calculate only a provisional SQG_{HH} which is less than the existing interim soil quality criterion (CCME 1991). Thus the provisional SQG_{HH} becomes the soil quality guideline for this land use.
[r] Data are sufficient and adequate to calculate only a provisional SQG_{HH}. An interim soil quality criterion (CCME 1991) was not established for this land use therefore, the provisional SQG_{HH} becomes the soil quality guideline.
[s] Data are sufficient and adequate to calculate only an SQG_{HH}. An interim soil quality criterion (CCME 1991) was not established for this land use therefore, the SQG_{HH} becomes the soil quality guideline.
[t] Data are sufficient and adequate to calculate an SQG_{HH} and an SQG_E. Therefore the soil quality guideline is the lower of the two and represents a fully integrated *de* novo guideline for this land use.
[u] This guideline may be less than the common limit of detection.
[v] Data are sufficient and adequate to calculate only a provisional SQG_{FWAL} (Soil Quality Guideline for Freshwater Aquatic Life). This value is 6,210 mg/kg.
[w] 10^{-5} incremental risk.
[x] 10^{-6} incremental risk.
[y] Unless otherwise indicated supporting documents are available from the National Guidelines and Standards Office, Environment Canada.
[z] Supporting documents are available from the Canadian Council of Ministers of the Environment.

Table A4-2. Interim Remediation Criteria (mg/kg soil).

These interim remediation criteria should only be used when soil quality guidelines have not yet been developed for a given contaminant (see table A4-1).

Substance	Land Use and Soil Texture			
	Agricultural/ Wildland	Residential/ Parkland	Commercial	Industrial
General Parameters				
Conductivity [dS/m]	2	2	4	4
pH	6 to 8	6 to 8	6 to 8	6 to 8
Sodium adsorption ratio	5	5	12	12
Inorganic Parameters				
Antimony	20	20	40	40
Beryllium	4	4	8	8
Boron (hot water soluble)	2	-	-	-
Cobalt	40	50	300	300
Fluoride (total)	200	400	2000	2000
Molybdenum	5	10	40	40
Silver	20	20	40	40
Sulphur (elemental)	500	-	-	-
Tin	5	50	300	300
Monocyclic Aromatic Hydrocarbons				
Chlorobenzene	0.1	1	10	10
l,2-Dichlorobenzene	0.1	1	10	10
l,3-Dichlorobenzene	0.1	1	10	10
l,4-Dichlorobenzene	0.1	1	10	10
Styrene	0.1	5	50	50
Phenolic Compounds				
Chlorophenols[a] (each)	0.05	0.5	5	5
Nonchlorinated[b] (each)	0.1	1	10	10
Polycyclic Aromatic Hydrocarbons (PAHs)				
Benzo(*a*)anthracene	0.1	1	10	10
Benzo(*b*)fluoranthene	0.1	1	10	10
Benzo(*k*)fluoranthene	0.1	1	10	10
Dibenz(*a,h*)anthracene	0.1	1	10	10
Indeno(l,2,3-c,d)pyrene	0.1	1	10	10
Phenanthrene	0.1	5	50	50
Pyrene	0.1	10	100	100
Chlorinated Hydrocarbons				
Chlorinated aliphatics[c] (each)	0.1	5	50	50
Chlorobenzenes[d] (each)	0.05	2	10	10
Hexachlorobenzene	0.05	2	10	10
Hexachlorocyclohexane (Lindane)	0.01	-	-	-
Miscellaneous Organic Parameters				
Nonchlorinated aliphatics (each)	0.3	-	-	-
Phthalic acid esters (each)	30	-	-	-
Quinoline	0.1	-	-	-
Thiophene	0.1	-	-	-

Notes (Table 4A-2):

All values are in mg/kg soil unless otherwise indicated.

Interim remediation criteria were published in 1991 in "Interim Canadian Environmental Quality Criteria for Contaminated Sites (CCME, 1991).

These interim remediation criteria are considered generally protective of human and environmental health and were based on experience and professional judgement.

These interim criteria (CCME, 1991) should only be used when soil quality guidelines based on the CCME soil protocol (CCME, 1996; 2006) have not yet been developed for a given chemical. Also, because the interim remediation criteria were not developed using the soil protocol and its integral checks, they cannot be modified through the site specific remediation objective procedure.

a = Chlorophenols include
- Chlorophenol isomers (ortho, meta, para)
- Dichlorophenols (2,6- 2,5- 2,4- 3,5- 2,3- 3,4-)
- Trichlorophenols (2,4,6- 2,3,6- 2,4,5- 2,3,4- 3,4,5-)
- Tetrachlorophenols (2,3,5,6- 2,3,4,5- 2,3,4,6-)

b = Nonchlorinated phenolic compounds include
- 2,4-dimethylphenol
- 2,4-dinitrophenol
- 2-methyl 4,6-dinitrophenol
- Nitrophenol (2-,4-)
- Phenol
- Cresol

c = Aliphatic chlorinated hydrocarbons include
- Chloroform
- Dichloroethane (1,1- 1,2-), Dichloroethene (1,1- 1,2-)
- Dichloromethane
- 1,2-dichloropropane, 1,2-dichloropropene (cis and trans)
- 1,1,2,2-tetrachloroethane, tetrachloroethene
- Carbon tetrachloride
- Trichloroethane (1,1,1- 1,1,2-), trichloroethene

d = Chlorobenzenes include
- All trichlorobenzene isomers
- All tetrachlorobenzene isomers
- Pentachlorobenzene

APPENDIX 5 – FIELD SCREENING AND INTRUSIVE SAMPLING

Field screening and sampling methods are to be consistent with current professional standards. Because soils on any given site can be variable and complex (e.g. type of soil, grain size, depth of permafrost), all reasonable efforts must be made to ensure samples provide a true 'representation' of the site. Efforts should also be made to minimize the spread of contamination from one location to another as a result of activities during site assessment and cleanup.

Field screening methods help to identify suitable locations for more intrusive sampling and analysis. Screening with portable instruments is acceptable if the instruments are capable of calibrating measurements to relative or absolute levels of contamination, if the screening is verifiable in regard to procedures and results and finally, if results of such techniques can be correlated to *Canadian Association for Environmental Analytical Laboratories (CAEAL*) accredited laboratory results.

On sites where it cannot be determined through historical records that previous tanks and lines have been removed, an appropriate survey (e.g. ground penetrating radar) should be carried out before drilling, to determine whether tanks and lines are present.

Sample locations should provide an adequately detailed description of the nature and extent of contamination in three dimensions and provide information on potential subsurface contaminant migration pathways. The following are considered minimum requirements:

- Soil - 3-5 boreholes or test pits for each potential source area, except very small sites where a minimum of 1 borehole or test pit is sufficient. Potential source areas include storage tanks and barrels, lines, pump islands, loading areas, previous underground installations and areas of discoloured or stained soil. At a typical community POL facility with 1 tank nest, 1 set of lines, 1 pump island, and 1 waste oil tank, this would equate to 4 source test locations.
- Groundwater - Sufficient test locations to determine the direction of groundwater flow on-site should be selected (minimum of 3 groundwater monitoring wells or piezometers, including at least 1 multilevel installation to assess vertical gradients). Shallow wells are to be screened across the water table to intercept floating product.
- All soil test holes should extend to the bottom of the contaminated soil zone or to an impermeable layer (e.g. bedrock), whichever is shallower.
- All test holes and wells should be monitored for the presence of free product.
- At least 1 'control' site should be established to determine accurate background concentrations of the suspected contaminant.

Each sample location should be marked or documented so it can be found again, if needed.

APPENDIX 6 – SAMPLE ANALYSIS

Soil samples may be screened in the field for vapours, staining or odour in order to reduce the number of samples to be analyzed by the laboratory. All field observations must be included in reports.

Chemical analyses are to be conducted on at least 2 soil samples per test hole location - one surface <1.5 m depth, one subsurface >1.5 m depth. Chemical analyses are to be conducted on at least one groundwater sample from each well sampled.

Chemical analyses for petroleum hydrocarbon impacted sites are to include PHC and BTEX (benzene, toluene, ethylbenzene, xylene)[1]. Analysis for additional site-specific parameters may be required, depending on past or present land use (e.g. PAHs, lead, PCBs).

Grain size analyses are to be conducted on at least 1 sample per hydrogeologic unit if soil grain size criteria are to be applied.

Quality Assurance/Quality Control (QA/QC) – For small batches of soil samples (less than 10 samples), at least one blind duplicate should be analyzed per batch of samples. For larger batches of soil samples (greater than 10 samples), 10% duplicates should be analyzed. For groundwater samples, a blind duplicate and field blank sample should be collected and analyzed with each batch of samples tested. The QA/QC results should be presented and interpreted in the closure report.

All sampling, sample handling and chemical analysis must be consistent with accepted practices. In particular, samples for volatile organics must be collected such that there is a minimum headspace in soil samples and no headspace in water samples. Samples should be kept cool, but not frozen, until they are delivered to the laboratory. Sample handling procedures should be verified with the receiving laboratory and chemical analysis should be consistent with the PHC Canada-Wide Standard reference method. See *Guidance Manual on Sampling, Analysis and Data Management for Contaminated Sites, Volume 1: Main Report (*CCME, 1993), and *Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil – Tier 1 Method (CCME, 2001)*.

Accredited Laboratory

Laboratory analysis of contaminated soil, water and other materials must be conducted by laboratories that have been formally recognized as competent to perform specified tests by the Canadian Association for Environmental Analytical Laboratories (CAEAL*)*. CAEAL is a non-profit organization dedicated to raising the level of competency, consistency, capability, and communication within environmental testing laboratories in Canada. Their member laboratories voluntarily participate in rigorous programs of proficiency testing and accreditation, demonstrating their commitment to generate high quality and consistent data (see Appendix 8).

[1] Soils with high natural organic carbon (such as peats) may give a "false positive" result when analyzed. If this is suspected, it may be beneficial to collect additional background soil samples for organic carbon analysis.

APPENDIX 7 - TRANSPORTATION OF CONTAMINATED SOIL

Contaminated soil must be transported in accordance with requirements of the appropriate transport authority. The road transportation of contaminated soil is administered by the Nunavut Department of Economic Development and Transportation under the territorial *Transportation of Dangerous Goods Act* and Regulations (TDGR). The transportation of contaminated soil by air and marine mode is administered by Transport Canada under the federal *Transportation of Dangerous Goods Act* and *International Maritime Dangerous Goods Code,* respectively.

The TDGR require that a waste manifest form accompany shipments of contaminated oil and other hazardous waste. The completed manifest form provides:

- Detailed information on the types and amounts of hazardous waste shipped;
- A record of the parties involved in the shipment;
- Information on the storage, treatment or disposal of the waste; and
- Confirmation that the waste reached the final destination.

No chemical test of the hydrocarbon is required as “petroleum distillate” is a specified dangerous good in List II, Schedule II of TDGR. The word “waste” must precede the shipping name.

Manifest requirements:

	Shipping name:	WASTE SOLIDS CONTAINING FLAMMABLE LIQUID, n.o.s.*, (gasoline or diesel, as appropriate)
	Classification:	4.1
	UN number:	UN3175
	Packing group:	II
or	Shipping name:	WASTE ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, n.o.s.*, (gasoline or diesel, as appropriate)
	Classification:	9
	UN number:	UN3077
	Packing group:	III

Further assistance in completing a waste manifest can be obtained by referring to the *User’s Guide for the Hazardous Waste Manifest* produced by Environment Canada or by contacting the Motor Vehicles Division of the Department of Economic Development and Transportation. Further information on hazardous waste management in Nunavut can be obtained by referring to the *Environmental Guideline for the General Management of Hazardous Waste (January 2002)* produced by the Department of Environment.

APPENDIX 8 - ADDITIONAL CONTACTS

Canadian Council of Ministers of the Environment (CCME)
CCME works to promote effective intergovernmental cooperation and coordinated approaches to interjurisdictional issues such as air pollution and toxic chemicals. Under the auspices of CCME, the federal, provincial and territorial ministers of environment collectively establish nationally consistent environmental standards, strategies and objectives so as to achieve a high level of environmental quality across the country. Comprehensive literature and technical documentation is available from:

Canadian Council of Ministers of the Environment
123 Main Street, Suite 360
Winnipeg, Manitoba R3C 1A3
Phone: (204) 948-2090; Fax: (204) 948-2125
Website: http://www.ccme.ca
E-mail: info@ccme.ca

Canadian Association for Environmental Analytical Laboratories (CAEAL)
CAEAL is a not-for-profit organization formed in 1989 dedicated to raising the level of competency, consistency, capability, and communication within environmental testing laboratories in Canada. Membership in CAEAL is open to individuals, institutions, user groups, consultants, industrial organizations, regulatory agencies, materials and laboratory equipment suppliers, and others interested in the work being carried out in environmental analytical laboratories. More information on CAEAL may be obtained from:

Canadian Association for Environmental Analytical Laboratories
300-265 Carling Avenue
Ottawa, Ontario K1S 2E1
Phone: (613) 233-5300; Fax: (613) 233-5501
Website: http://www.caeal.ca/

Canadian Standards Association (CSA)
CSA is a not-for-profit membership-based association serving business, industry, government and consumers in Canada and the global marketplace. As an organization, CSA works to develop standards that address a wide variety of needs, such as enhancing public health and safety, occupational health and safety, and the environment. More information on CSA may be obtained from:

Canadian Standards Association
5060 Spectrum Way
Mississauga, Ontario L4W 5N6
Phone: (416) 747-4000; Fax (416) 747-2473
Website: http://www.csa.ca

Appendix B

Site Photos

Appendix C

Operational Procedures for Site Personnel

LANDFARM OPERATION AND MAINTENANCE PROCEDURES FOR SITE PERSONNEL

The following describes specific procedures for the the operation and maintenance of the contaminated soil facility ("landfarm") at the Meadowbank site. Operation and monitoring of the facility will come under the responsibility of the Environmental Superintendent. Any questions about operation and maintenance procedures should be directed to the Environment Department.

1 TYPE OF CONTAMINATION

1.1 Acceptable Types of Contamination

The landfarm facility is designed to accept, treat and/or store petroleum hydrocarbon contaminated soils that have been generated through mine-related activities (i.e. spills) at the Meadowbank Gold Project and the Meadowbank exploration camp. The following products may be treated in the landfarm if used onsite and spilled on soil or snow:

- Gasoline
- Diesel fuel
- Aviation fuel (Jet A)
- Hydraulic oil
- Other light oils e.g. engine oil, lubricating oil

If the source of contamination is unknown, or the contaminated material is suspected to contain any non-PHC contaminants, additional analyses should be performed (see Section 1.2).

1.2 Unknown Contamination

In the event that the contaminant source is unknown, Environment Department should be notified so that soil can be analyzed for petroleum hydrocarbons and possibly additional contaminants prior to placement in the landfarm.

- Additional parameters could include:
    - Total heavy metals
    - Heavy oil and grease
    - Volatile organic compounds
- Concentrations of additional contaminants will be compared to the site background values (for metals) and/or criteria in the Government of Nunavut (GN) Guidelines for Contaminated Site Remediation.

- If non-PHC soil contamination is below background or agricultural/wildland GN guidelines (whichever is higher), the material will be accepted into the landfarm as usual (see Section 2).
- If non-PHC contamination is above background or GN agricultural/wildland criteria but below GN industrial use criteria, soil will be placed in a designated area in the landfarm for PHC remediation prior to disposal in the Portage Rock Storage Facility (PRSF).
- If non-PHC contamination is above GN industrial criteria, the material cannot be remediated in the landfarm. Spills of > 100 L of non-PHC material (e.g. solvents, glycol) will be placed in drums and stored in the site Hazmat area for shipment south to approved facilities during barge season. Spills of non-PHC material < 100 L will be placed in the TSF.

2 HANDLING CONTAMINATED SOIL AND SNOW

2.1 Spill Excavation

2.1.1 General Procedures

- All spills must be reported to the Environment Department in accordance with AEM's Spill Reporting Procedures. Spills that are acceptable as described in Section 1 will be excavated for treatment in the landfarm.
- Prior to excavation, absorbent pads will be used to contain the spill and minimize excavated soil volumes. Used absorbent pads will be disposed of in the onsite incinerator.
- During excavation, larger coarse material (>1") should be separated as much as possible. Coarse and fine material will be treated separately in the landfarm.
- Care should be exercised to ensure that the entire spill is excavated. The excavation should be thoroughly assessed for any visible remaining product or odour, and the extents of excavation approved by Environment Department.

2.1.2 Spills on Snow

- For spills < 100 L, PHC-contaminated snow will be placed in a designated area of the landfarm and treated as contact water after snowmelt.
- For spills > 100L, excavated snow will be stored in drums until it has melted. The melt water will be processed in the oil/water separator (carbon filter) to remove PHC residue. The treated water will be sampled per Part F, Item 6 of the Water License, and discharged to the Stormwater Management Pond if criteria are met. If criteria not met, water will be treated as hazardous material.

2.1.3 Records

- In addition to the regular spill report provided by the affected department, the following information should be recorded by Environment Department at the excavation of potentially landfarmable material:
    - Time and date of excavation
    - Estimated quantity of excavated material (soil or snow)
    - Destination of excavated material (storage or landfarm)

2.2 Addition of Soil to the Landfarm

- Environment Department should be contacted prior to any additions of soil or snow to the landfarm.
- During transport to the landfarm, care should be exercised to ensure that no contaminated material is lost. If this occurs, it should be cleaned up immediately, ensuring none is left behind.
- If not already removed, efforts should be made to separate larger coarse material (> 1”) from the finer material in the landfarm, using a screen sieve if necessary.
- Each load of contaminated soil will be placed in an area designated by Environment Department staff. The layout of the landfarm should be prepared by the Environment Department and provided to Site Services and the Mine Department as changes occur.
- Location will be based on:
    - Year
        - New windrows will be developed annually at a minimum so that new product is not added to partially remediated piles
    - Grain size
        - Material < 1” will be piled and shaped into windrows with maximum dimensions of ~15 m wide at base x 4 m high x 50 m long
        - Material > 1” will be spread out in a thin layer (< 30 cm) for volatilization
    - Presence of other contaminants
        - Material contaminated with concentrations of other contaminants above background/GN wildland criteria will be treated in a separate area in the landfarm
    - Nutrient amendment
        - Certain windrows are treated with sewage sludge as a nutrient amendment

2.3 Remedial Activities

Environment Department will determine the timing of all remedial activities, and will maintain detailed records.

2.3.1 Absorbent material

- Oil-absorbent pads will be used to help remove visible product from coarse material as necessary.
- Used absorbent materials will be incinerated.

2.3.2 Aeration

- Windrows will be mixed mechanically with earth-moving equipment two - four times per year, during the summer months.
- Prior to turning, site personnel will ensure that soil is not so dry as to generate significant dust, nor overly saturated.
    - If soil is dry, water from within the landfarm containment area will be used as a moisture source and sprayed on the piles. If no accumulated water is available, a freshwater supply will be used.
    - If the windrows are saturated, aeration will be conducted at a later date.

2.3.3 Nutrient Amendment – Pilot Project

- Two pilot piles in the landfarm facility were treated in 2012 with 400 gallons of sewage sludge as a nutrient source.
- Depending on the effectiveness of this treatment (to be determined by Fall 2013), future additions of sewage sludge will be determined by Environment Department, and procedures updated at that time.

2.4 Sampling

All sampling of the landfarm will be conducted by the Environment Department.

- Windrows will be sampled annually at the end of the summer season to determine if remediation objectives have been met.
- For each 10 m of windrow length, one composite sample will be collected, each consisting of three sub-samples from the surface and three sub-samples at 1 m depth. Sub-samples will be taken approximately 3.3 m apart, and will be taken from both sides of the windrow.
- Samples should be analyzed for BTEX and PHC Fractions 1 – 4.

2.5 Removal of Soil from the Landfarm

- All removal of soil from the landfarm will be directed by the Environment Department, who will maintain a record of all soil removal operations, including the date, quantity of soil, location in the landfarm and end use.

2.5.1 Coarse-grained Material

- Will be assessed near the end of the summer season by Environment Department technicians for PHC product and odour.
- When PHC odours are no longer detected, this material will be removed to the PRSF and disposed of as PAG material.

2.5.2 Fine-grained Material

- When sample analysis indicates that concentrations of PHC contaminants are below GN guidelines, a soil pile or the appropriate section of a pile will be deemed acceptable for removal from the facility.
- The soil to be removed will be delineated by Environment Department staff.
- If agricultural/wildland criteria are met, soil can be stockpiled outside the landfarm and used in site works or reclamation activities.
- If industrial criteria are met, soil will be placed in the PRSF as PAG.
- GN criteria for agriculture/wildland use are targeted, but if remediation to this level is not feasible based on time/space, industrial-use criteria will be used (discretion of Environment Department).

3 WATER MANAGEMENT

3.1 Winter

- Snow should be removed as much as possible before spring to minimize the quantity of melt water inside the berm.
- This activity is to be undertaken by Site Services.
- Care should be taken to ensure contaminated snow/soil is not removed by leaving a base layer of snow (> 10 cm) in place.
- Removed snow will be placed in the TSF.

3.2 Summer

The monitoring and removal of any water accumulated within or around the berm will be directed by the Environment Department.

- Monitoring for water accumulation within the berm, or seepage through the berm will be conducted on a weekly basis, after freshet, when water is likely to be present.
- In the event of water accumulation or seepage, the ponded water will either be:
    - Collected and pumped to the adjacent Tailings Storage Facility after analysis for BTEX, lead, oil and grease per Part F, Item 6 of the Water License OR

    - Sprayed on the windrows to increase moisture content, if required
- Water accumulating in the landfarm should not be discharged to the environment.

4 SUMMARY OF ACTIVITIES

The following table summarizes landfarm-related activities, possible analyses, and the records to be maintained. Environment Department will direct all activities.

Activity	Analysis	Frequency of Analysis	Record
Excavation of spill and transport of contaminated material	If unsure of full excavation - F1-F4, BTEX	As needed	Date and time of excavation; estimated quantity of excavated soil; storage/disposal location of excavated soil, if applicable; any evidence of remaining product
Contaminated soil additions to landfarm	If contaminant source unknown, F1-F4, BTEX, metals, oil and grease, VOCs (at discretion of Environment Department)	Prior to soil addition at facility	Date and time; quantity of soil; original location; landfarm location; spill/excavation record # or storage container label
Soil aeration	N/A	Two - four times during summer	Date and time; location; soil condition (moisture, odour, etc.)
Soil treatment with sewage sludge as nutrient supplement	Visual inspection to ensure proper incorporation	At least once during summer on selected windrows	Date and time; type of treatment (aeration or nutrient amendment); location in landfarm; any odour noticed during aeration
Sampling for progress of remediation	Hydrocarbon vapour in headspace (by PID); F1-F4, BTEX (laboratory)	Vapour – as needed; Laboratory - annually	Date and time; location; odour; laboratory report;
Soil removal from landfarm	Removal subject to meeting GN criteria	N/A	Date and time; location; quantity of soil removed; final location
Ponded contact water	BTEX, oil and grease, lead – as per Part F, Item 6 of Water License	Prior to any dewatering; if re-used in landfarm, no sampling necessary	Date and time, location, laboratory report, Annual Report
Seepage	Visual inspection	Weekly during summer	Location, extent, approximate depth, evidence of sheen
Identification of maintenance requirements	Visual inspection of facility	Twice annually during summer	Inspected areas; condition of berm and base; previously unidentified safety concerns

5 ASSESSMENT AND REPORTING

5.1 Feasibility

After two seasons of treatment in the landfarm (Fall 2013), degradation rates of PCH contaminants will be assessed to estimate the total remediation time required under these conditions.

- If remediation to GN guidelines is feasible within the life-of-mine timeframe, landfarm operations will continue, with aeration and possible nutrient amendments as described above.
- If rates of TPH degradation are not sufficient through this method, alternate options will be further investigated (see Landfarm Design and Management Plan – Section 5).

5.2 Reporting

- A report of landfarm activities will be prepared annually by Environment Department, indicating the volume of material added to the facility, amount of material removed and disposal or re-use location, all analysis results, volume and type of nutrient addition, visual inspection results and volume of contact water pumped.
- This information will be appended to AEM's NWB Annual Report.

5.3 Plan Review and Continual Improvement

- The Landfarm Design and Management Plan will be reviewed annually by the Meadowbank Environmental Superintendent in consultation with the Mine General Manager and be updated at least every two years of operation.

MEADOWBANK GOLD PROJECT

Groundwater Monitoring Plan

In Accordance with Water License 2AM-MEA0815

Prepared by:
Agnico-Eagle Mines Limited – Meadowbank Division

Version 3
January 2012

EXECUTIVE SUMMARY

This document presents the Meadowbank Mine Groundwater Monitoring Plan, a requirement of the Meadowbank Type A Water License No. 2AM-MEA0815. Conditions applying to groundwater monitoring; Schedule 1, Table 2: annual monitoring of groundwater quality at well locations that are to be determined.

The Meadowbank Mine has currently four operating groundwater monitoring wells. Two of these wells were drilled in 2008 and two were drilled in 2011. Additional, wells were previously drilled in 2003, 2006, and 2008, however these wells are inoperable. The design, installation, and initial production of each well were completed by Golder Associates.

Groundwater quality data has been used to predict the future quality of water that will accumulate in the pits during operation, and to determine baseline groundwater quality underneath the tailings basin before tailing deposition.

Groundwater wells will be sampled on a bi-annual basis. Analytical parameters will comply as per Schedule 1, Table 1, Group 3 of the Meadowbank Water License. Quality Assurance/Quality Control procedures and samples will be implemented for each monitoring well for each sampling occurrence.

An annual groundwater monitoring report will be submitted by Agnico-Eagle Mines Limited to the Nunavut Water Board (NWB) by March 31 annually. This report will conclude the data from the previous year's results, changes, dates in which sampling took place, methods, personnel involved with sampling, and an assessment of the data obtained.

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ᐊᐳᖅᑎᓇᖅᑐᒥ ᓱᑕᒪᓂᒃ ᐃᒪᖏᑦᒃ ᖃᐅᔨᓴᖅᓇᒃᖃᖅᑐᖅ. ᑕᑯᐊ ᒪᓂᕆᒥ ᐃᑯᑕᖅᓱᒪᔪᑦ, ᐃᒪᖏᑦᒃ ᖃᐅᔨᓴᖅᓇᑦ. ᒪᑭᒃ ᐃᑯᑕᖅᑕᐅᓕᐅᖅᓴᑎᒃ ᐅᑭᐅᖅ 2008ᒥ ᐊᒪᓗ ᒪᑭᒃ ᐃᑯᑕᖅᑕᐅᓕᐅᖅᓴᑎᒃ 2011ᒥ. ᐊᓱᖏᑦ ᐃᒪᖏᑦᒃ ᖃᐅᔨᓴᖅᓇᑦ ᐃᑯᑕᑎᐅᓕᓴᐅᑦ 2003ᒥ, 2006ᒥ ᐊᒪᓗ 2008ᒥ, ᑭᓱᐊᓂ ᑕᑯᐊ ᐊᑐᖏᑐᑦ. ᑕᑯᐊ ᓴᓇᔨᐅᓂᖏᑦ, ᐃᒪᖏᑦᒃ ᖃᐅᔨᓴᖅᓇᑦ ᕿᓴᔪᑕᐅᓕᐅᓂᑦ ᐅᑯᓇᖏᓂᑦ, ᖃᐅᔨᓴᖅᑎᓂᓂᒃ Golder Associates.

ᑕᒪᑯᐊ ᐃᒪᖏᑦᒃ ᒪᓂᕆᒥ ᖃᐅᔨᓴᕿᑕᐅᓕᖅᑐᖅᑐᑦ, ᑐᑭᓱᔾᑕᐅᓕᖅᑭᖅᑐᑦ ᐅᓗᓚᐊᓇᕿᓴᖅᑐᑦ ᒪᓂᕆᔪᑦ ᐃᖏᕐᕋᒪᖏᓕᒃ, ᐅᓴᕆᖅᑕᕐᓴᒃᓂᓕᒃ.
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IMPLEMENTATION SCHEDULE

As required by Water License 2AM-MEA0815, Part B, Item 16, the proposed implementation schedule for this Plan is outlined below.

This Plan will be immediately implemented (January 2012) 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	Page	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;

Version 3
Prepared By: _____
Jeffrey Pratt
Environment Coordinator

Approved by: _____
Stéphane Robert
Environment Superintendent

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INTRODUCTION

This document presents the Meadowbank mine Groundwater Monitoring Plan. The location of each of the groundwater wells, design characteristics of each and the groundwater sampling methodology used to recover water samples for chemical analysis are presented.

1.1 PURPOSE OF GROUNDWATER MONITORING

Groundwater quality data has been used to predict the future quality of water that will accumulate in the pits during operation, and to determine baseline groundwater quality underneath the tailings basin (the northwest arm of Second Portage Lake) before tailing 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.

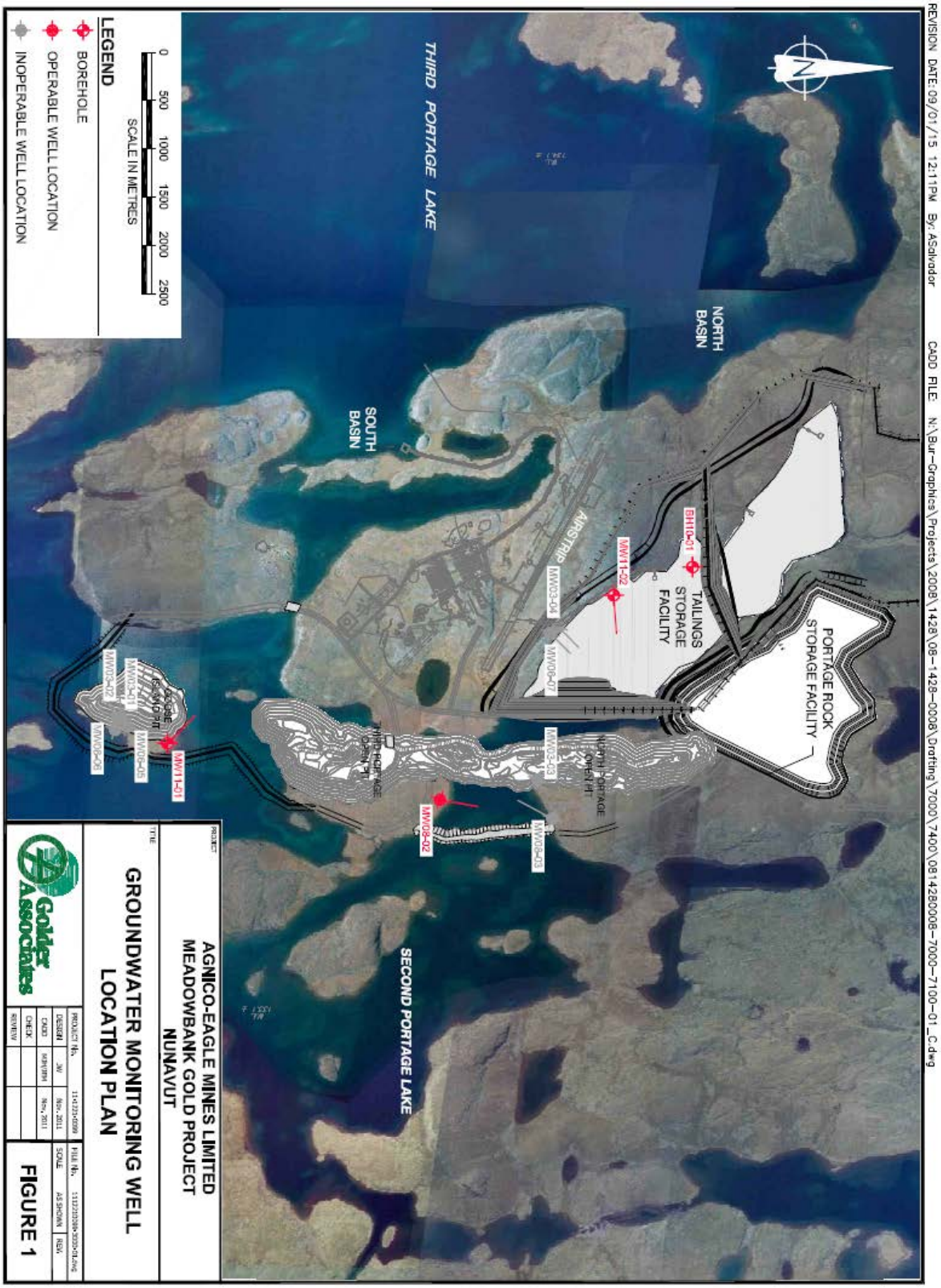
1.2 EXISTING MONITORING WELLS

Four monitoring wells were installed at the Meadowbank Gold Project 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 wells (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 open pit outline, to replace one of the 2003 wells (MW03-01), and 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 will be deposited. The well MW08-03 shows a blockage in 2010 and 2011. Action will be take in 2012 to try to recuperate this well. The coordinates for each of the groundwater wells and specific design characteristics are provided in Table 1.

Table 2 - Monitoring Well Locations

Well ID	Location UTM coordinates		Azimuth	Dip	Total Drilled	Screen Interval Depth
	Easting	Northing				
MW08-02	639185	7213901	010	60	200 m	170-200m
MW08-03	639282	7214483	200	60	200 m	170-200m
MW11-01	638893	7212488	315	50	220 m	195-220m
MW11-02	638125	7214802	80	80	81 m	65-81m

Figure 1 - Map of Monitoring Wells On the Meadowbank Site



WELL INSTALLATION

1.3 2008 WELL INSTALLATION

1.3.1 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. The well locations in UTM coordinates are presented in Table 1.

1.3.2 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.

1.4 2011 WELL INSTALLATION

1.4.1 MW11-01 & MW11-02

Two boreholes were drilled using standard HQ size coring method for the installation of monitoring wells MW11-01 and MW11-02. Heated lake water was used as drilling fluid during drilling. The borehole for MW11-01 was drilled to 220 m depth at an angle of 50 degrees below ground surface

and the borehole for MW11-02 was drilled to 81 m depth at an angle of 80 degrees below ground surface. Each borehole was cased through the overburden and into the first few metres of bedrock. All core was recovered from both boreholes and logged by Agnico-Eagle geologists. The well locations in UTM coordinates are presented in Table 1. Borehole logs and monitoring well designs for previously-existing installations are presented in previous reports (Golder 2008).

1.4.2 INSTRUMENTATION

1.4.2.1 Well MW11-01

MW11-01 was constructed with 1.25 inch diameter, schedule 40 stainless steel pipe and 15 m of 2 inch diameter slotted stainless steel screen. The well was installed into an open borehole. A pneumatic packer was installed in between the slotted screen and the solid pipe at a depth of 193.28 m below ground surface (bgs). The pneumatic packer was inflated with propylene glycol (a non-toxic and biodegradable liquid with a low freezing point) and served as the seal between the talik water and the overlying permafrost and surface water. A heating cable was attached to the outside of the stainless steel pipes, above the packer through the entire anticipated interval of permafrost. The heating cables allow for thawing of the well for subsequent sampling events and prevent water from freezing during sampling. The annulus between the solid pipe and the borehole above the packer was filled with grout through a tremie line that was installed over the length of the solid pipe. The grout provides support and minimizes the potential for frost damage to the outside of the monitoring well.

1.4.2.2 Well MW11-02

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.

SAMPLING METHOD

1.5 GROUNDWATER WELL MW08-03

1.5.1 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.

1.5.2 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).

1.5.3 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.

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 chloride and dissolved metals only.

1.5.4 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.

1.6 GROUNDWATER WELLS MW08-02, MW11-01 & MW11-02

1.6.1 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.

1.6.2 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.

1.6.3 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 chloride and the suite of dissolved metals specified in Table 1 of Schedule 1 of the Meadowbank Water License.

1.6.4 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.

SAMPLING

Sampling of each well will be performed on an bi-annual basis. Each well will be thawed prior to commencement of purging. 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).

1.7 ANALYSIS

These samples will have field parameters taken (pH and Conductivity) and will also be sent to a certified laboratory for analysis. Analytical parameters will include the following, per Schedule 1, Table 1, Group 3 of the Meadowbank Water License: pH, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, total dissolved solids (TDS), total and free cyanide (for well located in the flow path of the tailings containment area) and the following dissolved metals: aluminum, arsenic, barium, cadmium, copper, iron lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium and zinc.

1.7.1 Analytical Laboratory

Meadowbank Gold Mine will use Multi-lab Direct as the analytical laboratory for analyzing samples for groundwater monitoring. Multi-lab Direct is ISO / IEC 17025 certified and is a reputable laboratory in the Abitibi Region of Quebec.

1.8 QUALITY ASSURANCE / QUALITY CONTROL

1.8.1 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.

1.8.2 Sampling

Do to the effort that is needed to thaw and sample these wells, field blanks and duplicates will be taken at each station for all sampling occurrences. This will assess variance of the total method including sampling and analysis as well as document the precision of the sampling and analytical process.

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:

- Description of the instrumentation and location in UTM coordinates of monitoring wells;
- Description of the working condition of the existing wells;
- Date of groundwater sampling;
- Name and title of personnel who completed groundwater quality monitoring;
- Analytical results including: field data, laboratory analytical data and QAQC information; and
- Comparative assessment of data obtained to date to input values used in the Water Quality Model for the site.

AGNICO-EAGLE MINES: MEADOWBANK DIVISION

NO-NET-LOSS PLAN

OCTOBER 15, 2012

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Appendix E - Technical Memorandum: Summary of 2012 field data collection in support of NNL planning

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EXECUTIVE SUMMARY

An updated no-net-loss plan (NNLP) has been developed for the Agnico-Eagle Mines Ltd.: Meadowbank site, near Baker Lake, Nunavut. This plan quantifies the losses to fish habitat that will occur through mine operations, and the gains that will be achieved through compensation measures. With approval from Fisheries and Oceans Canada (DFO), this new NNLP will replace the original NNLP that was created in 2006 (Cumberland, 2006).

The habitat evaluation procedure (HEP) followed in this plan was developed by Golder Associates and AEM, in consultation with DFO, and with adjustments as recommended in review by Dr. Ken Minns. These adjustments were approved by DFO in the draft Meadowbank NNLP (June 2012). As in the original NNLP, this HEP involves the multiplication of affected areas (in ha) by a habitat suitability index (HSI) in order to derive a value in habitat units (HUs) that describes both the quality and quantity of habitat.

Baseline HU calculations (losses) for the Meadowbank site were conducted for three separate areas to facilitate the use of historically accepted loss:gain ratios. These are: the Main Minesite Area, the Tailings Storage Facility (TSF) and the Vault Lake Area. Habitat compensation is provided through a number of features which increase the area and value of habitat for the fish species present at Meadowbank, using the habitat suitability index (HSI) developed as part of the HEP. The majority of habitat compensation consists of re-flooding of pits and basins after implementation of habitat improvement features (pit backfilling, boulder gardens and constructed reef habitat). Supplementary habitat enhancements proposed onsite include the construction of a connecting channel, finger dikes and improvement of access for native fish species to certain areas.

To align with historical documentation, and to meet the required compensation ratios for each area, portions of habitat gains from certain areas were “allotted” to other areas where deficits occurred. After allotment, the calculated habitat units and ratios for each area are:

Area	Habitat Losses (HUs)	Habitat Gains Allotted (HUs)	Loss:Gain Ratio
Main Minesite	66.12	111.08	1:1.68
TSF	37.85	75.70	1:2
Vault Lake	33.09	65.32	1:1.97

Thus, based on the compensation measures proposed in this NNLP, targeted historic ratios for gains in habitat units would be met for the Main Minesite Area and the TSF, and NNL would be achieved for the Vault Lake Area.

A suite of contingency options is proposed in the event that any of the primary options are not constructible or fail to meet the criteria for success outlined in the monitoring plan and the original authorization.

ACKNOWLEDGEMENTS

This NNLP was coordinated and written by Leilan Baxter (consultant to AEM), with major contributions, technical review and project management by Ryan Vanengen (AEM Biologist). GIS work and mapping was conducted by Dougan and Associates. AEM would like to thank Bobby Bedingfield, Derrick Moggy and Elizabeth Patreau (DFO) for review of the methods and document drafts; and the Kivalliq Inuit Association and Hunters and Trappers Organization for providing feedback.

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
1	2005-10	All	All	Cumberland Resources- Meadowbank Gold Project No Net Loss of Habitat (NNL)Report
2	2006- 11	All	All	Cumberland Resources- Meadowbank Gold Project No Net Loss Plan
3	2012-10-15	All	All	AEM- Meadowbank Division No Net Loss Plan

Version 3:
Managed and Prepared By:

Ryan VanEngen
Environmental Biologist- Meadowbank

Coordinated and written by Leilan Baxter

Approved By:

Kevin Buck
Environmental Superintendent

SECTION 1 • INTRODUCTION

The following report describes the new no-net-loss plan (NNLP) that has been developed for the Meadowbank Gold site, near Baker Lake, Nunavut. With approval from Fisheries and Oceans Canada (DFO), this updated NNLP replaces the original that was created in 2006 (Cumberland, 2006), prior to acquisition of the site by Agnico-Eagle Mines Ltd: Meadowbank Division (AEM). This plan quantifies the losses to fish habitat that will occur throughout the mine development and operational phase, and the gains that will be achieved through compensation measures.

1.1 SITE DESCRIPTION

1.1.1 Mine Site

Since 2009, AEM has operated the Meadowbank Gold Mine, which is located 75 km north of the Hamlet of Baker Lake, Nunavut (Figure 1-1). This hamlet is the furthest inland settlement in Nunavut, located 320 km west of Hudson Bay. The minesite is connected to the hamlet by a 110 km all-weather road, and an airstrip onsite allows direct access for personnel and freight.

The Meadowbank mine consists of several gold-bearing deposits that are currently planned to be extracted using three open pits (Goose Pit, Portage Pit, Vault Pit), two of which are currently operational (Portage Pit and Goose Pit). The current mining schedule for each pit is shown in Table 1-1. 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 10 km northeast of the main minesite (Figure 1-2).

Under the current design plans, a portion of each of the pits occurs in lacustrine environment. As a result, construction has commenced on a series of dikes to separate the pit areas from the remainder of the adjacent lakes. Four lakes (Second Portage Lake, Third Portage Lake, Vault Lake and Phaser Lake) are to undergo partial or complete dewatering following dike construction, to provide access to the pit areas. To date, dewatering has been completed in the northwest arm of Second Portage Lake, and the Bay-Goose Basin of Third Portage Lake. Dike construction is proposed for 2013 at Vault Lake. Phaser Lake is isolated and will be dewatered without dike construction. The sequence for dike construction is shown in Table 1-1.

Figure 1.1. Meadowbank Gold Project location. From Cumberland (2006).

Wally 3

Wally 4

Wally Lake

Vault Lake Area

Vault Lake

Phaser Lake

Main Minesite Area

Tailings Storage Facility

NP2

Dogleg North

Dogleg Pond

Second Portage Lake

Third Portage Lake

Bay - Goose Basin

0 0.5 1 2

Kilometres

Legend

- Study Lakes
- Facility
- Airstrip

Meadowbank Minesite
Project Lakes and Location

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CLIENT: Agnico-Eagle Mines Ltd., Meadowbank Div.

N W E S
UTM Zone 14 NAD83

DATE: OCTOBER 2012

SCALE: 1:55,000

DRAWN BY: LC

CHECKED BY:

FIGURE:

1-2

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Table 1-1. Dike construction and mining schedule at the Meadowbank mine, as of September, 2012. Note that while the majority of the in-lake portion of Portage Pit falls in Second Portage Lake, a small portion is in Third Portage Lake.

Lake	Dike Construction				Mining		
	Area to be Dewatered	Dike Name	Year Built	Dewatering	Pit	Start	End
Second Portage	Northwest Arm	East Dike	2008	2009-2011	Portage	2010	2016
Third Portage	Bay-Goose Basin	Bay-Goose Dike	2009/10	2010-2011	Goose	2012	2015
Vault Lake	Whole lake	Vault Dike	2013	2013	Vault	2014	2017
Phaser Lake	Whole lake	N/A	N/A	TBD	Vault	2014	2015

1.1.2 Ecological Setting

Situated near the border of the Northern and Southern Arctic ecozones, the terrain in the Meadowbank area is typical barren-ground subarctic, with low-growing vegetation in poorly developed soil with continuous permafrost. The landscape is dominated by many interconnected lakes and isolated ponds with indistinct drainage patterns, lying between low hills, boulder fields and bedrock outcrops. The mine site is located at the headwaters of the Quioch River system, which flows southeast through Chesterfield Inlet into Hudson Bay. The adjacent Back River and Meadowbank River systems flow north to the Arctic Ocean. Lakes in this region have small watersheds relative to their size, and are ultra-oligotrophic, with low productivity and short food chains. Studies have indicated that fish movement between lakes in the minesite area is limited due to small ephemeral connecting channels, or is random and not due to life history requirements of the species present (Cumberland, 2006). The project area lakes, with bathymetry, are shown in Figures 1-3 and 1-4.

1.1.3 Fish Species

According to baseline studies (BAEAR, 2005) and fishout programs that occurred in 2008 and 2010 in Second and Third Portage Lakes, three fish species are most prevalent in the Meadowbank region lakes. Lake trout (*Salvelinus namaycush*) are the dominant species and form between 60 and 100% of the population in studied lakes. Round whitefish (*Prosopium cylindraceum*) make up 15-25% of the populations, and landlocked arctic char (*S. alpinus*) comprise 10-15%. Minor species found in small numbers in certain lakes include burbot (*Lota lota*), ninespine stickleback (*Pungitius pungitius*) and slimy sculpin (*Cottus cognatus*). Two other species are known to occur in the region – arctic grayling and lake cisco. While arctic grayling (*Thymallus arcticus*) are not present in the project lakes, they have been found to use streams and tributaries in the adjacent Prince River system for spawning,

Main Minesite Area and Tailings Storage Facility

NP2

Dogleg North

Dogleg Pond

Second Portage Lake

Third Portage Lake

Bay - Goose Basin

0 250 500 1,000

Metres

Legend

Study Lakes

Bathymetry Contour

Major Contour (10 m)

Minor Contour (2 m)

Bathymetry
Main Minesite Area and
Tailings Storage Facility

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N W E S
UTM Zone 14 NAD83

DATE: OCTOBER 2012

SCALE: 1:20,000

DRAWN BY: LC

CHECKED BY:

FIGURE:

1-3

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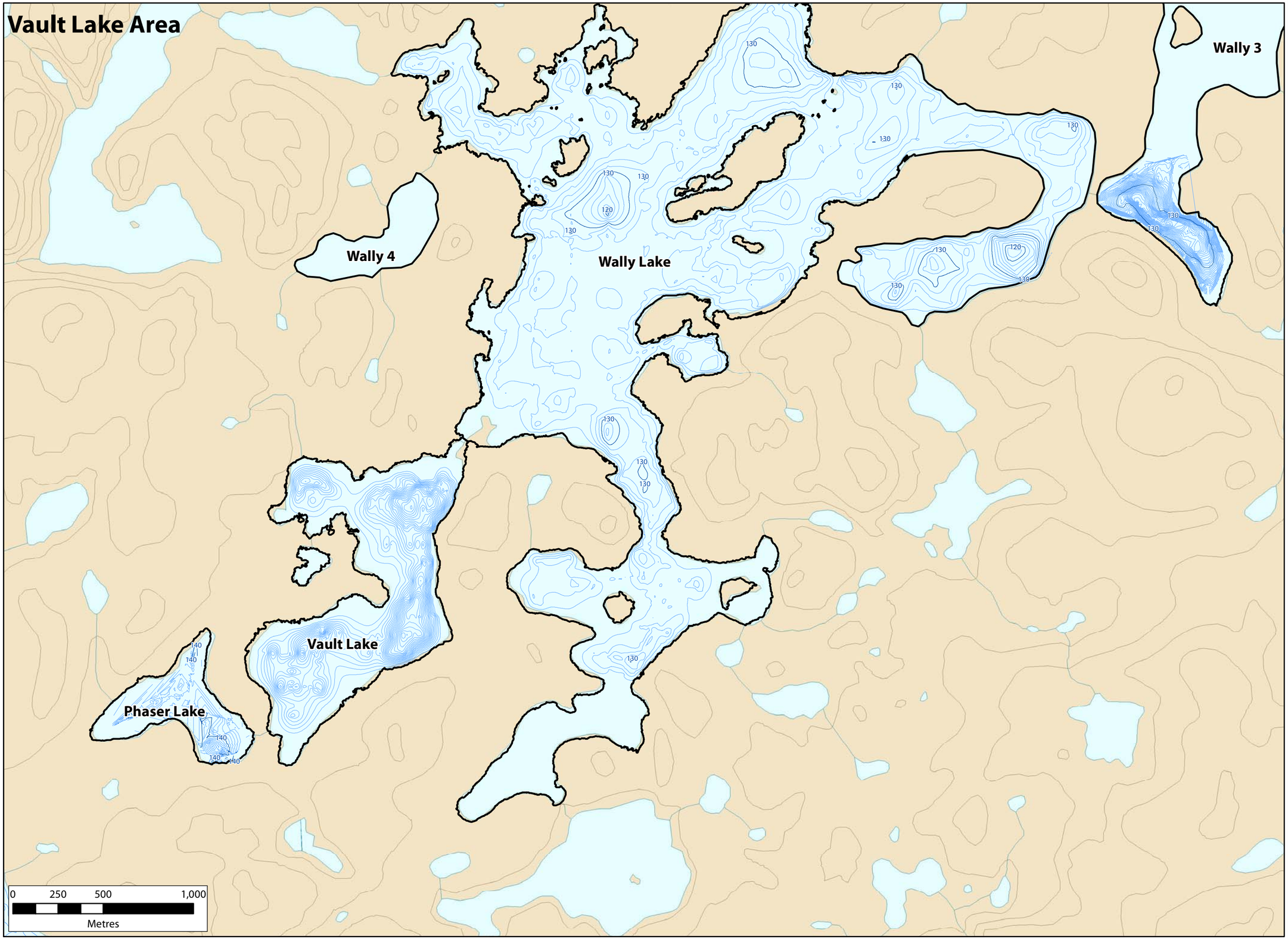
Vault Lake Area



Legend

- Study Lakes

Bathymetry Contour

- Major Contour (10 m)
- Minor Contour (2 m)

Bathymetry
Vault Lake Area

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FIGURE:

1-4

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rearing and migration. Lake cisco (*Coregonus artedii*) have not been found in the project lakes, but have been found in small numbers in nearby streams, and are common in lakes closer to Hudson Bay.

1.1.4 Habitat Preferences of the Meadowbank Fish Species

The following description of general habitat preferences is summarized from Cumberland (2006), and is largely based on Scott and Crossman (1979), McPhail and Lindsey (1970) and Richardson et al. (2001).

Lake trout, the dominant species in the project lakes, generally spawn over large, course gravel-cobble substrates on sloped structures (i.e. shorelines or shoals) with interstitial spaces that allow oxygenation of eggs. In the project lakes this type of habitat occurs between 2 – 6 m. Arctic char and round whitefish also use this type of habitat for spawning, although possibly prefer smaller grain sizes. Near-shore boulder-cobble areas (0-3 m) are generally used as refugia and considered rearing areas for young of the year of all three species that are dependent on the availability of zooplankton, their primary food source. The transition zones between angular substrate and fine sediment (occurring at 3 - 8 m) are important for foraging for juvenile lake trout and arctic char, and juvenile and adult round whitefish which feed primarily on benthos. Adult lake trout are omnivorous and feed at depths up to 35m, in both the near-shore and pelagic zones. Adult arctic char occupy a wide range of depths and were found to largely feed opportunistically in the project lakes on zooplankton. Burbot spawn in shallow water under ice cover, and juveniles follow nocturnal patterns in boulder/cobble littoral zones, while adults typically inhabit deeper areas regardless of substrate. Ninespine stickleback were most commonly found in small ephemeral streams in the region, but were occasionally observed in the project lakes in near-shore rocky shelves. Similarly, slimy sculpin were rarely caught, but are thought to prefer shallow boulder/cobble substrate as juveniles with a shift to moving waters at the outflow or inlets of lakes or streams and deeper water as adults. Overwintering habitat for all lake-dwelling species occurs at depths greater than 3-4 m, because of ice formation.

Arctic grayling and lake cisco utilize the region's streams for migration, spawning, and summery foraging. Preferred spawning areas for Arctic grayling are over pebbles or cobble in small tributaries and lake cisco over large boulders with very little cobble, or rocky segments of main rivers. Foraging occurs in shallow lacustrine zones. These fish do not reach the project lakes because of a lack of larger connecting channels and small tributaries. Although they are not present on the minesite, Arctic grayling and lake cisco are included in the development of species weights in this NNLP (see Section 2.2.4) because a regional approach has been suggested for this HEP component (Minns' review of Meliadine Conceptual NNLP, Feb. 4, 2012). These are important regional species and are known to inhabit areas along the Prince River near Baker Lake, which are included in contingency compensation plans (specifically, Airplane Lake).

1.1.5 Habitat as a Surrogate for Productive Capacity

Since it is necessary in NNL planning to compare relative fish production under current and modified aquatic environments, metrics such as habitat area and suitability are commonly used as surrogates for productive capacity of aquatic systems. The concept of a metric combining both habitat quantity and quality, termed "habitat units" (HUs), was first developed for this purpose by the US Fish and Wildlife Service in the 1980s and has since been adopted by habitat managers throughout Canada.

However, in order to establish quantifiable links between fish production and habitat, fish production must first be measured directly (Minns, 1995) and a habitat-productivity model established. To date, few field studies have specifically examined and validated habitat preferences of North American arctic fish species. A system to provide managers with repeatable habitat suitability indices based on measurable physical properties, such as the scientifically defensible Habitat Suitability Matrix model for fishes of the Great Lakes region (Minns et al. 2001), is not currently available for arctic development projects. With the exception of arctic grayling (Hubert et al. 1985; Jones and Tonn 2004), no habitat models have been validated for Arctic species. Furthermore, while general life history characteristics have been published for Arctic fishes, it is recognized that major gaps even exist in current understanding of northern fish preferences (Richardson et al. 2001), let alone productivity relationships. In order for habitat suitability indices to be developed and used effectively, data on habitat preferences must first be collected and the appropriate models generated (De Kerckhove et al. 2008).

It is therefore important to note that since there is little information on habitat suitability in the north, and few types of habitat enhancements have been evaluated for success, *a priori* estimates of gains in productive capacity are currently highly speculative in many cases. Although studies using fishout data from northern mines have begun to correlate fish production in the north with chemical or physical variables, field validated HSIs may not be available for some time. Until such linkages have been researched and published, NNL planners must rely on related literature and professional judgement in the development of HSIs. While the modified HEP has been the only method of no-net-loss planning used for mining projects in the NWT and Nunavut, it should be recognized that this system is still in the development stages in the Canadian Arctic. Therefore, despite the use of peer-reviewed literature to determine habitat suitability values, it should be noted that significant uncertainty remains when linking specific habitat types to productivity of fish populations.

1.2 HISTORY OF THE NNLP AT MEADOWBANK

Prior to the acquisition of the mining rights for Meadowbank by AEM in 2007, Cumberland Resources Ltd. (Cumberland) had begun baseline studies and permit applications for the site. As a development project that would cause the alteration, disruption or destruction of fish habitat, Cumberland obtained a Nunavut Impact Review Board (NIRB) Project Certificate (No 004 – dated December 30, 2006), which required Fisheries and Oceans

Canada (DFO) approval as part of the Final Environmental Impact Statement. Subsequently, a Fisheries Authorization from DFO (NU-03-0191; Appendix B) for the main portion of the minesite (Second and Third Portage Lakes) was provided to AEM in 2008 following DFO approval of the original NNLP with amendments (Cumberland, 2006; Azimuth, 2007). This plan described the impacts to fish habitat that were expected to occur, and the habitat compensation measures that would be implemented to re-gain the lost habitat. The approved plan was based on the guiding principle of the Policy for the Management of Fish Habitat (DFO, 1986), which stipulates that there will be no net loss of the productive capacity of fish habitat as a result of development activities. Although the Fisheries Authorization was obtained for the Main Minesite Area only (Second Portage and Third Portage Lakes), the original NNLP encompassed all areas of the Meadowbank site. Authorization for the Vault Lake Area was to be sought at a later date. The portion of Second Portage Lake that is used for tailings storage (the Tailings Storage Facility, or TSF) was authorized separately by the DFO and administered by Environment Canada under Section 36 of the Fisheries Act. Because of this historical regulatory separation of the three areas (Main Minesite Area, TSF, and Vault Lake Area), habitat loss and gain calculations are separately addressed and specifically provided for in this assessment.

Following the example of similar mining projects in the north, the original NNLP used a modified Habitat Evaluation Procedure (HEP) to calculate losses and account for them with gains in habitat units. The ratio of losses to gains described in that plan was 1:1 for the Main Minesite, and 1:2 for the TSF. Subsequent revisions and additions were presented (Azimuth, 2007), and the 2008 Fisheries Authorization provided by DFO for the Main Minesite had a loss:gain ratio of 1:1.68. Since the area to be used for tailings storage will be permanently infilled, a ratio of 1:2 was proposed and authorized for the TSF.

In 2010 and 2011, AEM revisited the original NNLP and addendums, and found discrepancies between the number of habitat units described in the plan and those in the Authorization granted by DFO. Specifically, gains for the Second Portage Northwest Basin and Third Portage Basin were estimated at 213 and 565.6 HUs, respectively in the NNLP, but were authorized at 401 and 701.6 HUs in the Fisheries Authorization (it should be noted that HUs were calculated differently in the original plan, and are not comparable to HUs calculated in this assessment). If the numbers reported in the NNLP were used in the Authorization, the total gains (after addition of the East Dike extension habitat and Second Portage habitat mounts presented in the 2007 NNLP Addendum) would have been 928 HUs, for a losses:gains ratio of 1:1.25. Since these discrepancies could not be accounted for by AEM, Cumberland consultants and DFO, the development of a new NNLP for the Meadowbank site was proposed by AEM and approved by DFO.

Furthermore, based on the experiences of AEM onsite, some of the compensation measures described in the original NNL plan do not appear to be feasible as conceptualized due to technically challenging construction. Based on AEM's experience with in-lake dike construction, the compensation features as proposed in the original NNLP have the potential to impact the receiving environment. Specifically, these compensation featured included dike extensions (approximately 19 ha), and six smaller sea mounts, to be

constructed in the open-water area of Third Portage Lake. AEM therefore proposes a number of alterations to compensation measures, as described herein, which avoid increasing the footprint of the mine.

Despite the differences in ratios, AEM has committed to the originally authorized ratio of 1:1.68 for the Main Minesite, and 1:2 for the TSF. The compensation ratio for the Vault Lake Area is proposed in this plan. Since an improved HEP has recently been developed by Golder Associates and AEM for AEM's Meliadine site, with input from DFO in consultation with Dr. Ken Minns, the use of this newer HEP was proposed and approved for the Meadowbank site's updated NNLP as well.

1.3 GOAL AND OBJECTIVES

The main goal of this NNLP is to quantify the losses to productive capacity of fish habitat that will occur as a result of mining activities at the Meadowbank mine, and to propose options to compensate for these losses. For the Main Minesite Area (Second and Third Portage Lakes, not including the TSF), gains should replace losses at a ratio of 1.68:1. For the TSF, gains should be achieved at a ratio of 2:1. The ratio of gains to losses for Vault and Phaser Lakes as a result of Vault Pit development is proposed herein. Following approval, Vault Pit mining activities will require a new, separate authorization.

This goal was addressed by examining the compensation options presented in the original plan, researching techniques and projects implemented at other northern mines, holding workshops and site visits with the local Hunter's and Trapper's Organization, Kivalliq Inuit Association and the DFO Habitat and Science & Research Departments, and reviewing the literature for information on effectiveness of compensation techniques in the north (see Appendix C).

This NNLP is a revision of the document prepared by Cumberland Resources Ltd. in 2006 and forms the basis for a revised Fisheries Authorization for the mine site. It includes all areas covered by the original NNLP, with the exception of the all-weather access road, for which authorization was separate and compensation has already been implemented. HADD areas are described as anticipated under current design plans, which have undergone numerous revisions since 2006. Although the general format of the report is the same, a substantially different HEP is described and used here. This NNLP uses the same supporting studies as referenced in the development of the 2006 document, including species lists, maps of bathymetry and substrate composition. As discussed with DFO, it also proposes similar compensation concepts that include end pit lakes, basin enhancements and dike face habitat. Two new compensation projects are proposed (improved access to the Dogleg and Wally Lake systems), but these are within the scope of similar developments in the north. Where the information in the original plan applies to the current situation (e.g. environmental setting, fish assemblage assessment), it is referenced and summarized here.

Compensation measures for this NNLP take into account the DFO's hierarchy of preferences for compensation types throughout Canada. These are:

- Create or enhance like-for-like habitat onsite or near site

- Create or enhance unlike habitat onsite or near site
- Create or enhance habitat away from site
- As a last resort:
    - artificial production techniques to maintain a stock of fish
    - deferred compensation
    - restoration of chemically contaminated sites

Based on these preferences and akin to the original NNLP (Cumberland, 2006), onsite habitat compensation was considered optimal, and form the majority of the compensation plan and contingency options.

SECTION 2 • HABITAT EVALUATION PROCEDURE

The guiding principle of the Fisheries Act's "Policy for the management of fish habitat" (1986) is that there will be no net loss of the productive capacity of fish habitat as a result of development activities. Productive capacity is defined as "the natural maximum capability of habitats to produce healthy fish, safe for human consumption, or to support or produce aquatic organisms upon which fish depend." Although any proponent who may cause harmful alterations, disruptions or destructions (HADDs) to fish habitat must quantify losses and propose compensation measures if they are to obtain authorization from DFO, the Act does not provide any stipulations as to how productive capacity of fish habitat is to be calculated.

Most commonly, a Habitat Evaluation Procedure (HEP) is used which involves the multiplication of each HADD area (in ha) by a habitat suitability index (HSI) and series of fish species weights in order to derive a value in habitat units (HUs) that describes both the quality and quantity of habitat. A version of this basic model was used in the original NNLP, and an updated model developed by Golder Associates and AEM is used here.

2.1 OVERVIEW

In 2011/2012, a Habitat Evaluation Procedure method was developed by Golder Associates and AEM for use at AEM's Meliadine site (as first presented to DFO at the Meliadine NNLP workshop, Nov. 17, 2011). This model was reviewed by DFO in consultation with Dr. Ken Minns (Meliadine NNLP review document; February 4, 2012), and the same approach was approved for use in the updated Meadowbank NNLP (emails from DFO; March 30, 2012 and July 19, 2012). See Appendix C for documentation of consultation.

In the first stage, of the habitat evaluation, pre-construction (natural, or baseline) habitat units are calculated for all areas of the mine site where a HADD will occur. These are referred to as "losses". Changes to habitat units occurring for each area post-closure are then calculated in the second stage based on mine construction designs, and incorporating any habitat compensation features, to determine the total number of habitat units present after mining ("gains"). To meet the conditions of the DFO Fisheries Authorization (NU-03-0191, July 30, 2008) granted for the Main Minesite Area, it was agreed that the loss:gain ratio for this revised NNLP would remain at 1:1.68. For the TSF, this ratio will remain at 1:2. The ratio for the Vault Lake Area is presented in this NNLP.

The net HUs will depend on the habitat type (11 groups, by substrate and depth) that is lost and gained in each area, and the suitability of that habitat type for each fish species. Suitability of each habitat type is ranked between 0-1 for each life stage of each fish species (spawning, nursery, foraging, overwintering).

For each minesite feature (e.g. pits, dikes, roads) where losses or gains are expected to occur, HUs are calculated by multiplying the area of each habitat type in that feature by the HSI allotted to each life function of each fish species, multiplied by the species weight

and life function weight, and summed. This subtotal is then multiplied by an access factor, which represents the accessibility of the area to each species, and a habitat co-factor which describes changes in hydrological, thermal or chemical water quality. The HEP model is described in further detail below, and an example calculation is provided in Appendix A.

2.2 HEP MODEL

The HEP model used here can be described, for each fish species (spp 1-n) as:

$$\mathbf{HU}_{spp\ 1\text{-}n} = \sum_{HT\ 1\text{-}11} \left(\sum_{sp,nu,fo,ow}(\mathbf{HT}_{1\text{-}11} \times \mathbf{HSI}_{sp,nu,fo,ow} \times \mathbf{life\ function\ weight} \times \mathbf{species\ weight})\right]) \times \mathbf{habitat\ co\text{-}factor} \times \mathbf{access\ factor}$$

Where $HT_{1\text{-}11}$ = area (ha) of habitat types 1 through 11

$HSI_{sp,nu,fo,ow}$ = habitat suitability index for each life function:

- sp = spawning use
- nu = nursery use
- fo = foraging use
- ow = overwintering use

The original model developed by Golder Associates and AEM (2011) did not include HT 11, and did not include the habitat co-factor and access factor terms. These last two factors were suggested in the review by Dr. Ken Minns and presented in a memo to DFO, dated June 7, 2012 and in the draft NNL Plan submitted to DFO for review on June 15, 2012. These are practical additions to the model, which improve the transferability between projects, providing fisheries managers improved ability to evaluate habitat gains and losses for a variety of development projects in the north. The habitat types proposed for use in the Meadowbank model, and the two new factor terms are discussed below.

2.2.1 Habitat Type Area ($HT_{1\text{-}11}$)

The foundation of the HEP is the delineation of "habitat types" – the method by which habitat areas are grouped, and thereby mapped. The Meadowbank HEP model proposes 11 habitat types, which are based on various combinations of substrate and depth. Habitat types 1-9 are applied to natural habitat for various combinations of substrate type and depth zone. Habitat type 10 is included in the HEP in recognition of reduced habitat quality in end pit lakes as a result of pit water stratification and monimolimnion development. Habitat type 11 is applied in end pit lakes where permanent stratification is not predicted, and water quality is expected to be more suitable for aquatic biota. The development of HSIs for this habitat type is discussed in Section 2.2.2. Substrate and depth zones associated with each habitat type are shown in Table 2-1.

Table 2-1. Physical characteristics of the habitat types proposed for the Meadowbank HEP.

Habitat Type	Depth Zone	Substrate	Use
1	0-2m	Fine	Loss/Gain
2	0-2m	Mixed	Loss/Gain
3	0-2m	Coarse	Loss/Gain
4	2-4m	Fine	Loss/Gain
5	2-4m	Mixed	Loss/Gain
6	2-4m	Coarse	Loss/Gain
7	>4m	Fine	Loss/Gain
8	>4m	Mixed	Loss/Gain
9	>4m	Coarse	Loss/Gain
10	>10m	None	End pit lake with monimolimnion
11	>10m	None	End pit lake, without monimolimnion and with WQ suitable for aquatic biota

In order to calculate the extents of each habitat type, depth zones and substrate were mapped for the entire Meadowbank site, for pre- and post-closure scenarios. All habitat type area calculations and mapping were completed by Dougan and Associates, as described in further detail below.

2.2.1.1 Substrate Mapping

The pre-construction maps of substrate for this updated NNLP were based on GIS files used in the original 2006 NNLP. As described in that document, aerial photography and underwater imagery were used to delineate areas dominated by the following substrate classes: boulder, boulder/cobble, sediment with boulder/cobble and sediment fines. GIS files containing only this sediment information were not available, so the substrate zones mapped for this updated assessment were based on the “habitat type” maps from 2006. Table 2-2 shows these “habitat types” from 2006, and the corresponding Golder/AEM model substrate type. Further descriptions of these “habitat types” can be found in Cumberland, 2006.

Table 2-2. Substrate category conversion for 2012 mapping from Cumberland (2006) "habitat types".

Golder/AEM HEP (2012) Categories	Cumberland (2006) Categories
Fines	Sediment Basin AND Sediment Apron
Mixed	Mixed Sediment Apron
Coarse	Boulder Apron AND Boulder Shoal AND Boulder Platform

2.2.1.2 Depth Zone Mapping

The mapping of depth zones for the minesite and TSF was based on GIS files used in the original 2006 NNLP (Cumberland, 2006). As described in that document, bathymetric maps were developed from aerial photography, underwater imagery and field measurements. For the Vault and Dogleg areas, depth zones were based on bathymetric surveys completed by AEM in August of 2010 and 2011 and mapped by Dougan and Associates.

2.2.1.3 Habitat Type Mapping

Habitat type areas were determined by overlaying depth and substrate layers. This was done for each minesite feature, in both the pre- and post-closure scenario in order to calculate losses and gains of each habitat type.

2.2.1.4 End Pit Lakes as Habitat Compensation in the North

The inclusion of habitat types specific to pits in this HEP implies that end pit lakes can provide suitable habitat for fish populations in the Arctic. While the creation of end pit lakes from mining operations is common in temperate regions of Canada, this practice is relatively new to the north. To date, the only no-net-loss plans found proposing re-flooding of excavated pits for use as fish habitat in the Northwest Territories or Nunavut were for Diavik Diamond Mine. As a result, few observational studies have been published to date examining fish populations or habitat suitability in Arctic pit lakes. Nevertheless, the use of end pit lakes for fish habitat in the north has historically been promoted (e.g. DFO, 2003; 2007), and since these lakes may present a viable option for habitat compensation, this avenue should continue to be explored.

Until further information is available from northern pit lakes, much can be interpolated from principles of limnology that apply in the south. Where end pit lakes studies have been conducted, reports of the re-establishment of successful fish populations are available. For example, the ability of re-habilitated end pit lakes at former coal mine pits

in Alberta to support fish populations has been observed and discussed (e.g. Hatfield Consultants, 2011). In 2009, Gammons et al. published a comprehensive review of considerations for the development of lakes from pits in the north. While the lack of information regarding the aquatic biology of these systems is recognized, a number of major factors that should be considered for fish survival are presented. These are discussed in the context of the Meadowbank pits, below, to indicate rationale for inclusion of this as a unique habitat type.

Stratification

The lakes of the Meadowbank area where pit development is occurring are naturally holomictic like many northern lakes. The development of meromictic conditions in pit lakes is a consideration in predicting fish productivity. This condition is more likely in pits, as the depth to width ratio increases (Gammons et al. 2009). While full mixing has the benefit of evenly distributing chemical elements, this may be undesirable if it occurs suddenly and unfavourable concentrations of contaminants or dissolved gases that have accumulated in the stratified layer at depth are moved to surface layers (Boehrer and Schultze, 2006).

The development and dispersal of stratified conditions can be determined through modeling, as completed for the Meadowbank site in Golder (2005). At the end of the 5-year re-flooding period, a density-based chemocline is predicted to be present in Portage Pit, due to inflow of high-TDS groundwater, creating meromictic conditions. However, the monimolimnion would only comprise 2% of the lake volume, and would be temporary. Over four years, the monimolimnion is predicted to dissipate slowly, and holomictic conditions would be restored. While modeling was only completed for the Portage Pit, conditions in the Bay-Goose and Vault Pits are expected to be similar (Golder, 2005).

Water quality

The ability of pit lakes to support viable fish populations depends on the maintenance of adequate water quality, including factors such as pH, DO, salinity, turbidity and concentrations of nutrients and potentially toxic elements. Depending on the local mineralogy, pit lakes formed from gold mines may contain heavy metals, which may cause toxicity in fish if concentrations are high enough (Gammons et al. 2009). Availability of metals is predominantly controlled by pH. As a result, it has been generalized that pit lakes with low to moderate acidity have a good chance of being restored to a beneficial ecological end use (Nixdorf et al. 2005 in Gammons et al. 2009). The rapid re-filling of pit lakes after mining is recommended to reduce the time available for oxidation of the rock face, thereby decreasing potential for acidic conditions (Castro and Moore, 2000). Further impacts on aquatic life may result from differences in salinity, turbidity, DO and nutrient concentrations. Many processes act together to control these components of water chemistry, and each has implications for fish populations in northern pit lakes. For example, pit lakes often have a higher chemical oxygen demand (COD) than natural lakes, due to dissociation of iron ions in the deep, anoxic monimolimnion, and oxidation in the hypolimnion (Gammons et al. 2009). As a result, fish in these lakes may be more susceptible

to winterkill, when ice cover prevents oxygen exchange at the surface. Since each pit's morphology and mineral deposit is different, predictions of water quality parameters need to be made individually, as performed for the Meadowbank pits in 2005 (Golder, 2005).

Based on results of modeling, end pit water quality at the Meadowbank site will be similar to un-impacted areas, and suitable for fish in the long-term (i.e., >25 years; Golder, 2005). Golder (2005) predicted that post-closure, re-flooded pit lake water quality will meet MMER concentrations and nearly all CCME criteria (with the exception of cadmium and zinc at a steady state). The predicted concentrations of these metals are similar to background levels of water quality (see Azimuth, 2012) and therefore water quality following re-flooding is not expected to affect aquatic biota. Furthermore, prior to breaching, flooded pits and basins will be monitored and managed until the water quality is considered suitable for mixing with adjacent lakes.

Temperature and Sunlight

Cold temperatures in northern climates result in some specific considerations for pit lakes in that region. The temperature of the bottom layer of stratified lakes (hypolimnion or monimolimnion) is theoretically 4°C, the temperature at which water reaches its maximum density. This should occur in both temperate and northern climates (Gammons, 2009). Ice cover, however, persists much longer in arctic lakes. This can increase chances of oxygen depletion, leading to fish winterkill, particularly if COD is elevated as a result of anoxic conditions in the monimolimnion. Further, ice formation can cause increased salinity in the deep pits through the process of thermohaline convection. Ice melting then intensifies the layer of lower-density water at the surface, resulting in density-stratification, and increasing the chances of meromictic conditions (Gammons, 2009). As descried above, water quality (DO) is predicted to be high in the Meadowbank pit lakes, and stratification is expected to dissipate after 4 years. Furthermore, the Meadowbank regions consists predominantly of large, oligotrophic water bodies, such that the pits formed here by deepening existing lakes are relatively consistent with the regional limnology.

Ice cover also reduces the amount of solar radiation that reaches the water column. This along with extreme seasonal variability in the north, results in photosynthetic processes that are slowed, and primary production, which supports the aquatic food web, declines. However, this phenomenon may actually be beneficial to end pit lake use in the north. While rates of primary production may initially be considered slow in temperate-climate pit lakes, northern lakes are commonly highly oligotrophic in their natural state (Gammons, 2009). Since local biota are adapted to nutrient- and light-depleted conditions, production in pit lakes in this region would be expected to mimic surrounding lakes more rapidly.

Habitat Diversity

Since fish require different types of habitat for different life functions, the availability of diverse substrates and depth zones is important for maximum population productivity. In many pit lakes studied to date, the low habitat diversity relative to nearby natural lakes is

the biggest differentiating factor. Assuming adequate water quality, it is generally recommended that the successful restoration of pits for use as fish habitat needs to include provisions for habitat diversity. Suggested methods include such additions as logs, rock piles, macrophyte beds or artificial islands (Gammons et al. 2009). While the applicability of each of these methods is clear in temperate climates, many have limitations in Arctic regions. In areas above the tree-line, the addition of log piles would not be in keeping with natural systems. Similarly, lakes in this region contain few macrophytes. Of the reclamation strategies mentioned, rock fill presents the greatest utility and most common application in northern no-net-loss plans for mines (e.g. Diavik, Jericho, Doris North, Meadowbank). This typically occurs in the form of artificial reefs or shoals constructed in deep water, soft sediment basins, in an effort to improve habitat quality.

Along with these additions, various methods for re-contouring pit dimensions have been suggested to produce more natural systems. These may include sloping pit walls, excavation of littoral bays, or pit backfilling (Gammons et al. 2009). While re-sloping pit walls and the construction of shallow littoral zones has been implemented in north-temperate regions (e.g. Brinker et al. 2011), and are feasible options further north, no records of the use of these methods to date were found in the north. As well, re-flooded pit areas will be well connected to shallow basins and enhanced littoral areas to provide habitat diversity. Similarly, backfilling deep pits to more natural depths with waste rock is a theoretically viable technique. This option is proposed at Meadowbank, and with approximately 30% of the final pit areas to be filled to a depth of at least 4-10 m, will significantly reduce the proportion of ultra-deepwater areas, and will provide improved habitat suitability. Further details of habitat improvements to end pit lakes at Meadowbank are discussed in Section 4.

2.2.2 Habitat Suitability Index ($HSI_{sp,nu,fo,ow}$)

The habitat suitability term represents the relative quality of each habitat type for each life function of each fish species present in the region. In the case of this HEP, the life functions spawning, nursery, foraging and overwintering were considered. In this HEP, habitat suitability is indicated through a ranking of 0, 0.25, 0.5, 0.75 or 1.

HSIs for 10 habitat types were developed by Golder/AEM for the Meliadine site, and were approved by DFO. HSIs are generally developed based on literature reviews, and should apply regionally. Since no additional fish species are present at the Meadowbank site, no supplements or changes were made to the HSIs prepared by Golder/AEM for these 10 habitat types. However, with the addition of HT11 here, HSIs needed to be developed for this habitat type. HSIs for HT11 were generally based on HT9 (> 4 m, coarse substrate), with amendments as necessary based on literature review. Although the affected lakes at Meadowbank are naturally deep, and therefore HT9 incorporates depths up to 40 m, it is recognized that the much deeper pit areas (portions of the pit that may be up to 200 m deep) cannot be considered in the same habitat classification. HSIs for HT11 were determined based on predicted water quality and habitat diversity in the end-pit lakes, as

discussed above, along with a review of the literature with respect to habitat preferences for the Meadowbank fish species. A summary of this review, along with the HT9, 10 (for reference) and 11 HSIs are presented in Table 2-3. Since no new information was found for overwintering habitat preferences, the preferences described in the 2006 NNLP (Cumberland, 2006) are shown, although these were generally unreferenced. HSIs for all fish species and habitat types used in this HEP are shown in Table 2-4.

Table 2-3. Summary of habitat preferences for Meadowbank region species, mainly from Richardson, 2001. Habitat type 9 (HT 9; > 4m, coarse substrate) and 10 (HT 10; pit habitat for application in monimolimnic conditions) and 11 (HT11; pit habitat for application in holomictic conditions) HSIs developed by Golder Associates and AEM. YoY = young of the year.

Fish	Overwintering	Foraging (adults)	Spawning	Nursery (larvae or young)
Lake trout	Juvenile - coarse, <8m Adult - basin, >8m (Cumberland, 2006)	>10m, pelagic (Richardson, 2001)	Over gravel, cobble etc. (free of fines), 0.12-55m up to 100m (Richardson, 2001)	YoY – benthic sandy; Juvenile – benthic cobble/boulder; <0.3m above bottom (Richardson, 2001)
HT 9 HSI	*1*	*1*	*1*	*0.5*
HT 10 HSI	*0.75*	*0.5*	*0*	*0*
HT 11 HSI	*1*	*1*	*0.5*	*0*
Arctic char	Shift from pelagic to benthic in fall (Cumberland, 2006)	Pelagic (Richardson, 2001)	Gravel, cobble, 2-10 m (Richardson, 2001)	Boulder/cobble; Littoral or pelagic; often deeper benthic (>5 m) (Richardson, 2001)
HT 9 HSI	*1*	*1*	*1*	*0.5*
HT 10 HSI	*0.75*	*0.25*	*0*	*0*
HT 11 HSI	*1*	*1*	*0*	*0*
Round whitefish	Estimated to be the same as lake trout (Cumberland, 2006)	Rocky/boulder, 7-22m, benthic (Richardson, 2001)	Gravel/rubble; typically <1m, sometimes 5-10m (Richardson, 2001)	Rock, sand, gravel, 1.5-4.5m (Richardson, 2001)
HT 9 HSI	*1*	*0.5*	*0.75*	*0.5*
HT 10 HSI	*0.75*	*0*	*0*	*0*
HT 11 HSI	*1*	*0.25*	*0*	*0*

Fish	Overwintering	Foraging (adults)	Spawning	Nursery (larvae or young)
Burbot	Adults - deeper, juveniles like coarse substrate; more active in winter (Cumberland, 2006)	Benthic (Bennett, 2006) Boulder, rubble, cobble, sand (Richardson, 2001) Adults observed up to 213 m in lakes (Ford, 1995)	Sand, gravel, rubble, 0.5-3 m; sometimes much deeper (Richardson, 2001)	Larvae – pelagic; YoY - benthic littoral, rock/gravel (Richardson, 2001)
HT 9 HSI	*1*	*1*	*0*	*0*
HT 10 HSI	*0.25*	*0.25*	*0*	*0*
HT 11 HSI	*1*	*1*	*0*	*0*
Slimy sculpin		Benthic (Bennett, 2006) 0.5-210 m, gravel, rock (Richardson, 2001)	Sand, gravel, rock, <1.5 m (Richardson, 2001)	Young – 0.5-1.5 m, sand/gravel; moving slightly deeper with age (Richardson, 2001)
HT 9 HSI	*1*	*0.5*	*0.5*	*0.5*
HT 10 HSI	*0.25*	*0*	*0*	*0*
HT 11 HSI	*1*	*0.5*	*0*	*0*
Ninespine stickleback	Deeper (Richardson, 2001)	Benthic (Bennett, 2006) Generally shallow, but seen at depths to 70m in Lake Superior (Richardson, 2001)	Shallow, but seen up to 40m (Richardson, 2001)	Shallow (Richardson, 2001)
HT 9 HSI	*1*	*0*	*0*	*0*
HT 10 HSI	*0.75*	*0*	*0*	*0*
HT 11 HSI	*1*	*0*	*0*	*0*

Fish	Overwintering	Foraging (adults)	Spawning	Nursery (larvae or young)
Arctic grayling	Deep pools of rivers, deeper portion of lakes (Richardson, 2001)	Sand, silt, gravel; <3 m (Richardson, 2001)	Streams; gravel, rock; 0.7 m (Richardson, 2001)	Lotic or littoral, 0.2-0.4 m; boulder (Richardson, 2001)
HT 9 HSI	*1*	*1*	*0*	*0*
HT 10 HSI	*0.5*	*0*	*0*	*0*
HT 11 HSI	*1*	*0*	*0*	*0*
Lake cisco	N/A	Pelagic, 10-60 m (Richardson, 2001)	Commonly sand, gravel, but wide range; 1- 5 m, up to 140 m (Richardson, 2001)	Larvae – shallow rocky Young – pelagic (Richardson, 2001)
HT 9 HSI	*1*	*0.75*	*1*	*0.25*
HT 10 HSI	*0.75*	*0.75*	*0*	*0*
HT 11 HSI	*1*	*0.75*	*0.25*	*0*

Note- HT9-11 were developed and refined in response to DFO review (DFO, July 2012)

Table 2-4. Proposed HSI values for the Meadowbank region fish species (sp=spawning, nu=nursery, fo=foraging, ow=overwintering). HSI values for habitat types 1-10 are identical to those proposed previously for the Meliadine HEP. Habitat type 11 is added for use in pits where mixing will occur, and water quality is expected to remain similar to baseline conditions.

Habitat Type	Depth	Substrate	Arctic Char				Lake Trout				Round Whitefish			
			SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	<2 m	Fines	0	0.25	0.25	0	0	0.25	0.25	0	0	0.25	0.75	0
2	<2 m	Mixed	0	0.25	0.25	0	0	0.5	0.5	0	0	0.75	0.5	0
3	<2 m	Coarse	0	0.5	0.5	0	0	1	0.75	0	0	0.75	0.5	0
4	2-4 m	Fines	0	0.5	0.5	0.75	0	0.5	0.5	0.75	0	0.25	1	0.75
5	2-4 m	Mixed	0.5	0.75	0.75	0.75	0.5	0.75	0.75	0.75	0.5	0.75	0.75	0.75
6	2-4 m	Coarse	1	1	1	0.75	1	1	1	0.75	1	1	0.75	0.75
7	>4 m	Fines	0	0.25	0.5	1	0	0.25	0.5	1	0	0.25	1	1
8	>4 m	Mixed	0.5	0.5	0.75	1	0.5	0.5	0.75	1	0.25	0.25	0.5	1
9	>4 m	Coarse	1	0.5	1	1	1	0.5	1	1	0.75	0.5	0.5	1
10	>10 m	None	0	0	0.25	0.75	0	0	0.5	0.75	0	0	0	0.75
11	>10 m	None	0	0	1	1	0.5	0	1	1	0	0	0.25	1

Habitat Type	Depth	Substrate	Burbot				Slimy Sculpin				Ninespine Stickleback			
			SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	<2 m	Fines	0	0.25	0.25	0	0	0	0.25	0	1	1	1	0
2	<2 m	Mixed	0	0.75	0.5	0	0.25	0.25	0.5	0	0.5	0.5	0.75	0
3	<2 m	Coarse	0	1	0.5	0	1	1	1	0	0	0.25	0.75	0
4	2-4 m	Fines	0	0.25	0.25	0.75	0	0	0.25	0.75	0	0	0.5	0.75
5	2-4 m	Mixed	1	0.5	0.75	0.75	0.25	0.25	0.5	0.75	0	0	0.25	0.75
6	2-4 m	Coarse	0.75	0.5	1	0.75	0.75	0.75	1	0.75	0	0	0.25	0.75
7	>4 m	Fines	0	0	0.25	1	0	0	0	1	0	0	0	1
8	>4 m	Mixed	1	0	0.75	1	0	0	0.25	1	0	0	0	1
9	>4 m	Coarse	0.75	0.25	1	1	0.5	0.5	0.5	1	0	0	0	1
10	>10 m	None	0	0	0.25	0.25	0	0	0	0.25	0	0	0	0.75
11	>10 m	None	0	0	1	1	0	0	0.5	1	0	0	0	1

Habitat Type	Depth	Substrate	Lake Cisco				Arctic Grayling			
			SP	NU	FO	OW	SP	NU	FO	OW
1	<2 m	Fines	0	0.25	0.5	0	0	0.25	0	0
2	<2 m	Mixed	0	1	1	0	0	0.25	0.25	0
3	<2 m	Coarse	0	1	1	0	0	0.5	0.25	0
4	2-4 m	Fines	0	0.25	0.75	0.75	0	0	0.5	0.75
5	2-4 m	Mixed	0.25	0.5	1	0.75	0	0	1	0.75
6	2-4 m	Coarse	0.75	0.75	0.75	0.75	0	0	1	0.75
7	>4 m	Fines	0	0	0.75	1	0	0	0.5	1
8	>4 m	Mixed	0.5	0.25	1	1	0	0	1	1
9	>4 m	Coarse	1	0.25	0.75	1	0	0	1	1
10	>10 m	None	0	0	0.75	0.75	0	0	0	0.5
11	>10 m	None	0.25	0	0.75	1	0	0	0	1

Note- HT9-11 were developed and refined in response to DFO review (DFO, July 2012)

2.2.3 Life Function Weight

Consistent with the Meliadine NNLP method, in this HEP, life function weights were equal, at 0.25 each for spawning, nursery, foraging and overwintering.

2.2.4 Species Weight

The overall species weights used in this method sum to 1 across species, and are comprised of a biomass weighting and a fisheries value weighting:

Species weight = (biomass weight/2) x (fisheries weight/2)

These two components are described below.

2.2.4.1 Biomass Weight

In the case of the Meadowbank assessment, biomass weights for all areas onsite are based on the average proportional biomass observed in the Second Portage Lake and Third Portage Lake fishouts. These biomass proportions are site-specific and known with certainty, while fish surveys are relatively limited in other area lakes. Furthermore, for all mine-affected lakes other than Second Portage and Third Portage, fish assemblages are expected to change following the implementation of compensation measures that improve access between lakes. Specifically, these access improvements are proposed to facilitate the movement of arctic char from W3 into Wally, Vault and Phaser Lakes (see Section 5). All of these lakes would then have the potential to contain the same diverse species assemblages as found in Second and Third Portage Lakes (and many other regional lakes). It should be noted that few small-bodied fish have been caught in fish surveys to date; however they are conservatively assumed to be present in all lakes as they were common in stomach contents. For reference, studies conducted in each lake and the baseline biomass proportions observed in each study are shown in Table 2-5. Studies were not necessarily of equal fishing effort. Details of specific efforts in the 2012 supplementary surveys for which the reference report has not yet been developed, are described in the relevant sections throughout this document.

Table 2-5. Most detailed information available regarding fish populations (biomass, abundance or presence), reference study, biomass summary and method of determination for HEP biomass weighting for each lake at the Meadowank site examined in this NNLP. Biomass is presented as total weight for fished out areas, or by proportion of biomass in the most recent study (%) for other areas. LKTR = lake trout; RNWH = round whitefish; ARCH = arctic char; BURB = burbot; NNST = ninespine stickleback.

Lake/Pond	Biomass, abundance or presence-absence	Study	Biomass Summary	Biomass weight in HEP based on:
Second Portage Lake	Biomass	2008 Fishout Report	715 kg LKTR 74 kg RNWH 295 kg ARCH 30 kg BURB	Actual value
Third Portage Lake	Biomass	2010 Fishout Report	119 kg LKTR 87 kg RNWH 52 kg ARCH 25 kg BURB 0.03 kg NNST	Actual value
Vault Lake	Biomass	Appendix E; BAEAR, 2005	93% LKTR 7% RNWH	Fish composition will change after connection to Wally. 2PL+3PL average used in calculations.
Phaser Lake	Biomass	Appendix E; BAEAR, 2005	67% LKTR 32% RNWH 1% BURB	Fish composition will change after connection to Wally. 2PL+3PL average used in calculations.
Dogleg Pond	Biomass	Appendix E; AEM, 2010; BAEAR, 2005	40% LKTR 60% RNWH	Fish composition will change after connection to Second Portage Lake. 2PL+3PL average used in calculations.
Dogleg North Pond	Abundance	AEM, 2010; BAEAR, 2005	No fish	Fish composition will change after connection to Second Portage Lake. 2PL+3PL average used in calculations.
NP-2	Presence/absence	BAEAR, 2005	LKTR only	Fish composition will change after connection to Second Portage Lake. 2PL+3PL average used in calculations.

Lake/Pond	Biomass, abundance or presence-absence	Study	Biomass Summary	Biomass weight in HEP based on:
Wally Lake	Biomass	Appendix E	95% LKTR 5% RNWH	Fish composition will change after connection to W3. 2PL+3PL average used in calculations.
W3	Biomass	Appendix E	87% LKTR 10.6% RNWH 2.4% ARCH	N/A (no losses/gains in this area)

2.2.4.2 Fisheries Weight

Fisheries weights reflect the relative value of each species for subsistence fishing. There are no commercial fisheries in the project lakes area. Fisheries weights sum to 1 across species. The values used here were developed by Golder Associates (Table 2-6).

Table 2-6. Fisheries weightings for AEM's Meliadine site, as developed by Golder Associates and AEM, and applied to Meadowbank.

Species	Weight
Arctic char	0.50
Lake trout	0.25
Round whitefish	0.05
Burbot	0.05
Slimy sculpin	0
Ninespine stickleback	0
Lake cisco	0.05
Arctic grayling	0.10

2.2.5 Habitat Co-factor

The habitat co-factor represents any changes to non-mapped habitat quality (thermal, hydrological, biological or chemical regimes) that will occur in the fish habitat in question post-closure. The use of this factor is suggested by Dr. Ken Minns, and his suggested values as presented in a workshop for DFO in February, 2012 (Minns, 2012), are shown in Table 2-7.

Table 2-7. Habitat co-factor for various pre- and post-compensation scenarios, according to Minns, 2012.

Change in regime	Description	Pre-compensation factor	Post-compensation factor
Degradation (expected)	Thermal, hydrologic, chemical and/or biological regime shifts away from preferred state for fish habitat	1	> 0 and < 1
No change	-	1	1
Enhancement (anticipated or proposed)	Thermal, hydrologic, chemical and/or biological regime expected to shift towards preferred state for fish habitat	> 0 and < 1	1

While the habitat co-factor has not been used to date in practice in the arctic, it is an appropriate weighting when remediation of non-pristine lakes is proposed as compensation. When there is no change in habitat quality pre- and post-mining, the weighting is 1 for both loss and gain calculations. This factor is therefore not an integral part of any compensation calculation that does not affect water quality. In this assessment, the habitat co-factor is only included in calculations for one option in the contingency plan (see Section 7). The derivation of the co-factor values is on a site-specific basis, and is discussed in more detail in that section.

2.2.6 Access Factor

Minns (2012) suggests the use of an access factor when fish assemblages are expected to change between the pre- and post-compensation scenarios. According to Minns (2012), the access factor is 1 for any species present in the habitat area, and 0 for any species not present. Each species receives an access factor in both the pre- and post- calculations (Table 2-8). Therefore, the opening of access to a habitat area for a species post-closure (that did not have access pre-construction), results in a gain of habitat units. Similarly, the loss of access results in a loss of habitat units. These gains or losses may be complete (affect all species, e.g. conversion to a tailings storage facility), or partial (only some species are affected).

Note that presence or absence of a species pre-construction is based on monitoring studies in the affected habitat area, whereas presence or absence in the post-closure scenario is anticipated (to be confirmed after access is altered as part of compensation monitoring).

Table 2-8. Access factor applied to each species, pre- and post-compensation, based on presence/absence (or anticipated presence/absence, for post-compensation).

Scenario	Pre-compensation	Post-Compensation
Species Present	1	1
Species Not Present	0	0

2.2.6.1 Potential for impacts to resident fish populations

To date the access factor has not been used in NNLPs in the Arctic, but it may be a particularly valuable component in this setting. It is well known that increased species diversity can increase system productivity as a result of optimal resource use (Cleland, 2011). Many isolated lakes or ponds are found in the region of the Meadowbank minesite, and a number contain only one or two species of fish. Since different species utilize different habitat niches, the introduction of a species through access enhancements could result in an increase in the total fish population, provided an under-utilized habitat niche is available and is suitable for the new species.

In the context of the Meadowbank site, access enhancements are suggested to allow native fish species to populate areas that have historically become isolated (mainly, W3 to Wally, Vault and Phaser Lakes). In both of these cases, current large-bodied fish populations in the isolated lakes consist of round whitefish and lake trout. Planned enhancements to connecting channels and access to end-pit-overwintering habitat in Vault Lake will allow arctic char to populate these areas as well. This species assemblage occurs frequently in the region (e.g. Second Portage Lake, Third Portage Lake, Turn Lake, Tehek Lake, Inuggugayulik Lake, Amarulik Lake (BAEAR, 2005)).

Although sympatric populations of arctic char, lake trout and round whitefish commonly occur in this area, potential negative impacts on resident fish populations that may occur with the addition of char are examined and discussed here. While it is recognized that small-bodied fish species are likely present as well, the following discussion focuses on these three large-bodied fish, since they comprise >99% of fish biomass in Meadowbank area lake surveys and fish-out programs.

Not surprisingly, no information could be found in the published literature regarding species dynamics when arctic char are introduced into lake trout/round whitefish systems. In the absence of observational evidence, an examination of the potential for niche use overlap between these species may provide insight into possible effects at the population level.

Firstly, niche segregation and resource partitioning in arctic fish species have been documented through both observational and experimental studies in northern European lakes. For example, Amundsen et al. (2010) found that where they co-occur, arctic char, European whitefish and arctic grayling have distinctly separate patterns of macrohabitat and microhabitat use, as well as different diets. Haugen and Rygg (1996) discuss similar patterns in sympatric brown trout and arctic grayling populations.

Through 7+ years of surveys of fish populations in the Meadowbank area, including analysis of stomach content and stable isotopes, the trophic structure of fish populations has been well established. Lake trout occupy the apex predator position, and feed cannibalistically on juvenile lake trout as well as other small fishes. Round whitefish occupy littoral zones, feeding primarily on benthos at all life stages. Arctic char have been found to exhibit a pelagic lifestyle, and feed opportunistically on zooplankton, which has no other adult predator in these lakes. In general, the literature indicates that char are inferior competitors in populations with other large-bodied fishes (e.g. Forseth et al. 2003; Amundsen et al. 2010), suggesting that the provision of access for this species would not significantly impact the productivity of resident fish.

While it would have been optimal to compare trophic position of lake trout and round whitefish in the absence of char as well as in their presence, so as to examine habitat niche changes *a priori*, site specific studies regarding this effect have not been conducted at Meadowbank. However, Cott et al. (2011) studied trophic position of fish species in the Yellowknife, NWT area, and found that these lakes contained burbot and lake trout in the top trophic piscivores, northern pike as an intermediate piscivore, and lake whitefish as lower-trophic benthic feeders. Inferring from this information that lake trout and round whitefish occupy the same habitat niches in the absence of arctic char as in their presence, it may be assumed that introduction of char would not substantially impact production of other large-bodied fish.

Furthermore, a recent study indicated that benthic production does not appear to be coupled to pelagic production in Arctic lakes (Hershey et al. 2006). In this report, near-shore benthic invertebrates relied primarily on allochthonous production, and nutrient additions that increased phytoplankton density did not affect their growth. Along with the knowledge that char do not compete directly with other large-bodied fish for specific food resources, this information further indicates that supplies of nutrients for benthic littoral resources (food for round whitefish) and pelagic resources (food for arctic char) are different. Thus, the increased consumption of zooplankton by char is unlikely to even indirectly affect the availability of food resources for (e.g.) round whitefish.

Although the above discussion provides indication that char would not negatively impact lake trout and round whitefish, it is possible that arctic char may not themselves be productive in the newly accessible lakes. While this may not be an inherent factor in NNL planning using the common HEP method (because HEPs evaluate the productive capacity of a system based on habitat availability, not species interactions), the ability for a species to be productive in its new environment remains uncertain. To address this issue, reasons for the current lack of arctic char in these systems are discussed below.

While arctic char are present in a number of lakes near the Meadowbank site, specific reasons for their presence or absence are unknown. Hershey et al. (1999) suggest that lake trout may be outcompeting char in the Toolik Lake region of Alaska. This was confirmed through an analysis of landscape factors affecting fish species distribution in lakes. It was found that altitude (not a factor in the Meadowbank region) and lake depth predicted arctic char presence 92% of the time. Specifically, lakes > 6.2 m were predicted to

contain char. Deep pelagic zones as a habitat preference for char is supported elsewhere in the literature as well (Richardson et al. 2001). If this concept is extrapolated to the Meadowbank area, it may be that where lake depth is sufficient, char are able to fill the pelagic niche and most effectively compete with lake trout for food resources. This would explain their relative absence from lake areas with little deepwater habitat (Dogleg, Vault, Phaser and Wally Lakes). Following construction of the Portage and Vault Pits, deepwater habitat would be accessible for char in all areas where access enhancements are proposed, removing that potential restriction to their population productivity. Interestingly, in an experimental study, Forseth et al. (2003) identified niche segregation between arctic char and brown trout in sympatric enclosures, but no expansion of the arctic char niche in allopatric enclosures. It is indicated that this niche segregation may therefore be a learned behaviour, suggesting that char entering lake trout/round whitefish systems from lake trout/round whitefish/arctic char systems would be adept at functioning in the available pelagic niche. At the Meadowbank site, it has been noted that due to the relatively low abundance of char in project lakes, and lack of another zooplankton predator, char have little inter- or intraspecific competition for food resources (Cumberland, 2006), further supporting the idea of their successful expansion into adjacent isolated lakes.

It is recognized that little can be predicted with certainty regarding fish population dynamics following the introduction of this native species. However, follow-up monitoring studies will accompany access enhancements at the Meadowbank site. Data collected during implementation and post-flooding in these areas will provide valuable insight into populations structure changes following access enhancements. Not only is there potential for significant gains in productive capacity through this compensation option, but it would provide a unique opportunity to collect fundamental information which is lacking from the literature, and which would be beneficial to subsequent development projects in the region.

2.3 HEP EXAMPLE CALCULATION

An example calculation of habitat units for a theoretical lake using the above approach is presented in a memo to DFO dated June 7, 2012, and is provided in Appendix A.

SECTION 3 • HABITAT LOSSES

As discussed in Cumberland (2006), the project site encompasses a number of headwater lakes with limited connectivity and small drainage areas. Lakes in this region are ultra-oligotrophic and productivity and diversity are low in comparison to lakes further south. Limited information is available on habitat preferences of fish in this region, which increases the uncertainty in developing HEPs and HSI values. However, the quantification of fish populations and physical features of the project lakes undertaken for this assessment were rigorous. Aerial photography, underwater video imagery, field studies, application of available literature and professional experience were used to estimate the extents of the habitat types described in the Golder/AEM HEP (Section 2). The majority of these studies were completed for the original NNLP (Cumberland, 2006), and are further described in that document. Studies for the Dogleg Pond system were completed to support the Airstrip Extension (AEM, 2010a) (this project has since been revised to reduce the impacts into Third Portage Lake, and therefore does not require a NNLP), and fish surveys in the Vault Lake area (including Wally Lake and W3) were updated in 2011 and 2012 (Appendix E).

A number of modifications to minesite construction and operational plans have been introduced since the 2006 NNLP was developed. These have impacted the design of pits, dikes, roads and other in-water features, so that current and projected HADD areas differ slightly from those used in the 2006 assessment, and subsequent 2007 and 2009 amendments. Furthermore, the projected life-of-mine timescale has also been reduced, with the current closure date set for 2017, rather than the date of 2019. While this does not directly affect calculations of HADD, timing of losses and gains is a general consideration in NNL planning.

In 2012- 2013, AEM will be reconfiguring the waste rock pile that will result in a revision to the existing mine plan and closure plan. A revision of the plan will be submitted to the Water Board as soon as final engineered designs and planning are completed. As well, AEM is currently conducting an evaluation of water use, which is regulated under the NWB License A. AEM is revising its water management plan to reflect the new life of mine, anticipated improvement of mill recovery and to incorporate East Dike seepage. These modifications are not anticipated to impact fish or fish habitat and therefore are not addressed in the NNL Plan.

The following section presents the calculation of habitat units for the pre-construction scenario (losses) at the Meadowbank site. Habitat areas affected by major project activities are addressed in this NNLP. Several minor project activities were described in the 2006 NNLP, but because of neutral or positive impact on habitats, these were not included in the loss/gain calculations at that time.

Habitat unit calculations for losses to fish habitat at the Meadowbank site were conducted for three separate areas, to facilitate the use of historically accepted loss:gain ratios. These are: the Main Minesite Area, the Tailings Storage Facility (TSF) and the Vault Lake Area (see Figure 1-2).

3.1 MAIN MINESITE AREA

3.1.1 Description

The Main Minesite area is located in the immediate vicinity of mine infrastructure (see Figure 1-2). Construction of the Portage Pit and Goose Island Pit will impact portions of two lakes (Second Portage and Third Portage Lake). Features of the Main Minesite Area, including locations of pits, roads and dikes, are shown in Figure 3-1. To provide context, features are shown on an aerial photo of the Bay-Goose area (Figure 3-2).

The areas where HADD will occur in the Main Minesite Area encompass:

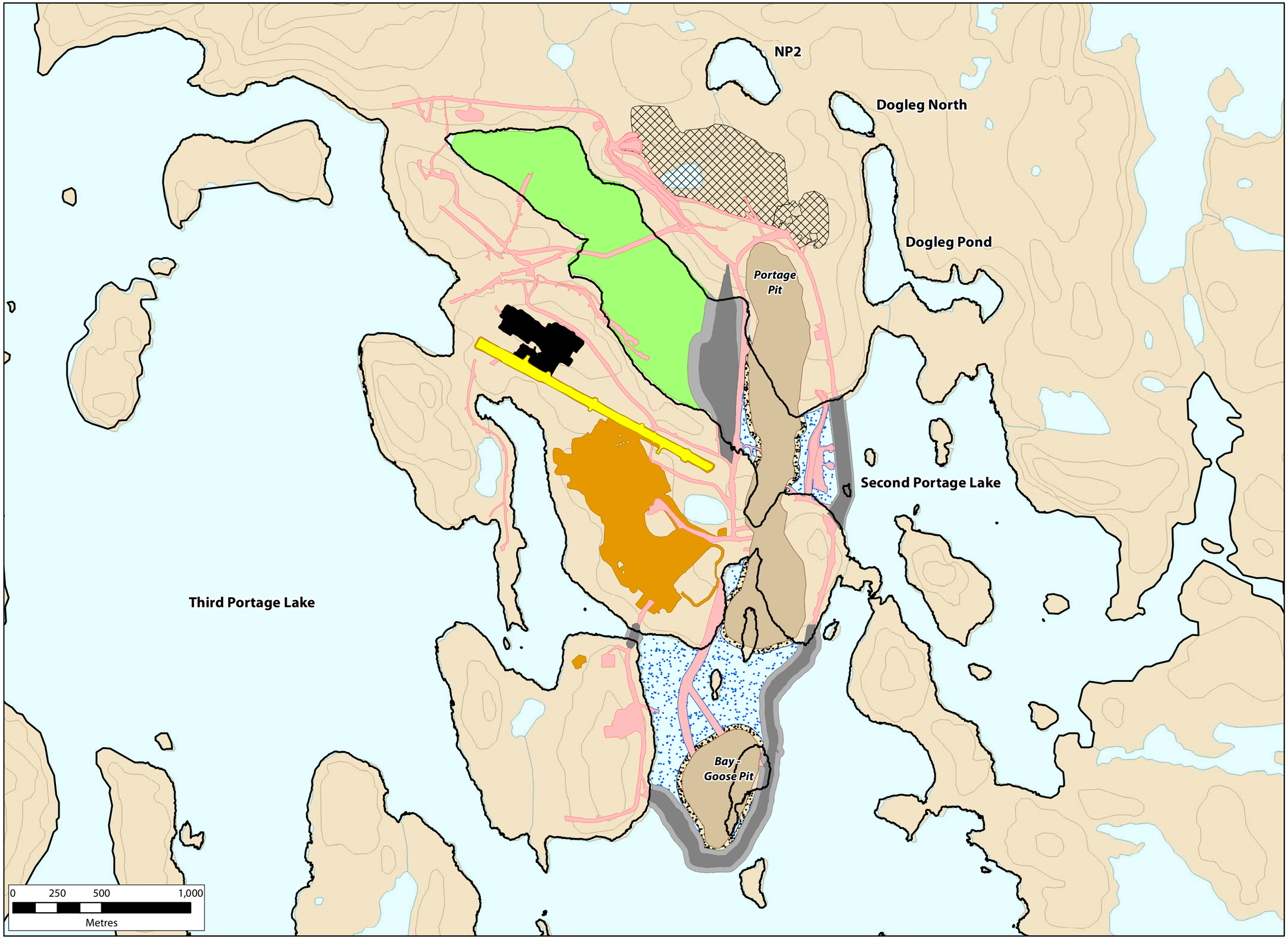
- The portion of Second Portage Lake between the East Dike and the Central Dike, including the dike footprints
- The Bay-Goose basin of Third Portage Lake, surrounded by the Bay-Goose Dike and the South Camp Dike, including the dike footprints

While the Tailings Storage Facility (TSF) is physically located in this area, TSF HADD is calculated and accounted for separately in this authorization to facilitate comparisons with historical documentation (Section 3.2). Aquatic habitat and baseline fish populations where HADD will occur in the Main Minesite Area are described below, and pre-construction habitat unit calculations (losses) are provided in Section 3.1.2.

3.1.1.1 Second Portage Lake

The area of Second Portage Lake impacted by mining activities is referred to as the "northwest arm". At 144 ha, it is approximately 35% of the area of the lake. The northwest arm is separated from the remainder of Second Portage Lake by the East Dike, and contains the Tailing Storage Facility and a portion of the Portage Pit. These are separated from each other by the Central Dike. The TSF is the only portion of a Meadowbank lake to be completely infilled due to mining activities. With the exception of dike bases, all other habitat losses at Meadowbank are temporary, and will be re-gained post-closure through re-flooding of the dewatered basins. Losses from the TSF are calculated separately (see Section 3.2.2 below), but the area between the East Dike and the Central Dike (including their footprints) is included in loss/gain calculations as part of the Main Minesite Area.

A fish-out occurred in the northwest arm of Second Portage Lake in 2008, during the construction of the East Dike (a cut-off net was installed to isolate this basin during dike construction). At that time the area was found to contain 3073 fish, including 66% lake trout, 10% round whitefish, 16% Arctic char and 9% burbot (Azimuth, 2009). This area was dewatered between 2009 and 2011, and thus would be lost habitat if compensation plans were not implemented.



Legend

- Study Lakes
- Quarry
- Tailings Storage Facility
- Dike
- Dike Base
- Roads
- Pit
- Pit Cap
- Lake Basin
- Facility
- Airstrip
- Rock Facility

Features
Main Minesite Area

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PROJECT: DA11-062-02

CLIENT: Agnico-Eagle Mines Ltd., Meadowbank Div.

N
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UTM Zone 14 NAD83

DATE: OCTOBER 2012

SCALE: 1:20,000

DRAWN BY: LC

CHECKED BY:

FIGURE:

3-1

The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation. MNR data provided by Queen's Printer of Ontario. Use of the data in any derivative product does not constitute an endorsement by the MNR or the Ontario Government of such products.

Bay Goose Basin
Conceptual Drawings

EXISTING CONDITIONS

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UTM Zone 14 NAD83

DATE: OCTOBER 2012

SCALE: NTS

DRAWN BY: MAY

CHECKED BY: RV

FIGURE:

3-2

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3.1.1.2 Third Portage Lake

The area of Third Portage Lake where HADD will occur includes 102 ha, or approximately 2.8% of the area of the lake (3600 ha). This area is impounded by the Bay-Goose Dike, and the smaller South Camp Dike, to allow construction of the Portage and Goose Island Pits. Dewatering was completed in this area in 2012, and thus this area would be lost as fish habitat if compensation plans were not implemented.

This area was fished out in 2010, and contained 2139 fish, including 36% arctic char, 29% lake trout, 24% round whitefish, 11% burbot and a few ninespine stickleback (North-South Consultants Inc., 2011).

3.1.2 HU Calculation - Losses

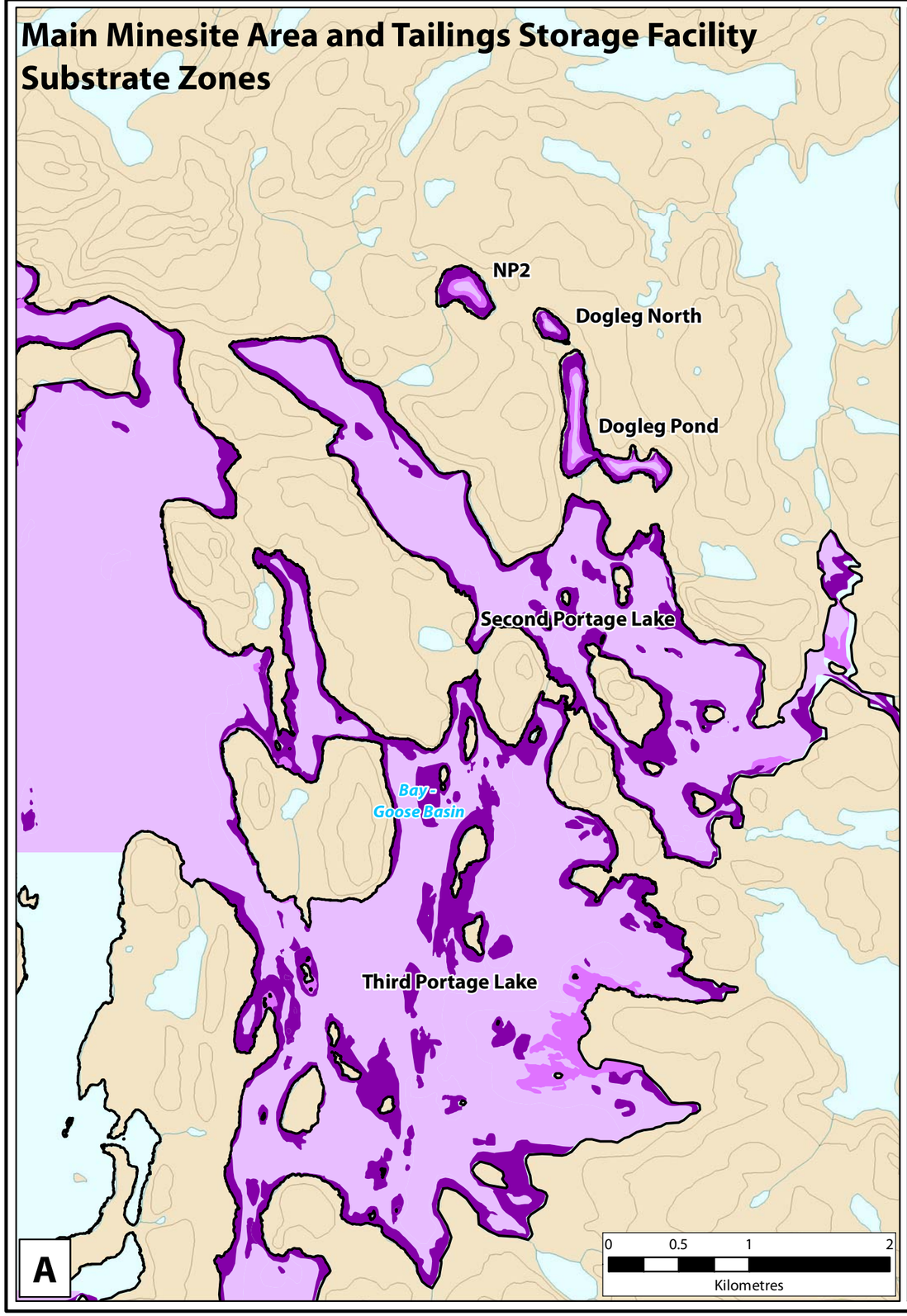
Substrate zones (fines, mixed, coarse) for the Main Minesite lakes, as determined by the method described in Section 2.2.1, are shown in Figure 3-3a. The majority of substrate in these deep lakes is fine grained, with coarse and mixed-grain substrate typically occurring around the shoreline. Note that although substrate and depth zones are shown for all areas surrounding the minesite to provide context, only those areas impacted by minesite features are included in loss/gain calculations.

The extents of the depth zones considered in this habitat assessment for the pre-construction scenario, calculated as described in Section 2.2.1, are shown in Figure 3-3b. Second Portage Lake reaches a depth of over 40 m (see Figure 1-2) in the area affected by mining. The Bay-Goose Basin of Third Portage Lake is somewhat shallower, with a maximum depth of about 20 m.

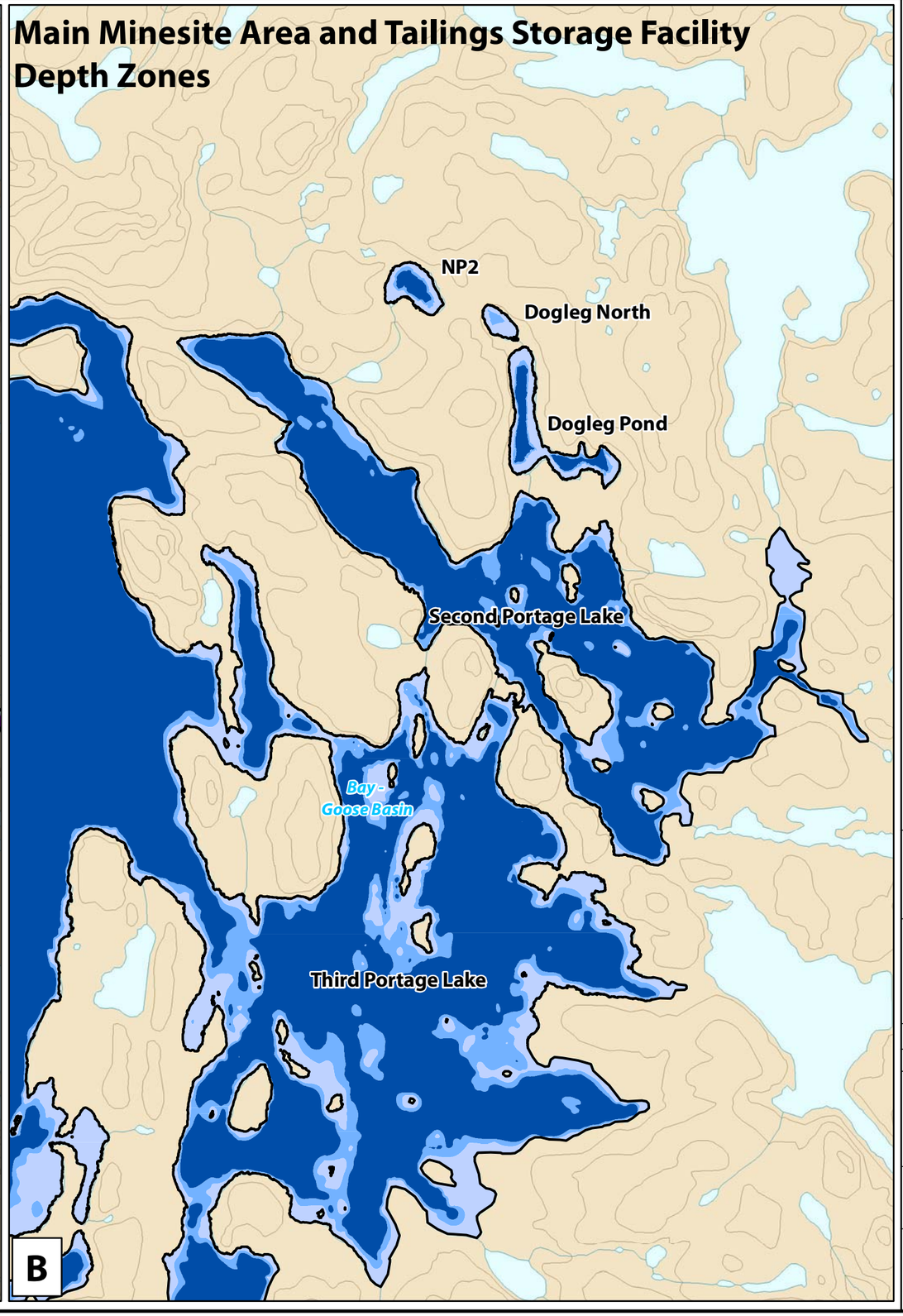
The extents of habitat types 1-11, as described in Section 3.2.1, were calculated by overlaying substrate and depth maps. Extents of each habitat type for the Main Minesite Area are shown in Figure 3-4. The majority of habitat in the Main Minesite Area is type 7 (>4 m, fine substrate).

A summary of the total habitat type areas and habitat units, calculated as described in Section 3.2, are shown in Table 3-1. The HU subtotal and total by species and minesite feature are provided in Appendix F.

Main Minesite Area and Tailings Storage Facility
Substrate Zones



Main Minesite Area and Tailings Storage Facility
Depth Zones



Legend

- Study Lakes

Substrate Zone

- Fines
- Mixed
- Coarse

Depth Zone

- <2m
- 2-4m
- >4m

Substrate and Depth Zones
Pre-Construction

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N / W / E / S
UTM Zone 14 NAD83

DATE: OCTOBER 2012

SCALE: 1:35,000

DRAWN BY: LC

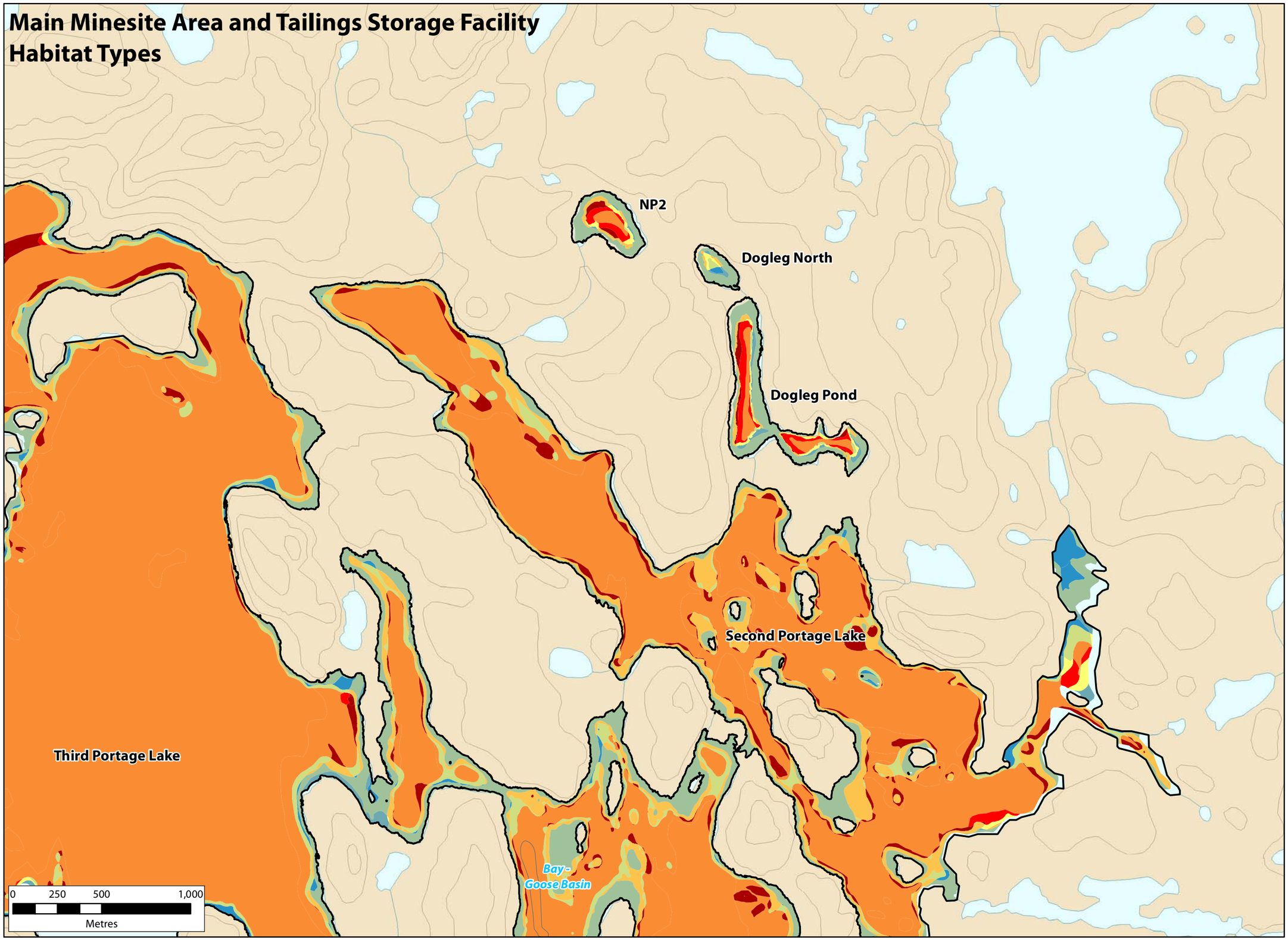
CHECKED BY:

FIGURE:

3-3

The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation. MNR data provided by Queen's Printer of Ontario. Use of the data in any derivative product does not constitute an endorsement by the MNR or the Ontario Government of such products.

Main Minesite Area and Tailings Storage Facility
Habitat Types



Legend

Study Lakes

Habitat Type

1
2
3
4
5
6
7
8
9

Habitat Type	Criteria	
	Depth Zone	Substrate
1	<2 m	Fines
2	<2 m	Mixed
3	<2 m	Coarse
4	2-4 m	Fines
5	2-4 m	Mixed
6	2-4 m	Coarse
7	>4 m	Fines
8	>4 m	Mixed
9	>4 m	Coarse

Habitat Types
Pre-Construction

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N
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UTM Zone 14 NAD83

DATE: OCTOBER 2012

SCALE: 1:20,000

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FIGURE:

3-4

The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation. MNR data provided by Queen's Printer of Ontario. Use of the data in any derivative product does not constitute an endorsement by the MNR or the Ontario Government of such products.

Table 3-1. Pre-construction, or lost habitat type areas (ha) and habitat units (HUs) for the Main Minesite Area.

Habitat Type	Area (ha)	HUs
1	0.36	0.05
2	0.00	0.00
3	29.57	9.42
4	9.20	3.73
5	0.00	0.00
6	20.02	17.01
7	84.34	34.81
8	0.00	0.00
9	1.41	1.10
10	N/A	N/A
11	N/A	N/A
Total	**144.90**	**66.12**

3.2 TAILINGS STORAGE FACILITY

3.2.1 Description

The Tailings Storage Facility (TSF) encompasses the majority of the northwest arm of Second Portage Lake, west of the Central Dike (see Figure 3-1). It includes the areas commonly referred to as the Portage Attenuation Pond, the Stormwater Dike, and the North Cell Tailings Impoundment Area. Eventually the whole area west of Central Dike will form the Tailings Impoundment Area.

This area of Second Portage Lake was fished out in 2008, prior to dewatering. See Section 3.1.1 for a description of the resident fish population.

3.2.1 HU Calculation - Losses

Substrate zones (fines, mixed, coarse) for the TSF area, pre-construction, as determined by the method described in Section 2.2.1, are shown in Figure 3-3a. The majority of substrate in this area of 2PL is fine grained, with coarse and mixed-grain substrate typically occurring around the shoreline.

The extents of the depth zones considered in the TSF for the pre-construction scenario, calculated as described in Section 3.2.1, are shown in Figure 3-3b.
The extents of habitat types 1-11, as described in Section 3.2.1, were calculated by overlaying substrate and depth maps. Habitat types for the TSF area are shown in Figure 3-4. This area consists of a relatively mixed proportion of habitat types.

A summary of the total habitat type areas and habitat units, calculated as described in Section 3.2, are shown in Table 3-2. The HU subtotal and total by species and minesite feature are provided in Appendix F.

Table 3-2. Pre-construction, or lost habitat type areas (ha) and habitat units (HUs) for the Tailings Storage Facility (TSF).

Habitat Type	Area (ha)	HUs
1	0.02	0.00
2	0.00	0.00
3	4.66	1.48
4	4.08	1.66
5	0.00	0.00
6	8.73	7.42
7	54.99	23.94
8	0.00	0.00
9	4.30	3.36
10	N/A	N/A
11	N/A	N/A
Total	**79.79**	**37.85**

3.3 VAULT LAKE AREA

3.3.1 Description

The footprint of mining activities in the Vault Lake Area is shown in Figure 3-5, including the location of pits, roads and dikes. HADD in the Vault Lake Area will occur in two lakes - Vault Lake and Phaser Lake. Both of these lakes are planned to be dewatered, the timing of which is currently being planned prior to development of the Vault Pit. The shallow passage between Vault Lake and the adjacent Wally Lake will be diked to provide hydraulic separation for these otherwise isolated lakes. A fish salvage program will be conducted prior to dewatering in Vault and Phaser Lakes. With DFO approval, all fish from Vault and Phaser Lakes will be transferred to Wally Lake or nearby waterbodies, helping to alleviate temporary losses in productive capacity in the area. A site specific fishout protocol will be developed in consultation with DFO representatives and implemented upon approval by DFO.

Both lakes are small in size, compared to the Portage lakes, at 94 ha and 25 ha, respectively. Vault Lake is connected via a semi-passable channel to the larger Wally Lake. One fish was observed crossing this passage in baseline studies (Azimuth, 2005). Adjacent to Vault Lake, Phaser Lake is small and isolated, with a maximum depth of 4-5 m. This lake was not included in the 2006 NNLP. However, based on current pit designs, this lake will now require dewatering, so it is included here in all HADD calculations.

Wally 4

Wally Lake

Wally 3

Vault Lake

Phaser Lake

0 0.5 1 2

Kilometres

Legend

- Study Lakes
- Dike
- Dike Base
- Roads
- Pit
- Pit Cap
- Lake Basin

Features
Vault Lake Area

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FIGURE:

3-5

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The fish populations of Vault and Phaser Lakes were examined briefly in a 2004 study for the BAEAR (Azimuth, 2005), and again in 2012 (Appendix E). Both lakes were found to contain populations of lake trout and round whitefish. A single burbot was found in Vault Lake in each study.

3.3.2 HU Calculation - Losses

Substrate zones (fines, mixed, coarse) for Vault and Phaser Lakes, pre-construction, as determined by the method described in Section 2.2.1, are shown in Figure 3-6a. The majority of substrate in Vault Lake is fine grained, with coarse and mixed-grain substrate typically occurring around the shoreline. Substrate in Phaser Lake is primarily mixed.

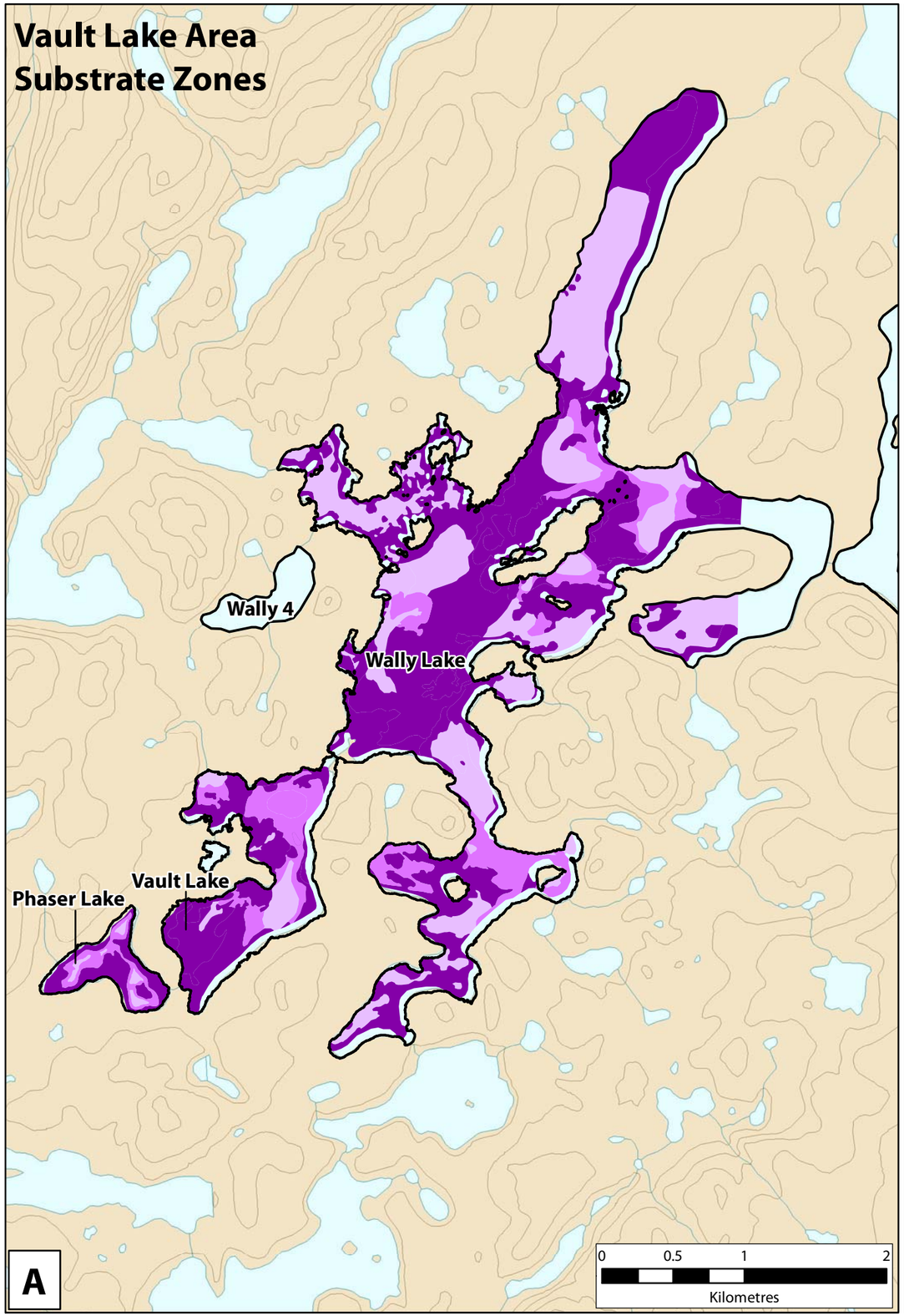
It should be noted that resolution differences between substrate maps and base maps for Vault Lake were found to produce an un-mapped zone around the south-eastern perimeter of the lake, for which HUs could not be calculated. Other than the habitat temporarily lost through de-watering, this area is unimpacted by mining activities, and would count equally in loss and gain calculations (re-flooding re-establishes this area as fish habitat identical to that available pre-construction).

The extents of the depth zones considered in the Vault Lake Area for the pre-construction scenario, calculated as described in Section 3.2.1, are shown in Figure 3-6b. Baseline depths in Vault and Phaser Lakes are moderate to shallow, compared to the Main Minesite Area lakes. A small area of Phaser Lake reaches a depth of 4-5 m, and the maximum depth in Vault Lake is approximately 9 m.

The extents of habitat types 1-11, as described in Section 3.2.1, were calculated by overlaying substrate and depth maps. Habitat types for the Vault Lake Area are shown in Figure 3-7. This area consists of a relatively mixed proportion of habitat types.

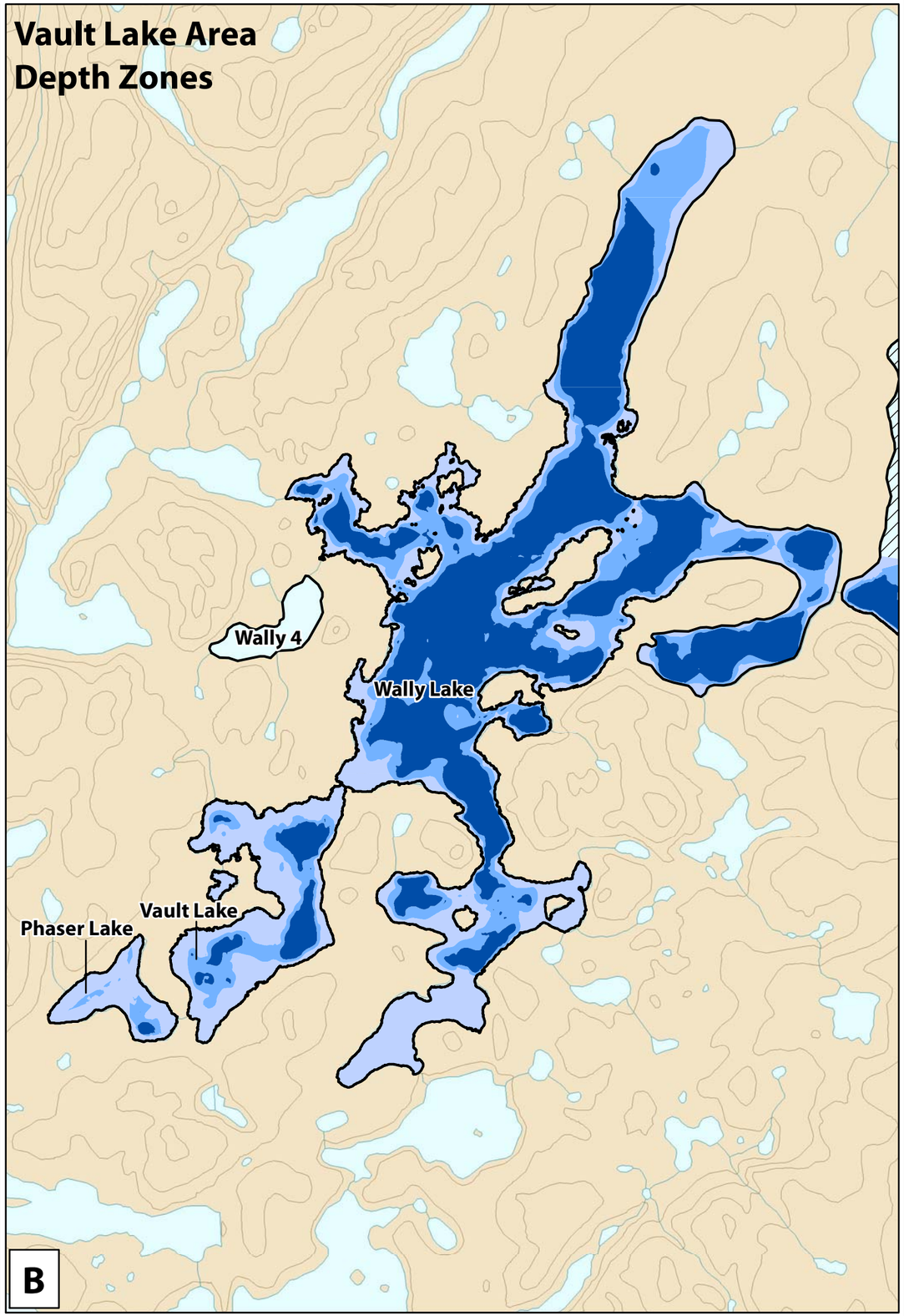
A summary of the total habitat type areas and habitat units, calculated as described in Section 3.2, are shown in Table 3-3. The HU subtotal and total by species and minesite feature are provided in Appendix F.

Vault Lake Area
Substrate Zones



A

Vault Lake Area
Depth Zones



B

Legend

- Study Lakes

Substrate Zone

- Fines
- Mixed
- Coarse

Depth Zone

- <2m
- 2-4m
- >4m
- N/A

Substrate and Depth Zones
Pre-Construction

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FIGURE:

3-6

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Vault Lake Area
Habitat Type

Wally 4
Wally Lake
Wally 3
Vault Lake
Phaser Lake

0 0.5 1 2
Kilometres

Legend

Study Lakes

Habitat Type

1
2
3
4
5
6
7
8
9

Habitat Type	Criteria	
	Depth Zone	Substrate
1	<2 m	Fines
2	<2 m	Mixed
3	<2 m	Coarse
4	2-4 m	Fines
5	2-4 m	Mixed
6	2-4 m	Coarse
7	>4 m	Fines
8	>4 m	Mixed
9	>4 m	Coarse

Habitat Types
Pre-Construction

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FIGURE:

3-7

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Table 3-3. Pre-construction, or lost habitat type areas (ha) and habitat units (HUs) for the Vault Lake Area.

Habitat Type	Area (ha)	HUs
1	4.26	0.36
2	13.10	1.89
3	52.81	11.77
4	4.19	1.02
5	9.72	3.73
6	13.03	6.60
7	8.09	2.05
8	9.40	3.42
9	4.87	2.26
10	N/A	N/A
11	N/A	N/A
Total	**119.47**	**33.09**

3.4 SUMMARY

Total lost aquatic habitat at the Meadowbank site without compensation measures totals 344.16 hectares, or 137.07 HUs.

This includes 144.90 hectares, or 66.12 HUs in the Main Minesite Area, 79.79 hectares, or 37.85 HUs in the TSF, and 119.47 hectares, or 33.09 HUs in the Vault Lake Area.

SECTION 4 • HABITAT GAINS

In the 2006 NNLP and subsequent amendments, habitat gains for the Meadowbank site were largely to be obtained from re-flooding of dewatered basins and newly excavated pits. The construction of boulder gardens, reef and shoal features within the dewatered basins was proposed to increase habitat value. In addition, large (19 ha) finger dikes and habitat mounts were planned for in-water construction in Second and Third Portage Lakes to provide supplementary habitat gains pre-closure.

Re-flooding of the dewatered areas remains the primary compensation measure to be implemented at Meadowbank. However, based on the experience of AEM with in-water dike construction (see Azimuth, 2009), the supplementary compensation projects proposed previously (19+ ha finger dikes, sea mounts and shoals) were found to be technically challenging to construct in a manner without possible short-term impacts on the aquatic system. This updated habitat compensation plan therefore includes similar features, with modifications for improved constructability and reduced potential for impact to the receiving environment. Several additional compensation projects are proposed, and all are similar to compensation seen elsewhere in the north. Supplementary compensation projects include increased area of the Dogleg System; improved access between W3 and Wally Lake, and Wally and Vault Lakes; and the construction of finger dikes off the Bay-Goose Dike, as per the original NNLP.

The net gains from these supplementary onsite projects are added to the net gains from re-flooding to calculate the total number of habitat units to be gained through all compensation measures. All habitat gains are accomplished in the creation of like for like habitat compensation onsite. The details of each compensation feature and the calculation of gained habitat units are described below.

4.1 RE-FLOODING OF DEWATERED BASINS AND PITS

4.1.1 Context

As previously stated the major compensation measure is proposed for the Meadowbank site is the re-flooding of dewatered basins and associated pits following mining activities (see discussion of end pit lakes as fish habitat, Section 2.2.1). In order to provide the greatest loss:gain ratio possible, considerations for improving fish habitat have been incorporated into the basin and pit designs (e.g. boulder gardens, backfilling of deep pits). The following sections provide further details on these features and the calculation of habitat units gained through this process in each of the dewatered areas.

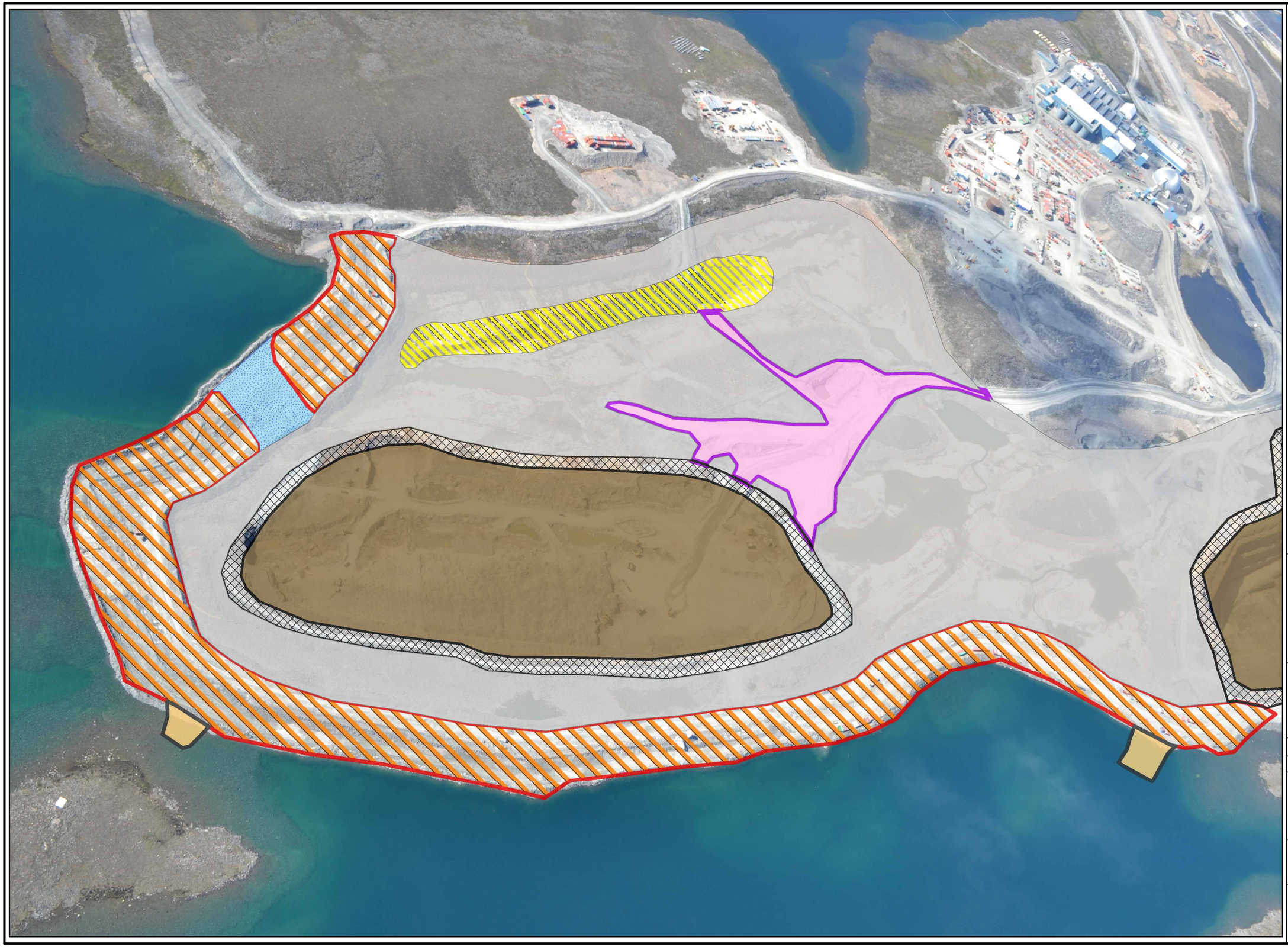
4.1.2 Main Minesite Area

4.1.2.1 Description

Post-closure, the Bay-Goose dike will be breached and the impounded area will be gradually re-flooded to re-gain the temporarily lost habitat. The portion of Second Portage Lake between the East Dike and the Central Dike will become part of Third Portage Lake, due to the land-to-lake conversion resulting from the Portage Pit construction. The East Dike will not be breached in order to maintain the current 1 m difference in elevation between Second Portage and Third Portage Lakes.

Prior to re-flooding, a number of habitat improvement measures will be implemented to increase the productive capacity of this area (Figure 4-1 A and B). Construction of a boulder garden feature along the west side of the soft-sediment Bay-Goose Basin will increase habitat suitability in this area. This feature will consist of approximately 2.97 ha of heterogeneous, coarse substrate habitat in the <4 m depth zone, just west of the Goose Island Pit. Further, construction of mine-related features (pit caps, roads and dikes) from coarse rock material throughout the basin will create new shoals and reefs after re-flooding. In addition, approximately 30% of the area of Portage Pit will be backfilled to a depth of 4-10 m during the construction phase, reducing the amount of ultra-deep water areas, and increasing habitat suitability in this area. A conceptual figure of the Bay-Goose basin area after re-flooding is shown in Figure 4-2.

As a result of changes from construction and compensation projects, habitat units post-closure in this area are different from those pre-construction. A description of each of the Main Minesite features, and the changes occurring to habitat types in each feature footprint, post-closure, is provided in Table 4-1, to indicate how post-closure habitat type areas were calculated.



Legend

Post-Closure Features

- Capped roadways
- Dike to remain
- Finger dike
- Breach in dike
- Free dump boulder garden
- Mixed substrate basin
- Pit
- Pit capping

Bay Goose Basin
Conceptual Drawings

POST-CLOSURE FEATURES

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FIGURE:

4-1a

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Bay Goose Basin
Conceptual Drawings

POST CLOSURE FEATURES PRE-FLOODING

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FIGURE:

4-1b

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Legend

- Dikes
- Island
- Re-flooded area

Bay Goose Basin
Conceptual Drawings

POST CLOSURE FEATURES POST-FLOODING

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FIGURE:

4-2

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Table 4-1. Features of the Main Minesite (as shown on Figure 3-1) and details of the assumptions used to calculate habitat type areas associated with each feature, post-closure. In addition, for all areas of Second and Third Portage Lakes, post-closure water levels were assumed to equal current water levels in Third Portage Lake (134 masl).

Lake	Feature Name	Description of Feature	Description of Habitat Post-Closure
Second Portage Lake (2PL)	Basin	Area of the current lake bed between East and Central Dikes that is not covered by any other feature	Placement of coarse material for temporary dewatering roads throughout this area will create mixed sediment substrate at depths based on pre-construction contours
	Portage Pit in 2PL	Portion of Portage Pit that overlays 2PL	Backfilled with coarse substrate to 4 - 10 m to provide increased habitat suitability
	Portage Pit in 2PL Cap	Safety set-back of coarse material around outside of Portage Pit in in-water portion of 2PL, used to protect pit edge from sediment; *design pending -assumed width similar to dike sides*	Cap area provides coarse substrate shoal habitat; no change in depth
	Roads	Road and adjacent parking pad between pit and East Dike; *assume bottom width = top width and no change in depth zones*	Simulated reef habitat (coarse substrate)
	Central Dike	Dike on west side of Portage Pit, divides TSF from 2PL basin; gains occur on east side only (west side is permanent loss); *assume base width is 2x top width and area calculated based on 2:1 slope*	Face provides simulated reef habitat (coarse substrate)

Lake	Feature Name	Description of Feature	Description of Habitat Post-Closure
Second Portage Lake (2PL)	East Dike	Dike on east side of Portage Pit, divides dewatered area from rest of 2PL; *assume base width is 2x top width and area calculated based on 2:1 slope*	Face provides simulated reef habitat (coarse substrate)
Third Portage Lake (3PL)	Basin	Area of the current lake bed between the mainland and Bay-Goose Dike that is not covered by any other feature	Placement of coarse material for temporary dewatering roads throughout this area will create mixed sediment substrate at depths based on pre-construction contours
	Portage Pit in 3PL	Portion of Portage Pit that overlays 3PL	All habitat types change based on pit excavation depths; all substrate is coarse; > 10m is HT 11
	Portage Pit in 3PL Cap	Safety set-back of coarse material around outside of Portage Pit in in-water portion of 3PL; *design pending - assumed width similar to dike sides*	Cap area provides coarse substrate shoal habitat; no change in depth
	Portage Pit Land-to-Lake	Portion of Portage Pit that overlays land, including areas south and north of 2PL	Middle portion (23.52 ha) backfilled to 4 - 10 m to provide increased habitat suitability. For all other areas, habitat types change based on pit excavation depths; all substrate is coarse; > 10 m is HT 11
	Goose Pit	Portion of Goose Pit that overlays 3PL	All habitat types change based on pit excavation depths; all substrate is coarse; > 10 m is HT 11
	Goose Pit Cap	Safety set-back of coarse material around outside of Goose Pit in in-water portion of 3PL; *design pending - assumed width similar to dike sides*	Cap area provides coarse substrate shoal habitat; no change in depth
	Goose Pit Land-to-Lake	Portion of Goose Pit that overlays land (Goose Island)	All habitat types change based on pit excavation depths; all substrate is coarse; > 10 m is HT 11

Lake	Feature Name	Description of Feature	Description of Habitat Post-Closure
Third Portage Lake (3PL)	Road	As-built road between minesite and Goose Pit; *assume > 4 m below water surface and bottom width = top width*	Simulated reef habitat (coarse substrate)
	Bay Goose Dike	Largest dike in 3PL; *assume base width is 2x top width and area calculated based on 2:1 slope*	Face provides simulated reef habitat (coarse substrate)
	South Camp Dike	Small dike between Third Portage Lake and Bay-Goose Basin; *assume base width is 2x top width and area calculated based on 2:1 slope*	Face provides simulated reef habitat (coarse substrate)
	Dike Breach	Sections of the Bay-Goose and East Dikes will be removed to re-flood the pits; *assuming 100 m wide breach to a depth of 2-4 m*	Dike top becomes submerged to a depth of 2-4 m, providing simulated reef habitat (coarse substrate)
	Free-dump boulder garden	2.97 ha between Goose Island Pit and South Island	Placement of coarse substrate waste rock in this area during construction creates boulder garden features; no change in depth zones

4.1.2.2 HU Calculation - Gains

Substrate zones (fines, mixed, coarse) for the Main Minesite Area were determined by the method described in Section 2.2.1, with the modifications described in Table 4-1. Substrate zones post-closure are shown in Figure 4-3a. A higher proportion of coarse and mixed substrate is present as a result of pit development and construction of roads and boulder gardens in formerly fine-substrate basins.

The extents of the depth zones considered in this habitat assessment for the post-closure scenario were calculated as described in Section 2.2.1, with the modifications shown in Table 4-1. Post-closure depth zones are shown in Figure 4-3b. As a result of pit development, maximum depths in this area increase to 229 m. Areas >10 m deep in pits have reduced HSIs in this assessment (see Section 2.2.2) to reflect the lack of benthic habitat.

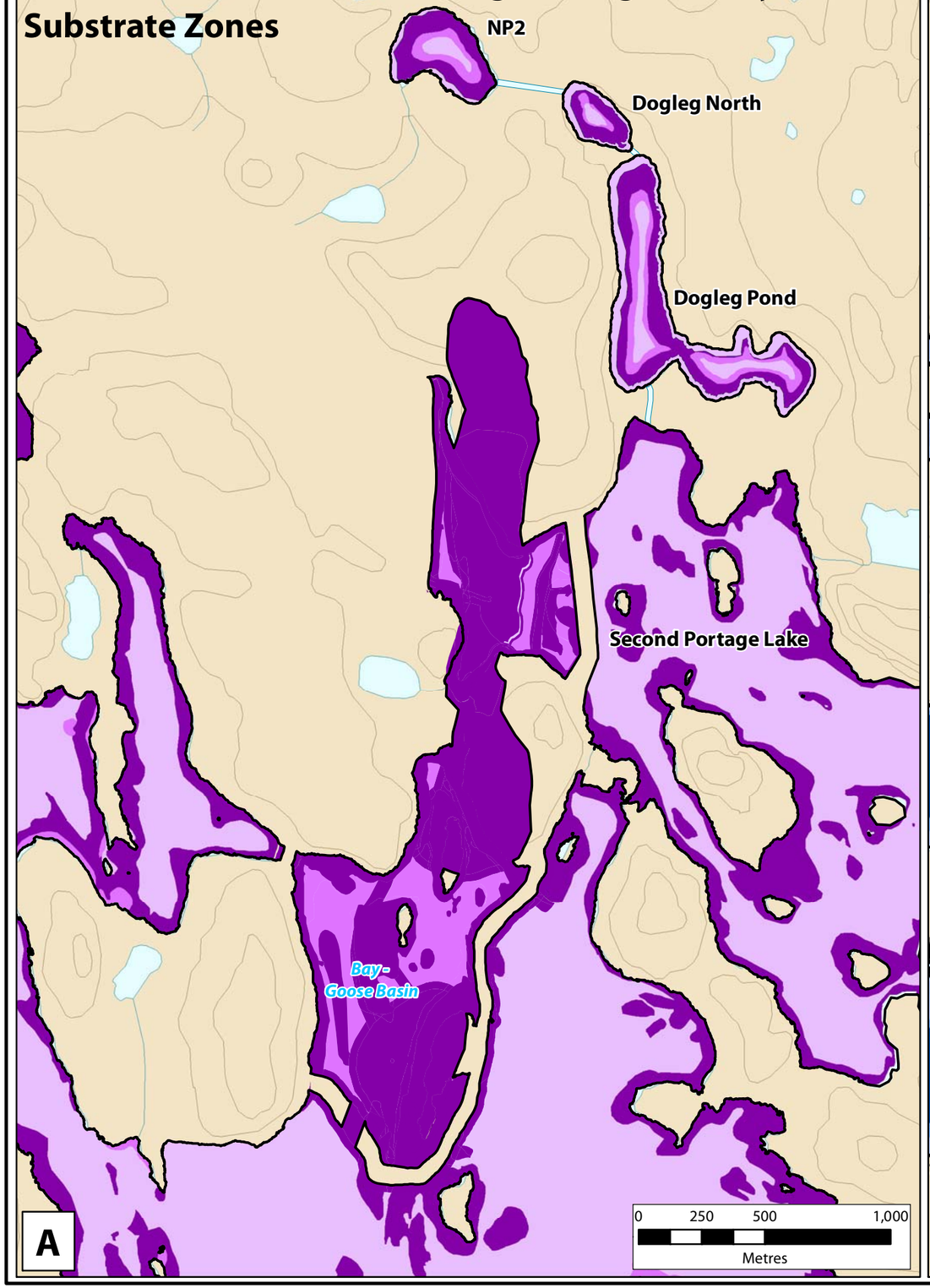
The extents of habitat types 1-11, as described in Section 2.2.2, were calculated by overlaying post-compensation substrate and depth zones. Post-compensation habitat types for the Main Minesite Area are shown in Figure 4-4. The majority of habitat in the Main Minesite Area post-closure is type 9.

Habitat units were calculated as described in Section 2. A summary of the total gained habitat units are shown in Table 4-2. The HU subtotal and total by species and minesite feature are provided in detail in Appendix F, and are summarized in Section 6.

Table 4-2. Net habitat units (HUs) gained through re-flooding in the Main Minesite Area. Pre-compensation HUs are 0 since there would be no fish habitat in this area without re-flooding.

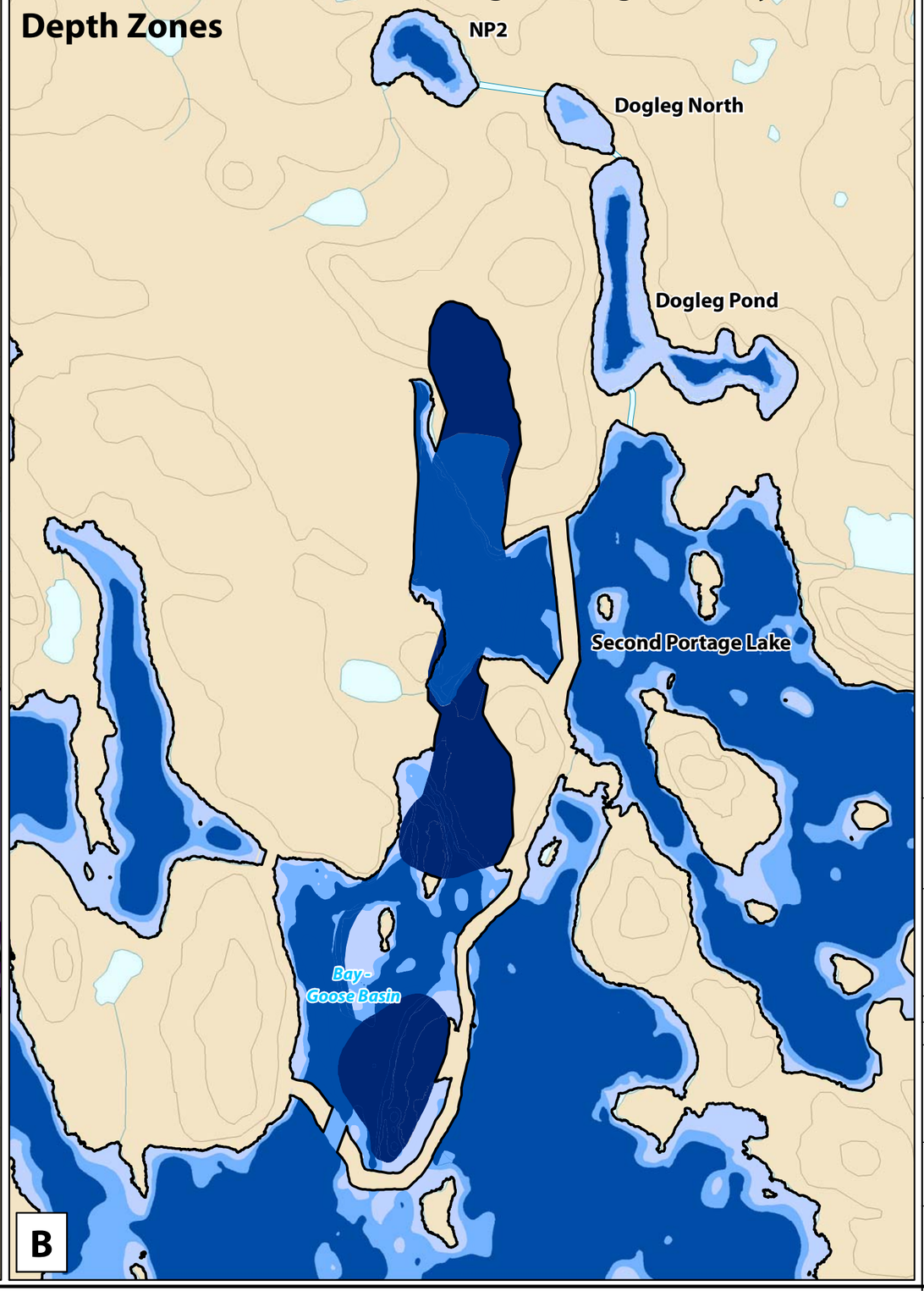
Habitat Type	Pre-compensation HUs	Post-compensation HUs	Net Gain HUs
1	0	0.00	0.00
2	0	0.01	0.01
3	0	5.33	5.33
4	0	0.00	0.00
5	0	2.06	2.06
6	0	11.11	11.11
7	0	0.00	0.00
8	0	13.67	13.67
9	0	33.39	33.39
10	0	0.00	0.00
11	0	28.60	28.60
Total	**0**	**94.18**	**94.18**

Main Minesite Area and Tailings Storage Facility
Substrate Zones



A

Main Minesite Area and Tailings Storage Facility
Depth Zones



B

Legend

- Study Lakes (Post-Closure)

Substrate Zone

- Fines
- Mixed
- Coarse

Depth Zone

- <2m
- 2-4m
- 4-10m
- >10m

Substrate and Depth Zones
Post-Closure

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4-3

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Main Minesite Area and Tailings Storage Facility
Habitat Types

NP2

Dogleg North

Dogleg Pond

Second Portage Lake

ge Lake

Bay -
Goose Basin

0 250 500 1,000
Metres

Legend

Study Lakes (Post-Closure)

Habitat Type

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 11

Habitat Type	Criteria	
	Depth Zone	Substrate
1	<2 m	Fines
2	<2 m	Mixed
3	<2 m	Coarse
4	2-4 m	Fines
5	2-4 m	Mixed
6	2-4 m	Coarse
7	>4 m	Fines
8	>4 m	Mixed
9	>4 m	Coarse
11	>10 m	Coarse

Habitat Types
Post-Closure

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FIGURE:

4-4

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4.1.3 Vault Lake Area

4.1.3.1 Description

After mining, Vault Pit will connect Vault and Phaser Lakes, and the Vault Dike will be breached to allow both lakes to gradually re-fill. Once these lakes are hydraulically and chemically stable (see Golder, 2005) and meet water quality requirements, the Vault Dike will be removed, allowing fish from Wally Lake access to Vault and Phaser Lakes.

Post-closure alterations to Vault and Phaser Lakes will result from construction of pits, pit caps, roads and dikes (as seen in Figure 3-5). Both lakes will be expanded as a result of land-to-lake conversion in the Vault Pit. Backfilling of a portion of the pit (3.94 ha) in Phaser Lake to 2-4 m depth will reduce the amount of ultra-deep areas. However, the un-filled portion of the pit will actually provide improved overwintering habitat, which is limited in these relatively shallow lakes. Further habitat improvements in these lakes will be made through development of shoals due to permanent roadway construction, areas of mixed substrate from temporary haul roads, and the improvement of the connecting channels between Vault and Wally Lakes, and Vault and Phaser Lakes, to allow fish movement. In particular, the connection to Wally Lake will provide access for arctic char (after connection to W3), which currently are not present in Vault and Phaser Lakes. This specific compensation project was discussed in Section 2.2.6 and is discussed further in Section 4.2.4. Improvement of the connection to Wally Lake will involve deepening the channel inside the Vault Dike to a depth of at least 3 m, while the lake is dewatered, to allow fish passage year-round after removal of the dike. The features of Vault and Phaser Lakes post-closure are described in Table 4-3.

Table 4-3. Features of the Vault Lake Area and details of the changes and assumptions used to calculate habitat type areas for each feature, post-closure.

Lake	Feature Name	Description of Feature	Description of Habitat
Vault Lake	Basin	Area in Vault Lake that is not covered by other features	Placement of coarse material for temporary roads will result in mixed substrate throughout basin area at depths based on pre-construction contours
	Vault Pit-Vault portion	Portion of Vault Pit that overlays Vault Lake	All habitat types changed based on pit excavation depths; all substrate is coarse; > 10m is habitat type 11
	Vault Pit Cap – Vault portion	Safety set-back of coarse material around outside of Vault Pit in in-water portion of Vault Lake; *design pending - assume width similar to dike sides*	Cap area provides coarse substrate shoal habitat; no change in depth
	Vault Pit Land-to-Lake – Vault portion	Portion of Vault Pit – Vault portion, that overlays land	All habitat types change based on pit excavation depths; all substrate is coarse; > 10 m is habitat type 11
	Vault Dike	Dike between Vault and Wally Lakes	Face provides simulated reef habitat on the Wally Lake side during construction. To be completely removed post-closure.
Phaser Lake	Basin	Area in Vault Lake that is not covered by other features	Placement of coarse material for temporary roads will result in mixed substrate throughout basin area at depths based on pre-construction contours
	Vault Pit – Phaser portion	Portion of Vault Pit that overlays Phaser Lake	Backfilled to 2-4 m to provide increased habitat suitability; all substrate is coarse

Lake	Feature Name	Description of Feature	Description of Habitat
Phaser Lake	Vault Pit Cap – Phaser portion	Cap around outside of Vault Pit in in-water portion of Phaser Lake; *design pending - assumed width similar to dike sides*	Cap area provides coarse substrate shoal habitat; no change in depth
	Vault Pit Land-to-Lake – Phaser portion	Portion of Vault Pit – Phaser portion, that overlays land	Habitat types change based on pit excavation depths; all substrate is coarse; > 10 m is habitat type 11
	Roads	Haul road to run north-south across Phaser Lake	Simulated coarse substrate reef habitat at pre-construction depth

4.1.3.2 HU Calculation - Gains

Substrate zones (fines, mixed, coarse) for the Vault Lake area, post-closure, as determined by the method described in Section 2.2.1, and incorporating the changes detailed in Table 4-3, above, are shown in Figure 4-5a. Post-closure, changes to substrate occur through pit and road development, creating areas of coarse and mixed sediment in previously fine-grained basins.

The extents of the depth zones considered in the Vault Lake Area for the post-closure scenario, calculated as described in Section 2.2.1, are shown in Figure 4-5b. Pit development will provide enhanced overwintering habitat, which is not abundant in this area.

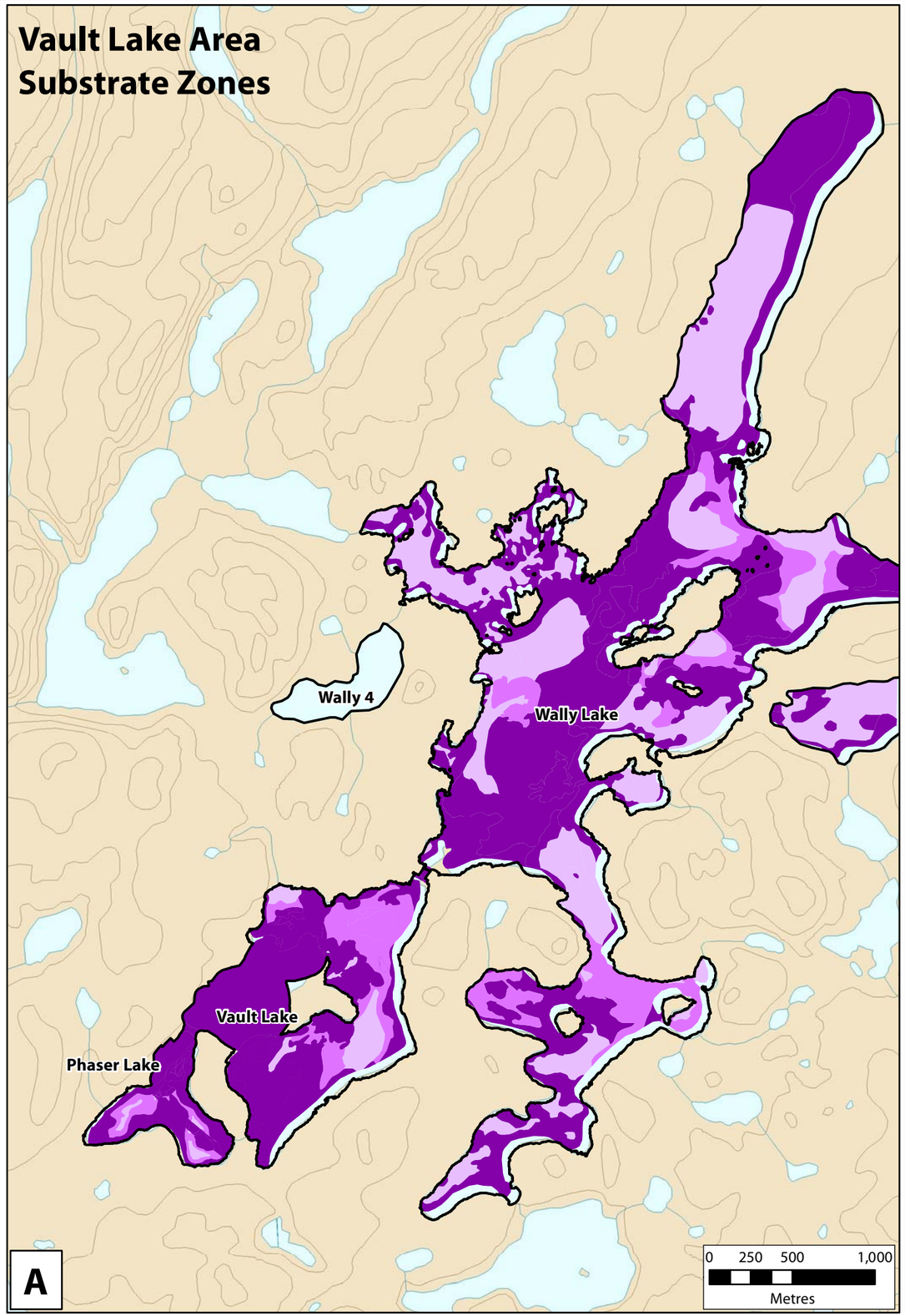
The extents of habitat types 1-11, as described in Section 2.2.1, were calculated by overlaying substrate and depth maps. Habitat types for the Vault Lake Area are shown in Figure 4-6. Post-closure, this area will consist of coarse- and mixed-grain habitat, without changes in depth zones other than non-backfilled pit areas.

A summary of the total habitat type areas and habitat units, calculated as described in Section 2.2, are shown in Table 4-4. The HU subtotal and total by species and minesite feature are provided in Appendix F.

Table 4-4. Net habitat units (HUs) gained through re-flooding in the Vault Lake Area. Pre-compensation HUs are 0 since there would be no fish habitat in this area without re-flooding.

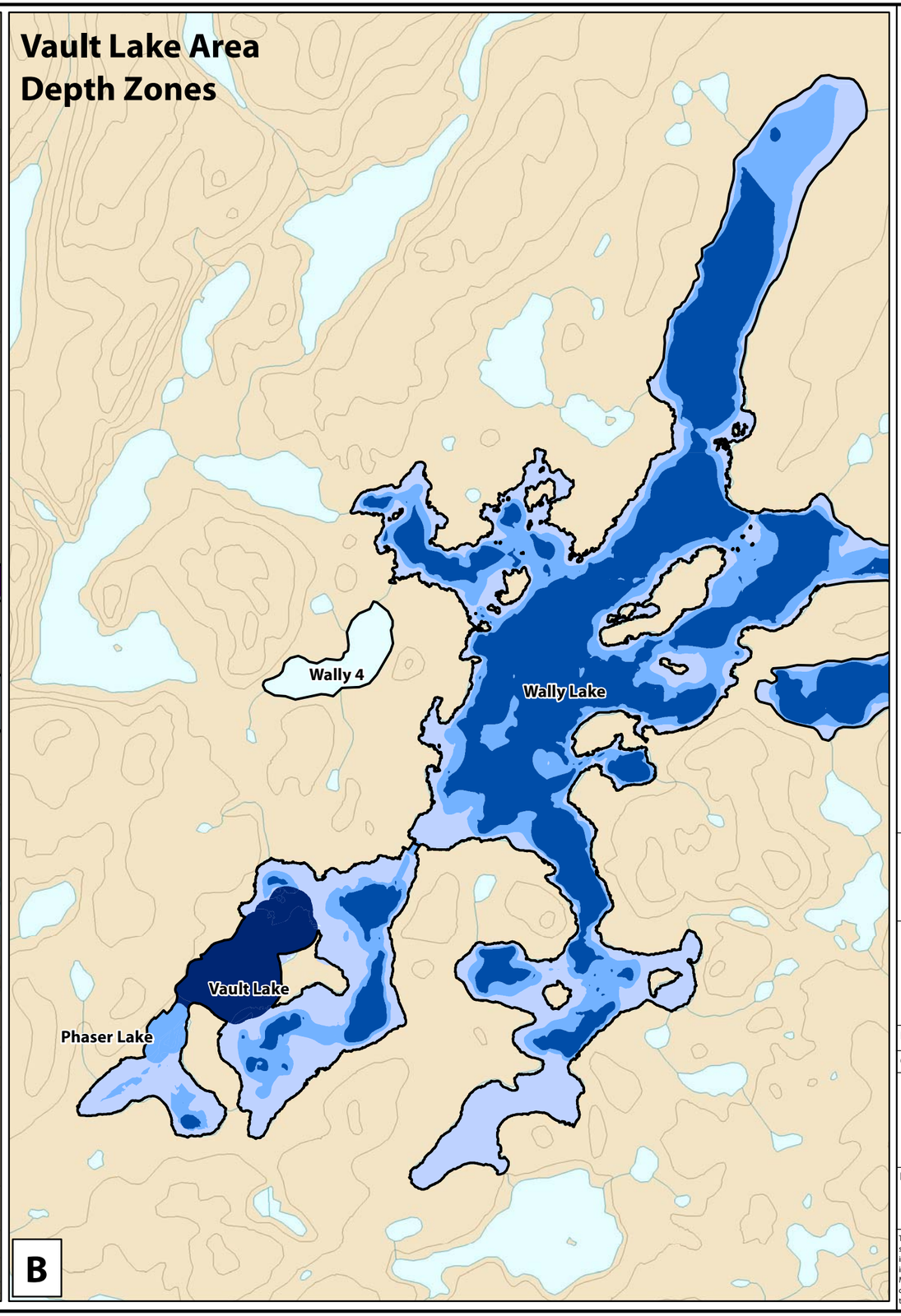
Habitat Type	Pre-compensation HUs	Post-compensation HUs	Net Gain HUs
1	0	0.00	0.00
2	0	2.19	2.19
3	0	10.89	10.89
4	0	0.00	0.00
5	0	4.89	4.89
6	0	10.44	10.44
7	0	0.00	0.00
8	0	6.34	6.34
9	0	2.31	2.31
10	0	0.00	0.00
11	0	11.79	11.79
Total	**0**	**48.84**	**48.84**

Vault Lake Area
Substrate Zones



A

Vault Lake Area
Depth Zones



B

Legend

- Study Lakes (Post-Closure)

Substrate Zone

- Fines
- Mixed
- Coarse

Depth Zone

- <2m
- 2-4m
- 4-10m
- >10m

Substrate and Depth Zones
Post-Closure

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PROJECT: DA11-062-02

CLIENT: Agnico-Eagle Mines Ltd., Meadowbank Div.

N W E S
UTM Zone 14 NAD83

DATE: OCTOBER 2012

SCALE: 1:30,000

DRAWN BY: LC

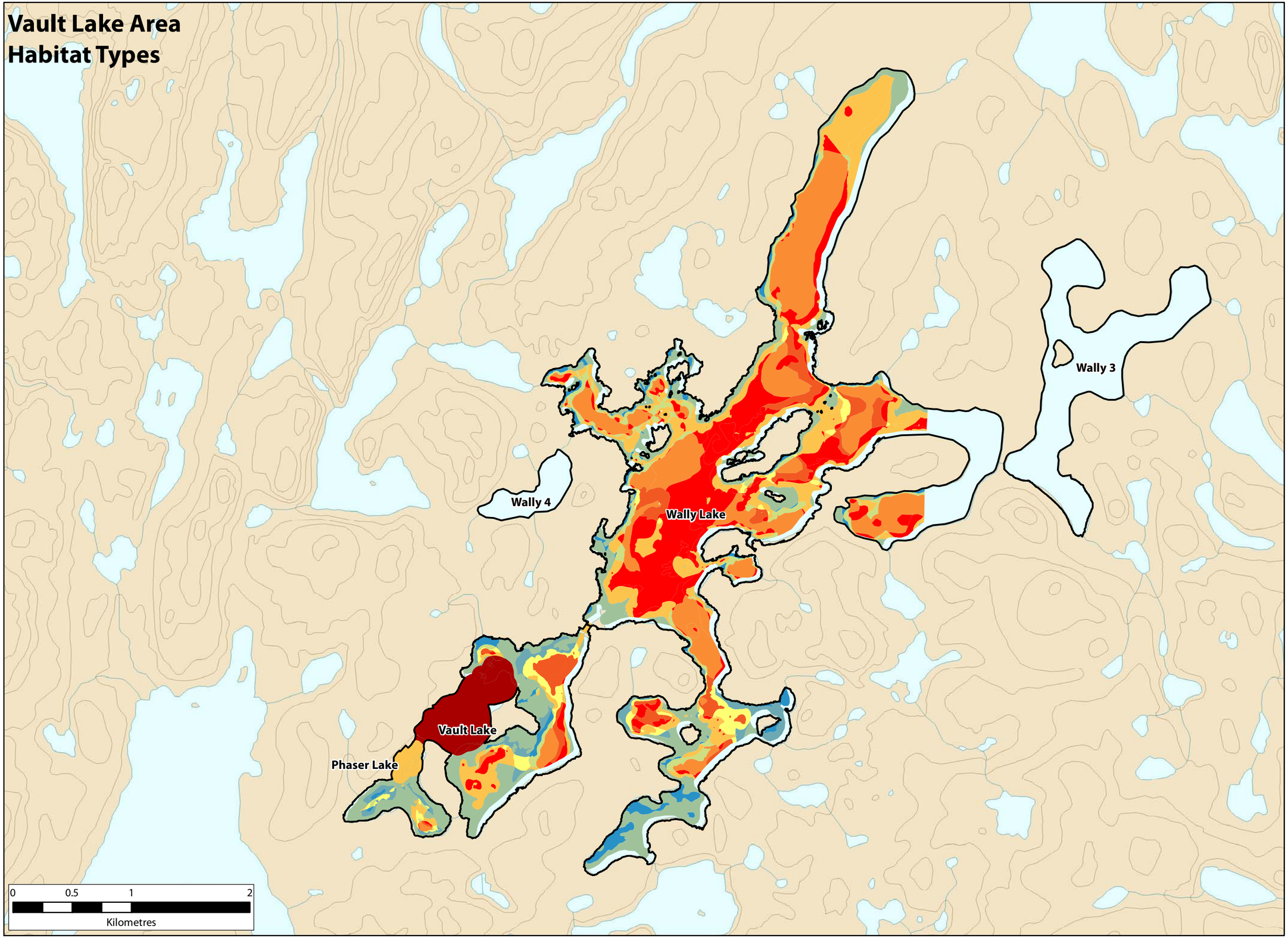
CHECKED BY:

FIGURE:

4-5

The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation. MNR data provided by Queen's Printer of Ontario. Use of the data in any derivative product does not constitute an endorsement by the MNR or the Ontario Government of such products.

Vault Lake Area
Habitat Types



Legend

Study Lakes (Post-Closure)

Habitat Type

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 11

Habitat Type	Criteria	
	Depth Zone	Substrate
1	<2 m	Fines
2	<2 m	Mixed
3	<2 m	Coarse
4	2-4 m	Fines
5	2-4 m	Mixed
6	2-4 m	Coarse
7	>4 m	Fines
8	>4 m	Mixed
9	>4 m	Coarse
11	>10 m	Coarse

Habitat Types
Post-Closure

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PROJECT: DA11-062-02

CLIENT: Agnico-Eagle Mines Ltd., Meadowbank Div.

N W E S
UTM Zone 14 NAD83

DATE: OCTOBER 2012

SCALE: 1:30,000

DRAWN BY: LC

CHECKED BY:

FIGURE:

4-6

The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation. MNR data provided by Queen's Printer of Ontario. Use of the data in any derivative product does not constitute an endorsement by the MNR or the Ontario Government of such products.

4.1.4 Summary of Gains from Re-flooding

The implementation of these compensation measures (re-flooding of the dewatered areas after construction of the described habitat features) will achieve a net gain of 143.02 HUs of aquatic habitat.

This includes 94.18 HUs in the Main Minesite Area and 48.84 HUs in the Vault Lake Area.

4.2 DOGLEG SYSTEM CONNECTING CHANNEL

4.2.1 Description

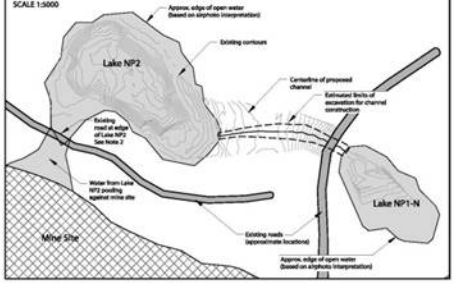
Dogleg Pond and the "North Portage" ponds, Dogleg North Pond and NP-2, are isolated ponds located near the waste rock area, just north of Second Portage Lake. They are the only shallow ponds considered in this area, with a maximum depth of 11 m in Dogleg Pond. Dogleg North Pond reaches about 3.8 m in depth, and NP-2 has a small area of about 5 m depth. The project described below was not specifically developed as compensation, but has integrated habitat compensation with water management to result in a small net gain of fish habitat.

NP-2 formerly drained into the TSF area of Second Portage Lake, while Dogleg and Dogleg North drain towards the main body of Second Portage Lake. Since drainage of NP-2 became blocked by the waste rock pile on the northern edge of the TSF, a connecting channel will be excavated to direct flow from NP-2 to Dogleg North (Figure 4-7, effectively increasing the drainage area of Dogleg and Dogleg North Pond. The accompanying increase in wetted area is 5% for Dogleg Pond, 15% for Dogleg North Pond, and 5% for NP-2.

Physical and ecological features of Dogleg Pond, Dogleg North Pond and NP-2 were examined as part of the Baseline Aquatic Ecosystem Report in 2005 (Azimuth, 2005). Currently all three are isolated with respect to fish movement. A gillnet survey in 2003 found populations of lake trout in Dogleg Pond (then called NP-1) and NP-2. The pond now called Dogleg North Pond (then unnamed) was observed to be fishless. Follow-up surveys of fish populations (with gillnets), habitat types (with underwater video) and bathymetry (with field measurements) were completed for Dogleg Pond and Dogleg North Pond in 2010 as part of the original Airstrip Extension proposal that has since been altered to reduce impacts into Third Portage Lake (AEM, 2010). Further fish surveys were completed in Dogleg Pond and NP-2 in 2011 and 2012 (Appendix E). Identical to the methods in Vault, Phaser and Wally, fine mesh index gill nets were used to quantitatively determine the species composition, size and catch-per-unit-effort (CPUE; # fish/100 m/hr) in Dogleg Pond. Panels of 25, 38, 51, 76, 102 and 126 mm stretch mesh gill nets were attached to one another in this order to create gangs of nets. Gangs were set with varying set times and durations. Nets were left for less than one day to provide daytime and overnight capture, after which time they were removed. A total of 17 hours of fishing effort was conducted to determine the presence of lake trout and round whitefish in Dogleg Pond. Lake trout only were caught in NP-2 during 2011 fish surveys.

KEY PLAN

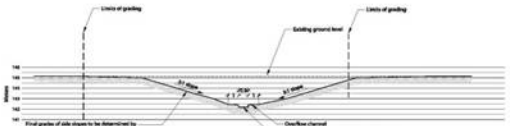
SCALE 1:5000



SECTION AA': PROPOSED CHANNEL CROSS SECTIONAL PROFILE

SCALE 1:200

NO VERTICAL EXAGGERATION



NOTE: Measurements are given in meters; actual elevations to be determined by an engineer to meet hydrological targets set by fisheries biologist to achieve fish habitat objectives.

NOTE 1: GENERAL

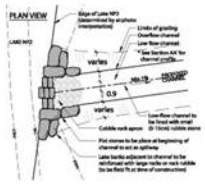
1. Channel design shown on this drawing is conceptual. Specifications and details for construction to be provided by an engineer, including special provisions and any operational constraints for construction in cold climate (i.e. permafrost)
2. Elevation of high point of channel at Lake NP2 has been approximated. Actual high point of channel to be determined by an engineer to ensure drainage, flow, and depth targets set by fisheries biologist are achieved.
3. Elevation of channel outlet at Lake NP1-N has been approximated. Actual outlet to be determined by an engineer to ensure drainage, flow, and depth targets set by fisheries biologist are achieved. Outlet to be field fit at time of construction to ensure smooth transition from sloped channel to lake level.
4. All debris, garbage and surplus material to be removed from the site. Keep the site clean and usable at all times.
5. Location for surplus rock produced through channel excavation shall be determined by engineers. Rock piles shall be sited to not disrupt water flow or fish habitat.

NOTE 2: EXISTING ROADS

1. Location of road running between Lakes NP2 & NP1-N is approximate. Culvert location to be field fit at time of construction. Cross-slope of channel to be 5% maximum.
2. Culvert size to be determined by project engineers to accommodate anticipated flows.
3. Water from Lake NP2 is percolating through existing road at edge of Lake NP2 and pooling against mine site. Edges of existing road at Lake NP2 should be made impermeable to prevent water from pooling against mine site and promote water flow towards constructed channel. Method used to create impermeable barrier to be determined by engineers.

DETAILS

SCALE 1:200

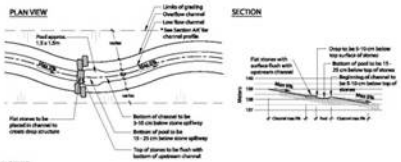


NOTES

1. Beginning of channel to be lined with flat stone. Actual elevations to be determined by an engineer to meet hydrological targets set by fisheries biologist to achieve fish habitat objectives.
2. Beginning of channel to be lined with cobble rock apron.
3. Average water level of lake to be confirmed on site and channel elevation to be field fit as appropriate.

1 TOP OF CHANNEL AT LAKE NP2

N.T.S.

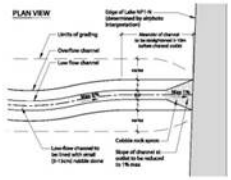


NOTES

1. Stone drop structures to be created using flat stone placed flush with the upstream channel bed.
2. Pools to be approx. 1.5 x 1.5 m in size, low-flow channel to return to 0.9 m width after pool.
3. Bottom of pools to be 15 - 25 cm below top of stones.
4. Where channel resumes, bottom of channel to be 5 - 10 cm below top of stones.
5. 5-10 drops & pools to be installed along channel section 2.
6. Drops & pools to be min. 10m apart.
7. No meanders or drops & pools 5m upstream or downstream of culvert (to be installed under existing roadway).

2 STONE DROPS & POOLS

N.T.S.



NOTES

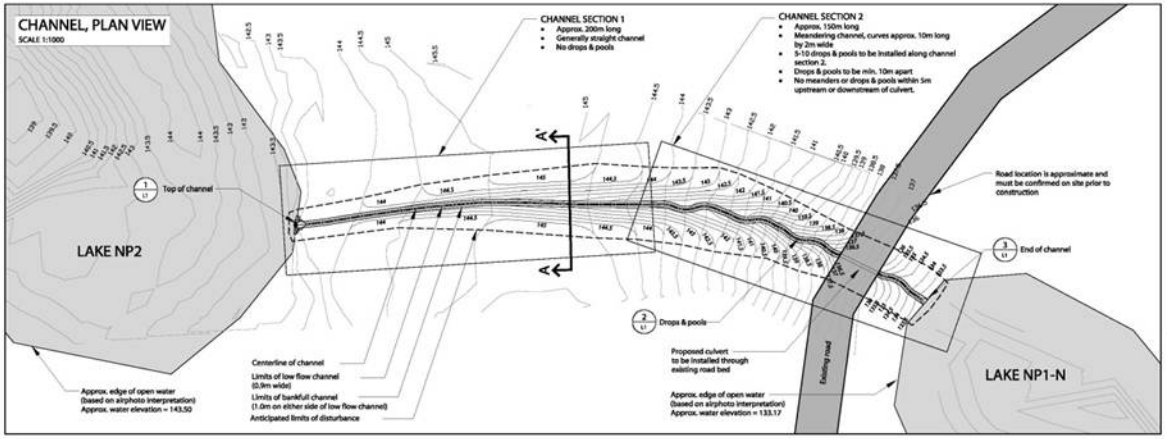
1. End of channel to be lined cobble rock apron.
2. Average water level of lake to be confirmed on site and elevation at end of channel to be field fit as appropriate.

3 END OF CHANNEL AT LAKE NP1-N

N.T.S.

CHANNEL, PLAN VIEW

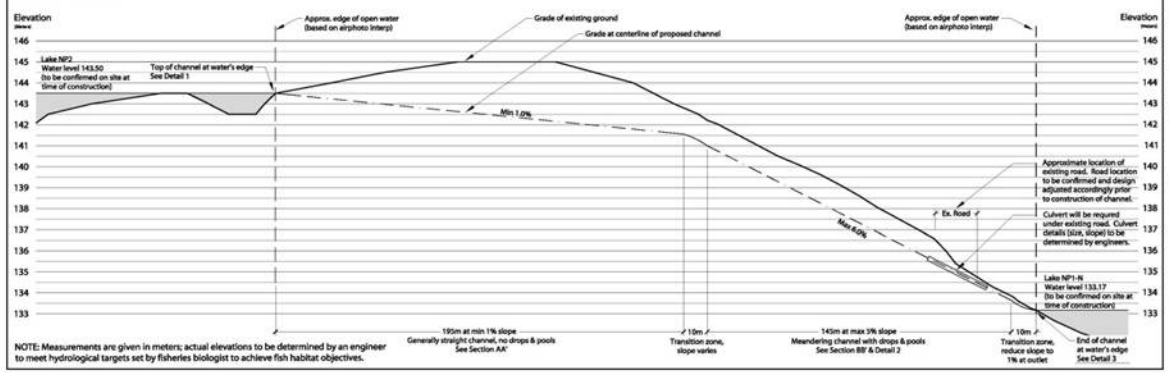
SCALE 1:1000



CHANNEL, SECTION VIEW

HORIZONTAL SCALE 1:1000

10x VERTICAL EXAGGERATION



NOTE: Measurements are given in meters; actual elevations to be determined by an engineer to meet hydrological targets set by fisheries biologist to achieve fish habitat objectives.

CONCEPTUAL CHANNEL DESIGN

Project: No Net Loss Mapping Nunavut DA11-062-01

Client: Agnico-Eagle Mines Ltd. Meadowbank Division

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North

Date: 2012-01-06

Scale: VARIES, AS SHOWN

Drawn By: MAY

Checked By: TF

Figure Number:

4-7

Through construction of the diversion channel, connectivity between the ponds would be improved, and previously inaccessible habitat in Dogleg North Pond[1] would be available for use by lake trout and round whitefish currently inhabiting Dogleg Pond and NP-2. Eventually these ponds may be seasonally accessible from Second Portage Lake. This connection would theoretically provide access for arctic char to the Dogleg system, but because it is deemed unlikely due to the shallow, ephemeral nature of the connections, access for char is conservatively excluded from habitat gain calculations.

The changes to habitat in the Dogleg ponds following channel construction are summarized in Table 4-5, below.

Table 4-5. Features of the Dogleg System and details of the changes and assumptions used to calculate net gain in habitat type areas.

Area	Feature	Description of Feature	Description of Habitat Change
Dogleg System	Dogleg Pond	Large pond, just to the north of East Dike in 2PL	Increased area (5%)
	Dogleg North Pond	Small pond just to the north of Dogleg Pond	Increased area (15%) and access for all 2PL species except char (currently fishless)
	NP-2	First pond to the northwest of Dogleg North Pond	Increased area (5%)

4.2.2 HU Calculation - Gains

Substrate and depth zones for the Dogleg system were mapped using bathymetric and substrate profiles collected in 2010 and re-mapped in 2011. Habitat type areas were calculated as described in Section 2.2, incorporating the above assumptions for the post-compensation values. Habitat units for pre- and post- scenarios are shown in Table 4-6. A net 1.85 HUs will be gained through the implementation of this compensation option.

[1] With DFO approval,lake trout and round whitefish from the Vault and Phaser Lake fishouts are proposed to be transferred into Dogleg North Pond

Table 4-6. Net habitat units (HUs) gained from the construction of a diversion channel between NP-2 and Dogleg North Pond.

Area	Feature Name	Pre-compensation HUs	Post-compensation HUs	Net Gain HUs
Dogleg System	Dogleg Pond	6.10	6.41	0.31
	Dogleg North Pond	0	0.91	0.91
	NP-2	2.19	2.82	0.63
TOTAL		**8.29**	**10.14**	**1.85**

4.3 CONSTRUCTION OF FINGER DIKES

4.3.1 Description

In keeping with the original NNLP, two finger dikes are proposed to be built, extending from the Bay-Goose Dike into Third Portage Lake. While the original NNLP proposed 19 ha of finger dikes, AEM has found that the method described for construction to be technically challenging and furthermore pose safety concerns, as well as potential concerns with elevated TSS during settling of material. Therefore, while AEM is committed to maintaining this compensation feature, the new finger dikes are proposed to be 0.5 ha each (base area). As previously, they will be constructed over fine substrate in depths greater than 4m (low-value habitat - HT 7). Finger Dike 1 will be constructed in an area of just over 4 m depth with fine substrate, and will extend upwards to approximately 3 m deep, changing the area to HT 6. Finger Dike 2 will be constructed in an area of > 4 m depth, with fine substrate, and will extend upwards approximately 1 m, staying within the same depth zone but changing the area to HT 9. Potential locations for each finger dike are shown in Figure 4-1 A and B. Specific locations will be chosen prior to construction, in the open-water season of 2013. Table 4-7 describes the assumptions used to calculate habitat units for this compensation feature.

Table 4-7. Details of the finger dike compensation feature, and assumptions used to calculate net gain in habitat type areas.

Lake	Feature	Description of Feature	Description of Habitat Change
Third Portage Lake	Finger Dike 1	0.5 ha underwater dike extending from Bay-Goose Dike	Simulated reef habitat - *conversion from HT 7 to HT 6*
	Finger Dike 2	0.5 ha underwater dike extending from Bay-Goose Dike	Simulated reef habitat - *conversion from HT 7 to HT 9*

4.3.2 HU Calculation - Gains

Based on these assumptions, habitat units for pre- and post-compensation scenarios are shown in Table 4-8. A net 0.40 HUs will be gained through the implementation of this compensation option.

Table 4-8. Net habitat units (HUs) gained from the construction of two 0.5 ha finger dikes in Third Portage Lake, off the Bay-Goose Dike.

Area	Feature Name	Pre-compensation HUs	Post-compensation HUs	Net Gain HUs
Third Portage Lake	Finger Dikes	0.21	0.42	0.22
	Finger Dike 2	0.21	0.39	0.18
TOTAL		**0.41**	**0.82**	**0.40**

4.4 VAULT LAKE AREA ACCESS ENHANCEMENTS

4.4.1 Description

Wally Lake is a 532 ha lake connected to Vault Lake (see Figure 3-5) via a seasonally passable channel. Fish movement between these lakes is currently almost nil (1 fish was observed using the channel in baseline studies – Azimuth, 2005), and this channel will be diked prior to de-watering of Vault Lake. Information in baseline (Azimuth, 2005) indicates that the only large bodied fish in Wally, Vault and Phaser Lakes are lake trout and round whitefish. In 2012, follow-up studies were completed to confirm these results. Fine mesh index gill nets that were used to quantitatively determine the species composition, size and catch-per-unit-effort (CPUE; # fish/100 m/hr) in Vault Lake, Phaser Lake and Wally Lake. Panels of 25, 38, 51, 76, 102 and 126 mm stretch mesh gill nets were attached to one another in this order to create gangs of nets. Gangs were set with varying set times and durations. Due to uncertainties in baseline data collection at Wally, fishing efforts there targeted deep zones to confirm presence and absence of arctic char. Nets were left for less than one day to provide daytime and overnight capture, after which time they were removed and re-set. Most of the locations had a total of two sets within the two days of monitoring. Nets were set for a total of 102 hours in Wally Lake, 78 hours in Vault Lake and 82 hours in Phaser Lake. Consistent with baseline data, no arctic char were found in any of these lakes. For the purposes of this assessment, it is conservatively assumed that burbot, ninespine stickleback and slimy sculpin are also found in all of the lakes, because these fish are known to be difficult to catch in gill nets.

Wally 3 (W3) is a smaller lake (approximately 100 ha) seasonally connected hydraulically to Wally Lake via an impassable channel (see photos, Appendix D). No fish were found to use this corridor in baseline studies (Azimuth, 2005). Follow-up studies conducted in 2011 used fine mesh index gill nets to quantitatively determine the species

composition, size and catch-per-unit-effort (CPUE; # fish/100 m/hr) as described above, in the southern basin. Nets were left for less than one day to provide daytime and overnight capture, after which time they were removed and re-set. Most of the locations had a total of two sets within the two days of monitoring and found that lake trout, round whitefish and arctic char, inhabit this small but deep lake.

Topographical surveys conducted in this area indicated that water levels in Wally Lake and W3 are similar (within cm), and therefore slight deepening of the connecting channel through selective substrate removal and excavation during winter would provide access to Wally Lake for the isolated arctic char population in W3.

In addition, improvement of the channel between Wally Lake and Vault Lake, post-closure, would further allow movement of char into Vault and Phaser Lakes (as Phaser Lake will be connected to Vault Lake through the Vault Pit). In order to make this channel passable year-round and provide access to newly created deep habitat in the Vault Pit, a passage will be excavated while Vault Lake is dewatered.

As discussed in Section 2.2.6, it is suspected that the lack of char in Wally, Vault and Phaser Lakes is due to historical isolation and the lack of deep-water habitat, which is preferred by this species. Pit development in the Vault Lake area will provide a significant quantity (approximately 45 ha) of this deep-water habitat, which is limited in the Vault Lake Area, but is prevalent in all nearby char-bearing lakes. While monitoring studies will be conducted to ensure compensation is implemented as designed (as in Azimuth, 2008), the opportunity for focussed research on niche use partitioning following fish community changes in the north could be available as part of this compensation feature.

4.4.2 HU Calculation - Gains

Substrate and depth zones do not change post-compensation in Wally, Vault and Phaser Lakes as a result of char access, but the access factor for char increases from 0. Since productivity of the introduced char is uncertain, the post-compensation access factor was conservatively set at 0.75, rather than 1. It is necessary to calculate existing habitat type areas based on substrate and depth zones, as in other compensation options. Baseline (pre-compensation) bathymetry and substrate surveys were conducted for the majority of Wally Lake for the original 2006 NNLP. However, it should be noted that substrate data was not available for the easternmost portion of Wally Lake (see Figures 4-5). Therefore, this area was not included in calculations, and net gains are underestimated. The HEP method described in Section 2.2 was used to calculate the net gain in HUs for Wally Lake, assuming the introduction of char from W3. Similarly, the net gain in HUs from the addition of char to Vault and Phaser Lakes were calculated using their post-closure habitat type areas as baseline values. Although small-bodied fish were not caught in surveys to date, they are conservatively assumed to be present in both the pre- and post-compensation calculations.

Substrate zones (fines, mixed, coarse) for Wally Lake are shown in Figure 4-5a. The majority of substrate in Wally Lake is fine grained, with coarse and mixed-grain substrate typically occurring around the shoreline.

The extents of the depth zones considered in Wally Lake for the pre- and post-compensation scenarios are shown in Figure 4-5b. Although Wally Lake is large in surface area, it is relatively shallow compared to the Main Minesite lakes.

The extents of habitat types 1-11, as described in Section 2.2.1, were calculated by overlaying substrate and depth maps. Habitat type areas for Wally Lake are shown in Figure 4-6. This area consists of a relatively mixed proportion of habitat types.

See Section 4.4 for post-closure substrate, depth zones and habitat type areas in Vault and Phaser Lakes. As noted above, post-closure habitat type areas were used to determine the net gains achieved from access improvements for arctic char.

Using the HEP described in Section 2.2, net gain in habitat units based on the addition of arctic char to Wally, Vault and Phaser Lakes was calculated, and is shown in Table 4-9. A net 107.37 HUs would be gained through the implementation of this compensation option.

Table 4-9. Pre- and post-compensation habitat units involved in the creation of access for arctic char between Wally Lake and W3, and Wally Lake and Vault Lake.

Area	Feature Name	Pre-compensation HUs	Post-compensation HUs	Net Gain HUs
Wally Lake	Access to W3	183.25	269.74	86.49
Vault Lake	Access to Wally Lake	39.71	56.85	17.14
Phaser Lake	Access to Wally Lake	9.13	12.87	3.74
TOTAL		**232.09**	**339.46**	**107.37**

4.5 DESIGN AND CONSTRUCTION OF THE COMPENSATION FEATURES

4.5.1 Re-flooding of Dewatered Basins and Pits

Construction of in-basin mine-related features including roads, pit caps, and pit backfilling is based on mine construction requirements. Dikes have already been constructed according to designs to maximize fish habitat suitability, which are discussed in detail in Cumberland (2006). Construction of the Vault Dike will be completed in the winter in the same manner as the South Camp Dike. Due to the narrow width of the Vault dike and the shallow water (<2m) it will be removed post-closure to allow adequate fish passage from Wally Lake into Vault and Phaser Lake.

The boulder garden in the Bay-Goose Basin is to be constructed by free-dumping coarse-grained waste rock to create a heterogeneous, coarse substrate habitat in the <4 m depth zone. This area extends approximately 2.97 ha, and is located just west of the Goose Island Pit (see Figure 4-1). Contours of the final boulder garden will be approved by a qualified environmental technician or biologist to ensure maximum utility as fish habitat.

While in-basin features will continue to be constructed in the Main Minesite and Vault Lake Areas throughout the life-of-mine, gains in fish habitat will not be realized until

the basins are re-flooded and the dikes are breached to allow fish passage. Re-flooding of the Portage Pit is proposed to begin in 2016 and continue during closure (after 2017). Bay-Goose Basin is currently estimated to begin during closure, with breaching of the dike to allow fish passage occurring during closure, assuming water quality monitoring within the basin indicates acceptable conditions (as in Golder, 2005). The Bay-Goose Dike will be breached by excavating a section approximately 100 m-long along the southern stretch of the dike to a depth of 2-4 m. Note that after re-flooding, the dewatered portion of Second Portage Lake will be connected to the dewatered portion of Third Portage Lake, as a result of the Portage Pit. This area will connect to Third Portage Lake at the southern edge of the Bay-Goose basin through breaching of the Bay-Goose Dike.

Following the same conditions for acceptable water quality, Vault and Phaser Lakes are currently expected to be re-flooded during closure, with removal of the Vault Dike. Table 4-10 summarizes the estimated timing of the re-establishment of fish habitat in the Main Minesite and Vault Lake Areas from re-flooding.

4.5.2 Supplementary Compensation Projects

Construction of the diversion channel connecting NP-2 to Dogleg North began in summer 2012, and will be completed in 2013 to assist in water management during 2013 freshet. Design of this short channel was mainly to improve water management north of the TSF, and thus any incidental habitat gained in channel area itself is not included in this assessment. The channel was excavated to an average width of approximately 1.5 m (see Figure 4-7), and lined with boulder and cobble material to restrict flow and control erosion and the introduction of sediment downstream. Since the water redirected by this channel into Dogleg North Pond is non-contact flow, water quality in the Dogleg System is not expected to be impacted. Spring flows are expected to provide seasonal connection between ponds however the viability of fish passage between ponds and natural connection between lakes will be limited in the spring during freshet and during rain events. As a result of this uncertainty, fish passage is assumed limited and therefore conceptual channel areas are not included in the calculations.

Construction of the finger dikes will occur as previously described (Cumberland, 2006), by placement of the appropriate volume of NPAG waste rock material on ice. The process may need to be repeated to achieve the desired depth of dike top. However, with the smaller area (1 ha) compared to that originally proposed (19 ha), successful construction of this compensation feature within a shorter time frame is more feasible. Construction of one of the finger dikes is planned to begin in 2015 and both finger dikes will be completed by closure.

Creation of access for arctic char between Wally Lake and W3 will occur through selective substrate removal and excavation, during the winter in 2016. At this point, heavy equipment will be nearby at Vault Lake, and moving it across the tundra to W3 after the ground is frozen will be least disruptive to the terrestrial environment. Removal of substrate

will be overseen by a qualified environmental technician or biologist to ensure removal of appropriate sizes and quantity of substrate to allow fish passage.

As discussed in Section 4.5.1, re-flooding of Vault and Phaser Lakes will occur during closure, with breaching of the Vault Dike to provide fish access post closure, assuming water quality monitoring within the basin indicates acceptable conditions (as in Golder, 2005).

Table 4-10 provides the estimated timing of construction for each of the compensation features described above.

Table 4-10. Estimated timing for gains of fish habitat through compensation options.

Lake	Feature Name	Date of Completion
Second and Third Portage Lakes	In-basin habitat improvements	Ongoing until re-flooding
	Re-flooded basins and pits	2014- closure
	Finger dikes	2015- closure
Vault and Phaser Lakes	In-basin habitat improvements	2014 until re-flooding
	Re-flooded basins and pits	Closure and reclamation
	Access for arctic char	Closure and reclamation
Dogleg System	NP-2 channel	2013
	NP-2 (increase in area)	2013- closure
	Dogleg North Pond (increase in area and access)	2013- closure
	Dogleg Pond (increase in area)	2015- closure
Wally Lake	Access for arctic char	2016- closure

SECTION 5 • LOSS/GAIN COMPARISON

Losses to fish habitat incurred through mining activities are compared here with net gains achieved through habitat compensation measures. In order to provide direct comparisons with historical documentation and authorized loss/gain ratios, losses and net gains are "allotted" to the Main Minesite, TSF and Vault Lake Areas.

5.1 SUMMARY OF LOSSES

A summary of the habitat unit losses associated with the footprint of each feature located in the Main Minesite, TSF, and Vault Lake Areas, should no compensation measure be implemented (e.g. no re-flooding), is shown in Table 5-1. Refer to Section 4 for a detailed description of each of these features.

Table 5-1. Summary of pre-construction, or lost habitat units (HUs) associated with each lake and minesite feature for the Main Minesite, TSF and Vault Lake Areas.

Area	Lake	Feature Name	Lost HUs
Main Minesite	Second Portage Lake (2PL)	Basin	3.46
		Portage Pit in 2PL	7.45
		Portage Pit in 2PL Cap	1.36
		Roads	3.87
		Central Dike	7.79
		East Dike	2.53
	Third Portage Lake (3PL)	Basin	17.67
		Portage Pit in 3PL	3.41
		Portage Pit in 3PL Cap	0.87
		Goose Island Pit	6.43
		Goose Island Pit Cap	1.74
		Roads	2.40
		Bay Goose Dike	7.04
		South Camp Dike	0.12
	Subtotal		*66.12*
TSF	Second Portage Lake	Tailings Storage Facility	*37.85*
Vault Lake Area	Vault Lake	Basin	25.46
		Vault Pit	1.40
		Vault Pit Cap	0.78
		Vault Dike	0.09
	Phaser Lake	Basin	4.11
		Vault Pit – Phaser portion	0.48
		Vault Pit Cap – Phaser portion	0.16
		Roads	0.6
	Subtotal		*33.09*
TOTAL LOSSES			**137.07**

5.2 SUMMARY OF GAINS

Overall, habitat units will be gained post-closure as a result of various compensation measures, as described in Section 4. Significant habitat gains are made through re-flooding of the dewatered basins after construction of habitat improvements such as pit backfilling and a boulder garden. Additional onsite gains are derived by constructing finger dikes, improving access and increasing size in the Dogleg system, and creating access for arctic char in Vault, Phaser and Wally Lakes. A summary of the habitat unit gains associated with each compensation measure are shown in Table 5-2. Refer to Section 4 for a detailed description of how gains were calculated for each compensation measure and feature.

Table 5-2. Summary of gained habitat units (HUs) associated with each minesite feature following implementation of the specified compensation measure.

Location	Compensation Measure	Feature Name	Gained HUs
Second Portage Lake (2PL)	Re-flooding after pit backfill	Basin	4.47
		Portage Pit in 2PL	12.32
		Portage Pit in 2PL Cap	2.37
		Roads	5.98
		Central Dike	0.80
		East Dike	0.25
Subtotal			*26.20*
Third Portage Lake (3PL)	Re-flooding after pit backfill	Basin, including boulder garden	22.99
		Portage Pit in 3PL	3.83
		Portage Pit in 3PL Cap	1.28
		Portage Pit Land-to-Lake	21.51
		Goose Island Pit	7.29
		Goose Island Pit Cap	2.49
		Goose Island Pit Land-to-Lake	2.01
		Roads	3.19
		Bay Goose Dike, including breach	3.35
		South Camp Dike	0.04
	Finger Dikes	Finger Dike 1	0.22
		Finger Dike 2	0.18
Subtotal			*68.38*
Vault Lake	Re-flooding	Basin	26.98
		Vault Pit	1.83
		Vault Pit Cap	0.85
		Vault Pit Land-to-Lake	9.96
		Vault Dike removal	0.09
	Access to Wally Lake	Access for arctic char to Vault Lake	17.14
Subtotal			*56.85*
Phaser Lake	Re-flooding after pit backfill	Basin	4.70
		Vault Pit – Phaser portion	1.42
		Vault Pit Cap – Phaser portion	0.20
		Vault Pit Land-to-Lake – Phaser portion	2.01
		Roads	0.80
	Access to Wally Lake	Access for arctic char to Phaser Lake	3.74
Subtotal			*12.87*
Wally Lake	Access to W3	Access for arctic char to Wally Lake	*86.49*

Location	Compensation Measure	Feature Name	Gained HUs
Dogleg System	Connecting channel	Dogleg Pond (increase in area)	0.31
		Dogleg North Pond (access and area)	0.91
		NP-2 (increase in area)	0.63
Subtotal			*1.85*
TOTAL GAINS			**252.65**

Overall, losses to fish habitat would total 137.06 HUs, should no compensation measures be implemented. The implementation of the above-described compensation measures would total 252.65 gained HUs. The ratio of gains to losses for the entire minesite, based on this compensation plan, is therefore 1.84:1.

5.3 ALLOTMENT OF GAINS

Since the three areas of the minesite (Main Minesite, TSF and Vault Lake Area) must be considered separately for various historical and regulatory purposes (see Section 1.3), the total losses associated with each area must be offset by specifically identified gains, at the ratios authorized previously. This allotment of gains is described below.

5.3.1 Main Minesite Area

The natural pre-construction habitat units associated with the Main Minesite Area total 66.12 HUs. The habitat units gained in this area post-closure from re-flooding of the dewatered areas after implementation of habitat improvements, total 94.18 HUs, for a natural total gains:losses ratio of 1.42:1. The approved gains:losses ratio for this area in the Fisheries Authorization was 1.68:1. Therefore, consistent with Cumberland (2006), gains from the Vault Lake Area are used to supplement gains in the Main Minesite Area.

Additionally, in the original NNLP (Cumberland, 2006), a number of gains from features in the Main Minesite were allotted to the TSF. In keeping with the Authorization granted for the TSF, gains from these Main Minesite features have been allotted to the TSF in this NNLP. Therefore in Table 5-3 below, no gains are associated with these items (indicated with a "-"). These gains appear in the TSF allotment table, Table 5-4.

With a loss of 66.12 HUs in the Main Minesite Area, the allotted gains for this area must total 111.08 HUs to meet the approved compensation ratio of 1.68:1. The allotted gains are shown in Table 5-3, below.

Table 5-3. Gained habitat units (HUs) allotted to the Main Minesite Area, in keeping with historical documentation and to meet the approved compensation ratio of 1.68:1 (total losses = 66.12 HUs). "-" indicates gains from features in the Main Minesite Area that have been allotted to the TSF (see Table 5-4) in accordance with the existing Fisheries Authorization for that area. *partial gains from W3 access are allotted in each area.

Lake	Compensation Measure	Feature	Gains (HUs)
Second Portage Lake (2PL)	Re-flooding after pit backfill	Basin	4.47
		Portage Pit in 2PL	-
		Portage Pit in 2PL Cap	2.37
		Roads	5.98
		Central Dike	-
		East Dike	-
Subtotal			*12.82*
Third Portage Lake (3PL)	Re-flooding after pit backfill	Basin, including boulder garden	22.99
		Portage Pit in 3PL	-
		Portage Pit in 3PL Cap	1.28
		Portage Pit Land-to-Lake	-
		Goose Island Pit	-
		Goose Island Pit Cap	2.49
		Goose Island Pit Land-to-Lake	-
		Roads	3.19
		Bay Goose Dike, including breach	-
		South Camp Dike	-
	Finger Dikes	Finger Dike 1	-
		Finger Dike 2	-
Subtotal			*29.95*
ADDITIONAL ALLOTTED GAINS			
Vault Lake	Re-flooding	Basin	26.98
		Vault Dike removal	0.09
Wally Lake	Access to W3	Access for arctic char to Wally Lake	41.24*
Subtotal			*68.31*
TOTAL ALLOTED GAINS			**111.08**

Based on this allotment of gains, the compensation ratio for the Main Minesite Area is 1.68:1.

5.3.2 TSF

The pre-construction habitat units associated with the TSF total 37.85 HUs. This area will be infilled post-closure, so all habitat is permanently lost. Specific gains from the Main Minesite

Area and the Vault Lake Area are allotted to the TSF in accordance with the existing Fisheries Authorization for this area. These allotted gains are specified in Table 5-4.

Table 5-4. Gained habitat units (HUs) allotted to the Tailings Storage Facility, in keeping with historical documentation and to meet the approved compensation ratio of 2:1 (total losses = 37.85 HUs). *partial gains from W3 access are allotted in each area.

Area	Compensation Measure	Feature	Gains (HUs)
Tailings Storage Facility	N/A		0.00
ADDITIONAL ALLOTTED GAINS			
Second Portage Lake	Re-flooding after pit backfill	Portage Pit in 2PL	12.32
		Central Dike	0.80
		East Dike	0.25
Third Portage Lake	Re-flooding after pit backfill	Portage Pit in 3PL	3.83
		Portage Pit Land-to-Lake	21.51
		Goose Pit	7.29
		Goose Pit Land-to-Lake	2.01
		Bay Goose Dike	2.62
		South Camp Dike	0.04
	Finger Dikes	Finger Dike 1	0.22
		Finger Dike 2	0.18
Vault Lake	Re-flooding	Vault Pit	1.83
		Vault Pit Land-to-Lake	9.96
Wally Lake	Access to W3	Access for arctic char to Wally Lake	12.64*
Subtotal			*75.70*
TOTAL ALLOTTED GAINS			**75.70**

Based on this allotment of gains, the compensation ratio for the TSF is 2:1.

5.3.3 Vault Lake Area

Habitat units lost in the Vault Lake Area total 33.09 HUs. The habitat units gained in this area after implementation of habitat compensation and re-flooding total 48.84 HUs, for a total gains:losses ratio of 1.48:1, before allotment of gains to other areas. Since nearly all gains have been allotted to other areas, in keeping with past documentation, net gains from the W3 access improvement are used to supplement gains for this area. The allotment of habitat unit gains for the Vault Lake Area is shown in Table 5-5

Table 5-5. Gained habitat units (HUs) allotted to the Vault Lake area (total losses = 33.09 HUs). Gains allotted to other areas as necessary or in keeping with historical documentation are indicated as "-".*partial gains from W3 access are allotted in each area.

Lake	Compensation Measure	Feature Name	Gains (HUs)
Vault Lake	Re-flooding	Basin	-
		Vault Pit	-
		Vault Pit Cap	0.85
		Vault Pit Land-to-Lake	-
		Vault Dike removal	-
	Access to Wally Lake	Access for arctic char to Vault Lake	17.14
Subtotal			*17.99*
Phaser Lake	Re-flooding after pit backfill	Basin	4.70
		Vault Pit – Phaser portion	1.42
		Vault Pit Cap – Phaser portion	0.20
		Vault Pit Land-to-Lake – Phaser portion	2.01
		Roads	0.80
	Access to Wally Lake	Access for arctic char to Phaser Lake	3.74
Subtotal			*12.87*
ADDITIONAL ALLOTTED GAINS			
Dogleg System	Connecting channel	Dogleg Pond	0.31
		Dogleg North Pond	0.91
		NP-2	0.63
Wally Lake	Access to W3	Access for arctic char to Wally Lake	32.61*
Subtotal			*35.76*
TOTAL ALLOTTED GAINS			**65.32**

Based on this allotment of gains, the compensation ratio for the Vault Lake Area would be 1.97:1.

Furthermore, although there will be a temporary loss of habitat in these lakes, with DFO approval, live fish will be transferred to adjacent lakes prior to dewatering, in an effort to maintain the population in the area during operation.

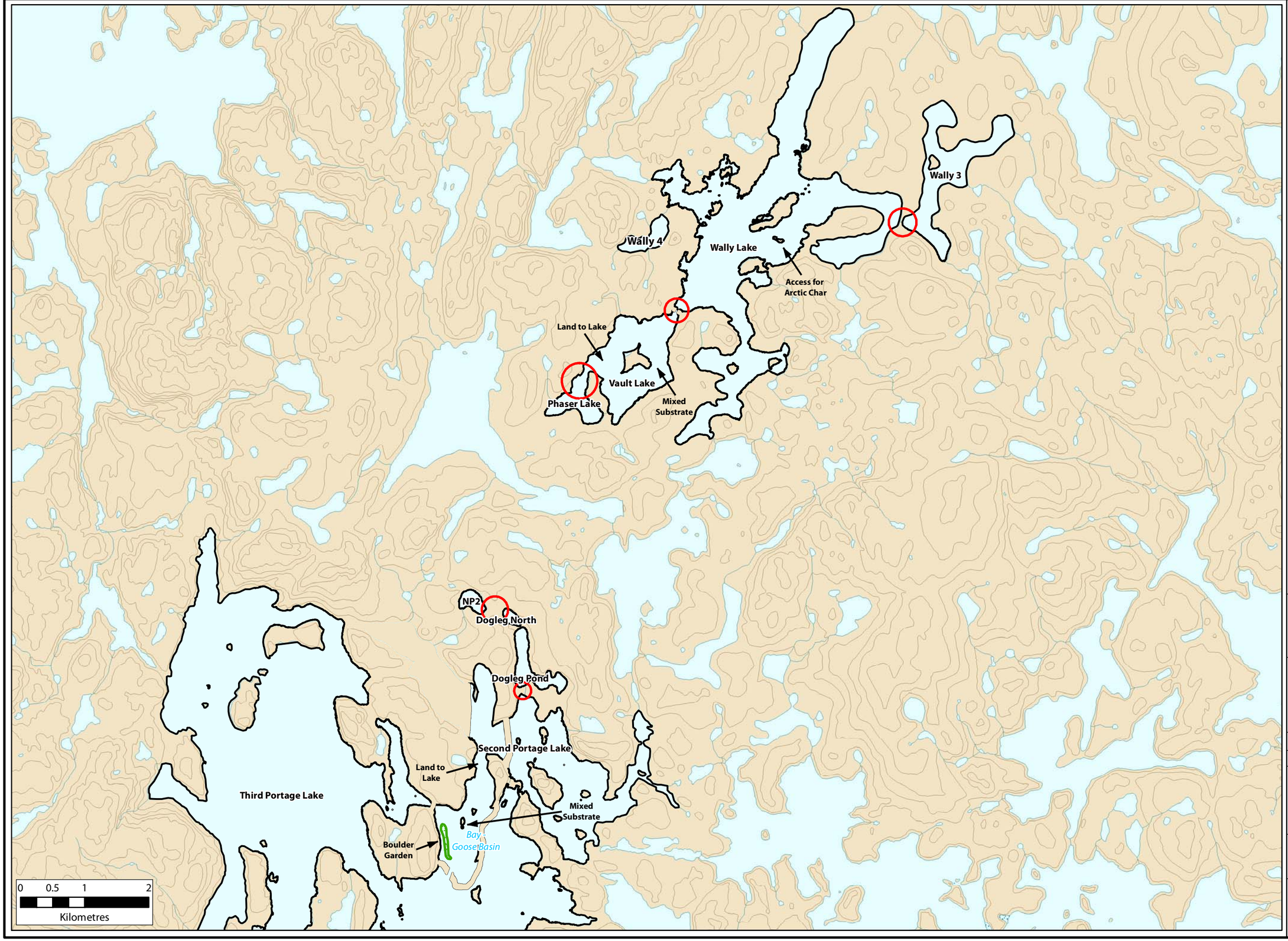
5.4 OVERALL SUMMARY

In summary, based on the compensation plan described above, the gains:losses ratio for the Main Minesite Area will be 1.68:1, as authorized previously. Gains for this area are mainly achieved through re-flooding of basins after construction of habitat improvement features such as boulder gardens.

With the allotment of gains from the Main Minesite and Vault Lake Areas to the TSF, the ratio of gains:losses for the TSF is 2:1, as authorized previously. With the addition of the Phaser Pit cap, the same compensation gains are allotted to this area as in Meadowbank's historical permit. This compensation includes the creation of habitat from re-flooded pits, and the creation of finger dikes.

Nearly all gains for the Vault Lake Area are allotted to the Main Minesite Area and the TSF, consistent with the original NNLP (Cumberland, 2006). The W3 access improvement compensation project is used to supplement gains in the Vault Lake Area, and the resulting proposed gains:losses ratio for this area is 1.97:1.

Extents of the minesite lakes, post-closure, are shown in Figure 5-1.



Legend

- Study Lakes (Post-Closure)
- Improved Access

Meadowbank Minesite
Post-Closure

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PROJECT: DA11-062-02

CLIENT: Agnico-Eagle Mines Ltd., Meadowbank Div.

N W E S
UTM Zone 14 NAD83

DATE: OCTOBER 2012

SCALE: 1:55,000

DRAWN BY: LC

CHECKED BY:

FIGURE:

5-1

The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation. MNR data provided by Queen's Printer of Ontario. Use of the data in any derivative product does not constitute an endorsement by the MNR or the Ontario Government of such products.

SECTION 6 • NNL CONTINGENCY OPTIONS

All available compensation options at Meadowbank were evaluated based on efficiency in achieving NNL, cost, environmental effects and acceptability under DFO criteria and community values. Following discussions with DFO, the most favourable options were included in the NNLP, above. The success of each will be assessed post-closure based on physical and biological monitoring programs, as in Azimuth (2008). As described in the 2008 Fisheries Authorization, contingency options were established, which may be implemented in the case that the primary plan fails, either due to inability to construct, or failure to meet the criteria for success established in the Habitat Compensation Monitoring Plan. These subsequent compensation projects will be implemented as required, and only in the event that they are necessary. All options will be discussed and accepted by DFO prior to implementation and are presented below conceptually.

The compensation contingency options currently under consideration for the Meadowbank site are (in order of desirability):

1. Improvement of Airplane Lake culverts
2. Improvement of access between Wally Lake and Wally 4
3. Construction of arctic grayling spawning pads
4. Remediation of Airplane Lake water quality
5. Provision of funding for research opportunities aimed at validating HSIs
6. Creation of larger finger dikes and sea mounts

6.1 OPTION 1: IMPROVEMENT OF AIRPLANE LAKE CULVERTS

6.1.1 Description

Water flow from upstream areas into Airplane Lake is restricted on the western edge (under the road to Baker Lake) and northern edge (under the Prince River Road) by culverts that are too small to handle flow during certain times of the year (see photos, Appendix D). AEM has observed that water regularly flows over the road in these areas, likely impeding fish passage at this location during peak freshet, contributing excess TSS to Airplane Lake and requiring continual road repair. These culverts are owned and maintained by the Hamlet of Baker Lake, and therefore are not part of AEM's All Weather Access Road DFO Authorization (NU-03-0190). As a compensation contingency option, AEM proposes to replace the small culverts with larger ones, facilitating water flow and fish movement, and reducing roadway erosion.

Similar access improvements have been presented historically in NNLPs in the north. For example, stream barrier removal was proposed as compensation for the Snap Lake

project (Golder, 2004), the Jericho project (Mainstream Aquatics Ltd., 2004), and the Doris North project (Golder, 2007).

Fish surveys in 2012 indicated populations of lake trout, round whitefish, arctic grayling and burbot in Airplane Lake. In 2012 fine mesh index gill nets were used to quantitatively determine the species composition, size and catch-per-unit-effort (CPUE; # fish/100 m/hr) in Airplane Lake. Panels of 25, 38, 51, 76, 102 and 126 mm stretch mesh gill nets were attached to one another in this order to create gangs of nets. Gangs were set with varying set times and durations. Nets were left for approximately one day to provide daytime and overnight capture, after which time they were pulled. A total of four nets for a total 47 hours of fishing effort was conducted and determined the percent biomass of arctic grayling in Airplane lake to be 20% 12% lake trout, 67% round whitefish, 1% burbot). This indicates a significant difference from biomass and species assemblages present within the Meadowbank Project Lakes. For the purposes of this contingency plan, it is assumed that the widening of the Prince River Road culvert will improve access for arctic grayling to two northern tributaries of Airplane Lake (Airplane North 1 and 2 – see Figure 6-1), where spawning occurs. Since some grayling can pass under current conditions, access is assumed to be improved relatively from 50% to 100%. While water quality improvements from reductions in TSS are likely to be associated with the repair of each culvert, gains are not calculated quantitatively here.

6.1.2 Estimation of Habitat Gains

Based on brief field surveys, the Airplane North lakes are estimated to be relatively shallow, with bathymetry and substrate zones similar to the Bay-Goose Basin of Third Portage Lake. For the purposes of this draft assessment, areas of habitat types in these lakes were assumed to have the same proportional distribution as those found in the Bay-Goose Basin, in both pre- and post-compensation assessments. For the pre-compensation assessment, access for arctic grayling was 0.5. This value was increased to 1 in the post-compensation assessment.

A summary of the total habitat type areas and habitat units, using the above assumptions and calculated as described in Section 2.2, are shown in Table 6-1. The HU subtotal and total by species and minesite feature are provided in Appendix F.

Airplane Lake North 1

Airplane Lake North 2

Airplane Lake

0 250 500 1,000

Metres

Legend

Airplane Lake Subwatershed

Airplane Lake Area

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PROJECT: DA11-062-02

CLIENT: Agnico-eagle Mines Ltd., Meadowbank Div.

N W E S

UTM Zone 17 NAD83

DATE: OCTOBER 2012

SCALE: 1:18,859

DRAWN BY: LC

CHECKED BY:

Figure:

6-1

The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation. MNR data provided by Queen's Printer of Ontario. Use of the data in any derivative product does not constitute an endorsement by the MNR or the Ontario Government of such products.

Table 6-1. Net gain of habitat units (HUs) for contingency option 1 - replacing culverts in the Airplane Lake area (improving access for arctic grayling to spawning tributaries and the Airplane North lakes).

Habitat Type	Pre-compensation HUs	Post-compensation HUs	Net Gain HUs
1	0.02	0.03	0.00
2	0.00	0.00	0.00
3	3.64	3.87	0.23
4	1.36	1.47	0.11
5	0.00	0.00	0.00
6	4.29	4.55	0.26
7	7.46	8.12	0.65
8	0.00	0.00	0.00
9	0.51	0.55	0.04
10	N/A	N/A	N/A
11	N/A	N/A	N/A
Total	**17.28**	**18.57**	**1.30**

6.2 OPTION 2: IMPROVEMENT OF ACCESS BETWEEN WALLY LAKE AND W4

6.2.1 Description

Wally 4 (W4) is a small (~25 ha), isolated lake just west of Wally Lake (see Figure 1-2). Based on similar lakes in the area (Phaser, Dogleg), this lake is expected to contain an isolated population of lake trout and round whitefish. By improving the impassable connection between W4 and Wally Lake with deepening and selective substrate removal, access would be created for arctic char into W4.

6.2.2 Estimation of Habitat Gains

Since the habitat type areas of W4 have not yet been determined, it is assumed to be the same size and have the same habitat type distribution as nearby Phaser Lake. Substrate and depth zones will not change post-closure, but the access factor for arctic char will increase from 0 to 1.

Based on these assumptions, habitat units for pre- and post- scenarios are shown in Table 6-2

Table 6-2. Net gain of habitat units (HUs) for contingency option 2 – creation of access between Wally Lake and W4.

Habitat Type	Pre-compensation HUs	Post-compensation HUs	Net Gain HUs
1	0.07	0.12	0.05
2	0.77	1.13	0.36
3	3.01	4.60	1.60
4	0.24	0.42	0.18
5	0.61	1.12	0.51
6	0.57	1.03	0.46
7	0.12	0.21	0.09
8	0.07	0.12	0.06
9	0.05	0.09	0.04
10	N/A	N/A	N/A
11	N/A	N/A	N/A
Total	**5.51**	**8.84**	**3.34**

6.3 OPTION 3: CONSTRUCTION OF ARCTIC GRAYLING SPAWNING PADS

6.3.1 Description

In 2009, a habitat compensation project was constructed at a stream crossing along the all-weather access road to provide compensation for HADDs occurring through the construction of this road. The compensation project consists of four gravel berms, approximately 4 m wide by 20 m long, extending from the shoreline. These were built according to design specifications that met biological criteria aimed at enhancing arctic grayling productivity at R02. The construction focused on creating high value spawning and nursery habitat to compensate for the loss of the low and medium value habitat affected by bridge abutment construction at the four crossings (AEM, 2010).

After construction of this feature, monitoring data has indicated significant increases larval drift in this area, and an increase in the number of immature fish.

6.3.2 Estimation of Habitat Gains

Pre- and post- habitat units were calculated for a spawning pad project according to the stream-based HSIs provided in the Golder/AEM HEP. Considering an area of 0.1 ha, which is approximately the size of the current spawning pad, and a transition from fine-grained to coarse-grained sediment, there is a net gain of 0.02 HUs. However, it is difficult to quantify the number of lake-based habitat units that would be offset by in-stream spawning pad construction. Considering the 4x increase in larval drift, and 6x increase in immature fish

caught per unit effort in 2011 compared to the year before spawning pad construction, it is clear that significant relative gains in productive capacity may be obtained through this option. The observations detailed in the 2012 AWAR report (AEM, 2012) suggest that the constructed spawning pads provide substantial increases in productive capacity in the Prince River system, and are a suitable contingency plan option. For the purposes of this contingency plan, gains from spawning pad construction are estimated at 29 HUs (based on preliminary calculations, NNL Productivity presentation to DFO, Sept. 2, 2011).

In addition, the data collected at R02 since 2005 may provide an opportunity for an in-depth *a posteriori* analysis of the actual gains in productive capacity (and relationship to habitat types) that have been achieved as a result of construction. Since little information is available on the success of compensation structures, particularly in the north, this analysis may provide valuable insight that could be used to inform future in-stream projects, and for HSI validation. Should contingency compensation be required, quantitative contributions of this project to net gains in habitat units would be agreed upon through discussion with DFO before implementation.

6.4 OPTION 4: REMEDIATION OF AIRPLANE LAKE

6.4.1 Description

Airplane Lake (Figure 6-1) currently receives sewage waste from the hamlet of Baker Lake, which has undergone primary treatment in a settling basin, and further purification through a natural tundra wetland. Despite these processes, preliminary water quality measurements in Airplane Lake have shown that turbidity, dissolved carbon, and concentrations of nutrients and some metals far exceed background values. Through this contingency plan option, opportunities would be sought to improve nutrient and metal absorption through implementation of natural treatment systems, such as a series of constructed wetland cells, or augmentation of the existing natural tundra wetland. Recently, an investigation into the use of constructed wetlands for sewage waste treatment in the Arctic was conducted at Baker Lake by researchers at the University of Waterloo (Yates, 2012). While the specific system tested did not perform as desired, it is suggested that augmenting tundra wetlands or constructing improved retention and filtering may provide a viable system for remote communities, because they provide low-cost and low-maintenance wastewater treatment.

6.4.2 Estimation of Habitat Gains

Estimated gains that would be achieved through this option are based on an assumed habitat type distribution in Airplane Lake that is proportional to the Bay-Goose Basin. While habitat type areas would not change post-compensation, the habitat co-factor (see Section 2.2.5) for all fish species would increase. Upon implementation of this compensation option, the pre-compensation habitat co-factor value would be determined from further

studies of water quality and biological populations. The post-compensation value would be based on estimated improvements to water quality in Airplane Lake after implementation of the compensation measure, and expected impacts of productive capacity for fish. For the purposes of contingency plan, productive capacity is estimated to increase by 50%, based on estimated reductions in anoxic conditions resulting from nutrient enrichment. However it should be noted that this value is essentially a place-holder until further examination is required.

Based on these assumptions, habitat units for pre- and post- scenarios are shown in Table 6-3. A net 24.70 HUs will be gained through the implementation of this contingency option.

Table 6-3. Net gain of habitat units (HUs) for contingency option 4 – water quality improvements at Airplane Lake.

Habitat Type	Pre-compensation HUs	Post-compensation HUs	Net Gain HUs
1	0.03	0.07	0.03
2	0.00	0.00	0.00
3	5.15	10.29	5.15
4	1.95	3.90	1.95
5	0.00	0.00	0.00
6	6.05	12.10	6.05
7	10.80	21.60	10.80
8	0.00	0.00	0.00
9	0.73	1.45	0.73
10	N/A	N/A	N/A
11	N/A	N/A	N/A
Total	**24.70**	**49.41**	**24.70**

6.5 OPTION 5: FUNDING FOR VALIDATION OF HABITAT SUITABILITY INDICES

6.5.1 Description

Generally, Packman et al. (2006) and Birtwell et al. (2005) indicate that HSI models have not been validated for northern species. The validation of HSI models will theoretically provide better habitat compensation for all future northern projects. This may be achieved initially through correlational evidence using fish-out databases, as currently underway at the University of Toronto by Dr. Brian Schuter, and previously at the University of Calgary, by Dr. Bill Tonn. Experimental validation should follow, and may include the use of

compensation projects at Meadowbank to study effects of manipulating habitat variables on population productivity (e.g. in-stream spawning pad, dikes and boulder gardens).

We therefore propose, as a contingency option, to provide funding for specific academic research, in the form of graduate student projects aimed at furthering HSI models. This option may include both direct funding through grants, and/or the provision of sampling and analysis services, depending on research requirements and the status of mine operation at the time of study. Exact details of research projects would be determined in consultation with interested institutions, but will be aimed at HSI development for one or more species occurring in the Meadowbank region.

6.5.2 Estimation of Habitat Gains

Although net gains cannot be calculated in habitat units for this option, it is generally recognized that the further development of habitat suitability indices will improve accuracy of predictions in all future NNLPs. Currently, as a result of the lack of information for habitat preferences of northern fishes, habitat suitabilities are extrapolated from southern-developed models, with an unknown degree of certainty. It has been suggested that the accuracy of predictions made using HSIs may not transfer well between watersheds (De Kerckhove et al. 2008), let alone ecozones. Furthermore, it is known that the way fish adapt to habitat change is dependent on many factors, including location, temperature, season, maturity, population diversity and the availability of habitat (Smokorowski and Pratt 2006). While uncertainty factors (associated with habitat suitability determinations) can be included in compensation ratio calculations (Minns, 2006) by increasing required compensation amounts, it may be difficult for northern developers to find feasible opportunities for compensation that have historically been demonstrated as successful. Thus plans which optimize the required ratio will likely have a greater chance at achieving NNL. Providing the most effective compensation possible would help minimize the development footprint, and validated HSI models are needed to achieve this.

Additionally, since no reference models are available for most northern species, and no standardized no-net-loss plan (NNLP) approach is published, each proponent develops slightly different HEP methods and new HSIs for their projects. Usually, HSI values are determined by professional judgement, and/or modifications from previously developed NNLPs at other northern mines. Aside from the loss of efficiency and the extreme variability of results inherent in this exercise, this approach means that compensation units are not directly comparable between sites, impeding the creation of area habitat management plans which may become increasingly important as development in the north progresses.

Currently, proponents are only responsible for ensuring the physical presence and condition of any habitat compensation feature that is proposed. As a result, there is little information readily available on how many projects actually achieve no net loss of productive capacity of fish habitat (Quigley and Harper, 2006). In a 2006 study, Quigley and Harper found that in 16 projects evaluated across Canada (none in north), 63% did not achieve no net loss (average ratio of 0.7:1). In the north, the paucity of information

regarding how well compensation projects achieve no net loss is even scarcer, with only two published examinations of specific projects (see Gammons et al. 2009).

Lastly, even if standardized habitat suitability models were to be developed from observational data, it has been argued that correlative studies of habitat selectivity are not necessarily representative of actual habitat requirements, and these models are rarely validated with experimental evidence (Rosenfeld, 2003). According to Rosenfeld (2003), the removal or conversion of an apparently "preferred" habitat may not actually affect productivity of the population, if alternate habitats provide adequate life-functions. Therefore, if robust models are to be developed, field-validation is an important component in the process.

6.6 OPTION 6: CREATION OF SEA MOUNTS AND DIKE EXTENSIONS

6.6.1 Description

This contingency option involves the creation of sea mounts and dike extensions, as previously proposed for primary compensation in the original NNLP. These features would create areas of moderately deep (2-4 m), coarse-grained habitat, which is of the highest suitability. As described in Cumberland (2006), this would involve:

Second Portage Mounts - Six habitat mounts would be constructed just to the east of the East Dike by placing waste rock on ice during the winter, likely over two or more seasons. They would be situated in areas where habitat is of low value (HT 7), but relatively shallow such that construction to a depth of 2-4 m below the water surface is feasible. Base diameter would be approximately 50 m, for a total area of 1.25 ha.

East Dike Extension - A finger dike is proposed for the northern end of the East Dike, extending to the east over low value, deep sediment habitat (HT 7). This feature would be constructed in a similar manner (i.e., end dumping and return side casting) to the smaller proposed finger dikes in Third Portage Lake. The final dike surface would be 2 - 4 m below water level to maximize the value of this habitat. This dike would be approximately 5 ha in area.

Third Portage Finger Dike Extension – A large finger dike would be extended into low value, deep sediment habitat (HT 7) in an "S" curve manner. Construction would be similar to the other finger dikes. Total area would be approximately 11 ha.

6.6.2 Estimation of Habitat Gains

Based on these assumptions, habitat units for pre- and post- scenarios are shown in Table 6-4. A net 7.47 HUs will be gained through the implementation of this contingency option.

Table 6-4. Net gain of habitat units (HUs) for contingency option 6 - construction of sea mounts and dike extensions.

Lake	Feature Name	Pre-compensation HUs	Post-compensation HUs	Net Gain HUs
Second Portage Lake	Sea Mounts (6)	0.52	1.06	0.54
	East Dike Extension	2.06	4.25	2.19
Third Portage Lake	Finger Dike Extension	4.54	9.35	4.81
TOTAL		**7.12**	**14.66**	**7.54**

6.7 SUMMARY

The estimated net gained HUs associated with the contingency options for which HUs can be calculated total an estimated 65.88 HUs. Additional benefits would be obtained from funding for HSI research.

The contingency options presented here provide a variety of features for compensation, should one or more portions of the primary plan not be constructible or fail to meet the criteria for success established in the monitoring plan (Azimuth, 2008). The implementation of any contingency option would proceed in consultation with DFO. Specific design plans are to be determined in the case of implementation.

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APPENDIX A – Technical Memorandum: Revised Meadowbank No Net Loss Plan Model – June 7, 2012

Technical Memorandum

Date: June 7, 2012

To: Bobby Beddingfield and Derrick Moggy (DFO)
From: Ryan Vanengen (AEM) and Leilan Baxter (Baxter Consulting)

Re: DRAFT- *2012 Revised Meadowbank No Net Loss Plan Model*

Recently, a habitat evaluation procedure (HEP) was developed by Golder Associates and AEM for use at AEM's Meliadine site (Meliadine No Net Loss Plan workshop, November 17, 2011). This method was reviewed by DFO in consultation with Dr. Ken Minns (February 4, 2012), and it was approved as a foundation for the Meadowbank site HEP (March 30, 2012). With DFO approval, we propose, three adjustments to the Meliadine model for use in the Revised Meadowbank Mine No Net Loss Plan (Draft due June 15 and final plan due October 1st, 2012), which we believe improves the transferability of this model between projects and will provide fisheries managers improved ability to evaluate habitat gains and losses for a variety of No Net Loss Plans in the north. These adjustments are:

- Addition of the habitat co-factor
- Addition of the access factor
- Addition of habitat type (HT) 11 (>10 m, in-end pit lakes with good water quality predictions)

Two of these adjustments – the access factor and the habitat co-factor – were suggestions from the Minns review. The addition of HT 11 is suggested to account for the favourable water quality predictions for Meadowbank end pit lakes (Golder, 2005) which is consistent with the original Meadowbank Gold Project No Net Loss Plan Cumberland (2005). These factors are discussed in the following memo and a theoretical example of their application is presented in the final section. We look forward to your feedback and follow-up discussion. If you have any questions contact Ryan VanEngen at 519.400.7979 or rvanengen@agnico-eagle.com. .

1 Overview

As in the original Meadowbank NNLP, the basic HEP model involves the multiplication of an area (in ha) by a habitat suitability index (HSI) and fish species weights in order to derive a value in habitat units (HUs) that describes both the quality and quantity of habitat.

Pre-construction (natural, or baseline) habitat units are calculated for all areas of the mine site where a HADD will occur. These are referred to as "losses". Changes to habitat units occurring for each area post-closure are then calculated based on mine construction designs, and incorporating any habitat compensation features, to determine the total number of habitat units present after mining ("gains").

The net HUs will depend on the amount of each habitat type (determined by substrate and depth) that is lost and gained in each area, and the suitability of that habitat type for each fish species. Suitability of each habitat type is ranked between 0-1 for each life stage of each fish species (spawning, nursery, foraging, overwintering).

For each minesite feature occurring in-water (e.g. pits, dikes, roads) where losses or gains are expected to occur, HUs are calculated by multiplying the area of each habitat type in that feature by the HSI allotted to each life function of each fish species, then multiplied by the species weight and life function weight, and summed across life functions. This subtotal is then multiplied by an access factor, which represents the accessibility of the area to each species, and a habitat co-factor which describes changes in hydrological, thermal or chemical water quality. The HEP model is shown in further detail below.

2 Habitat Evaluation Procedure (HEP) Model

The Golder/AEM HEP model used here can be described, for each fish species (spp 1-n) as:

$$HU_{spp\ 1\text{-}n} = \sum_{HT\ 1\text{-}10} \{\sum_{sp,nu,fo,ow}(\mathbf{HT_{1\text{-}11}} \times HSI_{sp,nu,fo,ow} \times \text{life function weight} \times \text{species weight})] \} \times \mathbf{habitat\ co\text{-}factor} \times \mathbf{access\ factor}$$

Where $HT_{1\text{-}11}$ = area (ha) of habitat types 1 through 11

$HSI_{sp,nu,fo,ow}$ = habitat suitability index for each life function:

- sp = spawning use
- nu = nursery use
- fo = foraging use
- ow = overwintering use

The original model developed by Golder Associates and AEM (2011) did not include HT11, and did not include the habitat co-factor and access factor terms. These last two factors were suggested in the review by Dr. Ken Minns. We feel these are practical additions to the model, which make it more adaptable for use in a wider variety of No Net Loss plans and habitat compensation options in the north. The habitat types proposed for use in the Meadowbank model, and the two factor terms are discussed below.

2.1 Habitat Types

The Meadowbank HEP model proposes 11 habitat types, which are delineated based on various combinations of substrate and depth. The first 10 are identical to Habitat Type (HT) 1-10 in the Meliadine model. Habitat Type 11 is proposed in recognition of favourable water quality predictions for Meadowbank end-pit lakes that will not cause adverse effects on biota (Golder, 2005). The substrate and depths associated with each habitat type are shown in Table 2-1, and the rationale for this addition is described below.

Table 2-1. Physical characteristics of the habitat types proposed for the Meadowbank HEP.

Habitat Type	Depth Zone	Substrate	Use
1	0-2m	Fine	Pre-/Post-
2	0-2m	Mixed	Pre-/Post-
3	0-2m	Coarse	Pre-/Post-
4	2-4m	Fine	Pre-/Post-
5	2-4m	Mixed	Pre-/Post-
6	2-4m	Coarse	Pre-/Post-
7	>4m	Fine	Pre-/Post-
8	>4m	Mixed	Pre-/Post-
9	>4m	Coarse	Pre-/Post-
10	>10m	None	In-pit, stratified
11	>10m	None	In-pit, good WQ throughout

The HSIs associated with HT 10, developed for the Meliadine end-pit lakes, reflect conditions where pelagic life functions (foraging and overwintering) are impeded by pit development below 10 m depth. The Habitat Type 10 was adopted to conservatively estimate that very deep pits may be permanently stratified, resulting in diminished water quality below a theoretical boundary layer of 10m below the surface. End pit water quality at the Meadowbank site has been predicted to be similar to un-impacted areas, and suitable for fish in the long-term (i.e., >25 years; Golder, 2005). Golder (2005) predicted that post-closure, re-flooded pit lake water quality will meet MMER concentrations and nearly all CCME criteria (with the exception of cadmium and zinc at a steady state). The predicted concentrations of these metals are similar to background levels of water quality (see Azimuth, 2012) and therefore water quality following re-flooding is not expected to cause adverse effects on biota. Furthermore, prior to breaching, flooded pits and basins will be monitored and managed until the water quality is considered suitable for mixing with adjacent lakes (Golder 2005). Therefore, we believe an additional HT is needed for use in end-pit lakes such as Portage Pit, Bay-Goose Pit and Vault Pit, that have lower

impacts on habitat suitability than the conservative assumptions of the Meliadine Model (November 2011).

As described in Cumberland (2005), flooding the Meadowbank pits after mine closure will re-establish these areas as fish habitat. Although fish may or may not use the deepest areas of the pits, the photic zone will remain suitable habitat for pelagic functions, similar to deep-water areas pre-construction. Foraging and overwintering functions, particularly for pelagic zone feeders, should not be impeded in these areas. Unless littoral areas are created, it is recognized that end-pit lakes will not provide spawning or nursery habitat. We therefore propose the following HSIs for HT 11 (Table 2-2). Spawning and nursery HSI values are zero for all species. Foraging and overwintering values are taken from HT 9 (> 4 m, coarse substrate) for each species.

Table 2-2. Proposed HSI values for the Meadowbank region fish species (sp=spawning, nu=nursery, fo=foraging, ow=overwintering). HSI values for habitat types 1-10 are identical to those proposed previously for the Meliadine HEP. Habitat type 11 is added for use in pits where mixing will occur, and water quality is expected to remain similar to baseline conditions.

Habitat Type	Depth	Substrate	Arctic Char				Lake Trout				Round Whitefish			
			SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	<2 m	Fines	0	0.25	0.25	0	0	0.25	0.25	0	0	0.25	0.75	0
2	<2 m	Mixed	0	0.25	0.25	0	0	0.5	0.5	0	0	0.75	0.5	0
3	<2 m	Coarse	0	0.5	0.5	0	0	1	0.75	0	0	0.75	0.5	0
4	2-4 m	Fines	0	0.5	0.5	0.75	0	0.5	0.5	0.75	0	0.25	1	0.75
5	2-4 m	Mixed	0.5	0.75	0.75	0.75	0.5	0.75	0.75	0.75	0.5	0.75	0.75	0.75
6	2-4 m	Coarse	1	1	1	0.75	1	1	1	0.75	1	1	0.75	0.75
7	>4 m	Fines	0	0.25	0.5	1	0	0.25	0.5	1	0	0.25	1	1
8	>4 m	Mixed	0.5	0.5	0.75	1	0.5	0.5	0.75	1	0.25	0.25	0.5	1
9	>4 m	Coarse	1	0.5	1	1	1	0.5	1	1	0.75	0.5	0.5	1
10	>10 m	None	0	0	0.25	0.75	0	0	0.5	0.75	0	0	0	0.75
11	>10 m	None	0	0	1	1	0	0	1	1	0	0	0.5	1

Habitat Type	Depth	Substrate	Burbot				Slimy Sculpin				Ninespine Stickleback			
			SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	<2 m	Fines	0	0.25	0.25	0	0	0	0.25	0	1	1	1	0
2	<2 m	Mixed	0	0.75	0.5	0	0.25	0.25	0.5	0	0.5	0.5	0.75	0
3	<2 m	Coarse	0	1	0.5	0	1	1	1	0	0	0.25	0.75	0
4	2-4 m	Fines	0	0.25	0.25	0.75	0	0	0.25	0.75	0	0	0.5	0.75
5	2-4 m	Mixed	1	0.5	0.75	0.75	0.25	0.25	0.5	0.75	0	0	0.25	0.75
6	2-4 m	Coarse	0.75	0.5	1	0.75	0.75	0.75	1	0.75	0	0	0.25	0.75
7	>4 m	Fines	0	0	0.25	1	0	0	0	1	0	0	0	1
8	>4 m	Mixed	1	0	0.75	1	0	0	0.25	1	0	0	0	1
9	>4 m	Coarse	0.75	0.25	1	1	0.5	0.5	0.5	1	0	0	0	1
10	>10 m	None	0	0	0.25	0.25	0	0	0	0.25	0	0	0	0.75
11	>10 m	None	0	0	1	1	0	0	0.5	1	0	0	0	1

Habitat Type	Depth	Substrate	Lake Cisco				Arctic Grayling			
			SP	NU	FO	OW	SP	NU	FO	OW
1	<2 m	Fines	0	0.25	0.5	0	0	0.25	0	0
2	<2 m	Mixed	0	1	1	0	0	0.25	0.25	0
3	<2 m	Coarse	0	1	1	0	0	0.5	0.25	0
4	2-4 m	Fines	0	0.25	0.75	0.75	0	0	0.5	0.75
5	2-4 m	Mixed	0.25	0.5	1	0.75	0	0	1	0.75
6	2-4 m	Coarse	0.75	0.75	0.75	0.75	0	0	1	0.75
7	>4 m	Fines	0	0	0.75	1	0	0	0.5	1
8	>4 m	Mixed	0.5	0.25	1	1	0	0	1	1
9	>4 m	Coarse	1	0.25	0.75	1	0	0	1	1
10	>10 m	None	0	0	0.75	0.75	0	0	0	0.5
11	>10 m	None	0	0	0.75	1	0	0	1	1

2.2 Habitat Co-factor

The habitat co-factor represents any changes to non-mapped habitat quality (thermal, hydrological, biological or chemical regimes) that will occur post-closure. The habitat co-factor values as presented by Dr. Minns in a workshop for DFO in February, 2012 (Minns, 2012), are shown in Table 2-3.

Table 2-3. Habitat co-factor for various pre- and post-closure scenarios, according to Minns, 2012.

Change in regime	**Description**	**Pre-construction factor** (losses calculation)	**Post-closure factor** (gains calculation)
Degradation (expected)	Thermal, hydrologic, chemical and/or biological regime shifts away from preferred state for fish habitat	1	> 0 and < 1
No change	-	1	1
Enhancement (anticipated or proposed)	Thermal, hydrologic, chemical and/or biological regime expected to shift towards preferred state for fish habitat	> 0 and < 1	1

The habitat co-factor has not been used to date in practice in the arctic. When there is no change in water quality post-closure, the weighting is 1 for both loss and gain calculations. This factor is therefore not an integral part of any compensation calculation that does not affect water quality[1]. However, in situations where degradation or remediation may occur, such as with the remediation of the Baker Lake landfill and sewage discharge upstream of Airplane Lake (which is considered a contingency in the revised Meadowbank No Net Loss Plan), it is important to recognize that physical habitat characteristics are not the only determinant of productive capacity. Although physical habitat features remain a surrogate for measuring productive capacity in this model, the co-factor provides managers the ability to adjust the model to account for remediation within a physical habitat compensation framework.

[1] Meadowbank Mine site post closure compensation is an example of this scenario where water quality will be monitored and managed until the water quality is considered suitable for mixing with adjacent lakes

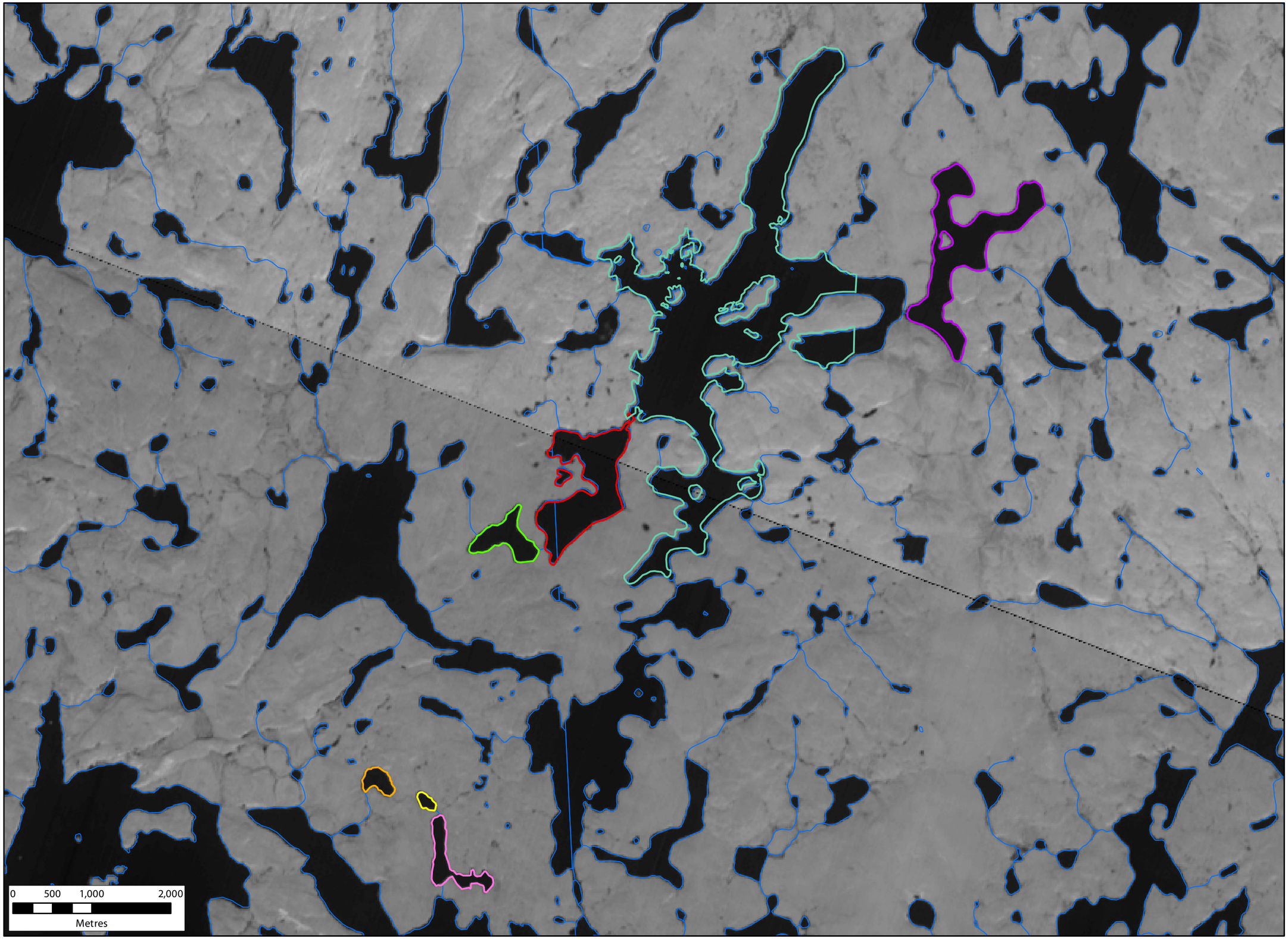
The review by Minns did not indicate specifically how to determine a value between 0-1. Although this method has not been thoroughly developed, as it will not be applied in the main revised Meadowbank No Net Loss Plan (rather as part of the contingency plan as previously discussed with DFO representatives), we believe a clear transparent method is achievable based on professional judgement on a case-by-case basis. In concept, the co-factor value could be calculated by using an abbreviated risk assessment process that incorporates a theoretical effect on population size estimates by examining published concentration-response models. Alternatively this evaluation may adopt a variation on the CCME water quality index method that evaluates various water quality parameters to determine fair, marginal or poor water quality that can be related to population estimates either based on productive capacity models or field measurements compared to reference lakes. The nature of this co-factor does not lend itself to a blanket method of calculation, since relative effects on productive capacity are completely dependent on which water quality factor changes. Regardless, the rationale for the choice of habitat co-factor should be detailed and approved by DFO.

2.3 Access Factor

Minns (2012) further suggests the use of an access factor to account for known or expected presence/absence of each fish species in a particular water body. To date this factor has not been used in NNLPs in the arctic, but it may be a particularly valuable component in this setting. Many isolated lakes or ponds are found in the region of the Meadowbank minesite, and a number contain only one or two species of fish. Since different fish species utilize different habitat niches, the introduction of a species will likely result in an increase in the total fish population and improved bio-diversity, provided the available habitat is suitable for that species (accounted for through the HSI). Various studies have observed niche use and resource partitioning in artic lakes (Amundsen et al., 2010; Hershey et al. 2006), and stable isotope studies in the Experimental Lakes in NT and at the Meadowbank site provide site-specific evidence of low food source overlap (Cott et al., 2011 and R. Vanengen, unpublished thesis).

According to Minns (2012), the access factor is 1 for any species present in the habitat area, and 0 for any species not present. Each species receives an access factor in both the pre-construction and post-closure calculations (Table 2-4). Therefore, the opening of access to a habitat area for a species post-closure (that did not have access pre-construction), results in a gain of habitat units. As discussed with DFO, the revised Meadowbank No Net Loss Plan will include improved access of fish species (i.e.lake trout) through a channel that connects pond NP2 to Dogleg North pond (see Figure 2-1). Dogleg North Pond presently does not have any fish and therefore access gained by fish species will be calculated accordingly. As well, Vault, Phaser and Wally currently do not have arctic char, (BAER, 2005)[2] and yet char are confirmed in an adjacent lake W3 (see Figure 2-1). By creating overwintering habitat and improving

[2] To be confirmed during August 2012 fisheries studies at Meadowbank



Legend

- NP1 (Dogleg)
- NP1N (Dogleg North)
- NP2
- Phaser Lake
- Wally 1
- Wally 3
- Vault Lake
- Wally Lake

Agnico-Eagle Mines Ltd.,
Meadowbank Division
Study Lakes

DOUGAN & ASSOCIATES
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77 Wyndham Street South • Guelph ON N1E 5R3
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PROJECT: DA11-062-01

CLIENT: Agnico-Eagle Mines Ltd., Meadowbank Div.

N
W E
S
UTM Zone 14 NAD83

DATE: NOVEMBER 2011

SCALE: 1:45,000

DRAWN BY: LW

CHECKED BY:

FIGURE:

2-1

The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation. MNR data provided by Queen's Printer of Ontario. Use of the data in any derivative product does not constitute an endorsement by the MNR or the Ontario Government of such products.

connection in perpetuity, post-closure compensation results in a gain of habitat units for the specific species that have been provided access. Similarly, the loss of access results in a loss of habitat units. These gains or losses may be complete (affect all species), or partial (only some species are affected).

Note that presence or absence of a species pre-construction is based on monitoring studies in the affected habitat area, whereas presence or absence in the post-closure scenario is anticipated and monitored as evidence for success or failure.

Table 2-4. Access factor applied to each species, pre- and post-closure, based on presence/absence (or anticipated presence/absence, for post-closure) (adapted from Minns 2012).

Scenario	Pre-Construction	Post-closure
Species Present	1	1
Species Not Present	0	0

3 Example Calculation

The following is an abbreviated theoretical example of a habitat assessment and habitat unit calculation which uses the approved Meliadine Method (HSI and species weighting) and applies the changes discussed in the previous sections. Although not all components of this example apply to the Meadowbank Mine, we have tried to provide tangible references where they may apply. It is important to note that the areas and simple habitat types presented in this example are theoretical and that further detail and referencing would be provided in the real scenario.

Consider Lake A, with an area of 10 ha, containing an isolated population of lake trout. Similar to Vault Lake at the Meadowbank Mine, this lake will be dewatered for mining, and re-flooded post-closure. The pit development will expand this lake, and after mining, a channel will be excavated to improve connection for fish between Lake A and nearby Lake B, thereby providing access for the arctic char and lake trout population currently only present in Lake B. For the purposes of this example, assume there is a historic landfill adjacent to Lake B that is affecting the water quality of Lake B. and therefore affect Lake A once the connection is made. . Based on water quality assessments in both lakes, the landfill is expected to increase chromium concentrations to a level which has been found to have chronic impacts on 10% of the fish compared to a reference lake. Pre-construction, Lake A contains 7.0 ha of habitat type 3 (<2 m, coarse substrate), and 3.0 ha of habitat type 4 (2-4 m, fine substrate). Figure 3-1 and Figure 3-2 depict the project lakes, pre-construction and during operation.

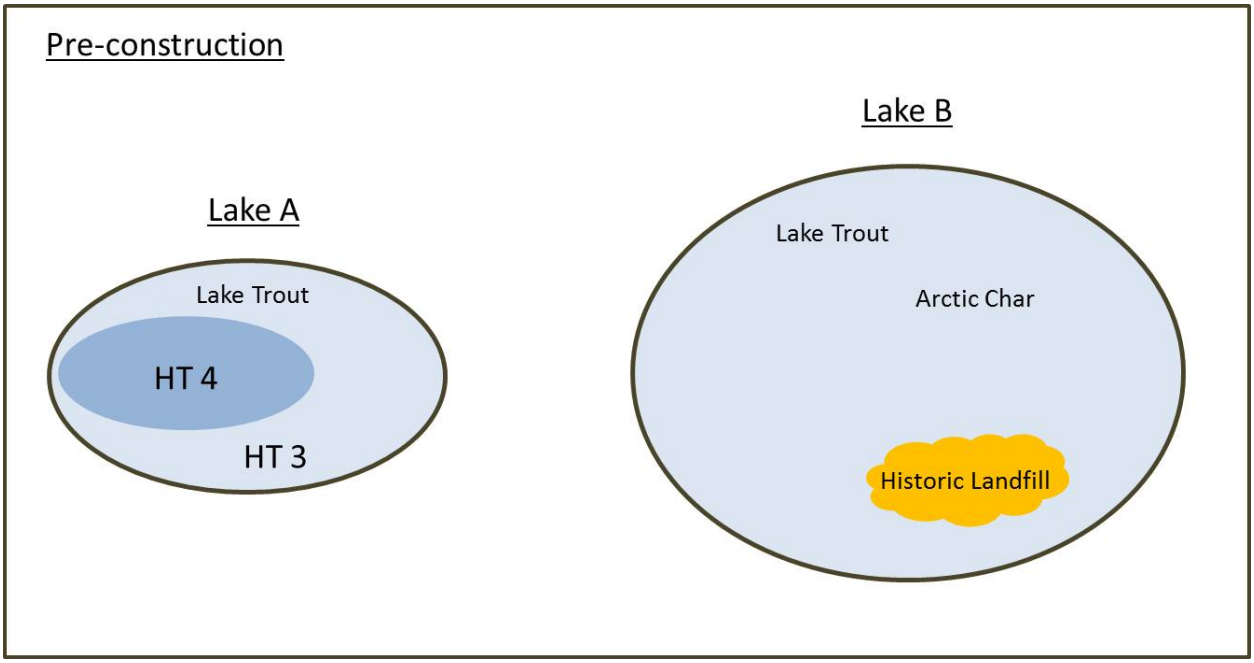

Figure 3-1. Schematic of the example project lakes, showing pre-construction habitat types (HT) in Lake A.

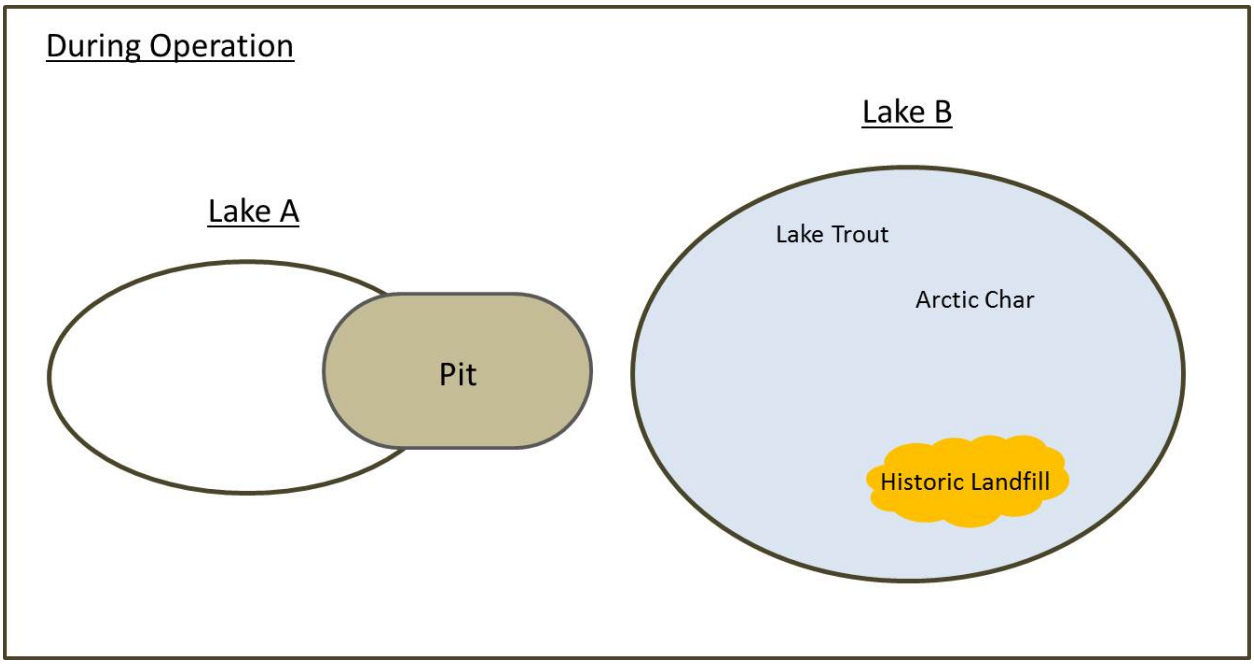

Figure 3-2. Schematic of the example project lakes during operation. Lake A is dewatered, and pit construction is partially in-lake.

HSIs, life stage weights, species weights and access factors for this example project are shown in Table 3-1.

Table 3-1. Habitat Suitability Index (HSI), life stage weight (sp=spawning, nu=nursery, fo=foraging, ow=overwintering), species weight and access factors for lake trout and Arctic char in example Lake A. Habitat types shaded in grey are found in the example lake.

	Habitat Type	Description	Lake Trout				Arctic Char			
			SP	*NU*	*FO*	*OW*	*SP*	*NU*	*FO*	*OW*
HSI	1	<2 m, fine	0	0.25	0.25	0	0	0.25	0.25	0
	2	<2 m, mixed	0	0.5	0.5	0	0	0.25	0.25	0
	3	<2 m, coarse	0	1	0.75	0	0	0.5	0.5	0
	4	2-4m, fine	0	0.5	0.5	0.75	0	0.5	0.5	0.75
	5	2-4m, mixed	0.5	0.75	0.75	0.75	0.5	0.75	0.75	0.75
	6	2-4m, coarse	1	1	1	0.75	1	1	1	0.75
	7	>4m, fine	0	0.25	0.5	1	0	0.25	0.5	1
	8	>4m, mixed	0.5	0.5	0.75	1	0.5	0.5	0.75	1
	9	>4m, coarse	1	0.5	1	1	1	0.5	1	1
	10	>10 m, stratifed	0	0	0.5	0.75	0	0	0.25	0.75
	11	>10 m, non-stratified	0	0	1	1	0	0	1	1
Life Stage Weight			0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Species Weight			0.5				0.38			
Access Factor		*Pre-*	1				0			
		Post-	1				1			
Habitat Co-Factor		*Pre-*	1				1			
		Post-	0.9				0.9			

Pre-construction HU calculations for Lake A are shown in Table 3-2. Lake A consists of a total of 2.19 HUs pre-construction.

Table 3-2. Pre-construction habitat unit (HU) calculation for Lake A.

Habitat Type	Area (ha)	*HU Subtotal* (= area x HSI x Life Stage Weight x Species Weight)				*HU Total* (=∑subtotals x access x habitat co-factor)
		SP	*NU*	*FO*	*OW*	
Lake Trout						
3	7.0	0	0.87	0.66	0	1.53
4	3.0	0	0.19	0.19	0.28	0.66
11	0.0	0	0	0	0	0.00
Arctic Char						
3	7.0	0	0.33	0.33	0	0.00
4	3.0	0	0.14	0.14	0.21	0.00
11	0.0	0	0	0	0	0.00
Grand Total - *Losses*						**2.19**

Pit development alters the depth and substrate zones, and converts 5 ha of land to lake, so that post-closure, Lake A consists of 5.0 ha of habitat type 3, 3.0 ha of habitat type 4, and 7.0 ha of habitat type 11 (> 4 m, in-pit, non-stratifed). The small improved connection provides an additional 1.0 ha of habitat type 3, which is included in the Lake A calculation. A schematic of the project lakes post-closure is shown in Figure 3-3.

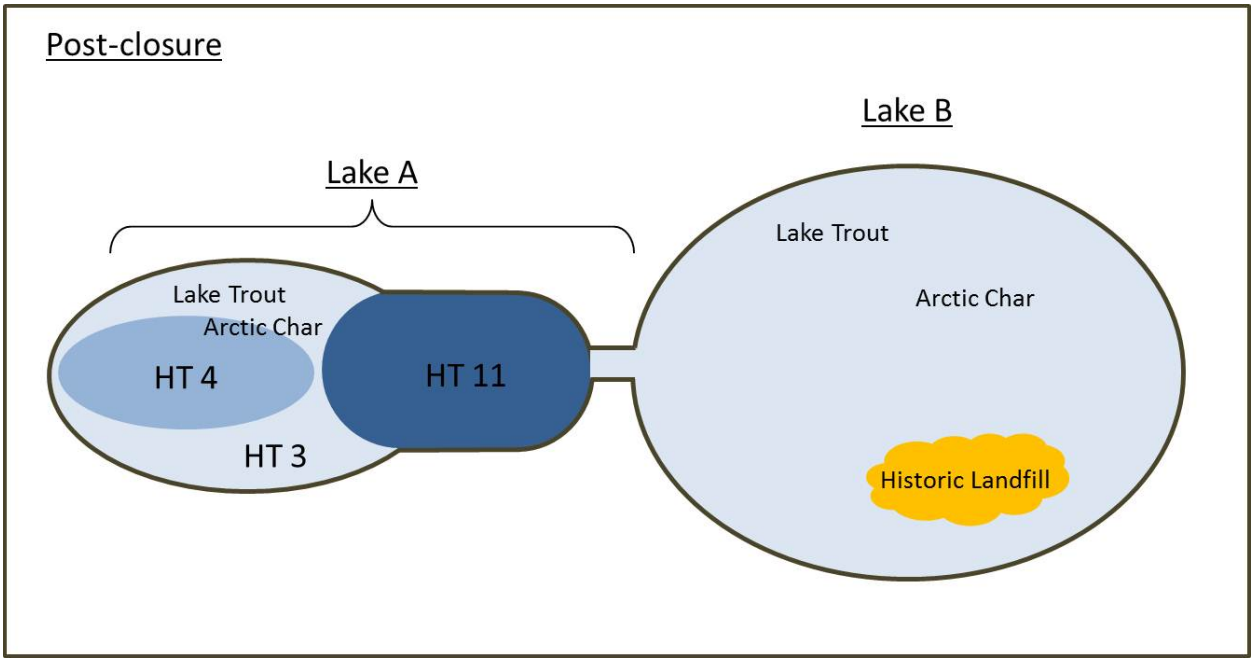

Figure 3-3. Schematic of the example project lakes, showing post-closure habitat types (HT) in Lake A.

Table 3-3 describes the post-closure habitat units calculation for Lake A. A total of 5.52 HUs are present in Lake A post-closure. The total gains:losses ratio in this example situation would therefore be 2.52:1.

Table 3-3. Post-closure habitat unit (HU) calculation for Lake A.

Habitat Type	Area (ha)	***HU Subtotal*** (= area x HSI x Life Stage Weight x Species Weight)				***HU Total*** (=∑subtotals x access x habitat co-factor)
		SP	*NU*	*FO*	*OW*	
Lake Trout						
3	6.0	0	0.75	0.56	0	1.18
4	3.0	0	0.19	0.19	0.28	0.60
11	7.0	0	0	0.88	0.88	1.58
Arctic Char						
3	6.0	0	0.29	0.29	0	0.52
4	3.0	0	0.14	0.14	0.21	0.44
11	7.0	0	0	0.67	0.67	1.20
Grand Total - *Gains*						**5.52**

References

Azimuth Consulting (2012). Aquatic Effects Monitoring Program- Core Receiving Environment Monitoring Program 2011- Meadowbank Mine. Prepared for Agnico-Eagle Mines Ltd- March 2012.

Cott PA, Johnston TA, Gunn JM. 2011. Food web position of burbot relative to lake trout, northern pike, and lake whitefish in four sub-Arctic boreal lakes. Journal of Applied Ichthyology 27:49-56

Cumberland (2005). Meadowbank Gold Project No-Net-Loss Plan (NNLP). November, 2006.

Golder Associates Ltd. 2005. Final Report on Water Quality Predictions, Meadowbank Gold Project, Nunavut. In: Cumberland Resources, 2005. Meadowbank Gold Project- Physical Environment Impact Assessment Report. October 2005 pp5-42 to 5-44.

Minns, K. (2012). No Net Loss Accounting Workshop. Presented to Fisheries and Oceans Canada. February, 2012.

APPENDIX B – DFO Mine Site Authorization (NU 03-0191)

DFO File No.: NU-03-0191
Referral File No.: 03-HCAA-CA7-00191
Authorization No.: 1

AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

Authorization issued to:

Agnico-Eagle Mines Ltd.
Meadowbank Division
#375 - 555 Burrard Street
Two Bentall Centre
Vancouver, British Columbia
V7X 1M8

Location of Project

The Meadowbank Gold Project is located 70 kilometres north of Baker Lake in the Kivalliq Region of Nunavut, Canada.
Latitude 65˚0'0" North, Longitude 96˚0'0"

Valid Authorization Period

The valid authorization period for the harmful alteration, disruption or destruction of fish habitat associated with the works or undertakings described in Table 1and within this authorization is:

From:	To:
Date of Issuance	December 31, 2015

The valid periods for other conditions of the authorization are as set out below.

Description of Works or Undertakings (Type of work, schedule, etc.)

The harmful alteration, disruption or destruction hereby authorized is the infilling and dewatering of fish habitat as a result of the following works or undertakings listed in Table 1.

Table 1: Works or Undertakings resulting in a harmful alteration, disruption or destruction of fish habitat.

Location	Work or Undertaking	Habitat Units Lost
Second Portage Lake	Construction of the east dike footprint (830 metres long)	39.28
	Construction of the west (central) dike footprint	22.27
	Dewatering of Second Portage basin	111.30
	Quarrying the Portage Pit	49.75
Third Portage Lake	Construction of the Goose Island dike footprint (1720 metres long)	73.46
	Construction of South Camp dike footprint (Bay Zone dike with length of 1480 metres)	1.00
	Dewatering of Third Portage basin	301.04
	Quarrying Goose Island Pit	61.07
	Quarrying the Portage Pit	35.16

	Finger Dike Habitat Footprint	46.95
Total		**741.28**

Conditions of Authorization

1. The conditions of this Authorization notwithstanding, should the above works or undertakings, due to weather conditions, different soil or other natural conditions, or for any other reason, appear, in the opinion of the Department of Fisheries and Oceans ("DFO") likely to cause greater impacts than the parties previously contemplated, then DFO may direct Agnico-Eagle Mines Ltd. (hereafter referred to as the "Proponent"), and its agents, and contractors, to suspend or alter works and activities associated with the project, to avoid or mitigate adverse impacts to fisheries resources. DFO may also direct the Proponent and its agents, and contractors, to carry out at the Proponent's expense any works or activities deemed necessary by DFO to avoid or mitigate further adverse impacts to fisheries resources. In circumstances where DFO is of the view that greater impacts may occur than were contemplated by the parties DFO may also modify or rescind this authorization. If the authorization is to be changed the Proponent will be given an opportunity to discuss any proposed modifications or rescission.

2. Conditions that relate to the Proponent plan:

   2.1. The Proponent confirms that all plans and specifications relating to this Authorization have been duly prepared and reviewed by appropriate professionals working on behalf of the Agnico-Eagle Mines Ltd. The Proponent acknowledges that they are solely responsible for all design, safety and workmanship aspects of all the works associated with this Authorization.

   2.2. The works or undertakings described in Table 1 shall comply with those criteria as identified within this Authorization. Harmful alteration, disruption or destruction of fish habitat other than that specifically identified within this Authorization is prohibited.

   2.3. Works and undertakings shall be conducted in accordance with the practices outlined in the following reports, and as approved by DFO:

      2.3.1. Application for Authorization for Works or Undertakings Affecting Fish Habitat, signed by Rachel Gould (Agnico-Eagle Mines Ltd.), dated May 28, 2008.

      2.3.2. Meadowbank Gold Project No-Net-Loss-Plan (NNLP), prepared by Azimuth Consulting Group Inc., dated November 2006.

      2.3.3. Technical Memorandum, RE: Cumberland Meadowbank NNLP – Habitat Compensation Addendum, prepared by Gary Mann and Randy Baker (Azimuth Consulting Group Inc.), dated February 7, 2007.

      2.3.4. Aquatic Effects Management Program, prepared by Cumberland Resources Ltd., dated October 2005.

      2.3.5. Report Addendum Detailed Design of Dewatering Dikes Meadowbank Gold Project, Golder Associates Ltd., dated July 12, 2007.

      2.3.6. Meadowbank Gold Project – Type A Water License Application, prepared by Meadowbank Mining Corporation, dated August 2007.

      2.3.7. Technical Memorandum Fish Habitat Compensation Structures – Meadowbank Gold Project, Nunavut, Document Number 585 ver.0, signed by Paolo Chiaramello, Dan Walker and Nathan Schmidt (Golder Associates), dated February 13, 2008.

      2.3.8. Final Report Detailed Design of Dewatering Dikes Meadowbank Gold Project, 3 Volumes, Document No. 342, Ver. 0, prepared by Golder Associates, dated March 13, 2007.

      2.3.9. Report Addendum Detailed Design of Dewatering Dikes Meadowbank Gold Project, 3 Volumes, Document No. 492, Ver. 0, prepared by Golder Associates, dated July 12, 2007.

      2.3.10. Technical Memorandum – Fish-Out Program for the Meadowbank Gold Project, prepared by Ryan Hill and Gary Mann (Azimuth Consulting Group Inc.), dated May 30, 2008.

      2.3.11. Meadowbank Gold Project, Aquatic Effects Management Program Targeted Monitoring – Habitat Compensation Monitoring Plan, version 4, Project No. AEM-07-01, prepared by Azimuth Consulting Group Inc., dated May 2008.

      2.3.12. Proposed Water Quality Monitoring and Management Plan for Dike Construction and Dewatering at the Meadowbank Mine , Version 6, prepared Agnico-Eagle Mines Ltd., dated April 2008.

      2.3.13. No Net Loss Plan Implementation Cost Estimate & Construction Schedule – Meadowbank Gold Mine Project, Revision 1,

prepared by Agnico-Eagle Mines Ltd. – Meadowbank Division, dated July 08, 2008.

2.3.14. Meadowbank Type A Water License – Response to Pre-Hearing Commitments, signed by Rachel Gould (Agnico-Eagle Mines Ltd.), dated March 7, 2008.

2.3.15. The above document(s) and/or drawing(s) are hereafter referred to as the "proponent plan".

3. Conditions that relate to the mitigation of potential harmful alteration, disruption or destruction ("HADD") of fish habitat. The following measures shall be implemented to avoid unauthorized HADD of fish habitat:

3.1. A qualified biologist or environmental inspector shall be on site during all in-water construction, compensation and restoration works to ensure implementation of the designs as intended in the proponent plan and conditions of this Authorization.

3.2. Fish salvage methods shall be implemented as per the approved Fish-Out program at the Meadowbank Property for removing fish in the diked-off portions of Second Portage Lake and Third Portage Lake.

3.3. All materials and equipment used for the purpose of site preparation and project completion shall be operated and stored in a manner that prevents any deleterious substance (e.g. petroleum products, debris, etc.) from entering the water.

3.3.1. Any stockpiled materials shall be stored and stabilized above the ordinary high water mark of any water body.

3.3.2. Vehicle and equipment re-fuelling and maintenance shall be conducted above the ordinary high water mark of any water body.

3.3.3. Any part of equipment entering the water shall be free of fluid leaks and externally cleaned/degreased to prevent any deleterious substance from entering the water.

3.4. Only clean material free of fine particulate matter shall be placed in the water.

3.5. Sediment and erosion control measures shall be implemented prior to work, and maintained during the work phases, including decommissioning and restoration phases, to mitigate impacts to fish habitat.

3.5.1. All disturbed areas shall be stabilized upon completion of work and restored to a pre-disturbed state or better.

3.5.2. Sediment and erosion control measures shall be left in place and maintained until all disturbed areas have been stabilized

3.6. The Proponent shall develop and enforce a policy that prohibits fishing on Second Portage Lake and Third Portage Lake and surrounding lakes and streams by individuals on the mine site in a capacity as mine employee, contractor or visitor during all phases of mining activities, unless otherwise agreed to by DFO.

3.6.1. This Policy shall be made available and understood by individuals on the mine site in a capacity as mine employee, contractor or visitor during all phases of mining activities.

4. Conditions that relate to the compensation for the loss of **741.28** Habitat Units (HU) of fish habitat as defined in the proponent plan.

4.1. The Proponent shall ensure that fish habitat compensation efforts in Second Portage Lake and Third Portage Lake will achieve a total gained HUs:lost HUs ratio of 1.68 or better for the harmful alteration, disruption, or destruction of fish habitat. This shall be achieved as described in Table 2:

Table 2: Fish Habitat Compensation Features

Location	Fish Habitat Feature	Habitat Units Gained	Construction Schedule - Year(s)
Second Portage Lake	Re-flooded basin of Second Portage Lake (includes creation of shoals, reefs, and boulder gardens within the basin)	401.0	2015-2022
	Creation of six habitat shoals (Habitat Mounts)	8.2	2009-2011
	Creation of a reef (East Dike Finger Extension)	33.0	2009
Third Portage Lake	Breaching of Goose Island Dike	26.6	2025

	Re-flooded basin of Third Portage Lake (includes creation of shoals, reefs, and boulder gardens within the basin)	701.6	2015-2022
	Creation of a reef (Goose Island Dike Finger Extension – excludes the five finger dike extensions off Goose Island Dike)	81.6	2013
Total		**1252.0**	

4.2. Final detailed design plans and drawings for the inside dike shoals, reefs and boulder gardens in Second Portage and Third Portage Lakes shall be submitted to the Iqaluit, Nunavut office of Fisheries and Oceans Canada– Fish Habitat Management, Eastern Arctic Area by December 31, 2014, for review and subject to DFO approval.

4.3. If at any time the Proponent becomes aware that the compensatory habitat is not completed and/or functioning as described in the habitat compensation plan listed in condition 2.3 , it shall carry out any works which are necessary to ensure the compensatory habitat is completed and/or functioning as described in the approved No Net Loss plan.

4.4. The Proponent shall confirm that they shall leave the compensatory habitat undisturbed. After the compensatory habitat has been created the Proponent shall not carry on any work or undertaking that will adversely disturb or impact the compensatory habitat.

4.5. A **Contingency Plan** addressing alternative habitat compensation measures to be implemented to meet the required ratio of gainedHUs:lostHUs in the event the primary compensation plans fail either due to inability to construct as per the proponent plan, or failure of the habitat compensation measures to meet the criteria for success established in the Habitat Compensation Monitoring Plan, version 4, dated May 2008, shall be developed by the Proponent through consultation with impacted communities and/or the local Hunters and Trappers Organizations. These plans shall be submitted within **one (1) year** of the issuance of this Authorization to the Iqaluit, Nunavut office of Fisheries and Oceans Canada– Fish Habitat Management, Eastern Arctic Area for review and subject to DFO approval.

5. Conditions that relate to the **monitoring** of the proponent plan, the mitigation and the compensation is referred to as the "Monitoring Program".

5.1. The Proponent shall undertake the Monitoring Program according to the approved proponent plan. The Monitoring Program shall determine whether the works were conducted within the schedule of the approved proponent plan, whether the design intent was met, whether the habitat features are functioning as intended and whether the mitigation measures outlined in the approved proponent plan and this Authorization were followed**.**

5.2. The stability and successful utilization of all fish habitat compensation features shall be assessed according to the methodology and schedule detailed in the Habitat Compensation Monitoring Plan, version 4, dated May 2008 and the No Net Loss Plan Implementation Cost Estimate & Construction Schedule – Meadowbank Gold Mine Project, Revision 1, dated July 08, 2008.

5.3. Detailed monitoring plans for Tier 2 and Tier 3 criteria as per condition 5.3.1. and 5.3.2, shall be submitted to the Iqaluit, Nunavut office of Fisheries and Ocean Canada– Fish Habitat Management, Eastern Arctic Area by **March 31, 2009** for review and subject to DFO approval.

5.3.1. Tier 2 – Toxicity Testing
5.3.2. Tier 3 – In-situ Biological Studies such as "Trout Egg Development" and "Periphyton on Modified Natural Substrate"

5.4. A photographic record of before, during and after construction, during decommissioning and post-restoration, shall indicate that all works and undertakings have been completed according to the approved proponent plan and conditions of this Authorization.

5.4.1. The photographic record shall include, but not be limited to, a record of the sediment and erosion control measures and the fish habitat compensation measures.

5.4.2. The photographs for each pre-construction, during construction, post-construction, decommissioning and post-restoration time periods shall be taken from the same vantage point(s) and general direction.

5.4.3. All photographs shall be clearly labeled as to date and vantage point(s). The photographic vantage point(s) and viewing directions shall be indicated, and clearly indexed to the photographs, on a plan view drawing of the construction site(s).

6. Conditions that relate to Reporting

6.1. A written report and photographic record summarizing the results of the Monitoring Program undertaken as per condition 5. shall be submitted to the Iqaluit, Nunavut office of Fisheries and Oceans Canada– Fish Habitat Management, Eastern Arctic Area by **March 31** of each year following the monitoring year detailed in the No Net Loss Plan Implementation Cost Estimate & Construction Schedule – Meadowbank Gold Mine Project, Revision 1, dated July 08, 2008.

6.2. **As-Built Reports including engineer drawings** shall be submitted to the Iqaluit, Nunavut office of Fisheries and Oceans Canada– Fish

Habitat Management, Eastern Arctic Area within **six (6) months** of the respective completion of each fish habitat compensation effort identified in Table 2, with the exception of the six habitat shoals in Second Portage Lake, that demonstrates the application of the **approved No Net Loss Plan** referred to in condition 2.3.

6.3. **As-Built Reports including engineer drawings** shall be submitted to the Iqaluit, Nunavut office of Fisheries and Oceans Canada– Fish Habitat Management, Eastern Arctic Area within **eight (8) months** of the respective completion of each of the six habitat shoals in Second Portage Lake that demonstrates the application of the **approved No Net Loss Plan** referred to in condition 2.3.

7. Conditions that relate to the Security Deposit

7.1. The Proponent shall provide DFO with an irrevocable Letter of Credit as security for the completion and performance by the Proponent with regard to all of its obligations under this Authorization, including the required fish habitat compensation and monitoring, reporting, and additional work determined by DFO if required, according to the following schedule:

a) two (2) weeks after the issuance date of this Authorization an amount of six million seven hundred and fifty thousand ($6,750,000.00) dollars.

b) prior to commencement of Bay Zone dike construction an additional eight million eight hundred thousand ($8,800,000.00) dollars.

7.2. The Proponent shall provide DFO with the following items at the time of the Contingency Plan submission according to condition 4.5:

7.2.1. A cost estimate report of the amount to cover the Contingency Plan's implementation costs.

7.2.2. If the cost estimate for the implementation of the Contingency Plan exceeds the amount in the irrevocable Letter of Credit according to condition 7.1, the original irrevocable Letter of Credit shall be amended to reflect the greater amount and shall be submitted to the Iqaluit, Nunavut office of Fisheries and Oceans Canada– Fish Habitat Management, Eastern Arctic Area within two (2) weeks of DFO approval of the Contingency Plan.

7.3. The security deposit provided by the Proponent must be in a form agreed to by DFO.

7.4. The Proponent shall maintain the deposited amounts until all of the Proponent's obligations under this Authorization are satisfied.

7.5. At the discretion of DFO, the amount of the security deposit may be adjusted annually to account for fish habitat compensation completed or to accomplish additional work that DFO may require to satisfy the objectives of fish habitat compensation.

7.6. DFO shall be able to call on the security deposit unconditionally if the Proponent does not meet any of the requirements outlined within this Authorization, as determined solely by DFO.

7.7. To the extent not prohibited by law, the Proponent shall have the right to audit, from time to time with reasonable notice to DFO and at the Proponent's expense, any expenditure of funds withdrawn by DFO.

7.8. Once the Proponent has completed to the satisfaction of DFO all studies, reports and works required by DFO, DFO shall return to the Proponent any unused portion of the security deposit.

8. Any deviation from the approved proponent plans, the construction schedule, mitigation, compensation and/or monitoring measures stated above must be discussed with, and approved in writing by the Iqaluit, NU office of the Fisheries and Oceans Canada, Fish Habitat Management, Eastern Arctic Area.

9. All mitigation, compensation and monitoring measures shall be implemented, maintained and modified, as approved by DFO, to the satisfaction of the Iqaluit, NU office of the Department of Fisheries and Oceans, Habitat Management, Eastern Arctic Area.

10. Written notification of the commencement of works or undertakings shall be provided to the Iqaluit, NU office of the Department of Fisheries and Oceans, Habitat Management, Eastern Arctic Area, by e-mail to Amy.Liu@dfo-mpo.gc.ca or fax at (867) 979-8039 prior to the initiation of said works or undertakings.

The holder of this authorization is hereby authorized under the authority of section 35(2) of the *Fisheries Act*. R.S.C., 1985, c.F. 14, to carry out the work or undertaking described herein. This authorization is valid only with respect to fish habitat and for no other purposes. It does not purport to release the applicant from any obligation to obtain permission from or to comply with the requirements of any other regulatory agencies.

Failure to comply with any condition of this authorization may result in charges being laid under the *Fisheries Act*.

This authorization form shall be held on site and work crews shall be made familiar with the conditions therein.

Date of Issuance: 30 July 2008

Approved by: _____

Robert Lambe
Title: Regional Director General, Central and Arctic Region

APPENDIX C – Documentation of Consultation

No Net Loss Planning Consultation Summary

Date	Description	Attendees	Document Attached?
7-Mar-11	AEM No Net Loss Contingency Plan Terms of Reference	Sent to DFO by AEM	✖
28-Apr-11	DFO Approves Terms of Reference	Accepted by DFO	
30-May-11	Invitation to attend July 13th Workshop	sent to: KIA, NWB, NIRB, HTO, DFO	✖
13-Jun-11	Meadowbank Site visit with HTO- inpart discussed NNL Planning	HTO and AEM	
13-Jul-11	No Net Loss Planning Workshop	HTO, KIA, DFO, AEM, Consultants	✖
8-Aug-11	Email to DFO outlining DFO Authorization discrepancies	Sent to DFO by AEM	✖
12-Aug-11	Helicopter Tour with Workshop Attendees	HTO, KIA and AEM	
15-Aug-11	DFO Site Visit to Meadowbank and Meliadine	AEM and DFO	
11-Nov-11	Agenda sent for November 17th meeting in Ottawa	AEM and DFO	✖
17-Nov-11	November 17th and 18th meetings in Ottawa	AEM and DFO	✖
13-Dec-11	Follow-up teleconference	AEM, DFO and Consultants	
31-Jan-12	Technical Memorandum detailing a HEP method comparison	AEM, DFO and Consultants	✖
12-Feb-12	Exploratory Meeting with DFO Science to discuss research opportunities	AEM, U of G researchers, DFO Habitat and DFO Science	✖
23-Feb-12	Site visit and presentation on NNL Planning, Wildlife and Fisheries monitoring	AEM and HTO board members	
30-Mar-12	Email from DFO detailing expectations for a new Meadowbank NNLP	Sent by DFO to AEM	✖
7-Jun-12	Technical Memorandum detailing a adjusted HEP with example	Sent to DFO by AEM	
15-Jun-12	Submission of Draft NNL Plan	Sent to DFO by AEM	
16-Jul-12	Telephone conversation to discuss NNL Plan- Ryan V and Bobby Bedingfield	DFO and AEM	
19-Jul-12	Email- Comments and feedback from DFO on Draft NNL Plan; Email Entitled- Meadowbank Authorization Amendment and NNLP Contingency Plan	DFO response to AEM	✖
13-15 Aug-2012	Meadowbank site visit- discussions included the review of DFO comments and feedback on NNL Plan and monitoring programs	DFO and AEM	
28-Aug-12	DFO and AEM Meeting- Summary and Action Items	DFO and AEM	
12-Sep-12	AEM reponse to DFO July 19 email	AEM response to DFO	✖
26-Sep-12	DFO Response to AEM Email dated Sept 12	DFO response to AEM	✖

TECHNICAL MEMORANDUM

DATE: March 7, 2010

TO: Derrick Moggy, Team Leader Arctic Region, Department of Fisheries and Oceans Canada

FROM: Ryan VanEngen- Environment Biologist
Stéphane Robert – Environment Superintendent

RE: Agnico-Eagle Mines Ltd: Meadowbank Division – Terms of Reference for the No Net Loss Contingency Plan

Background

On July 30, 2008, Agnico-Eagle Mines Ltd. (AEM) was granted Fisheries Authorization NU-03-0191 for the Meadowbank gold project. The development and construction of habitat compensation for the loss of fisheries habitat (either due to harmful alteration, disruption or destruction) is a requirement of the project.

In addition to the development of habitat compensation, Condition 4.5 of this Fisheries Authorization states:

> *A Contingency Plan addressing alternative habitat compensation measures to be implemented to meet the required ratio of gained HUs : lost HUs in the event the primary compensation plans fail either due to inability to construct as per the proponent plan, or failure of the habitat compensation measures to meet the criteria for success established in the Habitat Compensation Monitoring Plan, version 4, dated May 2008, shall be developed by the Proponent through consultation with impacted communities and/or the local Hunters and Trappers Organizations. These plans shall be submitted within one (1) year of the issuance of this Authorization to the Iqaluit, Nunavut office of Fisheries and Oceans Canada– Fish Habitat Management, Eastern Arctic Area for review and subject to DFO approval.*

On January 15, 2009 AEM sent a letter to the Department of Fisheries and Oceans Canada (DFO) raising concerns with the development of an appropriate contingency plan in the specified period of time. These concerns regarded the current limited scientific research on the effectiveness and legacy of engineered structures in Arctic waters and the lack of potential locations for suitable habitat creation in the vicinity of the mine site and the Hamlet of Baker Lake. On May 19, 2009 DFO acknowledged these concerns and that for the benefit of all parties involved agreed to defer the development of a habitat compensation contingency plan. In follow-up meetings the DFO and AEM met to review the options for a contingency plan and the DFO recommended that the Terms of Reference for a contingency plan be developed.

Objectives

The Terms of Reference (ToR), outlined in this memorandum will guide the process for AEM to develop a no-net loss (NNL) habitat contingency plan that will meet the goals of the DFO. To ensure the goals of the contingency plan are met in a conciliatory manner, various workshops will be held to inform, involve and consult with stakeholders in the development of the contingency plan. The final product of the workshops, research and discussions is to submit an agreeable no-net loss contingency plan that is acceptable to the Department of Fisheries and Oceans.

The scope of the ToR includes:

- Identifying the stakeholders and their involvement;
- Outlining applicable deliverables;
- Areas of potential research; and
- Proposing a timeline that outlines the development of the Meadowbank no-net loss contingency plan.

Identification of Stakeholders and Their Responsibilities

As stated above, AEM will invite stakeholder participation by hosting workshops. The goal of these workshops will be to engage and provide consultation for identifying and developing alternative habitat compensation strategies for the Meadowbank Mine. The workshop invitees will be comprised and not limited to:

- The proponent (Agnico-Eagle Mines Ltd. [AEM]);
- Department of Fisheries and Oceans Canada (DFO);
- Baker Lake Hunters and Trappers Organization (HTO);
- Kivalliq Inuit Association (KIA); and
- Consultants or Researchers hired by any of the groups listed above.

In general, the following roles and responsibilities are assigned as part of the development of the No-Net-Loss Contingency Plan.

The proponent (AEM): Responsible for coordinating the workshops and organizing meetings with DFO representatives and researchers to meet the timelines proposed in the ToR. Responsible for researching and proposing alternative habitat compensation options, developing and assessing the feasibility, costs and schedules for any proposed habitat compensation features and lastly for preparing the NNL contingency plan.

DFO: When possible, the DFO is responsible to provide feedback and participate in the workshops and meetings hosted by AEM. Although the DFO is not directly responsible to develop an alternative plan, they are requested to participate in researching and providing advice on suitable alternative habitat contingency options for the project. The DFO is responsible for approving the final no-net loss habitat contingency plan under the Fisheries Authorization.

Inuit Associations: As representative land owners, the KIA is invited to participate and provide consultation by attending the workshops. As representative resource users, the Baker Lake HTO will be invited to participate in the workshop and provide consultation.

Consultants and Researchers: Responsible for participating and assisting group members in the development of alternative habitat compensation options for the project.

As outlined, consultation through meetings with DFO representatives and stakeholder workshops will provide accountability and guidance during the process of developing the No-Net-Loss contingency plan. Ultimately, the proponent is responsible for designing and providing the DFO with a compliant no net loss contingency plan.

Areas of Potential Research and Discussion for Alternative Habitat Compensation Options

Items that will be researched, pursued and discussed through the process of developing a no net loss contingency include (but are not limited to):

A review of the originally proposed habitat compensation

- A review of the originally proposed habitat compensation features (i.e. shoals, finger dikes, mounts), construction designs and costs.
- A review of the number of habitat units that are to be compensated for and the methods used to quantify habitat units.
- A review of the success criteria established in the Habitat Compensation Monitoring Plans.
- A review of in-water construction methods and the experiences learned during Meadowbank in-water dike construction in 2008 to 2010.
- The limitations of the originally proposed habitat compensation options.

Identification of contingency plan habitat compensation options

- Available methods to improve upon the currently proposed habitat compensation features (consideration for alternate accounting systems).
- A review of the scientific literature for any new developments on habitat compensation features in the Arctic.
- Consideration of developing an alternative accounting system (i.e. replacing habitat units with alternative units such as fish population or biomass replacement).
- A review of other constructed habitat compensation features in the Arctic, and if possible, the effectiveness of those features (i.e. end pit lakes, mounts, shoals).
- The identification of compensation options within the watershed of the mine site, near to the Hamlet of Baker Lake, within the Kivalliq region and/or outside the region.
- Creative alternative strategies for habitat compensation in the north
- The identification of compensation options that provide a tangible benefit to the local community. This might include: non like-for-like or off-site (e.g. improving the fisheries industry and researching related fisheries management in Nunavut).
- The identification of a suite of contingency options that collectively provides a suitable no net loss contingency plan.

Options Analysis

- The feasibility of any of the proposed compensation features.
- The environmental, social and economical benefits and risks from any of the proposed compensation options.
- Defining the measures and limitations in quantifying success (field data collection may be needed to assist with the formulation of a potential habitat compensation options).

Deliverables

Deliverables for the proponent include the following:

- Completing and distributing meeting agendas to DFO representatives and documenting minutes from each of the meetings and stakeholder workshops.
- A Meadowbank- No Net Loss Contingency Plan, as developed in consultation with the stakeholders and DFO representatives, shall be provided to the DFO for approval.

Timeline

- April 2011 – The proponent will contact all stakeholders and request their participation in a workshop.

- May- July 2011 – AEM will host a workshop with stakeholders to review the approved habitat compensation features at Meadowbank, review the requirements of the No-Net-Loss contingency and identify alternative options for habitat compensation.
- September- December 2011- AEM and DFO will meet to review the identified options and discuss the preferred options based on their feasibility.
- January- March 2012- AEM will host a workshop with stakeholders to review the feasibility of the options and the direction of the contingency plan.
- April 2012 - The proponent will formally submit the No-Net-Loss contingency plan to the DFO for approval.

AGNICO-EAGLE
MEADOWBANK DIVISION

May 30, 2011 (see translated version below)

Dear Workshop Invitee,

On July 30, 2008, Agnico-Eagle Mines Ltd. (AEM) was granted Fisheries Authorization NU-03-0191 for the Meadowbank Mine. The development and construction of habitat compensation for the loss of fisheries habitat (either due to harmful alteration, disruption or destruction) is a requirement of the project.

In addition to the development of habitat compensation, Condition 4.5 of this Fisheries Authorization states:

> *A Contingency Plan addressing alternative habitat compensation measures to be implemented to meet the required ratio of gained HUs : lost HUs in the event the primary compensation plans fail either due to inability to construct as per the proponent plan, or failure of the habitat compensation measures to meet the criteria for success established in the Habitat Compensation Monitoring Plan, version 4, dated May 2008, shall be developed by the Proponent through consultation with impacted communities and/or the local Hunters and Trappers Organizations. These plans shall be submitted within one (1) year of the issuance of this Authorization to the Iqaluit, Nunavut office of Fisheries and Oceans Canada– Fish Habitat Management, Eastern Arctic Area for review and subject to DFO approval.*

In response to discussions with the Department of Fisheries and Oceans Canada (DFO), on March 7th, 2011, AEM submitted a Terms of Reference to the DFO to guide the completion of a No Net Loss Contingency Plan for the Meadowbank Mine. On April 28, 2011 the DFO provided comments and approval for the Terms of Reference memorandum.

As stated in the Terms of Reference, AEM is encouraging the participation of relevant stakeholders during the No Net Loss Contingency plan development; it is for this reason that AEM would like to invite you and relevant members of your organization to participate in a workshop that will be held on July 13th, 2011 in Baker Lake. A follow-up workshop will also be completed at the beginning of 2012 prior to the final submission of the plan.

The goal of these workshops will be to engage and consult with relevant stakeholders for identifying and developing alternative habitat compensation strategies for the Meadowbank Mine. The workshop invitees will be comprised and not limited to:

- The proponent (Agnico-Eagle Mines Ltd. [AEM]);
- Department of Fisheries and Oceans Canada (DFO);
- Baker Lake Hunters and Trappers Organization (HTO);
- Nunavut Water Board (NWB);

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Tel: 819-759-3700 Fax: 819-759-3663

Baker Lake Office:
P.O. Box 540
Baker Lake, Nunavut
X0C 0A0
Tel: 867-793-4610 Fax: 867-793-4611

- Kivalliq Inuit Association (KIA); and
- Consultants or Researchers hired by any of the groups listed above.

During the July 13th workshop, we invite at least one representative of your organization to participate in an introduction to the project, a review of the approved no-net loss plan & habitat compensation for the Meadowbank Mine and a discussion on the development of alternative habitat contingencies for the *Meadowbank Mine No Net Loss Contingency Plan*.

We are requesting your response ASAP or at the latest by June 15th, 2011. Please reply to Ryan VanEngen: rvanengen@agnico-eagle.com or call Stephane or Ryan at the below email address.

Feel free to contact the undersigned any time if you have any questions or comments, otherwise we look forward to meeting with you on July 13th, 2011.

Regards,

Ryan Vanengen
rvanengen@agnico-eagle.com
519-400-7979
Environment Biologist

Stéphane Robert
Stephane.robert@agnico-eagle.com
819-763-0229
Environmental Superintendent

AGNICO-EAGLE
MEADOWBANK DIVISION

ᒪᐃ 30, 2011

ᑎᑎᕋᐃᐅᓪᓗᒃ, ᑲᑎᒪᖅᑐᑭᓇᖅᑐᑦ

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AGNICO-EAGLE
MEADOWBANK DIVISION

- ᑲᖏᒪᑐᖅᔪᓂᓂ ᑕᓗᐅᓕᓗᓂᒃ
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Meeting summary for:
Meadowbank Gold Project No Net Loss Contingency Plan Workshop
July 13, 2011 Nunamuit Lodge, Baker Lake, NU

In attendance:
Ryan VanEngen, AEM ; Stephane Robert, AEM ; Leilan Baxter, consultant to AEM- Meadowbank Mine; John Witteman, consultant to AEM- Meliadine Project; Michael Haqpi, AEM (Translator); Simeon Mikkungwak, KIA; James Tiriganiaq, HTO; Bobby Bedingfield, DFO

Minutes
Start - 9am.

Morning Session Summary

Ryan VanEngen presented an update on activities occurring at the mine site, including details on water management, construction of the in-lake dikes and the environmental monitoring programs. He continued to present a summary of the current fisheries no net loss plan (NNLP), including where habitat losses and gains will occur at the Meadowbank site. Leilan Baxter presented a summary of NNLP compensation options from other northern mines. Ryan VanEngen re-iterated the purpose of today's workshop and explained why AEM needs to develop a NNL contingency plan. See presentation file for details.

Morning Session Questions and Answers (paraphrased)

JK: When I was young in 1959 we fished in the mine site area and the fish were fat and healthy. Are they still?
RV: Yes they are. We monitor the condition factor of fish in the mine site area and they are healthy. We will continue to monitor the health of fish.
JK: On the E, W and S sides of the mine site there were a lot of fish.
RV: These areas are still very productive and that is where the best habitat is. We caught over 2000 fish in the Bay-Goose area (portion of east basin of Third Portage Lake) in 2009.
SM: Where did you put the fish that you caught in that area?

RV: 58% of the fish caught were released in Third Portage Lake outside the Bay-Goose dike. Those that died during collection were used for meristics (DFO required biological data), frozen and later delivered to the community for animal food.
JT: All around the mine site (E, W,S) is traditional fishing areas
RV: We have monitoring stations near the mine, as well as at far field sites that have been monitored prior to mine construction and will be monitored throughout production, in order to detect any effects on fish as a result of the mine.
SM: Before the mine was there, fish travelled from the north down into Tehek Lake.
RV: They can still do that – the channels draining to Tehek are unchanged. Are there any streams that you are aware of near the mine site that could be improved for fish passage?
JT: Most channels around that area have minnows and fish eggs in spring.
RV: Since most of the fish around here spawn in the fall usually the eggs that you see in the spring are likely unfertilized eggs from the fall and wash in the channels.
JT: How does the diversion channel used at Ekati improve fish habitat?
JW: For example, at Ekati they supplemented the channel construction with boulders and cobbles to make it good fish habitat, rather than leaving as a barren ditch. It provides some habitat for arctic grayling and studies are on-going to determine their effectiveness.

LUNCH BREAK

<u>Afternoon session summary</u>
Ryan VanEngen further explained the requirements of a contingency plan and what factors need to be considered in assessing the options. Several ideas were presented and discussed by the workshop participants. See presentation file for details.

<u>Afternoon Session Discussion (paraphrased)</u>
Re. stream habitat enhancements
SR to JK: Do you have any ideas for locations to improve fish habitat?
JT: At the mine site there are lots of shallow streams.
RV: Is there anywhere close to Baker Lake?
JT: Quich River stream between the mine and Baker Lake would be possible.

SM: The stream south of the mine flowing south.
JW to JK: Are there any waterfalls?
JT: There are some on the Quich.
RV: Where are they?
Looked at maps.
JK and SM: There are some places in the streams that flow through White Hills to Prince.
JT: People in the community would know more places to improve. There are a few people that used to live in that area. The small rivers flowing to White Hills would be the best place to help people fishing. There are lots of small streams along the Prince River that dry up. The other places maybe too far.
SM: There is a small falls (rapids with a pool below) south of the Prince River bridge and it's a traditional fishing spot (spearing).
RV/SR: Can the fish go up the falls or is it too high?
SM: You can see them jumping up the falls, but not all get through.
RV/SR: Do they swim up the rapids?
SM and JK: The small fish stay above the rapids, the big ones go back and forth.
SR: Would this be a good area to change?
JT and SM: No, people like this area how it is. But another good area to improve is further up from km 18 – a shallow area that maybe fish can't pass. Also by km 15/16 (all connections to White Hills Lake).

Re. Airplane Lake/sewage treatment enhancements
J: Before the sewage flowed to Airplane Lake it had lots of good fish (trout and grayling) and people used to fish there.

<u>Final Comments</u>
JT: There might be some areas to improve streams between Amarulik Lake and White Hills Lake too.
SM: Hardly anyone fishes north of the mine because it's too rocky. Any projects there wouldn't help local hunters.
BB: Good options presented.
JW: Some possibilities here could work for Meliadine NNLP as well.
AEM: Thank you for coming and contributing ideas.

Next Steps

AEM to go for a helicopter with HTO representatives in August to look at areas that could be candidates for improved stream habitat.

There will be additional meetings with the DFO in late 2011 and with the stakeholders (HTO, KIA and AANDC) in early 2012.

The community will be consulted before any options are finalized and implemented.

End - 2:30pm.

Table 1A. Total Habitat Units (HU) altered, disturbed or destroyed by the Meadowbank Gold Project (2006/2007 NNLP).

	Mine Component	High			Medium			Low			Total HUs			Difference of Mine vs DFO Auth
		HS I	ha	HU	HS I	ha	HU	HS I	ha	HU	Mine Site	DFO Authorization	TIA	
Second Portage Lake	*Tailings Impoundment Area*	8.90	12.70	**112.99**	6.06	20.95	**126.92**	2.34	55.75	**130.59**			**370.50**	
Second Portage Lake	*East Dike Footprint*	8.90	0.00	0.00	6.06	5.99	36.26	2.34	1.29	3.02	39.28	39.28		
	West (Central) Dike Footprint	8.90	0.03	0.24	6.06	0.64	3.88	2.34	7.75	18.15	22.27	22.27		
	*Second Portage - Basin**	8.90	1.13	10.05	6.06	12.87	77.94	2.34	9.95	23.31	111.30	111.30		
	*Portage Pit - Second Portage Lake**	8.90	0.004	0.04	6.06	3.55	21.52	2.34	12.03	28.18	49.75	49.75		
	Second Portage Habitat Mounts Footprint[*,1]*	8.90	0.000	0.00	6.06	0.00	0.00	2.34	1.25	2.93	2.93			2.93
	East Dike Extension Habitat Footprint[*,1]*	8.90	0.000	0.00	6.06	0.00	0.00	2.34	5.03	11.78	11.78			11.78
	Total			**10.3**			**139.6**			**87.4**	**237.3**	**222.6**	**0.0**	14.7
Third Portage Lake	*Goose Island (Bay Goose) Dike Footprint*	8.90	1.34	11.88	6.06	4.24	25.69	2.34	15.32	35.89	73.46	73.46		
	South Camp Dike Footprint	8.90	0.00	0.00	6.06	0.17	1.00	2.34	0.00	0.00	1.00	1.00		
	*Third Portage - Basin**	8.90	10.37	92.20	6.06	20.75	125.70	2.34	35.49	83.14	301.04	301.04		
	*Goose Pit - Third Portage Lake**	8.90	2.00	17.77	6.06	3.70	22.43	2.34	8.91	20.87	61.07	61.07		
	*Portage Pit - Third Portage Lake**	8.90	0.01	0.07	6.06	4.87	29.50	2.34	2.39	5.59	35.16	35.16		
	Finger Dike Extension Habitat Footprint[*,1]*	8.90	0.00	0.00	6.06	0.00	0.00	2.34	11.07	25.93	25.93			25.93
	*Finger Dike Habitat Footprint**	8.90	0.10	0.85	6.06	0.10	0.58	2.34	19.44	45.53	46.95	46.95		
	Total			**122.8**			**204.9**			**217.0**	**544.6**	**518.7**	**0.0**	25.9
										Subtotal Not Including Vault	**781.93**	**741.28**	**370.50**	40.6
Vault Lake	*Vault Dike Footprint**	8.90	0.00	0.00	6.06	0.00	0.00	2.34	0.04	0.09	0.09			
	Vault Pit - Vault Lake	8.90	0.65	5.79	6.06	7.79	47.18	2.34	0.00	0.00	52.97			
	Vault - Basin	8.90	34.89	310.38	6.06	42.90	259.87	2.34	11.02	25.82	596.07			
	Total			**316.2**			**307.1**			**25.9**	**649.1**		**0.0**	
Total HADD (HUs)											**1431.1**	**741.28**	**370.5**	

Note: * Component habitat loss temporary; future habitat quality may be vary (changed or enhanced) from baseline conditions.
1. Features were from the 2007 NNLP Addendum.

Table 1B. Total Habitat Units (HU) gained after closure implementation at the Meadowbank Gold Project (2006/2007 NNLP).

	Mine Component	High			Medium			Low			Total HUs			Difference of Mine vs DFO Auth	Portion of TIA gains included in DFO Auth?
		HS I	ha	HU	HS I	ha	HU	HS I	ha	HU	Mine Site	DFO Authorization	TIA		
Second Portage Lake	*East Dike - Exterior*	8.90	0.24	2.13	6.06	0.35	2.12	2.34	0.00	0.00			4.3		
	*East Dike - Interior**	8.90	0.04	0.36	6.06	0.34	2.06	2.34	0.00	0.00			2.4		
	*West (Central) Dike - Exterior**	8.90	1.04	9.25	6.06	0.83	5.03	2.34	0.00	0.00			14.3		
	*Second Portage - Basin**	8.90	23.95	213.01	6.06	0.00	0.00	2.34	0.00	0.00	213.0	401.0			
	*Portage Pit - Second Portage Lake**	8.90	2.27	20.15	6.06	0.19	1.14	2.34	20.475	47.96			69.2		69.2
	*Portage Pit - 2P Land to Lake**	8.90	3.81	33.87	6.06	0.32	1.91	2.34	34.42	80.63			116.4		116.4
	Second Portage Habitat Mounts[*,-]*	8.90	1.25	11.12	6.06	0.00	0.00	2.34	0.00	0.00	11.1	8.2			
	East Dike Extension Habitat[*,1]*	8.90	5.03	44.74	6.06	0.00	0.00	2.34	0.00	0.00	44.7	33.0			
	Total			**334.6**			**12.3**			**128.6**	**268.9**	**442.2**	**206.6**	173.32	185.6
Third Portage Lake	*Goose Island (Bay Goose) Dike - Exterior*	8.90	1.90	16.87	6.06	1.76	10.69	2.34	0.00	0.00			27.6		
	Goose Island (Bay Goose) Dike - Interior	8.90	0.89	7.92	6.06	0.59	3.57	2.34	0.00	0.00			11.5		
	Goose Island (Bay Goose) Dike - Restored	8.90	2.99	26.58	6.06	0.00	0.00	2.34	0.00	0.00	26.6	26.6			
	Finger Dike Habitat	8.90	19.63	174.59	6.06	0.00	0.00	2.34	0.00	0.00			174.6		
	Finger Dike Extension Habitat[1]	8.90	11.07	98.47	6.06	0.00	0.00	2.34	0.00	0.00	98.5	81.6			
	Third Portage - Basin	8.90	56.84	505.65	6.06	9.89	59.94	2.34	0.00	0.00	565.6	701.6			
	Goose Pit - Third Portage Lake	8.90	1.49	13.30	6.06	0.69	4.18	2.34	17.67	41.39			58.9		58.9
	Portage Pit - Third Portage Lake	8.90	1.97	17.57	6.06	0.16	0.99	2.34	17.85	41.81			60.4		60.4
	Goose Pit - 3P Land to Lake	8.90	0.98	8.68	6.06	0.45	2.73	2.34	11.53	27.01			38.4		
	Total			**869.6**			**82.1**			**110.2**	**690.6**	**809.8**	**371.3**	119.15	119.3
										Subtotal Not Including Vault	959.53	1252.00	577.90	292.47	304.90
Vault Lake	*Vault - Basin*	8.90	34.89	310.38	6.06	42.90	259.87	2.34	11.02	25.82	596.1				
	Vault Dike - Restored	8.90	0.04	0.36	6.06	0.00	0.00	2.34	0.00	0.00	0.4				
	Vault Pit - Vault Lake	8.90	1.13	10.01	6.06	0.15	0.92	2.34	11.423	26.76			37.7		
	Vault Pit - Vault Land to Lake	8.90	3.99	35.53	6.06	0.54	3.26	2.34	40.537	94.96			133.8		
	Total			**356.3**			**264.0**			**147.5**	**596.4**		**171.4**		
Habitat Gain (HUs)											**1556.0**		**749.3**		

Note: * Habitat components will be in the Third Portage Lake drainage after mine closure, but are shown here for "accounting" purposes.
1. Features were from the 2007 NNLP Addendum.

Table 2A. Total Habitat Units (HU) altered, disturbed or destroyed by the Meadowbank Gold Project (revised November 2009).

	Mine Component	High			Medium			Low			Total HUs			
		HS I	ha	HU	HS I	ha	HU	HS I	ha	HU	Mine Site	DFO Authorization	TIA	Difference of Mine vs DFO Auth
Second Portage Lake	*Tailings Impoundment Area*	8.90	12.55	**111.61**	6.06	19.96	**120.90**	2.34	51.56	**120.77**			**353.28**	
Second Portage Lake	*East Dike Footprint*	8.90	0.00	0.00	6.06	4.97	30.09	2.34	0.02	0.04	30.13	39.28		
	Central Dike Footprint	8.90	0.16	1.38	6.06	1.22	7.38	2.34	11.08	25.96	34.73	22.27		
	*Second Portage - Basin**	8.90	1.12	9.97	6.06	7.50	45.41	2.34	11.50	26.94	82.33	111.30		
	*Portage Pit - Second Portage Lake**	8.90	0.039	0.35	6.06	3.49	21.15	2.34	11.32	26.52	48.02	49.75		
	East Dike Extension Habitat Footprint	8.90	0.000	0.00	6.06	0.00	0.00	2.34	5.03	11.78	11.78			
	Second Portage Habitat Mounts Footprint	8.90	0.000	0.00	6.06	0.00	0.00	2.34	1.25	2.93	2.93			
	Total			**11.7**			**104.0**			**94.2**	**209.9**	**222.6**		**12.7**
Third Portage Lake	*Bay Goose Dike Footprint*	8.90	3.14	27.91	6.06	4.58	27.74	2.34	8.33	19.51	75.16	73.46		
	South Camp Dike Footprint	8.90	0.00	0.00	6.06	0.17	1.00	2.34	0.00	0.00	1.00	1.00		
	*Third Portage - Basin**	8.90	7.58	67.45	6.06	15.60	94.51	2.34	28.06	65.74	227.69	301.04		
	*Goose Pit - Third Portage Lake**	8.90	1.86	16.53	6.06	3.02	18.31	2.34	7.04	16.50	51.33	61.07		
	*Portage Pit - Third Portage Lake**	8.90	0.00	0.00	6.06	6.74	40.84	2.34	5.01	11.74	52.58	35.16		
	*Finger Dike Habitat Footprint**	8.90	0.01	0.10	6.06	0.02	0.13	2.34	14.04	32.89	33.12	46.95		
	Finger Dike Habitat Extension Footprint	8.90	0.00	0.00	6.06	0.00	0.00	2.34	10.53	24.66	24.66			
	Total			**112.0**			**182.5**			**171.0**	**465.5**	**518.7**	**0.0**	**53.1**
										Subtotal Not Including Vault	**675.47**	**741.28**	**353.28**	**65.81**
Vault Lake	*Vault Dike Footprint**	8.90	0.00	0.00	6.06	0.04	0.24	2.34	0.00	0.00	0.24			
	Vault Pit - Vault Lake	8.90	1.37	12.21	6.06	8.03	48.65	2.34	0.00	0.00	60.86			
	Vault - Basin	8.90	38.05	338.46	6.06	42.65	258.38	2.34	6.83	15.99	612.83			
	Total			**350.7**			**307.3**			**16.0**	**673.9**		**0.0**	
Total HADD (HUs)											**1349.4**		**353.3**	

Note: * Component habitat loss temporary; future habitat quality may vary (changed or enhanced) from baseline conditions.

Table 2B. Total Habitat Units (HU) gained after closure implementation at the Meadowbank Gold Project (revised November 2009).

	Mine Component	High			Medium			Low			Total HUs				
		HS I	ha	HU	HS I	ha	HU	HS I	ha	HU	Mine Site	DFO Authorization	TIA	Difference of Mine vs DFO Auth	Portion of TIA gains included in DFO Auth?
Second Portage Lake	*East Dike - Exterior*	8.90	0.63	5.60	6.06	0.47	2.85	2.34	0.00	0.00			8.5		8.5
	East Dike - Interior [1]	8.90	0.91	8.10	6.06	0.41	2.48	2.34	0.00	0.00			10.6		10.6
	Central Dike - Exterior [1]	8.90	1.37	12.19	6.06	0.30	1.82	2.34	0.64	1.50			15.5		15.5
	Second Portage - Basin [1]	8.90	20.12	178.98	6.06	0.00	0.00	2.34	0.00	0.00	179.0	401.0			
	Portage Pit - Second Portage Lake [1]	8.90	0.88	7.82	6.06	0.01	0.04	2.34	23.340	54.67			62.5		
	Portage Pit - 2P Land to Lake [1]	8.90	4.11	36.56	6.06	0.67	4.06	2.34	51.61	120.90			161.5		161.5
	Second Portage Habitat Mounts [2]	8.90	1.25	11.12	6.06	0.00	0.00	2.34	0.00	0.00	11.1	8.2			
	East Dike Extension Habitat [2]	8.90	5.03	44.74	6.06	0.00	0.00	2.34	0.00	0.00	44.7	33.0			
	Total			**305.1**			**11.2**			**177.1**	**234.8**	**442.2**	**258.6**	**207.4**	**196.1**
Third Portage Lake	*Bay Goose Dike - Exterior*	8.90	0.39	3.47	6.06	0.74	4.48	2.34	0.00	0.00			8.0		8.0
	Bay Goose Dike - Interior	8.90	0.53	4.71	6.06	0.63	3.82	2.34	0.00	0.00			8.5		8.5
	Bay Goose Dike - Restored	8.90	1.96	17.42	6.06	0.00	0.00	2.34	0.00	0.00	17.4	26.6			
	Finger Dike Habitat	8.90	13.18	117.24	6.06	0.00	0.00	2.34	3.27	7.66			124.9		124.9
	Finger Dike Extension Habitat	8.90	11.07	98.47	6.06	0.00	0.00	2.34	0.00	0.00	98.5	81.6			
	Third Portage - Basin	8.90	51.24	455.81	6.06	0.00	0.00	2.34	0.00	0.00	455.8	701.6			
	Goose Pit - Third Portage Lake	8.90	1.72	15.30	6.06	0.06	0.36	2.34	19.61	45.94			61.6		61.6
	Portage Pit - Third Portage Lake	8.90	0.69	6.17	6.06	0.00	0.02	2.34	18.48	43.29			49.5		49.5
	Goose Pit - 3P Land to Lake	8.90	0.00	0.00	6.06	0.00	0.00	2.34	5.43	12.72			12.7		
	Total			**718.6**			**8.7**			**109.6**	**571.7**	**809.8**	**265.2**	**238.1**	**252.5**
										Subtotal Not Including Vault	806.55	1252.00	523.78	445.45	448.60
Vault Lake	*Vault - Basin*	8.90	38.05	338.46	6.06	42.65	258.40	2.34	6.83	15.99	612.9				
	Vault Dike - Restored [2]	8.90	0.04	0.36	6.06	0.00	0.00	2.34	0.00	0.00	0.4				
	Vault Pit - Vault Lake	8.90	2.11	18.77	6.06	0.73	4.42	2.34	16.260	38.09			61.3		
	Vault Pit - Vault Land to Lake	8.90	3.01	26.78	6.06	0.95	5.76	2.34	42.870	100.42			133.0		
	Total			**384.4**			**268.6**			**154.5**	**613.2**		**194.2**		
Habitat Gain (HUs)											**1419.8**		**718.0**		

Note: 1. Habitat components will be in the Third Portage Lake drainage after mine closure, but are shown here for "accounting" purposes.
2. Areas for these features were not revised in 2009 (i.e., either the 2006 NNLP or 2007 NNLP Addendum figures were used).

MEETING AGENDA

Agnico Eagle Mines Ltd: Meadowbank Division
Environmental Department
Meadowbank, Nunavut, X0X 0A0
867.793.4610

November 17th and 18th, 2011

Department of Fisheries and Oceans and AEM - Meadowbank and Meliadine No Net Loss Planning Meeting

LOCATION: Sheraton Ottawa Hotel, Ottawa ON.

November 17th 9:30 to 18:00

Meeting Room: Sheraton Hotel- Salon C

9:15- Continental Breakfast Provided by AEM

9:30- Introduction (Larry Connell)

9:45 to 10:15- Meadowbank Mine Update (Ryan VanEngen)

- Second Portage Lake and Bay-Goose Dewatering,
- Water Management and
- Revised Waste Rock Storage to include pit backfilling

10:15 to 10:45- Revised Airstrip Extension and Vault Pit Extension

10:45 to 11:00- Overview of 2011 Fisheries Monitoring

11:00 to 11:15- Break

11:15 to 14:00- No Net Loss Contingency Plan

- No Net Loss Contingency Compensation Ideas
- Review of DFO Authorization
- Path Forward

14:00 –15:00- Lunch Break – Provided by AEM

15:00 to 16:00- Meliadine Project Update (Larry Connell)

16:00- 18:00- Meliadine Draft No Net Loss Plan

- Environmental Setting and Baseline Fisheries Review (Jack Patalas)
- No Net Loss Plan Methods (Jack Patalas)
- No Net Loss Compensation (Ryan VanEngen)
  - Schedule 2 Options and Mine Site Options

18:00- Closing

November 18th- 8:30 to 12:00

Meeting Room- Sheraton Hotel- Penthouse B

8:15- Continental Breakfast Provided by AEM

8:30 to 9:30- Review and Discussion of Meadowbank No Net Loss Planning

9:30 to 10:30- Review and Discussion of Meliadine Draft No Net Loss Plan

10:30 to 11:30- Round Table Discussion

11:30 to 12:00- Closing Remarks

If you have any questions please contact Larry Connell (lconnell@agnico-eagle.com) or Ryan VanEngen. 519.400.7979. (rvanengen@agnico-eagle.com)

MEMORANDUM

Agnico Eagle Mines Ltd: Meadowbank Division
Environmental Department
Meadowbank, Nunavut, X0X 0A0
867.793.4610

Follow-up Action Items for the Department of Fisheries and Oceans and AEM Meadowbank and Meliadine
RE: No Net Loss Planning Meeting on November 17th and 18th, 2011 at the Sheraton Ottawa Hotel, Ottawa ON.

Meadowbank Action Items and Deadlines:

DFO Deadline- December 23rd (mid December)

- DFO is to provide a rationale or reason for the habitat unit discrepancies in the Meadowbank DFO authorization- dated July 30, 2008. Specifically, AEM is requesting how the second portage and third portage basin habitat units were calculated or the basis for the difference in HU valuation for these compensation features compared to the mine site calculation. The DFO authorization provides a 1.68 to 1 ratio of gains to losses that cannot be accounted for in the mine site HU calculations mainly because of the discrepancy in the basin HUs (see Table 2B provided to DFO Sept 8 and Nov 8, 2011).
- AEM proposes to revise the mine site NNL Plan and incorporate a contingency plan within it. This will meet the conditions of the contingency plan terms of reference and provide clarity and transparency for no net loss planning at Meadowbank. AEM requests confirmation from DFO to move forward with a revised Mine Site NNL Plan.
- DFO is to provide feedback on the process to amend the TIA compensation. The TIA compensation presently is comprised of end-pit lake reflooding, dike face habitat and finger dikes which provides a 2:1 ratio of habitat unit gains to losses. AEM accepts the 2:1 ratio of the original TIA compensation plan but is requesting from DFO the replacement of finger dikes (which are technically complex and challenging to construct) with the creation of high and moderate value backfilled 40% and reflooded fish habitat in portage pit.
- DFO is to provide a confirmation that Vault will require a separate NNL Plan and subsequent authorization; DFO is to provide feedback on compensation concepts for Vault (pit backfilling and enhancement, improving connection between Vault and Wally, introducing arctic char given the creation of deep overwintering habitat)
- DFO is to provide an answer whether Vault pit should be calculated using the Cumberland (2005) HEP model or using the new Meliadine (2011) HEP model. AEM supports using the Meliadine model which will allow for comparison between projects, assist in research/ data collection and reduce uncertainties moving forward for backfilled pit lakes.

AEM Deadline- January 17th

- AEM to confirm with Environment Canada that PAG material is acceptable for backfilling portage pit.
- Provide DFO with maps (depth) for Wally and Vault lake

DFO Deadline- January 17th

- DFO to give feedback and guidance on the HU calculation for the spawning pads- specifically feedback on the comparison of immature fish/ HU at R02 vs immature fish/HU in Second Portage Lake fishout.
- Provide AEM with fish-out data from Diavik, Ekati, Snap Lake and other northern fishouts (specifically all of the "DFO fish-out protocol" data for these projects including: water quality, primary productivity, benthos data, fish meristics and CPUE data).
- DFO to inquire/ request DFO science's participation in research (productive capacity models)- DFO will speak/ present some of this information to DFO science

DFO Deadline – after 2011 annual report submission- March 31, 2012

- Frequency of testing at R02 (as per the authorization 2007 to 2010 and every other year after; AEM has completed monitoring from 2005-2011 and is requesting that we begin monitoring every other year).
- Is it possible to open discussions of sewage treatment in the north at a higher bureaucratic level? If so, using the Baker Lake sewage and landfill example, to whom should we address our request. AEM believes this to be a true benefit to the communities, the fishery and the environment in the north.

Meliadine Action Items and Deadlines:

AEM Deadline- November 29th- see attached spreadsheet

- AEM to provide Habitat Unit calculation spreadsheet to DFO for review of the Meliadine method of HU calculations

DFO Deadline- December 12th

- AEM is requesting DFO to review and provide feedback on the Meliadine method of calculating HUs: specifically- HSIs, sensitivity weighting, biomass and fishery valuation.
- If the method is not acceptable, will the DFO support a Delphi-type workshop to develop HSI for northern projects. AEM or Golder would host a workshop with experts from DFO, consultants and academics to determine HSI for each northern species and determine suitable weighting systems for use in the Meliadine method.
- DFO to confirm the inclusion of arctic char, lake trout and arctic grayling (?) as Valued Ecosystem Components in the EIS.

DFO Deadline- January 17th

- DFO to determine if AEM will require section 36 for pond H17 that *may* have TSS runoff and will be surrounded by multi-purpose pads.
- DFO to provide feedback on the fishout requirements for stickleback.

AEM will provide a Draft Meliadine No Net Loss Plan to DFO prior to EIS submission.

Next meeting is proposed for Jan 17th in Winnipeg; otherwise that week in Calgary or Edmonton.

If you have any questions please contact Ryan VanEngen. 519.400.7979. (rvanengen@agnico-eagle.com)

AGNICO-EAGLE
MEADOWBANK DIVISION

Date: January 30, 2011

To: Bobby Bedingfield and Derrick Moggy
Department of Fisheries and Oceans
Eastern Arctic Area

CC: Stephane Robert (Meadowbank Environment Superintendant) and Leilan Baxter (Environmental Scientist)

In follow-up to our recent discussions and workshops regarding an approved methodology of calculating habitat units in eastern arctic lakes, the following document briefly provides an introductory literature review, compares the Cumberland (2005) Meadowbank Gold Project No Net Loss Plan methodology with a recently developed AEM and Golder (2011) Meliadine Gold Project methodology for habitat units, and provides results and discussion using the Dogleg Pond Connection compensation project. The text, figures and data presented in this document are in *draft form* and therefore have not been finalized nor thoroughly peer reviewed. The calculations in this document are made for the comparison of habitat unit calculations methods and are not final habitat values for the Dogleg Pond Connection Compensation Project. The data presented in this document are for the purposes of assisting DFO in their upcoming workshop and subsequent discussions with AEM.

Should you require any further information or questions please contact the below via email or by telephone.

Regards,

Ryan Vanengen
rvanengen@agnico-eagle.com
519-400-7979
Environment Biologist- Meadowbank Division

DRAFT

DRAFT- Comparison of Cumberland (2005) and AEM/Golder (2012) HEP- A Case Study using the Meadowbank Gold Mine Dogleg Pond Connection

By: Ryan VanEngen (AEM) and Leilan Baxter (Independent Research Assistant)

Introduction

As a condition of an authorization from DFO to permit habitat alteration, disruption or destruction (HADD), the proponent must ensure there is no net loss of *productive capacity* of fish habitat. Since it is normally not possible to directly measure production of fish populations (i.e. kg/yr) because of time and expense, alternative metrics such as habitat area and suitability are commonly measured instead (Randall and Minns 2002). The concept of HUs as a surrogate measure for productive capacity of fish communities was first developed by the US Fish and Wildlife Service in the 1980s and has since been adopted by habitat managers in northern Canada. However, in order to establish quantifiable links between fish production and habitat, fish production must first be measured directly (Minns 1995) and a habitat-productivity model established. A system to provide managers with repeatable habitat suitability indices based on measurable physical properties, such as the scientifically defensible Habitat Suitability Matrix model for fishes of the Great Lakes region (Minns, Moore et al. 2001), is not currently available for arctic development projects. With the exception of arctic grayling (Hubert, Helzner et al. 1985; Jones and Tonn 2004), no habitat models are available for arctic species, to our knowledge. Furthermore, while general life history characteristics have been published for arctic fishes, it is recognized that major gaps even exist in current understanding of northern fish preferences (Richardson, Reist et al. 2001), let alone productivity relationships. In order for habitat suitability indices to be developed and used effectively, data on habitat preferences must first be collected and the appropriate models generated (De Kerckhove, Smokorowski et al. 2008).

A further consideration is that even if standardized habitat suitability models were to be developed from observational data, it has been argued that correlative studies of habitat selectivity are not necessarily representative of actual habitat requirements, and these models are rarely validated with experimental evidence (Rosenfeld 2003). According to Rosenfeld (2003), the removal or conversion of an apparently “preferred” habitat may not actually affect productivity of the population, if alternate habitats provide adequate life-functions.

As a result of this lack of information, habitat suitabilities for northern fish species are extrapolated from southern-developed models, with an unknown degree of certainty. It has been suggested that the accuracy of predictions made using HSIs may not transfer well between watersheds (De Kerckhove, Smokorowski et al. 2008), let alone ecozones. Furthermore, it is known that the way fish adapt to habitat change is dependent on many factors, including location, temperature, season, maturity, population diversity and the availability of habitat (Smokorowski and Pratt 2006). While uncertainty factors

(associated with habitat suitability determinations) can be included in compensation ratio calculations (Minns 2006) by increasing required compensation amounts, it may be difficult for northern project proponents to find feasible opportunities for compensation that have historically been demonstrated as cost-effective and successful. Thus plans which optimize the required ratio will likely have a greater chance at achieving NNL. An even greater consideration in this situation may be that compensation options in the north typically involve further alterations of pristine habitat, which arguably are not desirable.

Since no reference models are available for most northern species, and no standardized NNLP approach is available, proponents have developed slightly different HEP methods and new Habitat Suitability Indices for their projects. Usually, HSI values are determined by professional judgement, and/or modifications from previously developed NNLPs at other northern mines. Aside from the loss of efficiency and the extreme variability of results inherent in this exercise, this approach means that compensation units are not directly comparable between sites, impeding the creation of area habitat management plans which may become increasingly important as development in the north progresses.

In the interest of advancing general understanding of HEP methodology and the advantages and disadvantages of different approaches, AEM has conducted a comparison of HU results based on two methods. One was used historically at AEM's Meadowbank site while under the ownership of Cumberland Resources, while the other is proposed for use at AEM's Meliadine site in the near future.

In this document, we use the Meadowbank Mine Dogleg Pond Connection project to compare these two HEP methodologies: the Cumberland (2005) Meadowbank Gold Project No Net Loss Plan methodology ("Cumberland method") and the recently developed AEM/Golder (2012) Meliadine Gold Project methodology ("AEM/Golder method"). The text, figures and data presented in this document are in draft form and therefore have not been finalized nor thoroughly peer reviewed. The calculations in this document are made simply for the comparison of habitat unit calculations methods and are not final habitat values for this compensation project, and are presented for the purposes of assisting DFO in their upcoming workshop only.

Dogleg Pond Connection Concept (See Figure 1 and 2)

North of Second Portage Lake is a series of isolated ponds termed the "North Portage Ponds". The proposed project examines three of these ponds, named Dogleg Pond (or NP1, the largest), Dogleg North Pond, and NP2 (See Figure 1 and 2). In 2003, detailed water chemistry, fish population, benthic and zooplankton surveys were conducted to evaluate the North Portage ponds (NP) . NP1 (Dogleg Pond) and NP2 were found to have similar water chemistry, sediment chemistry and limnology as the project lakes. Zooplankton community abundance differed considerably among the ponds and differed

from the project lakes with no apparent patterns. Benthic species composition was similar among ponds and the project lakes. Only lake trout were found in NP1 and NP2, evidence of a relic population limited by overwintering and the ponds' historical isolation from Second Portage Lake. It was suspected that Dogleg North Pond did not contain fish, as it was too shallow.

In 2009, AEM biologist and technicians completed a follow-up bathymetric survey and habitat classification (including underwater video) in NP2, Dogleg Pond (NP1) and Dogleg North Pond (NP1-N). Additionally, 12.5, 25 and 38 mm gill nets were set for over 24 hrs in NP2 and Dogleg North Pond to collect both small bodied fish and large bodied fish. Lake trout were collected in NP2 and no fish were collected in Dogleg North Pond confirming the findings of 2003.

On January 19th 2012, DFO approved AEMs efforts to complete an updated Mine Site No Net Loss plan which will reflect changes of the mine site infrastructure (including pit dimensions and basin habitat features) and include updated habitat compensation concepts such as the Dogleg Pond connection. In concept, NP2, a pond located north of the waste rock pile, will be connected via a diversion ditch to Dogleg North pond to assist with non-contact water management at the mine site. Presently, Dogleg North Pond is isolated and freezes to the bottom and therefore is not inhabited by fish. As a result of connection to NP2, the water level in Dogleg North Pond is expected to increase by approximately 0.5 to 1 m and ultimately provide additional shoreline habitat and overwintering habitat similar to the reference pond (which has a small isolated lake trout and arctic char population; see Figure 2 for location). NP1-N would then drain into Dogleg Pond, eventually increasing water levels and creating additional shoreline habitat. Ultimately, NP2, NP1-N and NP1 will be connected and fish will have access to habitats in all ponds throughout the open water season. AEM proposes to transfer a small number of fish to this system during the Vault Pit fish transfer and closely monitor the success and habitat preferences of the introduced population. Monitoring data will assist in the validation of productive capacity models and HEP modelling at Meadowbank and Meliadine Projects.

Methods used for Calculating Habitat Units of Dogleg Pond Connection Comparison

Summary of Cumberland (2005) Method

The Cumberland (2005) HEP method involved the classification of the entire project lakes area by six attributes containing up to four classes as follows:

- Morphology (classes = apron, shoal, platform, sediment basin)
- Substrate (classes = boulder, boulder /cobble, boulder/cobble/fines, >90% fines).
- Depth (classes = 0-2m, 2-4m, 4-6m, >6m)
- Complexity (classes = uniform, moderate, complex)
- Ice-scour (classes = ice scoured (<2m) or not)

- Slope (classes = flat slope, steep slope)

The spatial extent of each attribute class was delineated and mapped. This resulted in a total of 627 spatially distinct polygons with different combinations of attribute classes.

A rank of the habitat structure or feature was calculated based on the cumulative contribution of morphology, substrate, depth, complexity, ice scour and slope for each polygon (See Cumberland 2005, Section 3.4). The structures were ranked and summed to derive a score that is a reflection of a generic habitat value in order to relate the physical attributes to fisheries resources. The polygons were grouped into 3 categories based on their score (high =18-22 points, medium/moderate=13-17 points and low value = <12 points). These groups were described as follows:

- High Value: High Value habitat polygons are characterized as complex, heterogeneous boulder or boulder/cobble substrate with few fines situated in moderate depth (2 to 5m) below the ice scour zone, but above the transition zone. These are typically situated near shoals or platforms or near sloped shorelines.

- Medium Value- Medium or Moderate value habitat polygons are typically found within two depth ranges: 0 to 2m and 4 to 6 or 8 meters. Moderate value polygons in shallow waters are characterized by large boulders and low complexity. Although they are not available throughout the open water season, these areas provide excellent rearing and foraging habitat. Moderate value polygons in deeper areas (>4m) are transition zones that provide good protection for all fish species, especially juveniles and is important for rearing and feeding.

- Low Value- Low value habitat polygons consist primarily of uniform fine substrate of low complexity in deep water (> 8m). The value of this habitat varies depending on species and has been ranked accordingly.

It should be noted that because of the scoring system used, it is theoretically possible for a polygon to possess an attribute that is different from the general group description, but to still fall into that category (e.g. a shallow, uniform boulder platform receives a score of 11, but is not well described by the “low value” group).

As is typical with all HEP methods, an HSI for project lake species for four life function stages (spawning, foraging, nursery and overwintering) was multiplied by the area of the habitat value and the HSI was weighted by species according to the species assemblages during baseline data collection; ultimately total habitat units lost and conceptual gains were determined by:

$HUTotal = \sum[HSI \text{x species assemblage from baseline data}] \text{ x area of habitat value})$

Refer to Cumberland (2005) for complete description of the methodology.

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In 2009, the substrate and bathymetry of Dogleg Ponds were mapped using the Cumberland (2005) habitat groups. Boulder aprons of depth below 2 meters are likely candidate spawning areas for lake trout and are thus considered high value habitat (See Figure 3). The remainder of the shoreline is classified as boulder platforms (moderate value) and sediment basins (low value). Dogleg Pond North and NP2 area were also mapped according to the Cumberland (2005) habitat groups (see Figure 4).

Applying AEM and Golder (2012) Meliadine Method to Dogleg Pond

The methodology for calculating habitat units for the Meliadine Gold Project, located in Rankin Inlet, Nunavut was developed by AEM and Golder in 2011, and later presented to DFO at a workshop on November 17 and 18, 2011. The DFO has recently accepted the method presented and AEM will use this to finalize the No Net Loss plan for the Meliadine Gold Project (AEM/Golder, 2011).

In brief, the physical classification of habitat is separated into 3 depth intervals with 3 substrate categories for a total of 9 unique habitat classification identifiers. See Table 1 for identification of the substrate categories.

Table 1: AEM/Golder (2011) habitat classifications

Classification ID	Depth (m)	Substrate Type
1	<2	Fines
2	<2	Mixed
3	<2	Boulder/ Cobble
4	2-4	Fines
5	2-4	Mixed
6	2-4	Boulder/ Cobble
7	>4	Fines
8	>4	Mixed
9	>4	Boulder/ Cobble

As is typical with all HEP methods, an HSI was developed for project lake species for 4 life functional stages (spawning, foraging, nursery and overwintering) and the HSI was weighted by species according to the species abundance during baseline data collection. Furthermore, as recommended by Minns (2010), a fisheries value was used to weight species according to importance for traditional, sport and commercial fisheries. Overall the equation to calculate the habitat units lost and conceptual gains is:

HUTotal = ∑[(HSI x species specific biomass from baseline data x fish value) x habitat area of 9 classification identifiers]

HEP Method Comparison

The Cumberland (2005) and AEM/Golder (2011) method comparison, investigates the physical classification of habitat and does not include the specific species biomass/assemblage or fishery value weightings. For consistency, high, medium and low habitat values were assigned to the AEM/Golder (2011) substrate classification based on professional judgement to compare HU totals to those derived from the Cumberland (2005) method (see Table 2). To briefly introduce the application of the AEM/Golder (2011) physical classification to the Dogleg Pond connection, lake trout HIS are multiplied and presented in Figures 5-9, but these data are not quantitatively compared. In the future, other quantitative comparisons may be used that could include weightings for multispecies HSIs, however given the time constraints and need for GIS mapping, the generalized valuation approach provides a simple means of comparison between the two methods.

Table 2: Habitat Type Classification and Generalized Valuation

Classification ID	Depth (m)	Substrate Type Cumberland (2005)	AEM/Golder (2011) ID	Generalized Valuation for comparison to MBK (Low, Med. or High)
1	<2	Fines	Fines	Low
2	<2	Mixed	Mixed	Med
3	<2	Boulder/ Cobble	Course	Med
4	2-4	Fines	Fines	Low
5	2-4	Mixed	Mixed	Med
6	2-4	Boulder/ Cobble	Course	High
7	>4	Fines	Fines	Low
8	>4	Mixed	Mixed	High
9	>4	Boulder/ Cobble	Course	High

Results and Discussion

Table 3 presents the results of the habitat valuation for the Dogleg Ponds using the AEM/Golder 2011 method with a generalized valuation. Table 4 compares the final values in hectares by habitat type (high, medium and low value habitat). Figures 3 to 11 present the maps for comparison of the methods. More specifically, Figures 3 and 4 illustrate the habitat mapping results using Cumberland (2005) method and Figures 10

and 11 summarizes the AEM/Golder (2011) classifications, adapted with the generalized valuation.

Despite the methodological faults and over-simplification for comparison (by using the generalized valuation), the data presented in this case study indicates that medium value habitat is similarly estimated between the two methods, but that high and low value habitats differ between methods. The AEM/Golder 2011 method resulted in up to 3x ~~less~~ more high value habitat compared to the Cumberland 2005 method, and up to 2x ~~more~~ less low value habitat.

Although the HSIs have not been validated for either method, the Cumberland (2005) HU estimate for the northwest arm of Second Portage Lake was field-verified after de-watering of that basin. Field crews re-mapped the basin according to the habitat attributes originally established, and re-calculated the baseline HU estimate. Results of that study conducted by Azimuth Consulting Group in 2009 on behalf of AEM indicated an over-estimate of HUs by approximately 15%, largely due to over-estimates of high value habitat area.

Table 3: Dogleg Ponds Area by Classification ID (substrate, depth and generalized valuation)

				Area (ha)		
Classification ID	**Depth (m)**	**Substrate Type**	**Generalized Valuation**	**Dogleg Pond (NP1)**	**Dogleg Pond North (NP1N)**	**NP2**
1	<2	Fines	Low	0.07	0.19	0.01
2	<2	Mixed	Moderate	1.56	0.23	0.46
3	<2	Boulder/ Cobble	Moderate	11.32	2.31	5.28
4	2-6	Fines	Low	2.06	0.22	1.06
5	2-6	Mixed	High	2.30	0.24	1.38
6	2-6	Boulder/ Cobble	High	1.83	0.21	1.04
7	>6	Fines	Low	1.59		0.01
8	>6	Mixed	High	1.90		0.19
9	>6	Boulder/ Cobble	Moderate	0.22		0.00

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Table 4: Cumberland (2005) and AEM/Golder (2011) comparison of the High, Medium and Low Habitat Type Area (in ha) quantification

Pond ID	Area (ha)	Cumberland (2005) Habitat Type (Area in ha)			AEM/ Golder (2011) Habitat Type (Area in ha)		
		High	Med	Low	High	Med	Low
Dog leg Pond - NP1	22.85	2.75	13.54	6.56	6.03	13.10	3.72
Dog leg North Pond- NP1N	3.40	0.31	2.17	0.92	0.45	2.54	0.41
NP2	9.42	0.78	6.31	2.33	2.61	5.74	1.07

Although these maps were not quantified or thoroughly evaluated in this report, Figures 5 to 9 were produced as discussed during a conference call with DFO on December 13th, 2011. These figures use the lake trout HSIs from AEM/Golder (2011) to identify areas associated with specific habitat values (as estimated by professional judgement used to create the HSI model) for different life history/functional stages (Figure 5 to 8). Ultimately a map with the overall weighted life history habitat values for lake trout is provided with a colour coded scale (Figure 9). If this method is applied in the future, this type of mapping and scaling could be used to produce habitat value type areas in hectares using site specific ranges (for depth and substrate) with field-verified habitat suitability weightings. Although it has not been validated in the field for species use or productive capacity, this method is a transparent and robust method of quantifying habitat using modern GIS tools in non-complex northern aquatic systems.

Although the Cumberland (2005) methods provided detailed description of habitat from numerous polygons, the method is subjective and requires interpretation due to descriptive classifications such as morphology, ice scour and complexity which is later distilled into 3 habitat classifications. In our opinion, despite very good habitat description initially, the eventual grouping into only three categories, and the problems with scoring as previous discussed make this method inconsistent and non-transparent.

Further problems arise when re-weighting for site-specific limitations is required. Given that the Dogleg Ponds are small, overwintering habitat is undoubtedly the limiting factor for fish survival. In the 2005 method, overwintering areas are considered low value, which is representative of the larger project lakes such as Second Portage and Third Portage Lake (where overwintering habitat is nearly unlimited). In contrast the AEM/Golder (2011) model is adaptable to all lake sizes, and re-weighting for site-specific limitations is intuitive (whereas in the Cumberland 2005 method, “high value” habitat is not in fact good for overwintering). See Figure 9 - pockets >8 m are scored 0.25-0.75. These differences are primarily based on the fact that AEM/Golder (2011) method is less subjective and does not arbitrarily group habitat types, rather uses transparent and reproducible quantification of habitat features and multiplies the information directly from the physical data to the habitat suitability indices. Furthemore, it

is our opinion that the AEM/Golder (2011) method is superior because it incorporates species weightings based on both abundance and fisheries valuation.

AEM has requested the use of a common method for calculating habitat units at its projects in the north. With DFO acceptance and additional research funding (which AEM is interested to contribute to), it is our goal to pursue the development of a database of fisheries monitoring studies that will facilitate the eventual validation of HSI values through better understanding of fish habitat preferences in the north. Consistency in HEP methods will not only assist in expediting the NNL planning process, but will increase the utility of cross-site comparisons. A requirement of all DFO authorizations is that the proponent is to demonstrate the success of compensation projects. Currently only the physical construction must be shown successful, because presently habitat units are physical features. Measures of productivity are, however, necessary to determine whether NNL has actually occurred. A larger database of data from northern lakes would allow us to compare our success and failures consistently between projects and will ultimately assist in decision criteria for determining success of compensation projects *a priori*.

AEM feels the AEM/Golder (2011) HEP method is transferable between projects and could be used throughout the eastern arctic and possibly throughout the north with more field validation. Given that eastern arctic lakes rarely stratify and substrates types are simple and homogenous (i.e. there are few or no vegetation with little or no gravel at Meadowbank and Meliadine project lakes), substrate types across the north can be very easily subdivided into three categories: fines, mixed, and boulder/cobble. Subdivision by depth could be site specific (not limited to 0-2, 2-4, >4m); however in all cases, a depth range in the north requires a partitioning of ice cover along the shores which is between water level and maximum ice depth (approximately 2m).

Although the data presented has not been field validated, the Dogleg Pond connection case study comparison demonstrates that the methods of AEM/Golder (2011) are robust, transferable, ecologically relevant and less subjective than Cumberland (2005). In using a similar method across projects in the north, AEM can design monitoring studies and fish removal studies to validate our HEP methods and possibly relate it to productive capacity modelling through monitoring of introduced populations at the Dogleg Pond connection project.

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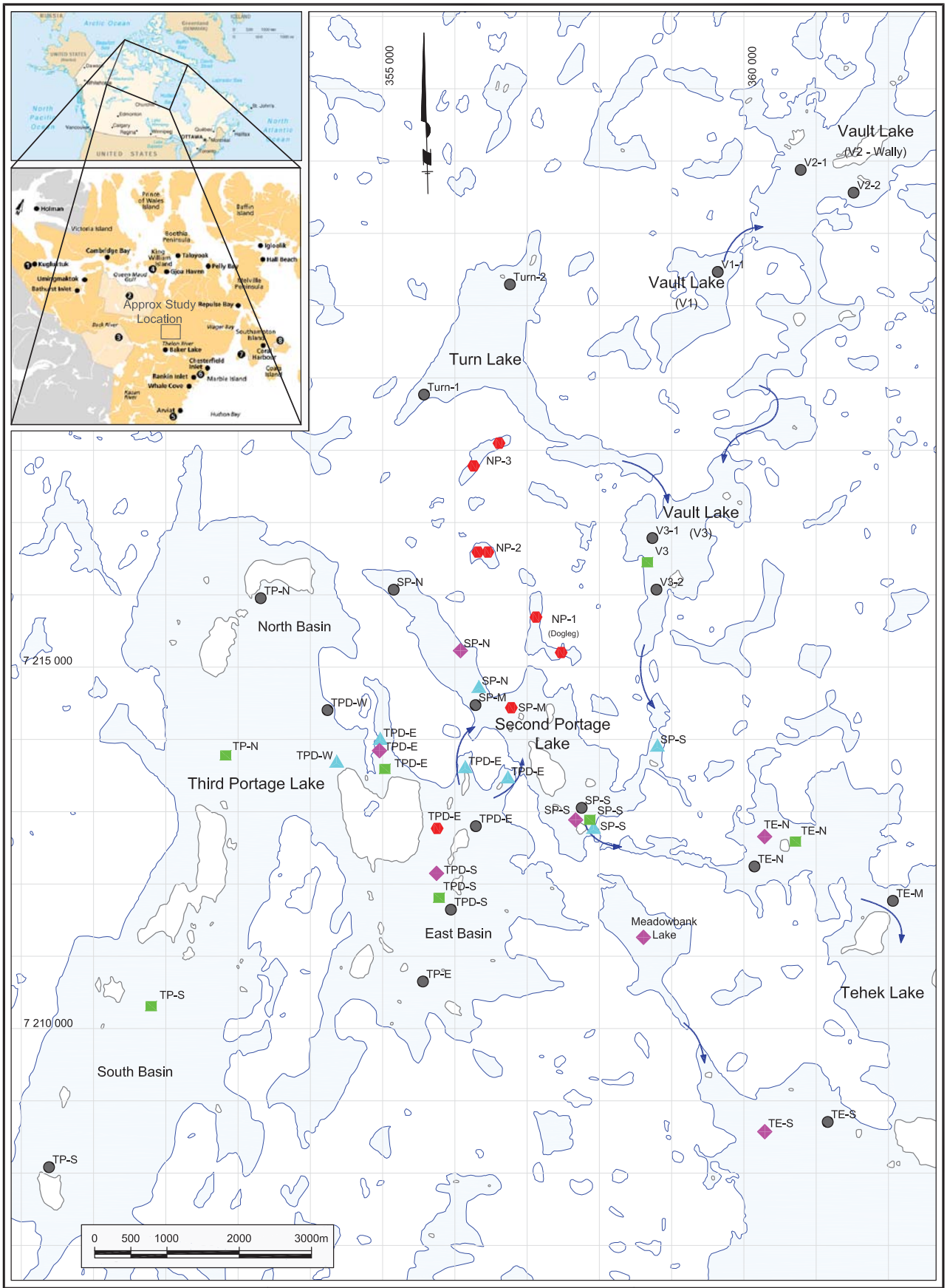

Legend

- Flow Direction
- 2003 Sampling Station
- 2002 Sampling Station
- 1998 Sampling Station
- 1997 Sampling Station
- 1996 Sampling Station

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

PROJECT: Meadowbank Baseline Study

TITLE:
Historic (1996 - 2003) Sampling Stations
Meadowbank Project Area Lakes
(Water and Sediment Chemistry; Lower Trophic Level Biota)

DRAWN BY:	CHK. BY:	PROJECT No:	CLIENT:
BT	RB	CBD-03-01	Cumberland Resources

SCALE:	DATE:	
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FORMAT ANSI B–PORTRAIT

DOG LEG NORTH POND

DOG LEG POND

REFERENCE POND

SOUTH CAMP POND

REV	DESCRIPTION	DATE	BY

REVISIONS

AGNICO-EAGLE

DRAWN BY	P. DAUDELIN
DATE	13/09/2010
CHECKED BY	
APPROVED BY	
PROJECT NO.	
DATE	

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TITLE
AGNICO–EAGLE – MEADOWBANK DIVISION

AIRSTRIP HABITAT COMPENSATION OPTION 1 - DOG LEG NORTH POND

FIGURE 1

SCALE	FILE
N.T.S.	.DWG

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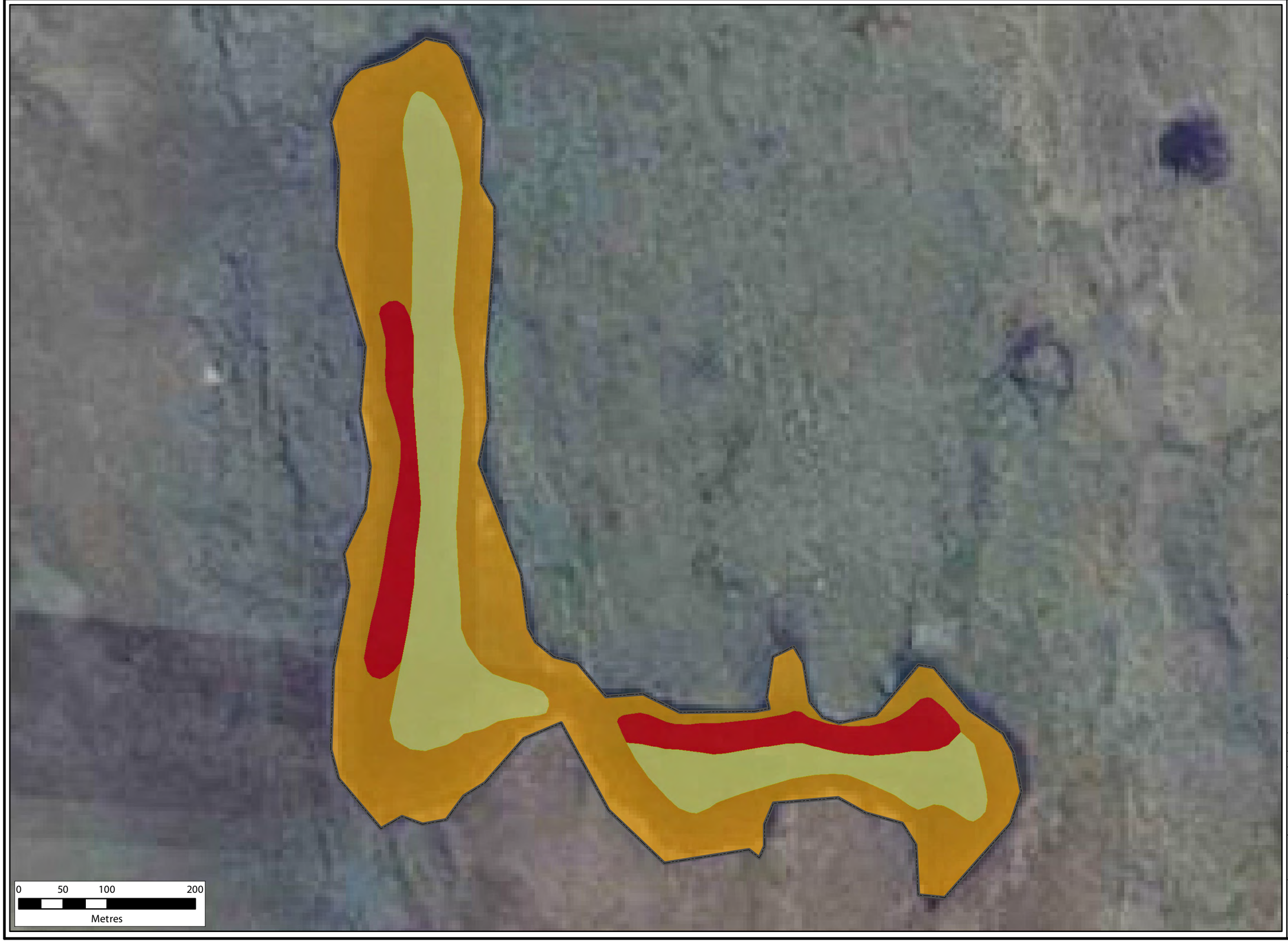

Legend

- Lake Boundary

Habitat Evaluation

- Low
- Medium
- High

2005 Habitat Evaluation
Dogleg Lake

DOUGAN & ASSOCIATES
ECOLOGICAL CONSULTING & DESIGN
77 Wyndham Street South • Guelph ON N1E 5R3
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PROJECT: DA11-062-01

CLIENT: Agnico-Eagle Mines Ltd., Meadowbank Div.

N
W E
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UTM Zone 17 NAD83

DATE: DECEMBER 2011

SCALE: 1:4,000

DRAWN BY: LW

CHECKED BY:

FIGURE:

3

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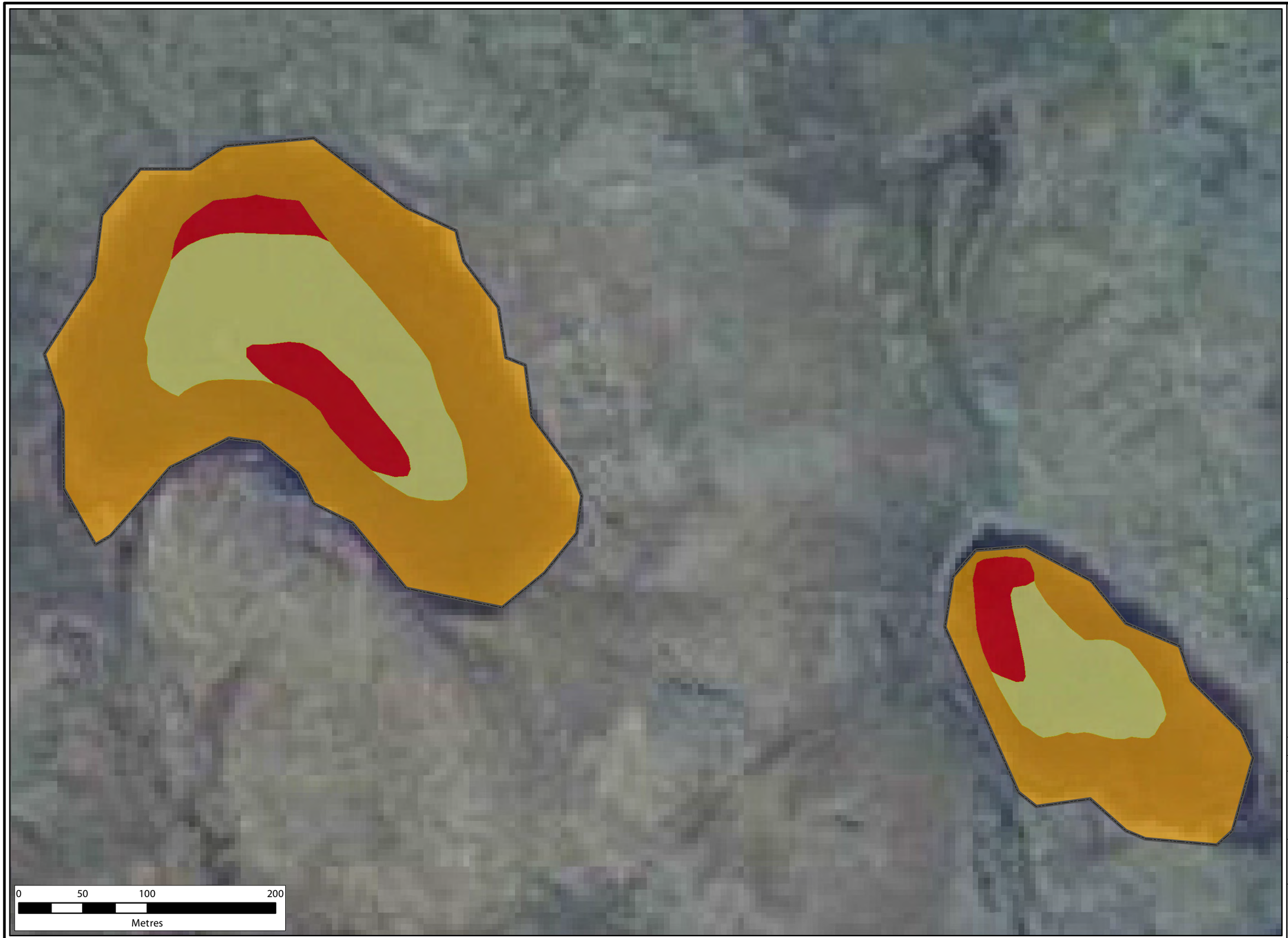

Legend

Lake Boundary

Habitat Evaluation

Low

Medium

High

2005 Habitat Evaluation
Dogleg North Lake

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PROJECT: DA11-062-01

CLIENT: Agnico-Eagle Mines Ltd., Meadowbank Div.

N
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S
UTM Zone 17 NAD83

DATE: DECEMBER 2011

SCALE: 1:2,750

DRAWN BY: LW

CHECKED BY:

FIGURE:

4

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Habitat type		Depth	Substrate	Lake Trout			
				SP	NU	FO	OW
Lakes / Ponds	1	<2 m	Fines	0	0.25	0.25	0
	2	<2 m	Mixed	0	0.5	0.5	0
	3	<2 m	Coarse	0	1	0.75	0
	4	2-6 m	Fines	0	0.5	0.5	0.75
	5	2-6 m	Mixed	0.5	0.75	0.75	0.75
	6	2-6 m	Coarse	1	1	1	0.75
	7	>6 m	Fines	0	0.25	0.5	1
	8	>6 m	Mixed	0.5	0.5	0.75	1
	9	>6 m	Coarse	1	0.5	1	1

0 100 200 400

Metres

Legend

Lake Boundary

Lake Trout Life History

0

0.25

0.5

0.75

1

Lake Trout Life History - Spawning -

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CLIENT: Agnico-Eagle Mines Ltd., Meadowbank Div.

N W E S

UTM Zone 17 NAD83

DATE: DECEMBER 2011

SCALE: 1:6,500

DRAWN BY: LW

CHECKED BY:

FIGURE:

5

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Habitat type		Depth	Substrate	Lake Trout			
				SP	NU	FO	OW
Lakes / Ponds	1	<2 m	Fines	0	0.25	0.25	0
	2	<2 m	Mixed	0	0.5	0.5	0
	3	<2 m	Coarse	0	1	0.75	0
	4	2-6 m	Fines	0	0.5	0.5	0.75
	5	2-6 m	Mixed	0.5	0.75	0.75	0.75
	6	2-6 m	Coarse	1	1	1	0.75
	7	>6 m	Fines	0	0.25	0.5	1
	8	>6 m	Mixed	0.5	0.5	0.75	1
	9	>6 m	Coarse	1	0.5	1	1

0 100 200 400

Metres

Legend

Lake Boundary

Lake Trout Life History

- 0
- 0.25
- 0.5
- 0.75
- 1

Lake Trout Life History
- Nursing -

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N W E S

UTM Zone 17 NAD83

DATE: DECEMBER 2011

SCALE: 1:6,500

DRAWN BY: LW

CHECKED BY:

FIGURE:

6

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Habitat type		Depth	Substrate	Lake Trout			
				SP	NU	FO	OW
Lakes / Ponds	1	<2 m	Fines	0	0.25	0.25	0
	2	<2 m	Mixed	0	0.5	0.5	0
	3	<2 m	Coarse	0	1	0.75	0
	4	2-6 m	Fines	0	0.5	0.5	0.75
	5	2-6 m	Mixed	0.5	0.75	0.75	0.75
	6	2-6 m	Coarse	1	1	1	0.75
	7	>6 m	Fines	0	0.25	0.5	1
	8	>6 m	Mixed	0.5	0.5	0.75	1
	9	>6 m	Coarse	1	0.5	1	1

0 100 200 400

Metres

Legend

Lake Boundary

Lake Trout Life History

0

0.25

0.5

0.75

1

Lake Trout Life History
- Foraging -

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N W E S

UTM Zone 17 NAD83

DATE: DECEMBER 2011

SCALE: 1:6,500

DRAWN BY: LW

CHECKED BY:

FIGURE:

7

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Habitat type		Depth	Substrate	Lake Trout			
				SP	NU	FO	OW
Lakes / Ponds	1	<2 m	Fines	0	0.25	0.25	0
	2	<2 m	Mixed	0	0.5	0.5	0
	3	<2 m	Coarse	0	1	0.75	0
	4	2-6 m	Fines	0	0.5	0.5	0.75
	5	2-6 m	Mixed	0.5	0.75	0.75	0.75
	6	2-6 m	Coarse	1	1	1	0.75
	7	>6 m	Fines	0	0.25	0.5	1
	8	>6 m	Mixed	0.5	0.5	0.75	1
	9	>6 m	Coarse	1	0.5	1	1

0 100 200 400

Metres

Legend

Lake Boundary

Lake Trout Life History

- 0
- 0.25
- 0.5
- 0.75
- 1

Lake Trout Life History - Overwintering -

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PROJECT: DA11-062-01

CLIENT: Agnico-Eagle Mines Ltd., Meadowbank Div.

N W E S

UTM Zone 17 NAD83

DATE: DECEMBER 2011

SCALE: 1:6,500

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FIGURE:

8

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Habitat type		Depth	Substrate	Lake Trout			
				SP	NU	FO	OW
Lakes / Ponds	1	<2 m	Fines	0	0.25	0.25	0
	2	<2 m	Mixed	0	0.5	0.5	0
	3	<2 m	Coarse	0	1	0.75	0
	4	2-6 m	Fines	0	0.5	0.5	0.75
	5	2-6 m	Mixed	0.5	0.75	0.75	0.75
	6	2-6 m	Coarse	1	1	1	0.75
	7	>6 m	Fines	0	0.25	0.5	1
	8	>6 m	Mixed	0.5	0.5	0.75	1
	9	>6 m	Coarse	1	0.5	1	1

0 100 200 400

Metres

Legend

Lake Boundary

Lake Trout Life History

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00

Note: This is the product of mapping the the multiplication of the overall lake trout weightings; a quantitive method that can be applied using the AEM/ Golder (2012) method. It is a more robust version of mapping low (0) to high (1) value habitat. It provides a better indication of what habitat is of greatest value for lake trout in this example but could be done for multiple species as well.

- Total Overview -

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N W E S

UTM Zone 17 NAD83

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FIGURE:

9

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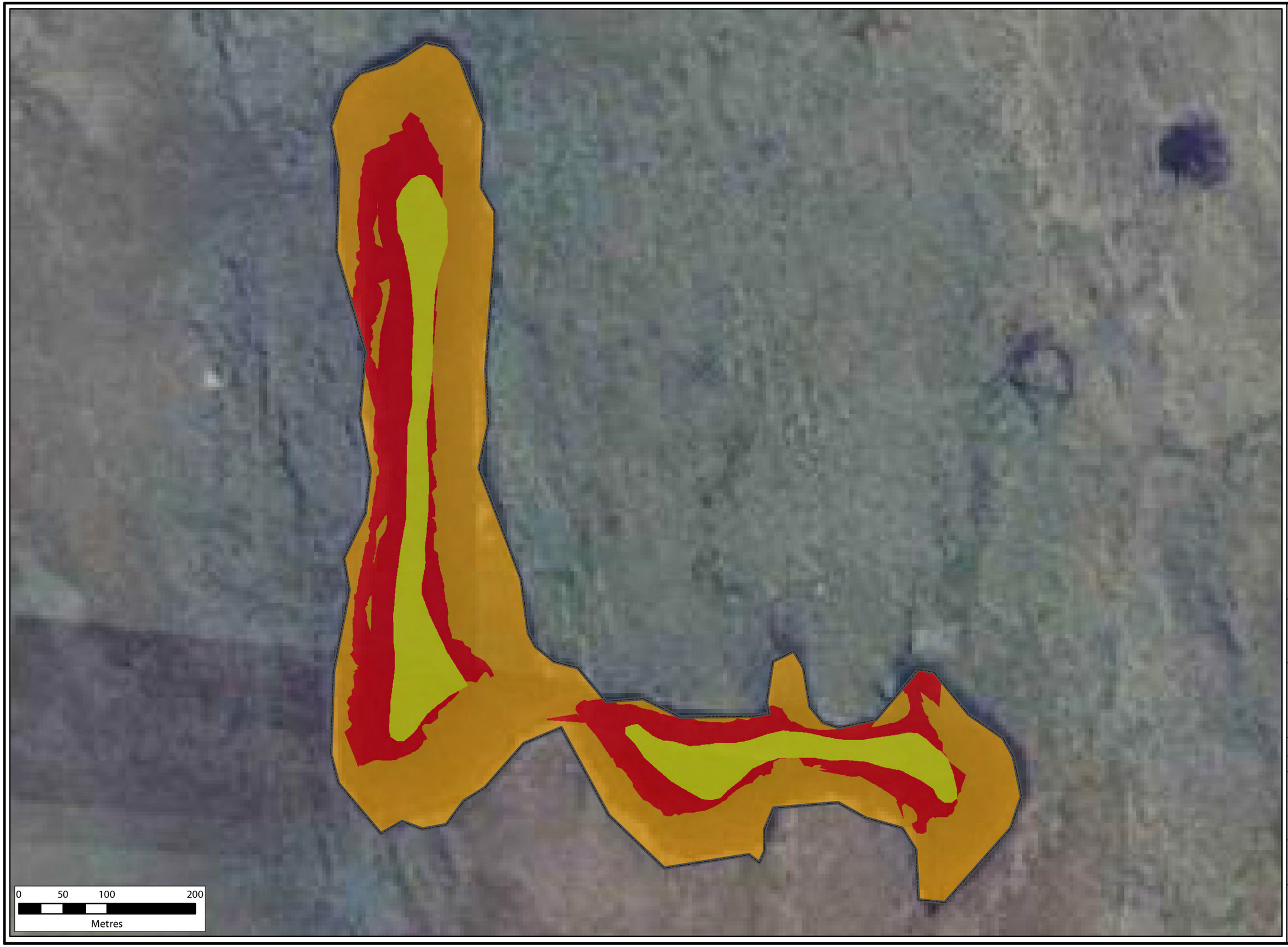

Legend

- Lake Boundary

Habitat Evaluation

- Low
- Medium
- High

2011 Habitat Evaluation
Dogleg Lake

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PROJECT: DA11-062-01

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UTM Zone 17 NAD83

DATE: DECEMBER 2011

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DRAWN BY: LW

CHECKED BY:

FIGURE:

10

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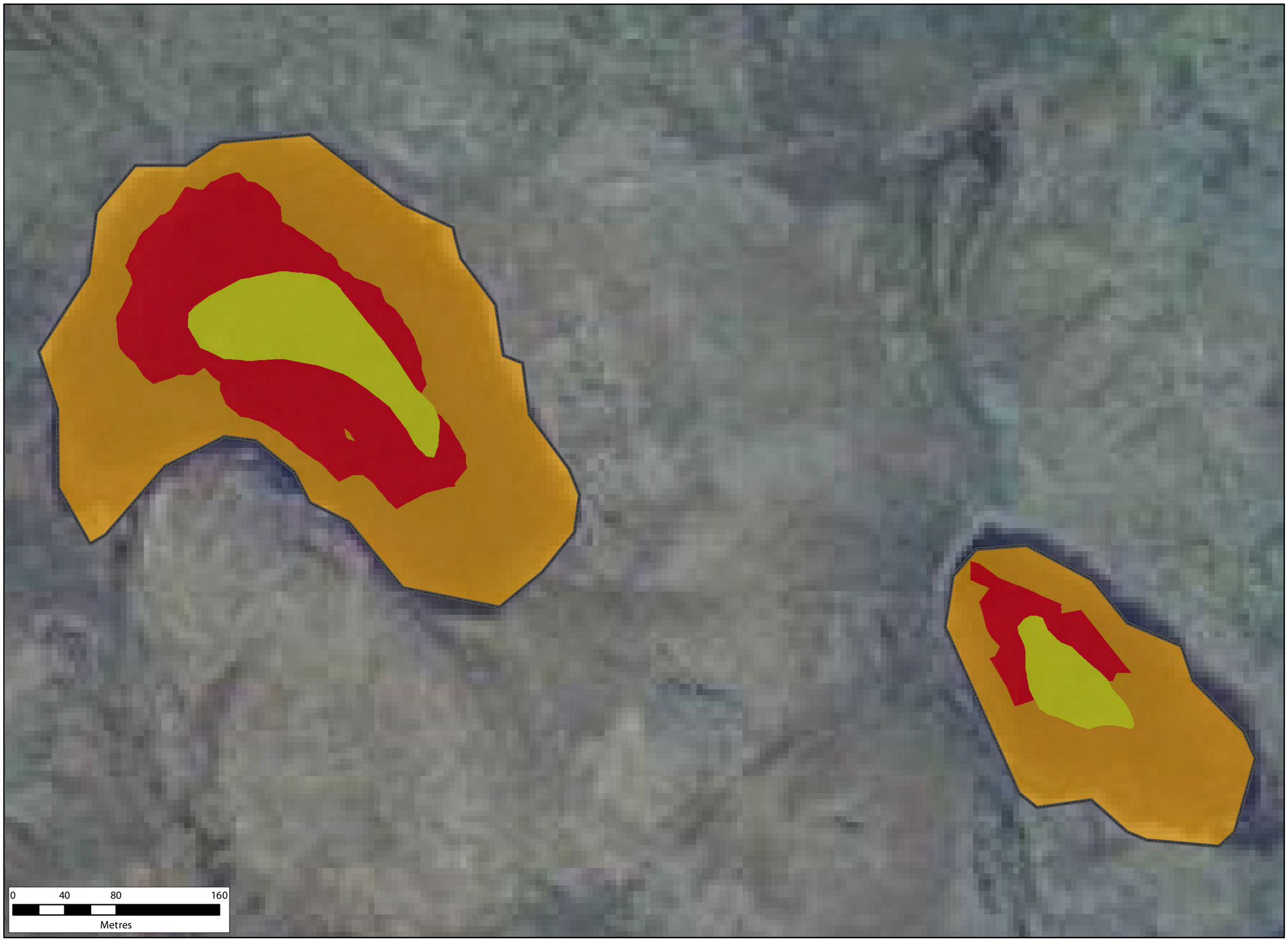

Legend

Lake Boundary

Habitat Evaluation

Low

Medium

High

2011 Habitat Evaluation
Dogleg North Lake

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PROJECT: DA11-062-01

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UTM Zone 17 NAD83

DATE: DECEMBER 2011

SCALE: 1:2,750

DRAWN BY: LW

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FIGURE:

11

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Date: February 15, 2012

To: Derrick Moggy
Department of Fisheries and Oceans
Eastern Arctic Area

CC: Bobby Beddingfield (DFO), Bev Ross (DFO), Julie Dahl (DFO), Stephane Robert (Meadowbank Environment- Superintendant), Leilan Baxter (Research Assistant) and Dr. Paul Sibley (Professor, U of G)

Throughout the development of the Meliadine Gold Project No Net Loss Plan and Meadowbank Mine Site Updated No Net Loss Plan, AEM has endeavoured to improve habitat evaluation procedures in the North. In preparation for the exploratory meeting with DFO Science on February 17th, the following letter outlines the preliminary steps taken by AEM towards establishing validated HSIs and a consistent, transparent HEP methodology. This letter presents potential research ideas that we feel will assist with this effort and could be pursued in collaboration with AEM, DFO Science and the University of Guelph researchers.

Habitat Evaluation Procedure and Habitat Suitability Index development

In 2011, AEM began working with Golder to refine an HEP method at the Meliadine Gold Project, using 9 combinations of simple habitat characteristics (depth and substrate). AEM and Golder have completed or will complete the following steps towards method development of a No Net Loss Plan at Meliadine Gold Project.

- A brief Meadowbank Dogleg Pond case study comparing 2005 Cumberland HEP methods versus 2011 AEM/Golder HEP method. These analyses found a similarity in evaluating *moderate* value habitat (i.e. year-round foraging) but differences in *high value* (i.e. nursery and spawning habitat) and *low value* habitat. These comparisons confirmed the transferability and precision of the 2011 AEM/Golder model to identify habitat types that the 2005 model does not allow. Furthermore, these models identified the need for field validation of HEP methods.
- Use of the HEP model and Habitat Suitability Indices for the submission of the Meliadine Project No Net Loss Plan by applying it to conceptual end pit lakes.
- Development of a risk characterization approach at Meliadine that uses a *GIS-based regional scale of negative effects* analysis to assist in the evaluate of impacts to ponds that freeze or nearly freeze to depth for 8 months of the year.

Gains in stream productivity vs. gains in lake productivity

Currently, we have no means to account for differences in stream and lake productivity in No Net Loss planning. This means that one HU gained in a stream is equal to one HU gained in a

lake. However, from personal experience we believe that actual gains in productivity from compensation efforts are higher in artic streams than in lakes. AEM has begun a comparison of productivity gains per HU in streams and lakes, using field data from the Meadowbank site (instream monitoring program and lake fishout data). To date we have:

- Conducted a preliminary comparison of Second Portage Lake (2008 fishout data), which examined immature fish per HU in the lake and changes in number of recruits after construction of the R02 Habitat Compensation feature (constructed spawning habitat). In this comparison, one stream HU was found to be associated with approximately 40x more immature fish than one lake HU.

Alternative Compensation Ideas and Fish Production Models

Although DFO advocates like-for-like compensation, opportunities may arise where tangible benefits to local communities could be achieved through offsite compensation options. In the experience of AEM, these benefits may not be well accounted for with HEP methods, and alternate models may need to be considered.

For example, in the past, Airplane Lake near the hamlet of Baker Lake was frequently accessed for recreational fishing but is now considered by many locals as unable *to produce healthy fish, safe for human consumption*, due to outflow from the hamlet's sewage lagoon. Based on preliminary water quality analysis, total phosphorus levels are elevated in this system. AEM believes an investigation into methods for improved sewage treatment, and the ultimate restoration of water quality in Airplane Lake (which flows directly into Baker Lake) could be a valuable compensation option. However, gains in fish habitat through improved water quality do not factor into any known HEP methods.

To address this issue, we have attempted to model fish production in Airplane lake using 2008 and 2010 Meadowbank Fishout data by applying fish production models from Downing et al. (1990). They found that fish production (FP; kg/ha·yr) in lakes worldwide is significantly correlated with average annual primary production (PP; gC/m2·yr), average annual total phosphorus concentration (TP; mg/L) and standing fish biomass (FB; kg/ha) using the following models:

logFP = 0.600 + 0.575logPP (n=19; r2 = 0.79)
logFP = -0.42 + 1.084logFB (n=23; r2 = 0.67)
logFP = 0.332 + 0.532logTP (n=14; r2 = 0.67):

- AEM has requested fishout data from other northern mines to validate these models together with the Meadowbank fishout data.
- These models were also applied to Airplane Lake to estimate fish production in a nutrient enriched arctic system.

- Future compensation monitoring will incorporate data collection that will aim to validate these models (i.e. Dogleg Pond compensation area).

These models may support the use of *alternative* habitat compensation such as restoration that diverges from commonly accepted DFO approach of constructing fish habitat structures.

Specific Research Ideas: AEM, U of G and DFO Science Collaboration

Dr. Paul Sibley at the University of Guelph, and graduated MSc student, Leilan Baxter, are interested in working with AEM and DFO to develop a research program based on the issues described above. The research directions discussed to date have been aimed at developing and testing habitat suitability indices for northern fish species. Further, many HSI models are not validated with experimental manipulations. Compensation programs at Meadowbank could provide the opportunity to research fish habitat requirements (as opposed to preferences) in the north. This program would assist in determining what types of compensation may truly be effective in achieving no-net-loss of productive capacity. Research questions may specifically include the following stages.

Stage 1: Development of HSI models (observational phase)

- determination of potentially suitable indices
    - (e.g. max depth, lake volume, temperature, TP, substrate, invertebrate and fish community composition) from literature review, professional interview
- observation of fish habitat preferences
    - measurement of chosen indices along with total fish biomass and/or health index
    - could include Meadowbank and/or Meliadine; lacustrine and/or riverine
    - much information already available from fishout data, but smaller systems need to be incorporated
        - could include refining CPUE model based on fishout datasets in order to obtain better estimates of population size (or apply another method e.g. capture-recapture)
        - could be for stream (use AWAR data), lake (use historical site data plus Vault, Phaser, data from other mines' fishouts etc.) or both
        - could be for all major species (lake trout, arctic char, lake whitefish, arctic grayling) or one initially
- calculation of HSI equations from observational data

Stage 2: Testing of compensation features (experimental phase)

- observe fish biomass/health/production in response to changes in various identified habitat indices (e.g. increase/reduce substrate complexity)
- could be conducted for streams (R02) or lakes/ponds (Dogleg) or both

We look forward to our exploratory meeting to discuss the work to date and future research ideas. Should you require any further information or questions please contact me via email or by telephone.

Regards,

Ryan Vanengen
rvanengen@agnico-eagle.com
519-400-7979
Environment Biologist- Meadowbank Division

Leilan Baxter
leilan@uoguelph.ca
519-829-5322
Research Assistant

Ryan Vanengen

From: Bedingfield, Robert <Robert.Bedingfield@dfo-mpo.gc.ca>
Sent: March-30-12 3:09 PM
To: Ryan Vanengen; Stephane Robert
Cc: Moggy, Derrick
Subject: Meadowbank Authorization Amendment and NNLP Contingency Plan
Attachments: Regulations Amending the Metal Mining Effluent Regulations - Meadowbank Gold Mine gazette 2.pdf; AEM 2009 TIA and NNLP 2007 vs DFO Authorization.pdf

Hi Gentlemen,
This email is to summarize the agreed upon process to amend authorization NU-03-0191 and to fulfill Agnico-Eagle Mines Ltd (AEM) obligations of developing a NNLP contingency plan for the Meadowbank Mine. The purpose of this email is to ensure that both DFO and AEM are agreeable and clear on the process that will occur.

Amendment of Authorization
The authorization for the Meadowbank mine will be amended to correct the discrepancies that are associated with each habitat compensation feature described in Authorization NU-03-0191. The reason for these discrepancies is unclear but the Habitat units (HU) that are associated with each compensation measure in the Meadowbank 2006/2007 NNLP and the November 2009 Meadowbank revised NNLP do not match the quantity of HU's listed in the authorization (see attachment, *AEM 2009 TIA and NNLP 2007 vs DFO Authorization*). The discrepancies that appear in the current authorization for the mine will be adjusted however the expectation is that that ratio of Compensation HU's to HADD HU's that appears in the authorization will still be honored by Agnico-Eagle. The compensation to HADD ratio for the TIA is 718.0 HU's to 318.3 HU (**2.03 : 1 ratio**) . The compensation ratio for the Mine Site is 1252.00 to 741.8 (**1.68 : 1 ratio**) The authorization will be amended to reflect the type and quantity of compensation that will be presented in the 2012 revised NNLP for the Meadowbank Mine that is currently being prepared by AEM.

The new NNLP that will be developed by AEM will also contain a new HEP model that will be developed based on principles that are presented in the HEP model for the Meliadine Mine. The timelines associated with the development of the revised NNLP for the Meadowbank mine are as follows:

Submission of a draft NNLP by June 15, 2012
Submission of a final NNLP by October 1, 2012

The revised NNLP for the Meadowbank Mine will include a NNLP for the Vault Pit. The NNLP for the Meadowbank mine should be one all-encompassing document but should contain clearly labelled sections discussing compensation associated with the TIA, Meadowank Mine and the Vault Pit. The revised NNLP document should clearly outline which compensation measure is associated with which location (TIA, Mine or Vault).

Contingency NNLP
Condition 4.5 in authorization NU-03-0191 states that a contingency no net loss plan should be developed by AEM by July 30, 2009. For a variety of reasons this contingency plan has not been finalized to date. The understanding that has been agreed upon by AEM and DFO is that a new NNLP will be developed by AEM to address issues such as a reduced mine life and the discrepancies with the amount of HU's that are associated with each compensation measure listed in the current authorization.

TIA compensation modifications
Slight modifications to the compensation that is associated with the TIA may be allowable. The description of the compensation associated with TIA is outlined in the MMER listing regulations. Any changes that occur to TIA related compensation must still satisfy the description of the compensation in the MMER regulations (attached).

If I have left out any important details or there needs to be further clarification or discussion on any of these points please contact myself of Derrick Moggy to discuss in greater detail.

Bobby Bedingfield
Telephone/Téléphone *403* 292-8675
Facsimile/Télécopieur *403* 292-5173
E-mail/Courriel Robert.Bedingfield@dfo-mpo.gc.ca

Fish Habitat Biologist
Eastern Arctic Area
Central and Arctic Region
Fisheries and Oceans Canada
7646 8th Street NE
Calgary, Alberta T2E 8X4

Biologiste, Habitat du poisson
Region Arctique de L'est
Région du Centre et de l'Arctique
Pêches et Océans Canada
7646, 8e Rue N.-E.
Calgary (Alberta) T2E 8X4

Ryan Vanengen

From: Patreau, Elizabeth <Elizabeth.Patreau@dfo-mpo.gc.ca>
Sent: Wednesday, September 26, 2012 1:19 PM
To: Ryan Vanengen
Cc: leilan@uoguelph.ca; Johnson, Nicola; Moggy, Derrick
Subject: RE: Meadowbank Authorization Amendment and NNLP Contingency Plan

Hi Ryan,

No particular preference. If it is easiest for you to submit all together, that will work for me.

Regards,

Elizabeth Patreau
Senior Fish Habitat Biologist | Biologiste principal, Habitat du poisson
Telephone - Téléphone: *867 979-8019*
Email - Courriel: Elizabeth.Patreau@dfo-mpo.gc.ca

From: Ryan Vanengen [mailto:RVanengen@agnico-eagle.com]
Sent: September 26, 2012 12:21 PM
To: Patreau, Elizabeth
Cc: 'leilan@uoguelph.ca'; Johnson, Nicola; Moggy, Derrick
Subject: Re: Meadowbank Authorization Amendment and NNLP Contingency Plan

Hello elizabeth,
Thank you for your response. We planned to submit the literature reviews when we submit the final. Would you prefer to receive the literature review and tables in advance of the submission?
Ryan

From: Patreau, Elizabeth [mailto:Elizabeth.Patreau@dfo-mpo.gc.ca]
Sent: Wednesday, September 26, 2012 09:11 AM
To: Ryan Vanengen
Cc: Stephane Robert; Kevin Buck; leilan@uoguelph.ca <leilan@uoguelph.ca>; Johnson, Nicola <Nicola.Johnson@dfo-mpo.gc.ca>; Moggy, Derrick <Derrick.Moggy@dfo-mpo.gc.ca>
Subject: RE: Meadowbank Authorization Amendment and NNLP Contingency Plan

Ryan, In preparation for AEM's final NNLP submission to DFO, please see below response to each of AEM's bullets (your email below):

1. DFO will await the literature review information. Please provide to DFO asap in order for DFO to compile finalized comments.

2. DFO will await literature review. A conference call may be useful to discuss once all have opportunity to review literature comments.

3. DFO nothing further to add here.

4. DFO nothing further to add here at this time.

5. DFO will await summary table from AEM.

6. DFO has no issues with this extension and provides the following additional comment :

At our meeting in August, AEM informed DFO that an Amendment/Revised Authorization may be sought for the East Dyke, to expand existing water usage allotment and to extend the area of the waste rock pile - the current NNLP does not reflect these additions. Please ensure this is referenced should any impacts to fish and fish habitat be anticipated.

Should you have any questions or concerns please feel free to contact me.

Regards,

Elizabeth Patreau
Senior Fish Habitat Biologist | Biologiste principal, Habitat du poisson
Telephone - Téléphone: *867 979-8019*
Email - Courriel: Elizabeth.Patreau@dfo-mpo.gc.ca

From: Ryan Vanengen [mailto:RVanengen@agnico-eagle.com]
Sent: September 12, 2012 5:58 PM
To: Patreau, Elizabeth; Moggy, Derrick
Cc: Stephane Robert; Kevin Buck; leilan@uoguelph.ca; Johnson, Nicola
Subject: RE: Meadowbank Authorization Amendment and NNLP Contingency Plan

Hello Elizabeth and Derrick,

As discussed during the site visit, below each bullet are responses to DFOs Draft Meadowbank NNL plan comments. If you have any questions, contact me by email or cell.

As an update, we are on-track and have begun integrating additional GIS information and 2012 field data to submit the final Meadowbank NNL Plan on October 15th, 2012.

Thanks,

Ryan VanEngen, MSc.
Agnico-Eagle Mines Ltd. -Meadowbank Division
Environment Department
rvanengen@agnico-eagle.com
519.400.7979

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From: Bedingfield, Robert [mailto:Robert.Bedingfield@dfo-mpo.gc.ca]
Sent: Thursday, July 19, 2012 4:29 PM
To: Ryan Vanengen

Cc: Stephane Robert; Kevin Buck; leilan@uoguelph.ca; Moggy, Derrick; Patreau, Elizabeth
Subject: RE: Meadowbank Authorization Amendment and NNLP Contingency Plan

Hi Ryan,
I am sending out this email to follow up with our telephone conversation regarding DFO's review of the DRAFT Amended NNLP for the Meadowbank Mine. DFO's comments are summarized in point form below.

- The structure and layout of the Draft NNLP is appropriate and addressed the issue of the required contingency options as well as identified habitat losses and gains for each section of the mine.
- Pg 11 - The addition of the Habitat type 11 (HT11)raised some issues for the fish species such as burbot, slimy sculpin, ninespine stickleback and arctic grayling that are typically associated with the lake bottom substrate and structure for foraging (FO) and overwintering(OW). The HSI values for HT-11 were taken from HT-09 (>4m, course substrate) however HT-11 has no substrate associated with it. For this reason DFO would suggest that the HSI values for the above mentioned species be re-evaluated and decreased because no substrate is available for fish use in HT-11.

  Based on suggestions from DFO regarding Meadowbank's draft NNLP, AEM agrees that the proposed HT 11 HSIs for benthic-foraging species should be revised. While overwintering and foraging HT 11 HSIs for all species were proposed to be the same as HT 9 HSIs, it is recognized that deeper pit habitat may be less valuable than natural- mixed- deep-water habitat for benthic fish species. However, based on a review of the literature (mainly Richardson, 2001), several benthic species are found at significant depths, suggesting that pit habitat may provide some utility. AEM will complete a literature review, present the information in the final NNL plan, and revise the HT11 to reflect the findings discussed during the site visit.

- Pg 14 –DFO is agreeable to the use of the Access Factor in the HEP model however further work needs to be done to understand potential inter-species interactions and dynamics should new fish species be introduced into a lake.

  AEM agrees and will complete a literature review on this topic and present the findings in the final NNL plan. AEM will continue to discuss with the DFO the ecological implications of introducing new fish species into lakes prior to implementation.

- Pg 45- Again, DFO is agreeable to the incorporation of the habitat co-factor to incorporate water quality into the HEP calculation however further discussion between DFO and AEM is required to determine how this co-factor would be determined based on present and predicted water quality characteristics.

  AEM agrees and will continue to discuss the use of a habitat co-factor with DFO prior to implementation. Currently, the co-factor is not applied in the main NNL Plan, rather it's application is suggested in the contingency plan (i.e. remediation of airplane lake option). If the contingency plan is implemented, AEM will develop a detailed methodology and model in consultation with DFO prior to implementation.

- Pg46 – The construction of more arctic grayling spawning pads is a viable option in DFO's opinion based on the past success of the spawning pads associated with R02 bridge crossing. Further discussion between AEM and DFO is required to finalize details of how this compensation would be quantified should this contingency option be chosen to be implemented.

  AEM agrees and will discuss the valuation of additional spawning pads with DFO prior to implementation.

- DFO would request a summary Table to show all the losses and gains of HU's and show which compensation options would be associated with specific HADDs (losses). The summary table should summarize all the losses and gains associated with the main mine site, vault pit as well as tailings storage facility location.

AEM agrees and will complete a summary table as requested and discussed during the site visit.

The final draft of the amended NNLP is scheduled to be submitted to DFO for final review on or before October 1, 2012.

During the site visit DFO agreed with AEM's request for an extension to October 15th to allow AEM to integrate 2012 field data and additional GIS information into the final NNL Plan.

During the DFO site visit that is scheduled to occur August 13-15, the amended NNLP can be discussed in further detail or a conference call can be arranged at an earlier date should it be required.

I hope everyone is having a good summer.

Bobby Bedingfield
Fisheries and Oceans Canada
Telephone/ Téléphone 403-292-8675
Email/Courriel Robert.Bedingfield@dfo-mpo.gc.ca

From: Ryan Vanengen [mailto:RVanengen@agnico-eagle.com]
Sent: June 18, 2012 4:32 PM
To: Bedingfield, Robert; Moggy, Derrick
Cc: Stephane Robert; Kevin Buck; Leilan Baxter (leilan@uoguelph.ca)
Subject: RE: Meadowbank Authorization Amendment and NNLP Contingency Plan

Hello Bobby and Derrick,

Attached you will find a DRAFT Meadowbank No Net Loss Plan- AEM, June 15,2012 for your review. We look forward to your feedback and discussions leading up to our site visit on August 13-15 where we can thoroughly discuss the attached plan. We are currently conducting studies near Airplane lake and will be conducting additional studies throughout the summer to confirm baseline data and some of the assumptions in the attached report.

Please feel free to contact me by email or phone if you have any questions.

Ryan VanEngen, MSc.
Agnico-Eagle Mines Ltd. -Meadowbank Division
Environment Department
rvanengen@agnico-eagle.com
519.400.7979

Please consider the environment before printing this email

From: Bedingfield, Robert [mailto:Robert.Bedingfield@dfo-mpo.gc.ca]
Sent: May-25-12 10:02 AM
To: Ryan Vanengen; Stephane Robert
Cc: Moggy, Derrick
Subject: RE: Meadowbank Authorization Amendment and NNLP Contingency Plan

Hi Ryan and Stephane

The Red font that has been inserted into my previous email below will clarify some of DFO's expectations regarding the NNL contingency plan for Meadowbank.

Thank you,

Bobby Bedingfield
Fisheries and Oceans Canada
Telephone/ Téléphone 403-292-8675
Email/Courriel Robert.Bedingfield@dfo-mpo.gc.ca

From: Bedingfield, Robert
Sent: March 30, 2012 2:09 PM
To: Ryan Vanengen (RVanengen@agnico-eagle.com); Stephane Robert (stephane.robert@agnico-eagle.com)
Cc: Moggy, Derrick
Subject: Meadowbank Authorization Amendment and NNLP Contingency Plan

Hi Gentlemen,
This email is to summarize the agreed upon process to amend authorization NU-03-0191 and to fulfill Agnico-Eagle Mines Ltd (AEM) obligations of developing a NNLP contingency plan for the Meadowbank Mine. The purpose of this email is to ensure that both DFO and AEM are agreeable and clear on the process that will occur.

Amendment of Authorization
The authorization for the Meadowbank mine will be amended to correct the discrepancies that are associated with each habitat compensation feature described in Authorization NU-03-0191. The reason for these discrepancies is unclear but the Habitat units (HU) that are associated with each compensation measure in the Meadowbank 2006/2007 NNLP and the November 2009 Meadowbank revised NNLP do not match the quantity of HU's listed in the authorization (see attachment, *AEM 2009 TIA and NNLP 2007 vs DFO Authorization*). The discrepancies that appear in the current authorization for the mine will be adjusted however the expectation is that that ratio of Compensation HU's to HADD HU's that appears in the authorization will still be honored by Agnico-Eagle. The compensation to HADD ratio for the TIA is 718.0 HU's to 318.3 HU (**2.03 : 1 ratio**) . The compensation ratio for the Mine Site is 1252.00 to 741.8 (**1.68 : 1 ratio**) The authorization will be amended to reflect the type and quantity of compensation that will be presented in the 2012 revised NNLP for the Meadowbank Mine that is currently being prepared by AEM.

The new NNLP that will be developed by AEM will also contain a new HEP model that will be developed based on principles that are presented in the HEP model for the Meliadine Mine. The timelines associated with the development of the revised NNLP for the Meadowbank mine are as follows:

Submission of a draft NNLP by June 15, 2012
Submission of a final NNLP by October 1, 2012

The revised NNLP for the Meadowbank Mine will include a NNLP for the Vault Pit. The NNLP for the Meadowbank mine should be one all-encompassing document but should contain clearly labelled sections discussing compensation associated with the TIA, Meadowank Mine and the Vault Pit. The revised NNLP document should clearly outline which compensation measure is associated with which location (TIA, Mine or Vault).

Contingency NNLP

Condition 4.5 in authorization NU-03-0191 states that a contingency no net loss plan should be developed by AEM by July 30, 2009. DFO still requires this contingency plan to fulfill AEM's obligations stated in the authorization. The contingency plan should be incorporated into the revised NNLP document that is to be completed by October 1, 2012 for the Meadowbank Mine. Enough design detail should be included in the contingency NNLP to show that each proposed contingency measure is feasible and has been given sufficient thought to implement if necessary. Final construction design detail is not required. For a variety of reasons this contingency plan has not been finalized to date. The understanding that has been agreed upon by AEM and DFO is that a new NNLP will be developed by AEM to address issues such as a reduced mine life and the discrepancies with the amount of HU's that are associated with each compensation measure listed in the current authorization.

TIA compensation modifications

Slight modifications to the compensation that is associated with the TIA may be allowable. The description of the compensation associated with TIA is outlined in the MMER listing regulations. Any changes that occur to TIA related compensation must still satisfy the description of the compensation in the MMER regulations (attached).

If I have left out any important details or there needs to be further clarification or discussion on any of these points please contact myself of Derrick Moggy to discuss in greater detail.

Bobby Bedingfield

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Fish Habitat Biologist
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Biologiste, Habitat du poisson
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Région du Centre et de l'Arctique
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7646, 8e Rue N.-E.
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APPENDIX D – Photos

Photo 1-1 : Meadowbank Mine Site aerial photograph- taken summer 2012.

Photo 1-2 Second Portage Lake Northwest Basin- taken during East Dike construction, July 2008 .

Photo 1-3: Aerial photo of Bay-Goose Basin prior to de-watering - taken summer 2010.

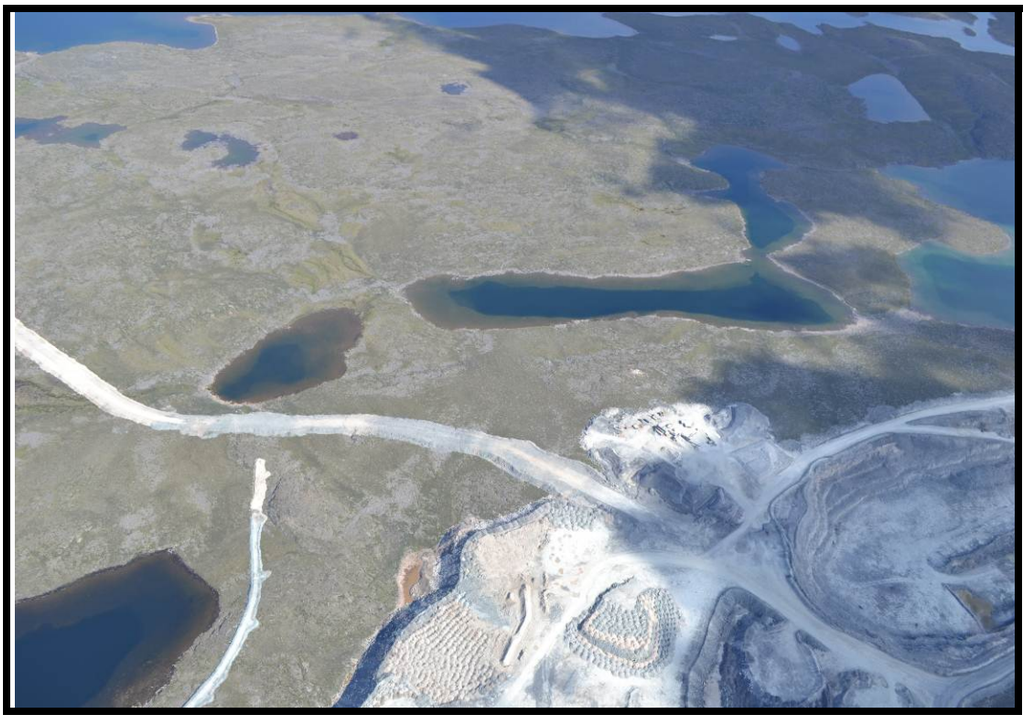

Photo 1-4 Dogleg Pond series (NP-2 in foreground, Dogleg North across road) - taken Aug 8 2011.

Photo 1-5 :Airplane Lake with small culvert at far edge of lake, along road to Meadowbank Mine (going left-right). Road to landfill and sewage lagoon is beyond - taken August 8, 2011.

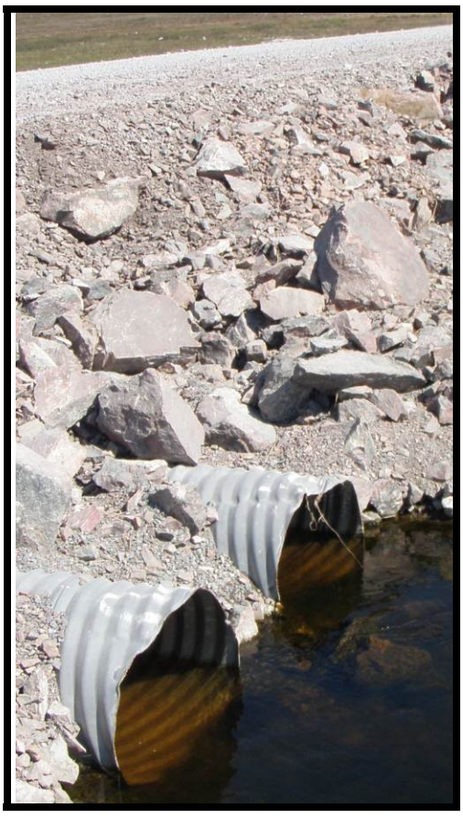

Photo 1-6 : Hamlet-maintained small culverts (undersized during freshet) that drain into Airplane Lake- taken mid-July 2011.

Photo 1-7 :Spawning pads and berms constructed in Winter of 2009 upstream of Bridge 1 (R02)- photo was taken in the fall during low flow. Structures were constructed to target arctic grayling spring spawning and have effectively increased young of the year and larval drift compared to before construction.

Photo 1-8 :Current condition of channel connecting Wally Lake (left) and W3 (right).

APPENDIX E – Technical Memorandum:
Summary of 2012 field data collection in support of NNL planning

TECHNICAL MEMORANDUM

Agnico Eagle Mines Ltd: Meadowbank Division
Baker Lake, Nunavut, X0C 0A0

Date: October 1st, 2012
Subject: Summary of Fisheries Data Collection in Support of the Meadowbank Mine Revised No Net Loss Plan
By: Ryan VanEngen (Environment Biologist) and Tom Thomson (Environment Technician

1 Introduction

In 2011, AEM revisited the original NNLP, and found discrepancies between the number of habitat units described in the plan and those in the Authorization granted by DFO. Specifically, gains for the Second Portage northwest Basin and Third Portage Basin were overestimated and unaccounted for. In addition to these discrepancies, the original DFO Authorization required AEM to develop a contingency plan which required additional research, monitoring data collection and public consultation. Furthermore, Vault Pit operations were not permitted under the original DFO Authorization and therefore required AEM to develop a No Net Loss Plan for the HADD related to the Vault Operations that will result in a HADD.

The following document summarizes the data collected in 2012 to support No Net Loss planning for the Meadowbank Project. The data collected in 2012 included: fish surveys completed in Airplane lake, Vault Pit Area (Wally, Vault and Phaser Lake), and Dogleg Pond and stream habitat assessments completed near Airplane Lake.

2 Methodology

Based on the recommendations in Azimuth (2009) and AEM (2012), only fine mesh index gill nets were used to evaluate fish presence in 2012. Fine mesh gill nets were used to quantitatively determine the species composition, size and catch-per-unit-effort (CPUE; # fish/100 m/hr) in Airplane Lake, Vault Lake, Wally Lake, Phaser Lake and Dogleg Lake. Panels of 25, 38, 51, 76, 102 and 126 mm stretch mesh gill nets were attached to one another in this order to create gangs of nets. Gangs were set with varying set times and durations. Procedures were nearly identical on all dates and locations.

Nets were set in different habitat types to target all fish species. The sets included perpendicular shoreline sets that spanned from littoral areas into deep water sets areas and deep water sets to target pelagic fish. Due to uncertainties in baseline data collection at Wally, fishing efforts mostly targeted deep zones to confirm presence and absence of arctic char. Nets were left for less than one day to provide daytime and overnight capture, after which time they were pulled and re-set. Most of the locations had a total of two sets within the two days of monitoring. Fish captured were identified by

species, measured for fork length (mm), weighed, and if they were in good condition following capture were floy- tagged in Vault and Phaser. All fish were returned to the lake of their capture. The DFO Animal Use Protocols and License to Fish for Scientific Purposes authorizations for these studies are presented in Appendix C. GPS locations of the net sets are presented in Appendix A.

3 Results and Discussion

3.1 Summary of Fish Collected

In 2012, index gill nets were set in various locations throughout Wally, Vault, Phaser, Dogleg Pond and Airplane lake. In total 377 fish were collected. Two hundred and forty eight (248) were collected in the project lakes, 174 of these were lake trout and most of the remainder were round whitefish. The percent biomass by species for project lakes are presented in Figure 3.1 Airplane lake, immediately west of the hamlet of Baker Lake, within the Baker Lake watershed, had a significantly different species assemblage than the project lakes with 67% biomass represented by round whitefish and only 12% by lake trout. A summary of the fish data collection is presented in Table 3.1. All field data sheets are presented in Appendix A.

The data collected in 2012 supported baseline findings in Wally, Vault and Phaser Lake. As previously documented, no arctic char were collected despite efforts and net placements to target arctic char. The 2012 data collection in Dogleg Pond determined both round whitefish and lake trout are present which updates the historical findings that determined only lake trout were present. These findings will be reflected in the NNL plan.

Figure 3.1- Percent fish biomass by species by waterbody

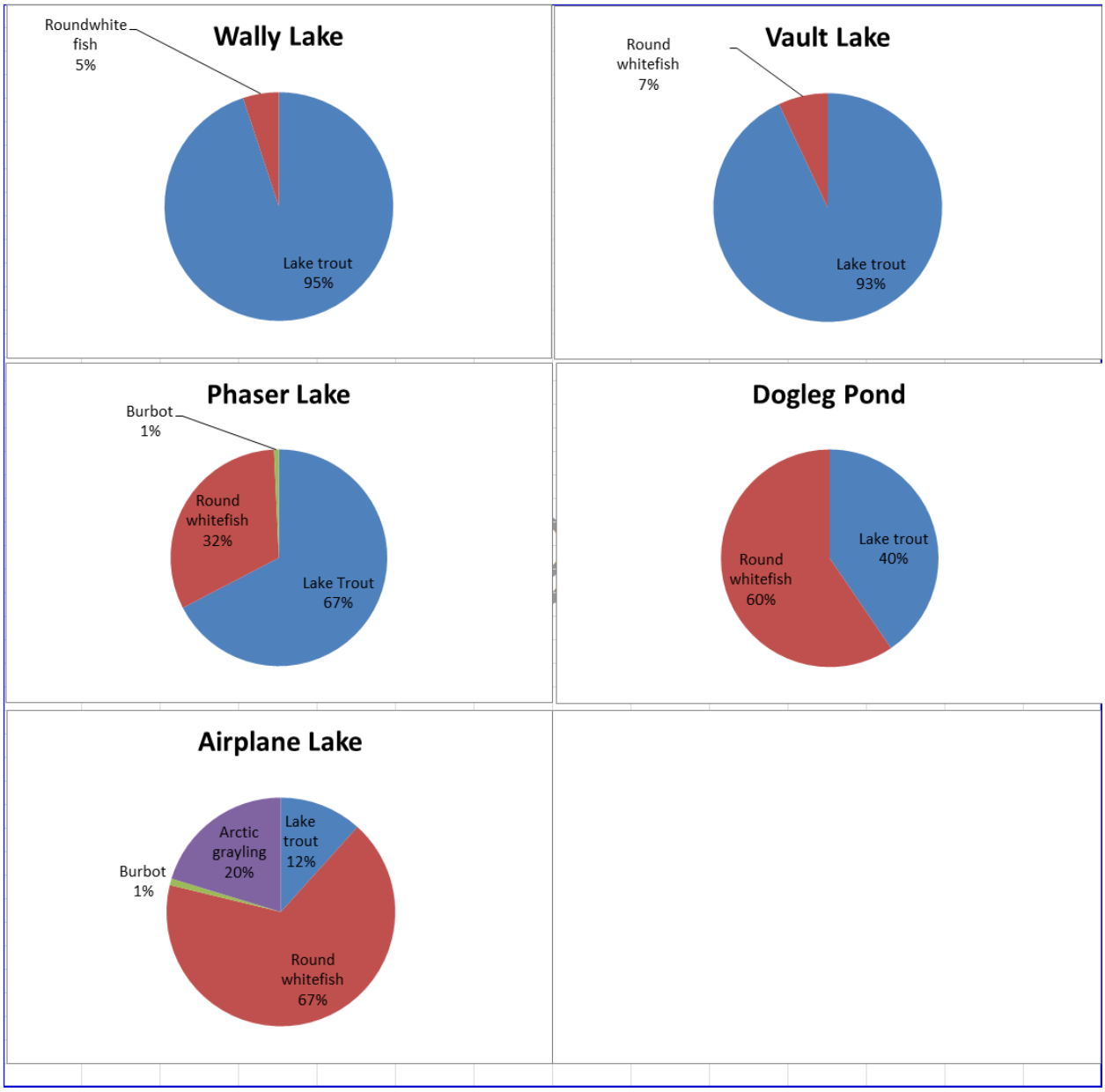

Table 3.1- Summary of the number of fish collected by waterbody

Waterbody	Lake Trout	Arctic char	Round Whitefish	Arctic grayling	Burbot	Totals
Wally	55	0	8	-	0	**63**
Vault	67	0	12	-	0	**79**
Phaser	41	0	36	-	1	**78**
Dogleg Pond	11	0	17	-	0	**28**
Subtotal						**248**
Airplane Lake*	6	0	124	36	7	**173**
Total	180	0	197	36	8	**377**
* Located near Baker Lake; ~ 100km from the Project Lakes						
- not found in Project Lakes						

3.2 CPUE

Catch per unit effort (CPUE) for index gill net sets by waterbody are presented in Table 3.2. Mean CPUE for Wally was 11.03 (n=9), Vault was 15.54 (n=6), Phaser was 23.74 (n=4) and Dogleg was 40.73 (n=1). There was not a statistically significant difference between Wally, Vault and Phaser (ANOVA $p=0.21$). Airplane Lake had a statistically significant difference in CPUE compared to Wally, Vault and Phaser (ANOVA followed by a Tukey's pairwise comparison; $p<0.05$).

These results suggest a greater number of fish are present in Dogleg Pond compared to Wally, Vault and Phaser and a significantly greater number of fish are present in Airplane Lake. This difference in Airplane Lake compared to the project lakes may simply be due to location and characteristics of the waterbody (with smaller tributaries that connect to upstream waterbodies), but is most likely due to its' proximity to sewage discharge outflow from the Baker Lake sewage lagoon and has resulted in nutrient enrichment of the waterbody. Although these CPUE findings are not explored in greater detail in the NNL plan, they will serve as useful baseline data for fishout protocol development and if required, contingency planning.

Table 3.2- Catch per unit effort by waterbody

Lake	Station ID	Start	Finish	Hours	# of Fish Caught	CPUE # of fish/index net/day	CPUE # of fish/ 150m net/day	
Wally	W1	8-Aug		6	2	8.00	4.00	
	W2	8-Aug		6	3	12.00	6.00	
	W2	8-Aug	9-Aug	22	11	12.28	6.14	
	W3	8-Aug		6	1	4.00	2.00	
	W3	8-Aug	9-Aug	19	20	25.26	12.63	
	W4	8-Aug	9-Aug	22	22	24.00	12.00	
	W5	17-Aug		7	0	0.00	0.00	
	W6	17-Aug		7	0	0.00	0.00	
	W7	17-Aug		7	4	13.71	6.86	
Total				**102**	**63**			
Avg				**11**	**7**	**11.03**	**5.51**	
Vault	V1	18-Aug		5	0	0.00	0.00	
	V2	18-Aug		5	0	0.00	0.00	
	V2	18-Aug	19-Aug	19	20	25.07	12.53	
	V3	18-Aug		4	1	6.00	3.00	
	V3	18-Aug	19-Aug	25	25	24.49	12.24	
	V4	18-Aug	19-Aug	21	33	37.71	18.86	
Total				**78**	**79**			
Avg				**13**	**13**	**15.54**	**7.77**	
Phaser	P1	20-Aug	21-Aug	17	18	25.41	12.71	
	P2	20-Aug	21-Aug	18	21	28.00	14.00	
	P3	20-Aug	21-Aug	23	13	13.57	6.78	
	P4	20-Aug	21-Aug	24	28	28.00	14.00	
Total				**82**	**80**			
Avg				**21**	**20**	**23.74**	**11.87**	
Dogleg Pond	DL1	26-Aug	27-Aug	**17**	**28**	**40.73**	**20.36**	
Airplane Lake	APL1 (3)	23-Aug	24-Aug	14	46	77.47	38.74	
	APL1 (3)	24-Aug		9	50	133.33	66.67	
	APL2 (4)	23-Aug	24-Aug	15	37	59.20	29.60	
	APL2 (4)	24-Aug		9	43	114.67	57.33	
Total				**47**	**176**			
Avg				**12**	**44**	**96.17**	**48.08**	*

* statistically significant difference in Airplane Lake CPUE compared to all other lakes (ANOVA followed by Tukey's pairwise comparison $p<0.05$)

3.3 Stream habitat assessments near Airplane Lake

Habitat evaluations of all streams connected to Airplane Lake were conducted in 2012 to provide data on the watershed area of Airplane Lake and it's connectivity to upstream lakes. These habitat assessments are presented in Appendix B and may be referred to upon implementation of contingency options around Airplane Lake.

4 References

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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.

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Golder, 2009. East dike construction as-built report Meadowbank Gold Project, Nunavut.
A report prepared for Agnico-Eagle Mines, Baker Lake NT by Golder Associates,
Burnaby BC. December 2009

McDonald M, Hershey A, O'Brien W. 1992. Cost of predation avoidance in young-of-year lake trout (Salvelinus namaycush): growth differential in sub-optimal habitats. Hydrobiologia 240:213-218.

Appendix A- Fish Collection Field Data Sheets

NNL Fisheries Field Sheets - 2012- Wally Lake

Date	Time	Net Set ID	GPS Co-ordinates - Start	Species	Fish #	Tag #	Fork Length (mm)	Weight (g)	Depth of C	Mesh Type	LR/D	Notes
8-Aug-12	10:00	W1	15W 0360486 7221955	-	-	-	-	-	-	-	-	NETS SET DEPTH 3M - 6.5M
8-Aug-12	14:00	W1	15W 0360486 7221955	LKTR	1	-	372	580	4	76	LR	-
8-Aug-12	14:00	W1	15W 0360486 7221955	LKTR	2	-	380	648	4	76	LR	-
8-Aug-12	10:20	W2	15W 0362330 7224083	-	-	-	-	-	-	-	-	NETS SET DEPTH 5M - 12M
8-Aug-12	14:40	W2	15W 0362330 7224083	LKTR	3	-	358	540	8	51	D	-
8-Aug-12	14:40	W2	15W 0362330 7224083	LKTR	4	-	360	510	7	51	D	-
8-Aug-12	14:40	W2	15W 0362330 7224083	LKTR	5	-	350	480	7.5	51	LR	-
8-Aug-12	11:30	W3	15W 0361017 7220547	-	-	-	-	-	-	-	-	NETS SET DEPTH 7M - 15M
8-Aug-12	15:36	W3	15W 0361017 7220547	LKTR	6	87956	595	2250	7	51	LR	
9-Aug-12	10:30	W3	15W 0361017 7220547	LKTR	1	-	321	395	10	25	D	OVERNIGHT SET RETRIEVAL FROM 11:30 AUG 8, 2012
9-Aug-12	10:30	W3	15W 0361017 7220547	LKTR	2	-	188	80	10	25	D	-
9-Aug-12	10:30	W3	15W 0361017 7220547	RNWH	3	-	354	445	10	25	D	-
9-Aug-12	10:30	W3	15W 0361017 7220547	RNWH	4	-	340	475	10	25	D	-
9-Aug-12	10:30	W3	15W 0361017 7220547	RNWH	5	-	209	115	10	25	D	-
9-Aug-12	10:30	W3	15W 0361017 7220547	LKTR	6	-	196	95	10	25	LR	-
9-Aug-12	10:30	W3	15W 0361017 7220547	LKTR	7	-	512	1035	8	25	LR	-
9-Aug-12	10:30	W3	15W 0361017 7220547	RNWH	8	-	350	505	8	25	LR	-
9-Aug-12	10:30	W3	15W 0361017 7220547	RNWH	9	-	330	375	8	38	D	-
9-Aug-12	10:30	W3	15W 0361017 7220547	RNWH	10	-	325	390	7	38	D	-
9-Aug-12	10:30	W3	15W 0361017 7220547	RNWH	11	-	295	315	7	38	D	-
9-Aug-12	10:30	W3	15W 0361017 7220547	LKTR	12	-	345	450	7	38	D	-
9-Aug-12	10:30	W3	15W 0361017 7220547	LKTR	13	-	304	345	5	38	LR	-
9-Aug-12	10:30	W3	15W 0361017 7220547	LKTR	14	-	610	2200	6	38	LR	-
9-Aug-12	10:30	W3	15W 0361017 7220547	LKTR	15	-	214	130	7	38	LR	-
9-Aug-12	10:30	W3	15W 0361017 7220547	LKTR	16	-	583	210	3	75	D	-
9-Aug-12	10:30	W3	15W 0361017 7220547	LKTR	17	-	400	725	4	76	D	-
9-Aug-12	10:30	W3	15W 0361017 7220547	LKTR	18	-	345	540	3	76	LR	-
9-Aug-12	10:30	W3	15W 0361017 7220547	RNWH	19	-	348	500	3	76	LR	-
9-Aug-12	10:30	W3	15W 0361017 7220547	LKTR	20	-	389	710	3	76	LR	-
9-Aug-12	12:00	W4	15W 0360486 7221955	-	-	-	-	-	-	-	-	:RNIGHT SET RETRIEVAL FROM 14:15 AUG 8, 2012 DEPTH 5M - 1
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	21	-	234	190	-	38	D	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	22	-	191	110	-	38	D	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	23	-	226	145	-	38	D	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	24	-	213	135	-	38	LR	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	25	-	192	85	-	38	LR	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	26	-	247	195	-	38	LR	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	27	-	269	275	-	38	LR	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	28	-	870	6800	-	51	-	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	29	-	323	455	-	76	D	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	30	-	262	255	-	76	D	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	31	-	302	360	-	76	D	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	32	-	276	305	-	76	D	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	33	-	275	350	-	76	D	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	34	-	236	190	-	76	D	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	35	-	370	580	-	76	LR	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	36	-	248	215	-	76	LR	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	37	-	825	6700	-	102	D	RIPE MALE
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	38	-	372	700	-	102	D	F1
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	39	-	335	465	-	102	D	M7, STOMACH PARASITES
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	40	-	346	430	-	102	LR	-
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	41	-	341	495	-	102	LR	-

NNL Fisheries Field Sheets - 2012- Wally Lake

Date	Time	Net Set ID	GPS Co-ordinates - Start	Species	Fish #	Tag #	Fork Length (mm)	Weight (g)	Depth of C	Mesh Type	LR/D	Notes
9-Aug-12	12:00	W4	15W 0360486 7221955	LKTR	42	-	705	3700	-	102	LR	-
9-Aug-12	12:15	W2	15W 0362330 7224083	LKTR	43	-	718	4050	-	76	LR	-
9-Aug-12	12:15	W2	15W 0362330 7224083	LKTR	44	-	321	400	-	76	LR	-
9-Aug-12	12:15	W2	15W 0362330 7224083	LKTR	45	-	248	165	-	76	LR	-
9-Aug-12	12:15	W2	15W 0362330 7224083	LKTR	46	-	232	155	-	76	LR	-
9-Aug-12	12:15	W2	15W 0362330 7224083	LKTR	47	-	665	3150	-	76	LR	-
9-Aug-12	12:15	W2	15W 0362330 7224083	LKTR	48	-	220	95	-	76	D	-
9-Aug-12	12:15	W2	15W 0362330 7224083	LKTR	49	-	562	1900	-	76	D	M8
9-Aug-12	12:15	W2	15W 0362330 7224083	LKTR	50	-	380	610	-	76	D	M6, FULL STOMACH
9-Aug-12	12:15	W2	15W 0362330 7224083	LKTR	51	-	367	615	-	76	D	M6, FULL STOMACH
9-Aug-12	12:15	W2	15W 0362330 7224083	LKTR	52	-	254	165	-	76	D	F1, FULL STOMACH
9-Aug-12	12:15	W2	15W 0362330 7224083	LKTR	53	-	635	3550	-	76	D	M7, FULL STOMACH
17-Aug-12	9:30	W5	15W 0362498 7221547	-	-	-	-	-	-	-	-	NETS SET, DEPTH 2.3M - 10.3M
17-Aug-12	14:30	W5	15W 0362498 7221547	-	-	-	-	-	-	-	-	NO FISH
17-Aug-12	10:00	W6	15W 0363477 7221805	-	-	-	-	-	-	-	-	NETS SET, DEPTH 3.3M - 4.1M - 2.8M
17-Aug-12	15:00	W6	15W 0363477 7221805	-	-	-	-	-	-	-	-	NO FISH
17-Aug-12	10:30	W7	15W 0362414 7222293	-	-	-	-	-	-	-	-	NETS SET, DEPTH 4.8M - 10.5M - 8.0M
17-Aug-12	15:30	W7	15W 0362568 7222286	LKTR	1	-	745	4250	10.3	51	LR	-
17-Aug-12	15:30	W7	15W 0362414 7222293	LKTR	2	-	340	450	9.7	51	LR	-
17-Aug-12	15:30	W7	15W 0362414 7222293	LKTR	3	-	670	3250	9	51	LR	-
17-Aug-12	15:30	W7	15W 0362414 7222293	LKTR	4	-	376	500	9	51	LR	-

NNL Fisheries Field Sheets - 2012- Vault Lake

Date	Time	Net Set ID	GPS Co-ordinates - Start	GPS Co-ordinates - End	Species	Fish #	Tag #	Fork Length (mm)	Weight (g)	Depth of C	Mesh Type	LR/D	Notes
18-Aug-12	9:00	V1	15W 0359721 7219738	15W 0359597 7219848	-	-	-	-	-	-	-	-	NET SET, DEPTH 3.6M - 11.1M - 9.7M
18-Aug-12	1:30	V1	15W 0359721 7219738	15W 0359597 7219848	-	-	-	-	-	-	-	-	NO FISH, NET RE-SET @ 15:00 AUG 18, 2012
18-Aug-12	9:30	V2	15W 0359077 7219593	15W 0358977 7219721	-	-	-	-	-	-	-	-	NET SET, DEPTH 4.2M - 8.1M - 2.3M
18-Aug-12	14:00	V2	15W 0359077 7219593	15W 0358977 7219721	-	-	-	-	-	-	-	-	NO FISH, NET RE-SET @ 15:30 AUG 18, 2012
18-Aug-12	10:30	V3	14W 0641042 7219309	15W 0358974 7219282	-	-	-	-	-	-	-	-	NET SET, DEPTH 2.0M - 5.0M - 3.0M
18-Aug-12	14:30	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	1	87958	370	500	3.1	38	LR	-
18-Aug-12	16:00	V4	15W 0359642 7220254	15W 0359741 7220177	-	-	-	-	-	-	-	-	NET SET, DEPTH 4.4M - 6.1M - 3.8M
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	1	87959	498	1400	-	76	LR	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	2	87960	490	1250	-	76	LR	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	3	87961	390	600	-	76	LR	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	4	87962	334	400	-	76	LR	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	5	87963	350	550	-	76	LR	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	6	-	361	550	-	76	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	7	-	290	270	-	51	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	8	-	234	140	-	51	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	9	-	252	180	-	38	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	10	-	236	130	-	38	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	11	-	268	200	-	38	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	12	-	220	110	-	38	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	13	-	207	90	-	38	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	14	-	329	430	-	38	LR	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	15	-	225	110	-	25	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	16	-	195	75	-	25	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	LKTR	17	-	125	20	-	25	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	RNWH	18	-	190	100	-	25	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	RNWH	19	-	281	250	-	25	D	-
19-Aug-12	9:15	V2	15W 0359077 7219593	15W 0358977 7219721	RNWH	20	-	400	900	-	25	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	21	-	255	300	-	102	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	RNWH	22	-	295	350	-	76	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	23	-	255	250	-	76	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	24	-	225	150	-	76	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	25	-	350	500	-	76	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	26	-	320	350	-	76	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	27	-	370	600	-	76	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	RNWH	28	-	275	250	-	76	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	29	87958	370	500	-	76	LR	CYRC
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	30	-	235	175	-	51	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	31	-	650	2000	-	51	LR	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	32	-	310	300	-	51	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	RNWH	33	-	315	350	-	51	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	34	-	255	200	-	51	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	35	-	335	400	-	51	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	36	-	200	100	-	51	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	37	-	200	150	-	51	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	RNWH	38	-	350	550	-	51	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	39	-	255	300	-	51	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	40	-	270	350	-	51	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	RNWH	41	-	370	600	-	51	LR	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	42	-	195	100	-	51	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	43	-	210	125	-	51	LR	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	RNWH	44	-	372	550	-	38	LR	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	45	-	232	200	-	38	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	46	-	200	100	-	38	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	47	-	430	900	-	38	LR	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	48	-	370	550	-	38	LR	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	49	-	275	200	-	38	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	RNWH	50	-	285	325	-	38	D	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	51	-	343	525	-	38	LR	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	52	-	295	300	-	25	LR	-
19-Aug-12	13:00	V4	15W 0359642 7220254	15W 0359741 7220177	LKTR	53	-	125	100	-	25	D	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	54	-	560	2400	-	102	D	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	55	-	666	2900	-	102	D	-

NNL Fisheries Field Sheets - 2012- Vault Lake

Date	Time	Net Set ID	GPS Co-ordinates - Start	GPS Co-ordinates - End	Species	Fish #	Tag #	Fork Length (mm)	Weight (g)	Depth of C	Mesh Type	LR/D	Notes
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	56	-	475	1000	-	102	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	57	-	475	900	-	102	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	58	-	415	900	-	102	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	59	-	463	1000	-	102	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	60	-	799	6300	-	102	D	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	61	-	603	2500	-	102	D	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	62	87964	443	950	-	102	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	63	-	414	1000	-	102	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	64	-	416	900	-	102	D	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	65	-	465	1700	-	102	D	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	66	87965	458	950	-	102	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	67	-	276	300	-	102	D	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	68	87966	455	950	-	102	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	69	-	387	700	-	76	D	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	70	87967	325	650	-	76	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	71	87968	395	950	-	76	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	72	87970	723	4300	-	76	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	73	87969	820	5450	-	76	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	RNWH	74	-	210	150	-	76	D	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	75	87971	777	4800	-	76	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	76	87972	425	900	-	51	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	LKTR	77	-	105	100	-	38	LR	-
19-Aug-12	15:00	V3	14W 0641042 7219309	15W 0358974 7219282	RNWH	78	-	125	100	-	38	D	-

NNL Fisheries Field Sheets - 2012- Phaser Lake

Date	Time	Net Set ID	GPS Co-ordinates - Start	GPS Co-ordinates - End	Species	Fish #	Tag #	Fork Length (mm)	Weight (g)	Depth of C	Mesh Type	LR/D	Notes
20-Aug-12	15:30	P1	14W 0640111 7219364	14W 0640224 7219421	-	-	-	-	-	-	-	-	NET SET, DEPTHS 3.2M - 4.3M - 2.9M
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	1	102799	365	500	3	76	LR	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	2	102796	347	450	3	76	LR	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	3	102795	385	525	3	76	LR	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	4	-	395	600	3.2	76	D	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	5	102794	385	550	3.2	76	LR	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	RNWH	6	-	355	400	3.5	51	D	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	RNWH	7	-	328	350	3.5	51	D	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	8	102793	370	525	3.5	51	LR	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	9	-	370	525	3.5	51	D	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	10	-	-	-	-	-	-	LOST IN TRANSFER
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	11	-	420	750	4	51	D	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	12	-	230	200	4	51	D	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	13	-	230	150	3.8	51	D	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	RNWH	14	-	255	250	3.7	51	LR	WEAK
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	15	-	167	100	3.5	38	D	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	16	-	179	125	3.5	38	D	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	RNWH	17	-	143	100	3	25	LR	-
21-Aug-12	8:30	P1	14W 0640111 7219364	14W 0640224 7219421	LKTR	18	-	160	100	3	25	LR	-
21-Aug-12	10:00	P1	14W 0640094 7219313	14W 0640216 7219387	-	-	-	-	-	-	-	-	NET RE-SET @ 10:00AM ON AUG 20 AS NET ID P3
20-Aug-12	16:00	P2	14W 0640472 7219446	14W 0640382 7219546	-	-	-	-	-	-	-	-	NET SET, DEPTH 2.6M - 3.1M - 1.8M
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	19	102792	385	650	-	76	LR	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	RNWH	20	-	356	600	-	76	LR	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	21	102790	353	550	-	76	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	22	102789	370	650	-	76	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	23	-	395	825	-	76	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	24	102788	350	525	-	76	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	25	-	420	750	-	76	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	26	102787	360	600	-	51	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	27	102791	370	625	-	51	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	28	-	380	800	-	51	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	RNWH	29	-	275	250	-	51	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	30	102786	375	750	-	51	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	31	-	350	650	-	51	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	32	-	370	700	-	51	LR	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	33	-	500	775	-	51	LR	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	RNWH	34	-	340	600	-	38	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	RNWH	35	-	230	200	-	38	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	36	-	235	200	-	38	LR	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	RNWH	37	-	360	700	-	38	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	38	-	138	100	-	38	D	-
21-Aug-12	10:00	P2	14W 0640472 7219446	14W 0640382 7219546	LKTR	39	-	175	200	-	25	D	-
21-Aug-12	11:15	P2	14W 0640544 7219752	14W 0640498 7219607	-	-	-	-	-	-	-	-	NET RE-SET @11:15AM ON AUG 21 AS NET ID P4
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	RNWH	1	-	364	500	-	76	LR	-
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	LKTR	2	102785	342	450	-	51	LR	-
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	LKTR	3	-	351	500	-	51	D	-
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	RNWH	4	-	220	150	-	51	LR	-
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	RNWH	5	-	320	400	-	51	D	-
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	RNWH	6	102784	263	250	-	51	LR	-
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	RNWH	7	-	188	100	-	51	LR	-
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	LKTR	8	-	250	150	-	38	D	-
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	LKTR	9	-	161	100	-	38	LR	-
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	LKTR	10	-	182	125	-	38	LR	-
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	RNWH	11	-	346	400	-	38	LR	-
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	RNWH	12	-	265	250	-	38	D	-
22-Aug-12	9:00	P3	14W 0640094 7219313	14W 0640216 7219387	RNWH	13	-	145	100	-	25	LR	-
22-Aug-12	9:20	P3	14W 0640094 7219313	14W 0640216 7219387	-	-	-	-	-	-	-	-	NET PULLED
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	LKTR	14	-	357	550	-	76	LR	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	LKTR	15	-	365	600	-	76	LR	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	LKTR	16	-	345	500	-	76	LR	-

NNL Fisheries Field Sheets - 2012- Phaser Lake

Date	Time	Net Set ID	GPS Co-ordinates - Start	GPS Co-ordinates - End	Species	Fish #	Tag #	Fork Length (mm)	Weight (g)	Depth of C	Mesh Type	LR/D	Notes
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	LKTR	17	-	340	450	-	51	LR	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	18	-	272	250	-	51	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	19	-	238	150	-	51	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	20	-	419	700	-	51	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	LKTR	21	-	645	5000	-	51	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	LKTR	22	-	275	300	-	51	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	23	-	341	400	-	38	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	24	-	314	325	-	38	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	25	-	310	350	-	38	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	26	-	270	250	-	38	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	27	-	334	400	-	38	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	28	-	312	325	-	38	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	BRBT	29	-	340	250	-	38	LR	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	30	-	274	250	-	38	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	31	-	257	225	-	38	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	32	-	304	325	-	38	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	33	-	257	200	-	38	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	34	-	320	350	-	38	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	35	-	290	300	-	38	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	36	-	239	175	-	25	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	37	-	247	200	-	25	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	38	-	221	150	-	25	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	RNWH	39	-	190	100	-	25	D	-
22-Aug-12	9:30	P4	14W 0640544 7219752	14W 0640498 7219607	LKTR	40	-	179	100	-	25	D	-
22-Aug-12	10:30	P4	14W 0640544 7219752	14W 0640498 7219607	-	-	-	-	-	-	-	-	NET PULLED

NNL Fisheries Field Sheets - 2012- Airplane Lake

Date	Time	Net Set ID	GPS Co-ordinates - Start	GPS Co-ordinates - End	Species	Fish #	Tag #	Fork Length (mm)	Weight (g)	Depth of C	Mesh Type	LR/D	Notes
23-Aug-12	17:37	APL-1	15W 0357138 7136206	15W 0357193 7136082	-	-	-	-	-	-	-	-	NET SET, DEPTHS 2M - 3.3M - 3.1M
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	1	-	355	500	3.2	102	LR	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	ARGR	2	102783	395	700	3.1	102	LR	MALE
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	3	-	340	500	3.2	76	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	4	-	350	500	3.1	76	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	5	-	340	500	3.1	76	LR	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	ARGR	6	102782	350	500	3.2	76	LR	FEMALE
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	7	-	345	500	3.2	76	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	8	-	370	650	3.2	76	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	9	-	330	450	3.1	76	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	LKTR	10	102781	475	1200	3	76	LR	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	11	-	335	500	3	76	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	12	-	360	600	3	76	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	13	-	370	550	3	76	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	14	102780	360	550	2.9	76	LR	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	ARGR	15	-	385	650	3	76	D	MALE
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	ARGR	16	-	345	600	3	76	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	17	-	365	600	2.9	76	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	18	-	350	550	2.8	76	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	19	-	330	450	2.8	51	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	20	-	320	400	2.7	51	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	ARGR	21	-	285	350	2.7	51	D	FEMALE
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	22	102779	350	500	2.7	51	LR	SMALL SCAR ON BODY
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	23	102778	310	350	2.7	51	LR	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	ARGR	24	-	290	400	2.7	51	D	FEMALE, PARASITES ON STOMACH
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	25	-	340	500	2.6	51	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	BRBT	26	-	250	100	2.6	51	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	27	101251	345	450	2.6	51	LR	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	BRBT	28	-	290	150	2.6	51	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	29	-	365	600	2.7	51	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	30	-	345	550	2.7	51	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	31	-	300	350	2.7	51	D	MALE, BENTHIC (CLAMS, CHIRONOMIDS) IN STOMACH
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	32	-	280	300	2.7	51	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	33	-	330	500	2.7	51	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	34	-	340	450	2.7	51	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	35	-	310	450	2.7	51	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	36	-	350	600	2.7	38	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	37	-	290	350	2.7	38	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	38	-	350	600	2.7	38	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	39	-	300	350	2.7	38	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	ARGR	40	-	280	300	2.7	38	LR	FEMALE
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	RNWH	41	-	290	300	2.6	38	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	ARGR	42	-	120	50	2.4	25	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	ARGR	43	-	120	50	2.4	25	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	BRBT	44	-	120	50	1.9	25	D	-
24-Aug-12	7:45	APL-1	15W 0357138 7136206	15W 0357193 7136082	BRBT	45	-	120	50	1.9	25	D	-
24-Aug-12	9:40	APL-1	15W 0356815 7135753	15W 0356805 7135892	-	-	-	-	-	-	-	-	NET RESET AS APL-3, DEPTHS 2M - 4M
23-Aug-12	17:48	APL-2	15W 0356889 7136046	15W 0357037 7135892	-	-	-	-	-	-	-	-	NET SET, DEPTHS 5M - 7.1M - 5.2M
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	1	-	345	550	7	102	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	2	-	360	650	6.5	76	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	3	-	365	600	6.2	76	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	4	-	365	600	6.2	76	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	ARGR	5	-	370	600	6.7	76	LR	MALE
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	6	-	345	500	6.5	76	LR	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	7	-	360	600	6.2	76	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	8	-	355	500	6.2	51	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	9	-	-	-	-	-	LR	LOST IN TRANSFER
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	10	-	-	-	-	-	LR	LOST IN TRANSFER
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	BRBT	11	-	290	150	6.1	51	D	-

NNL Fisheries Field Sheets - 2012- Airplane Lake

Date	Time	Net Set ID	GPS Co-ordinates - Start	GPS Co-ordinates - End	Species	Fish #	Tag #	Fork Length (mm)	Weight (g)	Depth of C	Mesh Type	LR/D	Notes
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	12	-	-	-	-	-	LR	LOST IN TRANSFER
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	13	-	340	450	6.1	51	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	14	-	325	450	6.1	51	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	15	-	355	550	6.1	51	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	16	-	290	300	6.1	51	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	17	-	355	500	6.1	51	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	18	-	360	600	6	51	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	BRBT	19	-	335	200	6	51	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	BRBT	20	-	-	150	6	51	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	21	-	355	550	6	51	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	22	-	285	300	6.2	51	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	23	-	-	-	-	-	LR	LOST IN TRANSFER
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	24	-	250	200	6.2	51	LR	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	25	-	340	550	6.3	51	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	26	-	330	450	6.3	38	LR	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	27	-	-	-	-	-	LR	LOST IN TRANSFER
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	28	101253	370	600	6.4	38	LR	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	29	101254	365	600	6.5	38	LR	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	30	-	345	550	6.4	38	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	31	-	345	550	6.5	38	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	ARGR	32	-	135	50	6.3	25	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	33	-	135	50	6.2	25	D	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	ARGR	34	-	125	50	6.2	25	LR	-
24-Aug-12	9:00	APL-2	15W 0356889 7136046	15W 0357037 7135892	RNWH	35	-	125	50	6.6	25	D	-
24-Aug-12	9:50	APL-2	15W 0356371 7135881	15W 0356433 7136007	-	-	-	-	-	-	-	-	NET RESET AS APL-4, DEPTHS 2.1M - 3.2M - 2.5M
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	ARGR	1	101255	385	800	3.7	102	LR	MALE
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	ARGR	2	101257	340	500	3.7	76	LR	FEMALE
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	ARGR	3	101256	365	600	3.7	76	LR	MALE
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	ARGR	4	-	360	600	3.7	76	D	FEMALE
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	ARGR	5	-	380	700	3.6	76	D	MALE
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	6	-	370	650	3.7	76	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	ARGR	7	101258	365	650	3.6	76	LR	MALE
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	8	-	350	700	3.5	76	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	ARGR	9	101259	350	650	3.6	76	LR	MALE
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	10	-	340	550	3.6	76	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	11	-	345	600	3.6	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	12	-	355	600	3.6	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	13	-	340	600	3.6	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	14	101260	285	400	3.6	51	LR	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	15	-	355	650	3.6	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	16	-	340	600	3.6	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	ARGR	17	101261	375	800	3.5	51	LR	FEMALE
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	18	101262	320	500	3.5	51	LR	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	19	-	290	400	3.6	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	20	-	375	700	3.6	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	21	-	295	400	3.6	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	22	-	320	500	3.4	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	23	101263	350	500	3.5	51	LR	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	ARGR	24	101264	390	750	3.6	51	LR	MALE
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	25	101265	355	650	3.5	51	LR	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	26	-	340	500	3.6	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	27	-	355	600	3.6	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	28	-	340	550	3.6	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	29	-	345	600	3.6	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	ARGR	30	101266	310	450	3.5	51	LR	FEMALE
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	31	-	350	550	3.5	51	LR	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	32	-	330	500	3.5	51	LR	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	33	-	345	600	3.5	51	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	34	-	290	400	3.5	51	LR	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	ARGR	35	101267	370	650	3.5	38	LR	FEMALE

NNL Fisheries Field Sheets - 2012- Airplane Lake

Date	Time	Net Set ID	GPS Co-ordinates - Start	GPS Co-ordinates - End	Species	Fish #	Tag #	Fork Length (mm)	Weight (g)	Depth of C	Mesh Type	LR/D	Notes
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	36	-	355	700	3.5	38	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	37	101268	300	400	3.5	38	LR	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	38	101270	335	500	3.4	38	LR	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	39	-	340	500	3.3	38	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	40	-	340	500	3.4	38	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	41	-	345	500	3.3	38	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	42	-	370	600	3.2	38	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	43	-	375	700	3.2	38	LR	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	44	-	350	500	2.2	25	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	45	-	340	550	2.2	25	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	46	-	120	50	2.1	25	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	47	-	370	600	2.1	25	D	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	ARGR	48	101271	340	550	2.1	25	LR	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	49	-	360	600	1.9	25	LR	-
24-Aug-12	18:15	APL-3	15W 0356815 7135753	15W 0356805 7135892	RNWH	50	-	345	600	1.9	25	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	ARGR	1	101272	370	650	3.3	102	LR	MALE
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	ARGR	2	101272	395	800	3.5	102	LR	MALE
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	LKTR	3	-	415	850	3.6	76	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	LKTR	4	-	535	2100	3.5	76	D	FULL STOMACH, NO PARASITES, MALE
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	5	-	355	550	3.6	76	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	ARGR	6	-	355	600	3.6	76	D	MALE
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	LKTR	7	-	510	1700	3.6	76	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	ARGR	8	101274	370	650	3.5	76	LR	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	9	-	370	650	3.5	76	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	10	-	370	600	3.5	76	LR	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	ARGR	11	-	390	750	3.6	76	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	12	-	345	500	3.6	76	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	13	-	375	650	3.6	76	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	14	-	310	400	3.5	51	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	ARGR	15	-	285	350	3.5	51	D	FEMALE
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	16	-	360	650	3.5	51	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	17	-	360	650	3.5	51	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	ARGR	18	101275	385	650	3.5	51	LR	MALE
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	19	-	360	650	3.4	51	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	LKTR	20	101300	620	3000	3.4	51	LR	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	LKTR	21	101299	520	1800	3.3	51	LR	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	22	101298	355	700	3.3	51	LR	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	ARGR	23	101297	325	500	3.2	51	LR	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	24	-	350	600	3.2	51	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	25	-	340	550	3.1	51	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	26	-	370	650	3.1	51	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	27	-	285	350	3.1	51	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	28	-	350	600	3.1	38	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	29	-	330	550	3	38	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	30	-	325	550	3.1	38	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	ARGR	31	-	205	200	3	38	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	32	-	280	300	2.9	38	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	33	101296	355	600	2.9	38	LR	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	34	-	370	800	2.9	38	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	35	-	365	700	2.9	38	LR	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	36	-	285	350	2.9	38	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	ARGR	37	101293	360	700	2.8	38	LR	FEMALE
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	38	-	250	250	2.9	38	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	39	-	340	550	2.9	38	LR	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	ARGR	40	-	345	600	2.8	38	LR	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	41	101292	350	600	2.6	25	LR	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	ARGR	42	-	120	50	2.2	25	D	-
24-Aug-12	19:00	APL-4	15W 0356371 7135881	15W 0356433 7136007	RNWH	43	-	270	300	2	25	D	-

NNL Fisheries Field Sheets - 2012- Dogleg pond

Date	Time	Net Set ID	GPS Co-ordinates - Start	Species	Fish #	Tag #	Fork Length (mm)	Weight (g)	Depth of C	Mesh Type	LR/D	Notes
26-Aug-12	16:30	DL1	14W 0639596 7215454	-	-	-	-	-	-	-	-	NET SET, DEPTHS 2.3M - 5.1M - 3.1M
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	1	-	355	400	2.6	38	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	2	-	328	350	2.7	38	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	LKTR	3	-	370	525	2.7	38	LR	NO TAG, WEAK
27-Aug-12	9:00	DL1	14W 0639596 7215454	LKTR	4	-	370	525	2.8	38	LR	NO TAG, WEAK
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	5	-	255	250	2.8	38	LR	NO TAG, WEAK
27-Aug-12	9:00	DL1	14W 0639596 7215454	LKTR	6	-	167	100	2.9	38	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	LKTR	7	-	179	125	3	38	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	8	-	143	100	3	38	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	LKTR	9	-	160	100	3	38	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	LKTR	10	-	385	650	3.2	51	D	EMPTY STOMACH, NO PARASITES, MALE
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	11	-	356	600	3.4	51	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	12	-	275	250	3.6	51	LR	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	13	-	364	500	3.7	51	LR	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	LKTR	14	-	342	450	3.7	51	LR	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	LKTR	15	-	351	500	3.9	51	D	SMALL MINNOW IN STOMACH, FEMALE
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	16	-	220	300	3.9	51	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	17	-	320	400	4	51	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	18	-	263	250	4.2	51	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	LKTR	19	-	265	350	4.2	51	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	LKTR	20	-	282	425	4.2	51	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	21	-	346	400	4.4	51	LR	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	22	-	265	250	4.4	51	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	LKTR	23	-	357	550	4.6	76	LR	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	24	-	365	600	4.3	76	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	25	-	272	250	4.2	76	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	26	-	238	300	4	76	D	-
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	27	-	419	700	3.9	102	D	SMALL CHIRONOMIDS IN STOMACH
27-Aug-12	9:00	DL1	14W 0639596 7215454	RNWH	28	-	300	425	3.7	102	D	-

Appendix B- Stream Habitat Assessment Sheets

Habitat Assessment Form

Location ID: APL2BL
UTM: 15W 0356170 7135665
Date: June 20, 2012
Personnel: TT; RV

Initial Characteristics:

	Wetland
x	Stream
	Channel
	Ephermal Channel
	Braided Channel

Setting Remarks: Stream discharges Airplane Lake into Baker Lake. 3 barriers along stream include: 2 sets of culverts and one set of falls approx 5m in height.

Discharge and Velocity:

Bankful (m)			
Wetted Width (m)	4.5	5	3
Depth (m)	0.3	0.3	0.4
Velocity (m/sec)	-	-	-

Total Estimated Discharge (m3/sec): n/a

Stream Flow Comments: Consistent flow with few pools (or none): winding and cascading closer to Baker Lake opening.

Stream Substrate and Geometry:

% Substrate	
Boulders	50
Cobble Rocks	40
Gravel	10
Sediment	
Grass	
Other	

Channel Feature Comments: Well defined stream with boulder/cobble substrate and consistent depth. Stream is approximately 1km long with a large elevational change from US lake to DS lake. One set of falls approximately 5m in height is present at the midway point between the US lake and the DS lake.

Discussion: Connectivity - Very Good/Excellent
Fish Habitat - Good/Very Good. Arctic Grayling were captured DS of the culverts S of Airplane Lake, however - it is beileved they may have come through the culverts from Airplane Lake. The falls presents a very challenging barrier for fish passage. If fish are able to pass the falls, this stream would be upgraded to excellent for fish habitat and connectivity between Airplane Lake and Baker Lake.

Habitat Assessment Form

Location ID: E1
UTM: 15W 0357563 7136161
Date: June 14, 2012 (14:49)
Personnel: TT; EU

Initial Characteristics:

x	Wetland
	Stream
x	Channel
	Ephermal Channel
	Braided Channel

Setting Remarks: US pond surrounded by grassy wetlands and network of small ponds that are connected through ephermal channels. Discharge from US Pond goes into DS Lake (Airplane Lake).

Discharge and Velocity:

Bankful (m)	-	-	-
Wetted Width (m)	0.8	0.9	0.8
Depth (m)	0.3	0.2	0.25
Velocity (m/sec)	0.4	0.68	0.98

Total Estimated Discharge (m3/sec):

Stream Flow Comments: A small narrow channel less than 50m in length, with good flow during freshet.

Stream Substrate and Geometry:

% Substrate	
Boulders	30
Cobble Rocks	20
Gravel	
Sediment	
Grass	50
Other	

Channel Feature Comments: Small channel with grassy vegatated banks. Side channels/overflow will be absorbed by vegetation and tundra.

Discussion: Connectivity: Good/Fair Fish Habitat: Poor/Nil
Channel is deep enough for fish passage from US Pond to DS Lake (Airplane Lake) and vice versa however, US Pond is likely fishless as it is likely not suitable for over-wintering.

Habitat Assessment Form

Location ID: E2
UTM: 15W 0358048 7135980
Date: June 20, 2012
Personnel: TT; RV

Initial Characteristics:

x	Wetland
	Stream
	Channel
x	Ephermal Channel
	Braided Channel

Setting Remarks: US pond connects to this small wetland ephermal channel. Area dominated by saturated sedge and grassy hummocks.

Discharge and Velocity:

Bankful (m)	
Wetted Width (m)	
Depth (m)	
Velocity (m/sec)	
Total Estimated Discharge (m3/sec):	n/a

Stream Flow Comments: Slow moving current through grassland, approx 6 inches depth.

Stream Substrate and Geometry:

% Substrate	
Boulders	
Cobble Rocks	
Gravel	
Sediment	5%
Grass	95%
Other	

Channel Feature Comments: Grassy wetland area with no defined channel. Standing pools of water likely from snow melt/freshet.

Discussion: Connectivity - Nil Fish Habitat - Poor. Possible habitat for NSST.

Habitat Assessment Form

Location ID: E4
UTM: 15W 0357885 7137390
Date: June 20, 2012
Personnel: TT; RV

Initial Characteristics:

x	Wetland
	Stream
	Channel
x	Ephermal Channel
x	Braided Channel

Setting Remarks: Small US Pond drains through culvert along Prince River road through wetland area to DS lake NE of Airplane Lake.

Discharge and Velocity:

Bankful (m)	
Wetted Width (m)	
Depth (m)	
Velocity (m/sec)	
Total Estimated Discharge (m3/sec):	n/a

Stream Flow Comments: Braided channel through sedge and grass - very little flow.

Stream Substrate and Geometry:

% Substrate	
Boulders	
Cobble Rocks	
Gravel	
Sediment	10%
Grass	90%
Other	

Channel Feature Comments: Grass and sediment make up this braided channel. Standing pools and flow may only occur during freshet.

Discussion: Connectivity - Nil Fish Habitat - Nil

Habitat Assessment Form

Location ID: N1
UTM: 15W 0356254 7136076
Date: June 17, 2012 (16:30)
Personnel: TT; EU

Initial Characteristics:

x	Wetland
	Stream
	Channel
x	Ephemeral Channel
	Braided Channel

Setting Remarks: A small ephemeral channel connecting a small US fishless pond, through a grassy wetland to a DS Lake (Airplane Lake).

Discharge and Velocity:

Bankful (m)	n/a
Wetted Width (m)	n/a
Depth (m)	n/a
Velocity (m/sec)	n/a

Total Estimated Discharge (m3/sec): n/a

Stream Flow Comments: Very little flow along ephemeral channel from US Ponds to DS Lake. A few standing pools of water were present, however no defined channel was evident along this watercourse.

Stream Substrate and Geometry:

% Substrate	
Boulders	
Cobble Rocks	
Gravel	
Sediment	
Grass	100%
Other	

Channel Feature Comments: Grassy wetland area with no defined channel. Standing pools of water likely from snow melt/freshet.

Discussion: Connectivity - Nil, Fish Habitat - Nil

Additional Observations: At no time during the year will this watercourse support fish migration or provide fish habitat.

Habitat Assessment Form

Location ID: N2
UTM: 15W 0357201 7136444
Date: June 17, 2012 (15:30)
Personnel: TT; EU

Initial Characteristics:

	Wetland
x	Stream
	Channel
	Ephemeral Channel
x	Braided Channel

Setting Remarks: Small stream connecting US Lake to Airplane Lake. US lake is similar in size to Airplane Lake.

Discharge and Velocity:

	A	B	C	Avg.
Bankful (m)	-	-	-	
Wetted Width (m)	2.5	3	3	
Depth (m)	0.325	0.35	0.6	
Velocity (m/sec)	0.71	0.65	0.27	

Total Estimated Discharge (m3/sec):

Stream Flow Comments: Good flow throughout entire US and DS sections of the stream. The stream also has numerous slow moving deep pools along the banks as well as US and DS of the riffle and rapid areas.

Stream Substrate and Geometry:

% Substrate	Run	Riffle	Rapid	Pools
Boulders	20	30	60	70
Cobble Rocks	60	50	35	25
Gravel	15	15	5	5
Sediment				
Grass	5	5		
Other				

Channel Feature Comments: Main channel ranges in width from 1m - 4m. Approximately 350m US of Airplane Lake - the main channel breaks into numerous smaller channels and then returns to one main channel. These channels are often less than 1m in width, with similar substrate to that of the main channel. This break also occurs at approximately 600m and 800m US of Airplane Lake. A small chute and rapid occur approximately 500m US of Airplane Lake. In one small US section of the stream - substrate is mostly sediment and grass with the occasional rock/boulder, but eventually returns to 1m - 3m in width with similar substrate to lower sections of the stream.

Discussion: Connectivity - Very Good, Fish Habitat - Excellent. Numerous grayling were observed at various locations during the habitat assessment. Very good substrate along US and DS sections of stream which should provide excellent spawning habitat.

Habitat Assessment Form

Location ID: N2 (North)
UTM: 15W 0356699 7137111
Date: June 22, 2012
Personnel: TT; EU

Initial Characteristics:

	Wetland
x	Stream
	Channel
	Ephermal Channel
x	Braided Channel

Setting Remarks: Large US lake discharges into small pond that empties into stream which passes through culverts and connects with N2 stream which feeds into Airplane Lake.

Discharge and Velocity:

Bankful (m)	1	3	3	4
Wetted Width (m)				
Depth (m)	0.4	0.2	0.4	0.25
Velocity (m/sec)				
Total Estimated Discharge (m3/sec):			n/a	

Stream Flow Comments: Going north at culverts, stream splits in two and then splits again into numerous channels approximately 250m north of culverts. Good flow throughout enitre lenth of stream and consistent in each channel.

Stream Substrate and Geometry:

% Substrate	
Boulders	50
Cobble Rocks	25
Gravel	10
Sediment	10
Grass	5
Other	

Channel Feature Comments: Channels are approximately 1m in width on average with an average depth of 0.2m in riffle/run and an average depth of 1m in pools. Substrate consists of more boulders and cobble rocks than lower section (N2) of stream.

Discussion: Connectivity - Very Good, Fish Habitat - Excellent. Numerous grayling were observed at various locations during the habitat assessment. Very good substrate along US and DS sections of stream which should provide excellent spawning habitat.

Habitat Assessment Form

Location ID: N3
UTM: 15W 0357285 7136367
Date: June 17, 2012 (14:00)
Personnel: TT; EU

Initial Characteristics:

x	Wetland
	Stream
	Channel
	Ephermal Channel
	Braided Channel

Setting Remarks: Very small US fishless pond, spills into grassy wetland which discharges into DS Lake (Airplane Lake).

Discharge and Velocity:

Bankful (m)	n/a
Wetted Width (m)	n/a
Depth (m)	n/a
Velocity (m/sec)	n/a
Total Estimated Discharge (m3/sec):	n/a

Stream Flow Comments: None

Stream Substrate and Geometry:

% Substrate	
Boulders	
Cobble Rocks	
Gravel	
Sediment	
Grass	95%
Other (Exposed Soil)	5%

Channel Feature Comments: No distinguished channel. Area is a grassy area with moderate saturation and a few standing pools of water.

Discussion: Connectivity - Nil, Fish Habitat - Nil

Appendix C- DFO Authorizations

Licence #: S-12/13-1023-NU

Ryan VanEngen
Agnico-Eagle Mines Ltd. P.O. Box 540
Baker Lake, NU, CA X0C 0A0

Dear Ryan VanEngen,

Enclosed is your Licence to Fish for Scientific Purposes issued pursuant to Section 52 of the Fishery (General) Regulations.

Please be advised that this licence only permits those activities stated on your licence. Any other activity may require approval under the Fisheries Act or other legislation. It is the Project Authority's responsibility to obtain any other approvals.

Failure to comply with any of the conditions specified on the attached licence may result in a contravention of the Fishery (General) Regulations.

Please ensure that you include the licence number and project title in any future correspondence and that you complete the Summary Harvest Report upon completion of activities under this licence.

Yours truly,

Rory MacDonald for Chris Lewis
Fisheries Management Technician
Eastern Arctic Area
Central and Arctic Region
Fisheries and Oceans Canada

June 14, 2012
Date

Enclosure

LICENCE TO FISH FOR SCIENTIFIC PURPOSES

S-12/13-1023-NU

Pursuant to Section 52 of the Fishery (General) Regulations, the Minister of Fisheries and Oceans hereby authorizes the individual(s) listed below to fish for scientific purposes, subject to the conditions specified.

Project Authority: Ryan VanEngen
Agnico-Eagle Mines Ltd. P.O. Box 540
Baker Lake, NU, CA X0C 0A0

Other Personnel: Tom Thomson
Maggie McConnell
Morgan Finley

Objectives: Agnico-Eagle Mines Ltd. has received a NIRB Project Certificate for its Meadowbank gold project, located
70km north of Baker Lake, Nunavut. Environmental monitoring has been ongoing at this site since 1999.
The purpose of the monitoring program is to avoid or mitigate negative impacts from mine activities, and
to meet the conditions and commitments of the NIRB Project Certificate and DFO Authorization (NU-03-
0109) for the all-weather road and project lake area. Specific objectives of the aquatic sampling program
are to:
- conduct annual water, sediment, plankton, periphyton and benthic sampling of lakes immediately
surrounding the mine site to provide baseline and operational data to inform the mine environmental management program,
- monitor fish utilization of habitat structures (within project lakes)
- evaluate spawning productivity in recently constructed habitat compensation area.
- evaluate impacts to fish and fish habitat due to mine site development thru habitat monitoring as part of the no net loss of fish habitat.

CONDITIONS

Waters: Specific locations and names for the waterbodies listed (sampling methods and sample size are listed under the "Waterbodies Listed" heading):
Vault Lake - 65d04'25"N; 95d59'14"W
Phaser Lake - 65d04'06"N; 96d00'49"W
Dogleg North Pond - 65d02'28"N; 96d03'07"W
NP2 Pond - 65d02'28"N; 96d03'07"W
Dogleg Pond - 65d01'51"N; 96d02'08"W
Airplane Lake - 64d05'25"N; 95d58'07"W

Water Body: Unnamed Lake (Inuggugayualik Lake)
Point A: 65° 1' N, 96° 23' W

Species: Benthos Gear: Ponar dredge

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
						5		

Water Body: Unnamed Lake (Inuggugayualik Lake)
Point A: 65° 1' N, 96° 23' W

Species: Zooplankton — Gear: Plankton Net

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
		2.00						

Water Body: Unnamed Lake & System (Portage Lake system)
Point A: 65° 0' N, 96° 5' W

Species: Zooplankton — Gear: Plankton Net

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
		2.00						

Water Body: Unnamed Lake & System (Portage Lake system)
Point A: 65° 0' N, 96° 5' W

Species: Benthos — Gear: Ponar dredge

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
						20		

Water Body: Unnamed Lake & System (Portage Lake system)
Point A: 65° 0' N, 96° 5' W

Species: Arctic Charr (SR OR LL)
Burbot
Sculpin, Slimy
Trout, Lake
Whitefish, Round

Gear: 10 MM Mesh Gillnets and Larger

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
			100					

Water Body: Unnamed Lake (Pipedream Lake)
Point A: 65° 1' N, 96° 23' W

Species: Zooplankton — Gear: Plankton Net

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
		2.00						

Water Body: Unnamed Lake (Pipedream Lake)
Point A: 65° 1' N, 96° 23' W

Species: Benthos — Gear: Ponar dredge

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
						5		

Water Body: Baker Lake
Point A: 64° 19' N, 96° 3' W

Species: Zooplankton Gear: Plankton Net

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
		2.00						

Water Body: Baker Lake
Point A: 64° 19' N, 96° 3' W

Species: Benthos Gear: Ponar dredge

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
						15		

Water Body: Tehek Lake
Point A: 64° 55' N, 95° 38' W

Species: Benthos Gear: Ponar dredge

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
						5		

Water Body: Tehek Lake
Point A: 64° 55' N, 95° 38' W

Species: Zooplankton Gear: Plankton Net

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
		2.00						

Water Body: Unnamed Lake (Wally Lake)
Point A: 65° 6' N, 95° 57' W

Species: Zooplankton Gear: Plankton Net

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
		2.00						

Water Body: Waterbodies Listed - See Conditions
Point A: 0° 0' N, 0° 0' W

Species: Zooplankton Gear: Plankton Net

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
		2.00						

Water Body: Unnamed Lake (Wally Lake)
Point A: 65° 6' N, 95° 57' W

Species: Benthos Gear: Ponar dredge

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
						5		

Water Body: Waterbodies Listed - See Conditions
Point A: 0° 0' N, 0° 0' W

Species: Benthos Gear: Ponar dredge

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
						5		

Water Body: Waterbodies Listed - See Conditions
Point A: 0° 0' N, 0° 0' W

Species: Arctic Charr (SR OR LL)
Burbot
Sculpin, Slimy
Trout, Lake
Whitefish, Round

Gear: 10 MM Mesh Gillnets and Larger

Total Weight	Weight Live	Weight Dead	Number Alive	Number Dead	Number Tows	Number Sets	Hours	Minutes
			200	50		4		

Fishing Period: June 15, 2012 to September 30, 2012

A copy of this licence must be available at the study site and produced at the request of a fishery officer.

Live fish may not be retained unless specified in the conditions of this licence.

The licence holder shall immediately cease fishing when the total fish killed or live sampled reaches any of the maximums set for any of the species listed.

Transportation:

Other approvals/permits may be necessary to collect or transport certain species, such as Marine Mammal Transportation Permits. For marine mammal parts, products and derivatives a Marine Mammal Transportation Licence is required for domestic transport and, for international transport a Canadian CITES Export Permit is also required.

Retention & Disposal of Fish Caught:

Fish not required for the purpose of dead sampling and/or retention MUST be returned to the water at the site of capture. Retained fish may be made available to the nearest settlement for domestic consumption or sold commercially within the Territory. Any dead fish for commercial sale beyond the Territory in which it was caught requires authorization under the Fish Inspection Regulations. Disposal of any fish remains must be in accordance with local land use regulations.

Report on Activities:

The Project Authority will submit to the Area Licensing Coordinator, Department of Fisheries and Oceans, within one month of the expiry date, a report stating:

i) whether or not the field work was conducted; and if conducted

ii) waterbody location, fishing coordinates, gear types used at each coordinate, numbers or amount of fish (by species) collected and/or marked and the date or period of collection.

A Summary Harvest Report template is provided by the Licensing Coordinator at time of issuance of this licence.

The Project Authority also will provide a copy of any published or public access documents which result from the project. Information supplied will be used for population management purposes by the Department of Fisheries and Oceans and becomes part of the public record.

All documents should be sent to:

Area Licensing Administrator
Fisheries and Oceans Canada
P.O. Box 358
Iqaluit, NU X0A 0H0
Email: XCA-NUpermit@dfo-mpo.gc.ca

Notification of Commencement:

Prior to the commencement of fishing the Project Authority will contact:

Area Licencing Administrator
Fisheries and Oceans Canada
Box 358
Iqaluit, NU X0A 0H0
email: XCA-NUpermit@dfo-mpo.gc.ca

Keith Pelley
A/Area Director, Eastern Arctic Area
Central and Arctic Region
Fisheries and Oceans Canada

14-JUN-2012
Date

For the Minister of Fisheries and Oceans.

Pursuant to Section 52 of the Fishery (General) Regulations.

Canada

Date: June 13, 2012

To: Ryan VanEngen
Agnico-Eagle Mines Ltd.
Baker Lake, Nunavut, X0C 0A0

Subject: Animal Use Protocol - Letter of Approval

Dear Ryan,

Your 2012 Animal Use Protocol (AUP), number FWI-ACC-2012-038 entitled "Meadowbank Mine: Aquatic Ecosystem Monitoring Plan (AEMP)", has been reviewed and approved by the Freshwater Institute Animal Care Committee. This AUP will expire on October 01, 2012.

Keep this signed letter of approval as well as the signed AUP approval form for your records. Please be advised that should there be a need to revise the protocol you are requested to contact the Freshwater Institute Animal Care Committee and obtain approval prior to proceeding.

In addition, you are required to submit a brief report within 30 days of completion of the project outlining the unexpected changes to the protocol, the number of animals used and any unanticipated results or mortalities. The report form is attached in your approval email.

Feel free to contact me if you have any questions or concerns.

Sincerely,

Kerri Pleskach *FWISL-ACC Acting Chairperson*

Freshwater Institute Science Laboratories Animal Care Committee
Arctic Aquatic Research
Central & Arctic / Région du Centre et de l'Arctique
Fisheries and Oceans Canada / Pêches et Océans Canada
501 University Crescent
Winnipeg, Manitoba R3T 2N6
Phone:204 984-2532
Fax:204 984-2403

Enclosure

Canada

APPROVAL BY ANIMAL CARE COMMITTEE MEMBERS

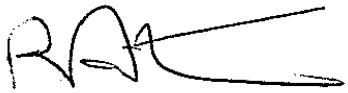
AUP#: ACC-2012-038 Date: June 13, 2012

Signatures of ACC Members

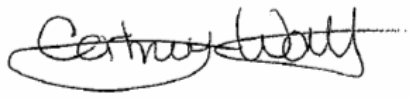
Kerri Pleskach, Chair

Theresa Carmichael

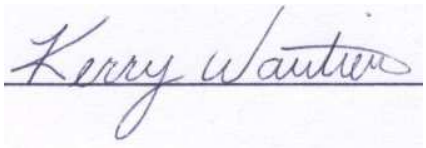
Dr. Ericka Anseeuw D.V.M.



Bob Artes



Cortney Watt



Kerry Wautier

Megan Desai

Bernard LeBlanc

Interim Approval ☐ **Final Approval** ☒

APPROVAL BY THE FWI ANIMAL CARE COMMITTEE IS FOR THE PERIOD STATED ON YOUR ANIMAL USE PROTOCOL.

Pêches et Océans Canada Fisheries and Oceans Canada

APPENDIX F – HU Subtotals and Totals by Species

Second Portage Lake
Losses from Mine Activities and Gains from Re-flooding

TOTAL BY FEATURE - Summary

Second Portage Lake				
Portage Pit in 2PL	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	1.21		0.39	0.00
4	0.13		0.05	0.00
5			0.00	0.00
6	1.58		1.34	0.00
7	11.88		4.91	0.00
8			0.00	0.00
9	0.98	15.79	0.76	12.32
11			0.00	0.00
Total	15.79	15.79	7.45	12.32

Second Portage Lake				
Portage Pit Cap in 2PL	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	0.14	0.14	0.05	0.05
4	0.03		0.01	0.00
5			0.00	0.00
6	0.12	0.15	0.10	0.13
7	2.73		1.13	0.00
8			0.00	0.00
9	0.09	2.82	0.07	2.20
11			0.00	0.00
Total	3.11	3.11	1.36	2.37

Second Portage Lake				
Roads	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	1.10	1.10	0.35	0.35
4	0.08		0.03	0.00
5			0.00	0.00
6	0.99	1.07	0.84	0.91
7	5.65		2.33	0.00
8			0.00	0.00
9	0.40	6.05	0.31	4.72
11			0.00	0.00
Total	8.22	8.22	3.87	5.98

Second Portage Lake				
Basin	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2		0.00	0.00	0.00
3	0.27	0.27	0.09	0.09
4	0.04		0.02	0.00
5		0.04	0.00	0.03
6	1.01	1.01	0.86	0.86
7	4.96		2.05	0.00
8		4.96	0.00	3.04
9	0.58	0.58	0.45	0.45
11			0.00	0.00
Total	6.86	6.86	3.46	4.47

Second Portage Lake				
East Dike	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	0.37	0.36	0.12	0.11
4	0.22		0.09	0.00
5			0.00	0.00
6	2.14	0.08	1.82	0.07
7	1.56		0.65	0.00
8			0.00	0.00
9	-0.17	0.09	-0.14	0.07
11			0.00	0.00
Total	4.12	0.53	2.53	0.25

HU LOSSES - Species Totals

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.11	0.21	0.04	0.02	0.00	0.00	0.00	0.00
4	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.54	0.58	0.16	0.06	0.00	0.00	0.00	0.00
7	1.88	2.03	0.79	0.20	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.31	0.34	0.08	0.04	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2.86	3.18	1.09	0.33	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00
4	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.04	0.04	0.01	0.00	0.00	0.00	0.00	0.00
7	0.43	0.47	0.18	0.05	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.03	0.03	0.01	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.52	0.57	0.21	0.06	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.10	0.19	0.04	0.02	0.00	0.00	0.00	0.00
4	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.34	0.36	0.10	0.04	0.00	0.00	0.00	0.00
7	0.89	0.97	0.38	0.10	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.13	0.14	0.03	0.02	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.47	1.67	0.56	0.17	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.02	0.05	0.01	0.01	0.00	0.00	0.00	0.00
4	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.34	0.37	0.11	0.04	0.00	0.00	0.00	0.00
7	0.78	0.85	0.33	0.08	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.18	0.20	0.05	0.02	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.34	1.47	0.49	0.15	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.03	0.06	0.01	0.01	0.00	0.00	0.00	0.00
4	0.03	0.04	0.01	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.73	0.78	0.22	0.09	0.00	0.00	0.00	0.00
7	0.25	0.27	0.10	0.03	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	-0.05	-0.06	-0.01	-0.01	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.99	1.09	0.34	0.12	0.00	0.00	0.00	0.00

HU LOSSES -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.05	0.05	0.00	0.00	0.12	0.09	0.00	0.00	0.03	0.02	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00
4	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.14	0.14	0.14	0.11	0.15	0.15	0.15	0.12	0.05	0.05	0.04	0.04	0.02	0.01	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.01
7	0.00	0.27	0.54	1.08	0.00	0.29	0.58	1.16	0.00	0.09	0.35	0.35	0.00	0.00	0.04	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.07	0.00	0.00	0.07	0.15
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.09	0.04	0.09	0.09	0.10	0.05	0.10	0.10	0.02	0.01	0.01	0.03	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.23	0.52	0.83	1.28	0.25	0.62	0.93	1.38	0.07	0.18	0.42	0.42	0.03	0.03	0.08	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.08	0.09	0.00	0.01	0.11	0.18

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.09	0.09	0.09	0.07	0.10	0.10	0.10	0.07	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.11	0.22	0.45	0.00	0.12	0.24	0.48	0.00	0.04	0.15	0.15	0.00	0.00	0.02	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	0.03	0.06
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.05	0.03	0.05	0.05	0.06	0.03	0.06	0.06	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.14	0.24	0.38	0.57	0.16	0.28	0.42	0.62	0.04	0.08	0.18	0.19	0.02	0.01	0.04	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.04	0.00	0.00	0.05	0.08

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.02	0.02	0.00	0.00	0.04	0.03	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.19	0.19	0.19	0.15	0.21	0.21	0.21	0.16	0.06	0.06	0.05	0.05	0.02	0.01	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.03	0.02
7	0.00	0.04	0.07	0.14	0.00	0.04	0.08	0.15	0.00	0.01	0.05	0.05	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.01	0.02
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	-0.02	-0.01	-0.02	-0.02	-0.02	-0.01	-0.02	-0.02	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.18	0.25	0.28	0.29	0.19	0.29	0.31	0.31	0.06	0.08	0.10	0.09	0.02	0.02	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.00	0.00	0.04	0.04

Second Portage Lake
Losses from Mine Activities and Gains from Re-flooding

TOTAL BY FEATURE - Summary

Second Portage Lake				
Central Dike	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	0.49	0.02	0.16	0.01
4	0.09		0.04	0.00
5			0.00	0.00
6	0.66	0.10	0.56	0.08
7	15.64		6.46	0.00
8			0.00	0.00
9	0.74	0.91	0.58	0.71
11			0.00	0.00
Total	17.62	1.03	7.79	0.80

Second Portage Lake				
Tailings Storage Facility	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.02		0.00	0.00
2			0.00	0.00
3	4.66		1.48	0.00
4	4.08		1.66	0.00
5			0.00	0.00
6	8.73		7.42	0.00
7	57.99		23.94	0.00
8			0.00	0.00
9	4.30		3.36	0.00
11			0.00	0.00
Total	79.79	0.00	37.85	0.00

HU LOSSES - Species Totals

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.04	0.08	0.02	0.01	0.00	0.00	0.00	0.00
4	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.22	0.24	0.07	0.03	0.00	0.00	0.00	0.00
7	2.48	2.67	1.04	0.26	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.23	0.25	0.06	0.03	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2.99	3.27	1.19	0.33	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.42	0.80	0.17	0.09	0.00	0.00	0.00	0.00
4	0.65	0.70	0.24	0.07	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	2.96	3.20	0.90	0.35	0.00	0.00	0.00	0.00
7	9.18	9.92	3.86	0.98	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	1.36	1.47	0.35	0.17	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	14.57	16.08	5.53	1.67	0.00	0.00	0.00	0.00

HU LOSSES -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight																																
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.02	0.02	0.00	0.00	0.05	0.04	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.06	0.06	0.06	0.04	0.06	0.06	0.06	0.05	0.02	0.02	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
7	0.00	0.35	0.71	1.41	0.00	0.38	0.76	1.53	0.00	0.12	0.46	0.46	0.00	0.00	0.05	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.10	0.00	0.00	0.10	0.20
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.07	0.03	0.07	0.07	0.07	0.04	0.07	0.07	0.02	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.13	0.47	0.86	1.53	0.14	0.54	0.94	1.66	0.04	0.16	0.50	0.50	0.01	0.01	0.08	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.08	0.11	0.00	0.00	0.12	0.21

Habitat type area x HSI x species weight x life function weight																																
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.21	0.21	0.00	0.00	0.46	0.34	0.00	0.00	0.10	0.07	0.00	0.00	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.03	0.01	0.00
4	0.00	0.18	0.18	0.28	0.00	0.20	0.20	0.30	0.00	0.03	0.12	0.09	0.00	0.01	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.00	0.00	0.03	0.04
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.79	0.79	0.79	0.59	0.85	0.85	0.85	0.64	0.26	0.26	0.19	0.19	0.09	0.06	0.12	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.00	0.00	0.11	0.08
7	0.00	1.31	2.62	5.25	0.00	1.42	2.83	5.67	0.00	0.43	1.72	1.72	0.00	0.00	0.20	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.36	0.00	0.00	0.36	0.72
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.39	0.19	0.39	0.39	0.42	0.21	0.42	0.42	0.10	0.06	0.06	0.13	0.04	0.01	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.02	0.03	0.00	0.00	0.05	0.05
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.18	2.69	4.20	6.50	1.27	3.14	4.65	7.03	0.35	0.89	2.16	2.13	0.13	0.15	0.42	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.08	0.38	0.45	0.00	0.03	0.57	0.90

Second Portage Lake
Losses from Mine Activities and Gains from Re-flooding

TOTAL BY FEATURE - Summary

Second Portage Lake				
Portage Pit in 2PL	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	1.21		0.39	0.00
4	0.13		0.05	0.00
5			0.00	0.00
6	1.58		1.34	0.00
7	11.88		4.91	0.00
8			0.00	0.00
9	0.98	15.79	0.76	12.32
11			0.00	0.00
Total	15.79	15.79	7.45	12.32

HU GAINS - Species Totals

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	5.00	5.40	1.29	0.64	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	5.00	5.40	1.29	0.64	0.00	0.00	0.00	0.00

HU GAINS -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	1.43	0.71	1.43	1.43	1.54	0.77	1.54	1.54	0.35	0.23	0.23	0.47	0.16	0.05	0.21	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.02	0.07	0.10	0.00	0.00	0.20	0.20
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.43	0.71	1.43	1.43	1.54	0.77	1.54	1.54	0.35	0.23	0.23	0.47	0.16	0.05	0.21	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.02	0.07	0.10	0.00	0.00	0.20	0.20

Second Portage Lake				
Portage Pit Cap in 2PL	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	0.14	0.14	0.05	0.05
4	0.03		0.01	0.00
5			0.00	0.00
6	0.12	0.15	0.10	0.13
7	2.73		1.13	0.00
8			0.00	0.00
9	0.09	2.82	0.07	2.20
11			0.00	0.00
Total	3.11	3.11	1.36	2.37

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.05	0.06	0.02	0.01	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.89	0.96	0.23	0.11	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.96	1.04	0.25	0.12	0.00	0.00	0.00	0.00

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.25	0.13	0.25	0.25	0.28	0.14	0.28	0.28	0.06	0.04	0.04	0.08	0.03	0.01	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.02	0.00	0.00	0.04	0.04
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.27	0.15	0.28	0.27	0.29	0.17	0.30	0.29	0.07	0.05	0.05	0.09	0.03	0.01	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.02	0.00	0.00	0.04	0.04

Second Portage Lake				
Roads	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	1.10	1.10	0.35	0.35
4	0.08		0.03	0.00
5			0.00	0.00
6	0.99	1.07	0.84	0.91
7	5.65		2.33	0.00
8			0.00	0.00
9	0.40	6.05	0.31	4.72
11			0.00	0.00
Total	8.22	8.22	3.87	5.98

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.10	0.19	0.04	0.02	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.36	0.39	0.11	0.04	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	1.92	2.07	0.49	0.24	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2.38	2.65	0.64	0.31	0.00	0.00	0.00	0.00

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.05	0.05	0.00	0.00	0.11	0.08	0.00	0.00	0.02	0.02	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.10	0.10	0.10	0.07	0.10	0.10	0.10	0.08	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.55	0.27	0.55	0.55	0.59	0.30	0.59	0.59	0.13	0.09	0.09	0.18	0.06	0.02	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.03	0.04	0.00	0.00	0.08	0.08
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.64	0.42	0.69	0.62	0.70	0.51	0.78	0.67	0.17	0.15	0.13	0.20	0.07	0.04	0.10	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.04	0.04	0.00	0.01	0.09	0.09

Second Portage Lake				
Basin	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2		0.00	0.00	0.00
3	0.27	0.27	0.09	0.09
4	0.04		0.02	0.00
5		0.04	0.00	0.03
6	1.01	1.01	0.86	0.86
7	4.96		2.05	0.00
8		4.96	0.00	3.04
9	0.58	0.58	0.45	0.45
11			0.00	0.00
Total	6.86	6.86	3.46	4.47

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.02	0.05	0.01	0.01	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
6	0.34	0.37	0.11	0.04	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	1.23	1.33	0.29	0.18	0.00	0.00	0.00	0.00
9	0.18	0.20	0.05	0.02	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.79	1.96	0.46	0.25	0.00	0.00	0.00	0.00

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.01	0.01	0.00	0.00	0.03	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.09	0.09	0.09	0.07	0.10	0.10	0.10	0.07	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.22	0.22	0.34	0.45	0.24	0.24	0.36	0.48	0.04	0.04	0.07	0.15	0.07	0.00	0.05	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.03	0.03	0.00	0.00	0.06	0.06
9	0.05	0.03	0.05	0.05	0.06	0.03	0.06	0.06	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.37	0.36	0.50	0.57	0.40	0.40	0.54	0.62	0.08	0.08	0.11	0.19	0.08	0.01	0.07	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.00	0.00	0.08	0.08

Second Portage Lake				
East Dike	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	0.37	0.36	0.12	0.11
4	0.22		0.09	0.00
5			0.00	0.00
6	2.14	0.08	1.82	0.07
7	1.56		0.65	0.00
8			0.00	0.00
9	-0.17	0.09	-0.14	0.07
11			0.00	0.00
Total	4.12	0.53	2.53	0.25

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.03	0.06	0.01	0.01	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.03	0.03	0.01	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.03	0.03	0.01	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.09	0.12	0.03	0.01	0.00	0.00	0.00	0.00

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.02	0.02	0.00	0.00	0.04	0.03	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Second Portage Lake
Losses from Mine Activities and Gains from Re-flooding

TOTAL BY FEATURE - Summary

Second Portage Lake				
Central Dike	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	0.49	0.02	0.16	0.01
4	0.09		0.04	0.00
5			0.00	0.00
6	0.66	0.10	0.56	0.08
7	15.64		6.46	0.00
8			0.00	0.00
9	0.74	0.91	0.58	0.71
11			0.00	0.00
Total	17.62	1.03	7.79	0.80

HU GAINS - Species Totals

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.03	0.04	0.01	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.29	0.31	0.07	0.04	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.32	0.35	0.09	0.04	0.00	0.00	0.00	0.00

HU GAINS -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight																																
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.08	0.04	0.08	0.08	0.09	0.04	0.09	0.09	0.02	0.01	0.01	0.03	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.09	0.05	0.09	0.09	0.10	0.06	0.10	0.10	0.02	0.02	0.02	0.03	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01

Second Portage Lake				
Tailings Storage Facility	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.02		0.00	0.00
2			0.00	0.00
3	4.66		1.48	0.00
4	4.08		1.66	0.00
5			0.00	0.00
6	8.73		7.42	0.00
7	57.99		23.94	0.00
8			0.00	0.00
9	4.30		3.36	0.00
11			0.00	0.00
Total	79.79	0.00	37.85	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Habitat type area x HSI x species weight x life function weight																																
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Third Portage Lake
Losses from Mining Activities and Gains from Re-flooding

TOTAL BY FEATURE - Summary

Third Portage Lake

Portage Pit in 3PL	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.15		0.02	0.00
2			0.00	0.00
3	4.10		1.31	0.00
4	0.90		0.37	0.00
5			0.00	0.00
6	1.31		1.12	0.00
7	1.24		0.51	0.00
8			0.00	0.00
9	0.11		0.08	0.00
11		7.82	0.00	3.83
Total	**7.82**	**7.82**	**3.41**	**3.83**

Third Portage Lake

Portage Pit Cap in 3PL	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.08		0.01	0.00
2			0.00	0.00
3	0.73	0.81	0.23	0.26
4	0.40		0.16	0.00
5			0.00	0.00
6	0.23	0.63	0.20	0.54
7	0.61		0.25	0.00
8			0.00	0.00
9	0.02	0.63	0.01	0.49
11			0.00	0.00
Total	**2.07**	**2.07**	**0.87**	**1.28**

Third Portage Lake

Portage Pit Land-to-Lake	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3			0.00	0.00
4			0.00	0.00
5			0.00	0.00
6			0.00	0.00
7			0.00	0.00
8			0.00	0.00
9		7.73	0.00	6.04
11		31.64	0.00	15.48
Total	**0.00**	**39.37**	**0.00**	**21.51**

Third Portage Lake

Goose Pit	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.02		0.00	0.00
2			0.00	0.00
3	4.02		1.28	0.00
4	1.65		0.67	0.00
5			0.00	0.00
6	1.33		1.13	0.00
7	7.66		3.16	0.00
8			0.00	0.00
9	0.23		0.18	0.00
11		14.91	0.00	7.29
Total	**14.91**	**14.91**	**6.43**	**7.29**

Third Portage Lake

Goose Pit Cap	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	1.32	1.32	0.42	0.42
4	0.22		0.09	0.00
5			0.00	0.00
6	0.49	0.71	0.42	0.61
7	1.79		0.74	0.00
8			0.00	0.00
9	0.09	1.88	0.07	1.47
11			0.00	0.00
Total	**3.91**	**3.91**	**1.74**	**2.49**

HU LOSSES - Species Totals

HU total per species x access weight

Third Portage Lake

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.37	0.70	0.15	0.08	0.00	0.00	0.00	0.00
4	0.14	0.15	0.05	0.02	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	0.48	0.14	0.05	0.00	0.00	0.00	0.00
7	0.20	0.21	0.08	0.02	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.03	0.04	0.01	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.20	1.59	0.44	0.18	0.00	0.00	0.00	0.00

HU total per species x access weight

Third Portage Lake

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.07	0.12	0.03	0.01	0.00	0.00	0.00	0.00
4	0.06	0.07	0.02	0.01	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.08	0.09	0.02	0.01	0.00	0.00	0.00	0.00
7	0.10	0.10	0.04	0.01	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.31	0.39	0.12	0.04	0.00	0.00	0.00	0.00

HU total per species x access weight

Third Portage Lake

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

HU total per species x access weight

Third Portage Lake

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.36	0.69	0.15	0.08	0.00	0.00	0.00	0.00
4	0.26	0.28	0.10	0.03	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	0.49	0.14	0.05	0.00	0.00	0.00	0.00
7	1.21	1.31	0.51	0.13	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.07	0.08	0.02	0.01	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2.36	2.85	0.91	0.30	0.00	0.00	0.00	0.00

HU total per species x access weight

Third Portage Lake

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.12	0.23	0.05	0.03	0.00	0.00	0.00	0.00
4	0.03	0.04	0.01	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.17	0.18	0.05	0.02	0.00	0.00	0.00	0.00
7	0.28	0.31	0.12	0.03	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.03	0.03	0.01	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.63	0.78	0.24	0.08	0.00	0.00	0.00	0.00

HU LOSSES -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight

Third Portage Lake

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.19	0.19	0.00	0.00	0.40	0.30	0.00	0.00	0.09	0.06	0.00	0.00	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.03	0.01	0.00
4	0.00	0.04	0.04	0.06	0.00	0.04	0.04	0.07	0.00	0.01	0.03	0.02	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.12	0.12	0.12	0.09	0.13	0.13	0.13	0.10	0.04	0.04	0.03	0.03	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.01
7	0.00	0.03	0.06	0.11	0.00	0.03	0.06	0.12	0.00	0.01	0.04	0.04	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.02
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.13**	**0.38**	**0.41**	**0.27**	**0.14**	**0.61**	**0.55**	**0.29**	**0.04**	**0.15**	**0.16**	**0.09**	**0.01**	**0.07**	**0.05**	**0.04**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.03**	**0.04**	**0.02**	**0.00**	**0.03**	**0.04**	**0.04**

Habitat type area x HSI x species weight x life function weight

Third Portage Lake

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.03	0.03	0.00	0.00	0.07	0.05	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.02	0.02	0.03	0.00	0.02	0.02	0.03	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.01	0.03	0.06	0.00	0.01	0.03	0.06	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.02**	**0.09**	**0.10**	**0.10**	**0.02**	**0.13**	**0.13**	**0.11**	**0.01**	**0.03**	**0.05**	**0.03**	**0.00**	**0.01**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**	**0.00**	**0.00**	**0.01**	**0.01**

Habitat type area x HSI x species weight x life function weight

Third Portage Lake

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.06	0.06	0.00	0.00	0.13	0.10	0.00	0.00	0.03	0.02	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00
4	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.04	0.04	0.04	0.03	0.05	0.05	0.05	0.04	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
7	0.00	0.04	0.08	0.16	0.00	0.04	0.09	0.17	0.00	0.01	0.05	0.05	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.02
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.05**	**0.16**	**0.20**	**0.22**	**0.06**	**0.24**	**0.25**	**0.24**	**0.02**	**0.06**	**0.09**	**0.07**	**0.01**	**0.02**	**0.02**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.02**	**0.02**	**0.00**	**0.01**	**0.02**	**0.03**

Habitat type area x HSI x species weight x life function weight

Third Portage Lake

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Habitat type area x HSI x species weight x life function weight

Third Portage Lake

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.06	0.06	0.00	0.00	0.13	0.10	0.00	0.00	0.03	0.02	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.

Third Portage Lake

Losses from Mining Activities and Gains from Re-flooding

TOTAL BY FEATURE - Summary

Third Portage Lake				
Goose Pit Land-to-Lake	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3			0.00	0.00
4			0.00	0.00
5			0.00	0.00
6			0.00	0.00
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11		4.10	0.00	2.01
Total	**0.00**	**4.10**	**0.00**	**2.01**

Third Portage Lake				
Basin, inc boulder garden	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.07		0.01	0.00
2		0.07	0.00	0.01
3	7.77	7.77	2.47	2.47
4	3.19		1.29	0.00
5		3.19	0.00	2.04
6	5.52	5.52	4.69	4.69
7	20.28		8.37	0.00
8		17.31	0.00	10.62
9	1.06	4.03	0.83	3.14
11			0.00	0.00
Total	**37.89**	**37.89**	**17.67**	**22.99**

Third Portage Lake				
Bay-Goose Dike	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.04		0.01	0.00
2	0.00		0.00	0.00
3	5.98	3.12	1.90	0.99
4	1.64		0.67	0.00
5	0.00		0.00	0.00
6	3.51	1.22	2.98	1.04
7	8.92		3.68	0.00
8	0.00		0.00	0.00
9	-2.83	0.75	-2.20	0.59
11			0.00	0.00
Total	**17.27**	**5.09**	**7.04**	**2.62**

Third Portage Lake				
South Camp Dike	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	0.39	0.13	0.12	0.04
4			0.00	0.00
5			0.00	0.00
6		0.00	0.00	0.00
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11			0.00	0.00
Total	**0.39**	**0.13**	**0.12**	**0.04**

HU LOSSES - Species Totals

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.70	1.33	0.29	0.16	0.00	0.00	0.00	0.00
4	0.50	0.55	0.19	0.05	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	1.87	2.02	0.57	0.22	0.00	0.00	0.00	0.00
7	3.21	3.47	1.35	0.34	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.34	0.36	0.09	0.04	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	6.63	7.73	2.49	0.82	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.54	1.02	0.22	0.12	0.00	0.00	0.00	0.00
4	0.26	0.28	0.10	0.03	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	1.19	1.29	0.36	0.14	0.00	0.00	0.00	0.00
7	1.41	1.53	0.59	0.15	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	-0.89	-0.97	-0.23	-0.11	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2.51	3.15	1.05	0.33	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.04	0.07	0.01	0.01	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.04	0.07	0.01	0.01	0.00	0.00	0.00	0.00

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.02	0.02	0.00	0.00	0.04	0.03	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**	**0.02**	**0.02**	**0.00**	**0.00**	**0.04**	**0.03**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.27	0.27	0.00	0.00	0.58	0.44	0.00	0.00	0.13	0.09	0.00	0.00	0.08	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.00	0.04	0.02	0.00
4	0.00	0.07	0.07	0.11	0.00	0.08	0.08	0.12	0.00	0.01	0.05	0.04	0.00	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.02
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.32	0.32	0.32	0.24	0.34	0.34	0.34	0.26	0.10	0.10	0.08	0.08	0.04	0.02	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.00	0.00	0.04	0.03
7	0.00	0.20	0.40	0.81	0.00	0.22	0.44	0.87	0.00	0.07	0.26	0.26	0.00	0.00	0.03	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.06	0.00	0.00	0.06	0.11
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	-0.26	-0.13	-0.26	-0.26	-0.28	-0.14	-0.28	-0.28	-0.06	-0.04	-0.04	-0.08	-0.03	-0.01	-0.04	-0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	-0.01	-0.02	0.00	0.00	-0.04	-0.04
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.06**	**0.74**	**0.81**	**0.90**	**0.07**	**1.09**	**1.02**	**0.97**	**0.04**	**0.27**	**0.44**	**0.29**	**0.01**	**0.10**	**0.09**	**0.13**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.09**	**0.06**	**0.00**	**0.04**	**0.09**	**0.12**

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.02	0.02	0.00	0.00	0.04	0.03	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**	**0.02**	**0.02**	**0.00**	**0.00**	**0.04**	**0.03**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Third Portage Lake

Losses from Mining Activities and Gains from Re-flooding

TOTAL BY FEATURE - Summary

Third Portage Lake				
Roads	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	1.68	1.68	0.54	0.54
4	0.60		0.24	0.00
5			0.00	0.00
6	1.11	1.71	0.95	1.46
7	1.41		0.58	0.00
8			0.00	0.00
9	0.12	1.53	0.09	1.20
11			0.00	0.00
Total	4.93	4.93	2.40	3.19

Third Portage Lake				
Dike Breach	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3			0.00	0.00
4			0.00	0.00
5			0.00	0.00
6		0.86	0.00	0.73
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11			0.00	0.00
Total	0.00	0.86	0.00	0.73

HU LOSSES - Species Totals

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.15	0.29	0.06	0.03	0.00	0.00	0.00	0.00
4	0.10	0.10	0.04	0.01	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.38	0.41	0.12	0.05	0.00	0.00	0.00	0.00
7	0.22	0.24	0.09	0.02	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.04	0.04	0.01	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.89	1.08	0.32	0.12	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

HU LOSSES -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight																																
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.08	0.08	0.00	0.00	0.16	0.12	0.00	0.00	0.04	0.02	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00
4	0.00	0.03	0.03	0.04	0.00	0.03	0.03	0.04	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.10	0.10	0.10	0.08	0.11	0.11	0.11	0.08	0.03	0.03	0.02	0.02	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01
7	0.00	0.03	0.06	0.13	0.00	0.03	0.07	0.14	0.00	0.01	0.04	0.04	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.02
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.11**	**0.24**	**0.28**	**0.26**	**0.12**	**0.34**	**0.34**	**0.28**	**0.04**	**0.09**	**0.11**	**0.08**	**0.01**	**0.03**	**0.03**	**0.04**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.02**	**0.03**	**0.02**	**0.00**	**0.01**	**0.03**	**0.04**

Habitat type area x HSI x species weight x life function weight																																
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Third Portage Lake
Losses from Mining Activities and Gains from Re-flooding

TOTAL BY FEATURE - Summary

Third Portage Lake				
Portage Pit in 3PL	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.15		0.02	0.00
2			0.00	0.00
3	4.10		1.31	0.00
4	0.90		0.37	0.00
5			0.00	0.00
6	1.31		1.12	0.00
7	1.24		0.51	0.00
8			0.00	0.00
9	0.11		0.08	0.00
11		7.82	0.00	3.83
Total	**7.82**	**7.82**	**3.41**	**3.83**

Third Portage Lake				
Portage Pit Cap in 3PL	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.08		0.01	0.00
2			0.00	0.00
3	0.73	0.81	0.23	0.26
4	0.40		0.16	0.00
5			0.00	0.00
6	0.23	0.63	0.20	0.54
7	0.61		0.25	0.00
8			0.00	0.00
9	0.02	0.63	0.01	0.49
11			0.00	0.00
Total	**2.07**	**2.07**	**0.87**	**1.28**

Third Portage Lake				
Portage Pit Land-to-Lake	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3			0.00	0.00
4			0.00	0.00
5			0.00	0.00
6			0.00	0.00
7			0.00	0.00
8			0.00	0.00
9		7.73	0.00	6.04
11		31.64	0.00	15.48
Total	**0.00**	**39.37**	**0.00**	**21.51**

Third Portage Lake				
Goose Pit	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.02		0.00	0.00
2			0.00	0.00
3	4.02		1.28	0.00
4	1.65		0.67	0.00
5			0.00	0.00
6	1.33		1.13	0.00
7	7.66		3.16	0.00
8			0.00	0.00
9	0.23		0.18	0.00
11		14.91	0.00	7.29
Total	**14.91**	**14.91**	**6.43**	**7.29**

Third Portage Lake				
Goose Pit Cap	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	1.32	1.32	0.42	0.42
4	0.22		0.09	0.00
5			0.00	0.00
6	0.49	0.71	0.42	0.61
7	1.79		0.74	0.00
8			0.00	0.00
9	0.09	1.88	0.07	1.47
11			0.00	0.00
Total	**3.91**	**3.91**	**1.74**	**2.49**

HU GAINS - Species Totals

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	1.41	1.91	0.29	0.21	0.00	0.00	0.00	0.00
Total	1.41	1.91	0.29	0.21	0.00	0.00	0.00	0.00

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.71	0.71	0.38	0.00	0.76	0.76	0.00	0.00	0.06	0.23	0.00	0.00	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.04	0.05	0.00	0.00	0.00	0.10
Total	**0.00**	**0.00**	**0.71**	**0.71**	**0.38**	**0.00**	**0.76**	**0.76**	**0.00**	**0.00**	**0.06**	**0.23**	**0.00**	**0.00**	**0.11**	**0.11**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.04**	**0.05**	**0.00**	**0.00**	**0.00**	**0.10**

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.07	0.14	0.03	0.02	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.21	0.23	0.07	0.03	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.20	0.21	0.05	0.03	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.49	0.58	0.15	0.07	0.00	0.00	0.00	0.00

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.04	0.04	0.00	0.00	0.08	0.06	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.06	0.06	0.06	0.04	0.06	0.06	0.06	0.05	0.02	0.02	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.06	0.03	0.06	0.06	0.06	0.03	0.06	0.06	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.11**	**0.12**	**0.15**	**0.10**	**0.12**	**0.17**	**0.18**	**0.11**	**0.03**	**0.05**	**0.04**	**0.03**	**0.01**	**0.02**	**0.02**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	**0.00**	**0.01**	**0.02**	**0.01**

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	2.45	2.65	0.63	0.31	0.00	0.00	0.00	0.00
11	5.72	7.73	1.17	0.85	0.00	0.00	0.00	0.00
Total	8.17	10.37	1.80	1.16	0.00	0.00	0.00	0.00

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.70	0.35	0.70	0.70	0.76	0.38	0.76	0.76	0.17	0.11	0.11	0.23	0.08	0.03	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.04	0.05	0.00	0.00	0.10	0.10
11	0.00	0.00	2.86	2.86	1.55	0.00	3.09	3.09	0.00	0.00	0.23	0.94	0.00	0.00	0.43	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.15	0.20	0.00	0.00	0.00	0.40
Total	**0.70**	**0.35**	**3.56**	**3.56**	**2.30**	**0.38**	**3.85**	**3.85**	**0.17**	**0.11**	**0.35**	**1.17**	**0.08**	**0.03**	**0.53**	**0.53**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.10**	**0.01**	**0.18**	**0.25**	**0.00**	**0.00**	**0.10**	**0.49**

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.12	0.23	0.05	0.03	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.24	0.26	0.07	0.03	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.59	0.64	0.15	0.08	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.96	1.13	0.28	0.13	0.00	0.00	0.00	0.00

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.06	0.06	0.00	0.00	0.13	0.10	0.00	0.00	0.03	0.02	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.06	0.06	0.06	0.05	0.07	0.07	0.07	0.05	0.02	0.02	0.02	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.17	0.08	0.17	0.17	0.18	0.09	0.18	0.18	0.04	0.03	0.03	0.06	0.02	0.01	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.02	0.02
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.23**	**0.21**	**0.29**	**0.22**	**0.25**	**0.29**	**0.35**	**0.24**	**0.06**	**0.08**	**0.06**	**0.07**	**0.03**	**0.03**	**0.04**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.01**	**0.02**	**0.02**	**0.00**	**0.01**	**0.04**	**0.03**

Third Portage Lake

Losses from Mining Activities and Gains from Re-flooding

TOTAL BY FEATURE - Summary

Third Portage Lake				
Goose Pit Land-to-Lake	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3			0.00	0.00
4			0.00	0.00
5			0.00	0.00
6			0.00	0.00
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11		4.10	0.00	2.01
Total	**0.00**	**4.10**	**0.00**	**2.01**

Third Portage Lake				
Basin, inc boulder garden	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.07		0.01	0.00
2		0.07	0.00	0.01
3	7.77	7.77	2.47	2.47
4	3.19		1.29	0.00
5		3.19	0.00	2.04
6	5.52	5.52	4.69	4.69
7	20.28		8.37	0.00
8		17.31	0.00	10.62
9	1.06	4.03	0.83	3.14
11			0.00	0.00
Total	**37.89**	**37.89**	**17.67**	**22.99**

Third Portage Lake				
Bay-Goose Dike	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.04		0.01	0.00
2	0.00		0.00	0.00
3	5.98	3.12	1.90	0.99
4	1.64		0.67	0.00
5	0.00		0.00	0.00
6	3.51	1.22	2.98	1.04
7	8.92		3.68	0.00
8	0.00		0.00	0.00
9	-2.83	0.75	-2.20	0.59
11			0.00	0.00
Total	**17.27**	**5.09**	**7.04**	**2.62**

Third Portage Lake				
South Camp Dike	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	0.39	0.13	0.12	0.04
4			0.00	0.00
5			0.00	0.00
6		0.00	0.00	0.00
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11			0.00	0.00
Total	**0.39**	**0.13**	**0.12**	**0.04**

HU GAINS - Species Totals

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.74	1.00	0.15	0.11	0.00	0.00	0.00	0.00
Total	0.74	1.00	0.15	0.11	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
3	0.70	1.33	0.29	0.16	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.79	0.86	0.26	0.13	0.00	0.00	0.00	0.00
6	1.87	2.02	0.57	0.22	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	4.31	4.65	1.02	0.64	0.00	0.00	0.00	0.00
9	1.28	1.38	0.33	0.16	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	8.95	10.24	2.47	1.31	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.28	0.53	0.12	0.06	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.41	0.45	0.13	0.05	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.24	0.26	0.06	0.03	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.93	1.24	0.30	0.14	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00

HU GAINS -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.37	0.37	0.20	0.00	0.40	0.40	0.00	0.00	0.03	0.12	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.03	0.00	0.00	0.00	0.05
Total	**0.00**	**0.00**	**0.37**	**0.37**	**0.20**	**0.00**	**0.40**	**0.40**	**0.00**	**0.00**	**0.03**	**0.12**	**0.00**	**0.00**	**0.06**	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.02**	**0.03**	**0.00**	**0.00**	**0.00**	**0.05**

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.35	0.35	0.00	0.00	0.76	0.57	0.00	0.00	0.17	0.11	0.00	0.00	0.10	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.05	0.02	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.14	0.22	0.22	0.22	0.16	0.23	0.23	0.23	0.05	0.07	0.07	0.07	0.04	0.02	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.04	0.03
6	0.50	0.50	0.50	0.37	0.54	0.54	0.54	0.40	0.16	0.16	0.12	0.12	0.06	0.04	0.07	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.00	0.00	0.07	0.05
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.78	0.78	1.17	1.57	0.85	0.85	1.27	1.69	0.13	0.13	0.26	0.51	0.23	0.00	0.17	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.03	0.11	0.11	0.00	0.00	0.22	0.22
9	0.36	0.18	0.36	0.36	0.39	0.20	0.39	0.39	0.09	0.06	0.06	0.12	0.04	0.01	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.02	0.03	0.00	0.00	0.05	0.05
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**1.79**	**2.03**	**2.61**	**2.52**	**1.93**	**2.58**	**3.01**	**2.72**	**0.43**	**0.60**	**0.63**	**0.83**	**0.37**	**0.18**	**0.39**	**0.38**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.11**	**0.12**	**0.22**	**0.17**	**0.00**	**0.05**	**0.40**	**0.35**

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.14	0.14	0.00	0.00	0.30	0.23	0.00	0.00	0.07	0.05	0.00	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.01	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.11	0.11	0.11	0.08	0.12	0.12	0.12	0.09	0.04	0.04	0.03	0.03	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.01
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.07	0.03	0.07	0.07	0.07	0.04	0.07	0.07	0.02	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.18**	**0.29**	**0.32**	**0.15**	**0.19**	**0.46**	**0.42**	**0.16**	**0.05**	**0.12**	**0.08**	**0.05**	**0.02**	**0.05**	**0.05**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.03**	**0.03**	**0.01**	**0.00**	**0.02**	**0.03**	**0.02**

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Third Portage Lake

Losses from Mining Activities and Gains from Re-flooding

TOTAL BY FEATURE - Summary

Third Portage Lake				
Roads	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	1.68	1.68	0.54	0.54
4	0.60		0.24	0.00
5			0.00	0.00
6	1.11	1.71	0.95	1.46
7	1.41		0.58	0.00
8			0.00	0.00
9	0.12	1.53	0.09	1.20
11			0.00	0.00
Total	4.93	4.93	2.40	3.19

Third Portage Lake				
Dike Breach	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3			0.00	0.00
4			0.00	0.00
5			0.00	0.00
6		0.86	0.00	0.73
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11			0.00	0.00
Total	0.00	0.86	0.00	0.73

HU GAINS - Species Totals

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.15	0.29	0.06	0.03	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.58	0.63	0.18	0.07	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.49	0.52	0.12	0.06	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.22	1.44	0.36	0.17	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.29	0.32	0.09	0.03	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.29	0.32	0.09	0.03	0.00	0.00	0.00	0.00

HU GAINS -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.08	0.08	0.00	0.00	0.16	0.12	0.00	0.00	0.04	0.02	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.16	0.16	0.16	0.12	0.17	0.17	0.17	0.13	0.05	0.05	0.04	0.04	0.02	0.01	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.02
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.14	0.07	0.14	0.14	0.15	0.07	0.15	0.15	0.03	0.02	0.02	0.05	0.02	0.01	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.02	0.02
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.29	0.30	0.37	0.26	0.32	0.41	0.44	0.28	0.08	0.11	0.09	0.08	0.03	0.04	0.06	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.02	0.00	0.01	0.05	0.04

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.08	0.08	0.08	0.06	0.08	0.08	0.08	0.06	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.08	0.08	0.08	0.06	0.08	0.08	0.08	0.06	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01

TOTAL BY FEATURE - Summary

Vault Lake				
Vault Pit	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2	0.35		0.05	0.00
3	5.18		1.18	0.00
4			0.00	0.00
5	0.31		0.12	0.00
6	0.09		0.05	0.00
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11		5.93	0.00	1.83
Total	**5.93**	**5.93**	**1.40**	**1.83**

Vault Lake				
Vault Pit Cap	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2	0.29		0.04	0.00
3	2.12	2.42	0.48	0.55
4			0.00	0.00
5	0.31		0.12	0.00
6	0.19	0.50	0.10	0.26
7			0.00	0.00
8	0.10		0.04	0.00
9		0.10	0.00	0.05
11			0.00	0.00
Total	**3.02**	**3.02**	**0.78**	**0.85**

Vault Lake				
Vault Pit Land-to-Lake	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3			0.00	0.00
4			0.00	0.00
5			0.00	0.00
6			0.00	0.00
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11		32.31	0.00	9.96
Total	**0.00**	**32.31**	**0.00**	**9.96**

Vault Lake				
Basin	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	3.40		0.29	0.00
2	7.01	10.41	1.06	1.58
3	31.14	31.14	7.11	7.11
4	3.16		0.78	0.00
5	7.39	10.55	2.89	4.12
6	11.53	11.53	5.89	5.89
7	7.57		1.93	0.00
8	9.10	16.67	3.32	6.08
9	4.76	4.76	2.21	2.21
11			0.00	0.00
Total	**85.06**	**85.06**	**25.46**	**26.98**

Vault Lake				
Dike	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	0.41	0.41	0.09	0.09
4			0.00	0.00
5			0.00	0.00
6			0.00	0.00
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11			0.00	0.00
Total	**0.41**	**0.41**	**0.09**	**0.09**

HU LOSSES - Species Totals

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.03	0.01	0.01	0.00	0.00	0.00	0.00
3	0.00	0.89	0.19	0.10	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.08	0.02	0.01	0.00	0.00	0.00	0.00
6	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	1.04	0.24	0.13	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00
3	0.00	0.36	0.08	0.04	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.08	0.02	0.01	0.00	0.00	0.00	0.00
6	0.00	0.07	0.02	0.01	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.57	0.14	0.07	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.17	0.10	0.02	0.00	0.00	0.00	0.00
2	0.00	0.69	0.26	0.12	0.00	0.00	0.00	0.00
3	0.00	5.32	1.15	0.63	0.00	0.00	0.00	0.00
4	0.00	0.54	0.19	0.05	0.00	0.00	0.00	0.00
5	0.00	1.99	0.60	0.30	0.00	0.00	0.00	0.00
6	0.00	4.23	1.19	0.47	0.00	0.00	0.00	0.00
7	0.00	1.29	0.50	0.13	0.00	0.00	0.00	0.00
8	0.00	2.44	0.54	0.34	0.00	0.00	0.00	0.00
9	0.00	1.63	0.39	0.19	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	18.29	4.93	2.24	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.07	0.02	0.01	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.07	0.02	0.01	0.00	0.00	0.00	0.00

HU LOSSES -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.01	0.01	0.00	0.00	0.02	0.02	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.23	0.23	0.00	0.00	0.51	0.38	0.00	0.00	0.11	0.08	0.00	0.00	0.07	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.03	0.02	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.02**	**0.27**	**0.27**	**0.03**	**0.02**	**0.55**	**0.43**	**0.03**	**0.01**	**0.13**	**0.09**	**0.01**	**0.01**	**0.08**	**0.04**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.04**	**0.04**	**0.00**	**0.00**	**0.03**	**0.02**	**0.00**

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.10	0.10	0.00	0.00	0.21	0.16	0.00	0.00	0.05	0.03	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.04**	**0.15**	**0.15**	**0.04**	**0.04**	**0.27**	**0.22**	**0.05**	**0.01**	**0.07**	**0.05**	**0.01**	**0.01**	**0.03**	**0.02**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.02**	**0.00**	**0.00**	**0.01**	**0.02**	**0.01**

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.02	0.02	0.00	0.00	0.04	0.03	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.08	0.08	0.00	0.00	0.08	0.08	0.00	0.00	0.03	0.08	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00
2	0.00	0.16	0.16	0.00	0.00	0.34	0.34	0.00	0.00	0.16	0.10	0.00	0.00	0.07	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.00	0.02	0.02	0.00
3	0.00	1.41	1.41	0.00	0.00	3.04	2.28	0.00	0.00	0.69	0.46	0.00	0.00	0.42	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.19	0.00	0.00	0.19	0.10	0.00
4	0.00	0.14	0.14	0.21	0.00	0.15	0.15	0.23	0.00	0.02	0.09	0.07	0.00	0.01	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.03
5	0.33	0.50	0.50	0.50	0.36	0.54	0.54	0.54	0.11	0.16	0.16	0.16	0.10	0.05	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.03	0.00	0.00	0.09	0.07
6	1.04	1.04	1.04	0.78	1.13	1.13	1.13	0.85	0.34	0.34	0.26	0.26	0.12	0.08	0.16	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.00	0.00	0.14	0.11
7	0.00	0.17	0.34	0.68	0.00	0.18	0.37	0.74	0.00	0.06	0.22	0.22	0.00	0.00	0.03	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.00	0.00	0.05	0.09
8	0.41	0.41	0.62	0.82	0.44	0.44	0.67	0.89	0.07	0.07	0.13	0.27	0.12	0.00	0.09	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.06	0.06	0.00	0.00	0.11	0.11
9	0.43	0.22	0.43	0.43	0.47	0.23	0.47	0.47	0.11	0.07	0.07	0.14	0.05	0.02	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.02	0.03	0.00	0.00	0.06	0.06
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**2.22**	**4.13**	**4.72**	**3.44**	**2.40**	**6.15**	**6.03**	**3.71**	**0.62**	**1.59**	**1.58**	**1.12**	**0.39**	**0.66**	**0.69**	**0.51**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.12**	**0.35**	**0.48**	**0.24**	**0.00**	**0.23**	**0.60**	**0.47**

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.02	0.02	0.00	0.00	0.04	0.03	0.00	0.00	0.01	0.01	0.00	0.00	0.01

TOTAL BY FEATURE - Summary

Vault Lake				
Vault Pit	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2	0.35		0.05	0.00
3	5.18		1.18	0.00
4			0.00	0.00
5	0.31		0.12	0.00
6	0.09		0.05	0.00
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11		5.93	0.00	1.83
Total	5.93	5.93	1.40	1.83

Vault Lake				
Vault Pit Cap	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2	0.29		0.04	0.00
3	2.12	2.42	0.48	0.55
4			0.00	0.00
5	0.31		0.12	0.00
6	0.19	0.50	0.10	0.26
7			0.00	0.00
8	0.10		0.04	0.00
9		0.10	0.00	0.05
11			0.00	0.00
Total	3.02	3.02	0.78	0.85

Vault Lake				
Vault Pit Land-to-Lake	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3			0.00	0.00
4			0.00	0.00
5			0.00	0.00
6			0.00	0.00
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11		32.31	0.00	9.96
Total	0.00	32.31	0.00	9.96

Vault Lake				
Basin	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	3.40		0.29	0.00
2	7.01	10.41	1.06	1.58
3	31.14	31.14	7.11	7.11
4	3.16		0.78	0.00
5	7.39	10.55	2.89	4.12
6	11.53	11.53	5.89	5.89
7	7.57		1.93	0.00
8	9.10	16.67	3.32	6.08
9	4.76	4.76	2.21	2.21
11			0.00	0.00
Total	85.06	85.06	25.46	26.98

Vault Lake				
Dike	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3	0.41	0.41	0.09	0.09
4			0.00	0.00
5			0.00	0.00
6			0.00	0.00
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11			0.00	0.00
Total	0.41	0.41	0.09	0.09

HU GAINS - Species Totals

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	1.45	0.22	0.16	0.00	0.00	0.00	0.00
Total	0.00	1.45	0.22	0.16	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.41	0.09	0.05	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.18	0.05	0.02	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.63	0.15	0.07	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	7.89	1.20	0.87	0.00	0.00	0.00	0.00
Total	0.00	7.89	1.20	0.87	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	1.02	0.39	0.18	0.00	0.00	0.00	0.00
3	0.00	5.32	1.15	0.63	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	2.83	0.86	0.43	0.00	0.00	0.00	0.00
6	0.00	4.23	1.19	0.47	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	4.48	0.99	0.62	0.00	0.00	0.00	0.00
9	0.00	1.63	0.39	0.19	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	19.51	4.97	2.51	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.07	0.02	0.01	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.07	0.02	0.01	0.00	0.00	0.00	0.00

HU GAINS -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.54	0.54	0.29	0.00	0.58	0.58	0.00	0.00	0.04	0.18	0.00	0.00	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.04	0.00	0.00	0.00	0.07
Total	0.00	0.00	0.54	0.54	0.29	0.00	0.58	0.58	0.00	0.00	0.04	0.18	0.00	0.00	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.04	0.00	0.00	0.00	0.07

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.11	0.11	0.00	0.00	0.24	0.18	0.00	0.00	0.05	0.04	0.00	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.01	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.05	0.05	0.05	0.03	0.05	0.05	0.05	0.04	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.05	0.16	0.16	0.04	0.06	0.29	0.24	0.05	0.02	0.07	0.05	0.01	0.01	0.04	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02	0.01

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.02	0.02	0.00	0.00	0.04	0.03	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.02	0.02	0.00	0.00	0.04	0.03	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	2.92	2.92	1.58	0.00	3.16	3.16	0.00	0.00	0.24	0.96	0.00	0.00	0.44	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.15	0.20	0.00	0.00	0.00	0.40
Total	0.00	0.00	2.92	2.92	1.58	0.00	3.16	3.16	0.00	0.00	0.24	0.96	0.00	0.00	0.44	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.15	0.20	0.00	0.00	0.00	0.40

Habitat type area x HSI x species weight x life function weight																														
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Phaser Lake
Losses from Mining Activites and Gains from Re-flooding

TOTAL BY FEATURE - Summary

Phaser Lake

Phaser Pit	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.23		0.02	0.00
2	1.23		0.17	0.00
3	1.04		0.22	0.00
4	0.19		0.04	0.00
5	0.09		0.03	0.00
6	0.01	2.78	0.01	1.42
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11			0.00	0.00
Total	2.78	2.78	0.48	1.42

Phaser Lake

Phaser Pit Cap	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.05		0.00	0.00
2	0.30		0.04	0.00
3	0.49	0.83	0.10	0.19
4			0.00	0.00
5	0.03		0.01	0.00
6		0.03	0.00	0.02
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11			0.00	0.00
Total	0.86	0.86	0.16	0.20

Phaser Lake

Phaser Pit Land-to-Lak	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3			0.00	0.00
4			0.00	0.00
5			0.00	0.00
6		3.94	0.00	2.01
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11			0.00	0.00
Total	0.00	3.94	0.00	2.01

Phaser Lake

Basin	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.56		0.04	0.00
2	3.45	4.01	0.46	0.61
3	11.21	11.21	2.33	2.56
4	0.53		0.12	0.00
5	1.44	1.97	0.50	0.77
6	0.88	0.88	0.41	0.45
7	0.52		0.12	0.00
8	0.20	0.71	0.07	0.26
9	0.11	0.11	0.05	0.05
11			0.00	0.00
Total	18.89	18.89	4.11	4.70

Phaser Lake

Roads	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.02		0.00	0.00
2	0.47		0.06	0.00
3	1.23	1.72	0.26	0.39
4	0.31		0.07	0.00
5	0.16		0.06	0.00
6	0.32	0.80	0.15	0.41
7	0.00		0.00	0.00
8			0.00	0.00
9		0.00	0.00	0.00
11			0.00	0.00
Total	2.52	2.52	0.60	0.80

HU LOSSES - Species Totals

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	0	0	0	0	0
1	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
2	0.00	0.12	0.05	0.00	0.00	0.00	0.00	0.00
3	0.00	0.18	0.04	0.00	0.00	0.00	0.00	0.00
4	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00
5	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.37	0.11	0.00	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	0	0	0	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00
3	0.00	0.08	0.02	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.12	0.03	0.00	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	0	0	0	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	0	0	0	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.00
3	0.00	0.21	0.05	0.00	0.00	0.00	0.00	0.00
4	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.00
5	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00
6	0.00	0.12	0.03	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.47	0.13	0.00	0.00	0.00	0.00	0.00

HU LOSSES -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.03	0.03	0.00	0.00	0.06	0.06	0.00	0.00	0.03	0.02	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
3	0.00	0.05	0.05	0.00	0.00	0.10	0.08	0.00	0.00	0.02	0.02	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00
4	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.01	0.10	0.10	0.02	0.01	0.18	0.16	0.02	0.00	0.06	0.05	0.01	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.01	0.01	0.00

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.02	0.02	0.00	0.00	0.05	0.04	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.03	0.03	0.00	0.00	0.07	0.05	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.01	0.01	0.00	0.00	0.02	0.02	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.06	0.06	0.00	0.00	0.12	0.09	0.00	0.00	0.03	0.02	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00
4	0.00	0.01	0.01	0.02	0.00	0.02	0.02	0.02	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.04	0.12	0.12	0.05	0.04	0.20	0.17	0.06	0.01	0.05	0.05	0.02	0.01	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.01

Phaser Lake
Losses from Mining Activites and Gains from Re-flooding

TOTAL BY FEATURE - Summary

Phaser Lake

Phaser Pit	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.23		0.02	0.00
2	1.23		0.17	0.00
3	1.04		0.22	0.00
4	0.19		0.04	0.00
5	0.09		0.03	0.00
6	0.01	2.78	0.01	1.42
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11			0.00	0.00
Total	2.78	2.78	0.48	1.42

Phaser Lake

Phaser Pit Cap	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.05		0.00	0.00
2	0.30		0.04	0.00
3	0.49	0.83	0.10	0.19
4			0.00	0.00
5	0.03		0.01	0.00
6		0.03	0.00	0.02
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11			0.00	0.00
Total	0.86	0.86	0.16	0.20

Phaser Lake

Phaser Pit Land-to-Lak	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1			0.00	0.00
2			0.00	0.00
3			0.00	0.00
4			0.00	0.00
5			0.00	0.00
6		3.94	0.00	2.01
7			0.00	0.00
8			0.00	0.00
9			0.00	0.00
11			0.00	0.00
Total	0.00	3.94	0.00	2.01

Phaser Lake

Basin	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.56		0.04	0.00
2	3.45	4.01	0.46	0.61
3	11.21	11.21	2.33	2.56
4	0.53		0.12	0.00
5	1.44	1.97	0.50	0.77
6	0.88	0.88	0.41	0.45
7	0.52		0.12	0.00
8	0.20	0.71	0.07	0.26
9	0.11	0.11	0.05	0.05
11			0.00	0.00
Total	18.89	18.89	4.11	4.70

Phaser Lake

Roads	Hectares		HU	
Habitat Type	Losses	Gains	Losses	Gains
1	0.02		0.00	0.00
2	0.47		0.06	0.00
3	1.23	1.72	0.26	0.39
4	0.31		0.07	0.00
5	0.16		0.06	0.00
6	0.32	0.80	0.15	0.41
7	0.00		0.00	0.00
8			0.00	0.00
9		0.00	0.00	0.00
11			0.00	0.00
Total	2.52	2.52	0.60	0.80

HU GAINS - Species Totals

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	1.02	0.29	0.11	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	1.02	0.29	0.11	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.14	0.03	0.02	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.15	0.03	0.02	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	1.44	0.41	0.16	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	1.44	0.41	0.16	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.39	0.15	0.07	0.00	0.00	0.00	0.00
3	0.00	1.92	0.41	0.23	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.53	0.16	0.08	0.00	0.00	0.00	0.00
6	0.00	0.32	0.09	0.04	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.19	0.04	0.03	0.00	0.00	0.00	0.00
9	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	3.39	0.87	0.44	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.29	0.06	0.03	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.29	0.08	0.03	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.59	0.15	0.07	0.00	0.00	0.00	0.00

HU GAINS -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.25	0.25	0.25	0.19	0.27	0.27	0.27	0.20	0.08	0.08	0.06	0.06	0.03	0.02	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.03	0.03
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.25	0.25	0.25	0.19	0.27	0.27	0.27	0.20	0.08	0.08	0.06	0.06	0.03	0.02	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.03	0.03

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.04	0.04	0.00	0.00	0.08	0.06	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.04	0.04	0.00	0.00	0.08	0.06	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.09	0.09	0.00	0.00	0.20	0.20	0.00	0.00	0.09	0.06	0.00	0.00	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.01	0.01	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.09	0.13	0.13	0.13	0.10	0.14	0.14	0.14	0.03	0.04	0.04	0.04	0.03	0.01	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.02	0.02
6	0.08	0.08	0.08	0.06	0.09	0.09	0.09	0.06	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.03	0.03	0.05	0.06	0.03	0.03	0.05	0.07	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
9	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.21	0.85	0.87	0.27	0.23	1.56	1.31	0.29	0.06	0.41	0.30	0.09	0.05	0.21	0.14	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.11	0.12	0.02	0.00	0.08	0.09	0.04

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.08	0.08	0.00	0.00	0.17	0.13	0.00	0.00	0.04	0.03	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.07	0.07	0.07	0.05	0.08	0.08	0.08	0.06	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.07	0.15	0.15	0.05	0.08	0.25	0.20	0.06	0.02	0.06	0.04	0.02	0.01	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.02	0.01

Other Onsite Compensation
Net Gains

TOTAL BY FEATURE - Summary

Vault Lake

Access to Wally	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.00	0.00	0.00	0.00	0.00	0.00
2	10.41	10.41	0.00	1.58	1.93	0.35
3	33.96	33.96	0.00	7.75	10.06	2.30
4	0.00	0.00	0.00	0.00	0.00	0.00
5	10.55	10.55	0.00	4.12	6.09	1.97
6	12.03	12.03	0.00	6.14	9.20	3.06
7	0.00	0.00	0.00	0.00	0.00	0.00
8	16.67	16.67	0.00	6.08	9.19	3.11
9	4.86	4.86	0.00	2.25	3.41	1.15
11	38.24	38.24	0.00	11.79	16.97	5.19
Total	**126.72**	**126.72**	**0.00**	**39.71**	**56.85**	**17.14**

Phaser Lake

Access to W3	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.00	0.00	0.00	0.00	0.00	0.00
2	4.01	4.01	0.00	0.61	0.74	0.14
3	13.76	13.76	0.00	3.14	4.07	0.93
4	0.00	0.00	0.00	0.00	0.00	0.00
5	1.97	1.97	0.00	0.77	1.14	0.37
6	8.43	8.43	0.00	4.30	6.44	2.14
7	0.00	0.00	0.00	0.00	0.00	0.00
8	0.71	0.71	0.00	0.26	0.39	0.13
9	0.11	0.11	0.00	0.05	0.08	0.03
11				0.00	0.00	
Total	**28.99**	**28.99**	**0.00**	**9.13**	**12.87**	**3.74**

Wally System

Access to W3	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	21.01	21.01	0.00	1.79	2.50	0.71
2	9.67	9.67	0.00	1.46	1.79	0.33
3	82.89	82.89	0.00	18.92	24.54	5.62
4	23.92	23.92	0.00	5.91	8.75	2.84
5	12.01	12.01	0.00	4.69	6.93	2.24
6	100.10	100.10	0.00	51.10	76.56	25.47
7	137.63	137.63	0.00	35.02	51.36	16.34
8	29.16	29.16	0.00	10.64	16.08	5.44
9	115.81	115.81	0.00	53.72	81.22	27.50
11				0.00	0.00	
Total	**532.20**	**532.20**	**0.00**	**183.25**	**269.74**	**86.49**

Dogleg System

Dogleg Pond	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.03	0.03	0.00	0.00	0.00	0.00
2	1.26	1.32	0.06	0.19	0.20	0.01
3	9.23	9.69	0.46	2.11	2.21	0.11
4	0.37	0.38	0.02	0.09	0.09	0.00
5	1.08	1.13	0.05	0.42	0.44	0.02
6	1.38	1.45	0.07	0.70	0.74	0.04
7	3.32	3.49	0.17	0.85	0.89	0.04
8	3.43	3.60	0.17	1.25	1.31	0.06
9	1.06	1.11	0.05	0.49	0.52	0.02
11						
Total	**21.15**	**22.21**	**1.06**	**6.10**	**6.41**	**0.31**

Dogleg System

Dogleg North Pond	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.19	0.22	0.03	0.00	0.02	0.02
2	0.23	0.26	0.03	0.00	0.04	0.04
3	2.13	2.45	0.32	0.00	0.56	0.56
4	0.22	0.26	0.03	0.00	0.06	0.06
5	0.24	0.27	0.04	0.00	0.11	0.11
6	0.21	0.24	0.03	0.00	0.12	0.12
7						
8						
9						
11						
Total	**3.22**	**3.70**	**0.48**	**0.00**	**0.91**	**0.91**

PRE-COMPENSATION HUs - Species Totals

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	1.02	0.39	0.18	0.00	0.00	0.00	0.00
3	0.00	5.81	1.26	0.69	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	2.83	0.86	0.43	0.00	0.00	0.00	0.00
6	0.00	4.41	1.25	0.49	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	4.48	0.99	0.62	0.00	0.00	0.00	0.00
9	0.00	1.66	0.40	0.20	0.00	0.00	0.00	0.00
11	0.00	9.34	1.42	1.03	0.00	0.00	0.00	0.00
Total	0.00	29.55	6.55	3.62	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.39	0.15	0.07	0.00	0.00	0.00	0.00
3	0.00	2.35	0.51	0.28	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.53	0.16	0.08	0.00	0.00	0.00	0.00
6	0.00	3.09	0.87	0.34	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.19	0.04	0.03	0.00	0.00	0.00	0.00
9	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	6.59	1.74	0.80	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	1.03	0.62	0.14	0.00	0.00	0.00	0.00
2	0.00	0.94	0.36	0.16	0.00	0.00	0.00	0.00
3	0.00	14.17	3.07	1.67	0.00	0.00	0.00	0.00
4	0.00	4.09	1.42	0.40	0.00	0.00	0.00	0.00
5	0.00	3.23	0.98	0.48	0.00	0.00	0.00	0.00
6	0.00	36.68	10.37	4.04	0.00	0.00	0.00	0.00
7	0.00	23.53	9.17	2.32	0.00	0.00	0.00	0.00
8	0.00	7.84	1.73	1.08	0.00	0.00	0.00	0.00
9	0.00	39.61	9.43	4.68	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	131.12	37.14	14.98	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	0	0	0	0	0	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PRE-COMPENSATION HUs -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.24	0.24	0.00	0.00	0.51	0.51	0.00	0.00	0.23	0.15	0.00	0.00	0.11	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.00	0.00	0.03	0.03	0.00
3	0.00	1.54	1.54	0.00	0.00	3.32	2.49	0.00	0.00	0.75	0.50	0.00	0.00	0.46	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.21	0.00	0.00	0.21	0.11	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.48	0.72	0.72	0.72	0.52	0.77	0.77	0.77	0.16	0.23	0.23	0.23	0.14	0.07	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.07	0.05	0.00	0.00	0.13	0.10
6	1.09	1.09	1.09	0.82	1.18	1.18	1.18	0.88	0.36	0.36	0.27	0.27	0.12	0.08	0.16	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.06	0.06	0.00	0.00	0.15	0.11
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.75	0.75	1.13	1.51	0.81	0.81	1.22	1.63	0.12	0.12	0.25	0.49	0.22	0.00	0.17	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.03	0.10	0.10	0.00	0.00	0.21	0.21
9	0.44	0.22	0.44	0.44	0.47	0.24	0.47	0.47	0.11	0.07	0.07	0.14	0.05	0.02	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.02	0.03	0.00	0.00	0.06	0.06
11	0.00	0.00	3.46	3.46	1.87	0.00	3.74	3.74	0.00	0.00	0.28	1.13	0.00	0.00	0.51	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.18	0.24	0.00	0.00	0.00	0.48
Total	**2.76**	**4.55**	**8.60**	**6.94**	**4.85**	**6.83**	**10.38**	**7.49**	**0.74**	**1.77**	**1.76**	**2.27**	**0.54**	**0.73**	**1.32**	**1.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.22**	**0.40**	**0.71**	**0.48**	**0.00**	**0.24**	**0.69**	**0.96**

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.09	0.09	0.00	0.00	0.20	0.20	0.00	0.00	0.09	0.06	0.00	0.00	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.01	0.01	0.00
3	0.00	0.62	0.62	0.00	0.00	1.34	1.01	0.00	0.00	0.31	0.20	0.00	0.00	0.19	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.09	0.04	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.09	0.13	0.13	0.13	0.10	0.14	0.14	0.14	0.03	0.04	0.04	0.04	0.03	0.01	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.02	0.02
6	0.76	0.76	0.76	0.57	0.82	0.82	0.82	0.62	0.25	0.25	0.19	0.19	0.09	0.06	0.11	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.00	0.00	0.11	0.08
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.03	0.03	0.05	0.06	0.03	0.03	0.05	0.07	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
9	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.89**	**1.65**	**1.67**	**0.78**	**0.97**	**2.55**	**2.24**	**0.84**	**0.29**	**0.69**	**0.51**	**0.26**	**0.12**	**0.30**	**0.26**	**0.12**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.16**	**0.17**	**0.05**	**0.00**	**0.10**	**0.20**	**0.11**

Habitat type area : Lost Habitat Units per Species per Life Function

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.48	0.48	0.00	0.00	0.51	0.51	0.00	0.00	0.16	0.47	0.00	0.00	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.00	0.00	0.07	0.00	0.00
2	0.00	0.22	0.22	0.00	0.00	0.47	0.47	0.00	0.00	0.21	0.14	0.00	0.00	0.10	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.03	0.03	0.00
3	0.00	3.75	3.75	0.00	0.00	8.10	6.07	0.00	0.00	1.84	1.23	0.00	0.00	1.12	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.52	0.00	0.00	0.52	0.26	0.00
4	0.00	1.08	1.08	1.62	0.00	1.17	1.17	1.75	0.00	0.18	0.71	0.53	0.00	0.08	0.08	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.11	0.11	0.00	0.00	0.15	0.22
5	0.54	0.81	0.81	0.81	0.59	0.88	0.88	0.88	0.18	0.27	0.27	0.27	0.16	0.08	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.08	0.06	0.00	0.00	0.15	0.11
6	9.05	9.05	9.05	6.79	9.78	9.78	9.78	7.34	2.96	2.96	2.22	2.22	1.01	0.67	1.35	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.47	0.47	0.47	0.00	0.00	1.25	0.94
7	0.00	3.11	6.22	12.45	0.00	3.36	6.72	13.45	0.00	1.02	4.07	4.07	0.00	0.00	0.46	1.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.00	0.00	0.86	1.72
8	1.32	1.32	1.98	2.64	1.42	1.42	2.14	2.85	0.22	0.22	0.43	0.86	0.39	0.00	0.29	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.05	0.18	0.18	0.00	0.00	0.36	0.36
9	10.48	5.24	10.48	10.48	11.32	5.66	11.32	11.32	2.57	1.71	1.71	3.43	1.17	0.39	1.56	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	0.18	0.54	0.72	0.00	0.00	1.45	1.45
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**21.39**	**25.06**	**34.07**	**34.79**	**23.11**	**31.36**	**39.07**	**37.58**	**5.93**	**8.57**	**11.26**	**11.39**	**2.73**	**2.51**	**4.56**	**5.18**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.30**	**1.38**	**2.67**	**2.40**	**0.00**	**0.61**	**4.51**	**4.81**

Habitat type area : Lost Habitat Units per Species per Life Function

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.10	0.10	0.00	0.00	0.21	0.16	0.00	0.00	0.05	0.03	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00
4	0.00	0.01	0.01	0.02	0.00	0.01	0.01	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.03**	**0.15**	**0.15**	**0.05**	**0.03**	**0.27**	**0.22**	**0.05**	**0.01**	**0.07**	**0.06**	**0.01**	**0.01**	**0.04**	**0.02**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.02**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**

Other Onsite Compensation
Net Gains

TOTAL BY FEATURE - Summary

Dogleg System						
NP-2	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.16	0.16	0.01	0.02	0.02	0.01
3	3.95	4.15	0.20	0.76	0.95	0.19
4	0.03	0.03	0.00	0.01	0.01	0.00
5	0.59	0.62	0.03	0.18	0.24	0.06
6	0.96	1.01	0.05	0.39	0.52	0.12
7	1.04	1.10	0.05	0.20	0.28	0.08
8	1.28	1.35	0.06	0.39	0.49	0.10
9	0.64	0.67	0.03	0.24	0.31	0.07
11				0.00	0.00	
Total	8.66	9.09	0.43	2.19	2.82	0.63

Third Portage Lake						
Finger Dikes	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1			0.00	0.00	0.00	0.00
2			0.00	0.00	0.00	0.00
3			0.00	0.00	0.00	0.00
4			0.00	0.00	0.00	0.00
5			0.00	0.00	0.00	0.00
6		0.50	0.50	0.00	0.42	0.42
7	1.00		-1.00	0.41	0.00	-0.41
8			0.00	0.00	0.00	0.00
9		0.50	0.50	0.00	0.39	0.39
11			0.00	0.00	0.00	0.00
Total	1.00	1.00	0.00	0.41	0.82	0.40

PRE-COMPENSATION HUs - Species Totals

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	0	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.68	0.00	0.08	0.00	0.00	0.00	0.00
4	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.16	0.00	0.02	0.00	0.00	0.00	0.00
6	0.00	0.35	0.00	0.04	0.00	0.00	0.00	0.00
7	0.00	0.18	0.00	0.02	0.00	0.00	0.00	0.00
8	0.00	0.34	0.00	0.05	0.00	0.00	0.00	0.00
9	0.00	0.22	0.00	0.03	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	1.95	0.00	0.24	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.16	0.17	0.07	0.02	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.16	0.17	0.07	0.02	0.00	0.00	0.00	0.00

PRE-COMPENSATION HUs -Species Sub-Totals

Habitat type area : Lost Habitat Units per Species per Life Function																																
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.18	0.18	0.00	0.00	0.39	0.29	0.00	0.00	0.09	0.06	0.00	0.00	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.01	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.03	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
6	0.09	0.09	0.09	0.07	0.09	0.09	0.09	0.07	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
7	0.00	0.02	0.05	0.09	0.00	0.03	0.05	0.10	0.00	0.01	0.03	0.03	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01
8	0.06	0.06	0.09	0.12	0.06	0.06	0.09	0.13	0.01	0.01	0.02	0.04	0.02	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.02
9	0.06	0.03	0.06	0.06	0.06	0.03	0.06	0.06	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.23	0.42	0.50	0.38	0.25	0.65	0.64	0.41	0.06	0.16	0.16	0.12	0.04	0.07	0.07	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.05	0.03	0.00	0.03	0.06	0.05

Habitat type area x HSI x species weight x life function weight																																
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.02	0.05	0.09	0.00	0.02	0.05	0.10	0.00	0.01	0.03	0.03	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.02	0.05	0.09	0.00	0.02	0.05	0.10	0.00	0.01	0.03	0.03	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01

Other Onsite Compensation
Net Gains

TOTAL BY FEATURE - Summary

Vault Lake

Access to Wally	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.00	0.00	0.00	0.00	0.00	0.00
2	10.41	10.41	0.00	1.58	1.93	0.35
3	33.96	33.96	0.00	7.75	10.06	2.30
4	0.00	0.00	0.00	0.00	0.00	0.00
5	10.55	10.55	0.00	4.12	6.09	1.97
6	12.03	12.03	0.00	6.14	9.20	3.06
7	0.00	0.00	0.00	0.00	0.00	0.00
8	16.67	16.67	0.00	6.08	9.19	3.11
9	4.86	4.86	0.00	2.25	3.41	1.15
11	38.24	38.24	0.00	11.79	16.97	5.19
Total	**126.72**	**126.72**	**0.00**	**39.71**	**56.85**	**17.14**

Phaser Lake

Access to W3	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.00	0.00	0.00	0.00	0.00	0.00
2	4.01	4.01	0.00	0.61	0.74	0.14
3	13.76	13.76	0.00	3.14	4.07	0.93
4	0.00	0.00	0.00	0.00	0.00	0.00
5	1.97	1.97	0.00	0.77	1.14	0.37
6	8.43	8.43	0.00	4.30	6.44	2.14
7	0.00	0.00	0.00	0.00	0.00	0.00
8	0.71	0.71	0.00	0.26	0.39	0.13
9	0.11	0.11	0.00	0.05	0.08	0.03
11				0.00	0.00	
Total	**28.99**	**28.99**	**0.00**	**9.13**	**12.87**	**3.74**

Wally System

Access to W3	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	21.01	21.01	0.00	1.79	2.50	0.71
2	9.67	9.67	0.00	1.46	1.79	0.33
3	82.89	82.89	0.00	18.92	24.54	5.62
4	23.92	23.92	0.00	5.91	8.75	2.84
5	12.01	12.01	0.00	4.69	6.93	2.24
6	100.10	100.10	0.00	51.10	76.56	25.47
7	137.63	137.63	0.00	35.02	51.36	16.34
8	29.16	29.16	0.00	10.64	16.08	5.44
9	115.81	115.81	0.00	53.72	81.22	27.50
11				0.00	0.00	
Total	**532.20**	**532.20**	**0.00**	**183.25**	**269.74**	**86.49**

Dogleg System

Dogleg Pond	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.03	0.03	0.00	0.00	0.00	0.00
2	1.26	1.32	0.06	0.19	0.20	0.01
3	9.23	9.69	0.46	2.11	2.21	0.11
4	0.37	0.38	0.02	0.09	0.09	0.00
5	1.08	1.13	0.05	0.42	0.44	0.02
6	1.38	1.45	0.07	0.70	0.74	0.04
7	3.32	3.49	0.17	0.85	0.89	0.04
8	3.43	3.60	0.17	1.25	1.31	0.06
9	1.06	1.11	0.05	0.49	0.52	0.02
11						
Total	**21.15**	**22.21**	**1.06**	**6.10**	**6.41**	**0.31**

Dogleg System

Dogleg North Pond	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.19	0.22	0.03	0.00	0.02	0.02
2	0.23	0.26	0.03	0.00	0.04	0.04
3	2.13	2.45	0.32	0.00	0.56	0.56
4	0.22	0.26	0.03	0.00	0.06	0.06
5	0.24	0.27	0.04	0.00	0.11	0.11
6	0.21	0.24	0.03	0.00	0.12	0.12
7						
8						
9						
11						
Total	**3.22**	**3.70**	**0.48**	**0.00**	**0.91**	**0.91**

POST-COMPENSATION HUs - Species Totals

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0.75	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.35	1.02	0.39	0.18	0.00	0.00	0.00	0.00
3	2.30	5.81	1.26	0.69	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	1.97	2.83	0.86	0.43	0.00	0.00	0.00	0.00
6	3.06	4.41	1.25	0.49	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	3.11	4.48	0.99	0.62	0.00	0.00	0.00	0.00
9	1.15	1.66	0.40	0.20	0.00	0.00	0.00	0.00
11	5.19	9.34	1.42	1.03	0.00	0.00	0.00	0.00
Total	17.14	29.55	6.55	3.62	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0.75	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.14	0.39	0.15	0.07	0.00	0.00	0.00	0.00
3	0.93	2.35	0.51	0.28	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.37	0.53	0.16	0.08	0.00	0.00	0.00	0.00
6	2.14	3.09	0.87	0.34	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.13	0.19	0.04	0.03	0.00	0.00	0.00	0.00
9	0.03	0.04	0.01	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	3.74	6.59	1.74	0.80	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0.75	1	1	1	1	1	0	0
1	0.71	1.03	0.62	0.14	0.00	0.00	0.00	0.00
2	0.33	0.94	0.36	0.16	0.00	0.00	0.00	0.00
3	5.62	14.17	3.07	1.67	0.00	0.00	0.00	0.00
4	2.84	4.09	1.42	0.40	0.00	0.00	0.00	0.00
5	2.24	3.23	0.98	0.48	0.00	0.00	0.00	0.00
6	25.47	36.68	10.37	4.04	0.00	0.00	0.00	0.00
7	16.34	23.53	9.17	2.32	0.00	0.00	0.00	0.00
8	5.44	7.84	1.73	1.08	0.00	0.00	0.00	0.00
9	27.50	39.61	9.43	4.68	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	86.49	131.12	37.14	14.98	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.13	0.05	0.02	0.00	0.00	0.00	0.00
3	0.00	1.66	0.36	0.20	0.00	0.00	0.00	0.00
4	0.00	0.07	0.02	0.01	0.00	0.00	0.00	0.00
5	0.00	0.30	0.09	0.05	0.00	0.00	0.00	0.00
6	0.00	0.53	0.15	0.06	0.00	0.00	0.00	0.00
7	0.00	0.60	0.23	0.06	0.00	0.00	0.00	0.00
8	0.00	0.97	0.21	0.13	0.00	0.00	0.00	0.00
9	0.00	0.38	0.09	0.04	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	4.63	1.21	0.57	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
2	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00
3	0.00	0.42	0.09	0.05	0.00	0.00	0.00	0.00
4	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.00
5	0.00	0.07	0.02	0.01	0.00	0.00	0.00	0.00
6	0.00	0.09	0.03	0.01	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.66	0.17	0.08	0.00	0.00	0.00	0.00

HU GAINS -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.24	0.24	0.00	0.00	0.51	0.51	0.00	0.00	0.23	0.15	0.00	0.00	0.11	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.00	0.00	0.03	0.03	0.00
3	0.00	1.54	1.54	0.00	0.00	3.32	2.49	0.00	0.00	0.75	0.50	0.00	0.00	0.46	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.21	0.00	0.00	0.21	0.11	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.48	0.72	0.72	0.72	0.52	0.77	0.77	0.77	0.16	0.23	0.23	0.23	0.14	0.07	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.07	0.05	0.00	0.00	0.13	0.10
6	1.09	1.09	1.09	0.82	1.18	1.18	1.18	0.88	0.36	0.36	0.27	0.27	0.12	0.08	0.16	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.06	0.06	0.00	0.00	0.15	0.11
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.75	0.75	1.13	1.51	0.81	0.81	1.22	1.63	0.12	0.12	0.25	0.49	0.22	0.00	0.17	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.03	0.10	0.10	0.00	0.00	0.21	0.21
9	0.44	0.22	0.44	0.44	0.47	0.24	0.47	0.47	0.11	0.07	0.07	0.14	0.05	0.02	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.02	0.03	0.00	0.00	0.06	0.06
11	0.00	0.00	3.46	3.46	1.87	0.00	3.74	3.74	0.00	0.00	0.28	1.13	0.00	0.00	0.51	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.18	0.24	0.00	0.00	0.00	0.48
Total	**2.76**	**4.55**	**8.60**	**6.94**	**4.85**	**6.83**	**10.38**	**7.49**	**0.74**	**1.77**	**1.76**	**2.27**	**0.54**	**0.73**	**1.32**	**1.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.22**	**0.40**	**0.71**	**0.48**	**0.00**	**0.24**	**0.69**	**0.96**

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.09	0.09	0.00	0.00	0.20	0.20	0.00	0.00	0.09	0.06	0.00	0.00	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.01	0.01	0.00
3	0.00	0.62	0.62	0.00	0.00	1.34	1.01	0.00	0.00	0.31	0.20	0.00	0.00	0.19	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.09	0.04	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.09	0.13	0.13	0.13	0.10	0.14	0.14	0.14	0.03	0.04	0.04	0.04	0.03	0.01	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.02	0.02
6	0.76	0.76	0.76	0.57	0.82	0.82	0.82	0.62	0.25	0.25	0.19	0.19	0.09	0.06	0.11	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.00	0.00	0.11	0.08
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.03	0.03	0.05	0.06	0.03	0.03	0.05	0.07	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
9	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.89**	**1.65**	**1.67**	**0.78**	**0.97**	**2.55**	**2.24**	**0.84**	**0.29**	**0.69**	**0.51**	**0.26**	**0.12**	**0.30**	**0.26**	**0.12**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.16**	**0.17**	**0.05**	**0.00**	**0.10**	**0.20**	**0.11**

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.48	0.48	0.00	0.00	0.51	0.51	0.00	0.00	0.16	0.47	0.00	0.00	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.00	0.00	0.07	0.00	0.00
2	0.00	0.22	0.22	0.00	0.00	0.47	0.47	0.00	0.00	0.21	0.14	0.00	0.00	0.10	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.03	0.03	0.00
3	0.00	3.75	3.75	0.00	0.00	8.10	6.07	0.00	0.00	1.84	1.23	0.00	0.00	1.12	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.52	0.00	0.00	0.52	0.26	0.00
4	0.00	1.08	1.08	1.62	0.00	1.17	1.17	1.75	0.00	0.18	0.71	0.53	0.00	0.08	0.08	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.11	0.11	0.00	0.00	0.15	0.22
5	0.54	0.81	0.81	0.81	0.59	0.88	0.88	0.88	0.18	0.27	0.27	0.27	0.16	0.08	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.08	0.06	0.00	0.00	0.15	0.11
6	9.05	9.05	9.05	6.79	9.78	9.78	9.78	7.34	2.96	2.96	2.22	2.22	1.01	0.67	1.35	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.47	0.47	0.47	0.00	0.00	1.25	0.94
7	0.00	3.11	6.22	12.45	0.00	3.36	6.72	13.45	0.00	1.02	4.07	4.07	0.00	0.00	0.46	1.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.86	0.00	0.00	0.86	1.72
8	1.32	1.32	1.98	2.64	1.42	1.42	2.14	2.85	0.22	0.22	0.43	0.86	0.39	0.00	0.29	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.05	0.18	0.18	0.00	0.00	0.36	0.36
9	10.48	5.24	10.48	10.48	11.32	5.66	11.32	11.32	2.57	1.71	1.71	3.43	1.17	0.39	1.56	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	0.18	0.54	0.72	0.00	0.00	1.45	1.45
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**21.39**	**25.06**	**34.07**	**34.79**	**23.11**	**31.36**	**39.07**	**37.58**	**5.93**	**8.57**	**11.26**	**11.39**	**2.73**	**2.51**	**4.56**	**5.18**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.30**	**1.38**	**2.67**	**2.40**	**0.00**	**0.61**	**4.51**	**4.81**

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.03	0.03	0.00	0.00	0.06	0.06	0.00	0.00	0.03	0.02	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
3	0.00	0.44	0.44	0.00	0.00	0.95	0.71	0.00	0.00	0.22	0.14	0.00	0.00	0.13	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.06	0.03	0.00
4	0.00	0.02	0.02	0.03	0.00	0.02	0.02	0.03	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.05	0.08	0.08	0.08	0.06	0.08	0.08	0.08	0.02	0.03	0.03	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01
6	0.13	0.13	0.13	0.10	0.14	0.14	0.14	0.11	0.04	0.04	0.03	0.03	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.01
7	0.00	0.08	0.16	0.32	0.00	0.09	0.17	0.34	0.00	0.03	0.10	0.10	0.00	0.00	0.01	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.04
8	0.16	0.16	0.24	0.33	0.18	0.18	0.26	0.35	0.03	0.03	0.05	0.11	0.05	0.00	0.04	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.00	0.00	0.04	0.04
9	0.10	0.05	0.10	0.10	0.11	0.05	0.11	0.11	0.02	0.02	0.02	0.03	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.45**	**0.99**	**1.20**	**0.94**	**0.48**	**1.57**	**1.56**	**1.02**	**0.11**	**0.38**	**0.41**	**0.31**	**0.09**	**0.17**	**0.17**	**0.14**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.09**	**0.13**	**0.07**	**0.00**	**0.06**	**0.15**	**0.13**

Habitat type area x HSI x species weight x life function weight

| Species >> | ARCH | | | | LKTR | | | | RNWH | | | | BURB | | | | SLSC | | | | NNST | | |

Other Onsite Compensation
Net Gains

TOTAL BY FEATURE - Summary

Dogleg System						
NP-2	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.16	0.16	0.01	0.02	0.02	0.01
3	3.95	4.15	0.20	0.76	0.95	0.19
4	0.03	0.03	0.00	0.01	0.01	0.00
5	0.59	0.62	0.03	0.18	0.24	0.06
6	0.96	1.01	0.05	0.39	0.52	0.12
7	1.04	1.10	0.05	0.20	0.28	0.08
8	1.28	1.35	0.06	0.39	0.49	0.10
9	0.64	0.67	0.03	0.24	0.31	0.07
11				0.00	0.00	
Total	8.66	9.09	0.43	2.19	2.82	0.63

Third Portage Lake						
Finger Dikes	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1			0.00	0.00	0.00	0.00
2			0.00	0.00	0.00	0.00
3			0.00	0.00	0.00	0.00
4			0.00	0.00	0.00	0.00
5			0.00	0.00	0.00	0.00
6		0.50	0.50	0.00	0.42	0.42
7	1.00		-1.00	0.41	0.00	-0.41
8			0.00	0.00	0.00	0.00
9		0.50	0.50	0.00	0.39	0.39
11			0.00	0.00	0.00	0.00
Total	1.00	1.00	0.00	0.41	0.82	0.40

POST-COMPENSATION HUs - Species Totals

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00
3	0.00	0.71	0.15	0.08	0.00	0.00	0.00	0.00
4	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.17	0.05	0.03	0.00	0.00	0.00	0.00
6	0.00	0.37	0.10	0.04	0.00	0.00	0.00	0.00
7	0.00	0.19	0.07	0.02	0.00	0.00	0.00	0.00
8	0.00	0.36	0.08	0.05	0.00	0.00	0.00	0.00
9	0.00	0.23	0.05	0.03	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	2.05	0.52	0.25	0.00	0.00	0.00	0.00

HU total per species x access weight								
Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.17	0.18	0.05	0.02	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.16	0.17	0.04	0.02	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.33	0.35	0.09	0.04	0.00	0.00	0.00	0.00

HU GAINS -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight																																
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.19	0.19	0.00	0.00	0.41	0.30	0.00	0.00	0.09	0.06	0.00	0.00	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.03	0.01	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.03	0.04	0.04	0.04	0.03	0.05	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
6	0.09	0.09	0.09	0.07	0.10	0.10	0.10	0.07	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
7	0.00	0.02	0.05	0.10	0.00	0.03	0.05	0.11	0.00	0.01	0.03	0.03	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01
8	0.06	0.06	0.09	0.12	0.07	0.07	0.10	0.13	0.01	0.01	0.02	0.04	0.02	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.02
9	0.06	0.03	0.06	0.06	0.07	0.03	0.07	0.07	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.24	0.44	0.53	0.39	0.26	0.68	0.68	0.43	0.06	0.17	0.16	0.13	0.04	0.07	0.08	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.05	0.03	0.00	0.03	0.07	0.05

Habitat type area x HSI x species weight x life function weight																																
Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.05	0.05	0.05	0.03	0.05	0.05	0.05	0.04	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.05	0.02	0.05	0.05	0.05	0.02	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.09	0.07	0.09	0.08	0.10	0.07	0.10	0.09	0.03	0.02	0.02	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01

Compensation Contingency Options

TOTAL BY FEATURE - Summary

Second Portage Lake

Sea Mounts	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1			0.00	0.00	0.00	0.00
2			0.00	0.00	0.00	0.00
3			0.00	0.00	0.00	0.00
4			0.00	0.00	0.00	0.00
5			0.00	0.00	0.00	0.00
6		1.25	1.25	0.00	1.06	1.06
7	1.25		-1.25	0.52	0.00	-0.52
8			0.00	0.00	0.00	0.00
9			0.00	0.00	0.00	0.00
11			0.00	0.00	0.00	0.00
Total	1.25	1.25	0.00	0.52	1.06	0.55

Second Portage Lake

East Dike Extension	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1			0.00	0.00	0.00	0.00
2			0.00	0.00	0.00	0.00
3			0.00	0.00	0.00	0.00
4			0.00	0.00	0.00	0.00
5			0.00	0.00	0.00	0.00
6		5.00	5.00	0.00	4.25	4.25
7	5.00		-5.00	2.06	0.00	-2.06
8			0.00	0.00	0.00	0.00
9			0.00	0.00	0.00	0.00
11			0.00	0.00	0.00	0.00
Total	5.00	5.00	0.00	2.06	4.25	2.18

Third Portage Lake

Finger Dike Extension	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1			0.00	0.00	0.00	0.00
2			0.00	0.00	0.00	0.00
3			0.00	0.00	0.00	0.00
4			0.00	0.00	0.00	0.00
5			0.00	0.00	0.00	0.00
6		11.00	11.00	0.00	9.35	9.35
7	11.00		-11.00	4.54	0.00	-4.54
8			0.00	0.00	0.00	0.00
9			0.00	0.00	0.00	0.00
11			0.00	0.00	0.00	0.00
Total	11.00	11.00	0.00	4.54	9.35	4.81

Airplane System

Airplane Access	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.20	0.20	0.00	0.02	0.03	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00
3	16.62	16.62	0.00	3.64	3.87	0.23
4	4.63	4.63	0.00	1.36	1.47	0.11
5	0.00	0.00	0.00	0.00	0.00	0.00
6	7.89	7.89	0.00	4.29	4.55	0.26
7	23.26	23.26	0.00	7.46	8.12	0.65
8	0.00	0.00	0.00	0.00	0.00	0.00
9	1.08	1.08	0.00	0.51	0.55	0.04
11			0.00	0.00	0.00	0.00
Total	53.67	53.67	0.00	17.28	18.57	1.30

Airplane System

WQ Improvement	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.53	0.53	0.00	0.03	0.07	0.03
2	0.00	0.00	0.00	0.00	0.00	0.00
3	44.21	44.21	0.00	5.15	10.29	5.15
4	12.31	12.31	0.00	1.95	3.90	1.95
5	0.00	0.00	0.00	0.00	0.00	0.00
6	20.98	20.98	0.00	6.05	12.10	6.05
7	61.87	61.87	0.00	10.80	21.60	10.80
8	0.00	0.00	0.00	0.00	0.00	0.00
9	2.86	2.86	0.00	0.73	1.45	0.73
11	0.00	0.00	0.00	0.00	0.00	0.00
Total	142.76	142.76	0.00	24.70	49.41	24.70

HU LOSSES - Species Totals

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.20	0.21	0.08	0.02	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.20	0.21	0.08	0.02	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.79	0.86	0.33	0.08	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.79	0.86	0.33	0.08	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	1.74	1.88	0.73	0.19	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.74	1.88	0.73	0.19	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	0.5
1	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	1.35	1.87	0.19	0.00	0.00	0.00	0.23
4	0.00	0.37	0.83	0.04	0.00	0.00	0.00	0.11
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	1.37	2.48	0.18	0.00	0.00	0.00	0.26
7	0.00	1.88	4.71	0.22	0.00	0.00	0.00	0.65
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.17	0.27	0.02	0.00	0.00	0.00	0.04
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	5.15	10.18	0.65	0.00	0.00	0.00	1.30

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
H co-factor x	0	0.5	0.5	0.5	0.5	0.5	0	0.5
1	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	1.79	2.49	0.25	0.00	0.00	0.00	0.62
4	0.00	0.50	1.11	0.06	0.00	0.00	0.00	0.29
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	1.82	3.30	0.24	0.00	0.00	0.00	0.69
7	0.00	2.50	6.26	0.29	0.00	0.00	0.00	1.74
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.23	0.35	0.03	0.00	0.00	0.00	0.11
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	6.85	13.54	0.87	0.00	0.00	0.00	3.45

HU LOSSES -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.03	0.06	0.11	0.00	0.03	0.06	0.12	0.00	0.01	0.04	0.04	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.02
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.03	0.06	0.11	0.00	0.03	0.06	0.12	0.00	0.01	0.04	0.04	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.02

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.25	0.50	1.00	0.00	0.27	0.54	1.07	0.00	0.08	0.33	0.33	0.00	0.00	0.04	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.07	0.00	0.00	0.07	0.14
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.25	0.50	1.00	0.00	0.27	0.54	1.07	0.00	0.08	0.33	0.33	0.00	0.00	0.04	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.07	0.00	0.00	0.07	0.14

Habitat type area : Lost Habitat Units per Species per Life Function

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.52	0.52	0.00	0.00	0.77	0.58	0.00	0.00	1.12	0.75	0.00	0.00	0.12	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.31	0.16	0.00
4	0.00	0.14	0.14	0.22	0.00	0.11	0.11	0.16	0.00	0.10	0.42	0.31	0.00	0.01	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.00	0.00	0.09	0.13
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.49	0.49	0.49	0.37	0.36	0.36	0.36	0.27	0.71	0.71	0.53	0.53	0.04	0.03	0.06	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.00	0.00	0.30	0.22
7	0.00	0.36	0.73	1.45	0.00	0.27	0.54	1.08	0.00	0.52	2.09	2.09	0.00	0.00	0.04	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.15	0.00	0.00	0.44	0.87
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.07	0.03	0.07	0.07	0.05	0.02	0.05	0.05	0.07	0.05	0.05	0.10	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.04	0.04
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.56	1.56	1.95	2.11	0.41	1.54	1.64	1.56	0.78	2.51	3.85	3.03	0.05	0.17	0.18	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.15	0.28	0.21	0.00	0.31	1.01	1.26

Habitat type area : Lost Habitat Units per Species per Life Function

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	1.38	1.38	0.00	0.00	2.04	1.53	0.00	0.00	2.98	1.99	0.00	0.00	0.33	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.28	0.00	0.00	0.83	0.41	0.00
4	0.00	0.38	0.38	0.58	0.00	0.28	0.28	0.43	0.00	0.28	1.11	0.83	0.00	0.02	0.02	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.06	0.00	0.00	0.23	0.35
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	1.31	1.31	1.31	0.98	0.97	0.97	0.97	0.73	1.89	1.89	1.42	1.42	0.12	0.08	0.16	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.10	0.10	0.00	0.00	0.79	0.59
7	0.00	0.97	1.93	3.87	0.00	0.72	1.43	2.86	0.00	1.39	5.57	5.57	0.00	0.00	0.12	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.39	0.00	0.00	1.16	2.32
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.18	0.09	0.18	0.18	0.13	0.07	0.13	0.13	0.19	0.13	0.13	0.26	0.02	0.01	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.02	0.00	0.00	0.11	0.11
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.49	4.14	5.20	5.61	1.10	4.09	4.36	4.15	2.08	6.68	10.25	8.07	0.13	0.44	0.48	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.40	0.74	0.56	0.00	0.83	2.70	3.36

Compensation Contingency Options

TOTAL BY FEATURE - Summary

Second Portage Lake

Sea Mounts	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1			0.00	0.00	0.00	0.00
2			0.00	0.00	0.00	0.00
3			0.00	0.00	0.00	0.00
4			0.00	0.00	0.00	0.00
5			0.00	0.00	0.00	0.00
6		1.25	1.25	0.00	1.06	1.06
7	1.25		-1.25	0.52	0.00	-0.52
8			0.00	0.00	0.00	0.00
9			0.00	0.00	0.00	0.00
11			0.00	0.00	0.00	0.00
Total	**1.25**	**1.25**	**0.00**	**0.52**	**1.06**	**0.55**

Second Portage Lake

East Dike Extension	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1			0.00	0.00	0.00	0.00
2			0.00	0.00	0.00	0.00
3			0.00	0.00	0.00	0.00
4			0.00	0.00	0.00	0.00
5			0.00	0.00	0.00	0.00
6		5.00	5.00	0.00	4.25	4.25
7	5.00		-5.00	2.06	0.00	-2.06
8			0.00	0.00	0.00	0.00
9			0.00	0.00	0.00	0.00
11			0.00	0.00	0.00	0.00
Total	**5.00**	**5.00**	**0.00**	**2.06**	**4.25**	**2.18**

Third Portage Lake

Finger Dike Extension	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1			0.00	0.00	0.00	0.00
2			0.00	0.00	0.00	0.00
3			0.00	0.00	0.00	0.00
4			0.00	0.00	0.00	0.00
5			0.00	0.00	0.00	0.00
6		11.00	11.00	0.00	9.35	9.35
7	11.00		-11.00	4.54	0.00	-4.54
8			0.00	0.00	0.00	0.00
9			0.00	0.00	0.00	0.00
11			0.00	0.00	0.00	0.00
Total	**11.00**	**11.00**	**0.00**	**4.54**	**9.35**	**4.81**

Airiplane System

Airplane Access	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.20	0.20	0.00	0.02	0.03	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00
3	16.62	16.62	0.00	3.64	3.87	0.23
4	4.63	4.63	0.00	1.36	1.47	0.11
5	0.00	0.00	0.00	0.00	0.00	0.00
6	7.89	7.89	0.00	4.29	4.55	0.26
7	23.26	23.26	0.00	7.46	8.12	0.65
8	0.00	0.00	0.00	0.00	0.00	0.00
9	1.08	1.08	0.00	0.51	0.55	0.04
11			0.00	0.00	0.00	0.00
Total	**53.67**	**53.67**	**0.00**	**17.28**	**18.57**	**1.30**

Airiplane System

WQ Improvement	Hectares			HU		
Habitat Type	Pre-	Post-	Net	Pre-	Post-	Net
1	0.53	0.53	0.00	0.03	0.07	0.03
2	0.00	0.00	0.00	0.00	0.00	0.00
3	44.21	44.21	0.00	5.15	10.29	5.15
4	12.31	12.31	0.00	1.95	3.90	1.95
5	0.00	0.00	0.00	0.00	0.00	0.00
6	20.98	20.98	0.00	6.05	12.10	6.05
7	61.87	61.87	0.00	10.80	21.60	10.80
8	0.00	0.00	0.00	0.00	0.00	0.00
9	2.86	2.86	0.00	0.73	1.45	0.73
11	0.00	0.00	0.00	0.00	0.00	0.00
Total	**142.76**	**142.76**	**0.00**	**24.70**	**49.41**	**24.70**

HU GAINS - Species Totals

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.42	0.46	0.13	0.05	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.42	0.46	0.13	0.05	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	1.70	1.83	0.52	0.20	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.70	1.83	0.52	0.20	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	1	1	1	1	1	1	0	0
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	3.73	4.03	1.14	0.44	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	3.73	4.03	1.14	0.44	0.00	0.00	0.00	0.00

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
Access >>	0	1	1	1	1	1	0	1
1	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	1.35	1.87	0.19	0.00	0.00	0.00	0.47
4	0.00	0.37	0.83	0.04	0.00	0.00	0.00	0.22
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	1.37	2.48	0.18	0.00	0.00	0.00	0.52
7	0.00	1.88	4.71	0.22	0.00	0.00	0.00	1.31
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.17	0.27	0.02	0.00	0.00	0.00	0.08
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	5.15	10.18	0.65	0.00	0.00	0.00	2.59

HU total per species x access weight

Species >>	ARCH	LKTR	RNWH	BURB	SLSC	NNST	CISC	ARGR
H Co-Factor	0	1	1	1	1	1	0	1
1	0.00	0.01	0.05	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	3.58	4.97	0.50	0.00	0.00	0.00	1.24
4	0.00	1.00	2.22	0.12	0.00	0.00	0.00	0.58
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	3.64	6.61	0.47	0.00	0.00	0.00	1.38
7	0.00	5.01	12.53	0.58	0.00	0.00	0.00	3.48
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.46	0.71	0.06	0.00	0.00	0.00	0.21
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	13.70	27.08	1.73	0.00	0.00	0.00	6.90

HU GAINS -Species Sub-Totals

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.11	0.11	0.11	0.08	0.12	0.12	0.12	0.09	0.04	0.04	0.03	0.03	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.01
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.11**	**0.11**	**0.11**	**0.08**	**0.12**	**0.12**	**0.12**	**0.09**	**0.04**	**0.04**	**0.03**	**0.03**	**0.01**	**0.01**	**0.02**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	**0.00**	**0.00**	**0.02**	**0.01**

Habitat type area x HSI x species weight x life function weight

Species >>	ARCH				LKTR				RNWH				BURB				SLSC				NNST				CISC				ARGR			
Life Function >>	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00

MEADOWBANK GOLD PROJECT

Emergency Response Plan

Prepared by:
Agnico-Eagle Mines Limited – Meadowbank Division

Version 4
July 2012

EXECUTIVE SUMMARY

The Emergency Response Plan (ERP) is activated when a operations-related emergency, accident or malfunction occurs, or if such an incident is foreseeable. The ERP outlines potential emergency scenarios, initial actions for emergencies and the internal and external resources available including personnel, emergency response equipment and communication systems.

The ERP will be reviewed and updated at least annually.

IMPLEMENTATION SCHEDULE

This Plan will be immediately implemented**.**

DISTRIBUTION LIST

AEM – General Mine Manager / Designate

AEM – General Superintendent Operations

AEM – General Superintendent Maintenance

AEM - General Superintendent General Services

AEM – Health and Safety Superintendent / Designate

AEM – Human Resources Superintendent / Designate

AEM – Engineering Superintendent / Designate

AEM – Geology Superintendent / Designate

AEM – Environment Superintendent / Designate

AEM – Mill Superintendent / Designate

AEM – Site Services Superintendent / Designate

AEM – Mine Superintendent / Designate

AEM – Maintenance Superintendent / designate

AEM – Emergency Response Counselors

AEM – OHSC Co-chairs

AEM - Security

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
1	08/10/31	Appendix A		Revision to include East Dike design modifications
2	09/11/16	All Sections		Confirmation of specific details and procedures Account for as-built designs and emergency preparedness for dike failure scenarios
3	12/01/31	All Sections		Review of all the documents
4	12/07/27	All Sections		Review of all documents

Prepared By: _____
Len Kutchaw.
Health and Safety Superintendent

Prepared By: _____
Stéphane Robert.
Environment Superintendent

Approved By: _____
Dominique Girard
General Manager

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SECTION 1 • INTRODUCTION

1.1 PURPOSE AND SCOPE OF THE EMERGENCY RESPONSE PLAN

The purpose of this Emergency Response Plan (ERP) is to provide a consolidated source of information for employees, contractors, and site visitors to respond quickly and efficiently to any foreseeable emergency that would likely occur at the Meadowbank project site. This ERP forms a component of the Environmental Management System (EMS) for the Project. As such, it is a working document that will be reviewed and updated on a regular basis as mine development, construction and operations proceed.

This ERP addresses gold mining, processing, transportation and related activities at the Meadowbank site as well as possible emergency scenarios that may occur off-site along the All Weather Private Access Road or at the Baker Lake Marshalling Facility. Guiding the development of this document has been the principle that an effective ERP must provide:

- A clear chain of command for safety and health activities;
- Well-defined corporate expectations regarding safety and health;
- Comprehensive hazard prevention and control methods; and
- Record-keeping requirements to track program progress.

AEM will ensure that all employees, contractors and site visitors fully understand and comply with all legislated safety standards, and the policies and procedures outlined in the ERP.

This ERP will be reviewed annually, or more frequently as required, to ensure compliance with applicable legislation, to evaluate its effectiveness and to continually improve the procedures. All employees, contractors and site visitors are encouraged to offer suggestions for ways to eliminate potential hazards and improve work procedures.

1.2 AEM'S POLICY STATEMENT

AEM is committed to protecting the health and safety of all its workers and the environment, and to adhering to all legislated safety standards. The necessary resources will be available to respond quickly and efficiently to all emergencies to prevent injury to, or degradation of, the health of individuals or the environment. In implementing this emergency response policy, AEM will set preparedness targets and report its progress on a regular basis.

To this end:

All relevant safety and emergency response laws and regulations will be incorporated into the ERP as minimum standards.

Senior management is responsible for making funds and other resources available, including hiring and training qualified personnel, to ensure the successful implementation of the ERP in the event of an emergency.

All supervisors are responsible for ensuring that their employees are aware of, and trained in, the proper emergency response procedures and that procedures and contact information are posted in all work areas. Supervisors are also responsible for ensuring that all employees follow safe work methods and all related regulations to prevent emergencies from occurring, and that they are provided with the proper tools to do so, including Personal Protective Equipment (PPE).

An emergency response team and coordination centre is establishes at the Meadowbank site.

The ERP will be tested on a periodic basis to ensure its effectiveness.

1.3 POLICY WITH RESPECT TO CONTRACTORS AND VISITORS

Every person working at or visiting the Meadowbank site receives an orientation upon arrival and as such is apprised of, and required to follow the ERP policies and procedures set forth in this manual. For a list of responsibilities, see Section 2.

Major contractors, such as those for mining and hauling, are required to have their own HS services. This is verified by AEM management prior to engagement of the contractor.

1.4 ENVIRONMENTAL POLICY

AEM is committed to achieving a high standard of environmental care in conducting its mineral exploration activities. AEM's Environmental Policy includes:

- Compliance with all applicable legislation including laws, regulations, and standards. Where laws do not exist, appropriate standards will be applied to minimize environmental impacts resulting from exploration activities.
- Open communication with government, the community, and employees on environmental issues.
- Development and adherence to management systems that adequately identify, monitor, and control environmental risks associated with AEM's exploration activities.
- Assurance that the employees are aware of their responsibilities and comply with AEM's Environmental Policy and field guide.

It is the policy of AEM to protect the environment, public health and safety, and natural resources by conducting operations in an environmentally sound manner while pursuing continuous improvement of our environmental performance.

SECTION 2 • ORGANIZATIONAL AND RESPONSIBILITIES

This section details the roles and responsibilities of all parties involved in emergency response planning and implementation at the Meadowbank mine site.

2.1 GENERAL MANAGER

The General Manager is responsible for implementing and maintaining the ERP. In addition, the General Manager's responsibilities are to:

- Act as a spokesperson on behalf of AEM with the public, media, and government agencies, as required;
- Prepare and submit any formal reports (within the required time frame) to regulators and AEM management detailing the occurrence of an emergency; this includes submitting an incident reporting form;
- Ensure that the Health & Safety and Environment Superintendents have the means (financial and otherwise) to ensure that all required resources are made available, or provided from off-site if required;
- Work with the H&S, Human Resources and Environment Superintendent to evaluate what training is required by all staff, ensure that all staff are given appropriate training, and ensure that all staff are retrained as needed;
- Ensure that the Human Resources Superintendent has the means (financial and otherwise) to ensure that all employees' training requirements are current;
- Ensure that inspections of emergency response training practices and emergency response equipment are carried out;
- Ensure that emergency response exercises are conducted annually,
- Ensure that the results of the regular inspections are used to improve emergency response practices, and improve relevant plans accordingly;
- Complete an annual detailed review of the ERP with the management team and the Join Health and Safety Committee with particular emphasis on the objectives and methods of the plan, and the job descriptions of all positions named within;
- Ensure that updates to new emergency communications information (new phone numbers, changes in reporting structure, etc.) are distributed as soon as the new information becomes available;
- Keep a formal record of distribution and amendments to the ERP; and

2.2 EMERGENCY CONTROL TEAM – *ON SITE MANAGEMENT TEAM*

No single department can handle an emergency situation alone. Everyone must work together to manage the emergency and coordinate the effective use of all available resources.

Therefore at the time of any emergency, all the management team and/or their designate must report to the 3rd floor Emergency Response Control room #1 or to the Emergency Response Control Room #2, at the Training room.

The Emergency Control Team structure lends support, fosters efficiency and provides additional knowledge during an emergency response situation.

The Official In-Charge, (General Mine Manager or Designate) maintains the overall coordination and direction of the Emergency and ensures the continued safety of all employees and the public.

However, the Superintendent or designate of the Area affected by the emergency, will assist with the development of the overall emergency response plan.

The remainder of the Emergency Control Team will be given specific tasks to perform that will assist with the management and coordination of the emergency response plan.

Roles & Responsibilities of the Emergency Control Group

2.2.1 Official In-Charge

The Official In-Charge (General Manager or designate) will take charge for overseeing and approving the overall emergency strategy.

Immediate duties of the Official In-Charge include:

- Consult with the Incident Commander the status of emergency.
- Appoint an Emergency Log Recorder to maintain a written record of the time and events, including all discussions, instructions and decisions made by the Emergency Control Team;
- Appoint a Muster Station Coordinator, who will ensure that proper head counts are conducted at three (3) designated Muster Stations.
- Issues specific tasks to the members of the Management as they arrive at the Control Room, as per this guideline;
- Brief the Emergency Control Team;
- Ensure that the safety of personnel is maintained, throughout the operation.
- Ensure procedures are in place for prompt dispatch of requested personnel, materials and equipment to the emergency area.

- Arrange for all reports to be presented at specific intervals to the Emergency Control Team

- Finalize the recommendations of the Incident Commander for rescue and recovery operations.

- The Official In-Charge is the only person authorized to release information to Government Agencies, Corporate Office or the Local Communities. He may delegate this activity to other members of the Emergency Control Team.

    - Verify all information you release;
    - Keep a record of all inquiries (media and non-media);
    - Do not speculate on causes;
    - Do not speculate on resumption of normal operations or when the problem will be solved;
    - Advise that further updates will be forth coming.

- Notify the corporate management, if the following appear probable:
    - fatalities;
    - injuries that could probably become items of local, regional or national media interest;
    - there is a public health or environmental risk;
    - an incident involving chemicals where there is a large volume or the potential for over reaction (e.g., cyanide);
    - a spill of effluent or contaminated water or chemical substance to an area that lies outside the area of drainage control of the mine site (i.e., an external spill);
    - mine operations may be stopped for more than two (2) days;
    - Government authorities will become involved.

- Ensure all response teams, regulatory agencies and any other agency on emergency alert notice are advised when the emergency has ended.

- Ensure all documentation (i.e., notes, log sheets, written instructions, etc.) is gathered for the creation of the final report.

- Participate in debriefing.

2.2.2 **General Superintendents:**

- General Services, Operations and Maintenance will report to the Emergency Control Room and support the General manager/Designate in whatever capacity required.

- They will also ensure that the Superintendent/Designate in each of their respective Department's is aware of the emergency.

- They will assist with the investigation and write up of the final report

2.2.3 **Incident Commander**: – **Usually a Trained Staff Member (ERT Coordinators or Supt. / GF.)**

The responsibilities of the Incident Commander include;

- Ensure Security has been notified of emergency;
- Ensure the evacuation procedures have been activated, if required;
- Ensure that there are sufficient ERT members available to respond to the emergency;
- Ensure that the ERT has back-up support, a standby Team;
- Ensure that ERT Team has refreshments and nourishment (if the emergency requires several hours to resolve);
- Assess the size and severity of the emergency and the likely consequences. Establish response priorities;
- Maintain communication with the ERT Captain.
- Advise the Official In-Charge of the ERT Team's activities, regarding the rescue and recovery operations.
- Appoint sufficient personnel, equipment and outside services are available. Utilize the members of the Emergency Control Team to organize these resources.
- Advise Official In-Charge when the emergency situation is under control and give the "All Clear".
- Participate in emergency investigation.
- Coordinate an orderly return to normal operating conditions.
- Arrange for a debriefing session, and utilize the services of all involved in resolving the emergency.
- Assist to write the final report.

2.2.4 **Emergency Log Recorder / Muster Station Coordinator: - "***keep a systematic record of the emergency events" and get an accurate "Head Count during Emergencies***"**

- These persons can be the Geology/ Engineering Supt/Designate/ General Supt.(whoever is available to perform these duties)

- The log is intended to be a systematic record of the events from the start of the emergency through all phases to termination, and will be used in the preparation of the final report. It is important that the log be legible and that all information is recorded.

Emergency Log Recorder: **"***Keep a systematic record of the emergency events, phone calls and directives,."*

- Date and time the incident was reported, who reported the event;
- Record all subsequent developments as they occur;
- Record all phone calls all discussions and decisions made;
- Record any other information that needs to be captured for the final report;
- Keep all the sheets of paper used to record information numbered, for the final report;
- All the pages will be initialed by the recorder and official in-charge;
- The official document will stay with the Health & Safety Department upon completion of the emergency.

Muster Station Coordinator: *" Provide a Head Count during Emergencies".*

- As soon as Management begins to assemble in the Emergency Control Room , the Person In Charge (the manager/designate) needs to assign a member of the Management Team to be responsible for ensuring that the Muster Stations are contacted.

- The Muster Station Coordinator is required to contact the three Muster Stations by telephone, to ensure that there is a Supervisor is in charge of that specific muster station and give him/her 20 minutes to achieve the head count.

- The Muster Station Coordinator will need to record the time the muster station was called, who is in-charge of the muster station, and any other instructions that have been given.

- The Muster Station Coordinator needs to open the Flo on his/her laptop in order to cross reference the names, once they receive the lists from the Muster Stations.(additional persons may need to be assigned to assist with the cross reference, in order to complete the head count in a timely manner).

2.2.5 Emergency Response Team (ERT Team) Duties:

- The ERT Team Members must report to the Fire Hall, when paged for a “code One” emergency;
- ERT Team Members will be given instructions on the emergency by the Incident Commander;
- ERT Team Members will follow instructions from the Incident Commander and will not put the Team at risk;
- The ERT Team Captain will maintain radio contact with the Incident Commander throughout the emergency:

2.2.6 Mine Superintendent/Designate Duties;

- Ensure that all employees working, are accounted for;
- Ensure that the ERT Members of his crew have responded to the “code One” emergency;
- If the “Emergency” is in the Pit, them assist the Official-in-Charge with the action plan to deal with the emergency:
- Assist as required by supplying equipment and/or manpower;
- Assist with restoring of the Operations back to normal operating standards:

2.2.7 Mill Superintendent/Designate Duties;

- Ensure all employees working, at this time, are accounted for;
- Ensure that the ERT Members on his crew, have responded to the “ Code One” emergency;
- If the “ Emergency” is in the Mill facilities, assist the Official-in-Charge with the action plan to deal with the emergency:
- Assist as required by supplying equipment and/or manpower;
- Assist with restoring of the Operations back to normal operating standards:

2.2.8 Environmental Superintendent/Designate Duties:

- The following are the responsibilities of the Environmental Superintendent/Designate;
- Provide technical advice on probable environmental effects resulting from a spill and how to minimize them;
- Provide advice to the Official-in-Charge for appropriate spill response procedures;
- Ensure that Environmental Staff are available to direct the spill response action plan;
- Assist with restoring of the Operations back to normal operating standards:

2.2.9 Health and Safety Superintendent/Designate Duties:

The Health and Safety Superintendent/Designate will be responsible for:

- Ensure that an Incident Commander is in place to oversee the ERT Teams;
- Ensure that all Management respond to the emergency and meet in the emergency control room;
- He will oversee all activities that require Security or Nursing. He will arrange for Medevac transport, if required;
- Will assist with getting a “head count” for the Official in-charge;
- Assist with obtaining outside help if required:

2.2.10 Site Services Superintendent/Designate Duties:

The following are the responsibilities of the Site Services Superintendent/Designate;

- Ensure that all his employees are accounted for
- Ensure that all ERT Member on his Crew, respond to the “ code One” emergency;
- If the “ Emergency” is involves the Site facilities, assist the Official-in-Charge with the action plan to deal with the emergency:
- Assist as required by supplying equipment and/or manpower;
- Assist with restoring of the Operations back to normal operating standards:

2.2.11 Maintenance Superintendent/Designate:

The following are the responsibilities of the Maintenance Superintendent/Designate:

- Ensure that all of his employees are accounted for;
- Ensure that all ERT Members of his crew respond to the “Code One” emergency;
- If the “Emergency” is in the Maintenance Shops, then assist the Official-in-Charge with the action plan to deal with the emergency;
- Assist as required by supplying equipment and/or manpower;
- Assist with restoring of the Operations back to normal operating standards:

2.2.12 Human Resources Superintendent/Designate Duties:

The following are the responsibilities of the Human Resources (HR) Superintendent/Designate;

- Ensure that all HR employees are accounted for;
- Provide assistance to the Official-in-Charge if there are employees issues, such as injuries, transportation requirements, etc.:

2.2.13 Health Care Professional (Nurse/Medic):

The on-site health professionals are responsible for the following:

- Providing on-site first aid and other medical support;
- Establish a triage location if there are multiple casualties;
- Arrange for medevac transportation, if required;
- Ensuring that the first aid room is maintained at all times, by using First Responders as support:

2.2.14 Security Department:

The on-Site Security Supervisor is responsible for the following:

- Ensuring that the Security officer has activated the appropriate level of emergency notification;
- Ensure that access points to the emergency are properly guarded.

- Notify the Baker Lake Gatehouse if the emergency involves the Alll weather private Road (AWPR).

- Assist with other duties as requested by the Emergency Control Group.

2.2. OCCUPATIONAL HEALTH AND SAFETY COMMITTEE:

The Occupational Health and Safety Committee is responsible for:

- Review the emergency response plan on an annual basis.

- Assist with any investigation resulting from the emergency.

2.3 ALL EMPLOYEES:

All employees are responsible for:

- Reporting to the nearest Muster Station when an fire alarm is sounded;;
- Employees reporting to the Muster Station need to assemble at the placard that has their department name.
- Employee's must be quiet and await the "head count**".**

- Reporting any emergency by either using the radio on the dedicated emergency channel (#1) or using the telephone to call 6911, to describe the type, the location, and nature the emergency, including possible injuries, trapped personnel, and the presence of any chemical or explosive hazards.

2.4 SUPERVISOR:

The Supervisor is responsible for:

- Ensuring the " Code One" call in, is accurate and that all the pertinent information is available for the official-in-Charge. (providing details regarding the type, the location, and the nature of the emergency, including possible hazardous materials involved and health and safety concerns);

- Ensure all workers on his shift are accounted for:

2.5 OTHER PERSONNEL:

Depending on the nature of the emergency (medical, electrical, mechanical, fire, etc.) other site personnel, including the Site Electrician, Site Mechanic, and others, may be called upon to play key roles.

2.6 EMERGENCY RESPONSE CONTACT INFORMATION – INTERNAL & EXTERNAL

AEM internal emergency response personnel, their duties, and phone numbers has been compiled in Table 2.1, Important external contacts such as regulatory agencies, health organizations and transportation companies providing evacuation support are listed in Table 2.2.

Table 2.1: Internal Emergency Response Contact Information Chart

Position	Name/Location	24-Hour Contact #
General Manager	Dominique Girard	Ph: 867-793-4610 ext. 6901 cell: 819-277-4080
Ast. General Manager	Jean Beliveau	Ph: 867-793-4610 ext. 6901 Cell: 416-315-6745
Meadowbank Security	Denis Roy/Charles Blouin	Ph: 867-793-4610 ext. 6847
Emergency Response Team	Emergency response personnel available on site to assist with spill and emergency response activities	Code One activated by Site Security
Incident Commander	Philippe Beaudoin	Ph: 867-793-4610 ext. 6809 Radio Channel # 2
	Andre Rouleau	Ph: 867-793-4610 ext.6809 Radio channel # 2
Health and Safety Superintendent	Normand Ladouceur	Ph: 867-793-4610 ext. 6720 cell: 819-860-6258
Health and safety Superintendent Assistant	Len Kutchaw (temp)	Ph: 867-793-4610 ext. 6720 cell: 819-856-9051
Health Professionals / Medical Clinic	Medical Clinic 1	Ph: 867-793-4610 ext. 6734
	Medical Clinic 2	Ph: 867-793-4610 ext. 6751
Human Resource Superintendent	Not filled	Ph: ext 6723 cell:
HR Ast. Supt.	Krystel Mayrand	Ph: 867-793-4610 ext 6723 Cell: 819-856-9556
Environment Superintendent	Kevin Buck	Ph: 867-793-4610 ext 6838 Cell: 819 856-1956

Table 2.2: External Emergency Phone Numbers

Organization / Authority	Telephone Number	Fax Number
NT-NU 24-HOUR SPILL REPORT LINE	867.920.8130	867.873.6924
Nunavut Water Board	867.360.6338	867.360.6369
Environment Canada, Environmental Protection Branch	867.669.4700	867.873.8185
Environment Canada: 24-hour emergency pager monitored by Emergency and Enforcement	867.920.5131	
Manager Pollution Control & Air Quality Environmental Protection, Government of Nunavut	867.975.7748	867.975.5981
General Inquiry Department of Environment, Government of Nunavut	867.975.7700	
Indian and Northern Affairs Canada (INAC) – Water Resources Manager, Nunavut Regional Office	867.975.4550	867.975.4585
Indian and Northern Affairs Canada (INAC) – Manager, Land Administration, Nunavut Regional Office	867.975.4280	867.975.4286
Kivalliq Inuit Association – Reporting Line	867.645.2810 or 867.645.2800	
Department of Fisheries and Oceans (DFO) – Nunavut Regional Office	867.979.8000	867.979.8039
Workers Safety and Compensation Commission Mine Inspector: Martin Van Rooy	800.661.0792 867.979.8527	
Keewatin Health Services – Baker Lake	867.793.2816 867.793.2813	
Keewatin Air Ambulance (Medevac) 24h/7 – Rankin Inlet dispatch	867.645.4455	
Baffin Regional Hospital (Iqaluit)	867.979.7300	
Baker Lake RCMP	867.793.0123	
Baker Lake RCMP – emergency number	867.793.1111	
Cambridge Bay RCMP	867.983.2111	
Baker Lake Hamlet Office	867.793.2874	
Baker Lake Fire Emergency	867.793.2900	
Baker Lake Fire Marshall's Office	867.873.7944	
Baker Lake Radio Station	867.793.2962	
Baker Lake Airport	867.793.2564	
Department of Environment Health	867.983.7328	
Poison Control Centre	867.920.4111	
Search and rescue – Artic Armed Forces Rescue Coordination Centre Trenton	800.267.7270 613.965.3870	
NAVCAN (Flight Information Center North Bay)	866.541.4109	
CANUTEC (Spill Support Information)	613.996.6666	
Charter Aircraft (for Evacuation)		
Keewatin Air Ambulance (Medevac)	867.645.4455	

24h/7 – Rankin Inlet dispatch		
Calm Air	204.677.0513 204.677.0519	
Nolinor	450.476.0018 888.505.7025	
First Air	867.669.6694 867.444.2002	
Helicopter Transport Services	613.839.5868	
Nunavut Emergency Management – Rankin Inlet	1-867-645-6803	
Nunavut Emergency Management – Iqaluit	1-800-693-1666 1-867-979-6262	

2.7 EMERGENCY COORDINATION CENTRE

Emergency operations will be directed out of the Emergency Control Centre (ECC). The ECC is located in the 3rd Floor of the Service Building Conference Room, or in the Training room on the main floor, from where the following will take place:

- Key decisions will be made and operations will be managed;
- Technical information to direct emergency activities will be provided;
- A communications centre will be established for emergency operations and to communicate with other organizations;
- Resource procurement will be provided and resource use will be directed;
- Any damage will be assessed and long-range objectives and plans will be developed; and
- Information on the emergency will be stored and disseminated to all necessary internal and external parties.

The following information is available at the centre:

- Shutdown procedures for operations;
- Locations of hazardous material storage areas;
- Locations of emergency and safety equipment;
- Locations of first aid stations and muster areas;
- Maps of communities and environmental maps;
- Information on location of other communications equipment, including portable sets;
- Information on emergency power;

- Contacts for other utilities;
- Operating manuals;
- Materials Safety Data Sheets (MSDS);
- List of personnel with alternate skills for use in emergencies;
- Type and location of alarm systems;
- Accident report forms;
- Accident status board and log book;
- Notification lists, staff lists, contact lists, with regular and emergency telephone/pages numbers, etc.

The ICC will be located at a safe and secure place near the site of the emergency. All responses and mitigation efforts developed at the ECC will be implemented through the ICC.

In the event of an emergency, security personnel may be required to establish and maintain a security perimeter to prevent or minimize injury to personnel, to preserve evidence for investigation, or to prevent unauthorized access to the scene.

2.8 TRAINING

The HR Superintendent is responsible for documenting, tracking, and updating all training activities. Record of training requirements and training attendance will be kept, tracked and updated for all employees by the HR Superintendent to ensure that retraining occurs as required.

For mine operations, AEM will ensure a sufficient number of trained ERT team members are on site at all times. All members of the ERT will be trained and familiar with emergency and spill response procedures. Emergency training will be conducted annually to ensure that a sufficient number of team members are available and that their training is up-to-date. The following will be included in the training:

- A review of the SCP and responsibilities of the team members;
- The nature, status, and location of fuel and chemical storage facilities;
- The location of 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.

SECTION 3 • EMERGENCY RESPONSE EQUIPMENT

The Emergency Measures Counsellor will ensure that site drawings and equipment lists are posted conspicuously in key locations throughout the site so that important information is always readily available. This will include the following:

- Location and isolation points of energy sources;
- Location of emergency equipment (e.g., fire water pumps, fire extinguishers, monitors, self-contained breathing apparatus);
- Emergency procedures outlines, such as specialist firefighting, chemical neutralization;
- Location of equipment for combating pollution (e.g., booms, skimmers, pumps, absorbents, dispersants);
- Availability of internal and external emergency medical support (e.g., hospitals, clinics, ambulances, medical supplies, personnel with medical or first aid training);
- Location of toxicity testing facilities (e.g., gas and water);
- Location of wind direction / speed indicators;
- Directions on how to contact the local or regional weather forecasting service;
- Location of personal protective equipment and directions on its proper use; and
- Location of first aid stations and muster areas.

The Incident Commander, EMC, and Health and Safety Superintendent will know where, throughout the project site, all of this information is posted and where emergency equipment is stored. These individuals will also be trained in the proper use of emergency equipment.

External emergency response equipment includes the mobile emergency response equipment described in the SCP.

SECTION 4 • COMMUNICATION SYSTEMS

The primary basis for communication will be the phone system; back-up communication will be available via satellite phone. For on-site communication, hand-held radios will be mandatory for all employees working or travelling in remote areas from the main camp. Cell phones can be used as an additional means of communication. Back-up power sources and replacement batteries for communications equipment will be available to provide continuous, uninterrupted operation either at fixed facilities or at emergency sites.

Key site personnel will be accessible at all times by either portable radios, radios in vehicles, or office radios. The Health Care Professional will carry a hand-held radio and will be available at all times. Security personnel will monitor the emergency channel twenty-four hours per day. Senior management personnel will rotate as “On-Call Managers” for after-hour emergencies. An accommodations list that highlights key personnel will be posted and updated as required.

Lists of employees trained in first aid, mine rescue, and Emergency Response will also be posted. Employees and contractors who will be on site for extended periods will be trained initially and then retrained annually. This training will include the locations and use of emergency equipment, terminology used, and who needs to be contacted immediately in the event of an emergency.

SECTION 5 • EMERGENCY MEASURES

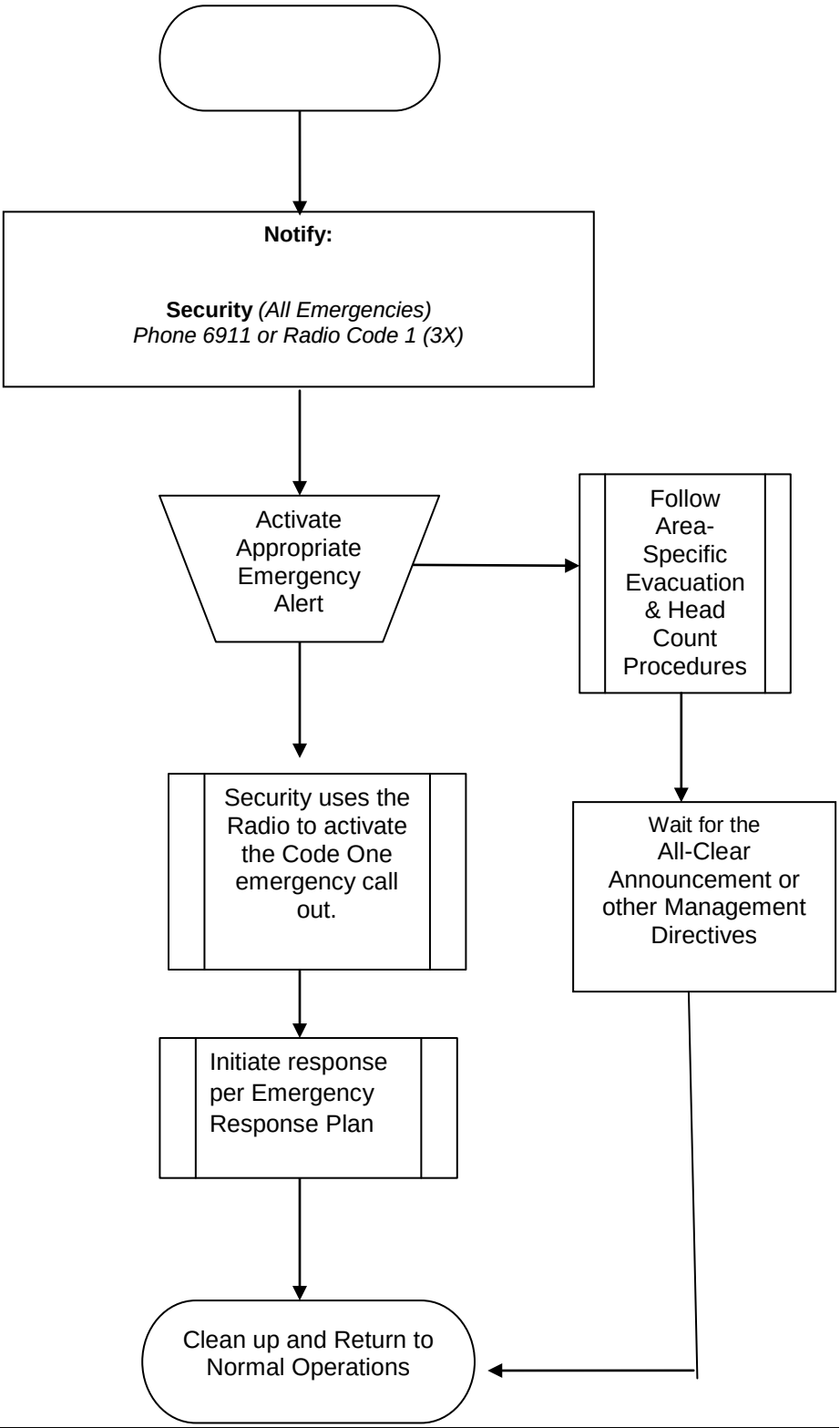
In the event of an emergency, the employee will have to follow our emergency procedure:

- Emergency is initiated - by calling **6911** on desk type phones, or calling on Two-way radio on **Channel 1 – 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 page goes off – all **ERT** team members will make their way expediently to the **ERT** hall.

GENERAL EMERGENCY RESPONSE FLOWCHART



FIRE

The Camp Complex and Process Plant is equipped with a fire detection and audible fire warning system. All site operating personnel receive basic training in the use of fire extinguishers. This training is tracked by the HR Superintendent.

For any situation involving fires, the first action will be to extinguish the fire if it is safe to do so and then report the incident. If the person cannot safely put out the fire, it must be reported as quickly as possible. In the event of a fire alarm, all employees not directly involved with fighting the fire will report to the designated muster location (section 5.2). Employees will remain in this area until assigned other duties by the ERT or until given clearance that the emergency is over.

In the event that a fire causes damage to mining equipment, site buildings, or chemical containers, particulates and/or gases could be released into the air, and hazardous materials and/or other chemicals (e.g., fuels, oils, battery acid, lime, etc.) could be spilled. In the short-term, this could result in air quality degradation, and potentially affect the local vegetation in the case of a spill or burn scar. Should such scenarios occur, the following actions will be taken, as required and WHEN IT IS SAFE TO DO SO:

- Air quality monitoring for airborne emissions;
- Collection and incineration of all putrescibles (food items);
- Removal of debris and contaminated soil for disposal on-site or off-site at a licensed disposal facility;

Further details on the cleanup of chemical spills are provided in the Spill Contingency Plan.

The incident commander will;

- Locate the source of fire.
- Dispatch the evacuation at the safest muster point.
- Assign a captain and his team.
- Ensure the security of all the ERT's members or any other service persons (medics, security guard, electricians, etc…).
- If the intervention of the mine inspector is necessary for a special investigation, he will ask to the security department to ensure the integrity of the scene.
- Call the end of the emergency measures and invites everyone evacuated to reintegrates their original locations.

General Manager or designate can decide to use any available machinery to separate all or part of a building to protect people or minimize losses.

Incident Reports are to be filed detailing the causes of the fires and responses undertaken. This information will be used by the EMC in subsequent fire prevention activities

5.1 MUSTER POINT

In the event that an evacuation is necessary, it is important that all affected personnel leave the emergency area and congregate at a pre-determined area or *Muster point* so that a head count can be taken to determine if there are any missing persons. Employees must remain at the muster point until the supervisor of the emergency area gives permission to return to work.

Upon hearing a fire alarm, smoke alarm, or evacuation alarm you shall ….

- ***Do Not Panic*** – Always ensure that you are prepared for the weather conditions – Dress appropriately – (Winter clothing during winter months).
- ***DO NOT*** delay and ***DO NOT*** stay and finish work before taking the proper steps to evacuate.
- Always **close** windows/doors as you leave your office etc.
- ***Always*** head to the ***closest*** **EXIT** door and follow **EXIT** signs to the closest outside door.
- Once outside head to the ***closest*** **"*Muster Station*".**
- Once in **"*Muster Station*"** – Stay put until relieved or instructed otherwise by your Supervisor.
- Your Supervisor and/or Senior Management person in your dept. will ***conduct a tally*** **(head count)** of everyone in his/her department. Ensure that you get your name on the **tally form**.
- Note: on nightshift, the highest level of Management may be a front line Supervisor.
- ***DO NOT*** **enter** a building when the alarm is sounding. Head straight to a "**Muster Station**".
- ***Never*** go through a building to get to a "**Muster Station**". Once you are outside, the first door you open should be the one to the "**Muster Station**".
- ***Never*** disregard an evacuation alarm. We understand that the system goes off without incident on occasion, but to disregard an ***alarm is to endanger your life and the lives of others.***
- ***Stay in*** "**Muster Station**" until you are instructed to "**Stand Down**" by the Incident Commander.
- ***Do Not*** leave "**Muster Station**" to go outside for a smoke. It is important for your Supervisor to know where you are at all times – especially during an "**Emergency**".
- The only person authorized to initiate a "**Stand Down**" is the incident commander or the General Manager or designate.
- **Failure to follow** proper Evacuation Procedures will result in Discipline.
- The following areas are considered "**Muster Stations**" (see Figure)

5.2 MEDICAL EVACUATION PLAN

In the event of serious injury, it may be necessary to remove the individual from the source of the danger and to administer emergency first aid. The Health Professional will be notified immediately in order to take charge of the situation and ensure the safe removal of the injured person to the first aid room if possible.

- The **ERT** team will respond with (Nurse / Medic) and assist as necessary with equipment, treatment etc.
- The (Nurse / Medic) and as many **ERT** team members as required will respond to the incident site. When the (Nurse / Medic) arrives at the scene, they will notify the First Aid Treatment Room.
- First Aid will be administered to casualty(s); the casualty(s) will be secured and transported to the First Aid Room. Vehicles transporting casualty(s) will have priority over any other vehicle on site.
- Once the "Mechanisms of Injury" and the patient's condition have been assessed, a decision will be made by the (Nurse / Medic) whether a Medevac is required and decide on ground or air transportation. There are guidelines to follow to make this determination.

- As per guidelines for transportation, the "Mechanism of Injury" and/or patient condition, the (Nurse / Medic) will contact one of the following Medical facilities:

Winnipeg Health and Science Centre

Trauma team **204-774-6511 or 204-787-3901**

Main ER doctor in charge **204-774-6511**

Baker Lake Health Centre - 867-793-2816

Churchill Hospital - 204-675-8881

Rankin Inlet Health Care Centre - 867-645-2816

In addition: Dr. Lee (AEM – MBK) Medical Director - will be notified.

If a **MEDEVAC** is required, the Health Care Provider, will call one of the following airlines::

- Baker Lake Medical Clinic (**867)-793-2816**
- Rankin Inlet Medical Clinic (**867)-645-2816**

The following **INFORMATION** will be relayed to **Medical Facility** that you have reached and to **MEDEVAC** dispatcher:

- Give Patient's Name, Age, Mechanism of Injury, Nature of Injuries, and Medical Condition. Give all tests, treatment which you have done as well as ALL of the medication that has been administered to patient including the patient's past medical history and medications that he/she is taking.
- The TRANSFER sheet should be included and if possible FAX: to the Health Care Facility who will be receiving the **MEDEVAC and patient.**

If a **MEDEVAC** is required and decision is made to go with one:

- The patient will STAY in First Aid Room until his/her **Condition is stabilized.**
- Unnecessary delays will be avoided in transportation of Patient to Receiving Health Care Provider.
- When **MEDEVAC** personnel arrive on site – they will help establish the patient for air transportation.
- (Nurse / Medic) will take instructions from Medical Director and act according to his/her instructions.
- All decision/interventions will be documented with time lines.

Depending on the **MEDEVAC** Company that has been chosen, the (Nurse / Medic) may have to escort the patient to the receiving Health Care Facility.

The Official In-Charge will notify the (Nurse / Medic) when the **MEDEVAC** has arrived and landed. The (Nurse / Medic) with the help of the **ERT** team will transfer the patient into the ambulance, to the aircraft.

If the **MEDEVAC** comes to site with a **Medical crew:**

- The **MEDEVAC** team will call ahead to notify their ETA.
- The Manager on Duty or designate will ensure that a vehicle is sent to the airstrip at the ETA.
- The **Medical crew** with their equipment will be brought to the First Aid Room.
- Once the **MEDEVAC** equipment is in place, the **ERT** team will assist the **MEDEVAC Medical crew,** and (Nurse / Medic) with the transfer of the patient to the ambulance, and into the aircraft.

After the aircraft has left AEM – MBK site, the (Nurse / Medic) will notify the receiving Medical facility with the ETA to their closest airport. The **MEDEVAC** pilot will advise receiving airport air traffic controller that an ambulance is required for transportation to receiving Medical facility.

All Operations type work will be suspended until (Nurse / Medic) are back in First Aid Room. The incident scene, materials, machinery, medical equipment etc. will remain undisturbed until the investigating team has conducted the investigation. This type of incident is considered a “Reportable Incident” therefore the Mines Inspector shall be notified (without delay). The Official In-Charge will be responsible for ensure that this occurs. Under no circumstances shall any person move, or otherwise interfere with any wreckage or equipment at the scene of a “reportable incident” until an inspector has conducted an investigation of the incident and has given permission to do so.

The Official In-Charge will make all necessary calls to the outside for notification purposes: I.e.: Corporate Office notification, Mines Inspector, RCMP, etc.

If the incident is of a fatality, it is CLEAR that the Coroner or in his/her absence, the RCMP are in total control of the incident scene. The scene is to remain undisturbed until orders have been issued by either of these two authorities.

The scene will then be released to the local authorities such as the Mines Inspector for their portion of the investigation.

Upon arrival of the aircraft to the airport of the Receiving Medical Facility (other than Baker Lake), the receiving team will be notified and a designated person will call the Incident Command (control center) and update them on their arrival and the next steps to be taken. I.e.: transportation to Receiving Medical Facility.

The Receiving Medical Facility will communicate with AEM – MBK Division (Nurse / Medic) on frequent basis to update site on patient’s condition and treatment. Such as surgery required,

As soon as steps have been implemented to properly attend to the injuries, the Incident Commander will notify the appropriate authorities of the accident by telephone, providing as much information as possible. A complete accident description and investigation form is required to be submitted as soon as possible. The accident description and investigation form will be completed and submitted by the General Mine Manager. Unless some action is required to remove an immediate hazard, the site of

any serious accident will be cordoned off and remain unchanged until clearance is received from the appropriate authorities.

5.3 AIRPLAN CRASH DISASTER

Emergency Response begins as soon as an air crash is identified or reported.

- When the Meadowbank Air Traffic Controller or Meadowbank Security is notified that an approaching aircraft is having difficulty, they will immediately notify the General Manager or Designate.

- In the event of reported air crash off-site the Meadowbank Air Traffic Controller or Meadowbank Security will notify the General Manager or Designate.

- Emergency Response procedure will be initiated if required for response by ERT

- The ERT Team on scene will make a preliminary assessment and notify the Nursing Clinic.

- The Nurse or Medic, with the ERT Team, shall establish triage, treatment, transportation, communication, and staging.

- The ERT Incident Commander will direct all emergency response actions, and assess the need for additional resources keeping the Command Post updated as to all actions

- The RCMP will establish access and traffic control and assist the Coroner in body recovery and identification, if necessary.

- The Incident Commander will instruct emergency response personnel to not move debris associated with the wreckage, ie. cargo, plane remnants, passenger belongings, unless there is imminent danger of items being destroyed, or unless they inhibit access to passenger rescue.

- The Coroner/RCMP is responsible for the identification, movement and/or removal of the fatality. Unauthorized personnel are not to move the dead without express approval of the Coroner/RCMP, except when there is a question of whether the person is deceased or if the body is in danger of being destroyed. In all cases involving the movement of a body, personnel moving the body shall make careful note of the location and condition of the body for the Coroner/RCMP.

- Upon notification of an air disaster, NAV Canada will be responsible for air traffic in proximity to the scene, with immediate regulatory control of airspace around the area.

They will keep the airspace clear of intrusive air traffic, to the limits of the regulations.

Recovery:

- Recovery immediately follows emergency response. It involves direction from the General Manager or Designate.

- Maintaining access control to the scene.
- Providing emergency social services (critical stress debriefing), for employees and rescue workers.
- Investigating the accident.
- Clean-up of the crash site.

5.4 PIPELINE BREAKAGE

Pipelines will be used to transport tailings solids, reclaim water, freshwater, and domestic sewage on site. Pipeline breakage could lead to localized, short-term smothering of vegetation, the release of poor-quality water, and potentially exposure of mine personnel to infectious or toxic substances. In the event of a pipeline breakage, the following actions will be taken as required and when it is safe to do so:

- Shut off the feed to the pipeline;
- Physically contain the spill through the construction of dikes, berms, sumps and collection ditches;
- Pump collected water to the tailings reclaim pond or sewage treatment plant;
- Collect and remove solids for disposal in the tailings facility, incineration, or off-site disposal at a licensed disposal facility; and
- Monitor for residual contaminants on land and in surface water.

A general response procedure for the handling of spilled domestic sewage (infectious substances) is provided in the Spill Contingency Plan.

5.5 TOXIC GAS RELEASES

In the event of a toxic gas release, the following actions will be taken:

- Immediately evacuate the area/building and notify the incident commander;
- If possible and safety permits, turn off the source of the gas and ventilate (i.e., open windows/doors to outdoors) the area;
- Isolate the area and restrict access to ERT personnel only; and
- Implement air quality monitoring.

For the mill, refer to the specific procedure *Toxic gas alarm emergency evacuation procedure*. A general response procedure for the release of compressed gases is provided in the SCP.

5.6 DIKE FAILURE

A detailed Emergency Preparedness Plan (EPP) will be developed to address the consequences of failure of any of the dikes on site. The procedure will be developed by the EMC and the Safety Superintendent with the assistance of the dike designer and Engineering Superintendent. Potential failure scenarios of the dikes and Tailings Storage Facility are provided in Appendix A.

5.7 EMULSION PLANT

A detailed Emergency Response Plan (ERP) was prepared by Dyno Nobel and addresses incidents and potential incidents involving the manufacturing, handling and storage of explosives and related products in Dyno Nobel Canada Inc.' magazines, emulsion plants and worksites at Meadowbank. The ERP for Dyno Nobel emulsion plant is provided in Appendix B.

5.8 BAKER LAKE MARSHALLING FACILITY

The Baker Lake Marshaling Facility is located 2 km east of the Hamlet of Baker Lake and is used for the interim storage of supplies, including hazardous materials, prior to being transported to the mine site. The fuel tank farm at the Facility is used for bulk fuel storage. Emergencies occurring at the Marshaling Facility will be handled according to the SCP.

SECTION 6 • REFERENCES

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NWT Water Board. January 1987. Guidelines for Contingency Planning. Government of the Northwest Territories.

SECTION 7 • LIST OF ACRONYMS

AEM	Agnico-Eagle Mines Limited – Meadowbank Division
AWPAR	All Weather Private Access Road
CDA	Canadian Dam Association
DFO	Fisheries and Oceans Canada
ECC	Emergency Coordination Centre
EIA	Environmental Impact Assessment
EMS	Environmental Management System
EPP	Emergency Preparedness Plan
ERP	Emergency Response Plan
ERT	Emergency Response Team
FoS	Factors-of-Safety
GN	Government of Nunavut
HAZCOM	Hazard Communication
HMMP	Hazardous Materials Management Plan
HR	Human Resources
HSC	Occupational Health & Safety Committee
IATA	International Air Transport Association
ICC	Incident Command Centre
INAC	Indian and Northern Affairs Canada
KIA	Kivalliq Inuit Association
MMER	Metal Mining Effluent Regulations
MSDS	Materials Safety Data Sheets

MSHA	Mine Safety and Health Administration
NWB	Nunavut Water Board
OHSA	Occupational Health and Safety Administration
OHSP	Occupational Health & Safety Plan
PPE	Personal Protective Equipment
SCP	Spill Contingency Plan
TDG	Transportation of Dangerous Goods
TSF	Tailings Storage Facility
WCB	Worker's Compensation Board
WHMIS	Workplace Hazardous Materials Information Syste

APPENDIX A

Dike Failure Scenarios

A.1 Dewatering Dikes

A.2 Central Dike

A.3 Saddle Dams

A.4 Stormwater Dike

Appendix A.1

Dewatering Dikes

Dewatering Dike System

The Dewatering Dike System includes the East Dike and the Bay Goose Dike, as shown on the general mine site plan provided at the beginning of this document. The dike construction will involve the dumping of rockfill into water to create the shells of the dikes, excavation through rockfill and lakebed soils to bedrock, placement of granular filter and core materials, dynamic compaction, construction of the cutoff wall using slurry supported trench techniques and grouting of the bedrock and contact between the cutoff wall and bedrock using cementitious grout. The dikes will have crest widths in excess of 50 m and may be used as a one-way haul road.

The East Dike was constructed in 2008, with foundation grouting continuing into early 2009. The East Dike has a crest length of 700 m, excluding abutments, was constructed in water with a maximum water depth to bedrock at the cutoff of 7.2 m. The crest of the East Dike is at elevation 137.1 m and the average lake level along the dike is 133.1 m.

The dewatering dikes are considered high consequence structures, based on Canadian Dam Association (CDA, 2007) Dam Safety Guidelines. The dikes are relatively low, wide structures that exceed the minimum design criteria factors-of-safety (FoS) for stability for pre-drawdown conditions, operation conditions with maximum head difference across the dikes, pseudo-static earthquake conditions, and post closure conditions. Consequently, the probability of dike failure is considered to be low provided that the dikes are constructed according to the design. Mitigation against failure of the dikes includes a quality control and quality assurance program during construction, and an ongoing program of dike surveillance and monitoring during operations, as specified in the design.

East Dike

During operations, the East Dike separates the eastern portion of Second Portage Lake from the Portage Pit and the Tailings Storage Facility behind the Central Dike. Following closure, the East Dike will remain as a permanent structure that will separate Third Portage Lake (El. 134.1 m) from Second Portage Lake (El. 133.1 m) and maintain the existing water elevation difference of 1 metre.

The East Dike is approximately 720 m in length through an average water depth of approximately 2.3 metres, and a maximum water depth to bedrock of about 7.2 m. Crest width is approximately 55 metres. Minimum setback from the Portage Pit (distance between dike toe and pit crest) is greater than 170 metres.

Bay Goose Dike

The Bay Goose Dike separates the Portage Pit from Third Portage Lake. The Bay Goose Dike acts as a permanent structure to allow mining of the south end of Portage Pit and the Goose pit.

The Bay Goose Dike will be approximately 2 km long, and will be constructed in water depths less than 10 metres at the cutoff. Crest width varies between approximately 85 and 100 m. Minimum design setback from the Portage and Goose Pit is 70 metres.

Table A.1: Meadowbank Dewatering Dikes Summary of Consequences and Proposed Monitoring/Action for Rare Events Based on Water Retaining Embankment Failure Modes Identified in ICOLD Study (1995)

Failure Mode	Scenario	Consequence	Monitoring/Action
Overtopping	(1) Lake level rise because of restricted outflow from Third Portage or Second Portage Lake (excessive inflow is a far less likely scenario).	Water spilling over the crest. The crest is wide and comprises coarse rockfill. Significant damage to the dike is not credible, based on performance of other rockfill structures subjected to overtopping or flow through events. Mining operations might need to be suspended, but there will be considerable warning time given the design freeboard and the storage volume within the lakes.	Lake levels should be part of safety information provided to mine management. Outflow channels should be inspected weekly during thaw, open water season, and during ice break-up. If overtopping is likely, a temporary spillway could be constructed and armoured to control and localize flow at shallow dike sections.
	(2) Dam crest settles more than 2m over a distance of (say) 50m or so. This scenario requires extensive loss of support in the foundation since the rockfill of the dikes is essentially not settlement prone itself. For foundation settlement of this magnitude to occur, a piping event must develop and which in itself might be a failure mode. Or, there would have to be an unexpected layer of compressible soil in the foundation.	Same as (1).	The situation envisaged in this scenario should develop slowly with crest settlement evident at least several weeks before a run-away event develops. Easily observed cracks should be evident. Monitoring of crest settlement is appropriate, and is included in the design. Rockfill and till available from the mining operation can be placed to raise the dike crest.

Failure Mode	Scenario	Consequence	Monitoring/Action
Internal Erosion	(1) Dike Section: Cutoff wall is defective, allowing high water flow across the wall. This defect occurs at a deep water location where the core backfill and filters are segregated and permeable; the combination allows erosion of the cutoff wall and increasing seepage.	The cutoff wall will develop a progressively increasing void ratio, thereby increasing the rate of water flow through the dike. This is not a catastrophic failure mode as the rockfill shoulders of the dike will be stable, and at its worst, would lead to temporary suspension of mining.	Monitor seepage from downstream face for rate of seepage, and for presence of sediment in seepage. Will become evident as localized intensive seepage at dike toe and can be repaired. May also see settlement in the cutoff wall. Will be most likely in deep water sections. Gradients across the cutoff wall in shallow water are not high enough to cause piping.
	(2) Dike Section: Cutoff wall loses bentonite because of improper construction.	Same consequences as erosion because of defect, as above.	Bentonite makes up 2% of the cutoff wall fill. Loss of this material will increase the permeability of the cutoff wall and increase the rate of seepage.
	(3) Foundation: Till is possibly non-uniform with more transmissive zones and not self-filtering. It is possible that one of these zones may align with defective construction of the core backfill and defective construction of the cutoff wall allowing high flows. Seepage could along the transmissive zone beneath the downstream rockfill section could erode the foundation tills at the downstream toe or into the downstream rockfill because of the lack of filtering.	Limited seepage at the toe or into the rockfill would accelerate into a large inflow, and could lead to the undermining of the dike if no action was taken. This is a credible catastrophic failure mode if increased seepage is not detected in time.	No particular instrumentation is needed as this failure mode will show itself as localized and increasing seepage. It could be detected by walk-over inspection by an experienced engineer or technician. Remedial action could comprise a reverse filter and rockfill buttress depending on location of the flow and configuration of the foundation, freezing, or grouting if identified in time. Quality control of cutoff is important, and most important for deep water sections. In the worst case, the pit may be deliberately flooded in a

Failure Mode	Scenario	Consequence	Monitoring/Action
			controlled manner, the cutoff repaired, and the pit dewatered.
Seepage within Embankment	Seepage on its own is not a credible failure scenario. The downstream rockfill shell has extremely high flow through capacity. The rockfill zone is both large and pervious, so that seepage will not daylight on the downstream face and lead to instability. Any seepage related failures must include internal erosion, see above.	No credible consequences. May require upgrade of the seepage collection system. May need to suspend mining activities while reducing seepage.	Seepage monitoring program.
Seepage within Foundation	Defective construction of cutoff leading to transfer of unexpectedly high fraction of the reservoir head into the downstream part of the dike foundation, or leading to a piping event as above.	This failure mechanism has caused embankment failures elsewhere because of straightforward pore pressure induced instability. However, it is unclear that it could cause failure of the Dewatering Dikes because of their large width compared to the retained water head. The most likely consequence is downstream toe slumping requiring a localized stabilizing berm before the crest roadway could be reinstated.	If this mechanism arises it should show itself during initial dewatering or very shortly thereafter.

Failure Mode	Scenario	Consequence	Monitoring/Action
Internal Conduit Rupture	There are no water offtake works or other structures extending through the dikes.	Not applicable.	Not applicable.
Slope Instability	(1) Normal Operation: The rockfill shoulders of the dike are wide and have high shear strength, making it a conservative design. Slope failure requires failure in the foundation and which would then extend into the overlying dike. Sliding failure is considered unlikely given the low horizontal forces generated by water and ice forces relative to the normal frictional force due to the weight of the dikes and the friction angles of foundation materials	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 rockfill shoulders will not necessarily compromise the water retaining function of the dikes. Failures which reach the core may cause failure.	This mechanism should develop during construction or dewatering, due to increase in load and associated pore water pressure increase. Initial stages of failure should be observable as tension cracks in the dike crest. Walk-over inspection of the dikes by a trained inspector is an appropriate monitoring strategy. Survey of crest, face, and toe is also appropriate. Stabilizing berms can be placed inside the dikes or through water along the upstream shoulder.
	(2) Earthquake Induced: Occurrence of an extreme earthquake, much in excess of the current understanding of seismicity of the area.	The extreme earthquake loading for this site is a low magnitude. Settlement of the dikes could occur in the event of a large earthquake. Dynamic compaction of the core during construction may have subjected the rockfill shells to accelerations equivalent to the expected earthquake loading. This would not be a failure situation. The crest is also erosion resistant for any earthquake induced wave action in the impounded water.	Dike inspection following earthquakes felt on site.

Failure Mode	Scenario	Consequence	Monitoring/Action
Failure of Cutoff Wall Due to Movement of the Dikes	Differential horizontal movement of dikes due to water or ice loading, or pit wall failure. Creates a breach in the cutoff wall. Ice and water forces are not credible due to the ratio of frictional forces generated by the self weight of the dike versus ice loads and water pressure. Pit wall failure involving the dike unlikely based on assessments of pit wall stability and setback distance between the pit and the dikes.	Large inflows through the breach. Pit would flood requiring suspension of mining activities. Potential for loss of life for workers inside dikes.	No enhanced monitoring. Prism monitoring program sufficient. If the pit floods, then repairs to cutoff would be done prior to dewatering.
Unexpected Settlements	Unexpected foundation soils consolidate during dike construction. A significant quantity of clay, that was not recognized during foundation excavation, would be required to generate settlement required for a water release event. Settlement of the core will be limited by dynamic compaction.	2 m of Core settlement would be required to allow water flow through the rockfill and over the settled core. This flow would not cause failure of the rockfill shells. It would also be readily repaired by placing more end-dumped till into the settled zone.	No enhanced monitoring required, as settlement would be apparent from prism monitoring data and visual inspection. Excessive settlements may be remediated by excavating rockfill above the core and placing more till. Soil conditions will be observed during construction, and design revised to accommodate actual conditions.

A.1.1 Failure Scenario during Operations

The 'worst-case' scenario for failure of the dewatering dikes during operations would involve a movement of the dikes that compromises the integrity of the cutoff wall. However, the rockfill has a very high flow-through capacity and a high strength and will not move unless the foundation is involved. The water will flow through the upstream rockfill first, then through the core and cutoff wall, and finally through the downstream rockfill berm. Flow through cracks opening in the foundation may erode the foundation soils and the core. The upstream rockfill will choke the flow to some degree, and flow will decrease once the downstream toe of the dike is inundated and the head difference across the dike begins to reduce.

Although this describes a 'worst-case' scenario, a catastrophic failure of the pit dewatering dike system is not considered a credible failure mode. Elements of the dike design, including the width of the dike section, and the inclusion of filters, in addition to the cutoff wall make catastrophic failure of the dike highly unlikely. However, for the purposes of this document, the effects of such a failure are described below.

Potential Effect

In the case of the East Dike, the worst-case scenario would be associated with the short portion of the dike through the deepest water along the alignment at the centre of the dike. In this area water depth is as much as 7 m to bedrock at the cutoff wall within the dike. This inflow could potentially result in loss of workers caught in flowing water. Breach of the East Dike would be unlikely to trap workers in the pit when access ramps are on the west side, opposite the inflows. Breach of the East Dike would result in cessation of mining, either temporarily or permanently.

Upon completion of the East Dike and dewatering of the northwest arm of Second Portage Lake, there will be approximately 17 million m^3 (Mm^3) of water remaining in Second Portage Lake. If the segment of dike at the deepest portion were suddenly removed, flow from Second Portage Lake into the pit would continue until the elevation of the lake drops by several metres, at which time the current lake bottom would be exposed and would act as a barrier to flow towards the pit. This scenario is the worst in the final year of pit operation when pit volume is the largest. The volume of water associated with this drawdown would be on the order of about 10 Mm^3. Some erosion of the till between the pit crest and dike toe would be expected, so the depth of water loss from the lake may be larger, but this would take some time to fully develop.

Inflow to the pit could expose large amounts of shoreline and shoal habitat around the lake. Water flowing into the pit could entrain suspended solids and dissolved constituents from the dike material and pit walls. If necessary, the water could be retained within the pit and diked area and would be amenable to treatment (e.g., particle settling, in-situ amendment) before discharge, should it be required.

The ecological effects of the exposure of shoreline and shoal habitat on fish and fish habitat would be to temporarily eliminate spawning areas and result in reduced water quality from exposure of sediment to wave and wind induced erosion. The effect of this would last approximately one year as inflow from Third Portage Lake to Second Portage Lake averages 10 Mm^3 annually (AMEC, 2003). Presuming that the dike breach is repaired, water levels in Second Portage Lake would rise over the spring and summer to return to pre-breach elevations and would re-fill the lake in the event of a 'worst-case' scenario.

In the case of the Bay Goose Dike, the worst-case scenario dike breach that could allow the greatest amount of water inflow would be associated with the southeast segment of the dike through the deepest water along the alignment. In this area, water depth is as much as 20 m deep at the cutoff, and the pit could be as deep as 130 m. This inflow could potentially result in loss of workers caught in flowing water. Breach of the Goose Island Dike would be unlikely to trap workers in the pit when access ramps are on the northwest side, opposite the inflows. Breach of the Goose Island Dike would result in cessation of mining of the Goose Pit, either temporarily or permanently.

In the unlikely even that such a failure of the Bay Goose Dike were to occur, the rate and volume of water entering the downstream pit would depend on the magnitude of the breach and the length of time to repair the breach. Third Portage Lake has an estimated volume of the lake is 446 Mm^3 (Golder, 2006). The final volume of Portage Pit (30.0 Mm^3) is roughly 6.7% of the volume of the lake, while Goose Pit (14.8 Mm^3) is approximately 3.3% of the volume. In the case of a catastrophic breach of the Bay Goose Dike, the estimated Third Portage Lake water level drawdown would be approximately 1.0 m and 0.5 m, respectively assuming that the failure occurs when the pits are completely excavated and a complete filling of the pits. These estimated worst-case scenario changes in water level are comparable to the mean average annual difference between high and low water (0.3 m) on Third Portage Lake.

There would be a small impact to fish and fish habitat in Third Portage Lake in the event of a 0.5 m to 1.0 m drop in water level. Areas used for spawning may be slightly nearer to the ice cover and a small amount of habitat might be vulnerable to freezing. Water quality within the pit would be temporarily impaired from an increase in suspended and dissolved solids, although water quality would return to near background during the first winter as sediment would settle under the ice cover.

Mitigation, Management, and Monitoring

A major cutoff breach scenario due to pit wall movement, while possible, has a low probability of occurrence. If foundation movement was sufficient to compromise the cutoff wall, then the core backfill would act as a semi-permeable element and limit flow. Water would first need to flow through the rockfill shell, the core backfill, the damaged cutoff wall, and then through more of the core, filters, and the downstream rockfill. Provided that the downstream filter elements against the rockfill shell are properly constructed, then migration of the core and cutoff wall into the rockfill will not occur. Some additional seepage may occur due to failure of the cutoff wall; however this would be noted during regular monitoring. Mitigation could be by jet grouting, freezing, or installation of sheet piling through the cutoff wall.

The use of appropriately graded filters in the design of dikes and dams is standard engineering practice, and is the key to preventing internal erosion. The dike design includes the use of a two zone filter on the upstream face of the pit side rockfill. During the construction of the dikes a quality control and quality assurance program will be undertaken.

Routine visual inspection of the dikes will be conducted on a regular basis to document any changes in the dikes.

During the operation of the dike, a series of monitoring instrumentation will be installed, including:

- Thermistors to monitor the thermal regime in the dike and foundations;

- Slope inclinometers and prisms to monitor deformations within the dikes; and
- Piezometers to measure pressure and to infer flow through the dikes.

Piezometers downstream of the cutoff wall would be monitored for pressure changes as the pit is deepened. Increasing pressure would indicate that less head loss is occurring across the seepage cutoff, which might indicate that a crack has formed, permeability is increasing, or the pit is experiencing inflows from some other potential flow pathway. The instrumentation will be monitored to identify any potentially problematic areas relating to dike instability. Mitigation measures for seepage and piping could include:

- Additional pressure grouting of bedrock materials;
- De-pressurization wells;
- Construction of a slurry cutoff wall within the core just upstream of the suspected seepage area;
- Jet grouting of the core and foundation in the suspected seepage or crack area;
- Construction of a cutter soil mixing (CSM) wall in the suspected crack area;
- Freezing;
- Installation of toe drains; and
- Construction of interceptor ditches within the down-stream overburden materials.
- Allow pit to flood, install new cutoff under no-flow conditions, then dewater and resume mining.

Specific monitoring and mitigation strategies will be developed as part of an Operations Plan for the de-watering dikes.

A.1.2 Failure Scenario during Closure

At end of mine life, once the water quality of the pit lake has been determined to be suitable for release, a portion of the south end of the Bay-Goose Dike will be removed resulting in a hydraulic connection between the Goose/Portage Pit Lake and Third Portage Lake. The East Dike will be the only dike that will remain in service. The elevation of the pit lake will be equal to Third Portage Lake. The elevation difference between the pit lake and Second Portage Lake will be approximately 1 m. Consequently, there will be a low hydraulic gradient from the pit lake towards Second Portage Lake. During the closure and post-closure period, the natural central and east channel outlets that connect Third Portage to Second Portage Lake will continue to carry the entire flow between the two lakes.

Potential Effect

A breach of the East Dike would create an additional outlet and cause water to leave the Portage/Goose pit area and spill into Second Portage Lake at a greater rate, partly at the expense of flow from the central and east channel outlets. This would cause a rise in water level in Second Portage Lake and a reduction in level in Third Portage Lake. The additional water would flow through the channel connecting Second Portage Lake to Tehek Lake until the water elevations in Second and Third Portage lakes equilibrated.

In the event of such a scenario, water would flow from Third Portage Lake, northward through the pit lake area, and then east through a potential East Dike breach and into Second Portage Lake. There is a naturally large outlet capacity via the connecting channel from Second Portage to Tehek Lake. Water residence time in Second Portage Lake during and after mine development is less than one year. Thus, in the event of an East Dike breach, any additional water added to Second Portage Lake would leave the system relatively quickly. Given the flow-through nature of the lake there would be little net change in Second Portage Lake volume or lake elevation as water would easily be absorbed into the much larger Tehek Lake.

Drawdown of Third Portage Lake would be limited, given the large size of the lake (33 km^2) and the constriction points within the system that would slow drawdown. Specifically, the magnitude of drawdown in the event of a breach would depend on the magnitude and depth of the breach, time of year (winter ice cover would prevent loss of water), response time, flow rate (i.e., the loss of water depends on the location of the breach and friction through the system), and the outlet capacity of Second Portage Lake. For example, total annual average discharge from Third Portage to Second Portage Lake is approximately 10 Mm^3 with a mean annual difference in water level between spring and fall of 0.3 m. Given the large size of Third Portage Lake, a breach resulting in the loss of 10 Mm^3 of water, which is equivalent to an entire open water season of runoff through all discharge channels would result in a drawdown of only about 0.3 m. Maximum drawdown would be one metre.

Reductions in water level would therefore be small and have only minor impacts to fish habitat in Third Portage Lake. Adverse impacts to water quality would not be expected given that water quality within Goose/Portage pits is expected to be very high.

Mitigation, Management and Monitoring

Internal erosion of the cutoff wall could result in increase of the rate of water flow through the East Dike. However, this is extremely unlikely due to the low hydraulic gradient across the East Dike (~ 1 m of head difference) and filter effect of the core backfill. Such a scenario is more likely to occur during the operational phase of the East Dike when the hydraulic gradient across the dike section is much higher, though in the opposite direction. If such a scenario were to occur, it would not be considered a catastrophic failure mode due to the stability of the rockfill shoulders comprising the outside structural elements of the dike.

A breach in the East Dike during closure could be managed by the placement of material to reduce the flow of water and reduce potential erosion of the till core. The hydraulic gradient across the dike at closure is low. The dike could be repaired and hydrologic conditions restored without any danger to the overall stability of the dike, provided annual monitoring is carried out following closure.

Appendix A.2

Central Dike

Tailings Storage Facility

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 1.5H:1V or flatter and the downstream face designed at a 1.5H:1V slope;
- An upstream two zone granular filter;
- A bituminous liner with appropriate cover on the upstream face;
- An upstream cutoff through the foundation soils to bedrock; and
- A grout curtain through the fractured bedrock zone (at this time it has been assumed that the fractured bedrock is up to 20 m deep, based on available geotechnical drilling information along the dike alignment).

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.

Table A.2: Meadowbank Central Dike 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 rockfill, 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 rockfill 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.

Failure Mode	Scenario	Consequence	Monitoring/Action
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 rockfill. This is not a catastrophic failure mode, because the rockfill 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, foundation slopes down towards the tailings, so seepage impounds in the rockfill 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 rockfill. This is not a catastrophic failure mode, because the rockfill of the dike will be stable, and at its worst, would lead to temporary suspension of mining. Accumulation of ponded water within the rockfill 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.

Failure Mode	Scenario	Consequence	Monitoring/Action
Seepage within Embankment	Seepage on its own is not a credible failure scenario. The rockfill is pervious so seepage will not daylight on the downstream face. Flow through the rockfill 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 cutoff 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 build up 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 offtake works or other structures extending through the dikes.	Not applicable.	Not applicable.

Failure Mode	Scenario	Consequence	Monitoring/Action
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 rockfill 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, 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 rockfill 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.

Failure Mode	Scenario	Consequence	Monitoring/Action
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 rockfill can withstand significant deformation, making this an unlikely scenario.	Tailings and water escape into the dike rockfill, 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 rockfill, but this would not cause failure of the rockfill. It could also be readily repaired by placing more end-dumped rockfill, 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 will be developed for the operation of the tailings facility, and will include 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 to be installed include:

- Thermistors to monitor the thermal regime in the dike and foundations, and deposited tailings;
- Prisms to monitor deformations within the dike; and
- Piezometers to measure pressure and to infer flow through the dike and foundation materials.

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 A.3

Saddle Dams

Saddle Dams

Six Saddle dams will be constructed around the limits of the tailings basin. 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 6 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 either attenuation water, reclaim water, or tailings to Third Portage Lake in the event of an overtopping or catastrophic failure..

A.3.1 Failure Scenario during Operation

Depending upon the phase of operations, breach or complete failure of a Saddle Dams 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 to be 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 Dams. As a result, the Reclaim Pond will be pushed away from the Saddle Dams. As the tailings and Saddle Dam are expected to freeze, and freezing will reduce the chance of tailings reaching Third Portage Lake, failure of the Saddle Dams at 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.

<u>Potential Effect</u>

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 Dam 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 Dam 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 will be constructed under controlled conditions. A comprehensive quality control and quality assurance program 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 Dam 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 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.

A.3.2 Failure Scenario during Closure

At closure Reclaim Pond water will be pumped to Portage pit, the basin behind the Saddle Dams will be drained and filled with run-of-mine, acid-buffering ultramafic waste rock. The rock is expected to freeze over time. Failure of the Saddle Dam 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 will be designed meet Dam Safety Guidelines (CDA, 2007). The dams will be constructed under controlled conditions. During the construction of the dams a comprehensive quality control and quality assurance program 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 South 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 A.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 will separate the tailings basin from the Attenuation Pond until approximately Year 4, at which point the Reclaim and Attenuation ponds will combine. 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 will be constructed using rockfill, with south face slope of 3H:1V, and a north face slope at angle of repose for rockfill. The minimum crest width will be 6 m. The dike will have a filter zone placed on the south face, underlying an impermeable element of bituminous geomembrane. The maximum height of the dike will be about 13 m. At the maximum cross section, the width of the base of the dike will be approximately 95 m.

A.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 South 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 will be constructed in the dry under controlled conditions. During the construction of the dike a comprehensive quality control and quality assurance program would be 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.

A.4.2 Failure Scenario during Closure

The Stormwater Dike will be covered by tailings during operations and will not exist at closure.

Potential Effect

There will be no environmental effect on the receiving environment.

Mitigation, Management, and Monitoring

None required.

APPENDIX B

Emergency Response Plan for Dyno Nobel Emulsion Plant

EMERGENCY RESPONSE PLAN

Meadowbank Mine Site.

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.

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	
February 14, 2011	Amendment #4	
	Updated site contacts	
	Updated site evacuation & Muster locations	
July 14, 2011	Amendment #5	
	Updated site contacts	
	Updated site evacuation & muster loaction (Map drawn)	
	Site specific emergency procedures	

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Work Site Phone Numbers and Magazine / Plant Details

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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 HSE Management System 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
Diethylene glycol

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.

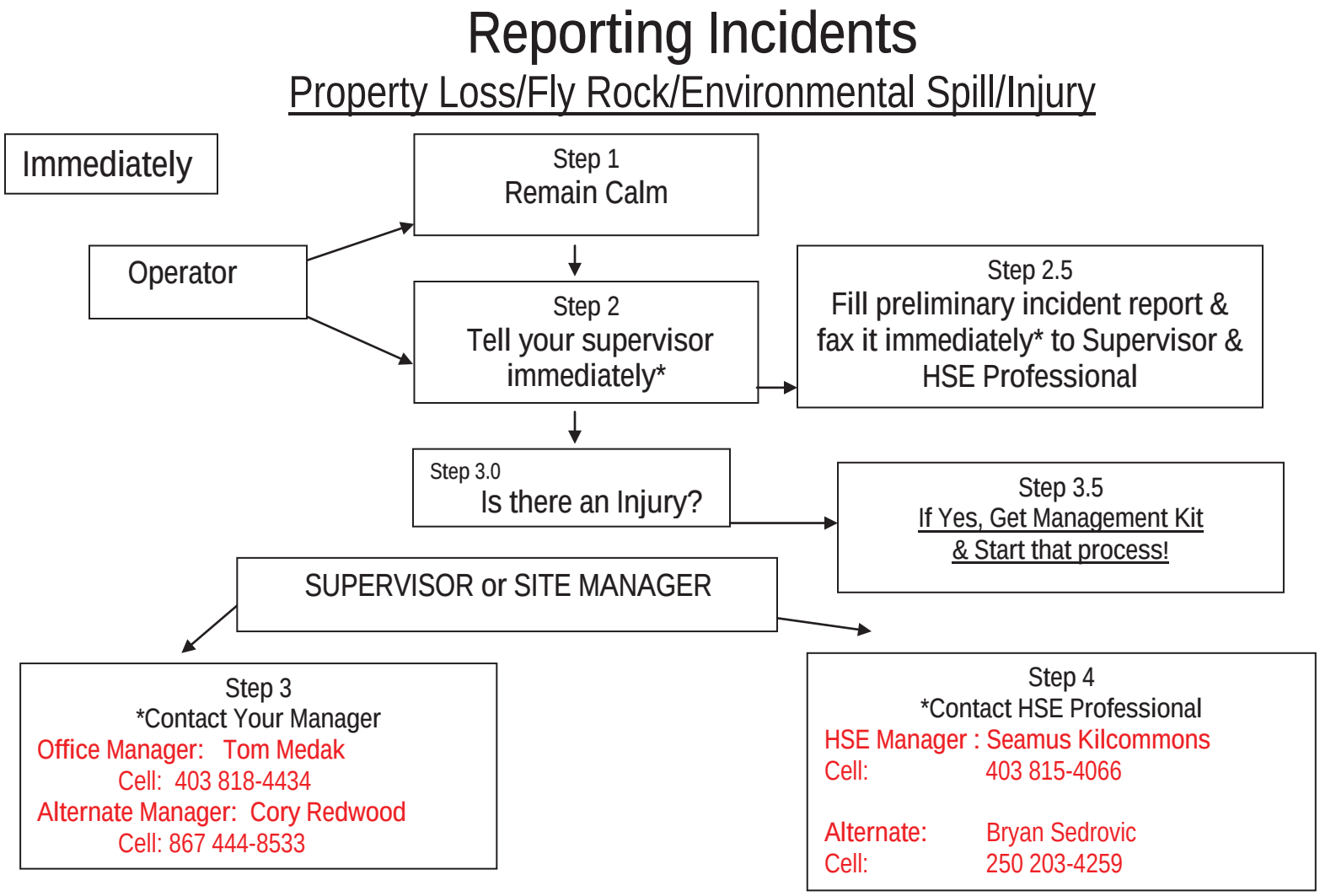
- All Plant & Magazine sites will have in place, a continuous (24 hour) access control system to control the entrance, presence and exit of visitor and contractors and their equipment and materials
- Employees must be trained on Reportable Quantities to the Government in the unlikely event of a spill.
- 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

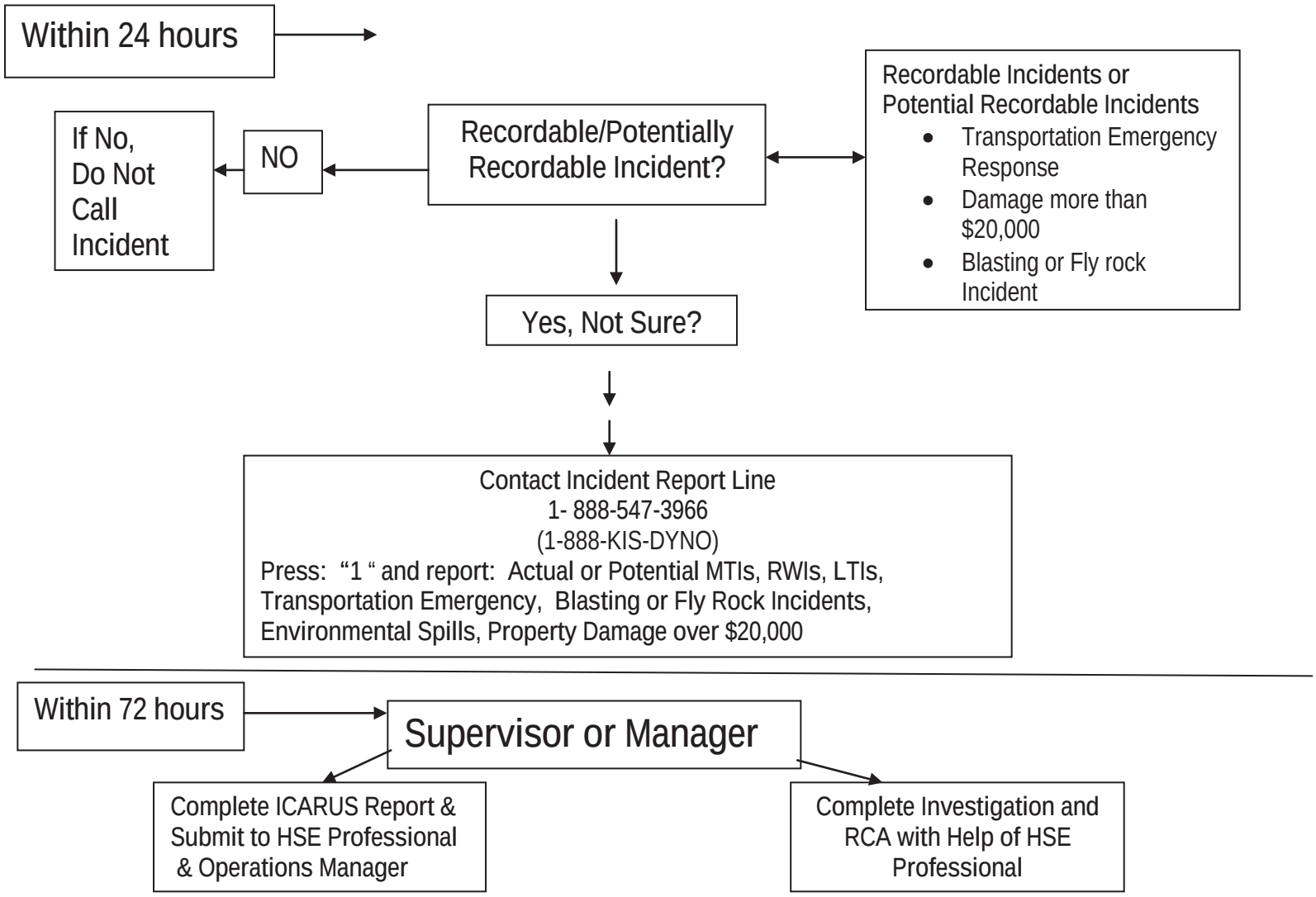
6.0 EMERGENCY PROCEDURES AND LINES OF AUTHORITY

6.1 GENERAL

Reporting Incidents Flow Chart (Following page)

Table 6-1
Emergency Response Flow Chart




Within 24 hours
Recordable/Potentially Recordable Incident?
NO
If No, Do Not Call Incident
Recordable Incidents or Potential Recordable Incidents
Transportation Emergency Response
Damage more than $20,000
Blasting or Fly rock Incident
Yes, Not Sure?
Contact Incident Report Line
1- 888-547-3966
(1-888-KIS-DYNO)
Press: "1 " and report: Actual or Potential MTIs, RWIs, LTIs, Transportation Emergency, Blasting or Fly Rock Incidents, Environmental Spills, Property Damage over $20,000

Within 72 hours
Supervisor or Manager
Complete ICARUS Report & Submit to HSE Professional & Operations Manager
Complete Investigation and RCA with Help of HSE Professional

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 **6911** (or the local emergency 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 territorial & 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, Willard Pierce, Dale Bodnarchuk or Francois Lambert)* 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. Fires Involving Components For Manufacture of Blasting Agents

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 vessels 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
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
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)	
	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 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	
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.
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

DNCI'S EMERGENCY REPORT FORM FOR INCIDENTS INVOLVING EXPLOSIVES

WHO IS CALLING? NAME:_____

PHONE #: _____ TIME:_____DATE:_____

CALLER'S ORGANIZATION:_____

LOCATION OF INCIDENT: _____

WHAT IS THE EMERGENCY?
PROBLEM**:** (Motor Vehicle Accident, Fire, Scattered Product, Disabled Truck, etc.)

_____

PRODUCTS INVOLVED : VISIBLE PLACARDS ? YES_____ NO_____

SHIPPING NAME(S)_____

UN NUMBER(S)_____

HAZARD CLASSIFICATION (ex: 1.1 D) :_____

QUANTITY: _____

INJURIES: _____

PROPERTY DAMAGE:_____

EXPLOSIVES VEHICLE UNIT NUMBER:_____LICENSE NO._____

DRIVER:_____CARRIER:_____

WHEN DID INCIDENT OCCUR? DATE: _____TIME: _____

WHERE IS THE EMERGENCY? (City, Town, Rural Area, Lat. & Long., Specific Directions)

_____

ARE THERE RESIDENCES, BUSINESSES, OR OTHER PUBLIC GATHERING PLACES WITHIN THE EVACUATION ZONE (what, where)?

_____

WHAT ACTION HAS BEEN TAKEN TO THIS POINT IN TIME?_____
(Medical, evacuation, fire fighting, etc.)

_____

APPENDIX 2

DNCI Corporate contact

Name	Position	Cell number
Benoit Choquette	Environmental Manager - Canada	(514) 246-6285
Nicholas Ebsworth	General Manager HSE - Canada	(514) 708-5417
Hubert Fafard	HSE Manager Eastern Canada	(418) 570-9257
Willard Pierce	Regional Manager -West	(403) 836-9029
Francois Lambert	Regional Manager –East	(514) 212-3490
Dale Bodnarchuk	Regional Manager – Central	(705) 715-6672
Seamus Kilcommons	HSE Manager Western Canada	(403) 815-4066
Brad Rhude	Sales Manager - Central	(705) 494-5171
Rick Chopp	HSE Manager – Central Canada	(705) 498-2855
Pierre Poulin	Sales Manager – Quebec/Maritimes	(418) 569-5565
Greg Brown	Sales Manager Western	(403) 512-5127
Bryan Sedrovic	HSE/ Regulatory Affairs Coordinator West	(250) 203-4259

APPENDIX 3

DNCI Emergency Response Advisors (ERA) per area

Name	Position	Cell number	Area (West, Central or East)
Tom Medak	Mgr, Bulk Emulsion Operations	(403) 818-4434	West
Ralph Olson	Operations Manager, Vancouver Island	(250) 713-8720	West
Darren Woodhead	Gregg River worksite supervisor	(780) 223-4491	West
Randy Armella	Bulk Operations Manager	(780) 865-6580	West
Cory Redwood	Manager dnx Drilling/ Joint Ventures	(867) 444 - 8533	West
Kevin S Kelly	Operations Manager – Seismic	(403) 934-0753	West
Tyrone McClean	Operations manager, Manitoba and Saskatchewan	(204) 687-0046	Central
Scott Smith	Operations Manager, Red Lake Ontario	(807) 727-7300	Central
Mike Ertel	Operation Manager – Ontario	(807) 629-9660	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
Pierre St-George	Regulatory Affairs Canada	(613) 677 - 1051	Canada

APPENDIX 4

SITE: Meadowbank Site

MANAGEMENT AND WORK SITE CONTACT LIST

NAME	TITLE	BUSINESS PHONE	HOME PHONE	CELL PHONE
Doug Robertson	Site Supervisor	(867) 793-4610 *(Option 2; option 1 ext 6804)*		(867) 222-3930
Dennis Wall	Site Supervisor	(867) 793-4610 *(Option 2; option 1 ext 6804)*		(867) 222-3930
Site employees	All employees on shift	(867) 793-4610 *(Option 2; option 1 ext 6804)*		
Tom Medak	Operations Manager	(403) 723-7530		(403) 818-4434
Seamus Kilcommons	HSE Manager	(403) 236-9160 Ext 7547		(403) 815-4066

EXTERNAL CONTACT NUMBERS

ORGANIZATION/CONTACT	LOCATION	PHONE NUMBER
Mine security	Meadowbank	Ext. 6817
Local Fire; ERT	Hinton	Ext 6911
Local Ambulance	Hinton	Ext 6911
Baker Lake RCMP	Hinton	867 793-1111

APPENDIX 5

Area Office Address:
Meadowbank site
Baker Lake, NU

Type of Facility:
Emulsion Plant
AN Tote storage

Emergency Meeting Place Upon Evacuation:
As identified on site orientation forms, employees and visitors are to meet at muster point for head count. Once all persons are accounted for, all will proceed to the Muster Point located at Security Gate #1, located at junction of All Weather Road. (see map)

Emergency Equipment On Hand:
Fire Extinguishers, First Aid Kits, Fire alarm system, video monitoring,

FY 2011 drill conducted

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)			
Calm	Slow	Crying	Slurred
Stutter	Deep	Loud	Broken
Giggling	Accent	Angry	Rapid
Stressed	Nasal	Lisp	Excited
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

NEW/TRANSFERED EMPLOYEE OR ANNUAL REFRESHER FORM

HSE Employee Orientation Form

To Be Completed By Supervisor (within 2 to 4 weeks of hiring)

(Employee Surname)	(Given Names)	(Worksite) (Date of Hire)
(Job / Position)	(RFT/ RPT/ Casual / Temp)	(End date if applic)

Show & Tell

	Date Completed			Date Completed
Tour Of Facility			Introduction To Staff	
Emergency/Fire Exits & Procedures			Workplace Hazards & Controls	
Environmental Clothing Issued			First Aid & WCB Reporting	
Overview Of Organization			Telephone Contacts	
Work Schedules			Time Sheets & Pay Periods	
Security & Key Control			E-mail & Website Access	
Expense Claims Procedures			Other:	

Documentation Given To &/or Discussed With Employee

Position Description		DYNO G & S Work Rules	
Worksite ERP, TDG ERAP & CCP		MSDS's	
Handling/Transporting Explosives		SOP's	
Employee Guidelines		Policy: HSE & Quality	
Policy: Privacy & Confidentiality		Policy: Substance Abuse	
icy: Violence In The Workplace		Policy: Security	
Policy: Smoking In The Workplace		Performance Reviews	
Other:		Other:	

New Hire Training Completed

Customer Orientation		WHMIS	
TDG Clear Language		PPE (as applicable)	
Handling/Transporting Explosives		Fire Extinguisher	
ICARUS (Incident Reporting)		Take 5 (Hazard Assessment)	
Worksite ERP, TDG ERAP & CCP			

_____ _____ _____

Supervisor (Print Name) Supervisor Signature Date

APPENDIX 8

QAAQTUQ Dyno Nobel

ANNUAL ERT VISIT 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.

On _____ the _____ of 2011, AEM ERT responder _____ attended the Dyno Nobel Meadowbank site for an annual visit and ERP review.

Signed:_____

Position:_____

Date:_____

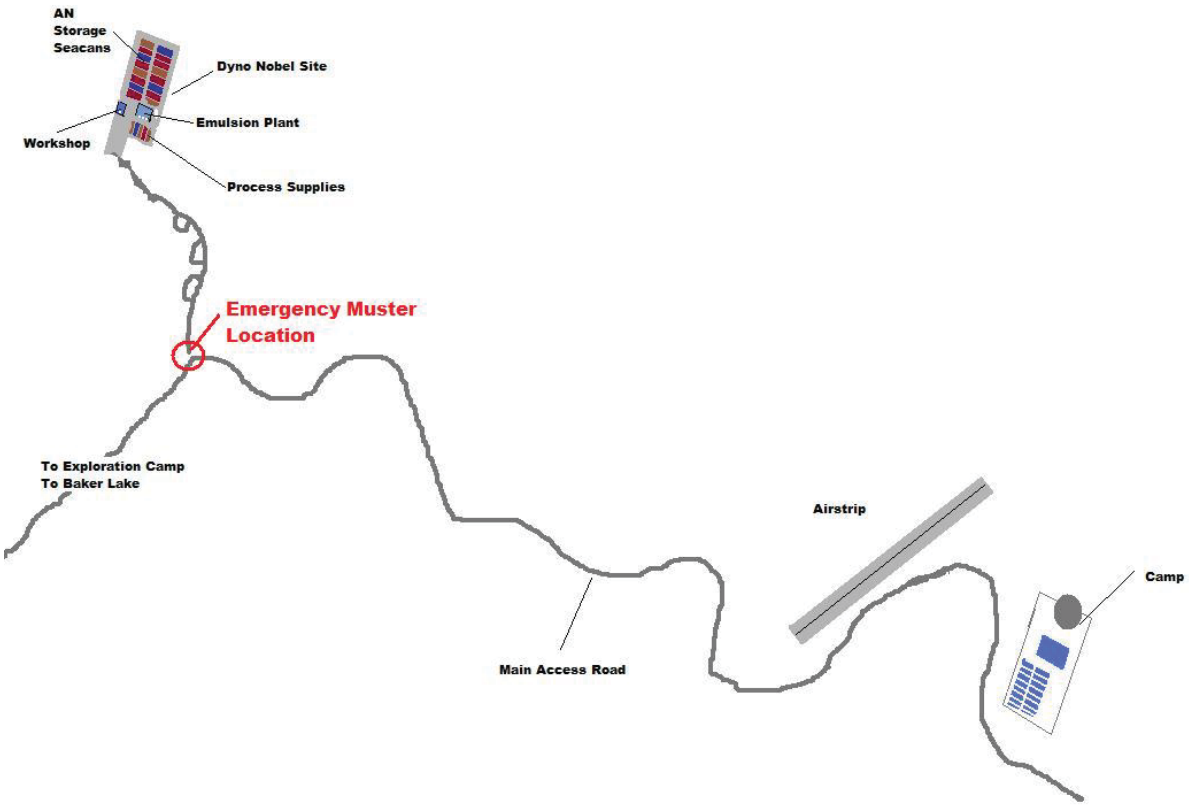
APPENDIX 9

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

Evacuation/ Muster location



MEADOWBANK GOLD PROJECT

Hazardous Materials Management
Meadowbank Mine Site
Baker Lake Facilities

In Accordance with Water License 2AM-MEA0815

Prepared by:
Agnico-Eagle Mines Limited – Meadowbank Division

Version 2
March 2012

EXECUTIVE SUMMARY

General Information

The Hazardous Materials Management Plan (HMMP) will be executed within the scope of normal operations. The Meadowbank Gold Project is in the Operations Phase, and as such, requires that the transportation, storage, handling and use of hydrocarbon products, ammonium nitrate and associated explosive materials, and all other chemicals be conducted in a safe and efficient manner.

Annual Review

The HMMP will be reviewed and updated at least annually. Completion of the annual review of the HMMP will be documented through signatures of the personnel responsible for reviewing, updating and approving the HMMP.

Record of Changes

A record will document all significant changes that have been incorporated in the HMMP subsequent to the latest annual review. The record will include the names of the persons who made and approved the change, as well as the date of the approval.

Distribution List

Agnico-Eagle Mines Limited (AEM) will maintain a distribution list for the HMMP providing information about all parties that receive the plan including mine personnel, departments, and outside agencies.

IMPLEMENTATION SCHEDULE

As required by Water License 2AM-MEA0815, Part B, Item 16, the proposed implementation schedule for this Plan is effective immediately (March 2012) subject to any modification proposed by the NWB as a result of the review and approval process.

DISTRIBUTION LIST

AEM - Environmental Superintendent

AEM – Environmental Coordinator

AEM – General Mine Manager

AEM – Health and Safety Superintendent

AEM – Mill Superintendent

AEM – Maintenance Superintendent

AEM – Mine Superintendent

AEM – Site Services Superintendent

AEM – General Services Superintendent

AEM – Procurement and Logistics Coordinator

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
1	2007/08			Comprehensive plan for Meadowbank Mine Site and Baker Lake Facilities
2	2012/3/12			Comprehensive review and update.

Table 1 - Document Control

Version 2:

Prepared By: _____
Jeffrey Pratt
Environmental Coordinator

Approved By: _____
Stephane Robert
Environmental Superintendent

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1 INTRODUCTION

1.1 PURPOSE & SCOPE OF THE PLAN

The purpose of this plan is to provide a consolidated source of information on the safe and environmentally sound transportation, storage, and handling of the major hazardous products that are used at the Meadowbank Gold Project. A hazardous material is one that, as a result of its physical, chemical, or other properties, poses a hazard to human health or the environment when it is improperly handled, used, stored, disposed of, or otherwise managed. In combination with AEM's Emergency Response Plan (ERP) and Spill Contingency Plan (SCP), this Hazardous Materials Management Plan (HMMP) provides instruction on the prevention, detection, containment, response, and mitigation of accidents that could result from handling hazardous materials.

The plan is based on the following principles of best practice management for hazardous materials:

- identify and prepare materials and waste inventories
- characterize potential environmental hazards posed by those materials
- allocate clear responsibility for managing hazardous materials
- describe methods for transport, storage, handling, and use
- identify means of long-term storage and disposal
- prepare contingency and emergency response plans
- ensure training for management, workers, and contractors whose responsibilities include handling hazardous materials
- maintain and review records of hazardous material consumption and incidents in order to anticipate and avoid impacts on personal health and the environment.

All hazardous materials to be used at the Meadowbank operation will be manufactured, delivered, stored, and handled in compliance with all applicable federal and territorial regulations AEM is committed to preventing, to the greatest extent possible, both inadvertent release of these substances to the environment and accidents resulting from mishandling or mishap. AEM has instituted programs for employee training, facility inspection, periodic drills to test systems, and procedural review to address deficiencies, accountability, and continuous improvement objectives.

AEM actively works towards minimizing the generation of hazardous wastes by investigating alternatives to the use of hazardous materials, by recycling products and containers wherever feasible, and by treating wastes using state-of-the-art technologies before any release to the environment.

As with all other aspects of health and safety policy at the Meadowbank mine, all employees will be expected to comply with all applicable precautions and handling procedures with regard to hazardous materials. Employees are also expected to report any concerns to their supervisors, the Occupational Health & Safety Committee (OH&SC), or senior site management. All staff is encouraged to bring forward suggestions for improvements that can be incorporated into procedure revisions as appropriate.

1.2 APPLICABLE LEGISLATION

Both federal and territorial legislation regulate the management of hazardous materials in Nunavut. Copies of relevant legal documents will be kept on file at the mine site. AEM will regularly update the HMMP with respect to applicable legislation, and ensure that current legislation documents are available at the mine site.

Management and safety personnel will provide an overview of the applicable regulations to all employees as part of their initiation and ongoing training. The acts, regulations, and guidelines pertinent to the hazardous products that will be used at the Meadowbank Gold Project are listed in Appendix A.

The *Transportation of Dangerous Goods Act* classifies hazardous materials into nine main classes according to an internationally recognized system, as follows:

Class 1 – Explosives;

Class 2 – Gases;

Class 3 – Flammable liquids;

Class 4 – Flammable solids;

Class 5 – Oxidizing substances and organic products;

Class 6 – Poisonous (toxic) and infectious substances;

Class 7 – Nuclear substances, within the meaning of the Nuclear Safety and Control Act, which are radioactive;

Class 8 – Corrosives; and

Class 9 – Miscellaneous products or substances.

Fuel products hazard classes and potential impacts located in Table 2.

2 OVERVIEW OF HAZARDOUS MATERIALS

2.1 HAZARDOUS MATERIALS AND FUEL STORAGE LOCATIONS

The primary storage locations for hazardous materials, hazardous wastes and fuel are shown on Figures 1 to 3. Figure 1 A map of the mine site. Figure 2 identifies storage areas at the mine site. Figure 3 identifies storage locations at the Baker Lake Marshalling Area. Comprehensive lists of all hazardous materials and the estimated quantities that are and will be stored at the mine site are provided in Appendix B Hazardous Materials Stored at Site during Operations. This table lists the maximum amount of product anticipated to be transported at the mine site, per trip, from the marshalling areas. The location(s) where the hazardous materials will be stored are also given in these tables.

Petroleum products, explosives, sodium cyanide and miscellaneous hazardous materials are stored in facilities that contain no open drains and are concrete berms, lined areas or within sea-cans. Storage tanks on site are regularly inspected and maintained.

The permanent storage facilities are clearly identified as storage facilities for hazardous materials with proper labelling. These are ventilated in order to prevent the build-up of toxic fumes or dust, which could harm both the personnel present and the environment. The facilities are secured and only authorized personnel have access to the area.

2.2 TYPES OF HAZARDOUS MATERIALS

The Meadowbank Gold Project will require the use of the following types of classified hazardous materials:

Petroleum Products and Lubricants – diesel fuel, oils, greases, anti-freeze, and solvents used for equipment operation and maintenance

Process Plant Consumables – sodium cyanide, Caustic Soda(Sodium Hyroxide), sulphur prills, Carbon sodium metabisulphite, Nitric acid , Calcine lime, flocculants, Calcium Chloride, Borax, Nitre, Silica, Lead Nitrate, and anti-scalants used in mineral extraction.

Water Treatment Consumables[1] *Silica sand*– and; floculant polymers;; *Explosives* – Emulsion, caps, and high explosives used for blasting in the mine

Laboratory Wastes – various by-products classified as hazardous waste and chemicals used in the assay laboratory.

Sections 5 and 7 contain general information and safe handling procedures for the first three categories above. Laboratory wastes are generally very limited in quantity and will be handled only by specialist lab technicians. These wastes will be pumped to the grinding circuit in the process plant for recycle and eventually become part of the tailings disposal stream. As such, they are not addressed separately in this document.

2.3 GENERAL HAZARDOUS MATERIAL STORAGE GUIDELINES

AEM is committed to the safe and appropriate storage of fuels, hazardous materials and hazardous wastes. The following sections outline AEM's general guidelines for storing fuels, hazardous materials and hazardous wastes.

2.3.1 General Guidelines for Storage Drums/Containers

Hazardous materials/waste shall be stored in Super Sacs/drums/in Sea containers according to the following guidelines:

In the original containers, where possible, or in containers compatible with the material being stored to prevent corrosion or chemical interaction that could lead to leaks or fires.

Storage containers shall be in good condition, sealable and not damaged or leaking.

Drums containing hazardous materials/wastes expected to be in storage for more than six months shall be placed on pallets or on a well-drained storage area to prevent rusting.

Each container shall be clearly labelled to identify the substance being stored according to the requirements of the *Workplace Hazardous Materials Information System* (WHMIS) and MSDS available.

Containers shall be kept closed except when adding or removing product.

Containers with product shall be kept in the upright position; empty drums can be placed horizontally.

Containers shall be arranged to prevent damage from falling or dislodging.

Containers shall be arranged to allow for easy access and inspections.

2.3.2 General Guidelines for Storage Areas

To assist in the safe and secure storage of fuels, hazardous materials and hazardous wastes, the following general guidelines for storage areas/facilities are followed:

Design of storage areas are in compliance with the *National Fire Code*, where appropriate.

Compliance with the Canadian Council of Ministers of the Environment (CCME) publication, *"Environmental Code of Good Practice for Above Ground Storage Tank Systems Containing Petroleum Products"* are followed. This CCME code deals with inventory control, inspections, corrosion protection, records and monitoring. Environment Canada's *Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations* outline registration and documentation requirements for storage tanks.

Storage areas are adequately signed indicating that hazardous materials/wastes are stored therein.

Storage locations are clearly defined and marked to prevent damage of storage drums and containers in the event they are covered by snow.

Incompatible materials are segregated by chemical compatibility within the storage area to prevent contact between materials in the event of a release.

Storage areas are located at least 30 metres from surface water and on a low-permeability area;

Storage areas are readily accessible for firefighting and other emergency procedures.

Storage areas are adequately ventilated to prevent the build-up of noxious or toxic vapours.

Secondary containment is installed to allow for the containment of at least 110% of the largest container or tank volume within the contained area,.

Storage areas are constructed, or provided with barriers, to protect containers from physical damage.

Adequate spill and emergency response equipment have been installed at each storage area (i.e. spill control, fire protection, etc.). A list of spill control equipment is provided in the Spill Contingency Plan.

3 HAZARDOUS MATERIALS LIFE CYCLE MANAGEMENT

3.1 LIFE CYCLE MANAGEMENT

"Life cycle management" implies the assessment of a particular product over its entire life — from the time a material need is identified to the time the product is fully consumed or disposed of as waste. It covers product supply, transportation, storage, handling, recycling, and waste disposal. AEM is committed to ensuring proper life cycle management of all products used at the Meadowbank site, including hazardous materials. AEM and its contractors will deal only with reputable, certified suppliers, transporters, and expediters.

3.1.1 Delivery

All hazardous materials are delivered to site by commercial carriers in accordance with the requirements of the *Canadian Transportation of Dangerous Goods Act* (TDGA). Carriers are licensed and inspected as required by the Department of Transportation. All required permits, licences, and certificates of compliance are the responsibility of the carrier. All shipments are properly identified and labelled. Shipping papers must be accessible and include information describing the substance, immediate health hazards, fire and explosion risks, immediate precautions, fire-fighting information, procedures for handling leaks or spills, first aid measures, and emergency response telephone numbers.

Each transportation company is required to develop a spill prevention, control, and countermeasures plan to address the materials they are importing. In the event of a release during transport, the commercial transportation company is responsible for first response and cleanup. AEM intends to periodically verify the qualifications of transport companies, their personnel and the existence of their spill prevention, control and countermeasures plan.

3.1.2 On-Site Handling

Once dangerous goods are received at the workplace, additional regulations apply. The federal *Workplace Hazardous Materials Information System* (WHMIS) calls for the proper labelling of products, the availability of product information in the form of MSDS, and employee education on how to identify and handle hazardous products. AEM has established procedures for obtaining MSDS with new product deliveries; maintaining MSDS current (i.e. no older than three years), and maintaining a system of hardcopy or electronic MSDS that are readily accessible by all employees. A chemical tracking system will be established.

All hazardous materials are stored in secured areas to prevent access by unauthorized personnel or any tampering. All tanks used for the storage of diesel fuel have been installed in secondary containment areas sized to hold at least 110% of the volume of the largest

tank,. Tanks and vessels in the process plant are installed on concrete surfaces sloping to interior sumps that will route spilled solutions to lined collection areas. Additional guidelines for the storage of hazardous materials are provided in Section 2.3.2.

In support of pollution prevention, AEM has established procedures for the regular inspection of storage containers and facilities. If deficient conditions are identified, appropriate corrective actions are taken and documented. Additional details for inspection of storage areas are provided in Section 9.

Emergency response procedures for spilled chemical substances are provided in the SCP (see also the ERP). These procedures outline the response to accidental spills or releases of hazardous materials to minimize health risks and environmental effects. Included are procedures for evacuating personnel, maintaining safety, cleanup and neutralization activities, emergency contacts, internal and external notifications to regulatory authorities, and incident documentation.

3.1.3 Wastes

On becoming wastes, materials are stored and/or disposed of in accordance with specific government regulations and guidelines. AEM stores most waste materials on site in secure facilities until they can be transported to other provincial jurisdictions for recycling or disposal. See Figure 4 for storage locations.

Process plant tailings pass through a treatment plant for cyanide destruction using the standard Inco SO_2/air process before being disposed of in the tailings pond. The cyanide content of the tailings material is reduced to 10 ppm (parts per million), which dissipates naturally on exposure to air in the Tailings Storage Facility. The current regulatory requirement for cyanide content in liquids released to the environment is 1 mg/L for a single grab sample, or no greater than a 0.5 mg/L average for the grab samples in any month..

The Department of Environment, Environment Protection Service (EPS) monitors the movement of hazardous waste, from the generator to final disposal, through use of a tracking document known as a Waste Manifest. Accordingly, a Waste Manifest accompanies movements of hazardous wastes for the Meadowbank Project. AEM is registered with the EPS as a waste generator, and employs only registered waste carriers to transport waste to registered/approved waste receivers. A copy of the completed manifest will be maintained for a period of two years after the hazardous waste is received by the authorized waste disposal facility.

3.1.4 Empty Product Containers

Many empty chemical containers are not safe to dispose of directly and require handling precautions identical to those for full containers. Chemical users must be familiar with safe waste handling and storage procedures supplied by manufacturers in MSDS. The containers are backhauled to the Baker Lake Marshalling Area for disposal at an approved facility. These containers are stored and hauled south via sealift.

4 SODIUM CYANIDE

4.1 INTRODUCTION

The operation will use relatively large quantities of sodium cyanide at the Meadowbank Gold Project. Due to transportation restrictions, normally a full year's supply of sodium cyanide will be transported and stored on site. This product will be transported, stored, handled, transferred and used in compliance with appropriate legislation and applying Best Management Practices.

4.1.1 Physical Properties

Cyanide is one of only a few chemical reagents that will dissolve in water. Gold mining operations use very dilute solutions of sodium cyanide, typically in the range of 0.01% to 0.05% cyanide
(100 to 500 ppm). Unlike many synthetic chemicals, cyanide oxidizes and decomposes when exposed to air or other oxidants, and does not persist in the environment. As such, it does not give rise to chronic health or environmental problems when present in low concentrations.

4.1.2 Cyanide Production

Cyanide production and handling are highly regulated, and its risk management is well documented. Both the manufacturer and AEM employ stringent risk management systems to prevent injury or damage from the use of cyanide.

Sodium cyanide for the Meadowbank project is in briquette form, and packaged in water-resistant super sac and 4mm bags inside an intermediate bulk container (IBC). The IBC will hold 1,000 kg of cyanide, and will have the following approximate dimensions: 44" x 44" x 44". For shipment, there are normally 20 IBCs in a container.

4.1.3 Cyanide Transport

Cyanide producers audit purchasers and transportation systems. They design special packaging for the transport of cyanide and inventory all shipments against delivery records to ensure proper surveillance at all times. All shipments are accompanied by MSDS that provide the chemistry and toxicity of sodium cyanide, instructions in case of accidents, and emergency telephone numbers for assistance.

Truck, rail, and barge transporters screen their employees, carefully inventory packages, and establish and maintain systems for loading and unloading cyanide products. Product handling and transportation are in accordance with protocols set by the industries and in compliance with national and international regulations.

For the Meadowbank Project, the IBCs are properly stacked in sea containers and transported by ship from Beacancour, QB to Baker Lake, NU. At Baker Lake, the containers will be transferred from barge to truck for transport to the Meadowbank mine site. At no point during transport will the sea container or IBCs be opened. From the point of cyanide packaging and onwards, the bags will only be opened on site, when use of the cyanide is required.

This method of cyanide transport provides three levels of containment. The cyanide is contained within plastic bags. In the event one of the bags ruptures, the cyanide is contained within the IBC. In the event the IBC container breaks, the cyanide is contained within the sea container, which provides a tertiary precautionary measure for minimizing the impact of the spilled material.

4.1.4 On-Site Storage & Handling

The cyanide is stored on site in a dark, cool, dry, location. Cyanide is stored within sealed sea cans until the time in which cyanide is needed for process. The cyanide storage area is located close to the processing plant. Only authorized personnel have access to the cyanide storage.

When cyanide is required a, only the quantity required for immediate use will be removed from storage. The cyanide bag will be lifted by its straps (the straps are provided by the manufacturer as part of packaging; see Appendix C for an illustration) using a forklift, then using and overhead crane to lower onto a specially designed knife slitter that cuts the bag. The contents of the bag will drop into a mixing tank. At no time does the cyanide need to be physically handled by Meadowbank personnel.

The IBC materials are properly decontaminated and disposed of according to all applicable regulations to prevent environmental impact. Before disposal, the bags are visually inspected to ensure they are empty, and flushed triple rinsed and drained to dissolve any residual cyanide left in the bag. Rinse water from the flushing process is recovered into the Cyanide mix tank and used in the gold recovery plant before discharge under controlled and permitted conditions.

All personnel potentially exposed to cyanide, including contractors and visitors, receive appropriate training (see Section 10).

4.1.5 Spills

In the event a spill occurs, the cyanide will be promptly cleaned up to minimize its exposure to humans and the environment. A dry spill will be swept up and disposed of in a drum or other suitable container. In the event of a wet spill, then spill procedures will be carried out to prevent environmental contamination and the appropriate authorities will be contacted. For more information on spills handling and containment, see the SCP and ERP.

After cleaning up as much cyanide as possible, the area will be decontaminated using a small amount of caustic solution (i.e., 1 oz. /5 gal hypochlorite solution). This will help keep the pH in the 10 to 11 range and suppress the formation lethal HCN gas.

4.1.6 International Cyanide Management Code

AEM is a signatory to the International Cyanide Management Code (the Code) for the manufacture, transport and use of cyanide in the production of gold. The Code is administered by a non-profit institute consisting of participants from the gold mining industry, governments, non-governmental organizations, labour, cyanide producers, and other interested parties.

The Code represents a voluntary commitment on the part of all signatories to identify and follow basic principles and guidelines for safe cyanide use at gold mining operations. This is the first such generic international code in the history of the mining industry. Under the Code, gold mines are required to manage their cyanide from source to site, thus assuming "cradle to grave" responsibility for all cyanide used at their operation.

5 PETROLEUM PRODUCTS

5.1 PRODUCT DESCRIPTION

The operation will use large amounts of fuel and lubricants (petroleum products). These products will be transported, stored, handled and transferred and used in compliance with the appropriate legislation and applying Best Management Practices.

5.2 DELIVERY TO SITE

With the exception of diesel fuel, most petroleum fuel and lubricant products will be delivered to site and stored in the original packing container from the manufacturer. These types of containers include a variety of sealed drums, pails, 1 ton super sac, bulk cubs, cans, and tubes.

Due to transportation restrictions, a full year's supply of fuel and lubricants will be transported and stored on-site, in order to meet the demand of the upcoming year. During the summer months, diesel will be shipped from Beacancour, QB to Baker Lake, NU where it is transferred into storage tanks. From the Baker Lake storage tanks, fuel is transported to the Meadowbank site via the AWPAR daily. Table 3 provides the varieties and volumes of petroleum products stored on site and the storage locations.

The storage tank at the Meadowbank site has a capacity of 5.7 million litres and is refuelled via tanker truck from the Baker Lake fuel farm. The Baker Lake fuel farm consists of six, 10 million liter tanks. The tanks are single-walled, constructed of welded steel and tanks and storage locations have been designed and constructed to meet the CCME guidelines for *Aboveground Storage Tank Systems Containing Petroleum and Allied Petroleum Products*. The fuel unloading facility in each area includes a sloped lined pad to prevent contamination of the receiving environment. A continuous 60 mm high-density, polyethylene liner sheet is installed under the tanks and the internal sides of the berm. The containment area is sized to hold 110% of the volume of the largest tank,.

All fuel transfer and storage facilities have been designed in accordance with the Canadian Council of Ministers for the Environment (CCME, 1994) *Environmental Code of Practice for Above Ground Storage Tank Systems Containing Petroleum Products*, and the *National Fire Code*.

Appropriate measures are in place to minimize impacts to surface water, groundwater and soils from potential vehicle accidents when transporting hazardous materials to the site. Details of petroleum product safe handling procedures and proper PPE can be found in

Tables 4 and 5. Details of spill responses are presented in the SCP. The following general precautions will be taken:

A maximum speed on the All-Weather Private Access Road for loaded and empty vehicles have been established based on the road design. This speed limit is 50 km/hr.

All trucks will carry a spill kit

Trucks are equipped with a reliable radio and/or satellite phone.

AEM commits to being prepared to respond to spills resulting from vehicle accidents in a timely and efficient manner.

5.3 FUEL TRUCK TRANSFER PROCEDURES

A contract supplier will fill the storage tanks in the main tank farms . General procedures to be followed are listed below. Similar procedures would be followed for fuelling remote station tanks.

Before fuel transfer, verify that:

All fuel transfer hoses are connected properly and couplings are tight.

Transfer hoses are not obviously damaged.

Fuel transfer personnel are familiar with procedures.

Personnel are located at both the fuel delivery truck and fuel transfer tank(s) and can manually shut off the flow of fuel.

If a high liquid level shutoff device is installed at the delivery tank, verify that the shutoff is operating correctly each time it is used.

Fuel transfer will then proceed per the established procedures of the contract supplier.

Any accidents or spills must be reported immediately to the Environmental Coordinator. Notification and response procedures are detailed in the SCP.

5.4 CONTAMINATED SOILS AND SPILLS

Contaminated spill pads and soils resulting from the storage and handling of fuels and lubricants will be salvaged at the time such impacts are identified, and put into Quatrex bags, labelled and eventually shipped off-site to an approved disposal facility

5.5 USED PETROLEUM PRODUCTS

Used oil that is no longer suitable for its intended use is classified as a hazardous waste. The discharge of used oil into the environment, including but not limited to landfills, sewers and water bodies, is prohibited.

AEM intends to apply for a permit to incinerate used oil in the camp incinerator as per Schedule B of the *Used Oil and Waste Fuel Management Regulations*; or use the oil in the production of ANFO. All used oil products will be collected in tanks or drums marked "Waste Oil" and disposed of at an approved facility. Empty petroleum containers will be stored on site in a designated area and returned to the supplier on backhauls. Oil filters will be punctured and/or crushed and drained of their contents for 24 hours prior to disposal.

In support of the permit to incinerate accumulations of used oil, a random sample will be analysed once a year to ensure that it does not contain unacceptable levels of impurities, including cadmium, chromium, lead, total organic halogens (such as chlorine compounds), polychlorinated biphenyls (PCB) and ash content. Samples will be sent to an accredited laboratory (Multi-lab) for analysis. Impurity concentrations will be compared to the levels set out in Schedule A of the *Used Oil and Waste Fuel Management Regulations*. Alternate arrangements will be made for the off-site disposal, treatment or recycling of used oil that contains levels of impurities above those that are set out in Schedule A of the regulations.

The following information will be recorded in association with the incineration of used oil:

- the volume of used oil generated at the facility
- the volume of used oil incinerated
- the name and address of the person in charge, management or control of the used oil, and the place where the used oil was produced
- the analysis of any representative sample of used oil
- a summary of maintenance performed on the incinerator or processing equipment
- the volume and nature of the products produced from the used oil
- the destination of the used oil products shipped from the facility

Table 2 - Fuel Products – Hazard Classes & Potential Impacts

Material	TDGA Class[a]	Potential Environmental Impact
Diesel	3	Water & soil contamination
Motor oil	Not regulated	Water & soil contamination
Aviation fuel	3	Water & soil contamination
Hydraulic fluid	Not regulated	Low risk to water & soil with proper handling
Varsol	3	Water & Soil contamination
Automotive grease	Not regulated	Low risk to water & soil with proper handling
Ethylene glycol	Not regulated	Toxic by ingestion, could potentially be consumed by wildlife.

Table 3- Fuel Products – Storage Locations

Product	Total Quantity On-Site	Storage Location	Container
Diesel	10 ML (potentially 70 ML including Baker Lake)	Fuel farm Powerhouse Exploration camp Airstrip Mechanical shop Explosives truck shop	bulk of 10 ML in bermed area 3x 25,000 L tank 25,000 L tank 250 L tank 1,000 L tank 25,000 L tank
		Baker Lake	bulk total of 60 ML in bermed area
Motor oils	*refer to Appendix B	Mechanical shop Powerhouse Exploration camp	Cubes or Barrels Cubes or Barrels Cubes or Barrels
Aviation fuel	24,000 L or less	Airstrip	25,000 L EnviroTank
Hydraulic fluid	*refer to Appendix B	Mechanical shop Powerhouse Plant	Cubes or Barrels Cubes or Barrels Cubes or Barrels
Ethylene glycol	*refer to Appendix B	Mechanical shop	Cubes

Note: ***L = litre; ML = Mega-litre (1X10^6 litres).***

Table 4 - Fuel Products – Safe Handling Procedures

Product	Handling Procedures
Diesel	Do not get in eyes, on skin, or on clothing. Avoid breathing vapours, mist, fume, or dust. Do not swallow. May be aspirated into lungs. Wear PPE and/or garments if exposure conditions warrant. Wash thoroughly after handling. Launder contaminated clothing before reuse. Use with adequate ventilation. Keep away from heat, sparks, and flames. Store in a well-ventilated area. Store in a closed container. Bond and ground during transfer.
Motor oil	Wear protective clothing and impervious gloves when working with used motor oils. To be handled generally consistent with other petroleum hydrocarbons.
Aviation fuel	See diesel procedures above.
Hydraulic fluid	Keep container closed until ready for use.
Ethylene glycol	Ensure adequate ventilation. Wear protective gloves and chemical safety goggles. Keep in tightly closed container, stored in a cool, dry, ventilated area. Separate from acids and oxidizing materials. Empty containers of this product retain product residues and may be hazardous.

Table 5 - Fuel Products – Personal Protective Equipment

Product	Personal Protective Equipment		
	Eyes	Skin	Respiration
Diesel	Chemical goggles	Neoprene or nitrile gloves; protective garments	None usually required
Motor oil	Chemical goggles	Neoprene or nitrile gloves; protective garments	None usually required
Aviation fuel	Chemical goggles	Neoprene or nitrile gloves; protective garments	None usually required; ensure adequate ventilation
Hydraulic fluid	Chemical goggles	None usually required	None usually required
Ethylene glycol	Chemical goggles	Neoprene or nitrile gloves; protective garments	None usually required; ensure adequate ventilation

6 EXPLOSIVES

6.1 PRODUCT DESCRIPTION

Explosives are required for blasting waste rock and ore in the mine. Transportation, storage, use, and handling of blasting materials are strictly regulated by the Federal *Explosives Act* and *Transportation of Dangerous Goods Act* (Class 1 – Explosives), as well as the following territorial Acts:

Explosives Use Act and Regulations

Mine Health and Safety Act and Regulations

6.2 EXPLOSIVES STORAGE

Manufacturing, handling, and storage of explosives are carried out by QAAQTUQ – Dyno Nobel Canada Inc.

The estimated annual explosives requirement for the Meadowbank mine will vary between 6,000 to 11,000 tonnes per year. However, only a small amount of explosive material will be shipped to site in the form of blasting caps, these are handled by AEM. The bulk of the explosives used at site will be Emulsion (XL-1000), which is a mixture of Nitrites and Emulsifier. Emulsion will be mixed in an on-site plant (Emulsion Plant shown on Figure 1 by Dyno Nobel.

Sea Cans of Emulsion and Nitrites are stored on the Emulsion Plant site. They are stored within sea cans in quantities of approximately 20,000 kg's per sea can. These items are stored in separate locations so as to prevent the mixing of the two products. These products are also stored away from any other products, >40m away from the emulsion plant, and >25m from the fuel tanks.

The high explosive detonators and blasting caps will be stored in an enclosed magazine. It is estimated that twelve magazines will be required on site, each being approximately 4 m x 14 m (i.e., not much bigger than a sea can). AEM looks after the handling of these explosive detonators.

The explosive mixing plant, product storage, and magazines are safely located away from vulnerable facilities (see Figure 1 in Appendix B for locations), as stipulated by the federal and territorial *Explosives Use Act* and Regulations. The mixing plant will also be used for the washing and minor repair of trucks and equipment used to handle the explosives.

6.3 USE OF EXPLOSIVES

The primary blasthole drills will be diesel-powered rigs capable of drilling 152.4 mm diameter holes. Drilling requirements were calculated for ore and waste. A pre-shear and buffer blasting followed by mechanical wall cleanup is used for the final wall. Blasting operations will be affected by several factors, including wall control and weather. A number of modified operating procedures will be implemented during the winter season. These may include minimizing the sleep time for loaded holes; ensuring that cuttings are mounded around the hole collars after loading to prevent snow drifting into the holes, and utilizing blasthole covers.

The responsibility for blasting will be split between appropriately trained mine personnel and the explosives supplier, Dyno Nobel. Dyno Nobel will be responsible for supplying and delivering blasting agents to the site, manufacturing the blasting product on site, delivering blasting agents to the blastholes and filling the holes. AEM Blasters will be responsible for charging the holes, placing the detonators and boosters, and tying-in the patterns. The AN and emulsion components will be loaded on barges and transported to the Baker Lake Marshalling Area for temporary storage, if necessary, prior to transport to site. Dyno Nobel will provide mixing and delivery trucks. AEM will provide fuel oil and accommodations.

Blasting will be approximately daily and will average, in size, the daily production requirement of 50-90,000 tonnes per blast. Blasting will likely be by electric initiation and will feature current technology with down-the-hole delays to minimize the energy per delay to single hole loads. This will minimize backbreak, fly rock, vibration levels and will optimize fragmentation and minimize digging problems.

Blasting will be carried out by certified blasters following blasting regulations and safe practices. All pit activities are under the supervision of certified mine supervisors, knowledgeable in mine operating regulations and best practices.

The manufacture and distribution of explosives is carried out by suppliers under Federal license to conduct such work. They provide and operate the explosives manufacturing plant under such license and authority.

Details on explosives inventory and inspection are provided in Section 9.2. Information on Explosives Handlers is available in Section 10.3.

6.4 DISPOSAL

Disposal of regular waste will follow the AEM waste management plan.

Wash water that is created at the Emulsion plant is sucked out via vacuum truck and taken to the tailings storage facility for disposal.

Any unusable Emulsion waste is taken to the mines blast pattern for disposal down the bore holes.

7 PROCESS PLANT & WATER TREATMENT REAGENTS & CONSUMABLES

7.1 PRODUCT DESCRIPTION

The Process Plant will use a number of chemicals and reagents to treat the ore, recover entrained gold. The Water Treatment Plant, if required, would also use a number of chemicals and reagents to treat water. Water Treatment chemicals would be used over a 3 to 4 month period during frost-free months only. The range in annual quantities used would reflect the different dosages that may be used during different mining stages (early operations, late operations, closure treatment of tailings water and polishing of pit lake water quality on a contingency basis). Material categories, site handling and storage requirements, and PPE recommended by manufacturers are summarized in Tables 6 to 9

Table 6 - Process Plant & Water Treatment Reagents – Use, Consumption & Storage

Reagent	Use	Approximate Consumption		Phase	Normal Delivery Format	On-Site Storage
		Daily	Annual			
Acetylene	Welding	1-2	600	gas	gas cylinders	secured upright
Activated carbon (granular)	Gold recovery	340 kg	140 t	solid	500 kg bags	Pallet
Anti-scalant	Water treatment	25 kg	10 t	liquid	650 kg tote tank	Pallet drums
Borax	Refinery	60 kg	22 t	solid	40 kg bags	Pallet
Silica	Refinery	30 kg	11 t	solid	22.7 kg bags	Pallet
Calcium oxide (Quicklime) (CaO)	pH control	7,814 kg	3150 t	solid	1 t supersacs	Pallet
Calcium peroxide (alternative to hydrogen peroxide)	Potential use: Water treatment	minimal*	minimal*	solid	45 kg drum	Pallet drums
Copper sulphate ($CuSO_4$)	Cyanide destruction	1450 kg	585 t	solid	1 t supersacs	Pallet
Flocculant (Magnafloc 338 or Magnafloc 10)	Settling aid	300 kg	120 t	solid	25 kg bags	Pallet
Hydrochloric acid (HCl)	Refining/stripping	200 kg	75 t	liquid	20 gal drums	Pallet drums
Hydrofluoric acid	Laboratory	5 gallons	1 825 gallons	liquid	20 gal drums	Pallet drums
Hydrogen peroxide (alternative to calcium hydroxide)	Potential use: Water treatment	minimal*	minimal*	liquid	1 m^3 HDPE tote	Pallet
Lead acid batteries	Vehicles	-	24	liquid	-	pallet
Nitric acid	Stripping	50 kg	18 t	liquid	34 kg bottle	Pallet
Paints	Maintenance	-	100 gallons	liquid	gallon	Pallet
Sodium cyanide (NaCN)	Leaching	3825 kg	1 540 t	solid	1 t box bags	Pallet
Sodium hydroxide (caustic soda) (NaOH)	Refining/stripping	20 kg	8 t	solid	25 kg bags	Pallet

	Refining/stripping	786 kg	320 t	solid	1000 kg	pallet
Sodium metabisulphite ($Na_2S_2O_5$)	Cyanide destruction	7710 kg	3100 t	solid	1 t supersacs	Pallet
Sodium nitrate	Refinery	40 kg	15 t	solid	50 kg bags	Pallet s
Sulphur	Cyanide destruction	745 kg	300 t	solid	1 t bags	Pallet

Note: kg = kilogram; t = ton; gal = gallon; m^3 = cubic metre.

Table 7 - Process Plant & Water Treatment Reagents – Hazard Classes & Potential Environmental Impacts

Material	Class	Potential Impact
Acetylene	2.1	Generally not hazardous for water.
Activated carbon	4.2	No information available.
Anti-scalant	Not regulated	Negligible with proper handling
Borax	Not regulated	Presents no health hazards.
Calcium oxide	Not regulated	No information available.
Calcium peroxide	5.1	Releases oxygen into environment when dissolved in water.
Copper sulphate	9	Harmful to aquatic life.
Flocculant	Not regulated	Acute fish, invertebrate, algae and bacteria toxicity.
Hydrochloric acid	8	Extremely toxic to aquatic life by lowering the pH below 5.5. When released into the soil, this material may leach into groundwater.
Hydrofluoric acid	8.6.1	No information available.
Hydrogen peroxide	5.1	Aquatic Toxicity 96-hour LC50.
Lead acid batteries	8	No information available.
Nitric acid	8	No information available.
Paints	Not regulated	No information available.
Silica	Not regulated	Generally not hazardous for water.
Sodium cyanide	6.1	Expected to be very toxic to aquatic life and to terrestrial life.
Sodium hydroxide	8	No information available.
Sodium metabisulphite	Not regulated	No information available.
Sodium nitrate	5.1	Possibly hazardous short-term degradation products are not likely. However, long term degradation products may arise. The products of degradation are less toxic than the product itself.
Sulphur	9	No info available (insoluble in water).

Table 8 - Process Plant & Water Treatment Reagents – Safe Handling Procedures

Product	Handling Procedure
Acetylene	Do not mix with air or oxygen above atmospheric pressure. Store away from oxidizing agents. Open and handle cylinder with care. Keep ignition sources away - Do not smoke. Protect from heat. Protect against electrostatic charges. Pressurized container: protect from sunlight, store in a cool location and do not expose to temperatures exceeding 50°C. Do not pierce or burn, even after use. Prevent impact and friction. Store in accordance with local fire code and/or building code or any pertaining regulations.
Activated carbon	Wash thoroughly after handling. Use with adequate ventilation. Minimize dust generation and accumulation. Avoid contact with eyes, skin, and clothing. Avoid ingestion and inhalation. Activated Carbon, especially when wet, can deplete oxygen from air in enclosed spaces, and dangerously low levels of oxygen may result. Store in a tightly closed container. Keep from contact with oxidizing materials. Store in a cool, dry, well-ventilated area away from incompatible substances.
Anti-scalant	Used in extremely small quantities. Can cause mild to moderate irritation of eyes, skin, and upper respiratory tract. Wash thoroughly after handling. Use sensible industrial hygiene and housekeeping products. Not flammable. Keep containers tightly closed
Borax	No special steps required.
Calcium oxide	Store in closed containers in a controlled drainage area under cover. Use in a well-ventilated area. Empty containers retain product residues and may be hazardous.
Calcium peroxide	Wash thoroughly after handling. Avoid all situations that could lead to harmful exposure. Store in a cool, dry, well-ventilated place. Keep container tightly closed and away from incompatible materials and sources of heat.
Copper sulphate	Avoid contact with skin and eyes. DO NOT breathe dust. Always wash hands thoroughly after contact. Store and use only in dry, well-ventilated areas. Keep container tightly closed.
Flocculant	Dust generated in handling of this product can be explosive if sufficient quantities are mixed in air, in which case ignition sources should be avoided. Employ grounding, venting and explosion relief provisions in accord with accepted engineering practices in process operations capable of generating dust/or static electricity. Handle in accordance with good industrial practice, handle with care and avoid unnecessary personal contact. Avoid contact with eyes and prolonged or repeated skin contact. Avoid continuous or repetitive breathing of dust. Use only with adequate ventilation. Remove contaminated clothing; launder or dry-clean before reuse. Wash thoroughly

Product	Handling Procedure
	with soap and water after using. For industrial use only. Slip hazard when wet.
	Material is slippery when wet. Store in the original container, securely closed, in a cool and dry location. Avoid extremes of temperature and ignition sources.
Hydrochloric acid	Do not get in eyes, on skin, or on clothing. Wear protective clothing. Avoid breathing vapours or fumes. Store in cool, dry, ventilated area with acid-resistant floors. Keep container closed, out of direct sunlight, and away from heat, water, and incompatible materials. When diluting, add acid slowly to water and in small amounts. Never use hot water and never add water to acid. When opening metal drum, use non-sparking tools because hydrogen gas may be present. Do not wash out container and use for other purposes. Empty containers retain product residues and may be hazardous.
Hydrofluoric acid	Wash thoroughly after handling. Remove contaminated clothing and wash before re-use. Use with adequate ventilation. Do not get on skin, in eyes or on clothing. Do not ingest or inhale.
	Store in a cool, dry, well-ventilated area away from incompatible substances. Do not store in metal or glass containers. Do not store in direct sunlight. Keep tightly closed. Empty container may contain hazardous residue. Do not add any other material to the container. Do not wash down the drain. Do not allow smoking or food consumption while handling. Store in approved containers only. Do not add water to acids.
Hydrogen peroxide	Use extreme care when attempting any reactions because of fire and explosion potential (immediate or delayed). Conduct all initial experiments on a small scale and protect personnel with adequate shielding as the reactions are unpredictable, and may be delayed, and may be affected by impurities, contaminants, temperature, etc. Do not get in eyes. Avoid contact with skin and clothing. Wash thoroughly after handling. Avoid contact with flammable or combustible materials. Avoid contamination from any source including metals, dust, and organic materials. In the event of an accident where large volumes of hydrogen peroxide might come into contact with external fires or with incompatible chemicals, a one-half mile area from the incident should be evacuated.
	Store in a properly vented container or in approved bulk storage facilities. Do not block vent. Do not store on wooden pallets. Do not store where contact with incompatible materials could occur, even with a spill (see "Hazardous Reactivity" on MSDS). Have water source available for diluting. Do not add any other product to container. Never return used or unused peroxide to container, instead dilute with plenty of water and discard. Rinse empty containers thoroughly with clean water before discarding. (See "Waste Disposal" on MSDS).
Lead Acid Batteries	Store batteries in a well ventilated cool area. Handle carefully to avoid damaging or turning batteries over.
Nitric acid	Class 8 products are not to be loaded with class 1, 4.3, 5, 6, 7 or foodstuffs or foodstuff empties. Store in a well ventilated area and out of direct sunlight. Keep containers closed at all times. Store away from oxidisable, caustic and combustible materials.

Product	Handling Procedure
	Vapours heavier than air, prevent concentration in sumps and hollows. DO NOT enter confined spaces where vapour may have collected. Strong oxidising agent, can lead to fire or explosion with organic and/or combustible materials.
Paints	No special steps required.
Silica	Prevent formation of dust. This product is not flammable. When pouring into a container of flammable liquid, ground both containers electrically to prevent static electric spark. Keep containers tightly sealed.
Sodium cyanide	Highly toxic, corrosive to eyes, skin, and respiratory tract. Can be fatal if swallowed, inhaled, or absorbed through skin. Keep cyanide antidote kit available in any cyanide work area. Wear personal protective clothing at all times. Keep in tightly closed container in cool, dry, ventilated area. Protect against physical damage to containers. Do not store under sprinkler systems. Do not wash out container and use for other purposes. Empty containers retain product residues and may be hazardous.
Sodium hydroxide (caustic soda)	Can cause severe injury to eyes, skin, and respiratory tract. Use PPE at all times and DO NOT contact product directly. Wash thoroughly after handling. Store in dry, well-ventilated area. Keep in original container, tightly closed. Empty containers retain product residues and may be hazardous.
Sodium metabisulphite	May cause irritation to eyes, skin, and respiratory tract with prolonged exposure. Sulphite-sensitive individuals may experience severe allergic reaction to dust. Releases sulphur dioxide gas when mixed with water. Wear PPE and wash thoroughly after handling. Store in dry, well-ventilated area away from heat, acids, and oxidizers. Keep container tightly closed. Use vacuum to clean up dust.
Sodium nitrate	Keep away from heat. Keep away from sources of ignition. Keep away from combustible materials. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe dust. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as reducing agents, combustible materials, acids.
	Keep container dry. Keep in a cool place. Keep container tightly closed. Keep in a cool and well-ventilated area. Highly toxic or infectious materials should be stored in a separate locked safety storage cabinet or room.
Sulphur	Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Minimize dust generation and accumulation. May form flammable dust-air mixtures. Avoid contact with skin, eyes and clothing. Empty containers contain product residue, (liquid and/of vapour), and can be dangerous. Keep containers tightly closed. Avoid contact with heat, sparks, and flame. Use with adequate ventilation. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat

Product	Handling Procedure
	spark, or open flames. Store away from heat, sparks, and flame. Keep away from sources of ignition. Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances (oxidizing agents).

Table 9 - Process Plant & Water Treatment Reagents – Personal Protective Equipment

Product	Personal Eyes	Protective Skin	Equipment Respiration
Acetylene	Tightly sealed goggles	Protective gloves	Use atmosphere-supplying respirators (e.g. supplied-air: demand, pressure-demand, or continuous-flow or self-contained breathing apparatus: demand or pressure-demand or combination supplied-air with auxiliary self-contained air supply atmosphere-supplying respirator in case of insufficient ventilation).
Activated carbon	None required	None required	None required
Anti-scalant	For splash protection use chemical goggles or full face shield	Rubber or neoprene gloves; impervious apron or coveralls and boots	Not normally needed
Borax	Avoid eye contact	None required	None required
Calcium oxide	For splash protection use chemical goggles or full face shield	Rubber, neoprene, or nitrile gloves; impervious apron or coveralls and boots.	NIOSH/MSHA approved respirator, if required
Calcium peroxide	Chemical goggles, full-face shield, or a full-face respirator is to be worn at all times when product is handled. Contact lenses should not be worn; they	Impervious gloves of chemically resistant material (rubber or neoprene) should be worn at all times. Wash contaminated gloves and	NIOSH-approved respirator for dust should be worn if needed.

Product	Personal Eyes	Protective Skin	Equipment Respiration
	may contribute to severe eye injury.	dry thoroughly before reuse. Body suits, aprons, and/or coveralls of chemical resistant material should be worn at all times. Wash contaminated clothing and dry thoroughly before reuse. Impervious boots of chemically resistant material should be worn.	
Copper sulphate	Chemical goggles or full face shield	Rubber or neoprene gloves; impervious apron or coveralls and boots	Dust mask; NIOSH/MSHA approved respirator, if required
Flocculant	For splash protection use chemical goggles or full face shield	Rubber or neoprene gloves; impervious apron or coveralls and boots	Dust mask
Hydrochloric acid	For splash protection use chemical goggles or full face shield	Rubber or neoprene gloves; impervious apron or coveralls and boots	NIOSH/MSHA approved respirator
Hydrofluoric acid	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133. Wear face shield.	Wear appropriate protective neoprene gloves to prevent skin exposure. Wear acid-resistant jacket, trousers and boots sufficient to protect skin.	Wear appropriate OSHA/MSHA approved chemical cartridge respirator regulations found in 29CFR 1910.134. If more than TLV, do not breathe vapour. Wear self-contained breathing apparatus. Always use an NIOSH-approved respirator when necessary.
Hydrogen peroxide	Wear coverall chemical splash goggles. In addition, where the possibility exists for eye or face contact due to splashing or spraying of material, wear chemical splash goggles/full-length face shield combination.	Where there is potential for skin contact, have available and wear as appropriate: impervious gloves, apron, pants, jacket, hood, and boots; or totally encapsulating chemical suit with breathing air supply. Permeation data supplied by vendors indicate that impervious materials such as natural rubber, natural	Where there is potential for airborne exposure in excess of applicable limits, wear NIOSH approved respiratory protection.

Product	Personal Eyes	Protective Skin	Equipment Respiration
		rubber plus neoprene, nitrile, or polyvinylchloride afford adequate protection. Do not wear leather gloves or leather shoes (uppers or soles) because they can ignite following contact with peroxide. Cotton clothing can also ignite. This effect may be within minutes, or delayed. Clothing fires and skin damage occur less quickly with 50% or lower hydrogen peroxide than with 70% material, but adequate personal protection is essential for all industrial concentrations. Protective skin creams offer no protection from hydrogen peroxide and should not be used.	
Lead Acid Batteries	Safety glasses must be worn when moving, connecting, disconnecting or maintaining batteries, or cleaning up acid spills; as well as, when brushing battery posts or handling solids from inside a battery.	When moving, connecting, disconnecting or maintaining batteries, or cleaning up acid spills acid resistant gloves and full coverage acid resistant clothing must be worn. When brushing battery posts or handling solids from inside a battery gloves and apron must be worn.	When brushing battery posts or handling solids from inside a battery, dust masks must be worn.
Nitric acid	Chemical safety goggles. A face shield may also be necessary.	Impervious gloves, coveralls, boots, and/or other resistant protective clothing. An impervious full-body encapsulating suit and respiratory protection may be required in some operations.	NIOSH/MSHA approved respirator, if required
Paints	None required.	None required.	None required.

Product	Personal Eyes	Protective Skin	Equipment Respiration
Silica	Safety goggles	Wear impervious gloves, shoes and protective clothing to prevent skin contact.	NIOSH/MSHA approved respirator, if required
Sodium cyanide	For dust and splash protection use chemical goggles or full face shield	Rubber or neoprene gloves; impervious lab coat, apron, or coveralls and boots	NIOSH/MSHA approved respirator, if required
Sodium hydroxide (caustic soda)	Tight-fitting goggles if dust is generated. For splash protection use chemical goggles or full face shield	Gauntlet type rubber or neoprene gloves; impervious apron or coveralls and boots	NIOSH/MSHA approved respirator
Sodium metabisulphite	Chemical safety goggles	Cotton gloves adequate for handling dry product. For solutions, use rubber or neoprene gloves; impervious apron or overalls and boots	NIOSH/MSHA approved respirator
Sodium nitrate	Contact lenses should not be worn; they may contribute to severe eye injury.	Impervious gloves of chemically resistant material (rubber or PVC), body suits, aprons, and/or coveralls of chemical resistant material and impervious boots of chemically resistant material should be worn at all times	For dusty or misty conditions, wear NIOSH-approved dust or mist respirator. In case of spill or leak resulting in unknown concentration, use NIOSH approved supplied air respirator.
Sulphur	Chemical safety goggles	Wear impervious gloves, shoes and protective clothing to prevent skin contact.	NIOSH/MSHA approved respirator, if required

8 MISCELLANEOUS HAZARDOUS/TOXIC MATERIALS

8.1 PRODUCT DESCRIPTION

Acids such as Nitric Acid, as well as emulsifiers and ammonium nitrate are used at the mine site. Gases such as propane, oxygen, and acetylene; solvents; water/effluent treatment chemicals and various additives are also utilized.

The release or spillage of any of these substances would possibly result in environmental impacts and pose a potentially hazardous situation for those personnel exposed to these materials. It is essential that materials deemed to be potentially hazardous be dealt with in a cautious manner, in strict adherence to recommended regulations outlined in the legislation, whether the substance is provided in large or smaller quantities as this will prevent serious repercussions should an accidental release of material happen.

8.2 STORAGE FACILITIES OF HAZARDOUS/TOXIC CHEMICALS

All explosive related chemicals will be stored as discussed in Section 6 of this report.

All other chemicals and gases will be stored in appropriate locations.

These storage facilities ensure that chemicals that could interact and cause a serious incident will be kept segregated.

9 INVENTORY, INSPECTION & RECORDS

A contract expediting company, Arctic Fuel, will arrange all deliveries from the Baker Lake Marshalling Area to the Meadowbank site. This will include the hazardous materials discussed in this plan. The General Mine Manager will have ultimate responsibility for supervising the receipt, inspection, and recording of all material inventories at site. The division managers will reconcile total amounts received against amounts ordered.

9.1 PETROLEUM PRODUCTS

9.1.1 Inventory Management

Diesel fuel use will be metered automatically when it is pumped from the bulk tanks. The metered volumes will be summarized weekly and reconciled against tank levels determined manually with a dipstick from the top of the tanks. Diesel fuel consumption for the power generators will be recorded weekly.

Aviation fuel will be dispensed from an EnviroTank as required under the supervision of aircraft personnel. Consumption and on-site volumes will be reconciled monthly. Lubricants and other petroleum products will be inventoried monthly.

9.1.2 Inspection

The Environmental Department performs regularly scheduled inspections of all fuel and lubricant storage areas. The inspection schedule and procedure to be followed are summarized in Table 10. All inspections will be logged with the date and time of inspection, facility inspected, and name of the person making the inspection.

The condition of hazardous materials storage areas, containers, tanks, connectors and associated plumbing will be checked on a regular basis. Observations on their condition will be logged, dated and kept near the corresponding storage area. Drums/containers will be inspected for the presence and legibility of symbols, words or other marks identifying the contents, signs of deterioration or damage such as corrosion, rust, leaks at seams or signs that the drum/container is under pressure such as bulging and swelling, spillage or discoloration on the top or sides of the drum/container. If leaks or deterioration is encountered it will be noted and addressed in a timely manner.

The hazardous materials area's secondary containment will be inspected and the condition of the secondary containment will be noted. Arrangements will be made for repairs if necessary.

Table 10 - Inspection of Petroleum Storage Sites

Fuel Tanks	*Schedule* – Daily Site Services Supervisor, Weekly by Environmental Technician, Quarterly by Environmental Coordinator. *Procedure* – Repair leaks and report promptly. Inspections will be reported annually and filed with the General Mine Manager or Site Services Superintendent and Environmental Superintendent.
Diesel Generating Plant	*Schedule* – Daily by powerhouse operator, weekly by Environmental Technician as part of internal environmental inspections. *Procedure* – Inspections will be reported annually and filed as above.
Other Fuelling Stations	*Schedule* – Daily by Site Services Supervisor, Weekly by Environmental Technician as part of regular inspections. *Procedure* – Inspections will be reported annually and filed as above.
Spill Kits	*Schedule* – Monthly by Environmental Technician, Quarterly by Environmental Coordinator. *Procedure* – Inspections will be reported annually and filed as above.
Other Hazardous Material Storage	*Schedule* – Daily Site Services Supervisor, Weekly by Environmental Technician when materials are on site. *Procedure* – Inspections will be reported annually and filed as above.

Any accidental damage to containment structures will be inspected immediately and appropriate repairs undertaken. The extent of damage will be reported in writing to the General Mine Manager and Environmental Superintendent. The report will note any remedial repairs that may be made, the date of any repairs, and the need for any follow-up inspection.

9.1.3 Records

Records pertaining to storage, use, and loss of fuels and lubricants are required by CCME and the Fire Marshal (under the *National Fire Code).* The following records are prepared by the Procurement and Logistics and Site Services departments.

reconciliation of bulk inventory from resupply logs

weekly use summaries

weekly reconciliation for each storage tank

overfill alarm tests

pressure tests (if applicable)

inspections and maintenance checks of the storage tank, piping, and delivery systems

any alteration to the systems

reports of leaks or losses

reports of spill responses

records of training.

9.2 EXPLOSIVES

9.2.1 Inventory Management

The Explosives Mixing Plant or Emulsion Plant is located Figure 1. The emulsions manufactured on-site are stored in a tank located at the Emulsion Plant. AEM's explosive contractor, Dyno Nobel Inc., performs daily and weekly inspections on the Emulsion Plant to ensure that Inventory used is documented. AEM conducts daily inspections of the seacan's storing the boosters, delays and detonator cords and provides an inventory to the Mine Manager.

9.2.2 Inspection

Access to and use of explosives will be under the exclusive control of AEM. AEM will be responsible for inspection of all explosives equipment and facilities, including the ammonium nitrate storage areas and the magazines for high explosive detonators and blasting caps The explosives manufacturing plant is inspected by Dyno Nobel Inc. and reports this to AEM Management.

9.2.3 Records

The *Federal Explosives Act* requires that the following records be kept with regard to explosives products:

quantity and strength of each explosive manufactured

quantity of each explosive issued to the mine site from the factory, including the dates of shipments and quantity of each explosive on site

The AEM staff will provide weekly reports to the General Mine Manager that will include.

staffing

safety concerns or incidents

total explosives consumption

the amount of ammonium nitrate remaining on site

inventory of other explosives and accessories to be audited for fiscal month-end balances.

9.3 MISCELLANEOUS HAZARDOUS/TOXIC MATERIALS

9.3.1 Inventory Management

Adequate quantities of all hazardous chemicals will be reconciled against orders on receipt. The appropriate department responsible for the miscellaneous chemicals is responsible for reconciling the resupply inventory.

9.3.2 Inspection

During operations, the appropriate department responsible for storage and handling of the miscellaneous chemicals are to regularly inspect all areas where such hazardous materials are used and stored. Any problems will be noted and reported to the Department Manager. The Department Manager will be responsible for weekly or monthly inspections of miscellaneous hazardous materials and storage areas.

9.3.3 Records

The quantity of hazardous materials received, used, and in possession of personnel are recorded by appropriate Departments. The departments are to comply with the environmental regulations.

10 TRAINING

10.1 GENERAL

All staff and contractors at the Meadowbank Gold project will receive the following training:

WHMIS

Emergency and spill response (see also the SCP and ERP)

Operations overview

Mine Standard Operating Procedures

Mine employees will receive additional training in mine safety as specified by the *Mine Health and Safety Act* and regulations. AEM will ensure compliance with the training requirements specified in the Act and regulations.

Plant employees will receive additional training specific to their area of work and duties, including safe operating practices, safe handling and storage of chemicals, and use of PPE. Other training includes cyanide and chemical awareness, specific chemical training for specific tasks, and a Mill induction training. This training will be the responsibility of AEM.

A record of training received will be maintained for each employee and also from contractors.

10.2 PETROLEUM PRODUCTS HANDLERS

Personnel who handle petroleum products will be expected to be conversant with relevant MSDS information. As well, these personnel will be given training in the following:

Transportation of dangerous goods (TDG)

AEM's fuel handling procedures (outlined in Section 6)

Spill response and cleanup procedures for petroleum (see the SCP)

Emergency response, especially firefighting procedures (see the ERP).

10.3 EXPLOSIVES HANDLERS

Only trained and certified persons will work with explosives. The explosives personnel will undertake formal training and on-the-job training to ensure compliance with legislation. The Mine Inspector will check the adequacy of training. Training requirements will include (but not necessarily be limited to):

Specific fire procedures as per the *Federal Explosives Act*

First aid

Transportation of dangerous goods (TDG)

WCB Blasting Certificate.

10.4 PLANT EMPLOYEES

Plant operators may receive TDG training, if appropriate. All plant employees will be trained in spill and emergency response procedures. Emergency response procedures for spilled chemical substances are provided in the SCP.

10.5 THIRD PARTY CONTRACTORS

It is expected that third party contractors receive adequate and comprehensive training to conduct their work tasks from their employer. AEM intends to review the general qualifications of third party contractors prior to having them work at the site. In addition, the contractor companies may also be requested to confirm the qualifications of specific individuals that they may have working at the site.

Third party contractors working on the site are required to participate in, and complete a site specific health and safety training session. The training session is envisioned to be valid for a period of 3 years, after which time the contractor may be required to complete the training again, or attend a refresher. The training session will outline site specific hazardous and response procedures that they should be aware of in the course of conducting their work on site. The training session will cover hazardous materials management.

11 PLAN EVALUATION, AUDIT & IMPROVEMENT

As part of AEM's commitment to attain certification under the International Cyanide Management Code, it will sponsor regular (every three years) audits by Institute-approved, third-party professionals to verify its compliance with the Code's principles and standards of practice with regard to cyanide handling

12 FIGURES

Figure 1: Meadowbank Mine Site, General Arrangement Plan, Hazardous Materials Storage Areas

Figure 2: Meadowbank Mine Site, Plant Site, Hazardous Materials Storage Areas

Figure 3: Baker Lake Marshalling Area Layout, Hazardous Materials Storage Areas

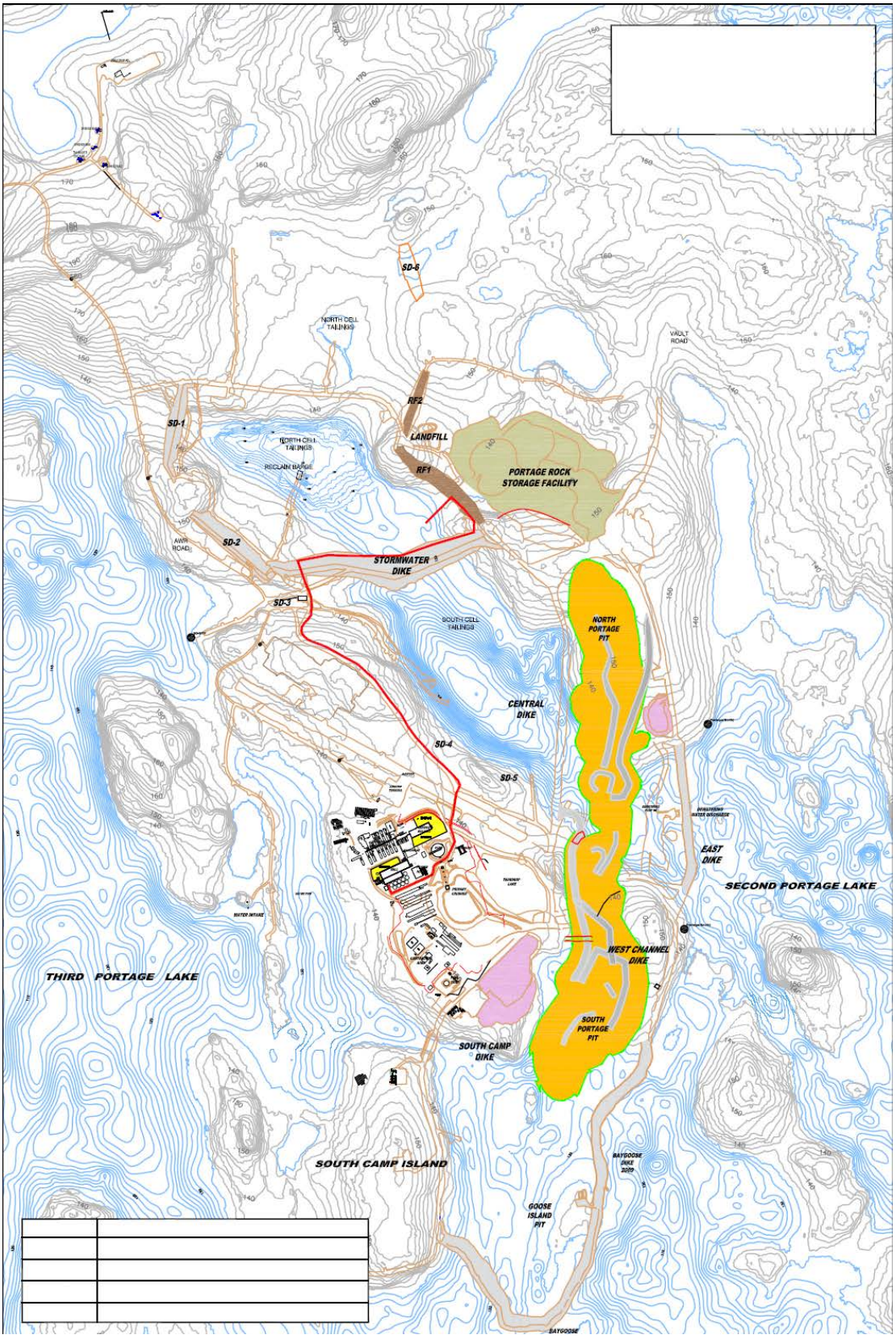

Figure 1 - Map of Meadowbank Site

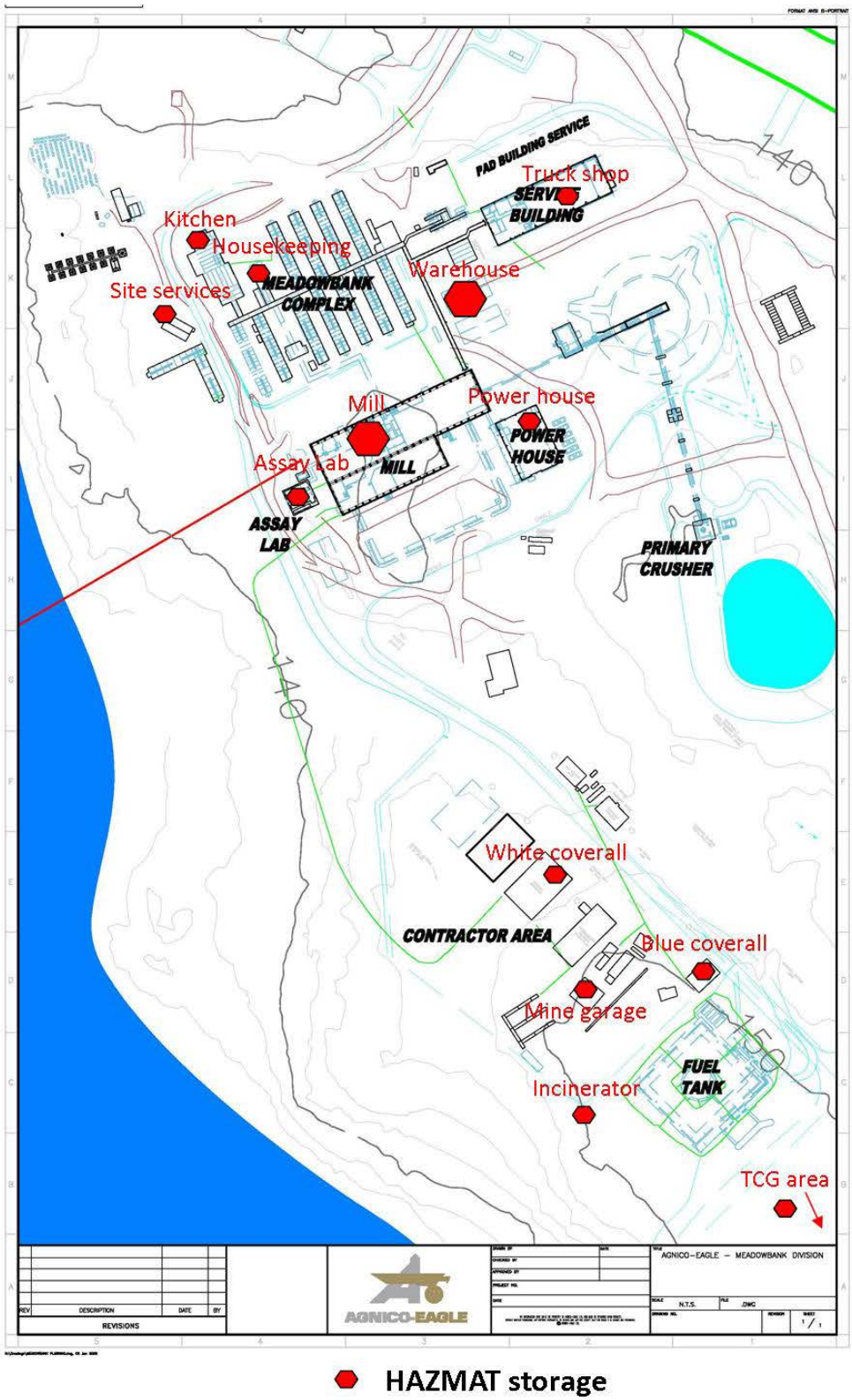

Figure 2 - Hazardous Material Storage Locations On the Meadowbank Site

Figure 3 - Fuel storage at Baker Lake Marshalling Area

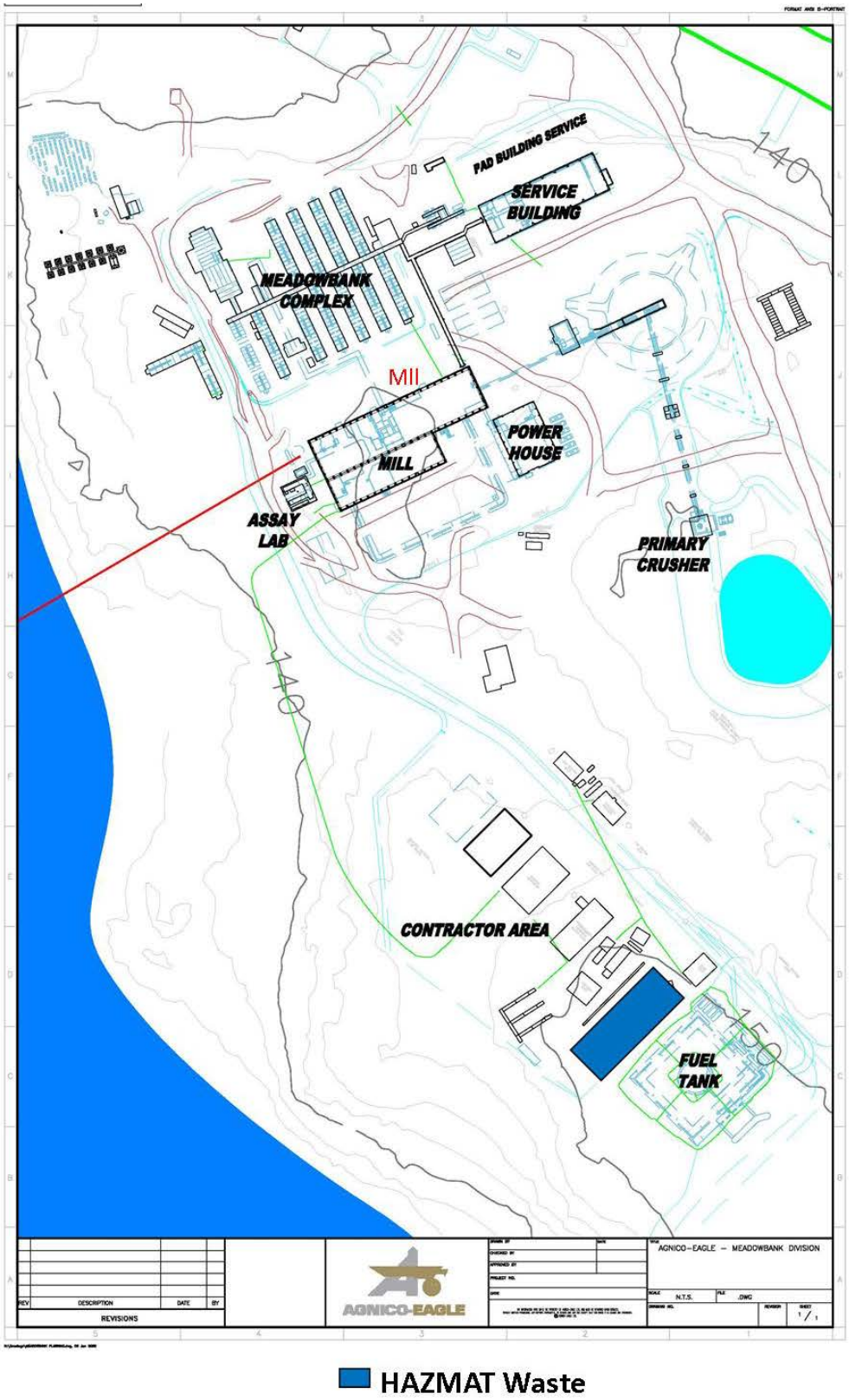

Figure 4 - Hazardous Waste Storage

13 LIST OF ACRONYMS

AEM	Agnico-Eagle Mines Ltd.
AN	Ammonium Nitrate
ANSI	American National Standards Institute
ANFO	Ammonium Nitrate Fuel Oil
CCME	Canadian Council of Ministers of the Environment
EPS	Environmental Protection Service
ERD	Explosives Regulatory Division, Natural Resources Canada
ERP	Emergency Response Plan
ERT	Emergency Response Team
FS	Fuel Storage Area
HAZCOM	Hazard Communication
HCN	Hydrogen Cyanide
HM	Hazardous Materials Storage Area
HMMP	Hazardous Materials Management Plan
HR	Human Resources
HSC	Occupational Health & Safety Committee
HW	Hazardous Waste Storage Area
IBC	Intermediate Bulk Container
ISO	International Organization for Standardization
MSDS	Materials Safety Data Sheets
MSHA	Mine Safety and Health Administration
NIOSH	National Institute for Occupational Safety and Health

OHSA	Occupational Health and Safety Administration
OHSP	Occupational Health & Safety Plan
PCB	Polychlorinated Biphenyls
PPE	Personal Protective Equipment
SCP	Spill Contingency Plan
TDG	Transportation of Dangerous Goods
TDGA	Transportation of Dangerous Goods Act
WCB	Workers' Compensation Board
WHMIS	Workplace Hazardous Materials Information System

Appendix A

List of Applicable Legislation

APPENDIX A - APPLICABLE LEGISLATION

The following is a list of federal and territorial legislation and guidelines that regulate the management of hazardous materials in Nunavut, and which are considered potentially applicable to the Meadow Gold Mine. As part of Meadowbank Mining Corp's overall environmental management system for the mine site, this list is updated at least annually to ensure it represents current and relevant information.

13.1.1.1.1 Federal Legislation

CANADIAN ENVIRONMENTAL PROTECTION ACT, 1999 S.C. 1999, c. 33

Code of Practice for the Reduction of Chlorofluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

Environmental Code of Practice on Halons Code of Practice EPS 1/RA/3E.

Environmental Emergency Regulations SOR/2003-307.

Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Aboveground Storage Tanks, CCME-EPC-87-E, as amended.

Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations SOR/2005-149.

Federal Halocarbon Regulations, 2003 SOR/2003-289.

Interprovincial Movement of Hazardous Waste Regulations SOR/2002-301.

Ozone-Depleting Substances Regulations, 1998 SOR/99-7.

EXPLOSIVES ACT R.S.C 1985, c. E-17

Ammonium Nitrate and Fuel Oil Order C.R.C. 1978, c. 598.

Explosives Regulations C.R.C. 1978, c. 599.

TRANSPORTATION OF DANGEROUS GOODS ACT, 1992 S.C. 1992, c. 34

Transportation of Dangerous Goods Regulations SOR/2001-286.

Transportation of Dangerous Goods Regulations - Schedules SOR/2001-286.

Federal Codes and Other Guidance Documents

National Fire Code.

Indian and Northern Affairs Canada. 2005. DEW Line Cleanup Barrel Protocol.

Canadian Council of Ministers for the Environment (CCME) - Environmental Code of Practice for Above-Ground and Underground Storage Tanks Systems containing Petroleum Products and Allied Petroleum Products (2003).

CCME - Canadian Wide Standards for Petroleum Hydrocarbons in Soil.

CCME - Canadian Environmental Quality Guidelines.

Environment Canada (Tilden & Westerman). 1990. Guidelines for the Preparation of Hazardous Material Spill Contingency Plans.

Department of Fisheries and Oceans. 1998. Guidelines for the Use of Explosives in or Near Canadian Fisheries Water.

13.1.1.1.2 Territorial Legislation

ENVIRONMENTAL PROTECTION ACT R.S.N.W.T. 1988, c. E-7

A Guide to the Spill Contingency Planning and Reporting Regulations January 2002.

Environmental Guideline for Contaminated Site Remediation November 2003.

Environmental Guideline for Waste Lead and Lead Paint.

Guideline for Ozone Depleting Substances.

Guideline for the General Management of Hazardous Waste in the NWT.

Guideline for the Management of Waste Antifreeze.

Guideline for the Management of Waste Batteries.

Guideline for the Management of Waste Paint.

Guideline for the Management of Waste Solvents.

Guideline for Dust Suppression, February 1998.

Spill Contingency Planning and Reporting Regulations R-068-93.

Used Oil and Waste Fuel Management Regulations R-064-2003.

Plain Language Guide to the Used Oil and Waste Fuel Management Regulations.

TRANSPORTATION OF DANGEROUS GOODS ACT, 1990 S.N.W.T. 1990, c. 36

Transportation of Dangerous Goods Regulations R-049-2002.

EXPLOSIVES USE ACT R.S.N.W.T. 1988, c. E-10

Explosives Regulations R.R.N.W.T. 1990, c. E-27.

Appendix B

Hazardous Materials Stored on the Meadowbank Site

Name	Description	Quantity
2,6 DIMETHYL 4 HEPTANONE 80 %	4LT	60
ABS GLUE CAN WITH BRUSH	500ML	3
ABS TO PVC TRANSITION GLUE	W/ BRUSH 500ML	11
ACETONE	4LT	4
ACETONE CLEANER		22
ACETYLENE	SIZE A390 CYLINDERS	506
ACETYLENE CGA510	SIZE MC CYLINDERS	20
ACETYLENE LABORATORY GRADE	SIZE K	42
ACTISAND 7E-3003	SILICE SAND 22.68KG	144
ACTIVATED CARBON	8 X 16 - 60% ACTIVE IN 500KG	504
ACTIVATED CARBON (GAC) FILTER	2 1/2" X 10" PHOSPHATE	12
ADDITIVE		16
ADHESIVE SILICONE	WITH RTV SUPERFLEX	40
ADHESIVE SILICONE	HIGH-TEMP RTV RED	93
ADHESIVE/SEALANT 277	BOT/250ML F/ LARGE BOLTS	41
ALIQUAT 336 AVERAGE MW 442	1LT	4
ALIQUOT 336	250ML	4
ALL SEASON SELECT OIL.	1L	16
ALL STEEL WELDING ELECTRODE	M4 5/32" 2.5KG/BX	2
ANHYDRE BORAX 12 MESH	25KG DEHYBOR	167
ANHYDRONE		7
ANIONIC FLOCCULANT 920 MC	750KG/BAG	181
ANIONIC FLOCCULANT 934 SH	750KG/BAG	151
ANTI SEIZE LOCTITE SILVER GR	CONTENANT 1LB	26
ANTI-STATIC/FOG BOTTLE CLEANER	MAGIC 225ML	36
ARC AIR TORCH	EXTREME K4000	4
ARC AIR TORCH 1000A	W/10' CABLE CSK4000W	9
ARCAIR SLICE ROD	1/4" X 22" LONG 100/PACK	2
ARCAIR SLICE ROD	3/8" X 18" LONG 50/PACK	2
ARCTIC GREEN LOW TEMP WET CHEM	FOR HVY EQUIP FIRE SUPPRESSION	15
ARDEE 100 ROCK DRILL OIL	20LT	201
ARDEE 32 ROCK DRILL OIL	20LT	1301
ARDEE 32 ROCK DRILL OIL	205LT DRUM	7
ARENA SILICA	MALLA 2030 INDUSTRIAL 25KG/BAG	0
ARGON	SIZE T CYLINDERS	118
ARSENIC EDL		2
ARSENIC STANDARD	1000PPM 500ML	4
ASSIST 1AL1 LIQUID ALKALI	18.9LT	107
ATF D3M	1040LT	1
AU LUMINA HCL		1
BACKING COMPOUND	MAGANESE	50
BATTERY	12V CM785	4
BATTERY	12 VOLTS	0
BATTERY	KAWASAKI MULE	12
BATTERY	12V 8DW ELECTROL F/ DM45 DRILL	2
BATTERY	CR2	6
BATTERY 12V	FOR HVY EQUIP FIRE SUPPRES	6
BATTERY ACID NEUTRALIZER		22
BATTERY ENERGIZER	6V	3
BATTERY ENERGIZER INDUSTRIAL	ALKALINE AAA 4/PK	2185
BATTERY ENERGIZER INDUSTRIAL	AA 4/PK	2554
BATTERY ENERGIZER INDUSTRIAL	C	39
BATTERY ENERGIZER INDUSTRIAL	ALKALINE D	572
BATTERY ENERGIZER INDUSTRIAL	9V	453

BATTERY INTERNATIONAL	LUBE AND SERVICE TRK	12
BATTERY LI-ION CP200	2250MA CAPACITY	13
BATTERY MOTORCRAFT	12V 850A	31
BLUESHIELD WIRE LA-S6.35	20KG ROLL	10
BODY PRIMER	F/ URATHANE WINDOW&WINDSHIELD	1
BONE ASH	20 MESH	27
BRAKE CLEANER	KLEEN-FLO 20LT	82
BRAKE CLEANER	12/CS	766
BRAKE FLUID DOT-3	1LT	32
BRP MINERAL OIL	946ML 2 STROKE	265
BUFFER SOLUTION PH 10	4L	3
BUFFER SOLUTION PH 4	4L	3
BUFFER SOLUTION PH12	R1300 (4 LITRES)	0
BUFFER SOLUTION PH7	4/CASE	2
BUG SPRAY DEEP WOOD OFF	100ML PUMP BTL	278
BURNING RODS LENCO	10' 6" 5/8ID 11/16OD	100
BUTANE FUEL	70ML	14
C25 ARGOSHIELD	SIZE T CYLINDERS	99
CALCIUM CHLORIDE LIQUID	29.6% 1000L/DM	1587
CALCIUM CHLORIDE LIQUID	29.6% 1200L/DM	303
CARBON DIOXIDE	SIZE T CYLINDERS	0
CAT DEO MONOGRADE 40 OIL	1200 LITERS/TOTE	93
CAT DEO MONOGRADE 40 OIL	205 LITERS DRUM	6
CATIONIC POLYMER	25KG HYDREX 3613	25
CAUSTIC SODA ANHYDRE	1000KG MICROPEARL	321
CAUSTIC SODA MICROPEARL	25KG/BG	1137
CAUSTIC ULTRATAK GREASE	CARTRIDGES	4
CELLULOSE		30
CHASSIS LUBRIFIANT	2KG CASTROL	2
CHIP CMS HYDROCYANIC ACID	2 - 50 PPM	10
CHOKE AND CARB CLEANER	KLEEN-FLO	37
CLEANER BATTERY MAINTENANCE	AERO 312GM	78
CLEANER CARBURATOR/CHOKE		9
COAGULANT ALUMINIUM HYDROXYDE	1000KG HYDREX 352 PASS-10S	123
COLORED FLEECE RAGS	20LB	314
COMPRESSOR OIL SYNTHETIC	COMPRO XL-S 32 205LT	23
COMPRO SYNTHETIC	205LT/DM	14
COOLANT CVC-7-A	1040LT TOTE YELLOW	1
COOLANT SAMPLE KIT		114
COOLANT TREATMENT		2
COPPER OXIDE		16
COPPER SULPHATE	PENTAHYDRATE MINE GRADE	447
COUPLER QUICK		34
CPVC GLUE	W/ BRUSH 500ML	7
CULTURE TUBE DISPOSABLE	BOROSILICATE16MMX150MM 1000/BX	196
CVC-7-A YELLOW COOLANT	3.78LT	50
DEB DEBBA PROTECTIVE CREAM	# 233 8 X 800ML	31
DEB NATURELL HAIR/BODY	# 266 4 X 4LT	166
DEB NATURELL SUNFLOWER	# 256	145
DEFLECT PRO SUN SCREEN	140ML	1174
DE-ICER LOCK POCKET SIZE	35ML	47
DIELECTRIC GREASE		7
DIESEL ADDITIVE	9.8L	145
DIESEL MELT	ANTI-GELLING TREATMENT	34
DIFERENCIEL LOCK ADDITIVE SEAL		6

DISSOLVED OXYGEN SERVICE KIT	HACH PORTABLE OXYGEN METER	6
DIXON LUBRICATOR	3/4"	3
DOW CORNING GREASE # 111 TUBE	HVY EQUIP FIRE SUPPRES	7
DPD FREE CHLORINE HACH	10ML SAMPLE REAGENT 100/PK	7
DRILL CARE MOTOR OIL	QT FOR DM45 DRILL	7
DRILL STEEL GREASE	KOPPER KOTE 10LT	76
DURADRIVE MV SYNTHETIC ATF	20LT PAIL	10
DURATRAN SYNTHETIC	205 LITERS DRUM	5
DURON E 15W40	1040LT IBC	80
DURON E SYN 0W40	1040LT IBC	27
DURON E SYNTHETIC 5W-40	4L	32
DURON SYNTHETIC 15W40	205LT	1
DURON XL 0W30	1040LT IBC	88
DUST BAN	20KG	95
DUST CONTROL NALCO	8882.61 1183KG TOTE	92
DYNALENE EG 60 A-RED	ETHYLENE GLYCOL (1078KG/TOTE)	15
ECOTRACTION	1 TON BULK TOTE IBC	15
EDGE DETERGENT	18.9LT	108
ELECTRODE	600-800-900	60
ELECTRODE CLEANING SOLUTION	HANNA INSTR.TESTER 230ML BTL	12
ENDURATEX EP150	205L/DM	86
ENDURATEX EP220	205LT/DRUM	30
ENDURATEX EP220	1040LB IBC	10
ENDURATEX EP320	205LT/DM	4
ENDURATEX EP460	205LT/DM	7
ENDURATEX EP68	205LT/DM	29
ENDURATEX SYN EP150	205LT/DM	3
ENDURATEX SYN EP220	205LT/DM	34
ENDURATEX SYN EP320	205L/DM	10
ENDURATEX XL SYN BLEND 68/220	205LT	7
ESAB WELDING WIRE	0.045 (15 Kg/ROLL)	50
ESAB WELDING WIRE	0.062 (15 Kg/ROLL)	82
ESSO XDO 60	1100L/TOTE	0
EXTENDED LIFE COOLANT -52	1040LT	123
EXTERIOR SEALANT MULCO	300ML BLUE SCOTIA	47
EXTERIOR SEALANT MULCO	300ML CLEAR	48
FLOCULANT	25KG/BG 85016	1
FUNNEL	DYNALINE	9
GASKET ELIMINATOR 515	50ML SMALL TUBE	16
GASKET MAKER HI-TEMP	80ML RED	5
GASKET SEALANT IN TUBE		94
GEAR CHAIN & CABLE LUBRICANT	LOCTITE 12 OZ. AEROSOL	26
GEARGUARD	180KG/DRUM	4
GENERAL PURPOSE THINNER	GALLON	59
GLUE STICK	20G	23
GLUE STICK ENIUM	40G	7
GLYCEROL (VERLUBE)	4LT/CONTAINER	1
GOLD SOLUTION STD	1000PPM	5
GREASE EP.	NLGI CHEVRON 6134 300GR	12
GREASE EP-1	IN TUBE ULTRA DUTY	58
GREASE FOR COUPLING	PEERLESS XCG FLEX GREASE	90
GREASE TUBE	TRAMAC	0
GREASE TUBE KIT	GRACO FIREBALL 425 50:1	8
HAND CLEANER GRIME EATER	3.5LT	7
HARD FACING ELECTRODE	3/16" 20KG/CS	0

HELISTAR CS GAS		30
HELIUM	SIZE T CYLINDERS	28
HIGH PRESSURE NITROGEN	SIZE T CYLINDERS	25
HIGH TEMPERATURE CONTROLLER		1
HIGH VACUUM GREASE		4
HYD ARCTIC OIL	FOR DM45	2
HYDRAULIC COOLER	THERMAL TRANSFER	1
HYDREX AW 46	HYDRAULIC OIL 20LT/PAIL	6
HYDREX EXTREME HYDRAULIC OIL	205LT	10
HYDREX MV ARCTIC 15	205LT	24
HYDREX MV22	20LT/PAIL	40
HYDREX MV36	20LT/PAIL	40
HYDREX MV60	20LT/PAIL	32
HYDREX XV ALL SEASON	1040LT IBC	0
HYDROCHLORIC ACID	240KG 20BE 32%	396
HYDROCHLORIC ACID REAGENT GRAD	2.5LT 4/CS	52
ICE FREE AIR TOOL OIL	1LT WHEEL & ACCESSORIES	0
INO FOAM SOAP	6 X 1LT	160
INT/EXT BLUE PAINT	AGNICO DEVOE	17
IRON ACCELERATOR		89
J-512 FINAL STEP/SANITIZER	4 X 1.89LB BY CS	15
JAVELISANT DIBAC	20LT	12
JERRYCAN GAS	20LT	30
KEEN-FLO	BRAKE & PARTS CLEANER 4LT	20
KIDDY APC WET CHEMICAL AGENT	MODEL # WHDR-125	2
KIDDY APC WET CHEMICAL AGENT	MODEL # : WHDR-600	2
KVS	20G/PKG	2
LAUNCH 6GL2 LIQUID SOUR	18.9LT	28
LEAD BULLION MOLD	1000 OZ	20
LEAD NITRATE	25KG 99% MIN	2730
LEAD NITRATE	1000 KG	138
LEPAGE BLUE CONTACT CEMENT	3.8L	0
LITHARGE GOLD FREE	25KG	2
LOCTITE 290	50ML GREEN	4
LOCTITE 510 GASKET ELIMINATOR	50ML	12
LOCTITE SUPER GLUE	SUPER GLUE 495	69
LOCTITE THREADLOCKER 242 BLUE	REMOVABLE BOT 250ML	7
LOW COOLANT SEN		2
LUBRICANT	5 GALLON	2
LUBRICANT OIL WD 40	AEROSOL	2
LUBRICANT OIL WD40	4LT	24
LUBRICANT SUPER PENETRATING	PL-100 350G 12/CS	20
LYSOL TOILET CLEANER	710ML	1
MAGIC BOND EPOXY STICK		6
MAGLITE RECHARGEABLE BATTERY		10
MERCON SP TRANSMISSION OIL	1 LITER CONTENANT	2070
METABISULFITE	97% W	1046
METABISULFITE	97% W 907.19KG	389
METABISULFITE	97% W 1200KG/BAG	51
METABISULFITE	97% W 1360KG/BAG	80
MILL PERSE 813	SCALE CONTROL 200LT	0
MILL PERSE 813	SCALE CONTROL 1000LT TOTE	34
MOBILE SHC 10/24	20LT COMPRESSOR OIL	4
MOBILITH	GREASE SHC100	10
MOBILTAC 325NC	205L/DM	1

MOBILTAC 375 NC	17.2KG PAILS	24
NEW FLUX	491KG BATCH (26 PAILS/18.8846)	34074.85
NICKEL ANTI-SEIZE	1LB. CAN	13
NITRIC ACID 67%	193LT/DM	467
NITRIC ACID REAGENT GRADE	2.5LT 4/CS	23
NITRO CARTRIDGE	FOR HVY EQUIP FIRE SUPPRESSION	14
NITROGEN PILOT CYLINDER KIT	FOR HVY EQUIP FIRE SUPPRESSION	4
NITROGEN PP4.8	SIZE T CYLINDERS	25
NU-ACTION-3	4LT	76
NU-BIO SCRUB	4LT	55
NU-KLEENSMELL	4LT	20
NU-TRAP	20LT	14
OIL ADDITIVE	301-A	20
OIL COOLER	COOLER	4
OIL COOLER		0
OIL COOLER		2
OIL F/ CHAIN LIGHT	WINTER -40°C RESISTANT	20
OIL MOTOR DRILL CARE	20 LITER	2
OIL RALUBE 40	1040 LITER TOTE IBC	40
OXYGEN	SIZE K CYLINDERS	286
OXYGEN CGA540	SIZE D CYLINDERS	10
OXYGEN LABORATORY GRADE	HYDROCARBON FREE SIZE K	67
PAINT	1GAL BRIGHT YELLOW	25
PAINT AERVOE INVERTED	ORANGE GLO 12CN/BX	158
PAINT AERVOE INVERTED	GREEN GLO 12 CAN/BX	78
PAINT BRUSH	2 1/2"	196
PAINT BRUSH ANGLE	2 1/2"	100
PAINT DEVOE	1GAL SAFETY BLUE H19	54
PAINT DEVOE	1GAL SAFETY YELLOW EPOXY	13
PAINT DEVOE RUST-OLEUM	1GAL SILVER GRAY	47
PAINT EXTERIOR LATEX	1GAL SAFETY BLUE	22
PAINT GREY	ATLAS-COPCO	15
PAINT PIZZAZZ ENAMEL ALKYD	1GAL SATURN YELLOW	2
PAINT RUST-OLEUM	14OZ FLUO GREEN	64
PAINT RUST-OLEUM	14OZ FLUO ORANGE	241
PAINT YELLOW	ATLAS-COPCO	12
PC ATF D3M	205LT/DM	5
PEERLESS LLG GREASE	TUBE	140
PEKOE THE VRAC	(1000/BX)	99
PERMATEX ORING&RUBBER ADHESIVE		11
PETROSOL 3139	205LT	1
PH 4.01 SOLUTION	HANNA INSTRUMENT PH TESTER	5
PH 7.01 SOLUTION	HANNA INSTRUMENT PH TESTER	6
PINE-SOL	443ML	0
POTASSIUM NITRATE	FA209A	0
PRECISION SYNTHETIC EMB	TUBE	90
PRECISION SYNTHETIC GREASE	TUBE	270
PRECISION XL EMB GREASE	TUBE	179
PRECISION XL EP2 GREASE	TUBE	782
PRECISION XL EP2 GREASE DRUM		15
PREMIX FLUX 66PB026SODA4.5	ORANGE 19KG/PAIL	0
PRIMARY OIL BURNER		1
PRODURO OIL FD-1 60	1100/TOTES	8
PRODURO TO -4+ SYNTH	ALL SEASON 205L	25
PRODURO TO-4 30 S	205LT/DRUM	9

PRODURO TO-4 SYN ALL SEASON	1040LT IBC	43
PRODURO TO-4 XL SYN LO-TEMP	1040LT	20
PROLEACH KG		10
PROLITE MOP STICK 54	#AG-1674	17
PROPANE FUEL TANK	16.9OZ	133
PVC GLUE W/ BRUSH	711 WELD*ON 946ML	16
PVC PRIMER WITH BRUSH	P70 500ML	2
QUICK LIME	1700KG 0-2 5MM 1152	2768
REAGENT TUBE	280 X 32MM F/ CHS500	2
REAGENT TUBE		1
REAGENT TUBE		1
RUBBER CLEANER RUB-O-MATIC	1 LITER	119
SAND FOR SANDBLAST JETMAG	GRIT 30-60 25KG OLIVINE	316
SILICA SAND	SILICA SAND 22.7KG	177
SILICON FOOD GRADE GREASE	4 OZ FOR AMP SERIES PUMPS	0
SILICONE LUBRICANT		11
SILVER ELECTRODE	M2.4 3/32" .5KG/TUBE	1
SILVER FOIL	1 ONCE 99.999% PURE	52
SILVER NITRATE	500GRAM	3
SODA ASH NA2CO3	25KG MR118	11
SODIUM CYANIDE	PELLETS 1000KG	1677
SODIUM HYDROXIDE	SCRUBBER FILL	8
SODIUM HYPOCHLORITE	20/LITERS	52
SODIUM NITRATE	22.27KG 98% INDUSTRIAL GRADE	226
SOLVENT VARSOL	PLASTIC BOTTLE 3.78LT	68
SPRAY SPATTER BLOCK	W/TRIGGER 500ML	10
STOKOLAN HAND CREAM		35
SULPHUR PRILLS	99.5% 1000KG	4497
SUPER 3000 MORTAR		4
SUPER 77 SPRAY ADHESIVE		0
SUPER 90 ABC DRY CHEMICAL	PAIL FOR HVY EQUIP FIRE SUPPRE	30
SUPER DUTY MOTOR OIL	4LT	18
SUPER FLUID KLAR PILOT		199
SWIVEL CASTERS WHEEL	8"	8
SYNDURO SHB150	205LT/DM	59
SYNDURO SHB32	20LT/BUCKET	262
SYNDURO SHB32 SYNT.	COMPRESSOR OIL 205L/DRUM	14
SYNDURO SHB460		2
SYNTETHIC SHB 68	205LT-45GAL	7
SYNTEX FAN MOP HEAD	20OZ 550G	70
SYNTHETIC 75W140	1040LT/TOTE	2
THREAD SEALANT	W/ PTFE	17
THREAD SEALANT W/TEFLON	PERMATEX 118ML	56
THREADLOCKER	36ML GREEN	4
THREADLOCKER 272 HIGH-TEMP	LOCTITE 250ML	2
TRANSFORMER OIL	VOLTESSO 205LT	1
TRAXON E SYN 80W140	1040LT/DRUM	3
TRAXON E SYN CD50	205LT/DRUM	8
TRAXON ENGRENAGE	20LT 85W140	1
TRAXON XL 75W90	205LT/DRUM	2
TRAXON XL SYNTH BLEND 75W90	60L	5
TUNGSTEN ACCELERATOR		15
TURBOFLO R&068	20LT PAIL	1
TURBOFLO R&O 100 OIL	20L PAIL	8
TWO CYCLE ENGINE OIL		12

ULTIMA EP150	205LT	2
ULTRA CLEAR PREMIUM OIL LAMP		3
URATHANE BRUSH	F/ URETHANE WINDOW&WINDSHIELD	33
URETHANE DUR-X-LINE MATERIEL	780001277 WRM-80T 1KG KIT	15
URETHANE DUR-X-LINE MATERIEL	780001276 WRM-80T 4KG KIT	5
URETHANE SEALANT IN TUBE		275
VALVE LUBRICANT AND SEALANT	400GR	40
VARSOL	PARTS CLEANER 45GAL/DM	8
VICTAULIC LUBRICANT	ONE QUART	0
VULTREX G-124 GREASE	TUBE	59
VULTREX GEARSHIELD NC	205 LITERS	120
VULTREX OGL SYNTHETIC	ALL SEASONS 54KG KEG	1
VULTREX OGL SYNTHETIC GREASE	ALL SEASON 680, 54KG	70
WELDING ELECTRODE BRONZE	3.2MM 1/8 SODEL 661 5KG/BX	5
WELDING ELECTRODE MG	1/8" 5KG/BX	2
WELDING ELECTRODE MG	3/32" 2.5KG/BX	2
WELDING ELECTRODE TRACTALOY	M2.4 3/32" 5KG/BX	2
WELDING FACE SHIELD		15
WELDING ROD	STUD-XTRACT SOUDOTEC 5KG/BX	2
WELDING ROD	0.156" NON FERROUS	12
WELDING ROD	3/32" 10.20KG/BOX 624P-3	5
WELDING ROD	1/8" 12.90KG/BX 624P-309	14
WELDING ROD	5/32" 12.90KG/BX 624P-309	7
WELDING ROD	3/32" 10KG/BX LA-11018	6
WELDING ROD	1/8" 20KG/BX LA-11018-M	5
WELDING ROD	5/32" 20KG/BOX LA-11018-M	5
WELDING ROD	3/32" 10KG/BX LA6010	14
WELDING ROD	1/8" 20KG/BX LA6010	14
WELDING ROD	3/32" 10KG/BX LA7018	8
WELDING ROD	1/8" 20KG/BX LA7018	25
WELDING ROD	5/32" 20KG/BX LA7018	24
WELDING ROD 1/4	6 X 450MM 19.5KG/CS	1
WELDING ROD 5/32	4 X 450MM 18.6KG/CS	1
WELDING ROD ALU LITE	3/32 2.5KG/BX	10
WELDING ROD ALU LITE	1/8 2.5 KG/BX	10
WELDING ROD CARBON ARC DCCC	1/8" X 12" 100/BX	15
WELDING ROD CARBON ARC DCCC	3/16" X 12" 50/BX	41
WELDING ROD CARBON ARC DCCC	1/4" X 12" 50/BX	22
WELDING ROD CARBON ARC DCCC	5/16" X 12" 50/BX	71
WELDING ROD CARBON ARC DCCC	3/8" X 12" 50/BX	98
WELDING ROD CARBON ARC DCCC	1/2" X 14" 50/BX	28
WELDING ROD FLAT DCCC	3/8" X 5/32" X 12" 50/BX	20
WELDING ROD FLAT DCCC	5/8" X 3/16" X 12" 50/BX	18
WELDING ROD HARD 58	1/8" 5KG/BX	6
WELDING ROD HARD 58	5/32" 5KG/BX	14
WELDING ROD STEEL ALLOY	1/8" (3.2mm) 5 KG/BOX	5
WELDING ROD TRI-CAST	3/32 5KG/BX	9
WELDING ROD TRI-CAST	1/8 5KG/BX	10
WELDING ROD XTREME	1/16 0.5KG/BX	11
WELDING ROD XTREME	3/32" 5KG/BX	7
WELDING ROD XTREME	1/8" 5KG/BX	7
WELDING WIRE LA 111 T1-K3M	1/16 FLUX CORE 15KG SPOOL	68
WELDING WIRE LA T-91	.045 CARBON STEEL 15KG SPOOL	155
WELDING WIRE LA T-91	1/16 CARBON STEEL 15KG SPOOL	215
WELDING WIRE OUTERSHIELD	0.045 33LBS	52

WELDING WIRE OUTERSHIELD	0.062 33LBS-	0
WET WASHING SIEVE 200 MESH		2
WHITE GREASE	KLEEN FLOW 225G/TUBE	51
WINDEX	765ML	437
WINDOW PRIMER	F/ URETHANE WINDOW&WINDSHIELD	6
WINDSHIELD GLUE TREMSHIELD		44
WINDSHIELD WASHER CONCENTRATE	SOLUTION 1000LT TOTE	54
WINDSOCK (ORANGE/WHITE)	AVIOATION STANDARD 36" x 12'	6
WIRE OPEN ARC	110-O 1/16 33LB WB	15
XL3 MOLY ARCTIC GREASE	54KG/KEG	636
ZEP LIQUID BOTTLE WASHER	X-2887 20LT/PAIL	4

Appendix C

Cyanide

Cyanide – Properties, Uses, Storage & Handling (Dupont) C.1

Material Safety Data Sheets – Sodium Cyanide C.**2**

C.1 Cyanide – Properties, Uses, Storage & Handling (Dupont)

Sodium Cyanide

PROPERTIES, USES, STORAGE, AND HANDLING

DUPONT CHEMICAL SOLUTIONS ENTERPRISE

DUPONT

The miracles of science™

Notice:

Sodium cyanide may be fatal if swallowed, inhaled, or with prolonged skin contact. Contact with acids, water, or weak alkalies liberates poisonous gas. Causes eye burns and may irritate skin. See "Personal Safety and First Aid." See DuPont's Sodium Cyanide Material Safety Data Sheet (MSDS) for more detailed safety and health information.

For Emergency Assistance, Call DuPont at

(901) 357-1546

(This is a transportation emergency Cyanide Hotline to our Memphis, TN plant.
Do not use for routine technical or commercial information.)

For Transportation Emergencies,

Call DuPont at (901) 357-1546, Then Call

CHEMTREC at (800) 424-9300

(See "Transportation Emergencies")

For commercial or technical information, call your DuPont marketing representative or a sales office listed on the back cover.

Sodium Cyanide: UN 1689

DO NOT USE AS A PESTICIDE.

See DuPont's MSDS for detailed instructions for treatment of cyanide poisoning.

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Product Information

Introduction

DuPont sodium cyanide (NaCN) is a white crystalline solid, available in a briquette or granular form. The briquettes are uniform in size, average 18 g (about ⅔ oz) in weight, and have overall dimensions of approximately 3.5 × 3.5 × 1.3 cm (1⅜ × 1⅜ × ½ in). They are resistant to breakage and dusting, easy to scoop up, and readily soluble in water. The granules are irregularly shaped particles, typically sized to generate a minimum of dust, and pass 90–100% through a ⅜-in screen and 3% maximum through a USS Sieve No. 50. Cyanobrik® and Cyanogran® are DuPont trade names (see **Figures 1** and **2**).

The Chemical Abstract Service Registry Number for NaCN is 143-33-9.

Table 1. Physical Properties of Sodium Cyanide

Formula Weight	49.007
Melting Point, °C (°F)	564 (1047)
Boiling Point, °C (°F)	1496 (2725)
Specific Gravity, Solid, 25°C (77°F)	1.60
Apparent Bulk Density, Solid, kg/m³ (lb/ft³)	880–960 (55–60)
Specific Gravity, Liquid, 850°C (1560°F)	1.19
Heat of Formation, ΔH° *f*	
25°C, cal/g	–438
25°C, kJ/kg	–1833
77°F, Btu/lb	–788
Specific Heat, 26–73°C (78–163°F)	
Btu/lb·°F or cal/g·°C	0.335
kJ/kg·K	1.402
Heat of Fusion, mp, Btu/lb	77
cal/g	43
kJ/kg	179
Heat of Vaporization, bp, Btu/lb	1309
cal/g	727
kJ/kg	3041
Vapor Pressure, mmHg	
800°C (1470°F)	0.76
1200°C (2190°F)	89.8
1360°C (2480°F)	314.0
Solubility in Water, g NaCN/100 g water	
(see **Figure 3**), –20°C (–4°F)	35.4
20°C (68°F)	58.3

Table 2. Specifications and Typical Analysis

	Cyanobrik®/Cyanogran® and Bulk Solution Specifications	Typical Analysis*
Product Code 1220 (Cyanobrik®)		
Product Code 1222 (Cyanogran®)		
Sodium Cyanide, %	98.0 minimum	99
Sodium Hydroxide, %	0.5 maximum 0.06 minimum	0.3**
Product Code 1254 (Mining Grade)		
Sodium Cyanide, %	96.0 minimum	98
Sodium Hydroxide, %	0.5 maximum 0.06 minimum	0.3**
Product Code 1249 (30% Solution)		
Sodium Cyanide, %	28 minimum	30
Sodium Hydroxide, %	0.5 minimum	1

* Typical analyses based on historical production performance. DuPont does not make any express or implied warranty that future production will demonstrate or continue to possess these analyses.

** **CAUTION:** Sodium hydroxide (NaOH) content can be below 0.1% versus 0.3%, typical. NaOH should be added as outlined on page 3 to suppress hydrogen cyanide formation when making a water solution.

Figure 1. Cyanobrik®

Figure 2. Cyanogran®

Uses and Applications

The mining, metal, and chemical industries are the principal consumers of sodium cyanide. Typical uses include:

Ore Extraction and Ore Flotation

The cyanide process for extracting gold and silver from low-grade ores uses aqueous solutions of sodium cyanide with oxygen (air) to convert the noble metal (M) to soluble $NaM(CN)_2$, from which M can be recovered either by precipitation with zinc dust or aluminum powder, carbon absorption, or electrowinning.

In the flotation of galena (lead sulfide) to separate it from mixed ores containing sphalerite (zinc sulfide) and pyrite (iron sulfide), sodium cyanide acts as a depressor; that is, it reduces the tendency of gangue materials to travel along on the froth and so impair the separation. Sodium cyanide finds similar use in the separation of pentlandite from pyrrhotite and molybdenite from copper concentrates by flotation. It is also used to purify the molybdenite by extraction of copper impurities.

Electroplating

Cyanide brass, cadmium, copper, gold, silver, and zinc baths deposit decorative and/or functional metal coatings on a variety of substrates. The good throwing power of the electrolyte causes relatively uniform deposition of the metal on intricately shaped parts. Small amounts of special additives in the baths give bright metal deposits, even on recessed surfaces of the work. Cyanide electroplating baths are versatile and capable of high production rates, whether plating large or small parts.

Case Hardening Steel

Molten salt baths containing 10–30% sodium cyanide find extensive use for case hardening steels at temperatures below 870°C (1600°F). The molten bath process is fast, easy to operate, and yields mixed carbon-nitrogen cases that have excellent wear resistance and uniformity. The addition of activators or accelerators to the bath results in deeper cases than those obtained with plain cyanide baths, but nitrogen pickup is usually less.

The life of keen-edged tools improves when the high-speed steel is cyanide-nitrided in molten cyanide baths at about 565°C (1050°F).

Metal Cleaning

Aqueous solutions of sodium cyanide are effective metal cleaners, especially for smut removal after acid pickling.

Chemical Manufacture

Sodium cyanide is used to make other chemicals that lead to such diverse products as pharmaceuticals, vitamins, animal food supplements, dyes and pigments, insecticides, sequestrants, polymers, and catalysts (see "Chemical Reactions" section).

In any synthesis or formulation involving sodium cyanide, no cyanide compound should survive in the final product as an impurity. This is especially important with regard to consumer products.

Chemical Reactions

The most hazardous reaction of sodium cyanide is with acids to form lethal hydrogen cyanide (HCN) gas, which is invisible and has a very weak odor. Smaller amounts of HCN gas can develop from contact with water and weak alkalies. When working with sodium cyanide, special provisions are needed to address HCN and cyanide toxicity.

Sodium cyanide deliquesces in moist air. Crystals of the dihydrate, $NaCN{\cdot}2H_2O$, form when saturated solutions of sodium cyanide cool at temperatures below 35°C (95°F) (see **Figure 3**). Sodium cyanide dissolves in methanol (6.05 g/100 mL saturated solution at 15°C [59°F]). It also dissolves in liquid ammonia (3.7 g/100 mL NH_3 at –33°C [–27°F]).

Sodium Cyanide Reactions in Water

Sodium cyanide dissolved in water forms an equilibrium between ionized sodium cyanide and highly volatile HCN. In sodium cyanide solutions, HCN concentrations must be kept low and/or contained to avoid toxic fumes. HCN formation varies with pH, cyanide concentration, and temperature. HCN in the air around a sodium cyanide solution will also be influenced by the amount of solution surface area and ventilation. At pH 8 or less, essentially all of the cyanide will be in the HCN form in dilute solutions (see **Figure 5**). To suppress HCN formation in typical concentrated sodium cyanide make-up solutions, a pH of 12 minimum (preferably 12.5–13) should normally be used. In operating tanks, HCN in the vapor space above a 23% solution at room temperature typically will be about 250 ppm (without pH adjustment). With the pH raised to 12–12.5, HCN levels drop to around 125 ppm and below 50 ppm, around pH 13. Higher temperatures and solution concentrations increase HCN fumes. The following recommendation is made to minimize HCN formation with a modest pH increase.

When making a concentrated (e.g., 10–30%) cyanide solution, the proper procedure is to add about 0.5% sodium hydroxide (caustic) (about 50 lb [22.7 kg] sodium hydroxide/1000 gal [3785 L] water) before adding the cyanide. More sodium hydroxide will not be chemically harmful to the cyanide and will further reduce HCN levels; however, increased alkalinity increases eye hazards from splashes. For most operations, pH 12.5–13.0 is a good compromise to reduce HCN without excessively high alkalinity. If process chemistry prevents adding caustic, adequate precautions in design and operation must be taken to protect against HCN fumes, HCN polymerization, and cyanide hydrolysis.

pH is a log scale measurement, which means it takes about ten times as much sodium hydroxide to raise the pH each subsequent unit than the previous. For example, if it took 1 lb (0.45 kg) of sodium hydroxide to go from pH 9 to 10, it would take 10 lb (4.5 kg) to raise the pH from 10 to 11 and 100 lb (45.4 kg) from 11 to 12, etc. Therefore, even pH 11 water will need

Figure 3. Solubility of Sodium Cyanide in Water

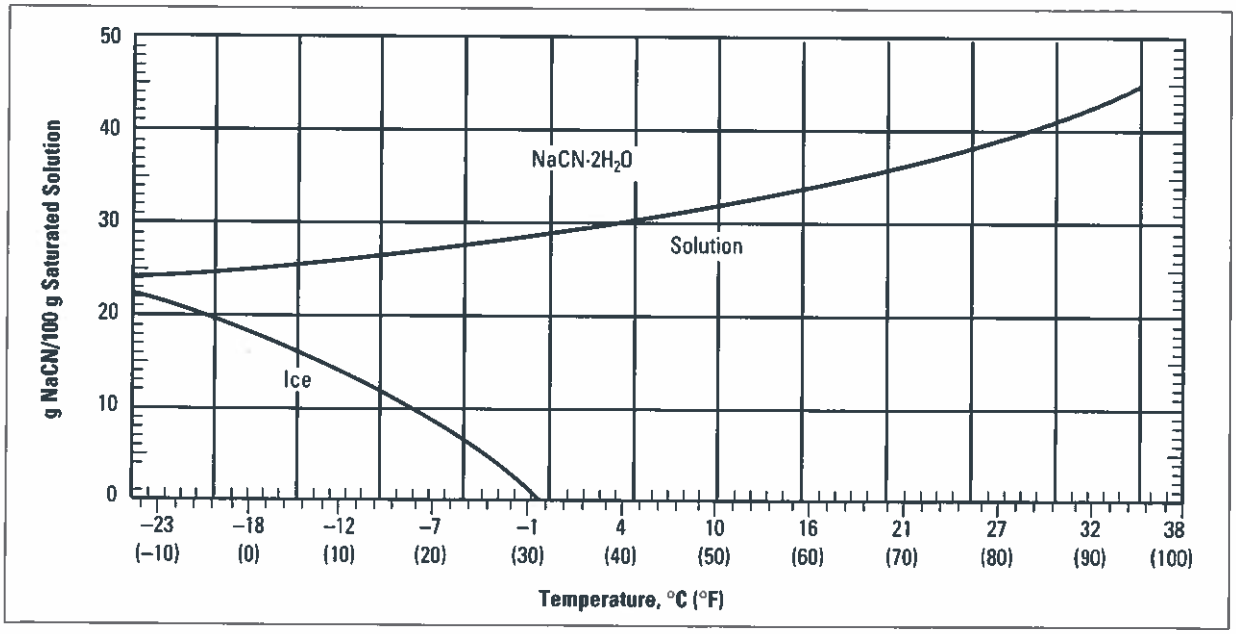


Figure 4. Densities of NaCN Solutions

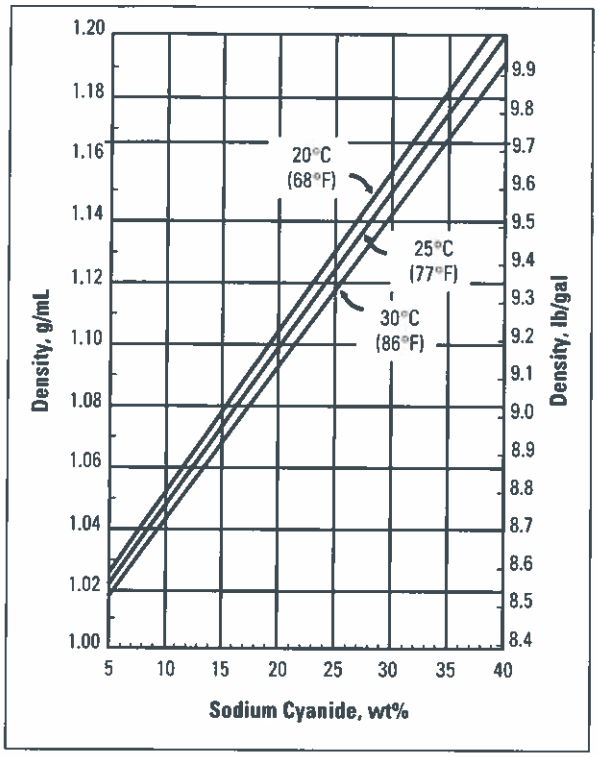
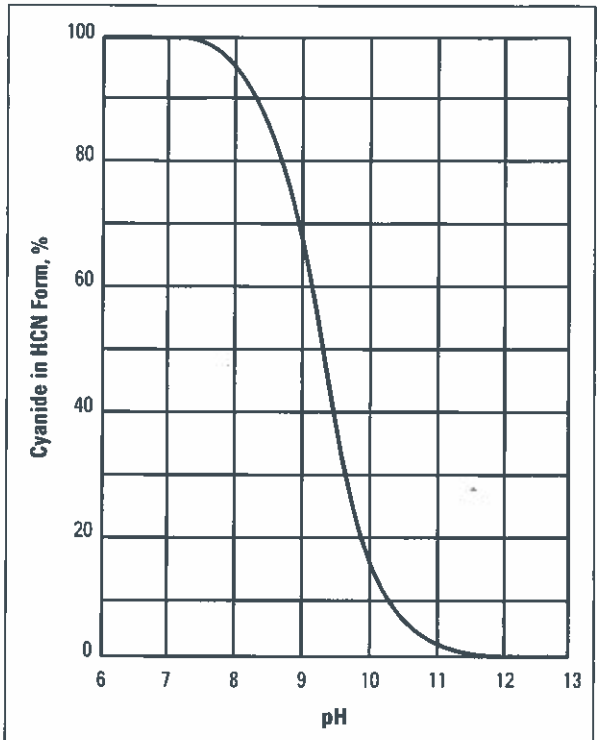


Figure 5. Effect of pH on Cyanide Ionization



Data based on work by D. Milne, 1950, for dilute sodium cyanide solutions at ambient temperature. Toxic HCN fumes increase as temperature and solution concentrations increase, requiring higher pH for safe operation.

nearly as much sodium hydroxide added to it as would the same amount of water with pH 6 to 11. Water at pH 10 or 11 does not eliminate the need to add sodium hydroxide to reduce HCN.

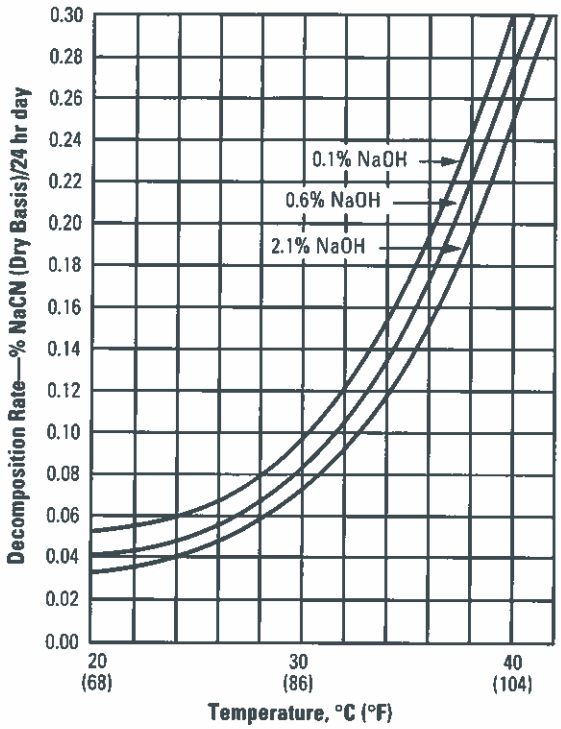
NOTE: Lime (calcium hydroxide) is not as effective as sodium hydroxide because of limited solubility, but it can be substituted to raise the pH to around 12.

Hydrogen cyanide molecules will polymerize to form the extremely inert HCN polymer. It is not unusual for HCN polymerization to occur in sodium cyanide solutions made without additional alkali, particularly if stored at elevated temperatures. In dilute solutions, HCN polymer will generate colors ranging from pale yellow to dark reddish brown. In stronger solutions, a dark brown precipitate resembling iron rust can form, which will interfere with heat transfer, plug pumps, orifices, etc., and may cause significant cyanide loss. HCN polymer will discolor chemical products. Again, high pH values give low HCN concentrations, which reduces the tendency for polymer formation.

Cyanide also reacts with water to form ammonia and formate ions. In the acid pH range, hydrolysis products are formic acid and ammonium salts. Alkaline solutions produce formate salts and volatile ammonia. With strong solutions, the volume of ammonia evolved can cause dangerous pressure buildup. One gallon of 30% sodium cyanide solution can produce more than 25 ft^3. For this reason, extra vent capacity is recommended for large, heated storage tanks.

Ordinarily, the reaction between cyanide and water proceeds slowly. However, the reaction rate increases exponentially with an increase in temperature. The critical range is around 60–70°C (140–158°F). At temperatures below this range, the reaction can be controlled by cooling and, where practical, by dilution. At higher temperatures, however, the reaction can be uncontrollable in large tanks for highly concentrated solutions and may proceed until substantially all the cyanide has been consumed, unless temperature control and adequate cooling and venting capacity exist (see **Figure 6**).

Figure 6. Decomposition Rate of NaCN Solutions



NOTE: The % NaOH shown above is the concentration in the final solution. The NaCN (as shipped–containing 0.1% NaOH), when diluted to a 30% solution, will have only 0.03% NaOH in the final solution, unless additional NaOH is added. (Decomposition rates based on DuPont experimental data using 35% NaCN solution.)

Heated sodium cyanide solution storage tanks should be equipped with facilities to measure and control solution temperature (see "Equipment" section). Heating may be needed to assist in dissolving the NaCN and to prevent freezing (see **Figures 3** and **7**). Cooling could be critically important, if the hydrolysis reaction begins to generate heat faster than it can be dissipated to the surroundings.

All the reactions discussed above consume a portion of the stored cyanide, and all are inhibited by maintaining low solution temperature and high pH.

If special precautions are taken, acidification of sodium cyanide to produce HCN gas for a chemical reaction is an acceptable procedure, but only when handled in special equipment by technically qualified people after detailed planning. HCN operations require much more stringent plans, procedures, and standards for safe operation.

CAUTION

Even in laboratory quantities, the accumulation and storage of liquid or gaseous HCN should not be considered until its properties and the required safety precautions for handling it have been studied carefully. In addition to toxicity considerations, violent exothermic polymerization reactions can occur with liquid HCN, even in the absence of air or oxygen.

Other Reactions

Oxidants, such as alkaline hypochlorite solutions, hydrogen peroxide solutions, and permanganate solutions can oxidize cyanide to sodium cyanate. These oxidation reactions find wide use in the control of cyanides in effluents. They must be done in dilute solutions at proper pH to avoid formation of highly toxic gases (see "Cyanide Destruction" section).

Strong oxidants, such as nitrites and chlorates, react violently when added to molten sodium cyanide (or vice versa).

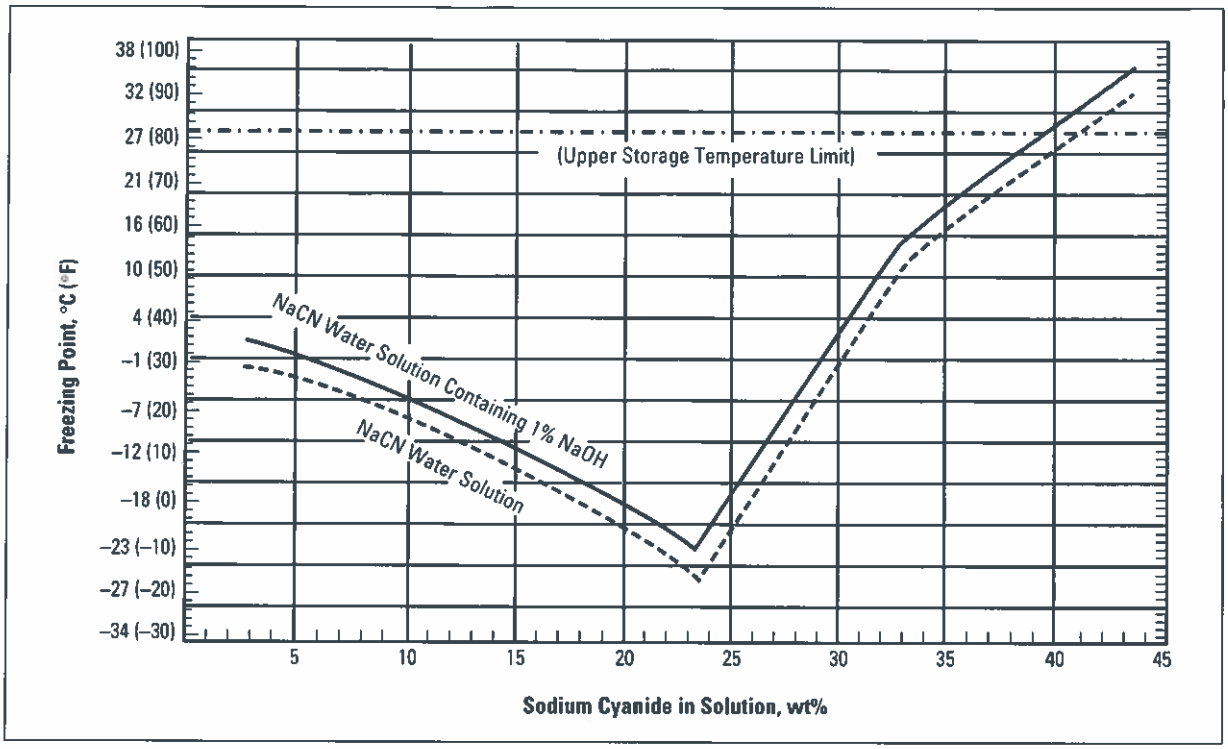
With the exception of lead and platinum, most metals (when finely divided) dissolve in aqueous sodium cyanide in the presence of oxygen.

Alkaline solutions of sodium cyanide dissolve water-insoluble cuprous and zinc cyanide with formation of sodium tricyanocuprate and tetracyanozincate, respectively.

Reacting an alkyl halide, sulfate, or toluene-sulfonate (p-$CH_3C_6H_4SO_2OR$) with sodium cyanide in aqueous alcohol, dimethylformamide (DMF), or similar aprotic solvent, leads to an alkyl cyanide (nitrile). Fusing a sodium aryl sulfonate with sodium cyanide yields the aryl nitrile; for example, sodium benzene-sulfonate (sodium phenyl sulfonate) gives benzonitrile (phenyl cyanide).

Hydrogen cyanide, generated by reacting an acid with sodium cyanide, is capable of adding to isolated double bonds and to the carbonyl group of an aldehyde or ketone. In the case of acetophenone, for example, the corresponding cyanohydrin forms, which hydrolyzes to atrolactic acid (a-phenylacetic acid, $C_6H_5[CH_3]C[OH]COOH$). Similarly, when preparing an alpha-amino acid from an aldehyde or ketone by Strecker synthesis, the hydrogen cyanide and ammonia needed can come from ammonium cyanide formed in the reaction of sodium cyanide with ammonium chloride.

Figure 7. Freezing Points of Sodium Cyanide Solutions



One method of synthesizing the sodium salt of ethylen ediaminetetraacetic acid (tetrasodium EDTA, a chelating agent) combines ethylenediamine with formaldehyde and sodium cyanide in hot (80°C [175°F]) alkaline solution.

Personal Safety and First Aid

Health and Safety Hazards

See DuPont's MSDS for detailed instructions for treatment of cyanide poisoning.

Because of the toxicity of sodium cyanide, all persons working with it should be completely familiar with and observe the established safety practices.

Sodium cyanide is a fast-acting poison that can cause death quickly at low levels of exposure. Its toxic effect results from the inhibition of specific processes in body cells by restricting oxygen use in cellular respiration, particularly cells in the brain and heart. Poisoning can result from breathing cyanide gas, dust, or solution; absorption through the skin, particularly the eyes and other membranes and feet; and from ingestion. Contact with the skin may cause irritation and poisoning, particularly with prolonged contact, or if open wounds, skin abrasions, or mucous membranes are involved. Sodium cyanide is alkaline and causes eye burns. Because of the possibility of skin absorption of hydrogen cyanide fumes, air monitoring for HCN is required, even for someone wearing an air mask.

Cyanide is not a cumulative poison, and it is not a carcinogen. It is believed that there are no chronic effects of cyanide poisoning, unless repeated, prolonged exposures, well above the established limits, were to occur. With prompt treatment, recovery from overexposure is normally quick and complete.

CAUTION

Sodium cyanide in contact with acids liberates highly toxic and flammable hydrocyanic acid gas. Also, toxic amounts of HCN can be liberated from water solutions of sodium cyanide or from contact with weak alkalies, if ventilation is inadequate (see "Sodium Cyanide Reactions in Water").

Safety Precautions

The basic safety precautions are:

- Do not breathe sodium cyanide dust, solution mist, or HCN gas. Wear an approved toxic dust and mist respirator when there is danger of inhaling cyanide dust or mist. Additional protection is required for HCN gas. The respirator should be one approved by the Mine Safety and Health Administration (MSHA) or by the National Institute for Occupational Safety and Health (NIOSH).
- Avoid skin contact with cyanides, particularly contact with open wounds or skin abrasions. Wash skin promptly and thoroughly if contact occurs. Wear protective gloves when handling solid cyanides. Wear rubber gloves when handling cyanide solutions (butyl rubber has very low permeability; neoprene is more rugged with low HCN permeability and is best for many jobs involving sodium cyanide).
- Do not get in eyes. Wear approved chemical splash goggles when handling cyanide solutions and when there is danger of splashing.
- Have available and wear other protective clothing as needed for job safety. Develop clothing change procedures to ensure cyanide is not scattered around the site or inadvertently carried home.
- Immediately sweep up any spilled cyanide and place in a suitable container. Wash area and/or treat contaminated area with dilute hypochlorite solution to destroy the cyanide. Comply with federal, state, or local regulations. If approved, drain to neutral chemical waste sewer.
- Take every precaution to keep acids from contacting sodium cyanide. Do not store with acids or weak alkalies.
- Do not eat, drink, or smoke in areas where cyanide is present. Do not handle or store food or beverages in cyanide areas.
- Store sodium cyanide in a ventilated, locked area. Containers should be kept closed and their contents dry. Do not store under sprinklers; sodium cyanide will not burn, but sprinkler activation could cause an environmental problem. Local fire regulations may require sprinklers. Always check and follow local regulations. If sprinkling is required, the area must be diked to contain the runoff.
- Have antidote, emergency plans, and training in place before using cyanide. See DuPont's Sodium Cyanide MSDS for detailed instructions.

Sodium Cyanide Exposure Limits

The U.S. Department of Labor (OSHA) has ruled that an employee's exposure to sodium cyanide in any 8-hr work shift of a 40-hr week shall not exceed a time-weighted average (TWA) of 5 mg of cyanide per cubic meter of air.[2,3] It also cautions that because cyanide may penetrate the skin, control of vapor or dust inhalation alone may not be sufficient to prevent absorption of an excessive dose.

HCN Exposure Limits

The current OSHA workplace exposure limit for HCN is 11 mg/m^3 (10 ppm), ***8-hr average***. A 1989 revision of the HCN limit (along with several hundred other chemicals) to 5 mg/m^3 (4.7 ppm), ***15-min average***, was vacated by court order, and the pre-1989 limit has been reinstated. OSHA (and others) also cautions that because hydrogen cyanide may penetrate the skin, control of vapor inhalation alone may not be sufficient to prevent absorption of an excessive dose.[2,3] During all of this, the U.S. Mine Safety and Health Administration (MSHA) limit stayed at 10 ppm for HCN. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a 4.7 ppm limit instantaneous ceiling value with a similar skin notation.[4] DuPont's experience supports the current OSHA and MSHA regulatory levels. However, as a matter of practice, DuPont does not have people working for prolonged periods under conditions approaching our upper limits, because we can design/operate to avoid prolonged exposure.

In summary, HCN air quality requirements will vary from jurisdiction to jurisdiction, and it is incumbent on each user to be aware of and comply with the rules regulating exposure to HCN in their regulatory jurisdiction. The specific OSHA and MSHA exposure limit for HCN is currently 11 mg/m^3 (10 ppm) for an 8-hr TWA. The ACGIH Threshold Limit Value (TLV) is 5 mg/m^3 (4.7 ppm), 15-min TWA. This is also a ceiling value. The DuPont Acceptable Exposure Limit (AEL) is 4.7 ppm, 15-min TWA with current regulatory ceiling limitations. All of these exposure limits carry a "skin" notation indicating that HCN may penetrate the skin; therefore, control of vapor inhalation alone may not be sufficient to prevent cyanide poisoning. Also, exposure limits are subject to change, and users should stay current with regulatory changes.

Symptoms of Cyanide Poisoning

Personnel should be constantly alert for symptoms of cyanide poisoning in themselves and others. The following poison symptoms can result from other causes, but should be investigated promptly when they occur around cyanide:

Reddening of the eyes*	Nausea*
Irritation of the throat	Headache*
Palpitation	Weakness of arms and legs
Difficulty in breathing	Giddiness
Salivation	Collapse
Numbness	Convulsions

Effects of Exposure to HCN Vapor

The following toxicity data show the "Reported Human Response to Various Concentrations of HCN Vapor"[5]:

2–5 ppm	Odor threshold
10 ppm	OSHA and MSHA exposure limit, 8-hr TWA[2]
20–40 ppm	Slight symptoms after several hours
45–54 ppm	Tolerated for ½ to 1 hr without significant immediate or delayed effects
100–200 ppm	Fatal within ½ to 1 hr
300 ppm	Rapidly fatal (if no treatment)

These numbers should be considered reasonable estimates only, because data are not exact and effects vary for different people. Also, *heavy breathing from physical work will increase cyanide intake and reduce the time for symptoms to show.* The "rapidly fatal" exposure level of 300 ppm assumes no first aid or medical treatment; either is very effective if used quickly.

* Reddening of the eyes (and skin) is one of the earliest symptoms, with nausea and/or headache common in low level exposure. These three are the most readily identifiable symptoms of low level cyanide overexposure.

Prompt administration of the recovery techniques has proven very effective, but emphasis must be placed on quick action. Seconds count, and treatment should be provided within about 200 sec (3–4 min). In case of overexposure to cyanide, quick action is required to sound the alarm, remove the patient from the contaminated area, and provide treatment. With prompt treatment as prescribed, recovery is normally quick and complete with no serious aftereffects. Treatment after 3–4 min can still be effective, but chances of recovery are reduced without prompt treatment. Unlike many poisons, cyanide is not cumulative. While cyanide poisoning can be rapidly fatal, no case should be considered hopeless. Treatment should be continued until a physician certifies death.

First Aid and Medical Treatment

See DuPont's MSDS for detailed instructions for treatment of cyanide poisoning.

Ordering Cyanide Poisoning Antidote Kits and Amyl Nitrite

To obtain cyanide poisoning antidote kits and/or amyl nitrite ampules:

1. Obtain a prescription from your local physician (required because amyl nitrite is a prescription product).
2. Purchase the cyanide antidote kit from your pharmacy. The pharmacy can obtain the kit from Akorn Pharmaceuticals at (800) 932-5676.
3. Amyl nitrite can also be purchased from your local pharmacy or from Save-A-Life Systems in Ft. Wayne, IN at (800) 933-5885.

Shipping

Containers

DuPont produces sodium cyanide in briquette and granular forms.

A variety of containers are used as follows:

Nonreturnable Drums

Net weight 50-kg (110.2-lb) steel drums stacked 9–27 to a pallet.

Net weight 100-kg (220.4-lb) steel drums stacked eight to a pallet (see **Figure 8**).

Note: Drums can be stored three pallets high in a warehouse.

Figure 8. Palletized 100-kg (220-lb) Drums Being Loaded into a Truck

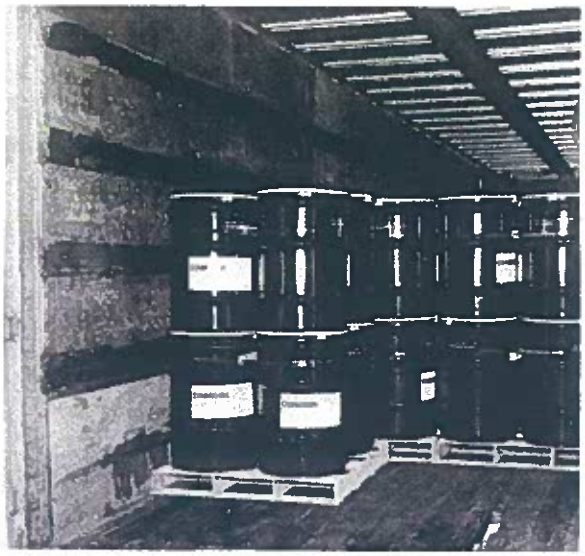


Figure 9. A Tuff-Pak Box Full of Bags

Tuff-Pak

- 48 20-kg (44-lb) pinch-bottom, multiwall composite bags that are hermetically sealed and water-resistant. The bags are packaged in a wooden box on a self-contained pallet. Net weight 960 kg (2116 lb). Individual bags are not to be sold separately (see **Figure 9**).

Figure 10. Partially Loaded Container of IBCs

Nonreturnable Intermediate Bulk Container (IBC)

- Water-resistant package holding 1000 kg (2205 lb). Box dimensions are 44¾ × 44¾ × 44⅜ in high (see **Figure 10**). For shipment, there are normally 20 IBCs in a container.

Returnable FLO-BIN® Containers (Briquettes Only)

- 1361- and 1497-kg (3000- and 3300-lb) net returnable FLO-BIN® containers, 12–14 bins per truck (see **Figures 11** and **14**).

Bulk Trucks

- 30% solution tank trailers (18,000 lb, 100% basis—8180 kg) are available from the Carlin, NV terminal. They can be unloaded using the customer's pump or by plant or truck air (see **Figure 13**).
- Excel I tank trucks (6804–9526 kg [15,000–21,000 lb]). These trucks are equipped with circulation pumps that will permit water addition, dissolving by circulation, and then pumping off into the customer's tank (see **Figure 15**).
- Excel II tank trucks (15,876–18,144 kg [35,000–40,000 lb]) are unloaded by circulating premeasured water from a storage tank by a driver/technician (see **Figures 12** and **16**).

Figure 11. Bins corded two abreast on a flatbed trailer. The bins are strapped to the trailer to prevent movement during transportation.

Transportation

Sodium cyanide must not be shipped by U.S. mail. The U.S. Department of Transportation (DOT)[3,6] hazard classification is Class 6.1 (Toxic) with an ID number of UN1689. A DOT toxic label is required. Transportation equipment must also be placarded with toxic placards in accordance with DOT requirements.

Sodium cyanide drums, Tuff-Paks, and IBCs should be shipped in vehicles that have secondary containment, such as vans. Pickup trucks, etc., should not be used. In case of an accident, secondary containment will minimize the impact of spilled material. Also, the driver must be in a separate compartment isolated from the cyanide.

Sodium cyanide must not be shipped with any acids (dry or liquid), food (human or animal), or ingredients for products used for human or animal consumption, including food, pharmaceuticals, food supplements, etc. Shipment with flammables and strong oxidizers should be avoided, as these mixed shipments can cause fire fighting complications, including cyanide runoff, in case of an accident and subsequent fire.

Storage and Handling

Storage and use areas should be designed so that accidental spillage can be contained and disposed of safely.

Storage Security

When sodium cyanide is stored, security should be maintained so only authorized people have access to it. Locked rooms or locked fenced areas can be used. Only the quantity required for immediate use should be removed from storage.

Figure 12. Excel II Truck

Drums

Drums of sodium cyanide should be stored inside and segregated from acids, weak alkalies, and strong oxidizing materials such as nitrates. It is also recommended that sodium cyanide be stored away from flammables and combustibles to minimize the chance of cyanide-water runoff as a result of fire fighting. Where local regulations permit, sodium cyanide drums should not be stored under sprinklers, because sodium cyanide will not burn in ordinary fires and cyanide runoff must be avoided. Storage with food or intermediates for human or animal products must be avoided. Observe all the precautions given under "Safety Precautions."

Figure 13. NaCN Solution Truck

If possible, open cyanide containers in the areas in which the cyanide is to be used. Remove the cover from the container, and remove the cyanide with a metal scoop or dump the cyanide from the container as required. Replace the cover on the container if the drum still contains cyanide. Store appropriately. Immediately pick up any spillage.

Drum Disposal

Sodium cyanide drums are nonreturnable, and it is against U.S. DOT regulations to reship or recoup the drum, except when approved for disposal of waste materials. Empty drums should be visually inspected for cyanide removal, flushed with large volumes of water, and then drained. This flush and drain cycle should be repeated three times to comply with federal regulations. Rinse water should be collected, treated, and disposed of according to local regulations (see "Cyanide Destruction" section). After cleaning, drum labels should be removed or obliterated to confirm cleaning, and the drum destroyed to prevent reuse. After the above, recycling as scrap metal is appropriate.

FLO-BIN®

A typical FLO-BIN® unloading and storage system is shown in **Figure 14**. A special design manual is available from DuPont. Contact DuPont's sales representative to discuss package and delivery options to meet specific needs.

Sodium cyanide is shipped in returnable FLO-BIN® containers (600 lb tare weight) to customers by truck or rail. In trailers, bins are shipped two abreast. Road weight limitations restrict the truck load to 12–14 bins. The advantages of FLO-BIN® deliveries are:

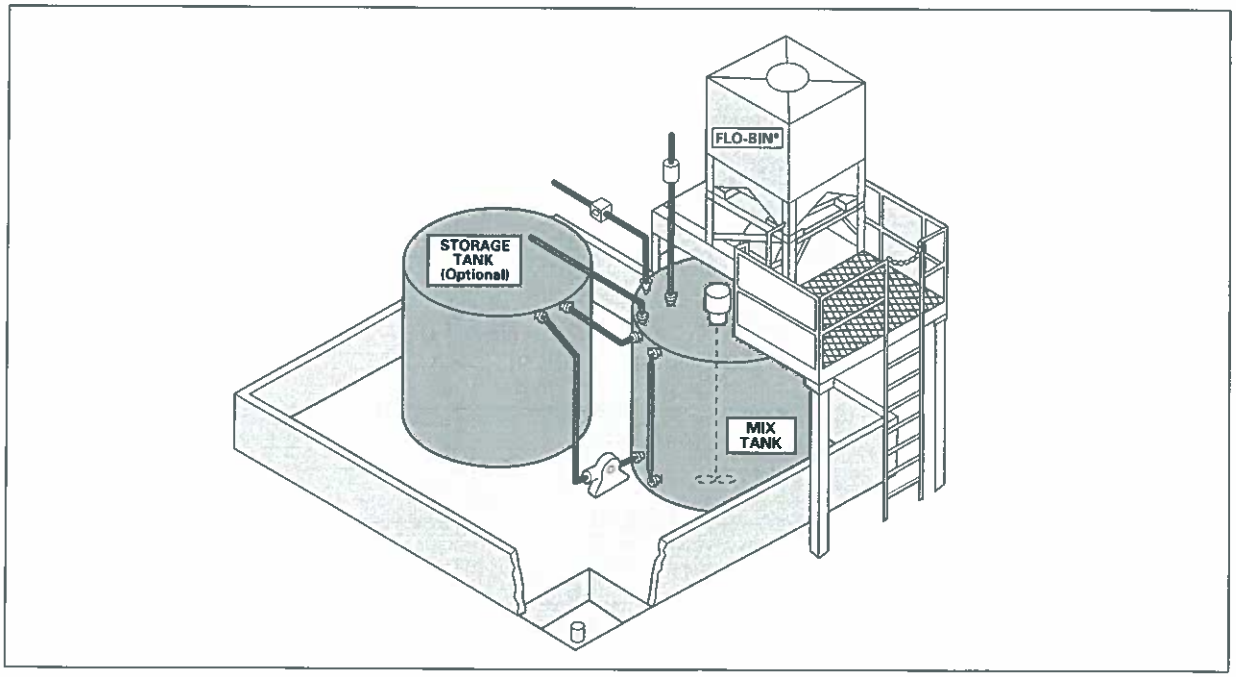
Economics—Customers using about 100,000 kg (200,000 lb) or more per year of sodium cya-nide can effect direct cost savings versus other smaller packages.

FLO-BIN® Customer Shipping Responsibility

When returning bins, the customer becomes the shipper and bears the responsibility for seeing that all safety precautions are carried out. DOT regulation 49 CFR 173.29 requires that a returnable container offered for transportation must meet the same standards as when the container previously held a greater quantity of a hazardous material. Returning bins do not have to be cleaned internally. Internal water washing is discouraged, because cyanide solution rundown is likely to create spillage, unless the bins are dried. External cleaning and inspection of each bin is required to ensure no cyanide is left on the outside and that the camlocks are locked closed with locking pins or wires.

When returning bins, secure bins with equipment provided. DO NOT reverse the poison placards (four) on car or truck. DO NOT remove or deface product label on bin.

Figure 14. Typical FLO-BIN® Unloading System



Intermediate Bulk Container (IBC)

IBCs are the ideal package for most large consumers of NaCN who are not near a manufacturing facility. IBCs are readily handled with forklift trucks. DuPont recommends stacking IBCs two high for storage. The DuPont IBC holds 1000 kg (2205 lb) of NaCN. When diluted to 23% (the minimum freezing point of a NaCN/water solution) with pH at 12 or above, the IBC will make about 3900 L (1030 gal).

The IBC is emptied by lifting the bag by the straps using a forklift or hoist and then positioning and lowering the bag onto the specially designed knife slitter that cuts the bag, allowing the contents to drop into the dissolving tank.

IBC Decontamination and Disposal

Decontamination and disposal of used IBC materials must be properly handled to prevent environmental contamination and meet regulations. The bags should be empty—this should be confirmed visually or by weight before they are sent to a disposal facility. Then, a flush and drain cycle, repeated three times, will dissolve any residual cyanide left in the bag. Care must be taken to ensure the bag material does not overlap and prevent water contact—interfering with the dissolving process. Rinse water should be collected and recycled or treated and disposed of according to local regulations. As part of the cleaning process, labels should be removed or obliterated. If burning is the method of disposal, keep in mind that all of the NaCN will probably not be destroyed during the burning process, and the ashes must be properly contained.

30% NaCN Solution

The DuPont terminal in Carlin, NV ships 30% NaCN solution as far away as 300 miles. The specially designed trailers hold 6300 gal—equivalent to 18,000 lb of dry NaCN. DuPont 30% NaCN solution is often the most convenient way to receive NaCN. The drivers are specially trained to make these deliveries and have a safety record envied in the trucking industry. DuPont offers technical assistance and support to assist with the design or modification of an existing system.

Excel Trucks

Excel trucks combine transportation and unloading safety by permitting shipment of solid sodium cyanide and unloading by dissolving the cyanide in place and then pumping the solution into appropriate storage. Excel I (see **Figure 15**) is ideal for customers with annual usage of ½ to 1 million lb, where 30% solution may not be desirable, but Excel I is only available in limited geographical areas. Excel II delivery systems (see **Figure 16**) are ideal for many large sodium cyanide users and usually require an annual NaCN usage of about 1 million lb per year to justify the larger investment compared to handling FLO-BIN® containers. Cost factors such as location (transportation), expected operating life, available space, inventory requirements, etc., should be evaluated with DuPont to determine the best system for each specific situation. Design manuals are available for Excel systems.

When dissolving the sodium cyanide in Excel systems, position the tank truck so that the hose connection can be made between the truck pipe headers and the storage tank and pump piping.

For Excel II, meter into the storage tank the amount of water and sodium hydroxide (NaOH) needed to make the desired concentration of sodium cyanide solution (about 363 kg [800 lb] NaOH for 18,144 kg [40,000 lb] NaCN). The water temperature needed for dissolving the NaCN depends on the solution concentration needed, the circulation rate, and weather conditions. The water can be preheated up to about 38°C (100°F) to speed the dissolving, but heated water is frequently not needed, unless cold weather and cold water are involved (see "Chemical Reactions" section).

Cyanide decomposition rates increase with higher temperatures, with sodium formate and ammonia being formed. Because the decomposition reaction is exothermic, provision must be made for temperature monitoring and emergency cooling, if heating is used (see "Temperature Indicators, Insulation, Heating, and Cooling").

Excel II Unloading Procedures

Position valves. Start the pump. Check the system for leaks. Circulate the water continuously from the storage tank through the tank truck from the bottom to top to flood the truck and overflow back to the storage tank. Listen to the rattling briquettes by placing your ear near the bottom of the tank trailer. Dissolving should be complete about 30 min after the rattling stops, but system experience will provide the best guide. Then, pump the sodium cyanide solution from the tank truck into the storage tank. The dissolving time varies with circulation rate, water temperature, and final concentration, but dissolving can be complete in about 1½ hr under best conditions. Typically, 3–4 hr are needed in winter, without heat, for a 20–25% concentration.

Figure 15. Typical Excel I Unloading System

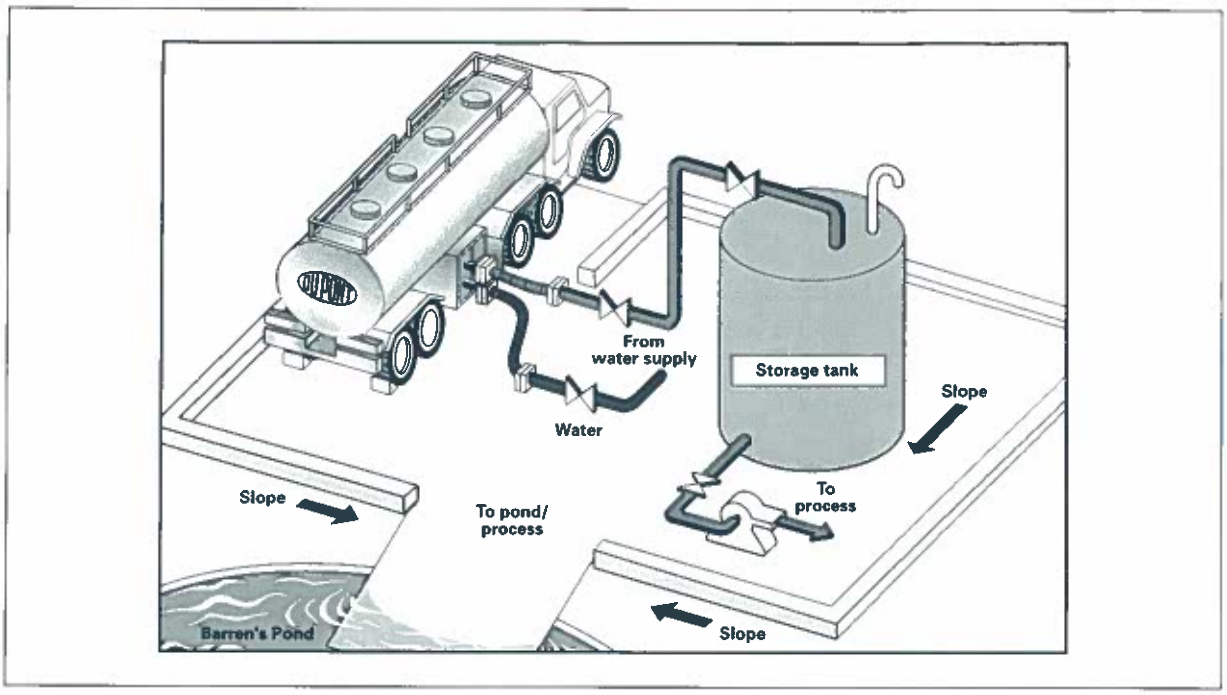
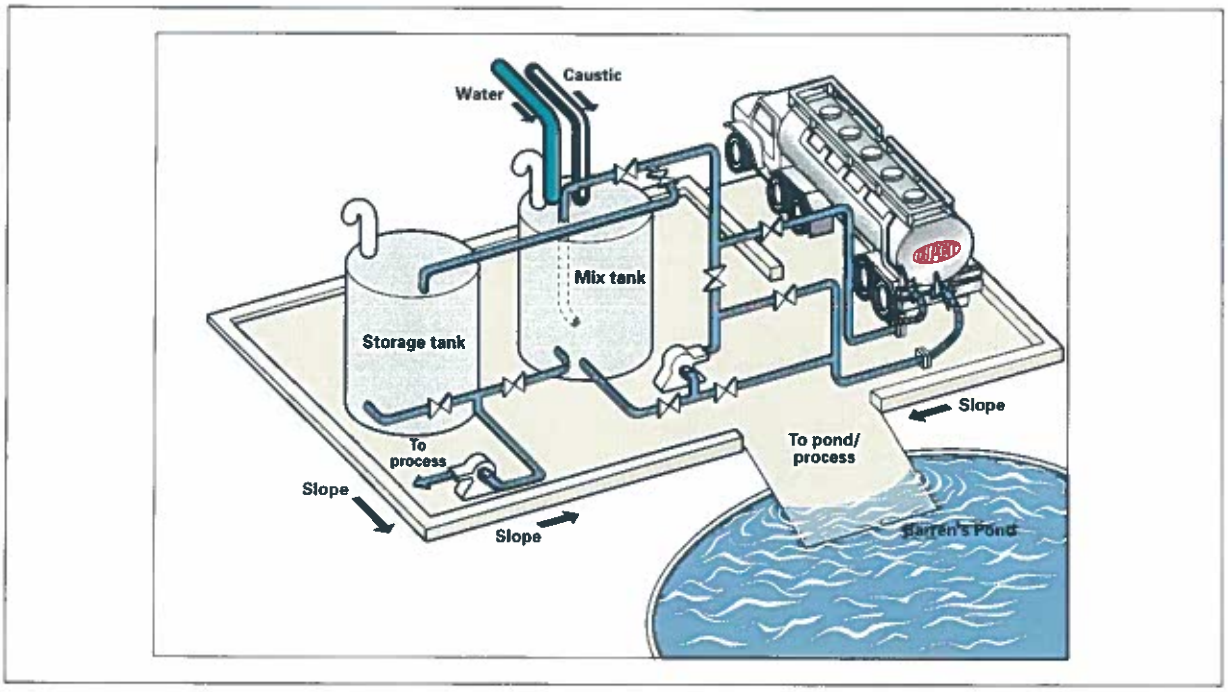


Figure 16. Typical Excel II Unloading/Storage System



Equipment

Materials of Construction

Carbon steel equipment is usually satisfactory for sodium cyanide solutions where velocities are not over 1.2–1.5 m/sec (4–5 ft/sec). At higher velocity, 304 or 316 stainless steel is sometimes recommended, because an erosion-corrosion effect occurs on steel. Carbon steel with a corrosion allowance may be acceptable instead of stainless to reduce cost, particularly if flow is frequently shut off so no erosion-corrosion is occurring. Even at very low velocities, welded, not threaded, piping should be used for all pipe materials to avoid leaks. To avoid leaks, no threaded connections should be used for piping instruments, drains, or any other connection. For pumps and instruments, 316 stainless is recommended. Valve operating conditions will determine whether carbon steel versus stainless can be used. Gaskets of Teflon® or nitrile-butadiene rubber (NBR), with Kevlar® filler, are recommended for sodium cyanide solutions.

Solution Storage Tank

Sodium cyanide solution is stored in a tank typically fabricated from ¼-in carbon steel plate. For bulk installations, top nozzles are recommended for a 15.2- to 20.3-cm (6- to 8-in) pipe vent, a 10-cm (4-in) fill and circulating line, level indicator, high-level alarm, provision for water, and caustic additions and manway. A top 4-in nozzle with a physical break in the water line will prevent backflow. Bottom openings must also be provided for a 15-cm (6-in) pump suction line, temperature control-alarm, and (optional) heating/cooling coils. The size of the storage tank depends upon the sodium cyanide shipment size and concentration of solution required. For example, 18,150 kg (40,000 lb) of sodium cyanide makes 71,000 L (18,750 gal) of 23% solution. A vertical tank 4.9 m (16 ft) in diameter by 5.0 m (16½ ft) high has a nominal 95,000-L (25,000-gal) capacity, which is sufficient to allow some outage and/or solution inventory (see **Figure 17**). The tank may be lined with neoprene to prevent buildup of iron content, if this is critical to the process. All pipe nozzles should be schedule 40 pipe minimum.

To provide mixing, a properly aligned dip tube/mixer with a siphon vent must be installed.

If the storage tank is located inside a building, all tank openings must be sealed and the tank vent routed outside the building to a safe location. This will prevent the discharge of hydrogen cyanide inside the building when the tank is being filled (see "Caustic Addition" on page 15).

Pump

For Excel II, a 316 stainless steel pump with a 10.2-cm (4-in) suction and a 7.6-cm (3-in) discharge is needed. It should be capable of delivering 2271–2650 L (600–700 gal) per minute at 18.3–21.3 m (60–70 ft) head. Small pumps will not provide sufficient agitation for tank car cyanide dissolving. Totally enclosed, fan-cooled, 25-HP motors are recommended.

Water Meter and Supply

A 7.6-cm (3-in) water meter with a preset totalizer and an automatic cutoff is recommended in the storage tank water addition line. There should be a physical disconnection in the water supply line to prevent cyanide from backing up into the water system.

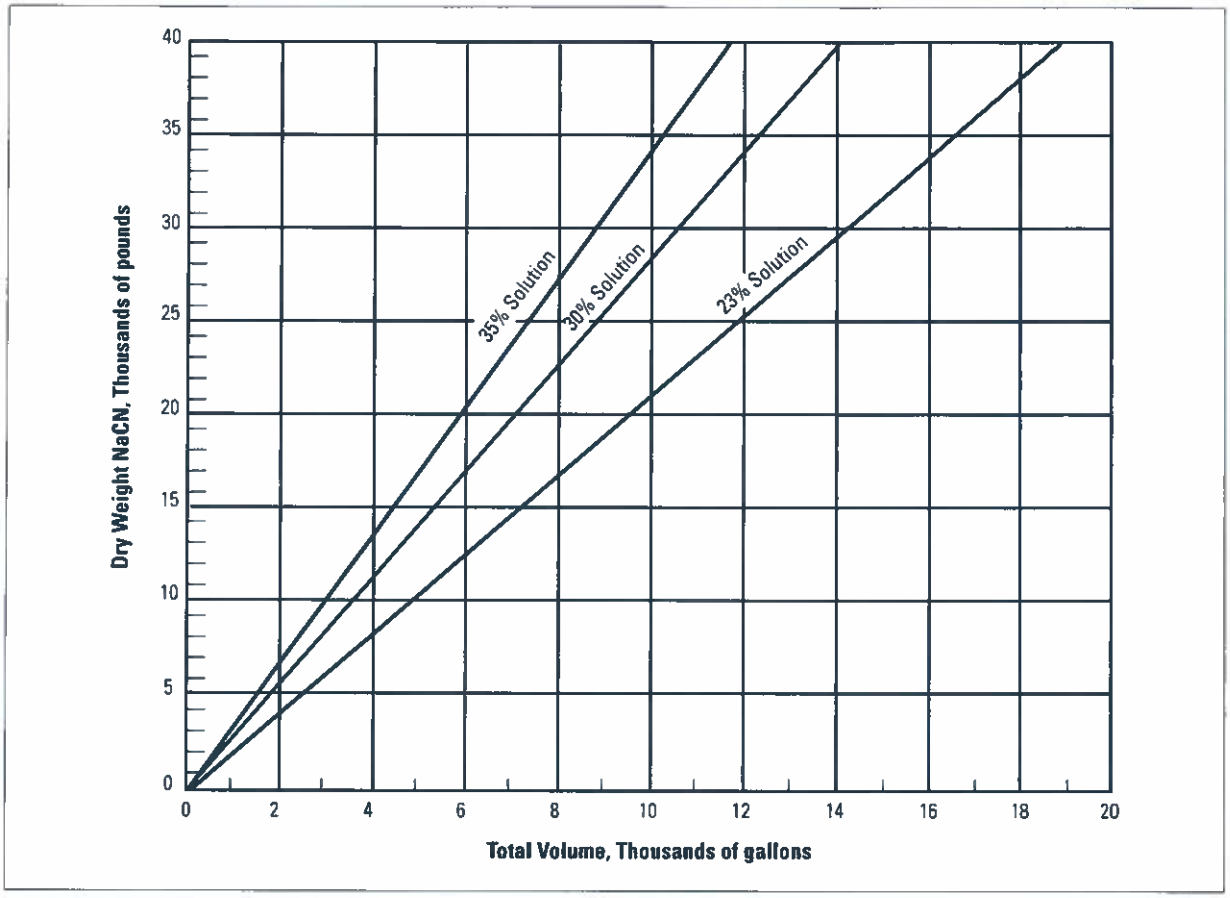
Pipe and Hoses

Welded, not threaded, carbon steel (or 304 or 316 stainless steel) pipe with minimum flanges can be used (see "Materials of Construction" for piping and gaskets). Excel II circulation piping of 10.2-cm (4-in) is recommended (except for the line from the tank to the pump inlet, which should be 6 in, to minimize NPSH losses) with all valves, pumps, etc., located inside the dike and minimum flanges outside the dike. Tank car and truck hoses should be overdesigned to ensure against failure. Hose pressure rating should be 225 psi minimum with burst pressure (including end connections) at least twice the rated pressure. Contact DuPont for hose design and vendor recommendations. Circulation piping system, including hoses, should be inspected before each use to protect against failure and a major spill. Hoses should be long enough to permit hookup, regardless of the direction the vehicle comes into the facility. Sodium cyanide solution trailer connections are located at the rear (bumper level) and middle (on top) of the trailer; Excel II trailer connections are located at the rear (bumper level); and Excel I connections are in the box located in the middle of the trailer (ground level). All connections are quick connects, except for the top solution connection, which may be either bolted or quick connect.

Drainage Control

The storage tank should be diked and have a sealed concrete bottom. No dike drain should be installed, because it might leak or be left open. The unloading area should be curbed and drainage control provided that will prevent spilled cyanide solution from draining into public water courses (see "Pipe and Hoses"). Specific spill control requirements depend on surroundings and local regulations. Impounded sodium cyanide can be reclaimed or chemically destroyed.

Figure 17. Solution Volume Curves—Gallons of Solution from Dry Weight at 35°C (95°F)



Filter

To obtain a clear solution, a filter can be used. It should be located so that it filters the solution between the tank car and the storage tank and, also, between the storage tank and process. Filters are not needed if a clear solution is not required.

Level Indicator and Alarm

A sonic liquid level indicator is preferred over a float-type instrument, as it is more reliable, easier to read, and can be installed at a convenient location. It is recommended that a high-level alarm system, equipped to shut off the pump, be installed to prevent overflowing the storage tank.

Temperature Indicators, Insulation, Heating, and Cooling

Sodium cyanide solution should be stored above the crystallization point (see **Figure 3**), but normally below 38°C (100°F), when possible, to reduce decomposition (see **Figure 6**). A temperature control system may be needed for high concentrations. Tank insulation can be fiberglass with a sheet aluminum cover, if climate and solution concentration warrant. Low pressure steam can be used to reduce localized overheating. The same coils can be used for circulating cold water when necessary. Alternately, live steam can be injected, if small concentration changes from condensation are acceptable.

CAUTION

Read the "Chemical Reactions" section carefully and note the dangers at high temperatures.

Caustic Addition

To minimize highly toxic HCN formation and prevent color formation from HCN polymerization in the stored sodium cyanide solution, sufficient caustic (sodium hydroxide) is added to give a pH 12, preferably 12.5–13. Caustic addition to provide a 0.3–0.5% solution (about 50 lb NaOH per 1000 gal water) is usually sufficient. A 50% caustic solution can be used during the summer, but 25% solution is recommended for winter to avoid freezing. Use of 22.7-kg (50-lb) bags of bead caustic may be convenient. Additions can be made directly to the tank. Caustic should be added before sodium cyanide is added. Where process chemistry prevents caustic addition, HCN formation will increase, which must be controlled by ventilation and/or other means.

Transportation Emergencies

How to Get Help

DuPont wants to be called about any transportation incident involving DuPont cyanide, regardless of whether a spill occurred. In the event of a transportation incident or other problem involving DuPont cyanide that requires immediate help, call the DuPont Cyanide Hotline at our Memphis, Tennessee plant:

Call Collect, Day or Night

(901) 357-1546

NOTE: Do not use this number for non-emergencies. Contact the sales office listed on the back cover for routine commercial or technical information.

Calling the DuPont Cyanide Hotline is the fastest way DuPont can provide guidance to assist in handling an emergency. DuPont will evaluate whether a team of specialists should be sent to the scene.

In the United States and Canada, CHEMTREC can also be called at:

(800) 424-9300

In the rest of the world, call CHEMTREC at:

001-703-527-3887

CHEMTREC uses Language Services for non-English speakers.

The DuPont or CHEMTREC information specialist on duty will ask the name and location of the caller, the name of the shipper, the product, the shipping point and destination as well as what happened, nature of any injuries, weather conditions, proximity to populated areas, etc. If you call CHEMTREC, the information specialist will then contact the manufacturer (DuPont) for further assistance.

In Canada, CANUTEC can also be called in Ottawa, Ontario, at:

(613) 996-6666

Action at the Scene

The following is intended to provide guidance to first responders to a DuPont sodium cyanide transportation emergency incident.

1. For any transportation incident involving DuPont sodium cyanide, call DuPont for assistance as soon as possible, regardless of whether there is a spill.
2. Avoid overreaction that can occur because "cyanide" is involved. Remember, in most cases, you are dealing with a dry, solid, nonvolatile material that is normally easy to clean up, unless the cyanide has contacted acid or some other incompatible chemical or is spilled into a water system. If sodium cyanide solution is spilled, the amount of HCN gas evolved will probably be greater than if dry sodium cyanide was spilled, but because of the amount of caustic contained in sodium cyanide solution, the amount of HCN will probably still be well below lethal limits (see "Effects of Exposure to HCN Vapor" on page 8)—unless the HCN vapors are somehow contained or the solution is in contact with an acid. Gasoline, diesel, or other motor oils do not generally cause large amounts of cyanide gas.
   a. The need for evacuation is highly unlikely. Unless acid and cyanide are mixed, hydrogen cyanide gas formation is limited.
   b. While rain or any water contact with sodium cyanide can produce hydrogen cyanide gas, the amount of gas is small and would not require evacuation. While dangerous levels of gas can develop in enclosed spaces, wet sodium cyanide in the open can be shoveled up by standing upwind during cleanup.
3. Shovel the cyanide into drums, plastic bags, or any suitable container.
4. If sodium cyanide solution is spilled, contain the spill as soon and as much as possible. Keep sodium cyanide out of lakes, streams, or any other water. Block off sewer system, drainage, or any other water access. Even small concentrations of cyanide can be fatal to aquatic life. As soon as is practical, place the spilled material into a container suitable for movement to a proper disposal area.
5. As with all chemical spills, approach the scene from upwind to determine what chemicals are involved. With sodium cyanide spillage, check for battery acid spillage.
6. Keep people (nonresponders) away.
7. Halt or divert traffic to prevent spreading the cyanide.
8. If raining, cover any spilled sodium cyanide with a tarp, plastic, or anything available to minimize water contact and subsequent cyanide-water runoff. Divert any water streams around the cyanide.
9. To repeat, call the DuPont Cyanide Hotline at:

(901) 357-1546

Cyanide Destruction

The entire process in which by-products are generated should be reviewed for possible recycle of sodium cyanide, instead of disposal. If recycle is not feasible, ion exchange and reverse osmosis may be useful for concentrating cyanides, but destruction is usually easier and more economical.

The most effective and widely used chemical methods to destroy cyanide are oxidizing it to cyanate (CNO^-) with hypochlorite or hydrogen peroxide. Both methods are effective for oxidizing free and weak acid-dissociable cyanide.

For concentrated cyanide solutions, long-term high-temperature heating will destroy much of the cyanide with associated ammonia release.

Chlorination

CAUTION

Concentrated hypochlorite should not be mixed with concentrated cyanide solutions or solid cyanide, because highly toxic cyanogen chloride gas will be released. Very dilute solutions, in the correct pH range, should be used.

Chlorination of dilute sodium cyanide solutions can be accomplished by treatment with diluted solutions of sodium hypochlorite, calcium hypochlorite, or by generating hypochlorite from NaOH and Cl_2 gas. The choice of hypochlorite is an economic and safety decision. Solution concentrations of 1% sodium cyanide and 1% hypochlorite can be reacted if mixed slowly (over, say, 10 min) and with proper pH control.

Hypochlorite reacts with cyanide ions (CN^-) to produce highly toxic cyanogen chloride, which, at pH 10–11, hydrolyzes promptly to form cyanate ions (CNO^-). Because cyanogen chloride is a poisonous gas with little water solubility, the treatment process must be designed and operated to prevent cyanogen chloride fumes. Fumes are best controlled by limiting the cyanide concentration to a few thousand parts per million and controlling pH. Below pH 10, cyanogen chloride release increases; above pH 11, cyanide destruction slows, particularly above pH 11.5.

Further chlorination to destroy cyanate, sometimes referred to as "complete" chlorination, can be accomplished with additional chlorine. After reaction at pH 10.5 for 10 min or more, the pH must be reduced to 7.5–9, preferably 8–8.5, and maintained at that pH until the reaction is complete. Completion of both reactions typically requires at least 2 hr and can use eight or more parts of Cl_2 per part of CN^- (versus about three parts of Cl_2 for oxidation to CNO^-), while producing CO_2 and N_2 as reaction products. Chlorination is effective for cyanide destruction and can be automated for continuous systems. However, other waste stream components are often chlorinated, which increases chlorine consumption and may produce undesirable by-products in the effluent.

pH 10–11

Normally fastest reaction rate. Reduced HCN release and pH drop during treatment favor starting around pH 11. Higher pH will slow reaction, particularly above 11.5.

CAUTION

Adequate ventilation and HCN monitoring are important and more so as cyanide concentrations increase and pH decreases, particularly below pH 11.

pH Below 10

Causes slower reaction and release of HCN and/or cyanogen chloride gas (highly toxic, like HCN, and a powerful lachrymator, causing tearing of the eyes). Also, there is greatly increased concern about HCN release.

Acid pH

CAUTION

In addition to toxic gas release, acidic conditions can result in nitrogen trichloride formation that can separate as an insoluble oil-like material and explode violently, even in small amounts.

Hydrogen Peroxide Oxidation

CAUTION

Concentrated hydrogen peroxide should not be mixed with concentrated cyanide solutions or solid sodium cyanide, because highly toxic HCN or ammonia gas could be released. Also, high heat and oxygen gas release may cause foaming or eruption and splash workers. Dilution minimizes these problems.

Depending on the composition of the waste, additions of copper or formaldehyde may be required to destroy cyanide. The waste liquor is adjusted to pH 11 (10.5–11.5), formaldehyde or copper ions (typically with copper sulfate) added if needed, and hydrogen peroxide mixed with the solution. The solution must be agitated mechanically or with air. The reaction rate is dependent on temperature. Dilute wastes can be warmed to 38–54°C (100–130°F), but temperature elevation is usually less economical than adding 10–20% excess peroxide to shorten reaction time (which is normally about ½–1 hr at ambient temperature). Dilution and/or controlled addition rate may be needed when treating more concentrated wastes.

Chlorination is faster than peroxide oxidation and is frequently more adaptable to continuous destruction systems. Where speed is not critical, such as in batch tanks, hydrogen peroxide has several advantages including:

- Cyanogen chloride and chlorinated by-products are not produced.
- More concentrated cyanide wastes can be treated safely.
- The hazards of handling chlorine are avoided.
- Chlorine/chloride in water discharges are prohibited in some locations and can be avoided with peroxide.
- Sulfur compounds will react with hypochlorite, but not peroxide, and can increase hypochlorite costs substantially.
- Peroxide may destroy other objectionable organics.

By-products from peroxide treatment are cyanate, ammonia, and glycolic acid amide. Cyanate does not revert to cyanide in surface waters or sewage treatment systems, according to a U.S. Public Health Service study. Both the cyanate and glycolic acid amide are biodegradable. The cyanate can be readily hydrolyzed in acid solutions to ammonia.

Hydrolysis

Hydrolysis is sometimes a practical treatment for strong sodium cyanide solutions. Simply heating a 10% sodium cyanide solution for about 36 hr to 95–100°C (about 210°F) should reduce the cyanide content well below 1%, where chemical oxidation can be used more effectively. Provisions should be made to accommodate the ammonia that will be generated (see "Sodium Cyanide Reactions in Water").

Metal Complexes

Strongly bonded metal cyanides, especially iron cyanides (ferrocyanide and ferricyanide), are apt to be found in cyanide waste streams. These will not be detected by simple analytical procedures, such as titration with silver nitrate, which are normally used for measuring "free" or "weak acid-dissociable" cyanides. However, they will be included in the "total cyanide" analyses using acid distillation procedures. These complexes are not effectively destroyed by the commonly used waste treatment processes. If regulations require removal of these generally stable complexes of low toxicity, other treatment methods such as precipitation to produce a solid waste may be required.

Handling Spills

Sodium cyanide spills should be cleaned up promptly to minimize exposure of people and the environment. Shovel and sweep dry spilled material into a drum or suitable container. Keep dry spilled material dry. If solutions are spilled, immediately contain them to prevent contaminating nearby water. Contact DuPont for additional actions at a spill scene. If raining, covering the spill will reduce sodium cyanide dissolving and runoff. Decontamination of an area, after cleaning up as much cyanide as possible, can be accomplished with hypochlorite solution. A small amount of caustic (1 oz/5 gal hypochlorite solution) will help keep the pH in the 10–11 range.

References and Notes

1. Elial, E. L., and Freeman, J. P., "Organic Syntheses," Wiley, New York, Coll. Vol. 4, 58–62.
2. OSHA, 29 CFR 1910.1000, Air Contaminants.
3. Due to changing governmental regulations, such as those of the Department of Transportation, Department of Labor, U.S. Environmental Protection Agency, and the Food and Drug Administration, references to governmental requirements may be superseded. Consult and follow the current governmental regulations, such as Hazard Classification, Labeling, Worker Exposure Limitations, and Waste Disposal procedures, for up-to-date requirements for sodium cyanide.
4. "HYDROGEN CYANIDE and CYANIDE SALTS" published in 2001 by American Conference of Governmental Industrial Hygienists (ACGIH) 1330 Kemper Meadow Drive, Cincinnati, OH 45240; telephone (513) 742-2020. The ACGIH recommends a 4.7 ppm ceiling for HCN. Both OSHA and ACGIH advise avoiding skin contact.
5. "Occupational Exposure to Hydrogen Cyanide and Cyanide Salts," NIOSH Criteria Document, U.S. Department of Health, Education, and Welfare, 1976.
6. DOT, 49 CFR 712.101, Hazardous Material Table.

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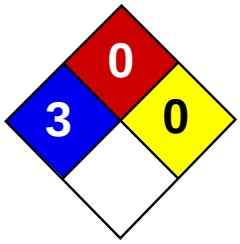
C.2 Material Safety Data Sheets – Sodium Cyanide



Material Safety Data Sheet
Sodium Cyanide MSDS

Section 1: Chemical Product and Company Identification

Product Name: Sodium Cyanide

Catalog Codes: SLS2314, SLS3736

CAS#: 143-33-9

RTECS: VZ7525000

TSCA: TSCA 8(b) inventory: Sodium Cyanide

CI#: Not available.

Synonym:

Chemical Name: Sodium Cyanide

Chemical Formula: NaCN

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sodium Cyanide	143-33-9	100

Toxicological Data on Ingredients: Sodium Cyanide: ORAL (LD50): Acute: 6.44 mg/kg [Rat]. DERMAL (LD50): Acute: 10.4 mg/kg [Rabbit].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Hazardous in case of skin contact (permeator). Corrosive to eyes and skin. The amount of tissue damage depends on length of contact. Eye contact can result in corneal damage or blindness. Skin contact can produce inflammation and blistering. Inhalation of dust will produce irritation to gastro-intestinal or respiratory tract, characterized by burning, sneezing and coughing. Severe over-exposure can produce lung damage, choking, unconsciousness or death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to skin, eyes, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure of the eyes to a low level of dust can produce eye irritation. Repeated skin exposure can produce local skin destruction, or dermatitis. Repeated inhalation of dust can produce varying degree of respiratory irritation or lung damage. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: Not available.

Flash Points: Not available.

Flammable Limits: Not available.

Products of Combustion: Some metallic oxides.

Fire Hazards in Presence of Various Substances: Slightly flammable to flammable in presence of acids, of moisture.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards:
Dangerous on contact with acids, acid fumes, water or stream. It will produce toxic and flammable vapors of CN-H and sodium oxide. Contact with acids and acid salts causes immediate formation of toxic and flammable hydrogen cyanide gas. When heated to decomposition it emits toxic fumes hydgrogen cyanide and oxides of nitrogen

Special Remarks on Explosion Hazards: Fusion mixtures of metal cyanides with metal chlorates, perchlorated or nitrates causes a violent explosion

Section 6: Accidental Release Measures

Small Spill: Use appropriate tools to put the spilled solid in a convenient waste disposal container.

Large Spill:
Corrosive solid. Poisonous solid. Stop leak if without risk. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Eliminate all ignition sources. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep container dry. Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe dust. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, acids, moisture.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 24°C (75.2°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:
Splash goggles. Synthetic apron. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor and dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
STEL: 5 (mg/m3) from ACGIH (TLV) [United States] SKIN CEIL: 4.7 from NIOSH CEIL: 5 (mg/m3) from NIOSHConsult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Granular solid. Flakes solid.)

Odor:
Faint almond-like odor. Odorless when perfectly dry. Emits odor of hydrogen cyanide when damp.

Taste: Not available.

Molecular Weight: 49.01 g/mole

Color: White.

pH (1% soln/water): Not available.

Boiling Point: 1496°C (2724.8°F)

Melting Point: 563°C (1045.4°F)

Critical Temperature: Not available.

Specific Gravity: 1.595 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Vapor Density of Hydrogen Cyanide gas: 0.941

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility:
Soluble in cold water. Slightly soluble in Ethanol

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Excess heat, moisture, incompatibles.

Incompatibility with various substances: Reactive with oxidizing agents, acids, moisture.

Corrosivity:
Corrosive in presence of aluminum. Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Violent reaction with fluorine gas, magnesium, nitrates, nitric acid. Dangerous on contact with acids, acid fumes, water or stream. It wil produce toxic and flammable vapors of CN-H and sodium oxide. Cyanide may react with CO2 in ordinary air to form toxic hydrogen cyanide gas. Strong oxidizers such as acids, acid salts, chlorates, and nitrates. Contact with acids and acid salts causes immediate formation of toxic and flammable hydrogen cyanide gas.

Special Remarks on Corrosivity: Corrosive to aluminum

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
Acute oral toxicity (LD50): 6.44 mg/kg [Rat]. Acute dermal toxicity (LD50): 10.4 mg/kg [Rabbit].

Chronic Effects on Humans: May cause damage to the following organs: skin, eyes, central nervous system (CNS).

Other Toxic Effects on Humans:
Very hazardous in case of skin contact (irritant), of ingestion, of inhalation. Hazardous in case of skin contact (permeator).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: May cause adverse reproductive effects (maternal and paternal fertility) based on animal data.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health effects: Skin: May cause itching and irritation. May be fatal if absorbed through injured skin with symtpoms similar to those noted for inhalation and ingestion. Eyes: May cause eye irritation and eye damage. Inhalation: May cause respiratory tract irritation. May be fatal if inhaled. The substance inhibits cellular respiration causing metabolic asphyxiation. May cause headache, weakness, dizziness, labored breathing, nausea, vomiting. May be followed by cardiovascular effects, unconciousness, convulsions, coma, and death Ingestion: May be fatal if swallowed. May cause

gastrointestinal tract irritation with nausea, vomiting. May affect behavior and nervous systems(seizures, convulsions, change in motor activity, headache, dizziness, confusion, weakness stupor, aniexity, agitation, tremors), cardiovascular system, respiration (hyperventilation, pulmonary edema, breathing difficulty, respiratory failure), cardiovascular system (palpitations, rapid heart beat, hypertension, hypotension). Massive doses by produce sudden loss of conciousness and prompt death from respiratory arrest. Smaller but still lethal doses on the breath or vomitus. Chronic Potential Health Effects: Central Nervous system effects (headaches, vertigo, insomnia, memory loss, tremors, fatigue), fatigue, metabolic effects (poor appetite), cardiovascular effects (chest discomfort, palpitations), nerve damage to the eyes, or dermatitis, respiratory tract irritation, eye irritation, or death can occur. may prolong the illness for 1 or more hours. A bitter almond odor may be noted

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: CLASS 6.1: Poisonous material.

Identification: : Sodium cyanide UNNA: 1689 PG: I

Special Provisions for Transport: Marine Pollutant

Section 15: Other Regulatory Information

Federal and State Regulations:
Connecticut carcinogen reporting list.: Sodium Cyanide Illinois chemical safety act: Sodium Cyanide New York release reporting list: Sodium Cyanide Rhode Island RTK hazardous substances: Sodium Cyanide Pennsylvania RTK: Sodium Cyanide Minnesota: Sodium Cyanide Massachusetts RTK: Sodium Cyanide Massachusetts spill list: Sodium Cyanide New Jersey: Sodium Cyanide New Jersey spill list: Sodium Cyanide Louisiana RTK reporting list: Sodium Cyanide Louisiana spill reporting: Sodium Cyanide California Director's List of Hazardous Substances: Sodium Cyanide TSCA 8(b) inventory: Sodium Cyanide TSCA 4(a) final test rules: Sodium Cyanide TSCA 8(a) PAIR: Sodium Cyanide TSCA 8(d) H and S data reporting: Sodium Cyanide TSCA 12(b) one time export: Sodium Cyanide SARA 302/304/311/312 extremely hazardous substances: Sodium Cyanide CERCLA: Hazardous substances.: Sodium Cyanide: 10 lbs. (4.536 kg)

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS B-6: Reactive and very flammable material. CLASS D-1A: Material causing immediate and serious toxic effects (VERY TOXIC). CLASS E: Corrosive solid.

DSCL (EEC):
R27/28- Very toxic in contact with skin and if swallowed. R41- Risk of serious damage to eyes. S1/2- Keep locked up and out of the reach of children. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S28- After contact with skin, wash immediately with plenty of water S36/37- Wear suitable protective clothing and gloves. S39- Wear eye/face protection. S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible). S46- If swallowed, seek medical advice immediately and show this container or label.

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 1

Reactivity: 0

Personal Protection: j

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Synthetic apron. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

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OIL HANDLING FACILITY

OIL POLLUTION EMERGENCY PLAN

For

Meadowbank Mine Fuel Farm in Baker Lake

August 2012

Version 1

EXECUTIVE SUMMARY

This document presents the Oil Pollution Emergency Plan for Agnico-Eagle Mines Limited (AEM) Meadowbank Mine Site, All Weather Private Access Road (AWPAR) and Baker Lake Facilities, which is a requirement of the Meadowbank Gold Project Type A Water License No. 2AM-MEA0815 issued on June 09, 2008. Oil Pollution Emergency Plan (OPEP) 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 Marshaling Facilities and the Fuel Farm located at latitude 64°18'36"N and longitude 95° 58'04"W and the AWPAR.

ACRONYMS

AEM	Agnico-Eagle Mines Limited
ERT	Emergency Response Team
ERP	Emergency Response Plan
Fuel	P50 Arctic Grade diesel fuel – the only oil product received at the Baker Lake Fuel Farm Oil Handling Facility
IMO	International Maritime Organization
MARPOL	*The International Convention for the Prevention of Pollution from Ships,* 1973, and the *Protocols* of 1978 and 1997, as amended from time to time
OHF	Oil Handling Facility
OPEP	Oil Pollution Emergency Plan
SOPEP	Ship Oil Pollution Emergency Plan
SMP	Spill Management Plan
TEU	Twenty-foot equivalent unit

IMPLEMENTATION SCHEDULE

As required by Water License 2AM-MEA0815, Part B, Item 16, the proposed implementation schedule for this Plan is effective immediately 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 – Health and Safety Superintendent

AEM – Site Services Superintendent

AEM – General Services Superintendent

AEM – ERT Coordinator

Baker Lake – Baker Lake Hamlet Office

Baker Lake – Fire Department

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
0	12/09/02	All	All	Comprehensive plan for AEM's Baker Lake Fuel Farm Facilities
1	12-09-17		10, 12, 13	P10: Tide and Currents reference change; P12: Rephrasing of the last paragraph title; P13: in INITIAL SPILL RESPONSE PRIORITIES table into Section 2 RESPOND SAFELY, rewording to show only diesel fuel actions.

Version 0:

Prepared By: _____

Steve Gaudreault
Permitting & Compliance Sr. Technician

Approved By: _____

Kevin Buck
Environmental Superintendent

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APPENDICES

Appendix A: Shipboard Oil Pollution Emergency Plan
Appendix B: Transport Canada Guideline TP- 9834E

1. Introduction

The Oil Pollution Emergency Plan (OPEP) is to set in motion the necessary actions to stop or minimize the loss of diesel fuel resulting from a mishap at Agnico-Eagle Mines Limited's Baker Lake Fuel Tank Oil Handling Facility located in Baker Lake, Nunavut. Additionally, it provides direction to AEM personnel and/or contractors at the laydown and tank farm areas, and to AEM's Emergency Response Team (ERT) for emergency spill response situations, describes oil pollution scenarios, defines the roles and responsibilities of management and responders, and outlines the measures taken to prevent spills. The purpose of the OPEP is to minimize potential health and safety hazards, environmental damage and cleanup costs.

The OPEP complies with the requirements for procedures, equipment and resources as set out in the *Canada Shipping Act* (s.s. 660.2(4)) specific to a fuel handling facility - the bulk incoming transfer of fuel from ship-to-shore and spill scenarios directly relating to this operation. This Plan is a working document that will be reviewed and, if necessary, updated on an annual basis.

This Plan specifically centres on the activities in ship-to-shore transfer of fuel from a small tanker delivering fuel to AEM's Baker Lake Fuel Tank Facility constructed in Baker Lake. On site personnel at the Facility are expected to respond to minor spill incidents[1] that can be contained and cleaned up without assistance, while the ERT will respond to larger spills.

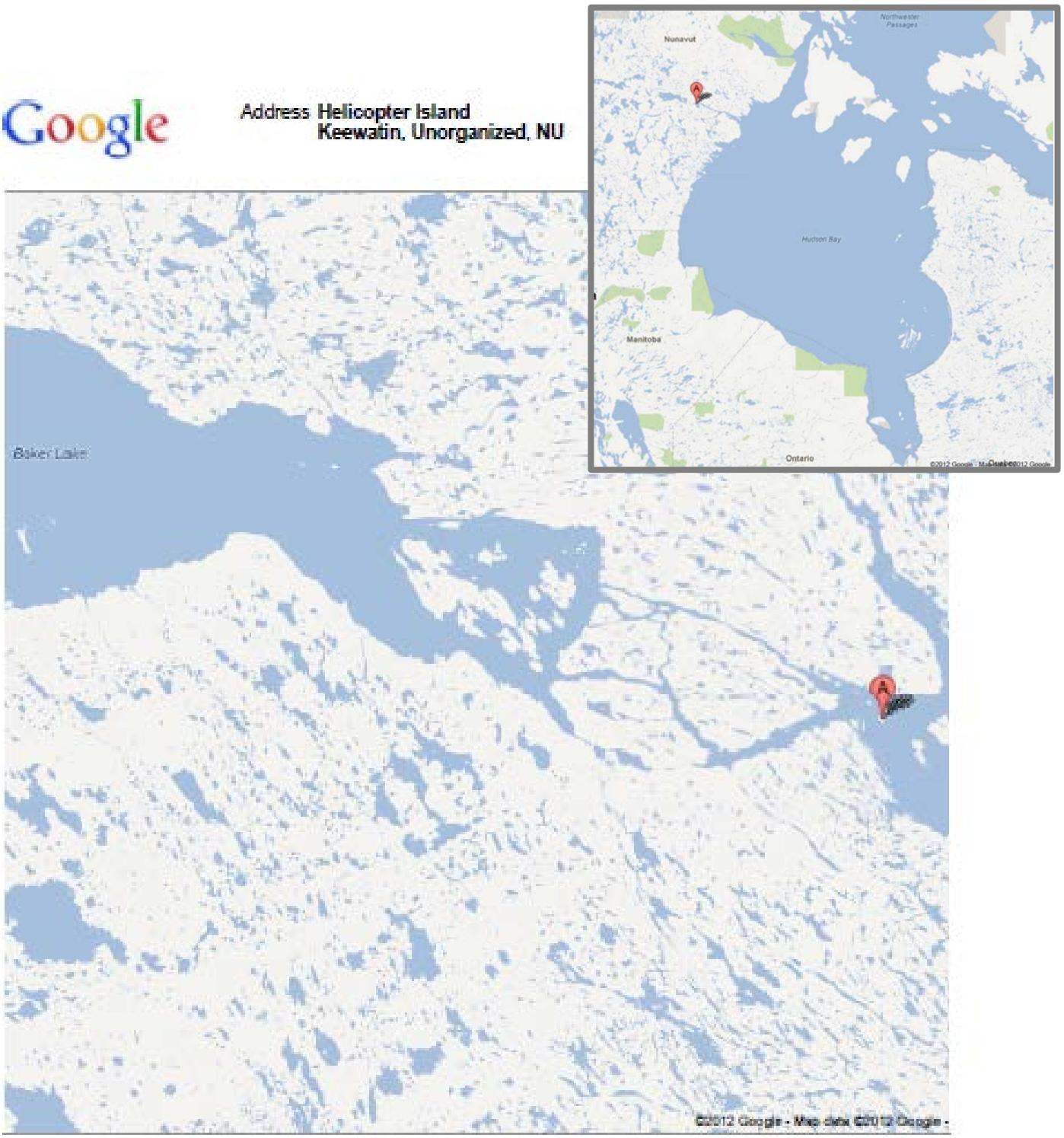
The Shipboard Oil Pollution Emergency Plan (SOPEP) is the responsibility of the shipping company; it covers the ship-to-ship transfer of fuel near Helicopter Island as shown on figure 1-1 (a copy of the contractor's plan is available in Appendix A). The containment and clean-up of inadvertent spills resulting from the tankers in transporting the fuel is the responsibility of the shipping company. In the unlikely event where a large 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[2].

Fuel is being delivered to AEM's Baker Lake Fuel Farm by Coastal Shipping Limited, a Division of the Woodward Group of Companies. Fuel is stored within the existing tank farm owned and operated by AEM. The outline of the SOPEP prepared by Coastal Shipping Limited is attached can be found in appendix A.

[1] A minor incident can be controlled and cleaned up readily by the polluter and has little effect on natural resources, the environment, or public property. Source Environment Canada 2002

[2] 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 1-1 Location of Ship-to-Ship and Ship-to-Shore Fuel Transfers



2. Fuel Storage Facilities and Infrastructure

AEM's Oil Handling Facility (OHF) is located in the area of Baker Lake at latitude 64° 18' 22.778" N and longitude 95° 57' 33.990" W. The location is shown on figure 1-1; figure 2-1 provides more detail. The Fuel Tank Facility consists of six - 10 million litre diesel fuel[3] (10,000 m^3) storage tanks all holding P50 grade diesel. The Facility is located adjacent to AEM's laydown area, approximately 250 metres from the shore of Baker Lake at high tide. Power is provided by a generator for the fuel pump module located next to the tank farm.

The tanks are contained within an impermeable lined and bermed area. The steel fuel tanks have been field-erected and built to API-650 standards with each bermed area holding two tanks. This area is capable of containing 110% of the volume of one 10,000 m3 storage tank. Each impermeable lined and bermed cell has the following:

- A granular base for the tank complete with an impermeable 60 mil HDPE liner system and granular dikes;
- Two – 10, 000 m^3 tanks complete with the required appurtenances such as stairs, base manholes, water draw offs, re-supply nozzle, suction nozzle, tank lighting, tank level monitoring, roof manhole, manual gauge hatch, tank temperature and P/V vent;
- Piping for unloading and loading; and
- Site lighting via fixtures mounted from the dispensing building.; and
- The Fuel Storage Facility also has one re-supply/dispenser building for loading the fuel trailer / truck and other vehicles.

The Tank Farm Facility is designed to meet the following standards:

- National Fire Code 2010;
- *Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations* – 2008; and
- Canadian Council of Ministers of the Environment, "*Environmental Code of Practice of Aboveground and Underground Storage Tank Systems Containing Petroleum Products and Allied Petroleum Products – 2003* (PN1326)"

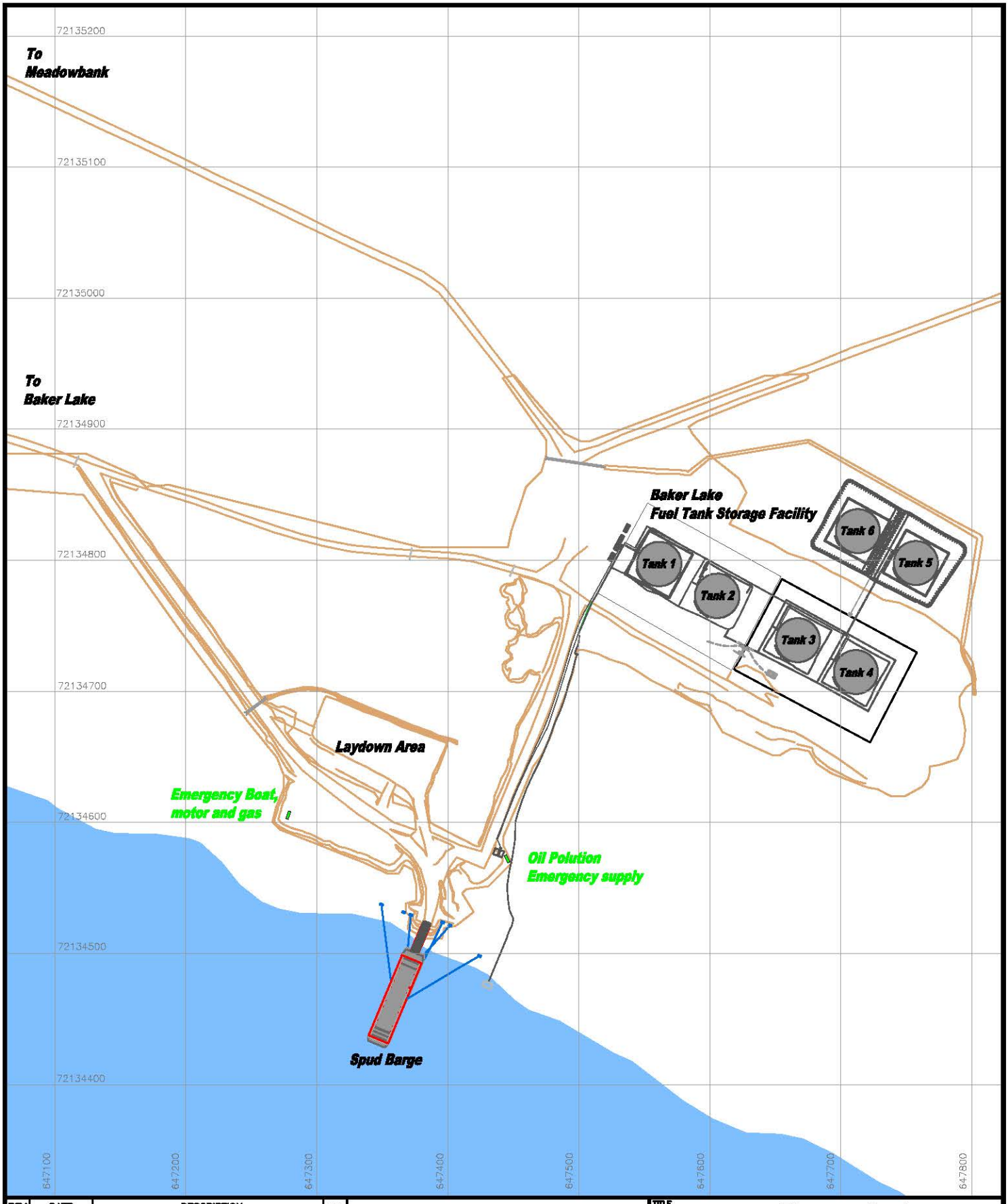
The oil handling facility (OHF) is constructed and operated in accordance with Transport Canada Arctic Waters Oil Transfer Guidelines (TP 10783E) and Oil Handling Facility Guidelines (TP 12402E). The environmental department and ERT team received training from a certified response organization and as a result will be able to respond to all incidents that might occur at the OHF.

A fuel dispensing pad area complete with a dispensing unit is located in a lined facility with a provision to capture any and all spills at the fueling area and direct them to a containment area provided at the tank farm.

All diesel fuel is transported to the mine site by tanker trucks on a year round basis. Tanker trucks are loaded on the fuel dispensing pad at rates of approximately 50 m^3/hr. Fuel loading rates for small

[3] 1000 litres = 1 m^3 of fuel. Cubic metres are used throughout this document.

vehicles is approximately 3 m^3/hr. The facility has incorporated the following; temperature compensated metering system to manage fuel flows, safety valve to prevent loss of fuel from the fuel facility, fire extinguishers, building heating and ventilation systems, building lighting systems and control systems for the pumps.



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TITLE

Figure 2–1

AEM Baker Lake Oil Handling Facility and Laydown Area

SCALE 1:4000	DATE 2012-05-10		
DRAWN BY S. Gaudreault			SHEET 1 / 1
APPROVED BY			
DRAWING NO.			REVISION

C:\Users\sgaudreault\Desktop\V\COMPLIANCE COORDINATOR\Acad drawings\Other\2012 OPEP Figure 2–1.dwg, 31 Aoû 2012

FILE NO.

3. Applicable Federal Acts, Regulations and Guidelines

This Plan was prepared in accordance with federal legislation outlined in Table 3-1, which lists legislative instruments applicable to AEM's Baker Lake Fuel Oil Handling Facility.

Table 3-1 Applicable Acts, Regulation and Guidelines

Federal Legislation		
Acts	**Regulations**[1]	**Guidelines**
Canada Shipping Act	Response Organizations and Oil Handling Facilities Regulations 1995	Oil Handling Facilities Standards – TP12402
	Pollutant Discharge Reporting Regulations, 1995	Environmental Prevention and Response National Preparedness Plan 2008 – TP13585
		Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and /or Marine Pollutants – TP9834E 2009
		Arctic Waters Oil Transfer Guidelines, 1997 - TP10783E
	Environmental Response Arrangements Regulations	Response Organizations Standards – TP 12401E 1995
	An Oil Prevention Emergency Plan is required under the Act [168(3)b]	Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants - TP- 9834E 2009
	Ballast Water Control and Management Regulations	
Oceans Act	Marine Liability Regulations	
Marine Liability Act		
Navigable Waters Protection Act	Transportation of Dangerous Goods Regulations	
Transportation of Dangerous Goods Act	Arctic Waters Pollution Prevention Regulations (C.R.C., c. 354)	
Arctic Waters Pollution Prevention Act	Arctic Shipping Pollution Prevention Regulations	
Canadian Environmental Protection Act	Environmental Emergency Regulations	
	Petroleum Products and Allied Petroleum Products Storage Tank System Regulations (2008)	
International Conventions signed by Canada		
MARPOL 73/78 Annexes	**Objective of Annex is to prevent pollution from:**	
Annex 1	Oil from ships	
Annex 2	Noxious liquid substances carried in bulk	
Annex 3	Harmful substances carried by ships in packaged form	
Annex 4	Sewage treatment and disposal	
Annex 5	Garbage handling	
Annex 6	Air pollution from ships	
International Maritime Dangerous Goods Code		
International Convention for the Safety of Life at Sea, 1974, SOLAS 74		

[1] Only Canada Shipping Act's regulations centered on the environment and that apply to Oil Handling Facility (OHF) and the Oil Pollution Emergencies Plan are listed. Legislative instruments not directly applicable to the OHF are not listed.

4. Related Documents

Management and monitoring plans for Meadowbank mine that provided input to the Oil Pollution Emergency Plan include the following:

1. Spill Contingency Plan;
2. Emergency Response Plan;
3. Shipboard Oil Pollution Emergency Plan[4]; and

The cornerstones of contingency planning for AEM are the Spill Management Plan and the Oil Pollution Emergency Plan. These, coupled with the Emergency Response Plan, describe the processes to be followed in responding to a spill. The OPEP on its own provides the necessary information in the event of a mishap where diesel fuel is lost during the transfer of fuel from a tanker vessel to the Fuel Tank Facility

The OPEP complements the Spill Contingency Plan and it should not be construed as superseding it. The Spill Plan addresses a wider scope of operations stretching 110 kilometres from the Meadowbank mine site in the north to their infrastructure in the south. It is inclusive of more than just diesel fuel, covering other hazardous materials such as Jet A, hydraulic fluids, and chemicals.

The Emergency Response Plan focuses on responding to all emergencies in a timely and adequate manner. Spills are an emergency where the AEM Emergency Response Team will respond. It commits AEM to being prepared for and providing adequate resources - qualified personnel and equipment - to handle a wide variety of emergency situations.

[4] The Shipboard Oil Pollution Emergency Plan (SOPEP) contains all information and operational instructions as required by the "Guidelines for the development of the Shipboard Marine Pollution Emergency Plan" as developed by the International Marine Organization. Woodward's, the shipping company, is responsible for this Plan.

5. Route of Tanker, Anchoring Location and Transfer of Fuel

Coastal Shipping Limited, a division of the Woodward's Group of Companies, is contracted by AEM to supply and deliver diesel fuel to AEM's facilities in Baker Lake. The tanker picking up the fuel will be double hulled, have segregated ballast compartments and would be able to carry up to 20,000 m^3 of diesel fuel. Ballast will not be required during the inward voyage to Baker Lake. However, ballast will be picked up while on anchor outside the access passage after offloading the diesel fuel for its outward journey. A total of three tanker loads of fuel will be required to fill the six tanks in the tank farm, cumulatively holding 60,000 m^3.

The diesel fuel pick-up point is most likely being an east coast refinery (east coast of North America). The marine transport of fuel to Baker Lake will be comprised of four main segments:

- From an east coast refinery along the coast of Labrador to the Hudson Strait;
- Through Hudson Strait to Hudson Bay;
- Across Hudson Bay to Chesterfield inlet; and
- From Chesterfield inlet to Helicopter Island, to an anchoring point outside the access passage to Baker Lake (see figure 2-1).

It is expected that the large tankers delivering diesel fuel will anchor in the same general location as the dry cargo vessels shown on figure 2-2. Ship-to-ship transfer of fuel will occur at this location from the larger tanker to a smaller tanker that can navigate the access passage. The carrying capacity of the small tanker will be either 7,300 m^3 or 10,500 m^3. Which one to be used at any one time will be subject to its availability at the time when the large fuel tanker is set to deliver fuel to AEM's Baker Lake Fuel Farm Facility. The small tanker will anchor directly to AEM's spud barge. From there, transfer hoses are connected to a shore based pipeline for transfer of fuel to the tank farm.

Ballast will not be required for the inward voyage of the small tanker as it arrives at Baker Lake loaded with diesel fuel. After transferring the diesel fuel to the tank farm, the small tanker will take on ballast in its segregated ballast compartments before sailing out to Helicopter Island to pick up another load of diesel from the large tanker anchored outside the access passage. Ballast will be dispelled as ship-to-ship transfer of diesel occurs and the small tanker is loaded with diesel. This sequence of events will be repeated until the large tanker is empty or the tank farm is full.

Due consideration will be given to prevailing and expected wind, weather and tide conditions when undertaking ship-to-ship and ship-to-shore fuel transfers. The large tanker anchored near Helicopter Island and the small tanker anchored near Baker Lake will be clear of land and traffic routes, and in open water of a depth exceeding the draught of the vessel(s). For ship-to-ship transfers, the ships will be secured alongside or anchored.

The small tanker will discharge at a rate of 400 m^3/hr with a 10,000 m^3 tank taking approximately a day to fill. Communications between the shore and the small tanker will be maintained throughout to

ensure the safe transfer of the diesel and to avoid the overfilling of the tanks. The ship-to-shore transfer to be used will be similar to that used at communities throughout Nunavut.

6. Oil Handling Standards

Facility Category

Oil handling facilities are categorized according to their maximum oil transfer rate in cubic metres per hour, in respect of the oil product loaded or unloaded to or from a ship, as follows:

Category of Oil Handling Facility	Maximum Oil Transfer Rate (cubic metres/hour)
Level 1	150
Level 2	750
Level 3	2 000
Level 4	More than 2 000

AEM's proposed oil handling facility at Baker Lake is a level 2 based on a diesel fuel transfer rate of 400 m^3/hr.

Nature of the Oil Product

No fuel other than P50 diesel will be stored at the AEM's Baker Lake Fuel Farm. All other fuels such as Jet A, gasoline and possibly other grades of diesel will be purchased in drums and brought to the mine site for storage into the Meadowbank Fuel Storage Facility.

Tides and Currents that Prevail at the Facility

There is a general southward current in Hudson Bay at Chesterfield Inlet of about 19 km/day (CCG 2008). Tides are 4.6 metres with strong cross-currents at Chesterfield Inlet; usually flowing SW at about 1.85 km/hr.

Meteorological Conditions Prevailing at the Facility

Monthly meteorological data has been collected from 1971 to 2000 from the Baker Lake "A" climate station, which is a Meteorological Service of Canada climate station. Snow and rain are combined to give monthly average precipitation. The prevailing winds for the area are generally from the N to NW and average 20.4 km/hr.

In table 6-1 below the meteorological records for the entire year are presented even though AEM will only receive fuel during the open water season – July to October. There will not be any shipping requiring ice breaking nor will any ships or barges holding fuel be left to freeze in over the winter.

Table 6-1 Summary of Baker Lake Meteorological Data

Month	Baker Lake A Climate Station (1971 to 2000)				
	Monthly Means Air Temperature (°C)	Precipitation (mm)	Mean Monthly Relative Humidity [%]	Average Wind Speed (km/h)	Most Frequent Direction (8 point compass)
January	-32.3	7.5	65.3	23.7	NW
February	-31.5	7.2	64.5	22.9	NW
March	-27.2	10.5	65.3	21.6	NW
April	-17.4	13.6	72.9	20.5	NW
May	-5.8	15.6	82.0	19.4	NW
June	4.9	24.1	74.8	16.5	E
July	11.4	41.8	69.5	16.6	N
August	9.5	47.0	75.5	17.7	NW
September	2.6	44.1	80.9	19.4	NW
October	-7.5	32.1	83.0	21.8	NW
November	-20.1	17.0	72.5	22.3	NW
December	-28.4	10.2	66.7	22.7	NW
Annual Average/Total	-11.8	270.4	72.8	20.4	NW

Measures to Minimize a Diesel Pollution Incident

The small tanker will be anchored offshore in water of sufficient depth to allow for draught and tidal changes during transfer.

The transfer of diesel fuel will use sound, well rehearsed practices, include an adequate number of trained and alert personnel, have sufficient materials, and use well maintained, thoroughly tested equipment. A team of trained personnel on the tanker will be in charge of the tanker fuel transfer equipment while an onshore team will be in charge of the land based transfer equipment. Fire-fighting and spill response equipment and supplies will be located on the tanker and onshore near to the

transfer point as required by Transport Canada. This will include readily available absorbent material at the flexible hose connections on deck and onshore to quickly address minor spills at predictable minor spill locations. Additionally, AEM has placed a sea can with spill response supplies (including boat) and equipment at AEM's Baker Lake Fuel Farm area where it can quickly be accessed in the event of a spill.

Four-inch (10 cm) steel piping able to accommodate a flow rate of approximately 400 m^3/hr will lead down to the shore from the proposed diesel fuel tank farm. Transfer hoses from ship-to-shore will be connected to the fuel-receiving manifold located onshore using a dry-break coupling(s). All connection points will be protected with save-alls. Other measures to be taken to minimize and prevent spills include:

- During the transfer, constant monitoring will be undertaken for detection of incipient spills and leaks between the tanker and the tank farm;
- Transfer operations will be suspended should any leak be detected;
- The onshore area and ship deck will be well lit as fuel transfers could continue around the clock;
- Minimization of land drainage containing spilled diesel to limit the amount reaching the marine environment;
- The regular update of the OHF Plan.

During the ship-to-shore transfer, AEM will have personnel on location at all times to monitor the fuel transfer and maintain contact with the tanker's crew. Should problems arise, the ship can be called to shut down the transfer and onshore piping will be closed down. In the event of a spill that escapes the containment boom, diversion booming will be deployed to minimize migration of a spill throughout Baker Lake.

Spills within the tank farm will be contained by the bermed, lined areas. Each bermed and lined area has sufficient storage to hold 110% of the largest tank. All fuel transfers from the tank farm to tanker trucks and small vehicles will occur on a pad that can contain any spilled product with the overflow being directed into the bermed area. Spilled diesel will not have the opportunity to migrate to the marine environment from this area.

Effective Time Line for a Response to a Diesel Pollution Incident

AEM and contractor personnel at Baker Lake Fuel Farm will be trained to respond to minor spills if it is safe to do so. This would be done without activating the Spill Contingency Plan, the OPEP or the Emergency Response Plan (ERP). Should it be proven necessary to activate the ERP, the Emergency Response Team located at Meadowbank site can realistically be on site within 120 minutes (or less) ready to commence containment and clean up activity.

7. Spill Response Procedures

AEM's Fuel Handling Facility is located 110 kilometres by road from the Meadowbank Mine site. A single AEM Emergency Response Team will be available to respond to all spill incidents, the proposed spill response sequence is schematically shown in figure 7-1.

Spill response procedures found in the Spill Contingency Plan and in the Oil Handling Facility Plan are one and the same. In this OPEP, the procedures have nonetheless been abridged to only address spills of diesel fuel at AEM's Baker Lake Fuel Farm Facility.

INITIAL SPILL RESPONSE PRIORITIES

SAFETY FIRST

1. RESPOND QUICKLY

a. Identify the spilled material.
b. Ensure safety of yourself and others.
c. Shut off ignition sources - NO SMOKING.
d. Attend to injured.
e. Assess the severity of the spill.
f. Call for assistance.
g. **On-site Manager mobilizes Emergency Response Team**.
h. Keep unnecessary people out of the area.
i. Wear impervious clothing, goggles, and gloves.
j. Approach spill from upwind IF **SAFE TO DO SO**.
k. Stop product flow if possible.
l. Contain and recover spill as soon as possible.
m. Notify the regulatory authorities.

2. RESPOND SAFELY

a. Do not contain diesel fuel if vapors might ignite.
b. Allow diesel fuel vapors to evaporate before intervention. Volatile components of diesel fuel are not as concentrated as gasoline or aviation fuel and are not as dangerous but caution should still be contemplated.

A proficient and timely response to a spill will be dependent on the following:

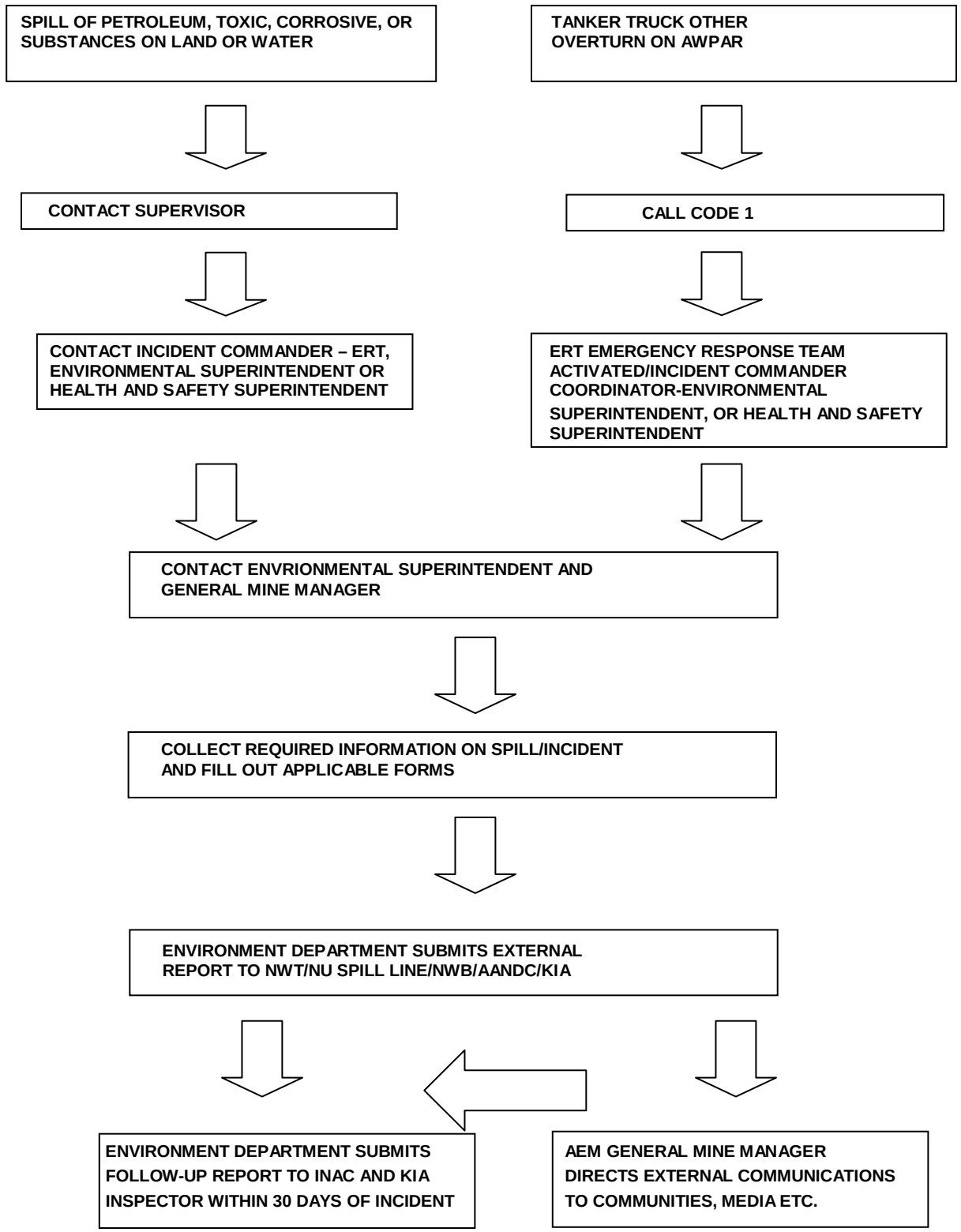
- Compiling and exercising contingency and emergency plans regularly and thoroughly, to familiarize all personnel involved with the essential needs and hazards of such operations.
- Immediately activate the OPEP in response to a spill;
- Safeguard life and property;
- Take immediate actions to lessen the environmental impact of the spill; and

- Ensure prompt and accurate reporting of diesel spills to enable responsible authorities to mobilize resources and take appropriate measures, if required, to lessen the impact of such an event.

For that purpose AEM has located a sea can with spill response equipment near the Baker Lake shore within AEM's Marshaling area and includes booms that can rapidly be deployed to limit the spread of any spill on water. The ERT stationed at the Meadowbank site will be able to respond within two hours.

The first person (first responder) to notice, or come in contact with, any spill situation either initiates a Code 1 (in the case tanker truck overturns on the municipal road or AWPR) or reports to his/her immediate supervisor (in the case of spills on land, ice or water). The supervisor is responsible to report the incident to the designated Incident Commander for a major spill or to the environment department for a minor spill. A Code 1 is initiated in the instance a tanker truck over turns, and the incident commander will respond in conjunction with the ERT. Major responsibilities such as initial coordination,

Figure 7-1 Spill/Incident Reporting Procedure Sequence



Spill clean-up and mobilizing the Emergency Response Team (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 VP, 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, Canadian Coast Guard[5], and Aboriginal Affairs and Northern Development Canada. Incidents that require media communications will be the responsibility of AEM General Mine Manager or alternate.

First Responder

The person who has caused a spill or is 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, ice 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.

Supervisor

The responsibilities of the Supervisor are as follows:

- Initial assessment of the severity of the incident;
- Contact the Incident Commander;
- Gather facts about the spill; and
- Participate in spill response as a member of the clean-up crew.

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;
- Activate the initial response plan;
- Alert and assemble key personnel in the response team, as deemed appropriate, to handle the situation;

[5] Only spills in the marine environment will be reported to the Canadian Coast Guard.

- 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 requirement 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;
- 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.

8. Emergency Response Team

AEM have an Emergency Response Team (ERT) at its Meadowbank Gold Mine trained and responsible for controlling the large spills as well as spills from tanker truck overturns along the municipal bypass road and AWAR, AEM's Baker Lake laydown and tank farm, and for assisting with medical and other emergencies that may occur at the camp. Team members will attend regular training.

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 fulfil their responsibilities as part of the ERT.

Environmental Superintendent or Designate

The Environmental Superintendent or designate is responsible for implementing and maintaining the SCP. In addition, the Environmental Superintendent's or designate's 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 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; and
- If authorized by the General Mine Manager, act as a spokesperson with the public and media, as required.

General Mine Manager or designate

The General Mine Manager or designate is required to inform team members of the detailed nature of the operations to be performed in the event of a facility malfunction causing a 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.

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), Hazard Communication (HAZCOM), Occupational Health and Safety Administration (OHSA), first aid, and respirator fit-testing prior to expiry of existing training certification; and
- Consult with appropriate organizations regarding retraining requirements and schedules.

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 could be called for assistance, if required. They may become the first to respond to injury incidents at AEM's Fuel Farm Facility and Laydown area because of their proximity to the site.

9. Spill Response Team Contact Information

Internal contact information is contained in table 9.1 for all AEM personnel involved in spill recovery and subsequent reporting. Table 9.2 provides contact information for AEM contractors present at the mine site. Important external contacts such as regulatory agencies and health organizations are listed in table 9.3. Table 9.4 provides contact information for external contractors should incident warrant assistance from outside sources. Table 9.5 provides available equipment stored in sea can by AEM's Marshaling area in Baker Lake.

Table 9-1 Internal Contacts

Title	Name	Telephone No.
Vice President, Environment and Sustainable Development	Louise Grondin	(416) 847-8656 Cell:819-724-2020
Corporate Director, Communications & Public Affairs	Dale Coffin	(416) 847-8669 Cell: (647) 274.4154
Corporate Director , Regulatory and External Affairs	Denis Gourde	(819) 759-3700 Cell: (819) 856-7863
Manager of Regulatory Affairs Nunavut	Stephane Robert	(819) 759-3700 ext. 5188 Cell: 819-763-0229
General Mine Manager	Dominique Girard	(867) 793-4610 ext. 6910 Cell: (819) 856-7863
Health and Safety Superintendent	Normand Ladouceur	(867) 793-4610 ext. 6720
Emergency Response Team	André Rouleau/Philip Beaudoin	(867) 793-4610 ext.6809
Environmental Superintendent	Kevin Buck	(867) 793-4610 ext. 6838
Environmental Coordinator or Environmental Department	Jeffrey Pratt Or Environmental Technicians	(867) 793-4610 ext. 6728 Or (867) 793-4610 ext. 6747
Incident Commander	Jeffrey Pratt/Kevin Buck	(867) 793-4610 ext. 6728 (867) 793-4610 ext. 6838
On site Medics	On-site Nurses	(867) 793-4610 ext. 6734
Site Security	On-site Security	(867) 793-4610 ext. 6748

Table 9-2 Contractor Contacts

Title	Telephone No.
Nolinor Aviation Services	Protocol Agent (867) 793-4610 ext. 6808
First Air	(867) 446-1744
Calm Air	(867) 793-2873
Dyno Nobel Explosives Ltd.	(867) 793-4610 ext. 6804
Woodward Group of Companies (Shipping)	(709) 896-2421 or (709) 896-6569

Table 9-3 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) 979-8637	(867) 979-8501
Kivalliq Inuit Association	(867) 645-5725	(867) 645-2348
Nunavut Water Board	(867) 360-6338	(867) 360-6369
AANDC Inspector	(867) 975-4548	(867) 979-6445
Environment Canada, Enforcement Branch	(867) 975-4644	(867) 975-4594
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	(867) 793-2813
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)	(800) 265-0237	(519) 337-2498

Table 9-4 External Spill Response Contractor Phone Numbers

Contractor	Telephone No.	Area of expertise
Local		
Baker Lake Contracting & Supplies	(867) 793-2831	General Contracting and Repairs
Peter's Expediting	(867) 793-2703	Transportation
NWT ltd. (Arctic Fuel)	(867) 793-2311	Fuel Transportation

Table 9-5 Material available in the Spill Response Sea Can at AEM's Fuel Farm Area

Quantity	Equipment/tool name
3	Empty drums (sealed)
2	Mini Berm 36"x 36"
2	4 Drums Berm 4'x 8'
4	Tarp 20'x 30'
4	Tarp 30'x 50'
10	Oil Spill Absorbent Pads
5	Universal Absorbent Boom 5"x 10' (For Hydro-soluble Chemical)
5	Universal Absorbent Boom 8"x 10' (For Hydro-soluble Chemical)
5	Petroleum base Absorbent Boom 5"x 10' (for Petroleum product)
3	Maritime Barrier (Baffle)
5	ABS pipe: 10' long x 4" diameter
2	Cell-U-Sorb (Absorbent)
2	Amerisorb Peat moss (Absorbent)
2	Oil Gator Absorbent
1	Plug Patties
4	Quatrex bags
2	Fork Lift Crate
4	Hand Shovel
1	Cro Bar Chisel
1	Ice Breaker Chisel
1	Sledge hammer
15	Rod bar 4'
1	½ drum containment
1	Boat with motor and gasoline jerry can (sea can #321225)

10. Training

On-site Personnel

A designated Emergency Response Team (ERT) consisting of on-site personnel is established at AEM's Meadowbank Mine Site. AEM will ensure that the ERT is trained and staffed in sufficient number so that the ERT is present at all times. All members of the team will be trained and familiar with emergency and spill response resources, including their location and access, the Spill Contingency Plan, the Oil Pollution Emergency Plan and appropriate emergency spill response methodologies. The ERT will have up to 60 members, each of whom will train approximately 8 hours per month.

The training will include the following:

- 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;
- Worker health and safety during emergency interventions;
- Communication methods and signals;
- Desktop exercises of "worst case" scenarios;
- Emergency evacuation;
- Fires or explosions;
- Emergency equipment and use;
- Personal protective equipment and clothing;
- Marine shoreline recovery operations; and
- The likely causes and possible effects of spills.

Every employee at the Meadowbank project will receive 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 will receive more extensive HAZMAT training and learn how to respond while wearing personal protective clothing.

The Environmental Department will regularly provide tool-box sessions to give information on spill response and reporting procedures.

11. Reporting

To ensure compliance with Section 36(3) of the *Fisheries Act*, all spills of fuel or hazardous materials, regardless of quantity, into a water body or onto ice will be reported immediately to the NT-NU 24-HOUR SPILL REPORT LINE (phone: (867) 920-8130, fax: (867) 873-6924, spills@gov.nt.ca). Spills to the marine environment will also be reported to the Canadian Coast Guard (phone: (800) 265-0237, fax: (519) 337-2498). Marine spills will be reported in accordance with Transport Canada Guideline TP-9834E, *Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and /or Marine Pollutants*. This guideline is attached in Appendix B. Others to receive the spill report include the Kivalliq Inuit Association, Hamlet of Rankin Inlet, and Fisheries and Oceans Canada.

12. Treatment and Disposal

All diesel fuel recovered through the spill response and any contaminated material will be taken to the Meadowbank mine site for recovery and, if applicable, incineration. It could also be packaged for disposal/recycling by a certified hazardous waste management company in southern Canada.

13. Spill Scenarios and Response Strategies

AEM will strive to prevent any accidental spills and take all reasonable steps to minimize the risk of spill incidents and their impact on the environment. Response personnel will have safety and spill response training. Use of personal protective equipment around water will be part of this training; this will include personal floating devices.

The minimum size of an oil pollution incident, in respect of each single oil product loaded or unloaded to or from a ship, for which a response needs to be described in the oil pollution emergency plan for a Level 2 facility is 5 cubic metres.

P50 Diesel is a bright oily substance that has a low viscosity. It spreads rapidly on the water, has a low solubility in salt water (60 mg/L), and a high evaporation rate as described in the text box below. At Baker Lake, the wind is largely from the NW to N.

Predicted Evaporation Rate of Spilled Diesel

Weight percent Evaporation = (5.8 + 0.045T) in(t)
Where T = water temperature
t = time in minutes

After a time span of 60 minutes at a surface temperature of 5°C, up to 25 % weight of the spilled diesel would have evaporated.

After 240 minutes, or 4 hours, the weight percent of the diesel that would have evaporated would be 33%.
Source: *Environment Canada, Emergencies Science and Technology Division*

As a result of the properties of diesel and the environmental conditions that predominate at Baker Lake, the spill response will need to aim to stop the spilled product from spreading across Baker Lake. This could include activating the Shipboard Oil Pollution Emergency Plan. The tanker would have response equipment on board and a fully trained crew in spill response. This, coupled with a shore based response under the OPEP, would ensure sufficient resources are available to control and recover as much diesel fuel as feasible. The following scenarios were developed with this in mind.

There are a number of safeguards in operating the ship-to-shore pipeline; these include:

- save-all trays to capture any minor spills at the ends of the floating pipeline;
- dry-break couplings at both ends of the floating pipeline;
- A pressure test will be performed before the diesel transfer to confirm the system is free of leaks
- Both the crew on the tanker and AEM's shore based personnel will be fully trained in spill response and spill recovery.

Five scenarios are considered, these being:

1. A leak at the ship based end of the floating pipeline resulting in the maximum loss of 100 to 600 litres of diesel fuel;
2. A leak at the shore based end of the floating pipeline resulting in the maximum loss of 20 to 600 litres of diesel fuel;
3. A major failure in the floating pipeline with 5,000 litres of fuel lost to the marine environment due to a rupture;
4. A major failure outside the tank farm resulting in the loss of 5,000 litres of diesel fuel[6]; and
5. At the municipal and AWAR road a tanker truck holding 40,000 litres turns over with its contents migrating towards the marine environment.

In most instances AEM personnel and/or contractors will be able to respond to the spill but if necessary, backup can be requested by calling for the assistance of the AEM Emergency Response Team that is stationed at the Meadowbank site located 110 kilometres away. The ERT can be at Baker Lake within 120 minutes to take charge of the spill response.

Scenario 1: Loss of diesel fuel onboard the tanker

Quantity spilled: 20 to 600 litres

Appropriate Actions	Resources
1. Stop the ship-to-shore transfer of diesel. 2. Try to contain the spilled diesel on the deck and keep it from flowing overboard into the marine environment. 3. Containment boom is manned to prevent the escape of diesel outside the boom 4. If necessary, place a diversion boom outside the containment boom to stop the diesel from getting onto the beach. 5. Spread absorbent material on the spill to capture it. 6. For larger amounts of spilled materials on water, use a skimmer to collect the spilled diesel and afterwards use absorbents to capture for residual amounts. 7. Monitor any diesel that could not be recovered and collect water samples near the spill site and in the access passage for analysis. Repeat as necessary 8. If diesel reaches the beach, excavate the	a. Crew on the tanker trained in spill response b. Crew from the large tanker anchored outside the access passage c. AEM's shore based personnel trained in spill response and recovery d. Emergency Response Team to take control of the spill response and recovery e. Spill response equipment and supplies maintained on board the tanker and also in the sea can located on shore of AEM's Fuel Farm and Marshalling area f. Save-alls placed under the pipeline manifolds to collect minor spills g. Shore-based boat to position booms h. Skimmer to recover spilled diesel on sea water i. Heavy equipment such as excavators, back hoes, vacuum trucks, and dump trucks

[6] Loss of diesel within the bermed and lined areas of the tank farm will be contained and recovered without any impact on the environment.

contaminated beach material and take it to the biopile treatment area at the Meadowbank site. 9. Notify local and regulatory authorities.	

Scenario 2: Loss of diesel fuel onshore

Quantity spilled 20 – 600 litres

Appropriate Actions	Resources
1. Stop the ship-to-shore transfer of diesel 2. Close all valves to the tank farm 3. Place a berm of any material between the spill and the high tide mark to stop the migration of the diesel to the marine environment, or dig a trench and line it with plastic sheeting between the spill and the high tide mark to capture the spilled diesel and use a vacuum truck to recover it 4. If the spill reaches the water, place a sorbent boom along the shoreline to collect and contain the spill next to the beach and to stop its spread. 5. For smaller quantities of diesel, spread absorbent materials on the spill to capture it 7. For larger amounts of spilled materials, use a skimmer to collect the spilled diesel contained within the booms and afterwards use absorbents to capture residual amounts. 8. Monitor any free floating diesel that could not be recovered and collect water samples near the spill site and in the access passage for analysis. Repeat as necessary 9. Excavate contaminated soil and move it to the biopile treatment area at the Meadowbank site 9. Notify local and regulatory authorities	a. Crew on the tanker trained in spill response. b. Crew from the large tanker anchored outside the access passage c. AEM's shore based personnel trained in spill response and recovery d. Spill response equipment and supplies maintained on board the tanker and also in the sea can at Itivia e. Save-all placed under the pipeline connection to collect minor spills f. Shore-based boat to position booms and spread absorbent materials g. Emergency Response Team to take control of the spill response h. Skimmer to recover spilled diesel on sea water i. Heavy equipment such as excavators, back hoes, vacuum trucks, and dump trucks

Scenario 3. Loss to the marine environment from a pipeline rupture

Quantity spilled 5,000 litres

Appropriate Actions	Resources
1. Stop the ship-to-shore transfer of diesel 2. Containment boom is manned to prevent the escape of diesel 4. Place a sorbent boom within the containment boom to collect and prevent the diesel from getting onto the beach. 5. Deploy skimmer to recover as much diesel as possible and spread absorbent material afterwards to capture any residual diesel remaining	a. Crew on the small tanker trained in marine spill response b. Crew from the large tanker anchored outside the access passage c. AEM's shore based personnel trained in near shore spill response and recovery d. Emergency Response Team trained for near shore spill response e. Call the Canadian Coast Guard for assistance

6. Monitor any free floating diesel that could not be recovered and collect water samples near the spill site and in the access passage for analysis. Repeat as necessary 7. If diesel reaches the beach, excavate the contaminated beach material and move it to the biopile treatment area at the Meadowbank site 8. Notify local and regulatory authorities	f. Spill response equipment and supplies maintained on board the tanker, in AEM sea can located at AEM's Marshalling area and the Coast Guard sea can of spill response equipment and supplies located in Baker Lake f. Skimmer to recover spilled diesel g. Additional booms to place outside the containment boom h. Shore-based boat to position booms and spread absorbent material i Heavy equipment such as excavators, back hoes, vacuum trucks, and dump trucks for waste materials

Scenario 4: A major spill outside the tank farm area

Quantity spilled 5,000 litres

Appropriate Actions	Resources
1. Stop the ship-to-shore transfer of diesel 2. Close all valves to the tank farm 3. Place a berm of any material between the spill and the high tide mark to stop the migration of the diesel to the marine environment or dig a trench and line it with plastic sheeting between the spill and the high tide mark to capture the spilled diesel and use a vacuum truck to recover it 4. If the spill reaches the water, place a sorbent boom along the shoreline to collect and contain the spill next to the beach 5. For smaller quantities of diesel in the water, spread absorbent materials on the spill to capture it 7. For larger amounts of spilled materials, use a skimmer to collect the spilled diesel contained within the booms and afterwards use absorbents to capture residual amounts. 8. Monitor any free floating diesel that could not be recovered and collect water samples near the spill site and in the access passage for analysis. Repeat as necessary 9. Excavate contained soil and move it to the biopile treatment area at the Meadowbank site 10. Notify local and regulatory authorities	a. Crew on the tanker trained in spill response. b. AEM's shore based personnel trained in spill response and recovery c. AEM's Emergency Response Team d. Spill response equipment and supplies maintained on board the tanker and also in the AEM sea can located at AEM's Marshalling area e. Save-all placed under the pipeline connection to collect minor spills f. Shore boat to position booms and spread absorbent materials g. Activate the Emergency Response Team to take control of the spill response h. Skimmer to recover spilled diesel on sea water i. Heavy equipment such as excavators, back hoes, vacuum trucks, and dump trucks

Scenario 5. Tanker truck rolls over along the road next to a bridge

Quantity spilled 40,000 litres

Appropriate Actions	Resources
1. Call a code 1 to mobilize the Emergency Response Team trained in responding to tanker mishaps along roads 2. If the tanker is not empty, seal the leak if possible but **ONLY IF IT SAFE TO DO SO** 3. AEM Marshalling personnel to take initial actions **IF IT SAFE TO DO SO** 2. Place a berm of any material between the spill and the shore line to stop the migration of the diesel to the marine environment or dig a trench or sumps between the spill and the high tide mark, line them with plastic sheeting to capture the spilled diesel and use a vacuum truck to recover it 4. If the spill reaches marine water, place a boom along the shoreline to contain the spill next to the beach to stop its spread. 5. For smaller quantities of diesel in the water, spread absorbent materials on the spill to capture it 7. For larger amounts of spilled materials, use a skimmer to collect the spilled diesel contained within the booms and afterwards use absorbents to capture residual amounts. 8. Monitor any free floating diesel that could not be recovered and collect water samples near the spill site and in the access passage for analysis. Repeat as necessary 9. Excavate contained soil and move it to the biopile treatment area at the Meadowbank site 10. Notify local and regulatory authorities	a. AEM's shore based personnel trained in spill response to take initial actions b. AEM's Emergency Response Team to take control of the spill site c. Spill response equipment and supplies stored in AEM's sea can at Itivia d. Shore based boat to position booms and spread absorbent materials e. Skimmer to recover spilled diesel on sea water f. Heavy equipment such as excavators, back hoes, vacuum trucks, and dump trucks

14. Preventive Measures

AEM recognises that spill prevention is more desirable than any modern efficient cleanup measures after the fact. Preventive measures have been adopted in relation to any transport, transfer, use and storage of diesel fuel. The tankers carry a Ship Oil Pollution Emergency Plan (SOPEP) as per the MARPOL 73/78 requirement under Annex I. All ships with 400 GT and above must carry an oil prevention plan as per the norms and guidelines laid down by the International Maritime Organization (IMO).

A SOPEP contains the following things:

- The action plan contains duty of each crew member at the time of spill, including emergency muster and actions;
- general information about the ship and the owner of the ship etc.;
- Steps and procedure to contain the discharge of oil into the sea using SOPEP equipments;
- On-board Reporting procedure and requirement in case of oil spill;
- List of authorities to contact and reporting requirements in case of oil spill. Authorities like port state control, oil clean up team etc. are to be notified;
- drawing of various fuel lines, along with other oil lines on board vessel with positioning of vents, save-all trays, etc.;
- General arrangement of ship, which includes location of all the oil tanks with capacity, content, etc.; and
- The location of the SOPEP locker and contents of the locker with a list of inventory. (Marine Insight 2012)

The Spill Contingency Plan, Emergency Response Plan and the Oil Pollution Emergency Plan identify potential causes of emergencies and provides for the development and implementation of strategies to minimize the likelihood of the same.

As described in the Spill Contingency Plan, exercises are part of training for the Emergency Response Team. This will include comprehensive spill response exercise to practice the use of spill response equipment, including the use of booms and skimmers.

If necessary, the OPEP will be updated annually based on the results of spill exercises, changes to the infrastructure at AEM's Fuel Handling Facilities, changes to procedures and other variables. The updated OPEP will be distributed to the AEM Emergency Response Team, Transport Canada, the Kivalliq Inuit Association, the Municipality of Baker Lake and other agencies as appropriate.

15. References

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Transport Canada Guideline, TP-10783E, 1997. *Arctic Waters Oil Transfer Guidelines,* Prairie and Northern Region, Marine (AMNS - OTT)

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Transport Canada Guideline TP- 9834E, 2009. *Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and /or Marine Pollutants*.

Oil Pollution Emergency Plan

The project requirements for an Oil Pollution Emergency Plan are covered in the Quality, Safety, Security and Environment (QSSE) management system of the shipping contractor / partners. This QSSE management system is comprised of several manuals on various topics and is schematically presented below in annex 1.

Also, we summarily reference below the QSSE documentation and manuals that include the listed requirements.

AEM shall present an Oil Pollution Emergency Plan for all Project-related shipping, in connection with the SOPEP (Standard Shipboard Oil Emergency Plans), the Wildlife Mitigation and Monitoring Plan, and other related plans as applicable. This plan includes the following:

Applicable environmental legislation, regulations Acts and guidelines associated with shipping, including:	**Shipping contractor/partners QSSE Management system references.**
➢ International legislation, such as: MARPOL Convention, Protocols and Annexes as set out by the International Maritime Organization (IMO, 2008; MARPOL 73/78)	Environmental legislations are included in our QSSE Management System which covers, among others, MARPOL and International Management Code for the safe Operation of Ships and for Pollution Prevention (ISM Code).
➢ Canadian legislation, such as: Canada Shipping Act, Arctic Waters Pollution Prevention Act (e.g., the Zone/Date System, the Arctic Ice Regime Shipping System, Ice Navigators if applicable)	Those regulations are included in our QSSE manuals, including Arctic water certification and requirements.
➢ How the Proponent and its shipping contractors/partners intend to either meet or exceed these requirements for both barging and deep sea shipping operations and for all marine shipping alternatives	Requirements of our QSSE Management System meet and exceed necessary legal requirements and are including the far reaching Tanker Management Self Assessment (TMSA) and Green Marine programs.
➢ Description of basic contingency planning asso ciated with the marine transportation component of the project, particularly in relation to the movement of oil, explosives and other hazardous materials;	Contingency planning is covered in the Office Contingency Plan, Vessel Contingency Plan and Shipboard Oil Pollution Emergency Program (SOPEP) and also through specific contingency plan developed as required.
➢ Provide a hazard identification analysis of the barge and ship routes and a preliminary risk analysis of the marine routes under consideration along with intended methods of mitigating marine transportation risks;	Most hazards of Arctic navigation are included in our extensive Arctic Navigation Guide which is complemented by a written risk assessment for each voyage permitting proper additional measures to be implemented.
➢ Discussion of proposed safety measures;	Safety measures are included in our Health,

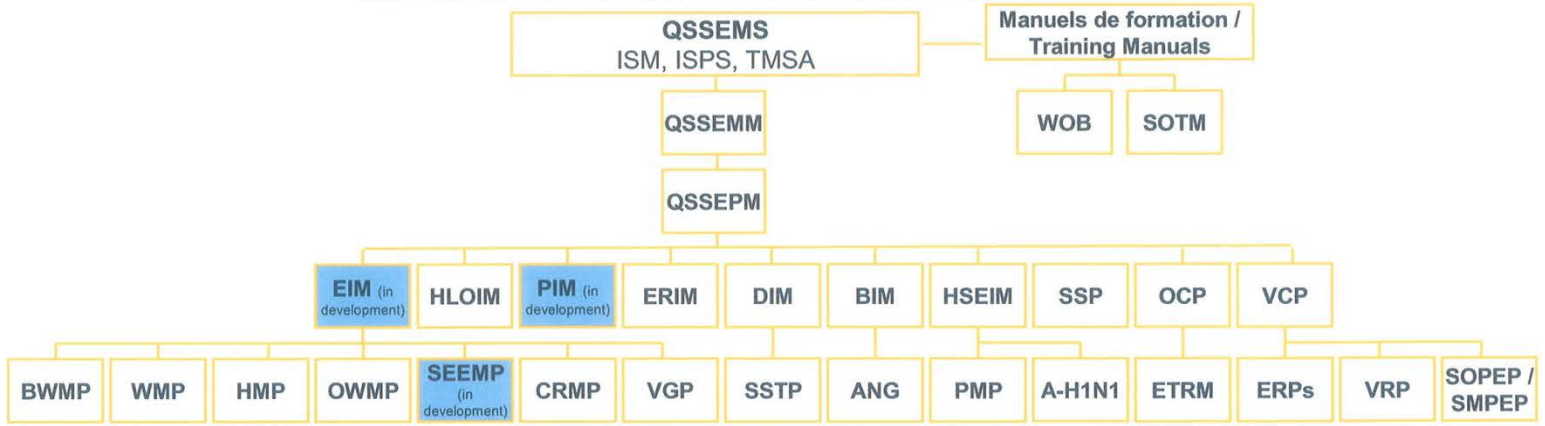
	Safety and Environmental Instruction Manual.
➢ Disposal plans and management for onboard was te including solid waste and sewage/grey water while docked at the dock facility and while in transit. Plans should include discussion on how the Proponent and its shipping contractors/partners intend to either meet or exceed legislation and/or regulations requirements;	Proper procedures are included in the Waste Management Plan, Engine Room Instruction Manual and by our commitment to Green Marine Program that meets and exceeds regulatory requirements.
➢ Ballast water management plan for all Project shipping, with indication of the proposed ballast water exchange locations in mid-ocean, at the dock facility in Rankin Inlet, and alternative exchange zones within waters under Canadian jurisdiction. Include associated implications for regulatory compliance (Government of Canada, 2006);	The regulatory requirements of ballast water management are all included in the Ballast Water Management Plan specifically developed for each vessel and approved by the Transport Canada.
➢ Proposed measures to eliminate or reduce the risk of invasive aquatic and non-aquatic species being introduced into Canadian waters as a result of shipping;	Those risks are included in our Ballast Water Management Plan and by our commitment through Green Marine Program best practices. Ballast water exchange is performed by every vessel coming from outside the Exclusive Economic Zone waters.
➢ Discussion of whether the shipping route or part of the proposed shipping route is a compulsory or non-compulsory pilotage area, and associated implications for regulatory compliance (Government of Canada, 2009) if applicable;	Our vessels comply with pilotage regulations.
➢ Marine wildlife mitigation and onboard monitoring plans, including: • Applicable guidelines, monitoring protocols, and reporting/action procedures • Measures to minimize the potential interactions between marine mammals and marine vessels • Description of how interactions between marine mammals and shipping operations will be dealt with	Monitoring and mitigation plans are developed for each specific project as required.
➢ Details regarding the proposed procedures for accident, malfunctions and incident management and reporting, including accidental spills of fuel and chemicals along the shipping routes, and from the accidental grounding/stranding of ships along the shipping routes. This should include	Procedures for such accidents/incidents are included in the Office Contingency Plan, Vessel Contingency Plan and Shipboard Oil Pollution Emergency Program (SOPEP) approved by Transport Canada. An emergency team is also

a discussion of the preparedness of adequate resources to respond to a large fuel spill from a cargo vessel in transit, with reference to the SOPEPs;	setup.
➢ Measures to mitigate potential impacts to the safety of persons traveling boats along Project shipping routes;	Those types of measures are included in our Bridge Instruction Manual.
➢ Smuggling prevention measures;	The Company has a Drug & Alcohol Policy stating that vessels are operating as ''dry ships''. Also, our Ship Security Plan includes access control to the vessel.
➢ Identified third party liabilities; and,	Proper insurance coverage is undertaken.
➢ Measures intended to mitigate potential socio-economic impacts as results of shipping.	Appropriate socio-economic measures will be applied as required.

Where the reference to SOPEPs contained in the NIRB's guidelines refers to the following:

➢ Requirements of national laws and regulations, as well as international regulations and standards for proposed shipping operation of the Project;	All laws and regulations are included in the SOPEP, which is approved by Transport Canada.
➢ Marine transportation to be used for the Project including fuel tankers, container ships, barges, tugs, and any other marine vessels;	Every vessel required to have a SOPEP have one, duly approved by Transport Canada, onboard.
➢ Discussion regarding the relationship between SOPEPs and the Canadian Coast Guard's Regional Response Plan, including identification of potential for the Regional Response Plan to be adapted to the Project;	If the project goes forward, the shipping contractor commits to have the proper discussion with the Canadian Coast Guard and response organization in order to adapt the Company response procedures.
➢ Procedures for accident/incident reporting and principle emergency response; and,	Procedures are included in the Office Contingency Plan and Vessel Contingency Plan.
➢ Parties (e.g., the Proponent, marine vessel operators and possible third parties) who carry out emergency actions.	We comply with regulations in regards to response organization contracts.

QSSE MANAGEMENT SYSTEM – DOCUMENTATION DIAGRAM
SCHÉMA DE LA DOCUMENTATION DU SYSTÈME DE GESTION QSSE



A-H1N1 :	Plan de continuité relatif à la grippe A-H1N1 / A-H1N1 Influenza Continuity Plan
ANG:	Arctic Navigation Guide / Guide de navigation dans l'Arctique
BIM :	Bridge Instruction Manual / Manuel d'instructions de la passerelle
BWMP:	Ballast Water Management Plan / Plan de gestion des eaux de ballast
CRMP:	Cargo Residue Management Plan / Plan de gestion des résidus de cargaison
DIM :	Deck Instruction Manual / Manuel d'instructions du pont
EIM :	Environmental Instruction Manual / Manuel d'instructions environnementales
ERIM :	Engine Room Instruction Manual / Manuel d'instructions de la salle des machines
ERPs :	Emergency Response Plans / Plans des mesures d'urgences
ETRM	Emergency Team Response Manual / Manuel d'intervention de l'équipe d'urgence
HLOIM :	Heavy Lift Operation Instruction Manual / Manuel d'instructions pour les opérations de levage de charges lourdes
HMP :	Halocarbon Management Plan / Plan de gestion des halocarbures
HSEIM :	Health, Safety and Environment Instruction Manual / Manuel d'instructions santé, sécurité et environnement
ISM :	International Management Code for the Safe Operation of Ships and for Pollution Prevention / Code international de gestion de la sécurité des navires et la prévention de la pollution
ISO :	International Standardization Organization / Organisation internationale de normalisation
ISPS :	International Ship and Port Security
OCP :	Office Contingency Plan / Plan d'urgence bureau
OWMP :	Oily Water Management Plan / Plan de gestion des eaux huileuses
PIM :	Passenger Instruction Manual /Manuel d'instructions relatives aux passagers
PMP	Pest Management Plan / Plan de gestion des organismes nuisibles
QSSE :	Quality, safety, security and environment / Qualité, sécurité, sûreté et environnement
QSSEMM :	QSSE Management Manual / Manuel de gestion QSSE
QSSEMS :	QSSE Management System / Système de gestion Qualité, sécurité, sûreté en environnement (SGQSSE)
QSSEPM :	QSSE Procedures Manual / Manuel des procédures QSSE
SEEMP :	Ship Energy Efficiency Management Plan / Plan de gestion d'efficacité énergétique
SMPEP:	Shipboard Marine Pollution Emergency Plan / Plan d'urgence en cas de pollution du milieu marin par des substances liquides nocives causées par des navires
SOPEP:	Shipboard Oil Pollution Emergency Plan / Plan d'urgence de bord contre la pollution par les hydrocarbures
SOTM :	Safety Officer Training Manual / Manuel de formation d'officier de sécurité
SSP :	Ship Security Plan
SSTP :	Ship to Ship Transfer Plan / Plan de transfert navire à navire
TMSA :	Tanker Management Self Assessment
VCP :	Vessel Contingency Plan / Plan d'urgence navire
VGP :	Vessel General Permit
VRP :	Vessel Response Plan
WMP :	Waste Management Plan / Plan de gestion des déchets
WOB :	Welcome Onboard Booklet / Feuillet Bienvenue à bord

Appendix A: Shipboard Oil Pollution Emergency Plan

SCHEDULE E

PRODUCT DISCHARGE AND DISTRIBUTION PROCEDURES

Advance Preparation

At least two months prior to delivery confirm with the customer the following:

- ✓ Determine the time that the ship is expected to arrive.
- ✓ Arrange for berthing availability.
- ✓ Verify space available in storage tanks.
- ✓ Ensure preventative maintenance checks are conducted and any deficiencies or problems identified are corrected.
- ✓ Ensure any major maintenance work, that may in some way inhibit normal operations during transfer of product, is completed.

Before Discharge from Tanker Vessel

Prior to receiving product from tanker, a Woodward's Oil representative will ensure the following is conducted:

- ✓ A safety meeting is held to review and discuss local safety regulations and operating procedures, facilities contingency plan, ship emergency procedures, location of fire alarms, closing down of operations, closing of valves and disconnection of hoses or metal arms.
- ✓ The deployment and checking of all safety equipment, such as portable fire extinguishers, portable fire pumps, hoses, absorbent booms and absorbent pads to ensure that they are ready for use.
- ✓ Portable communications equipment is agreed upon by vessel, berth and tank field personnel, and equipment is tested.
- ✓ Storage tanks are properly prepared prior to measuring so that if water is found to be present, the water is removed, if possible, transfer to other tanks have been made, and if tank can be isolated during discharge, close all suction valves on tanks to be gauged.

- ✓ Check on pipeline is made to determine if pipeline is full or not. If pipeline is empty or partially full then vent and fill line with appropriate product prior to measuring the tanks, open all lever check valves, and patrol the line to detect leakage, physical damage, and in line failure. When the line has been filled, place the open level check valves in the normal position for receiving cargo and close the marine line valve of the storage tanks.

- ✓ All shore tanks are gauged and a record is kept of the number of liters on-hand. For non-isolated tanks suspend all transfer activity prior to gauging. Ensure that suction valves on tanks to be gauged are in the closed position.

- ✓ Readings are recorded from dispenser units.

- ✓ Quality Control procedures for all shore tanks are conducted.

- ✓ Calculations of quantities of products to be received must be re-checked and verified. A cut-off point for each tank to receive products must be determined and agreed upon by both shore and ship personnel.

- ✓ A review and an evaluation of the results of the Quality Control checks is completed, and if all tests are verified as passing then discharge may commence.

During Cargo Discharge

Ship and shore personnel are jointly responsible for controlling cargo discharge and both must adhere to the following:

- ✓ Since discharging cargo from ship to shore tanks is a remote control operation it requires good communication to coordinate the work of ship and shore personnel. The methods of communication used during pumping operations shall be portable radios, when a fixed system is not available or a flag and whistle system, when telephone/portable radios are not available. Communications must be maintained at all times throughout discharging operations to ensure immediate response to emergency situations to reduce pumping rates as cut-off points are neared.

- ✓ Before starting to pump all connections must be checked to ensure that they are properly made. Shore, line and ship manifold valves must have settings checked to ensure that they are in correct position.

Bonded drip pans must be placed under ship and shore connections to catch minor leaks.

- ✓ Review method of communication and pumping schedule to ensure that both are clearly understood by ship and shore personnel.

- ✓ Periodic checks must be made on all connections throughout pumping operations to ensure that no leaks have occurred.

- ✓ Shore personnel must ensure sufficient notice is supplied to ship personnel to alert them about switching shore tanks, discontinuing or altering cargo discharge or topping shore tanks.

- ✓ The most vulnerable part of the system is the ship to shore connection. Throughout the pumping operations, ensure that no abrupt changes occur in the flow rate. The main cause of surge pressure in pipelines is the valve closing quickly against the flow of product, either partially or completely. When shore tanks are switched, open the valve to the tank receiving the product at the proper time before closing the valve on the tank which had been receiving product.

- ✓ Discontinue discharging if: an electrical storm occurs; fire breaks out; leakage exists and cannot be stopped; the product spills, because of system failure or tank overfill; conditions develop that jeopardize the mooring hold of the ship; all product required has been transferred.

- ✓ Once pumping has stopped the discharge hose will be pigged to push through any product left in the hose and then the sea hose will be disconnected from the shore manifold and retrieved.

Completing Cargo Discharge

After the cargo has been discharged ship and shore personnel should:

- ✓ Close and lock all valves in the system from berth to tankage.

- ✓ Measure and record all compartments of the ship containing product for ullage, water, and average temperature. Calculate amount of product transferred from ship to shore tanks.

- ✓ Gauge all shore tanks into which the ship has discharged product, thus determining the amount of product received. Be sure to allow a minimum settling time of thirty minutes prior to gauging.

✓ Take readings of all dispenser meters if product was dispensed during the discharge operation.

✓ Determine from measurements taken actual quantity of product received.

✓ Perform Quality Control checks on all shore tanks.

✓ Prepare report on the re-supply operation and submit to AEM.

SHIPBOARD OIL POLLUTION EMERGENCY PLAN

for

MT DORSCH

6720Gross Tons Register of St. John's, NL

PREPARED BY:

Poseidon Marine Consultants Ltd.
391 Stavanger Drive
St. John's NL A1A 5G1
Telephone: (709) 739-4321
Fax: (709) 739-4421

PREPARED FOR:

Coastal Shipping Ltd.
The Fortis Bldg.
139 Water St.
St. John's, NL
A1C 1B2

Issued: June 2005
Job Number: 05-037

Change Number

Examined under the provisions of Annex 1 of MARPOL 73/78 and the Canadian Oil Pollution Prevention Regulations (SOR/93-3) and found satisfactory.

Clifford Harvey/PPO July 8/06 Date

TRANSPORT CANADA TRANSPORTS CANADA MARINE SAFETY SECURITE MARITIME CANADA St. John's, NL

Change Number

Official Stamp Examined by Date

Change Number

Official Stamp Examined by Date

RECORD OF CHANGES

Amendment Number	Section and Page Affected	Date Entered	Remarks	Name and Position of Person Making Entry

RECORD OF OIL POLLUTION EMERGENCY DRILLS

DATE	TYPE OF OIL POLLUTION DRILL	LOCATION	REMARKS MASTER'S SIGNATURE

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A4	Flowcharts and Checklists
A5	Relevant Drawings

SHIP'S PARTICULARS

PRINCIPAL PARTICULARS

Vessel Name:	Dorsch
Flag / Port of Registry:	Canada / St John's, NL
GL Number:	16648
IMO Number:	8007195
Gross Registered Tonnage:	6720 (ITC69)
Net Registered Tonnage:	3548 (ITC69)
Length, Overall:	130 72 m
Length, B.P.:	122 0 m
Breadth, Max. at Deck:	18.5 m
Depth to Main Deck:	10.6 m
Design Draft (Summer):	7.2 m
Built:	Berner Schiffswerft GmbH & Co. KG
Year of Build:	1980
Complement:	18
Propulsion Power:	Krupp Mak 8 MU 552 AK 4410kW @ 480RPM

CAPACITIES

Fresh Water	Approx. 118m^3
Fuel Oil (MDO)	Approx. 171m^3
Fuel Oil (HFO)	Approx. 452m^3
Ballast Water	Approx 2459m^3
Cargo Hold (Incl. Slop Tanks)	Approx. 12153m^3

INTRODUCTION

1 This Plan is written in accordance with the Canadian Oil Pollution Prevention Regulations and also in accordance with the requirements of regulation 26 of annex I of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 thereto.

2. The purpose of the Plan is to provide guidance to on board operating personnel the vessel with respect to the steps to be taken when a pollution incident has or is likely to occur

3. The Plan contains all information and operational instructions required by the guidelines. The appendices contain names, telephone, telex numbers, etc. of all contacts referenced in the Plan, as well as other reference material

4. This Plan has been examined by the Canadian Board of Steamship Inspection, (herein after referred to as "the Board") and, except as provided below, no alteration or revision shall be made to any part of it without prior approval of the Board.

5. Changes to Sections 6, 7, 8, and the appendices will not be required to be approved by the Board. The appendices should be maintained up to date by the Owners, Operators, and Managers.

6. For the purposes of this Plan, the Master is taken to be that person who is a member of the vessel's operational personnel and to which is given senior responsibility for the vessel and any circumstances pertaining thereto.

7. Before entering a port of call, the Master should be aware of local emergency response procedures and organizations and have up to date contact information readily available.

SECTION 1 • Preamble

1.1 PURPOSE AND INTENT OF THIS PLAN

This Shipboard Oil Pollution Emergency Plan is intended to assist the vessel's officers, crew and management personnel in dealing with an unexpected discharge of oil Its primary purpose is to set in motion the necessary actions to stop or minimize the discharge and to mitigate its effects.

1.2 SUPPORT BY VESSEL'S MANAGEMENT

In accordance with the plans and policies of the vessel's management organization, management personnel will support the vessel's crew with additional resources, i e. personnel and materials, as the situation warrants.

1.3 PERSONNEL TRAINING AND EXERCISES

1 ***It is the responsibility of the Vessel's Management to ensure that, through training and exercises, all officers and crew are capable of confidently and safely carrying out their assigned duties.***

Officers responsible for maintaining the trim of the vessel and ordering transfers of ballast and/or cargo should be fully aware of the consequences of their actions and are expected to comply with the regulations and any documentation aboard the vessel which prescribes conditions of trim and stability , e.g. "Approved Stability Booklet"

Officers and crew responsible for cargo and or bunkering operations should also be fully aware of the consequences of their actions and are expected to comply with the regulations and any documentation aboard the vessel which prescribes methods of operation

Officers and crew assigned additional responsibilities for fire fighting or emergency response should have appropriate training as per the regulations and should participate in specific drills and exercises to maintain their abilities and be fully familiar with appropriate vessel systems.

The vessel's management and operating personnel should become familiar with this document and its format so that should an emergency occur, the response of the officers and crew and the vessel's management personnel will be carried out in a structured, logical and timely manner.

In order to ensure that the crew and management are completely familiar with this document and its prescribed procedures, training should be offered and oil pollution emergency drills should be carried out regularly.

A blank "Record of Oil Pollution Emergency Drills" form is provided at the beginning of this Plan to document the dates and results of such training exercises. This documentation is to be in addition to normal record keeping and log book entries.

3. ***All crew members should become familiar with the fundamentals of the ship's mechanical and electrical systems in order to be more confident and capable during an emergency.***

It is the responsibility of the vessel's senior officers to ensure that engineering fundamentals are taught to the crew and that the crew remain familiar with them through regular drills. Drawings detailing the various mechanical and electrical systems are carried aboard the vessel. Any drawing (e.g. "Natural Vents", "Engine Room Ventilation", "One Line Electrical Diagram", "Fuel Oil Transfer Diagram") can be obtained for study from the Engineering Document Library located in the Chief Engineer's Office. These drawings are thoroughly catalogued and easily referenced

In order to ensure a fundamental familiarity with the various engineering systems, oil pollution emergency drills should include such exercises as:

isolating and sealing off accommodations and/or machinery spaces using louvers and fan shutoffs to prevent ingress of dangerous fumes; and

isolating, at the distribution panels, various electrical circuits, e g. lighting, panel feeds, in order to reduce or eliminate sources of ignition in areas of risk.

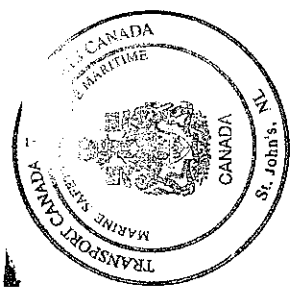
1.4 PLAN FORMAT

This plan is divided into five sections as follows:

Section 1 provides an introduction for this document and highlights some important considerations regarding the spillage of oil at sea.

Section 2 outlines the procedure and requirements for making a report to authorities in the event of a discharge or probable discharge of oil.

Section 3 provides a checklist of steps to be taken in the event of various operational or casualty related spills.



Section 4 outlines procedures for national and local coordination of response efforts.

Section 5 outlines procedures for ship to ship transfer operations

Section 6 outlines safety precautions for bunkering operations

Section 7 deals with non-mandatory provisions such as oil spill response materials onboard, media information, and plan review

Section 8 outlines the responsabilities of the Oil Pollution Prevention Team

Following the main body of this plan are appendices which provide contact information and/or useful forms. Appendix 1 is an example of an unofficial facsimile report, the use of which is outlined in Section 2. Appendix 2 provides contact information for coastal authorities and ship interests. Appendix 3 is a blank calculation form for vessel stress and stability which can be filled out by an officer of the vessel and sent to the vessel owners for calculation. The use of this calculation form is described in Section 3 Appendix 4 contains flowcharts and checklists for use in the event of an emergency. Appendix 5 contains relevant ship's drawings.

1.5 OIL DISCHARGE MONITORING SYSTEM

In accordance with MARPOL 73/78 Annex 1 Regulation 16 this ship is fitted with a Jowa Oil-A Triosep and Duosep bilge water separator and Jawa M-87 and M-93 ballast water monitors, both manufactured by Jowa AB, Sweden. The oil content meters associated with these units are fitted with 15ppm oil content alarms.

IMPORTANT:

1. **ANY** OIL SPILLAGE SHOULD BE TREATED AS AN EMERGENCY.

2. IN RESPONDING TO AN OIL SPILLAGE, THE MASTER'S PRIORITY WILL BE TO ENSURE THE SAFETY OF THE CREW AND OF THE VESSEL, AND TO TAKE ACTION TO PREVENT ESCALATION OF THE INCIDENT. IMMEDIATE CONSIDERATION SHOULD BE GIVEN TO MEASURES AIMED AT PREVENTING FIRE AND EXPLOSION

SECTION 2 • Reporting Requirements

Coast guard of nearest coastal State (see Appendix 2) is to be notified whenever there is:

a) **An actual discharge of oil**
b) **Reason to suspect a probable discharge of oil due to fire, grounding, list, loss of power, collision, flooding, explosion, structural failure, etc.**
c) **Any damage or failure which may affect the safety of the vessel, such as failure or breakdown of the electrical generating system, or essential shipborne navigational aids.**

2.1 DISCHARGE OF OIL

When reporting a discharge of oil, the Master is to provide all relevant information (as per section 2.4) to:

a) Coast Guard of nearest coastal State, or
b) Port Authorities, and also to
c) Vessel Interest Contacts.

A discharge of oil, for the purposes of this plan, refers to:

a) A discharge of oil, resulting from damage to the vessel or its equipment, or for the purpose of securing the safety of a vessel or saving life at sea; or
b) A discharge during the operation of the vessel of oil in excess of the quantity or instantaneous rate permitted under the present Convention.

2.2 PROBABLE DISCHARGE OF OIL

The Master must use good judgment to assess any circumstance which might be cause for probable discharge of oil. When making such judgment the following factors must be taken into account:

a) The nature of the damage, failure, or breakdown of the vessel, machinery, or equipment;
b) Vessel location and proximity to land or other navigational hazards;
c) Weather, tide, current, and sea state;
d) Traffic density; and
e) Morale, health and ability of crew onboard to deal with situation

2.3 DAMAGES AND/OR FAILURES

The Master must report any damage which may affect the safety of the vessel: collision, fire, grounding, explosion, cargo shifting, list, etc. The Master must also report any failure or breakdown of essential machinery which results in impairment of the safety of navigation: i.e electrical generating system or essential vessel-borne navigational aids

2.4 INITIAL REPORT

An initial report is to be made by radio communication without delay to one of the following Canadian radio ship reporting stations; Canadian Coast Guard Radio Station, Canadian Vessel Traffic Service Center, St. Lawrence Seaway Authority marine radio station, or Canadian harbour radio station. The report is to be made following the format given below. Where the report cannot be communicated by radio, it shall be communicated by telephone to the local Canadian radio ship reporting station or to the Canadian Coast Guard Operations Center in Ottawa. Contact information is provided in Appendix 2.

FOLLOW-UP REPORTS

Follow-up reports should be made at regular intervals to keep the coastal State and other concerned parties informed of developments including, but not limited to, change of course or position, change in quantity, rate or probability of oil discharge, injuries or casualties, or effects of actions taken to control discharge or assure safety of the vessel and crew. Follow-up reports should be made in the same format as the initial report.

WRITTEN REPORT

Within 24 hours of the incident, or as soon as possible thereafter, a written report on the incident, including a statement as to its probable cause, shall be forwarded by air mail without delay to the Chief, Marine Casualty Investigations, Department of Transport, Ottawa.

UNOFFICIAL FACSIMILE REPORT

An unofficial facsimile report is included in Appendix 1. This may be sent to any concerned parties but is not consistent with IMO Resolution A 648(16) for reporting of incidents involving dangerous goods, harmful substances and/or marine pollutants, and therefore cannot constitute an official report to the coastal State.

FORMAT AND INFORMATION REQUIRED FOR OFFICIAL REPORT

AA VESSEL NAME, CALL SIGN, FLAG

BB DATE AND TIME (GMT) OF INCIDENT: 111935 meaning 11th of month at 7:35 pm.

CC SHIPS POSITION: 2230N 0600E meaning 22 deg. 30 min. N, 6 deg. E

or

DD SHIPS POSITION BY TRUE BEARING (3 DIGITS) AND DISTANCE FROM CLEARLY IDENTIFIED LANDMARK.

EE TRUE COURSE (3 DIGITS)

FF SPEED IN KNOTS AND TENTHS OF A KNOT (3 DIGITS)

LL ROUTE INFORMATION - INTENDED TRACK

MM RADIO STATIONS AND FREQUENCIES GUARDED

NN TIME OF NEXT REPORT (same as in BB)

OO DRAFT (4 DIGITS - meters and centimeters)

PP TYPES AND QUANTITIES OF CARGO AND BUNKERS ON BOARD

QQ BRIEF DETAILS OF DAMAGE, LIMITATIONS ETC. (must include condition of vessel and ability to transfer cargo, ballast, or fuel)

RR BRIEF DETAILS OF ACTUAL POLLUTION (oil type, estimate of quantity discharged, whether discharge continues, cause, estimate of slick movement)

SS WEATHER AND SEA CONDITIONS (wind force/direction, relevant tidal and/or current information)

TT NAME, ADDRESS, TELEX, FAX, TELEPHONE NUMBERS OF VESSEL OWNER OR REPRESENTATIVE

UU DETAILS OF LENGTH, BREADTH, TONNAGE, AND TYPE OF VESSEL

WW TOTAL NUMBER OF PERSONS ON BOARD

XX MISC DETAILS (This includes brief details of incident, actions taken, injuries sustained and assistance required. If no outside assistance is required, then this should be clearly stated.)

2.5 WHO TO CONTACT

Contact information for coastal State and other concerned parties (port contacts, vessel interest contacts) is located in Appendix 2

2.6 ARRANGED RESPONSE ORGANIZATION(S)

The vessel, in accordance with the regulations, has onboard a **declaration** that the vessel's management has, in accordance with 660 2(2) of the Canada Shipping Act, entered into an arrangement with a response organization to which a certificate of designation has been issued pursuant to subsection 660.4(1) in respect of the quantity of oil that is carried both as fuel and cargo on board the vessel

The person or persons identified in the **declaration** shall be responsible for contacting and mobilizing the response organization.

SECTION 3 • Steps to Control Discharge

In cases of small spills on deck, the vessel's crew should take whatever actions are necessary to prevent oil from escaping over the side. Once the spill is contained on deck, the crew will need to take action to clean up the oil. SPILLED OIL SHOULD NOT BE WASHED OVER THE SIDE. Once oil is in the water, the crew's ability to respond in a practical manner is greatly reduced.

3.1 OPERATIONAL SPILLS

In the event of an operational spill which occurs during bunkering or cargo operations, it is important that the bunkering party terminate any and all bunkering operations and close all manifold valves.

Before closing any manifold valves, the bunkering / cargo party must immediately inform the terminal / loading master so that they may take action to eliminate the possibility of over-pressurization of the shore side transfer components.

After dealing with the cause of the spill, it may be necessary to obtain permission from local authorities and/or the terminal before resuming bunkering or cargo operations

If the possibility of fire or explosion exists, nonessential air intakes to accommodations and machinery spaces should be closed and all sources of sources of ignition should be eliminated. See Section 1 3 3 of this Plan.

In accordance with Section 1.3.3 of this Plan, all members of the vessel's crew should be familiar with the fundamentals of the ship's vital systems including the ventilation and electrical systems. Crew members should be able to: isolate the accommodation and/or machinery spaces using the louvers and fan shutoffs; and, from the distribution panels, isolate electrical circuits in areas of risk. Please refer to Section 1 3 3 of this Plan for additional details.

Care must be taken to consider stability and stress when taking action to mitigate the spillage of oil. Internal transfers should be undertaken only with a full appreciation of the likely impact on the vessel's overall stress and stability. Please refer to the "Approved Stability Booklet" carried on board.

Operational Spill Checklist

Action Considered	Designated Person	Completed
Sound emergency alarm	Person Discovering Incident	Y / N
Initiate emergency response procedures	Chief Officer	Y / N
Cease all bunkering operations	Chief / 2nd Engineer	Y / N
Locate source of leakage	Chief / 2nd Engineer	Y / N
Operate manifold valves	Chief / 2nd Engineer	Y / N
Close all nonessential vent intakes and tank vents as required	Chief / 2nd Engineer	Y / N
Stop or reduce outflow	Chief / 2nd Engineer	Y / N
Assess fire risk	Chief Officer	Y / N
Commence clean up	Chief Officer	Y / N
Assess Stress / Stability	Master / Chief Officer	Y / N
Transfer fuel from damaged area to slack tanks or other containment space	Chief / 2nd Engineer	Y / N
Request outside assistance if required	Master	Y / N
Counter excessive list if required / possible	Chief Officer	Y / N

1. PIPE LEAKAGE

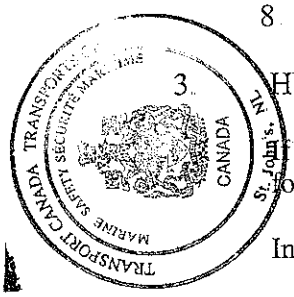
In the event of an oil pipe leakage, the Chief Engineer must ensure that the following actions are taken:

1. Stop oil flow and close manifold and other valves.
2. Sound Emergency Alarm and initiate emergency response procedures as posted aboard the vessel.
3. Locate the source and drain affected section into an available empty or slack tank. Repair if possible.
4. If there is any possibility of released vapours entering an engine room or the accommodation intake, appropriate preventative steps must be taken quickly.
5. Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.
6. If oil is overboard, report to proper authorities immediately (as per section 2 of this plan).
7. If oil is in bilges, pump through oil/water separator as per approved procedures.

2. TANK OVERFLOW

In the event of an oil tank overflow, the Chief Engineer must ensure that the following actions are taken:

1. Stop oil flow and close manifold and other valves.
2. Sound Emergency Alarm and initiate emergency response procedures as posted aboard the vessel.
3. Place drain buckets under overflow pipes to contain possible spills.
4. If there is any possibility of released vapours entering an engine room or the accommodation intake, appropriate preventative steps must be taken quickly.
5. Drain or transfer oil to slack or empty tanks if possible with due consideration paid to vessel stability. If no slack or empty tanks are available then oil may be pumped back ashore through delivery line, having first gained permission to do so.
6. Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.
7. If oil is overboard, report to proper authorities immediately (as per section 2 of this plan).
8. If oil is in bilges, pump through oil/water separator as per approved procedures.



3. HULL LEAKAGE

If oil is noticed on the water near the vessel during normal operations and cannot be accounted for, the possibility of hull leakage should be suspected.

In the event of a hull leakage, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm and initiate emergency response procedures as posted aboard the vessel.
1. Stop any and all transfer or bunkering operations.
2. Identify damage and report to proper authorities immediately (as per section 2 of this plan); consider a diver if necessary and possible.
3. If possible, contain spill using materials on hand and dispose of oil-soaked materials in an appropriate container.
4. If there is any possibility of released vapours entering an engine room or the accommodation intake, appropriate preventative steps must be taken quickly.

5. Transfer fuel away from suspected leaks to empty or slack tanks if possible or to a ballast tank if necessary. If in port, arrangements can be made to pump oil ashore to tank or truck Due consideration is to be paid to vessel stress and stability
6. If it is not possible to identify the leaking tank, reduce level in all tanks in vicinity, giving due consideration to vessel stress and stability.

4. SPILLS CAUSED BY EQUIPMENT IN MACHINERY SPACES

1. If operational spills are caused by a failure of equipment in machinery spaces, any further operations of this equipment should be stopped immediately and measures are to be taken to avoid a spill.
2. Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.
3. Do not restart equipment until problem has been rectified.

3.2 SPILLS RESULTING FROM CASUALTIES

ALL CASUALTIES ARE TO BE REPORTED BY THE MASTER AS PER SECTION 2.

The Master's priority, when responding to a casualty, will be to ensure the safety of personnel and the vessel and to take action to prevent escalation of the incident

In casualties involving spills, immediate consideration should be given to measures aimed at preventing fire and explosion, such as altering course so that the vessel is upwind of the slick, shutting down nonessential air intakes, etc.
If the vessel is aground, and therefore cannot maneuver, all possible sources of ignition should be eliminated and action taken to prevent flammable vapors entering accommodation and engine room spaces Please refer to Section 1.3.3

In accordance with Section 1.3.3 of this Plan, all members of the vessel's crew should be familiar with the fundamentals of the ship's vital systems including the ventilation and electrical systems. Crew members should be able to isolate the accommodation and/or machinery spaces using the louvers and fan shutoffs; and, from the distribution panels, isolate electrical circuits in areas of risk. Please refer to Section 1.3.3 of this Plan for additional details.

Prior to considering remedial action, the Master will need to obtain detailed information on the damage sustained by the vessel. A visual inspection should be carried out and all bunker tanks and other compartments sounded. However, due regard should be paid to the indiscriminate opening of ullage plugs or sighting ports, especially when the vessel is aground, as loss of buoyancy could result. The Master shall also ensure that all covers, doors, vents, and hatches to any and all holds, ballast tanks, and fuel tanks are sealed tightly and remain sealed to prevent possible loss of buoyancy. Having assessed the damage sustained by the vessel, the Master will be in a position to decide what action should be taken to prevent or minimize further spillage.

Great care must be taken to consider stability and stress when taking action to mitigate the spillage of oil or to free the vessel if aground Internal transfers should be undertaken only with a full appreciation of the likely impact on the vessel's overall stress and stability. Please refer to the "Approved Stability Booklet" carried on board.

Should the damage sustained be extensive, the impact of internal transfers on stress and stability may be impossible for the vessel's personnel to assess. In such cases, Appendix 3 of this plan is to be filled out as completely as possible and forwarded to the Owners to ensure the appropriate calculations can be done.

When it is possible to maneuver, the Master, in conjunction with the proper shore authorities, may consider moving the vessel to a more suitable location in order, for example, to facilitate emergency repair work or lightening operations, or to reduce the threat posed to any particularly sensitive shoreline areas Such maneuvering may be subject to coastal state jurisdiction.

Oil Spill Resulting from Casualty (Grounding, Collision, Fire, or Explosion)

Action Considered	Designated Person	Completed
Sound emergency alarm	Chief Officer / OOW	Y / N
Initiate emergency response procedures	Master / Chief Officer	Y / N
Close all nonessential vent intakes and tank vents as appropriate	Chief Officer / Chief Engineer	Y / N
Assess further danger to ship or personnel such as capsize or sinking	Master	Y / N
Cease all nonessential operations	Chief Officer / Chief Engineer	Y / N
Assess whether oil has actually been spilt / probability of spill	Chief Officer / Chief Engineer	Y / N
Sound all ER compartments to determine extent of damage	2nd Engineer	Y / N
Sound around vessel if grounded	Chief Officer	Y / N
Where possible transfer fuel away from damaged compartments	Chief Officer	Y / N
Request outside assistance if required	Master	Y / N
Contain / reduce oil outflow with resources on hand	Chief Officer / 2nd Engineer	Y / N
Commence Cleanup if possible	Chief Officer	Y / N

1. GROUNDING

If the vessel grounds, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm and muster crew.
2. Eliminate all avoidable sources of ignition and ban smoking on board. Action must be taken to prevent hazardous vapours from entering accommodation and machinery spaces. See Section 1.3.3.
3. Identify damage by means of a visual inspection.
4. Take soundings around vessel to determine nature and gradient of seabed.
5. Check differences in tidal ranges at grounding site.
6. Evaluate tidal current in grounding area.
7. Take soundings of all tanks on shell and compare with departure soundings.
8. Determine probability and/or quantity of oil released
9. If oil release is determined or is probable, this is to be included in the casualty report
10. Determine other possible hazards to the vessel, such as sliding off the grounding site, further damage from the seas / swell, and torsion forces.

At this point, determine risk of additional damage to vessel by attempting to refloat. If remaining aground is determined to be less of a risk then:

1. Use anchors to prevent vessel movement.
2. Take in ballast in empty tanks, with due consideration paid to stress and stability. Please refer to the "Approved Stability Booklet."
3. Consider transfer of fuel from damaged tanks, with due consideration paid to stress and stability. Please refer to the "Approved Stability Booklet."
4. Reduce longitudinal stress on hull by transfer of cargo internally. Please refer to the "Approved Stability Booklet."
5. If the change in stability and stress cannot be calculated on board, contact the Vessel's management to arrange for the necessary calculations. Refer to Appendix 3 for information which should be provided

2. FIRE / EXPLOSION

If a fire or explosion occurs on board, the vessel's fire control party must ensure that the following actions are taken:

1. Sound Emergency Alarm and muster crew.
1. Determine extent of damage and what damage control measures can be taken.
2. Determine whether there are casualties
3. Request assistance as deemed necessary.
4. Take necessary actions to prevent smoke and other hazardous vapours from entering the accommodation and machinery spaces.
5. Assess possibility of oil leakage.
6. Determine possible actions to control the discharge of oil. This will depend largely on the damage to the ship and cargo.
7. If there is a discharge or possible discharge of oil, this is to be included in the casualty report.
8. Should abandonment be necessary, the Master must ensure that every effort is made to maneuver survival craft upwind of any oil spill.

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3 COLLISION

If a collision occurs, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm and muster crew.
2. Determine whether there are casualties.
3. If there is a possibility of fire or explosion, eliminate all avoidable sources of ignition and ban smoking on board Action should be taken to prevent flammable vapours from entering accommodation and machinery spaces. See Section 1.3.3.
4. Decide whether separation of vessels may cause or increase spillage of oil, or increase the risk of sinking.
5. If any oil tanks are penetrated, isolate the penetrated tank or transfer oil to slack or empty tanks with due attention paid to stress and stability of the vessel. Please refer to the "Approved Stability Booklet."
6. If there is an oil spill, make a report as per section 2
7. If possible to maneuver, the Master, in conjunction with the appropriate shore authorities, should consider moving his ship to a more suitable location in order to facilitate emergency repair work or lightening operations, or to reduce the threat posed to any sensitive shoreline areas.

4. HULL FAILURE (INCLUDING ICE DAMAGE)

If the vessel suffers structural hull failure, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm and muster crew.
2. Reduce speed or stop to minimize stress on hull.
3. Assess immediate danger of sinking or capsizing.
4. Initiate damage control measures if possible.
5. If lightening is required, all efforts should be made to wait for a barge or other ship to receive the cargo.
6. If oil has spilled, or if it is necessary to jettison oil to maintain stability, make a report as per section 2.
7. If the change in stability and stress cannot be calculated on board, contact the Vessel's management to arrange for the necessary calculations
8. Consider forecast weather conditions and their effect on the situation.
9. Should abandonment be necessary, the Master must ensure that every effort is made to maneuver survival craft upwind of any oil spill

5. EXCESSIVE LIST

If excessive list occurs rapidly and unexpectedly, it may be due to:

1. Failure of hull plating
2. Failure of internal bulkhead between compartments
3. Shift of cargo.
4. Damage through grounding or collision.
5. Incorrect operating condition. Refer to "Approved Stability Booklet."
6. Flooding in Engine Room, where free surface can cause a list.

The Master must ensure the following steps are taken immediately:

1. Stop any cargo, bunkering, or ballast operations in progress.
2. Sound Emergency Alarm and muster crew
3. Determine whether there are casualties.
4. If under way, reduce speed or stop
5. Establish reason for list. See above.
6. Sound all tanks and compare with departure soundings
7. Close all openings and vent pipes.
8. Prepare ballast and transfer pumps for possible remedial action.
9. If lightening is required, all efforts should be made to wait for a barge or other ship to receive the cargo.
10. If oil has spilled, or it is necessary to jettison oil to maintain stability, make a report as per section 2.
11. If possible, take corrective action to rectify the situation with due consideration paid to vessel stress and stability. Please refer to the "Approved Stability Booklet "

SECTION 4 • National and Local Coordination

1 The Master will advise the Coast Guard of nearest coastal state regarding any oil spill. Vessel Interest Contacts must also be notified of any such incident. See Appendix 2 for details.

2. The Master will be the point of contact on the vessel for coordinating shipboard activities with national and local authorities, act as the Company's on-scene representative, and will be responsible for overseeing the action of any salvage or spill contractors employed until such time as he/she has been FORMALLY relieved of these responsibilities by the Company.

3. The person or persons identified in the declaration shall be responsible for contacting and mobilizing the response organization(s). These organizations will coordinate and conduct the response. It is not normally practical for vessel's personnel to be directly involved in cleanup activities. Therefore, their primary role will be to provide as much information as necessary to assist the response and to cooperate with cleanup personnel However, where no local response is forthcoming, or is delayed, the Master should consider the use of available shipboard materials to clean up or contain the spilled oil by, for example, using ship-stocked absorbent materials or utilizing mooring ropes or air-filled hoses as makeshift booms.

4. Dispersants or degreasers should not be used on oil spilled in the water as their use may contravene local regulations However, dispersants may be used if they are approved by Environment Canada specifically for a given incident. Environment Canada will allow and approve the use of dispersants on a case by case basis only

SECTION 5 • Ship to Ship Transfer Operations

Should a situation such as lightening due to damage require a ship to ship transfer of petroleum products, the Master must take into account but not limited to the following:

1. Proper lines of communication between ships including language and radio working frequency;
2. Current and forecasted weather conditions for the intended area of transfer;
3. The compatibility of the vessels involved with regards to size, freeboard, manifold location, list, trim, etc
4. The elimination of all possible ignition sources;
5. Oil spill clean up equipment and procedures in place;
6. Contingency planning for emergency situations in place
7. The need to notify and obtain the agreement of any responsible authority.
8. Site conditions such as available shelter, water depth, and available anchorage.
9. Traffic density.

For detailed procedures concerning ship to ship transfer of petroleum products, please refer to ***The Ship to Ship Transfer Guide (Petroleum)****, published by The International Chamber of Shipping Oil Companies International Marine Forum, 3rd edition, 1997 A copy of which is to be kept on board the ship at all times.*

SECTION 6 • Safety Precautions For Bunkering Operations

NO SMOKING THROUGHOUT BUNKERING OPERATION

Before beginning refuelling operations:

1. The spill control equipment should be in the immediate vicinity and readily accessible should it be required in the event of a fuel spillage. Note that the tanker or refueling station should also have its own spillage control kit.

2. Ensure that the approximate amount of fuel required is known. This can be confirmed from the Chief Engineer, Captain, or Vessel Manager.

3. The location and ready access to the nearest fire extinguishers should be confirmed

4. All save-alls must be empty and drain holes plugged.

5. Check that no *hot work* is being carried out in the vicinity

6. Check position (Open) of interconnecting valves.

7 Establish communication with tanker or fueling station operator using portable radios.

8. Check mooring lines are secure, to prevent the vessel hanging up on the hoses.

9. Confirm system alarms are activated.

10. Bunkering should take place with the vessel upright and with a minimal trim.
During refueling operations:

11. Tank fluid levels are to be closely monitored through soundings or some other means of accurately reading instantaneous volume.

12. A close watch must be maintained on the tank vents. In the event of foaming from the vent pipe, stop bunkering operations

13. Keep close watch on the trim of the vessel. As much as possible, minimize heel and trim by loading fuel in a symmetrical order.

After refueling operations:

1. Clean up any spills with available spill equipment.

2. Ensure all save-alls are clean and empty, then remove plugs.

SECTION 7 • Additional Information (Non-Mandatory)

This section provides for additional information that local authorities, insurance underwriters, or Vessel Management may wish to include, but is not mandatory. (Regulation 26, Annex I, Marpol 73/78)

MEDIA INFORMATION

In the event of an oil spill or other related casualty, the Master is to direct any Coastal Radio station being worked that inquiries from any of the various media nodes are to be directed to the Vessel Management, who will handle such incidents shore-side. This will enable the Master to concentrate on the matter at hand.

PLAN REVIEW

This plan is to be reviewed at regular intervals by the Vessel Management and Master such that the information contained herein is current. Changes should be incorporated in the plan as and when they occur and the changes noted and by whom. Reviews should be conducted annually to reflect changes in local laws or policies, contact names or numbers, vessel characteristics, or company policy.

Reviews should also be conducted after any use of the plan in response to an incident, in order to evaluate its effectiveness and make any modifications deemed prudent at that time.

COMPANY POLICY

The Master is responsible for maintaining the vessel's plans and technical information, in addition to the drawings contained in this plan, in an orderly and readily accessible fashion. The Master is to satisfy himself to the fact that the vessel's Chief Engineer complies in similar fashion as regards to plans and technical information in his possession.

DIAGRAMS AND DRAWINGS

Should the Master or Chief Engineer discover that crucial plans or manuals covering the operation of essential parts of the vessel are not on board, they are to request the company's head office in writing, to supply such plans and manuals.

RECORD KEEPING

As stated elsewhere in this plan, the Master shall use every effort to retain all records of a pollution incident and responses thereto, for later review by the company's technical department in conjunction with the crew. Such record keeping should include actual samples of oil spilled.

ONBOARD SPILL RESPONSE EQUIPMENT

Absorbent rags and boom are stored in the SOPEP store room at the aft stbd. side of the Main Deck. It is the responsibility of the Chief Engineer to keep inventory and maintain an adequate stock of equipment

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SECTION 8 • Oil Pollution Prevention Team

The master of the vessel is to appoint an Oil Pollution Prevention Team on board, to initiate recovery or cleanup procedures, and to secure the ship immediately if an incident occurs

The OPPT consists of the following crew members:

Master
Chief Officer
Chief Engineer

In the event of an emergency, the team should be called out immediately.

The team should be given necessary training in the use of such equipment as oil absorbents that the vessel may carry All members of the OPPT should be aware of their duties should an oil spill occur.

Instructions to the Oil Pollution Prevention Team

8.1 Master

In overall charge.
Informs terminal authorities or coastal authorities of incident.
Informs the local agent and requests agent to inform the local underwriter's representative.
Advises the company's head office of the situation. Keeps everyone updated at regular intervals and advises of any changes in status of the emergency
Keeps log of all events and progress of actions.

8.2 Chief Officer

In charge of deck / cargo operations.
In charge of lifeboats if required.
Keeps the Master informed and updated on the situation and of the results of steps taken to contain any spills and limit outflow.
Insures all openings in the deck and superstructure are closed to limit vapour entry

8.3 Chief Engineer

In charge of bunkering operations.
Organizes distribution of oil spill detergents if required.
Stops bunkering operations if applicable.
Stops pumps and any unnecessary pieces of machinery

Other Personnel

Deck Officer on duty
- Alerts and informs Chief Officer / Chief Engineer on the situation.
- Mobilize off duty crew as necessary.

Engineer on duty
- Assists the Chief Engineer.
- Prepare for fire fighting.
- Ensure sufficient power and water to deck.
- Organizes onboard clean up equipment.

Deck Officer off duty

Under the direction of the Master, responsible for the reporting and record keeping of all events.

On duty Ratings

Alerts the Officer on duty of any leakage.

Position sorbent / clean up material to prevent any fluid escape.

Off duty personnel

Assist as required

APPENDIX 1 • Report Format and Content

The report should contain the following:

AA VESSEL NAME, CALL SIGN, FLAG

BB DATE & TIME (GMT) OF INCIDENT: 111935 meaning 11th of month at 7:35 pm.

CC SHIPS POSITION: 2230N 0600E meaning 22 deg. 30 min. N, 6 deg. E

or

DD SHIPS POSITION BY TRUE BEARING (3 DIGITS) AND DISTANCE FROM CLEARLY IDENTIFIED LANDMARK

EE TRUE COURSE (3 DIGITS)

FF SPEED IN KNOTS AND TENTHS OF A KNOT (3 DIGITS)

LL ROUTE INFORMATION - INTENDED TRACK

MM RADIO STATIONS AND FREQUENCIES GUARDED

NN TIME OF NEXT REPORT (same as in BB)

OO DRAFT (4 DIGITS - meters and centimeters)

PP TYPES AND QUANTITIES OF CARGO AND BUNKERS ON BOARD

QQ BRIEF DETAILS OF DAMAGE, LIMITATIONS ETC (must include condition of vessel and ability to transfer cargo, ballast, or fuel)

RR BRIEF DETAILS OF ACTUAL POLLUTION (oil type, estimate of quantity discharged, whether discharge continues, cause, estimate of slick movement)

SS WEATHER AND SEA CONDITIONS (wind force/direction, relevant tidal and/or current information)

TT NAME, ADDRESS, TELEX, FAX, TELEPHONE NUMBERS OF VESSEL OWNER OR REPRESENTATIVE

UU DETAILS OF LENGTH, BREADTH, TONNAGE, AND TYPE OF VESSEL

WW TOTAL NUMBER OF PERSONS ON BOARD

XX MISC. DETAILS (brief details of incident, actions taken, injuries, assistance required)

UNOFFICIAL OIL POLLUTION EMERGENCY REPORT BY FACSIMILE

Vessel Name Call Sign Flag

Date and Time of Event

Vessel Position (Latitude & Longitude, Bearing & Distance from Landmark)

Course Speed

Intended Track

Radio Station

Date and Time of Next Report

Type and Quantity of Oil On board

Brief Details of Damage

Brief Details of Pollution

Details of Weather & Sea Conditions (Wind Speed/Direction, Swell Height/Direction)

Names of Vessel's Owner

Vessel Size and Type

Any Other Additional Information as Determined by Master

APPENDIX 2 • Who to Contact

In accordance with the Canadian Pollutant Discharge Reporting Regulations, the Master or Owner of a ship must report, without delay, any discharge or anticipated discharge of a pollutant in Canadian waters or fishing zones, to a Pollution Prevention Officer (PPO). Reports must be made in the manner described in Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants, TP 9834, or "General Principles for Ship Reporting Systems and Ship Reporting Requirements, including Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants" adopted by the IMO by Resolution A 648(16). These initial reports can be made to a Vessel Traffic Service Center (VTS) or any other Canadian Coast Guard Radio Station (CGRS), on the frequencies listed in the publication, Radio Aids to Marine Navigation (RAMN).

In addition to the above process for reporting a spill from a vessel to a PPO through a CGRS or VTS, the Canadian Coast Guard maintains a 24 hour Operations Center which can be contacted at:

Canadian Coast Guard Operations Center
344 Slater Street
Ottawa, Ontario
K1A 0N7

Tel: (613) 990-5600 Fax: (613) 995-4700 Tlx: (613) 053 3128

Alternatively, spills may be reported to the appropriate regional center or nearest Vessel Traffic Service Center:

Newfoundland

St. John's	Tel:	1-709-772-2083
		1-800-563-2444 (24 hr.)
	Fax:	1-709-772-5369
	Tlx:	016-4044
Placentia Bay	Tel:	1-709-227-2182
	Fax:	1-709-227-5637
Port Aux Basques	Tel:	1-709-695-2167
	Fax:	1-709-695-7784
Goose Bay	Tel:	1-709-896-2252
	Fax:	1-709-896-8455
St. Anthony	Tel:	1-709-454-3852
	Fax:	1-709-454-3716

Nunavut

Nordreg Canada	Tel:	1-867-979-5724
P.O. Box 189	Fax:	1-867-979-2464
Iqaluit, NU		
X0A 0H0		

Nova Scotia

Halifax	Tel:	(902) 426-9750 (MCTS Operations)
		(902) 426-9738 (Officer in charge)
	Fax:	(702) 426-4483
Sydney	Tel:	(902) 564-7751 (MCTS Operations)
		(902) 564-7752 (Officer in charge)
	Fax:	(702) 564-7662

New Brunswick

Saint John	Tel:	(506) 636-4696 (MCTS Operations)
		(506) 636-4269 (Officer in charge)
	Fax:	(506) 636-5000

Quebec

Quebec City	Tel:	(418) 648-4427 (MCTS Operations)
		(418) 648-7459 (Officer in charge)
	Fax:	(418) 648-7244
Montreal	Tel:	(450) 928-4544 (MCTS Operations)
		(450) 928-4547 (Officer in charge)
	Fax:	(450) 928-4547
Riviere-Au-Renard	Tel:	(418) 269-5686 (MCTS Operations)
		(418) 269-7718 (Officer in charge)
	Fax:	(418) 269-5514

Greenland

Spill Notification Point	Tel:	+299-101111
Groenlands Kommando	Fax:	+299-10112
Maritime Rescue Coordination Center Gronnedal	Tlx:	90502 GLK GD
KK-3930 Gronnedal		

Competent National Authority	Tel:	+45-31 578310
National Agency of Environmental Protection		+45-86 123099 (24 hr)
Strandgade 29	Fax:	+45-31 572449/+45-86 181140
DK-1401 Copenhagen	Tlx:	31209 MILJOE DK

Note:

The following contacts have been included as they are within the expected range of operation of the Vessel. Due to the nature of the Vessel's voyages and varied ports of call this list should not be considered exhaustive. For this reason space has been included at the end of this section for addenda.

Within Canada, administrative inquiries related to pollution prevention, compliance and enforcement, vessel regulations, design and construction should be directed to:

Director General, Marine Safety
Transport Canada
Mailstop: AMS
330 Sparks Street
Ottawa, Ontario
K1A 0N5
Tel: (613) 998-0610 Fax: (613) 954-1032

Inquiries relating to pollution response should be directed to:

Director General, Rescue and Environmental Response
Canadian Coast Guard
344 Slater Street
Ottawa, Ontario
K1A 0N7

Tel: (613) 990-3110 Fax: (613) 996-8902

Additional Contact Information

Region	
Spill Notification Point	Contact Numbers

Region	
Spill Notification Point	Contact Numbers

Region	
Spill Notification Point	Contact Numbers

Region	
Spill Notification Point	Contact Numbers

VESSEL INTEREST CONTACTS

VESSEL MANAGEMENT

Coastal Shipping Ltd.
P.O. Box 913
Happy Valley-Goose Bay, NL
A0P 1S0

Telephone: (709) 896-2421
Facsimile: (709) 896-5028

24 HOUR CONTACT

The following phone numbers are provided
for 24 hour contact, year round:

Kevin Brewer	(709) 682-0826	(Cellular)
	(709) 227-2600	(Home)
Gerry Burgess	(709) 745-2684	(Home)

APPENDIX 3 • Vessel Stress and Stability Calculations

VOYAGE PARTICULARS

Departure Port

Departure Date

Time (GMT)

VESSEL CONDITION IMMEDIATELY BEFORE CASUALTY

Mean Draft Forward

Mean Draft Aft

KG(solid)

KG(fluid)

LCG of Vessel

#	COMPARTMENT	S.G.	TONNES

DATA RELATING TO VESSEL AFTER CASUALTY

Nature of Casualty: Collision / Grounding (Fixed / Free) / Fire
Explosion / Heavy Weather / Other

Casualty Date Report Time (GMT)

Geographical Location of Casualty: LAT
LONG

Conditions at Site at Time of Casualty Report

Weather

Sea State

Tidal State

Tidal Range

Forecast

S G. of Surrounding Water

Position of Vessel relative to Wind, Waves, Tides, etc

Drafts Measured Port and Starboard:

Drafts at Fwd Marks/F P (Best Estimate)
Drafts at Aft Marks/A P (Best Estimate)
Drafts at Midships (Best Estimate)
Angle of Heel (Port / Starboard)

Best Estimate of Depth of Water (for Grounding)

Location	Port	Starboard

REPORTED DAMAGE

Details of each damaged compartment known to be open to the sea, including those damaged above the present waterline.

Compartment	Estimated Cargo Weight (tonnes)	Permeability of Cargo (%)	Comments

Extent and location of structural damage in way of above compartments. (Attach sketch)

Extent of additional damage to pipes, valves, hatches, doors, etc and list of compartments which may be subject to progressive flooding as a result.

Soundings from or estimates of amounts of flood water in spaces not directly open to sea

PROPOSED ACTION AND REQUIREMENTS

Any other relevant information, details of action being undertaken or proposed course of action, salvage operation etc.

APPENDIX 4 • Flowcharts and Checklists

HULL LEAKAGE

In the event of a hull leakage, the MASTER must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

PIPE LEAKAGE

In the event of a pipe leakage, the CHIEF ENGINEER must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Locate the source and repair if possible	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain affected section of pipe into empty or slack tank if possible	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

TANK OVERFLOW

In the event of a tank overflow, the CHIEF ENGINEER must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

HULL FAILURE including Ice Damage

In the event of hull failure (including ice damage), the MASTER must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

GROUNDING

In the event of a grounding incident, the MASTER must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

FIRE / EXPLOSION

In the event of a fire or explosion, the FIRE CONTROL PARTY CHIEF must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

COLLISION

In the event of a collision, the MASTER must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

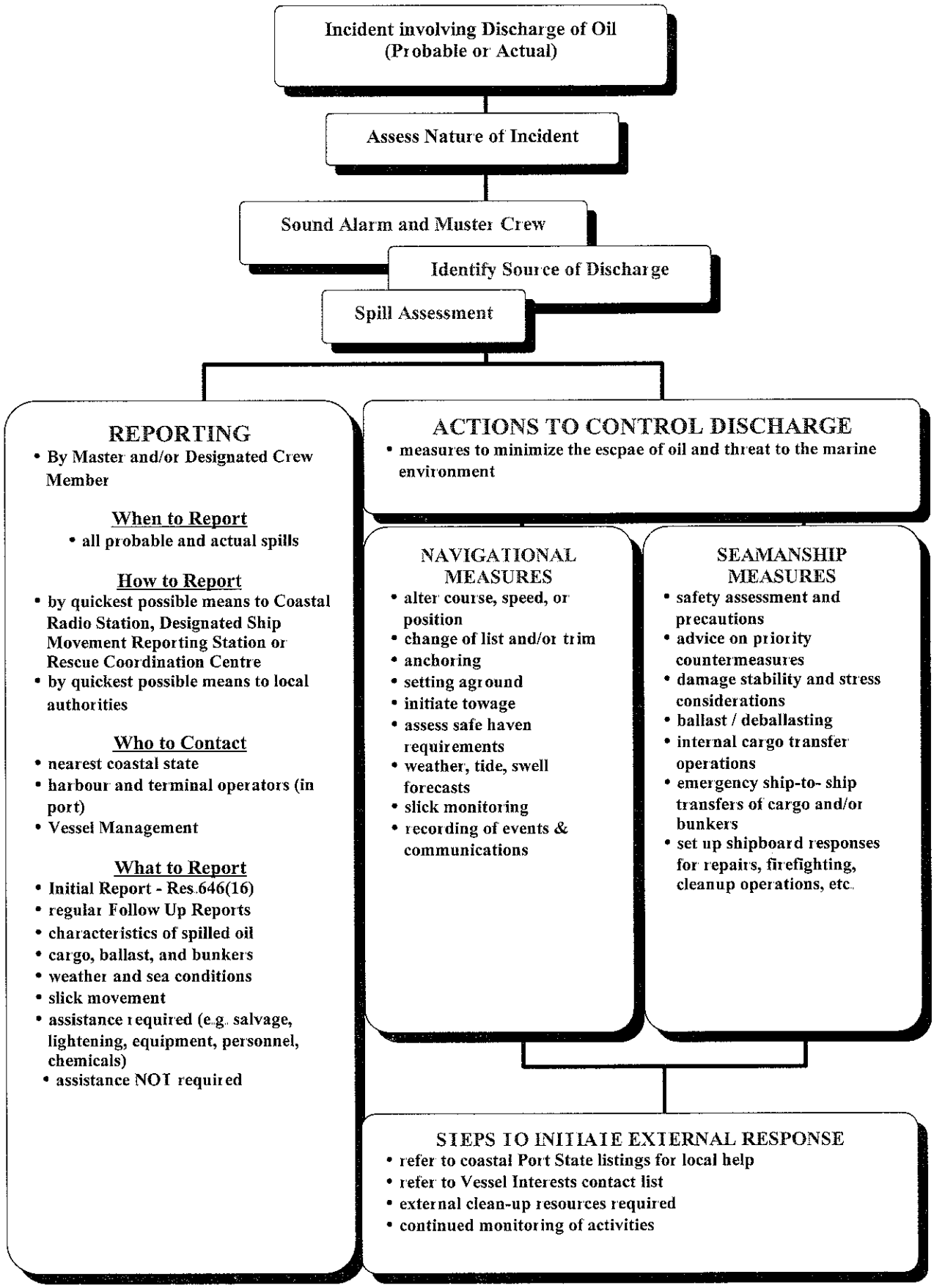
EXCESSIVE LIST

In the event of excessive listing, the MASTER must ensure that the following actions are taken:

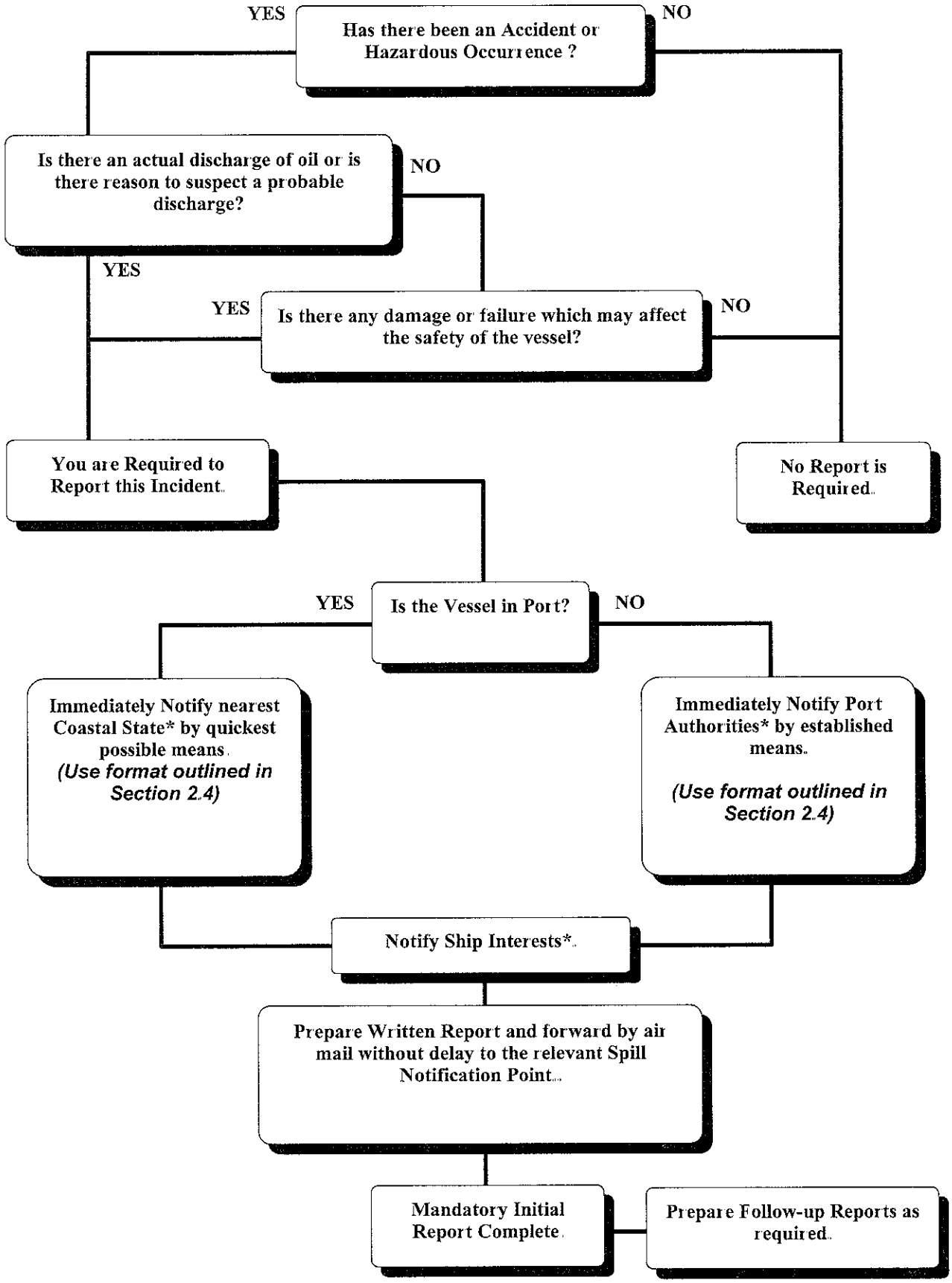
Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

SUMMARY FLOWCHART



REPORTING REQUIREMENTS (as per Section 2)



** contact information is located in Appendix 2.*

APPENDIX 5 • Relevant Drawings

FOLLOWING ARE DRAWINGS RELEVANT TO THIS VESSEL

General Arrangement
Tank Capacity Plan
Bilge and Ballast System
Fuel Oil System
Cargo Handling System

SHIPBOARD OIL POLLUTION EMERGENCY PLAN

for

MT NANNY

6,544 Gross Tons Register of St. John's, NL

PREPARED BY:

Poseidon Marine Consultants Ltd.
391 Stavanger Drive
St. John's NL A1A 5G1
Telephone: (709) 739-4321
Fax: (709) 739-4421

PREPARED FOR:

Coastal Shipping Limited
The Fortis Building
139 Water Street
St. John's, NL
A1C 1B2

Issued: April 2009
Job Number: 2008-118

Change Number

Official Stamp Examined by Date

Examined under the provisions of Annex I and Annex II of MARPOL 73/78 and the Canadian Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals SOR/2007-86

Stan Gutt Pollution Prevention Officer

2009-05-06

Date

Change Number

Official Stamp Examined by Date

Change Number

Official Stamp Examined by Date

RECORD OF CHANGES

Amendment Number	Section and Page Affected	Date Entered	Remarks	Name and Position of Person Making Entry

RECORD OF OIL POLLUTION EMERGENCY DRILLS

DATE	TYPE OF OIL POLLUTION DRILL	LOCATION	REMARKS MASTER'S SIGNATURE

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TRANSPORT CANADA TRANSPORTS CANADA MARINE SAFETY SÉCURITÉ MARITIME CANADA St. John's NL

A3 Vessel Stress and Stability Calculations
A4 Flowcharts and Checklists
A5 Relevant Drawings

SHIP'S PARTICULARS

PRINCIPAL PARTICULARS

Vessel Name:	Nanny (ex. Nathalie SIF)
Flag / Port of Registry:	Canada / St John's, NL
Official Number:	833250
Det Norske Veritas Number:	18064
IMO Number:	9051399
Call Sign:	CFN 5289
Gross Registered Tonnage:	6544 (ITC69)
Net Registered Tonnage:	3081 (ITC69)
Length, Overall:	116.40 m
Length, B.P.:	110.56 m
Breadth, Max. at Deck:	19.001 m
Depth, Moulded:	10.10 m
Design Draft (Summer):	7 814 m
Deadweight:	9,176 metric tons
Built:	Hyundai Heavy Industries Co , Republic of Korea.
Year of Build:	1993
Complement (Maximum):	17
Complement (Safemanning):	10
Propulsion Power:	1 X MAK 6M552C 4050 KW @ 500 rpm

CAPACITIES

Pot Fresh Water	Approx. 69.0 m^3	18,227 Gallons
Technical Fresh Water	Approx. 332.4 m^3	87,810 Gallons
Fuel Oil (MDO)	Approx. 70 8m^3	18,703 Gallons
Fuel Oil (HFO)	Approx. 524.8 m^3	138,637 Gallons
Cargo Hold Incl. Slop Tanks	Approx 10,942.4 m^3	2,890,571 Gallons
Ballast Water	Approx. 3728 4 m^3	984,833 Gallons
Lube Oil	Approx 29 8 m^3	7,872 Gallons
F.O Overflow (S)	Approx. 31.4 m^3	8,295 Gallons
L.O. Drain (P)	Approx. 8.8 m^3	2,324 Gallons
Oily Bilge (S)	Approx 3 9 m^3	1,030 Gallons
F.W. Drain Tk (P)	Approx 3.3 m^3	872 Gallons
Bilge Holding Tk	Approx. 15.8 m^3	4,174 Gallons
Sludge Tk (S)	Approx 12.2 m^3	3,223 Gallons
Boiler Water Drain Tk (S)	Approx 2.4 m^3	634 Gallons
Chain Locker (P)	Approx. 22.7 m^3	5,997 Gallons
Chain Locker (S)	Approx. 22.7 m^3	5,997 Gallons
M/E L.O. Sump Tk. (C)	Approx. 8.4 m^3	2,219 Gallons

TRANSPORT CANADA TRANSPORTS CANADA
MARINE SAFETY SÉCURITÉ MARITIME
CANADA

INTRODUCTION

1. This Plan is written in accordance with the Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals and also in accordance with the requirements of regulation 37 of annex I of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 thereto.

2. The purpose of the Plan is to provide guidance to on board operating personnel the vessel with respect to the steps to be taken when a pollution incident has or is likely to occur.

3. The Plan contains all information and operational instructions required by the guidelines. The appendices contain names, telephone, fax numbers, etc of all contacts referenced in the Plan, as well as other reference material.

4 This Plan has been examined by the Transport Canada - Marine Safety, (herein after referred to as "the Board") and, except as provided below, no alteration or revision shall be made to any part of it without prior approval of the Board.

5 Changes to Sections 6, 7, 8, and the appendices will not be required to be approved by the Board The appendices should be maintained up to date by the Owners, Operators, and Managers.

6 For the purposes of this Plan, the Master is taken to be that person who is a member of the vessel's operational personnel and to which is given senior responsibility for the vessel and any circumstances pertaining thereto

7. Before entering a port of call, the Master should be aware of local emergency response procedures and organizations and have up to date contact information readily available.

SECTION 1 • Preamble

1.1 PURPOSE AND INTENT OF THIS PLAN

This Shipboard Oil Pollution Emergency Plan is intended to assist the vessel's officers, crew and management personnel in dealing with an unexpected discharge of oil. Its primary purpose is to set in motion the necessary actions to stop or minimize the discharge and to mitigate its effects. For quick reference the responsibilities of the Oil Pollution Prevention Team is contained in Section 8 on Page 28.

1.2 SUPPORT BY VESSEL'S MANAGEMENT

In accordance with the plans and policies of the vessel's management organization, management personnel will support the vessel's crew with additional resources, i.e. personnel and materials, as the situation warrants.

1.3 PERSONNEL TRAINING AND EXERCISES

1. ***It is the responsibility of the Vessel's Management to ensure that, through training and exercises, all officers and crew are capable of confidently and safely carrying out their assigned duties.***

   Officers responsible for maintaining the trim of the vessel and ordering transfers of ballast and/or cargo should be fully aware of the consequences of their actions and are expected to comply with the regulations and any documentation aboard the vessel which prescribes conditions of trim and stability , e.g. "Approved Stability Booklet".

   Officers and crew responsible for cargo and or bunkering operations should also be fully aware of the consequences of their actions and are expected to comply with the regulations and any documentation aboard the vessel which prescribes methods of operation.

   Officers and crew assigned additional responsibilities for fire fighting or emergency response should have appropriate training as per the regulations and should participate in specific drills and exercises to maintain their abilities and be fully familiar with appropriate vessel systems.

2. ***The vessel's management and operating personnel should become familiar with this document and its format so that should an emergency occur, the response of the officers and crew and the vessel's management personnel will be carried out in a structured, logical and timely manner.***

   In order to ensure that the crew and management are completely familiar with this document and its prescribed procedures, training should be offered and oil pollution emergency drills should be carried out regularly.

TRANSPORT CANADA TRANSPORTS CANADA MARINE SAFETY SÉCURITÉ MARITIME

A blank "Record of Oil Pollution Emergency Drills" form is provided at the beginning of this Plan to document the dates and results of such training exercises. This documentation is to be in addition to normal record keeping and log book entries.

3. ***All crew members should become familiar with the fundamentals of the ship's mechanical and electrical systems in order to be more confident and capable during an emergency.***

It is the responsibility of the vessel's senior officers to ensure that engineering fundamentals are taught to the crew and that the crew remain familiar with them through regular drills. Drawings detailing the various mechanical and electrical systems are carried aboard the vessel. Any drawing (e.g. "Natural Vents", "Engine Room Ventilation", "One Line Electrical Diagram", "Fuel Oil Transfer Diagram") can be obtained for study from the Engineering Document Library located in the Chief Engineer's Office These drawings are thoroughly catalogued and easily referenced.

In order to ensure a fundamental familiarity with the various engineering systems, oil pollution emergency drills should include but not limited to such exercises as:

- isolating and sealing off accommodations and/or machinery spaces using louvers and fan shutoffs to prevent ingress of dangerous fumes; and
- isolating, at the distribution panels, various electrical circuits, e.g. lighting, panel feeds, in order to reduce or eliminate sources of ignition in areas of risk

1.4 PLAN FORMAT

This plan is divided into Eight sections as follows:

Section 1 provides an introduction for this document and highlights some important considerations regarding the spillage of oil at sea.

Section 2 outlines the procedure and requirements for making a report to authorities in the event of a discharge or probable discharge of oil.

Section 3 provides a checklist of steps to be taken in the event of various operational or casualty related spills.

Section 4 outlines procedures for national and local coordination of response efforts.

Section 5 outlines procedures for ship to ship transfer operations

Section 6 outlines safety precautions for bunkering operations

Section 7 deals with non-mandatory provisions such as oil spill response materials onboard, media information, and plan review.

Section 8 outlines the responsabilities of the Oil Pollution Prevention Team.

Following the main body of this plan are appendices which provide contact information and/or useful forms. Appendix 1 is an example of an unofficial facsimile report, the use

of which is outlined in Section 2. Appendix 2 provides contact information for coastal authorities and ship interests. Appendix 3 is a blank calculation form for vessel stress and stability which can be filled out by an officer of the vessel and sent to the vessel owners for calculation. The use of this calculation form is described in Section 3. Appendix 4 contains flowcharts and checklists for use in the event of an emergency. Appendix 5 contains relevant ship's drawings.

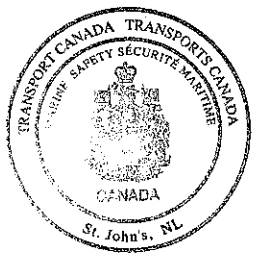
1.5 OIL DISCHARGE MONITORING SYSTEM

In accordance with MARPOL 73/78 Annex 1 Regulation 14 this ship is fitted with a Hanyoung OS-3 0 Capacity 3 m^3/hr oily water separator, manufactured by Hanyoung Engineering Ltd and Seres MKIII, S 663 ballast water monitor manufactured by Seres environment, France. The oil content meters associated with these units are fitted with 15ppm oil content alarms.

IMPORTANT:

1. **ANY** OIL SPILLAGE SHOULD BE TREATED AS AN EMERGENCY.

2. IN RESPONDING TO AN OIL SPILLAGE, THE MASTER'S PRIORITY WILL BE TO ENSURE THE SAFETY OF THE CREW AND OF THE VESSEL, AND TO TAKE ACTION TO PREVENT ESCALATION OF THE INCIDENT. IMMEDIATE CONSIDERATION SHOULD BE GIVEN TO MEASURES AIMED AT PREVENTING FIRE AND EXPLOSION



SECTION 2 • Reporting Requirements

Coast guard of nearest coastal State (see Appendix 2) is to be notified whenever there is:

a) **An actual discharge of oil**
b) **Reason to suspect a probable discharge of oil due to fire, grounding, list, loss of power, collision, flooding, explosion, structural failure, etc.**
c) **Any damage or failure which may affect the safety of the vessel, such as failure or breakdown of the electrical generating system, or essential shipborne navigational aids.**

*****See Reporting Requirement and Summary flowcharts in Appendix 4 for details*****

2.1 DISCHARGE OF OIL

When reporting a discharge of oil, the Master is to provide all relevant information (as per section 2.4) to:

a) Coast Guard of nearest coastal State, or
b) Port Authorities, and also to
c) Vessel Interest Contacts.

A discharge of oil, for the purposes of this plan, refers to:

a) A discharge of oil, resulting from damage to the vessel or its equipment, or for the purpose of securing the safety of a vessel or saving life at sea; or
b) A discharge during the operation of the vessel of oil in excess of the quantity or instantaneous rate permitted under the present Convention

2.2 PROBABLE DISCHARGE OF OIL

The Master must use good judgment to assess any circumstance which might be cause for probable discharge of oil. When making such judgment the following factors must be taken into account:

a) The nature of the damage, failure, or breakdown of the vessel, machinery, or equipment;
b) Vessel location and proximity to land or other navigational hazards;
c) Weather, tide, current, and sea state;
d) Traffic density; and
e) Morale, health and ability of crew onboard to deal with situation.

2.3 DAMAGES AND/OR FAILURES

The Master must report any damage which may affect the safety of the vessel: collision, fire, grounding, explosion, cargo shifting, list, etc. The Master must also report any failure or breakdown of essential machinery which results in impairment of the safety of navigation: i.e. electrical generating system or essential vessel-borne navigational aids.

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MARINE SAFETY SÉCURITÉ MARITIME
CANADA
St. John's, NL

2 4 INITIAL REPORT

An initial report is to be made by radio communication without delay to one of the following Canadian radio ship reporting stations; Canadian Coast Guard Radio Station, Marine Communication Traffic Services, St. Lawrence Seaway Authority marine radio station, or Canadian harbour radio station. The report is to be made following the format given in this section on the next page. Where the report cannot be communicated by radio, it shall be communicated by telephone to the local Canadian radio ship reporting station or to the Canadian Coast Guard Operations Center in Ottawa. Contact information is provided in Appendix 2.

FOLLOW-UP REPORTS

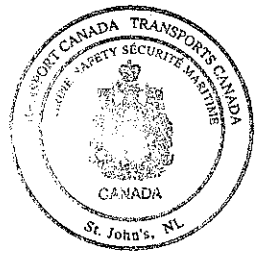
Follow-up reports should be made at regular intervals to keep the coastal State and other concerned parties informed of developments including, but not limited to, change of course or position, change in quantity, rate or probability of oil discharge, injuries or casualties, or effects of actions taken to control discharge or assure safety of the vessel and crew Follow-up reports should be made in the same format as the initial report

WRITTEN REPORT

Within 24 hours of the incident, or as soon as possible thereafter, a written report on the incident, including a statement as to its probable cause, shall be forwarded by air mail without delay to the Chief, Marine Casualty Investigations, Department of Transport, Ottawa.

UNOFFICIAL FACSIMILE REPORT

An unofficial facsimile report is included in Appendix 1. This may be sent to any concerned parties but is not consistent with IMO Resolution A 851(20) for reporting of incidents involving dangerous goods, harmful substances and/or marine pollutants, and therefore cannot constitute an official report to the coastal State



FORMAT AND INFORMATION REQUIRED FOR OFFICIAL REPORT

AA VESSEL NAME, CALL SIGN, FLAG

BB DATE AND TIME (GMT) OF INCIDENT: 111935 meaning 11th of month at 7:35 pm.

CC SHIPS POSITION: 2230N 0600E meaning 22 deg. 30 min. N, 6 deg. E

or

DD SHIPS POSITION BY TRUE BEARING (3 DIGITS) AND DISTANCE FROM CLEARLY IDENTIFIED LANDMARK.

EE TRUE COURSE (3 DIGITS)

FF SPEED IN KNOTS AND TENTHS OF A KNOT (3 DIGITS)

LL ROUTE INFORMATION - INTENDED TRACK

MM RADIO STATIONS AND FREQUENCIES GUARDED

NN TIME OF NEXT REPORT (same as in BB)

OO DRAFT (4 DIGITS - meters and centimeters)

PP TYPES AND QUANTITIES OF CARGO AND BUNKERS ON BOARD

QQ BRIEF DETAILS OF DAMAGE, LIMITATIONS ETC (must include condition of vessel and ability to transfer cargo, ballast, or fuel)

RR BRIEF DETAILS OF ACTUAL POLLUTION (oil type, estimate of quantity discharged, whether discharge continues, cause, estimate of slick movement)

SS WEATHER AND SEA CONDITIONS (wind force/direction, relevant tidal and/or current information)

TT NAME, ADDRESS, FAX, TELEPHONE NUMBERS OF VESSEL OWNER OR REPRESENTATIVE

UU DETAILS OF LENGTH, BREADTH, TONNAGE, AND TYPE OF VESSEL

WW TOTAL NUMBER OF PERSONS ON BOARD

XX MISC. DETAILS (This includes brief details of incident, actions taken, injuries sustained and assistance required If no outside assistance is required, then this should be clearly stated)

2 5 WHO TO CONTACT

Contact information for coastal State and other concerned parties (port contacts, vessel interest contacts) is located in Appendix 2

2 6 ARRANGED RESPONSE ORGANIZATION(S)

The vessel, in accordance with the regulations, has onboard a **declaration** that the vessel's management has, in accordance with 167 of the Canada Shipping Act 2001, entered into an arrangement with a response organization to which a certificate of designation has been issued pursuant to section 169 in respect of the quantity of oil that is carried both as fuel and cargo on board the vessel.

Four response organizations (RO) have been established in Canada. Although each of the RO's are independent Corporations they are linked together through various support and mutual aid agreements. Each of the RO's has a specific Geographic Area of Response (GAR) and a certified response capability of 10,000 tonnes. The following table provides a list of the RO's and a general description of their GAR's. A detailed description of the GAR for each of the RO's is provided in Item 3 5.

Response Organization	Geographic Area of Response (GAR)
• Western Canada Marine Response Corporation(WCMRC)	• In general the waters bordering British Columbia
• Eastern Canada Response Corporation Ltd. (ECRC)	• In general the waters of the Canadian Great Lakes, Quebec and the Atlantic Coast excluding areas covered by Alert and PTMS
• Atlantic Emergency Response Team ("ALERT") Inc.	• In general the Port of Saint John, New Brunswick and surrounding waters.
• Point Tupper Marine Services Limited (PTMS)	• In general the Port of Port Hawkesbury, Nova Scotia and surrounding waters .

Prior to commencing a voyage the master or his onboard designate is responsible to ensure that the necessary declarations for the intended voyage are onboard and necessary contact information has been inserted in the manual in Appendix 2: Who to contact under section " additional contact information".
As an example of whom to contact please refer to the page 34 for Eastern Canada Response Corporation (ECRC) call out sheet If conditions permit i.e. time, prevailing conditions , MASTER shall consult with vessel management contact prior to activation of any response organization.

SECTION 3 • Steps to Control Discharge

In cases of small spills on deck, the vessel's crew should take whatever actions are necessary to prevent oil from escaping over the side. Once the spill is contained on deck, the crew will need to take action to clean up the oil. SPILLED OIL SHALL NOT BE WASHED OVER THE SIDE. Once oil is in the water, the crew's ability to respond in a practical manner is greatly reduced.

3.1 OPERATIONAL SPILLS

In the event of an operational spill which occurs during bunkering or cargo operations, it is important that the bunkering party terminate any and all bunkering operations and close all manifold valves.

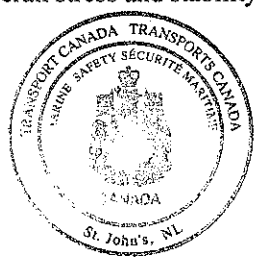
Before closing any manifold valves, the bunkering / cargo party must immediately inform the terminal / loading master so that they may take action to eliminate the possibility of over-pressurization of the shore side transfer components.

After dealing with the cause of the spill, it may be necessary to obtain permission from local authorities and/or the terminal before resuming bunkering or cargo operations

If the possibility of fire or explosion exists, nonessential air intakes to accommodations and machinery spaces should be closed and all sources of sources of ignition should be eliminated. See Section 1.3.3 of this Plan

In accordance with Section 1.3.3 of this Plan, all members of the vessel's crew should be familiar with the fundamentals of the ship's vital systems including the ventilation and electrical systems. Crew members should be able to: isolate the accommodation and/or machinery spaces using the louvers and fan shutoffs; and, from the distribution panels, isolate electrical circuits in areas of risk

Care must be taken to consider stability and stress when taking action to mitigate the spillage of oil. Internal transfers should be undertaken only with a full appreciation of the likely impact on the vessel's overall stress and stability. Please refer to the "Approved Stability Booklet" carried on board.



Operational Spill Checklist

Action Considered	Designated Person	Completed
Sound emergency alarm	Person Discovering Incident	Y / N
Mobilize Oil Pollution Prevention Team	Chief Engineer / Master	Y / N
Cease all bunkering operations	Chief / 2nd Engineer	Y / N
Locate source of leakage	Chief / 2nd Engineer	Y / N
Operate manifold valves	Chief / 2nd Engineer	Y / N
Close all nonessential vent intakes and tank vents as required	Chief / 2nd Engineer	Y / N
Stop or reduce outflow	Chief / 2nd Engineer	Y / N
Assess fire risk	Chief Officer	Y / N
Commence clean up	Chief Officer	Y / N
Assess Stress / Stability	Master / Chief Officer	Y / N
Transfer fuel from damaged area to slack tanks or other containment space	Chief / 2nd Engineer	Y / N
Request outside assistance if required	Master	Y / N
Counter excessive list if required / possible	Chief Officer	Y / N

1. PIPE LEAKAGE

In the event of an oil pipe leakage, the Chief Engineer must ensure that the following actions are taken:

1. Stop oil flow and close manifold and other valves.
2. Sound Emergency Alarm and Mobilize Oil Pollution Prevention Team.
3. Locate the source and drain affected section into an available empty or slack tank. Repair if possible.
4. If there is any possibility of released vapours entering an engine room or the accommodation intake, appropriate preventative steps must be taken quickly.
5. Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.
6. If oil is overboard, report to proper authorities immediately (as per section 2 of this plan)
7. If oil is in bilges, pump through oil/water separator as per approved procedures.

2. TANK OVERFLOW

In the event of an oil tank overflow, the Chief Engineer must ensure that the following actions are taken:

1. Stop oil flow and close manifold and other valves
2. Sound Emergency Alarm and Mobilize Oil Pollution Prevention Team
3. Place drain buckets under overflow pipes to contain possible spills.
4. If there is any possibility of released vapours entering an engine room or the accommodation intake, appropriate preventative steps must be taken quickly.
5. Drain or transfer oil to slack or empty tanks if possible with due consideration paid to vessel stability. If no slack or empty tanks are available then oil may be pumped back ashore through delivery line, having first gained permission to do so.
6. Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container
7. If oil is overboard, report to proper authorities immediately (as per section 2 of this plan)
8. If oil is in bilges, pump through oil/water separator as per approved procedures.

3. HULL LEAKAGE

If oil is noticed on the water near the vessel during normal operations and cannot be accounted for, the possibility of hull leakage should be suspected.

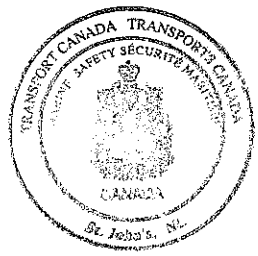
In the event of a hull leakage, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm and Mobilize Oil Pollution Prevention Team.
2. Stop any and all transfer or bunkering operations.
3. Identify damage and report to proper authorities immediately (as per section 2 of this plan); consider a diver if necessary and possible
4. If possible, contain spill using materials on hand and dispose of oil-soaked materials in an appropriate container.
5. If there is any possibility of released vapours entering an engine room or the accommodation intake, appropriate preventative steps must be taken quickly.
6. Transfer fuel away from suspected leaks to empty or slack tanks if possible or to a ballast tank if necessary. If in port, arrangements can be made to pump oil ashore to tank or truck. Due consideration is to be paid to vessel stress and stability.

7. If it is not possible to identify the leaking tank, reduce level in all tanks in vicinity, giving due consideration to vessel stress and stability.

4. SPILLS CAUSED BY EQUIPMENT IN MACHINERY SPACES

1. If operational spills are caused by a failure of equipment in machinery spaces, any further operations of this equipment should be stopped immediately and measures are to be taken to avoid a spill.
2. Sound Emergency Alarm and Mobilize Oil Pollution Prevention Team
3. Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.
4. Do not restart equipment until problem has been rectified.



3.2 SPILLS RESULTING FROM CASUALTIES

ALL CASUALTIES ARE TO BE REPORTED BY THE MASTER AS PER SECTION 2.

The Master's priority, when responding to a casualty, will be to ensure the safety of personnel and the vessel and to take action to prevent escalation of the incident.

In casualties involving spills, immediate consideration should be given to measures aimed at preventing fire and explosion, such as altering course so that the vessel is upwind of the slick, shutting down nonessential air intakes, etc.
If the vessel is aground, and therefore cannot maneuver, all possible sources of ignition should be eliminated and action taken to prevent flammable vapors entering accommodation and engine room spaces. Please refer to Section 1.3.3

In accordance with Section 1.3.3 of this Plan, all members of the vessel's crew should be familiar with the fundamentals of the ship's vital systems including the ventilation and electrical systems. Crew members should be able to isolate the accommodation and/or machinery spaces using the louvers and fan shutoffs; and, from the distribution panels, isolate electrical circuits in areas of risk. Please refer to Section 1.3.3 of this Plan for additional details.

Prior to considering remedial action, the Master will need to obtain detailed information on the damage sustained by the vessel. A visual inspection should be carried out and all bunker tanks and other compartments sounded. However, due regard should be paid to the indiscriminate opening of ullage plugs or sighting ports, especially when the vessel is aground, as loss of buoyancy could result. The Master shall also ensure that all covers, doors, vents, and hatches to any and all holds, ballast tanks, and fuel tanks are sealed tightly and remain sealed to prevent possible loss of buoyancy. Having assessed the damage sustained by the vessel, the Master will be in a position to decide what action should be taken to prevent or minimize further spillage

Great care must be taken to consider stability and stress when taking action to mitigate the spillage of oil or to free the vessel if aground. Internal transfers should be undertaken only with a full appreciation of the likely impact on the vessel's overall stress and stability. Please refer to the "Approved Stability Booklet" carried on board.

Should the damage sustained be extensive, the impact of internal transfers on stress and stability may be impossible for the vessel's personnel to assess. In such cases, Appendix 3 of this plan is to be filled out as completely as possible and forwarded to the Owners to ensure the appropriate calculations can be done.

When it is possible to maneuver, the Master, in conjunction with the proper shore authorities, may consider moving the vessel to a more suitable location in order, for example, to facilitate emergency repair work or lightening operations, or to reduce the threat posed to any particularly sensitive shoreline areas. Such maneuvering may be subject to coastal state jurisdiction.

Oil Spill Resulting from Casualty (Grounding, Collision, Fire, or Explosion)

Action Considered	Designated Person	Completed
Sound emergency alarm	Chief Officer / OOW	Y / N
Mobilize Oil Pollution Prevention Team	Master / Chief Officer	Y / N
Close all nonessential vent intakes and tank vents as appropriate	Chief Officer / Chief Engineer	Y / N
Assess further danger to ship or personnel such as capsize or sinking	Master	Y / N
Cease all nonessential operations	Chief Officer / Chief Engineer	Y / N
Assess whether oil has actually been spilt / probability of spill	Chief Officer / Chief Engineer	Y / N
Sound all compartments to determine extent of damage	2nd Engineer	Y / N
Sound around vessel if grounded	Chief Officer	Y / N
Where possible transfer fuel away from damaged compartments	Chief Engineer	Y / N
Request outside assistance if required	Master	Y / N
Contain / reduce oil outflow with resources on hand	2nd Engineer	Y / N
Initiate Cleanup (if possible)	Chief Officer	Y / N

1. GROUNDING

If the vessel grounds, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm, muster crew and Mobilize Oil Pollution Prevention Team.
2. Eliminate all avoidable sources of ignition and ban smoking on board. Action must be taken to prevent hazardous vapours from entering accommodation and machinery spaces See Section 1.3.3.
3. Identify damage by means of a visual inspection.
4. Take soundings around vessel to determine nature and gradient of seabed.
5. Check differences in tidal ranges at grounding site.
6. Evaluate tidal current in grounding area.
7. Take soundings of all tanks on shell and compare with departure soundings
8. Determine probability and/or quantity of oil released.
9. If oil release is determined or is probable, this is to be included in the casualty report.
10. Determine other possible hazards to the vessel, such as sliding off the grounding site, further damage from the seas / swell, and torsion forces.

At this point, determine risk of additional damage to vessel by attempting to refloat. If remaining aground is determined to be less of a risk then:

1. Use anchors to prevent vessel movement.
2. Take in ballast in empty tanks, with due consideration paid to stress and stability. Please refer to the "Approved Stability Booklet."
3. Consider transfer of fuel from damaged tanks, with due consideration paid to stress and stability. Please refer to the "Approved Stability Booklet."
4. Reduce longitudinal stress on the hull by transfer of fluids internally. Please refer to the "Approved Stability Booklet."
5. If the change in stability and stress cannot be calculated on board, contact the Vessel's management to arrange for the necessary calculations. Refer to Appendix 3 for information which should be provided

2. FIRE / EXPLOSION

If a fire or explosion occurs on board, the vessel's fire control party must ensure that the following actions are taken:

1. Sound Emergency Alarm muster crew and Mobilize Oil Pollution Prevention Team.
2. Determine extent of damage and what damage control measures can be taken.
3. Determine whether there are casualties.
4. Request assistance as deemed necessary.
5. Take necessary actions to prevent smoke and other hazardous vapours from entering the accommodation and machinery spaces.
6. Assess possibility of oil leakage
7. Determine possible actions to control the discharge of oil. This will depend largely on the damage to the ship and cargo.
8. If there is a discharge or possible discharge of oil, this is to be included in the casualty report.
9. Should abandonment be necessary, the Master must ensure that every effort is made to maneuver survival craft upwind of any oil spill.

3. COLLISION

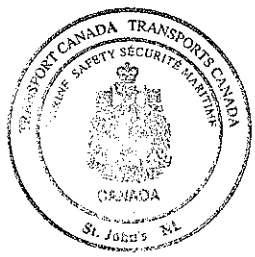
If a collision occurs, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm muster crew and Mobilize Oil Pollution Prevention Team
2. Determine whether there are casualties.
3. If there is a possibility of fire or explosion, eliminate all avoidable sources of ignition and ban smoking on board. Action should be taken to prevent flammable vapours from entering accommodation and machinery spaces See Section 1.3.3.
4. Decide whether separation of vessels may cause or increase spillage of oil, or increase the risk of sinking
5. If any oil tanks are penetrated, isolate the penetrated tank or transfer oil to slack or empty tanks with due attention paid to stress and stability of the vessel. Please refer to the "Approved Stability Booklet."
6. If there is an oil spill, make a report as per section 2.
7. If possible to maneuver, the Master, in conjunction with the appropriate shore authorities, should consider moving his ship to a more suitable location in order to facilitate emergency repair work or lightening operations, or to reduce the threat posed to any sensitive shoreline areas

4. HULL FAILURE (INCLUDING ICE DAMAGE)

If the vessel suffers structural hull failure, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm muster crew and Mobilize Oil Pollution Prevention Team
2. Reduce speed or stop to minimize stress on hull.
3. Assess immediate danger of sinking or capsizing.
4. Initiate damage control measures if possible.
5. If lightening is required, all efforts should be made to wait for a barge or other ship to receive the cargo.
6. If oil has spilled, or if it is necessary to jettison oil to maintain stability, make a report as per section 2.
7. If the change in stability and stress cannot be calculated on board, contact the Vessel's management to arrange for the necessary calculations.
8. Consider forecast weather conditions and their effect on the situation.
9. Should abandonment be necessary, the Master must ensure that every effort is made to maneuver survival craft upwind of any oil spill.



5. EXCESSIVE LIST

If excessive list occurs rapidly and unexpectedly, it may be due to:

1. Failure of hull plating.
2. Failure of internal bulkhead between compartments.
3. Shift of cargo
4. Damage through grounding or collision
5. Incorrect operating condition Refer to "Approved Stability Booklet"
6. Flooding in Engine Room, where free surface can cause a list.

The Master must ensure the following steps are taken immediately:

1. Stop any cargo, bunkering, or ballast operations in progress.
2. Sound Emergency Alarm muster crew and Mobilize Oil Pollution Prevention Team.
3. Determine whether there are casualties.
4. If under way, reduce speed or stop.
5. Establish reason for list. See above.
6. Sound all tanks and compare with departure soundings.
7. Close all openings and vent pipes.
8. Prepare ballast and transfer pumps for possible remedial action
9. If lightening is required, all efforts should be made to wait for a barge or other ship to receive the cargo.
10. If oil has spilled, or it is necessary to jettison oil to maintain stability, make a report as per section 2.
11. If possible, take corrective action to rectify the situation with due consideration paid to vessel stress and stability Please refer to the "Approved Stability Booklet."

SECTION 4 • National and Local Coordination

1. The Master will advise the Coast Guard of nearest coastal state regarding any oil spill. Vessel Interest Contacts must also be notified of any such incident. See Appendix 2 for details.

2 The Master will be the point of contact on the vessel for coordinating shipboard activities with national and local authorities, act as the Company's on-scene representative, and will be responsible for overseeing the action of any salvage or spill contractors employed until such time as he/she has been FORMALLY relieved of these responsibilities by the Company.

3 The person or persons identified in the declaration shall be responsible for contacting and mobilizing the response organization(s). These organizations will coordinate and conduct the response. It is not normally practical for vessel's personnel to be directly involved in cleanup activities. Therefore, their primary role will be to provide as much information as necessary to assist the response and to cooperate with cleanup personnel. However, where no local response is forthcoming, or is delayed, the Master should consider the use of available shipboard materials to clean up or contain the spilled oil by, for example, using ship-stocked absorbent materials or utilizing mooring ropes or air-filled hoses as makeshift booms.

4. Dispersants or degreasers should not be used on oil spilled in the water as their use may contravene local regulations. However, dispersants may be used if they are approved by Environment Canada specifically for a given incident. Environment Canada will allow and approve the use of dispersants on a case by case basis only.

SECTION 5 • Ship to Ship Transfer Operations

Should a situation such as lightening due to damage require a ship to ship transfer of petroleum products, the Master must take into account but not limited to the following:

1. Proper lines of communication between ships including language and radio working frequency;
2. Current and forecasted weather conditions for the intended area of transfer;
3. The compatibility of the vessels involved with regards to size, freeboard, manifold location, list, trim, etc.
4. The elimination of all possible ignition sources;
5. Oil spill clean up equipment and procedures in place;
6. Contingency planning for emergency situations in place.
7. The need to notify and obtain the agreement of any responsible authority.
8. Site conditions such as available shelter, water depth, and available anchorage
9. Traffic density.

For detailed procedures concerning ship to ship transfer of petroleum products, please refer to ***The Ship to Ship Transfer Guide (Petroleum)****, published by The International Chamber of Shipping Oil Companies International Marine Forum, 3rd edition, 1997*

SECTION 6 • Safety Precautions For Bunkering Operations

SHIP	DRIVER / SITE SUPERVISOR
1. International code flag BRAVO to be flown while fueling. 2. Ensure the vessel is adequately secured and has no excessive list or trim. 3. Plug all deck scuppers (openings) to ensure effective containment of a minor spill from tank vents, sounding pipes, manifolds and hose connections. 4. Support hose as necessary to prevent excessive strain. 5. Ensure overboards and other unused fuel manifold valves are closed and secured shut. 6. Monitor hose and connections on the vessel. 7. Monitor tanks, manifolds and vents. 8. Direct fuel to the designated tanks and allow for topping off of tanks. Request reduction in flow rate, when required, and always when topping off tanks. 9. Ship is responsible for and must report any pollutant discharge from the vessel. 10. Provide cleanup materials for minor shipboard spills.	1. Inspect and monitor hose and connections ashore. 2. Monitor truck tank and metering unit if used. 3. Reduce flow rate when requested. 4. Report spills from truck and hoses (If supplier becomes aware of a spill he/she should verify whether or not the spill has been reported. If it has not been reported he/she should do so). 5. Provide clean up materials for minor shore spills. 6. Locate hoses to minimize possibility of damage. Use safety cones to alert traffic if necessary.

COMMON

1. All personnel involved in the fueling operation must not be impaired for the duration of the fueling period. Impairment includes but is not limited to impairment by alcohol, drugs or fatigue.
2. Observe no smoking or open flame requirement for the area.
3. Establish and maintain effective voice communication. Prearrange signals for:
   - A - Standby to start transfer
   - B - start transfer
   - C - slow down transfer
   - D - standby to stop transfer
   - E - stop transfer
   - F - emergency stop of transfer
   - G - emergency shutdown of transfer
4. When fueling at night provide sufficient lighting for the area.
5. In case of emergency take all necessary measures to rectify or minimize the effects of the emergency. Dispersants must not be used without the approval of Environment Canada.
6. In the event of a spill, fueling will stop until relevant authorities have been notified. Containment and clean up measures must be taken at this time. Fueling process will recommence only when the cause of the spill has been determined and rectified unless prohibited by a recognized authority. The restarting of the fueling process must not interfere with the immediate, effective and sustained response to the spill incident.

TRANSPORT CANADA TRANSPORTS CANADA MARINE SAFETY SÉCURITÉ MARITIME CANADA

SECTION 7 • Additional Information (Non-Mandatory)

This section provides for additional information that local authorities, insurance underwriters, or Vessel Management may wish to include, but is not mandatory. (Regulation 37, Annex I, Marpol 73/78)

MEDIA INFORMATION

In the event of an oil spill or other related casualty, the Master is to direct any Coastal Radio station being worked that inquiries from any of the various media nodes are to be directed to the Vessel Management, who will handle such incidents shore-side. This will enable the Master to concentrate on the matter at hand.

PLAN REVIEW

This plan is to be reviewed at regular intervals by the Vessel Management and Master such that the information contained herein is current. Changes should be incorporated in the plan as and when they occur and the changes noted and by whom. Reviews should be conducted annually to reflect changes in local laws or policies, contact names or numbers, vessel characteristics, or company policy

Reviews should also be conducted after any use of the plan in response to an incident, in order to evaluate its effectiveness and make any modifications deemed prudent at that time. Any changes or revisions to the mandatory sections of this manual are to be resubmitted and approved by Transport Canada Marine Safety

COMPANY POLICY

The Master is responsible for maintaining the vessel's plans and technical information, in addition to the drawings contained in this plan, in an orderly and readily accessible fashion. The Master is to satisfy himself to the fact that the vessel's Chief Engineer complies in similar fashion as regards to plans and technical information in his possession.

DIAGRAMS AND DRAWINGS

Should the Master or Chief Engineer discover that crucial plans or manuals covering the operation of essential parts of the vessel are not on board, they are to request the company's head office in writing, to supply such plans and manuals.

RECORD KEEPING

As stated elsewhere in this plan, the Master shall use every effort to retain all records of a pollution incident and responses thereto, for later review by the company's technical department in conjunction with the crew. Such record keeping should include actual samples of oil spilled.

ONBOARD SPILL RESPONSE EQUIPMENT

Anchors, Buoys, Booms, Collapsible Tanks, Oil skimmer and Power pack with 100 feet of Hydraulic Hose, Air driven pump, Two 225 liter spill kits containing absorbent pads, booms, absorbant granular, spark proof shovels, protective clothing, etc., are stored onboard the vessel in the EQUIPMENT ROOM, Starboard side, main deck and readily accessible by the crew in case of spill . It is the responsibility of the Chief Engineer to keep inventory and maintain an adequate stock of equipment

SECTION 8 • Oil Pollution Prevention Team

The master of the vessel is to appoint an Oil Pollution Prevention Team (OPPT) on board, to initiate recovery or cleanup procedures, and to secure the ship immediately if an incident occurs.

The following is an example which can be used by the Master to aid in designating members of the OPPT. Should changes to the team be made, please make a record in this section :

Master
Chief Officer
Chief Engineer

In the event of an emergency, the team should be called out immediately

The team should be given necessary training in the use of such equipment as oil absorbents that the vessel may carry All members of the OPPT should be aware of their duties should an oil spill occur

Instructions to the Oil Pollution Prevention Team

8.1 Master

- In overall charge.
- Informs terminal authorities or coastal authorities of incident.
- Informs the local agent and requests agent to inform the local underwriter's representative.
- Advises the company's head office of the situation Keeps everyone updated at regular intervals. and advises of any changes in status of the emergency.
- Keeps log of all events and progress of actions

8.2 Chief Officer

- In charge of deck / cargo operations.
- In charge of lifeboats if required.
- Keeps the Master informed and updated on the situation and of the results of steps taken to contain any spills and limit outflow.
- Insures all openings in the deck and superstructure are closed to limit vapour entry

8.3 Chief Engineer

- In charge of bunkering operations.
- Organizes distribution of oil spill detergents if required.
- Stops bunkering operations if applicable.
- Stops pumps and any unnecessary pieces of machinery.

Other Personnel

Deck Officer on duty

- Alerts and informs Chief Officer / Chief Engineer on the situation.
- Mobilize off duty crew as necessary.

Engineer on duty

- Assists the Chief Engineer.
- Prepare for fire fighting
- Ensure sufficient power and water to deck.
- Organizes onboard clean up equipment.

Deck Officer off duty

- Under the direction of the Master, responsible for the reporting and record keeping of all events.

On duty Ratings

- Alerts the Officer on duty of any leakage.
- Position sorbent / clean up material to prevent any fluid escape

Off duty personnel

- Assist as required

APPENDIX 1 • Report Format and Content

The report should contain the following:

AA VESSEL NAME, CALL SIGN, FLAG

BB DATE & TIME (GMT) OF INCIDENT: 111935 meaning 11th of month at 7:35 pm

CC SHIPS POSITION: 2230N 0600E meaning 22 deg. 30 min. N, 6 deg. E

or

DD SHIPS POSITION BY TRUE BEARING (3 DIGITS) AND DISTANCE FROM CLEARLY IDENTIFIED LANDMARK.

EE TRUE COURSE (3 DIGITS)

FF SPEED IN KNOTS AND TENTHS OF A KNOT (3 DIGITS)

LL ROUTE INFORMATION - INTENDED TRACK

MM RADIO STATIONS AND FREQUENCIES GUARDED

NN TIME OF NEXT REPORT (same as in BB)

OO DRAFT (4 DIGITS - meters and centimeters)

PP TYPES AND QUANTITIES OF CARGO AND BUNKERS ON BOARD

QQ BRIEF DETAILS OF DAMAGE, LIMITATIONS ETC (must include condition of vessel and ability to transfer cargo, ballast, or fuel)

RR BRIEF DETAILS OF ACTUAL POLLUTION (oil type, estimate of quantity discharged, whether discharge continues, cause, estimate of slick movement)

SS WEATHER AND SEA CONDITIONS (wind force/direction, relevant tidal and/or current information)

TT NAME, ADDRESS, TELEX, FAX, TELEPHONE NUMBERS OF VESSEL OWNER OR REPRESENTATIVE

UU DETAILS OF LENGTH, BREADTH, TONNAGE, AND TYPE OF VESSEL

WW TOTAL NUMBER OF PERSONS ON BOARD

XX MISC. DETAILS (brief details of incident, actions taken, injuries, assistance required)

UNOFFICIAL OIL POLLUTION EMERGENCY REPORT BY FACSIMILE

Vessel Name Call Sign Flag

Date and Time of Event

Vessel Position (Latitude & Longitude, Bearing & Distance from Landmark)

Course Speed

Intended Track

Radio Station

Date and Time of Next Report

Type and Quantity of Oil On board

Brief Details of Damage

Brief Details of Pollution

Details of Weather & Sea Conditions (Wind Speed/Direction, Swell Height/Direction)

Names of Vessel's Owner

Vessel Size and Type

Any Other Additional Information as Determined by Master

APPENDIX 2 • Who to Contact

In accordance with the Canadian Pollutant Discharge Reporting Regulations, the Master or Owner of a ship must report, without delay, any discharge or anticipated discharge of a pollutant in Canadian waters or fishing zones, to a Pollution Prevention Officer (PPO) Reports must be made in the manner described in Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants, TP 9834, or "General Principles for Ship Reporting Systems and Ship Reporting Requirements, including Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants" adopted by the IMO by Resolution A.851(20) These initial reports can be made to Marine Communication and Traffic Service (MCTS) or any other Canadian Coast Guard Radio Station (CGRS), on the frequencies listed in the publication, Radio Aids to Marine Navigation (RAMN)

In addition to the above process for reporting a spill from a vessel to a PPO through a CGRS or MCTS, the Canadian Coast Guard maintains a 24 hour Operations Center which can be contacted at:

Canadian Coast Guard Operations Center
344 Slater Street
Ottawa, Ontario
K1A 0N7

Tel: (613) 990-5600 Fax: (613) 995-4700 Tlx: (613) 053 3128

Alternatively, spills may be reported to the appropriate regional center or nearest Vessel Traffic Service Center:

Newfoundland

St. John's	Tel:	1-709-772-2083
		1-800-563-2444 (24 hr.)
	Fax:	1-709-772-5369
Placentia Bay	Tel:	1-709-227-2182
	Fax:	1-709-227-5637
Port Aux Basques	Tel:	1-709-695-2167
	Fax:	1-709-695-7784
Goose Bay	Tel:	1-709-896-2252
	Fax:	1-709-896-8455
St. Anthony	Tel:	1-709-454-3852
	Fax:	1-709-454-3716

Nunavut

Nordreg Canada	Tel:	1-867-979-5724
P.O Box 189	Fax:	1-867-979-2464
Iqaluit, NU		
X0A 0H0		

Nova Scotia

Halifax	Tel:	1-902-426-9750 (MCTS Operations)
		1-902-426-9738 (Officer in Charge)
	Fax:	1-702-426-4483
Sydney	Tel:	1-902-564-7751 (MCTS Operations)
		1-902-564-7752 (Officer in Charge)
	Fax:	1-702-564-7662

New Brunswick

Saint John	Tel:	1-506-636-4696 (MCTS Operations)
		1-506-636-4269 (Officer in Charge)
	Fax:	1-506-636-5000

Quebec

Quebec City	Tel:	1-418-648-4427 (MCTS Operations)
		1-418-648-7459 (Officer in Charge)
	Fax:	1-418-648-7244
Montreal	Tel:	1-450-928-4544 (MCTS Operations)
		1-450-928-4547 (Officer in Charge)
	Fax:	1-450-928-4547
Riviere-Au-Renard	Tel:	1-418-269-5686 (MCTS Operations)
		1-418-269-7718 (Officer in Charge)
	Fax:	1-418-269-5514

Greenland

Spill Notification Point	Tel:	+299-101111
Groenlands Kommando	Fax:	+299-10112
Maritime Rescue Coordination Center Gronnedal		
KK-3930 Gronnndell		

Competant National Authority	Tel:	+45-31 578310
National Agency of Environmental Protection		+45-86 123099 (24hr)
Strandgade 29	Fax:	+45-31 572449/+45-86 181140
DK- 1401 Copenhagen		

Note:

The following contacts have been included as they are within the expected range of operation of the Vessel Due to the nature of the Vessel's voyages and varied ports of call this list should not be considered exhaustive For this reason space has been included at the end of this section for addenda.

Within Canada, administrative inquiries related to pollution prevention, compliance and enforcement, vessel regulations, design and construction should be directed to:

Director General, Marine Safety
Transport Canada
Mailstop: AMS
330 Sparks Street
Ottawa, Ontario
K1A 0N5
Tel: (613) 998-0610 Fax: (613) 954-1032

Inquiries relating to pollution response should be directed to:

Director General, Rescue and Environmental Response
Canadian Coast Guard
344 Slater Street
Ottawa, Ontario
K1A 0N7

Tel: (613) 990-3110 Fax: (613) 996-8902

Additional Contact Information

Region	
Spill Notification Point	Contact Numbers

Region	
Spill Notification Point	Contact Numbers

Region	
Spill Notification Point	Contact Numbers

Region	
Spill Notification Point	Contact Numbers

VESSEL INTEREST CONTACTS

Vessel Management
Coastal Shipping Limited (Owners)
P. O. Box 300, Station C
Happy Valley-Goose Bay, NL
A0P 1C0
Canada
Ph: (709) 896-2421
Fax: (709) 896-5028

Vessel Operations
Coastal Shipping Limited
139 Water Street, Suite 502
St John's, NL
A1C 1B2
Canada
Ph: (709) 579-6127
Fax: (709) 579-8103

24 Hour Emergency Contact

(709) 896-5036
(709) 896-9348

General Manager	Dennis White	(709) 896-2421 work (709) 896-1404 cell (709) 896-2870 home
Engineering Superintendent	Jim Babij	(709) 579-6127 work (709) 727-5065 cell (709) 576-0160 home
	Kevin Brewer	(709) 579-6127 work (709) 682-0826 cell (709) 227 2600 home
Designated Person Ashore	Philip Martin	(709) 579-6127 work (709) 727-4242 cell (709) 722-3781 home

Eastern Canada Response Corporation
Required Call Out Information

ECRC EMERGENCY NUMBER: 613 930-9690

CONTRACT NUMBER: _____

PROBLEM: _____

CURRENT STATUS: _____

CONDITIONS AT SPILL SITE: _____

THIS IS AN *(CIRCLE ONE)* EMERGENCY EXERCISE ALERT

R.O. RESPONSE REQUESTED BY *(PERSON S NAME)* _____

OF *(MEMBER COMPANY NAME)* _____ ON BEHALF OF

THE SHIP / FACILITY *(NAME)* _____

THE PRODUCT IS _____

SPILL VOLUME IS *(CIRCLE ONE)* _____ GAL / Litres / BBL /Tonnes

TOTAL VOLUME AT RISK IS *(STATE UNITS)* _____

LOCATED AT LATITUDE _____ LONGITUDE _____

OR GEOGRAPHIC LOCATION NAME IS _____

OR IT IS LOCATED _____km / miles (N / NE / E / SE / S / SW / W / NW) OF

(CITY NAME) _____

THE CLOSEST AIRPORT IS _____

I CAN BE REACHED AT THE FOLLOWING NUMBERS:

TEL: _____ CELL: _____ PAGER: _____

APPENDIX 3 • Vessel Stress and Stability Calculations

VOYAGE PARTICULARS

Departure Port

Departure Date

Time (GMT)

VESSEL CONDITION IMMEDIATELY BEFORE CASUALTY

Mean Draft Forward

Mean Draft Aft

KG(solid)

KG(fluid)

LCG of Vessel

#	COMPARTMENT	S.G.	TONNES

DATA RELATING TO VESSEL AFTER CASUALTY

Nature of Casualty: Collision / Grounding (Fixed / Free) / Fire
Explosion / Heavy Weather / Other

Casualty Date Report Time (GMT)

Geographical Location of Casualty: LAT
LONG

Conditions at Site at Time of Casualty Report

Weather

Sea State

Tidal State

Tidal Range

Forecast

S.G. of Surrounding Water

Position of Vessel relative to Wind, Waves, Tides, etc

Drafts Measured Port and Starboard:

Drafts at Fwd Marks/F.P. (Best Estimate)
Drafts at Aft Marks/A.P. (Best Estimate)
Drafts at Midships (Best Estimate)
Angle of Heel (Port / Starboard)

Best Estimate of Depth of Water (for Grounding)

Location	Port	Starboard

REPORTED DAMAGE

Details of each damaged compartment known to be open to the sea, including those damaged above the present waterline

Compartment	Estimated Cargo Weight (tonnes)	Permeability of Cargo (%)	Comments

Extent and location of structural damage in way of above compartments (Attach sketch)

Extent of additional damage to pipes, valves, hatches, doors, etc and list of compartments which may be subject to progressive flooding as a result.

Soundings from or estimates of amounts of flood water in spaces not directly open to sea.

PROPOSED ACTION AND REQUIREMENTS

Any other relevant information, details of action being undertaken or proposed course of action, salvage operation etc.

APPENDIX 4 • Flowcharts and Checklists

4A . OPERATIONAL SPILL CHECKLISTS

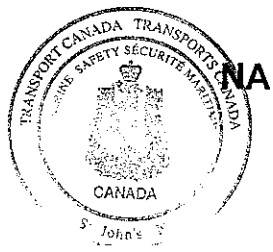
OPERATIONAL SPILL CHECKLIST

HULL LEAKAGE

In the event of a hull leakage, the MASTER must ensure that the following actions are taken:

Sound Emergency Alarm and	☐
Mobilize Oil Pollution Prevention Team	
Stop all transfers or bunkering operations	☐
Identify the damage and REPORT to proper	☐
authorities immediately as per Section 2 of this plan	
Absorb spill with any absorbent	☐
materials on hand and dispose of oil-soaked materials in an appropriate container	
Contain any spill vapours from entering	☐
Engine room or Accommodations	
Drain or transfer oil into empty or	☐
slack tanks if possible or arrange for transfer to shore	
If oil is in bilges, pump through	☐
oil/water separator	

✓ YES X NO NA Not Applicable



OPERATIONAL SPILL CHECKLIST

PIPE LEAKAGE

In the event of a pipe leakage, the CHIEF ENGINEER must ensure that the following actions are taken:

Stop Oil Flow and close manifold and other valves. ☐

Sound Emergency Alarm and Mobilize Oil Pollution Prevention Team ☐

Place drain buckets under overflow pipes to contain possible ☐

Locate the source and drain affected section into an available empty or slack tank. Repair. ☐

Contain any spill vapours from entering Engine room or Accommodations ☐

Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container ☐

If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan ☐

✓ YES X NO NA Not Applicable

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4B. CASUALTY SPILL CHECKLISTS

CASUALTY SPILL CHECKLIST

HULL FAILURE including Ice Damage

In the event of hull failure (including ice damage), the MASTER must ensure that the following actions are taken:

Sound Emergency Alarm and Muster Crew	☐
Mobilize the Oil Pollution Prevention Team	☐
Reduce Speed or Stop to Mimimize Hull Stress	☐
Assess Immediate Danger of Sinking/Capsizing	☐
Initiate Damage Control Measures with Due Care Paid to Vessel Strength and Stability	☐
REPORT to Proper Authorities Immediately as per Section 2 of this Plan	☐
Is Abandonment Necessary? **If YES then Ensure Every Effort is Made to Manoeuvre Survival Craft Upwind Of Any Oil Spill**	☐

✓ YES X NO NA Not Applicable

CASUALTY SPILL CHECKLIST

GROUNDING

In the event of a grounding incident, the MASTER must ensure that the following actions are taken:

Sound Emergency Alarm and Muster Crew	☐
Mobilize the Oil Pollution Prevention Team	☐
Eliminate All Avoidable Sources of Ignition and Ban Smoking on Board	☐
Identify Damage by Visual Inspection	☐
Take Soundings to Determine Nature and Gradient of Seabed	☐
Check Tidal Ranges at Grounding Site	☐
Evaluate Tidal Current at Grounding Site	☐
Take Sounding of All Tanks on Shell and Compare with Departure Soundings to Determine Probability and/or Quantity of Oil Released	☐
REPORT to Proper Authorities Immediately as per Section 2 of this Plan	☐
Determine Best Course of Action: Refloat or Remain Aground	☐
If Remaining Aground is Best, Take Additional Measures to Prevent Vessel Movement and Reduce Longitudinal Stress as per Section 3.1	☐

✓ YES X NO NA Not Applicable

CASUALTY SPILL CHECKLIST

FIRE / EXPLOSION

In the event of a fire or explosion, the FIRE CONTROL PARTY CHIEF must ensure that the following actions are taken:

Sound Emergency Alarm and Muster Crew ☐

Mobilize the Oil Pollution Prevention Team ☐

Determine Extent of Damage and Damage

☐

Control Measures to be Taken

Determine Whether there are Casualties ☐

Request Assistance as Necessary ☐

Assess Possibility of Oil Leakage ☐

REPORT to Proper Authorities Immediately as per Section 2 of this Plan ☐

Is Abandonment Necessary? ☐

If YES then Ensure Every Effort is Made to Manoeuvre Survival Craft Upwind Of Any Oil Spill

✓ YES X NO NA Not Applicable

CASUALTY SPILL CHECKLIST

COLLISION

In the event of a collision, the MASTER must ensure that the following actions are taken:

Sound Emergency Alarm and Muster Crew	☐
Determine Whether there are Casualties	☐
Mobilize the Oil Pollution Prevention Team	☐
Determine Whether Separation of Vessels May Cause or Increase Spillage of Oil	☐
Are Any Oil Tanks Penetrated? **If YES then Isolate Penetrated Tanks and/or Transfer Oil to Slack or Empty Tanks with Due Care Paid to Vessel Stress and Stability**	☐
REPORT to Proper Authorities Immediately as per Section 2 of this Plan	☐

✓ YES X NO NA Not Applicable

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MARINE SAFETY SÉCURITÉ MARITIME
CANADA
St. John's, NL

CASUALTY SPILL CHECKLIST

EXCESSIVE LIST

In the event of excessive listing, the MASTER must ensure that the following actions are taken:

Sound Emergency Alarm and Muster Crew ☐

Stop any Cargo, Bunkering or Ballasting Operations in Progress ☐

Determine Whether there are Casualties ☐

If Under Way then Reduce Speed or Stop ☐

Establish Reason for Excessive List ☐

- ☐ *Failure of Hull Plating?*
- ☐ *Failure of Internal Bulkhead between Compartments?*
- ☐ *Shift of Cargo?*
- ☐ *Damage from Grounding or Collision?*
- ☐ *Incorrect Operational Procedures?*
- ☐ *Flooding in Engine Room with Resultant Free Surface?*
- ☐ *Other?* _____

Sound All Tanks and Compare with Departure Soundings ☐

REPORT to Proper Authorities Immediately as per Section 2 of this Plan ☐

Initiate Corrective Action with Due Care Paid to Vessel Strength and Stability ☐

Is Abandonment Necessary? ☐

If YES then Ensure Every Effort is Made to Manoeuvre Survival Craft Upwind Of Any Oil Spill

✓ YES X NO NA Not Applicable

TRANSPORT CANADA TRANSPORTS CANADA MARINE SAFETY SÉCURITÉ MARITIME CANADA

4C. FLOW CHARTS

SUMMARY FLOWCHART

Incident involving Discharge of Oil (Probable or Actual)

Assess Nature of Incident

Mobilize Oil Pollution Team

Sound Alarm and Muster Crew

Identify Source of Discharge

Spill Assessment

REPORTING

- By Master and/or Designated Crew Member

When to Report

- all probable and actual spills

How to Report

- by quickest possible means to Coastal Radio Station, Designated Ship Movement Reporting Station or Rescue Coordination Centre
- by quickest possible means to local authorities

Who to Contact

- nearest coastal state
- harbour and terminal operators (in port)
- Vessel Management

What to Report

- Initial Report - Res.A 851(20)
- regular Follow Up Reports
- characteristics of spilled oil
- cargo, ballast, and bunkers
- weather and sea conditions
- slick movement
- assistance required (e.g. salvage, lightening, equipment, personnel, chemicals)
- assistance NOT required

ACTIONS TO CONTROL DISCHARGE

- measures to minimize the escpae of oil and threat to the marine environment

NAVIGATIONAL MEASURES

- alter course, speed, or position
- change of list and/or trim
- anchoring
- setting aground
- initiate towage
- assess safe haven requirements
- weather, tide, swell forecasts
- slick monitoring
- recording of events & communications

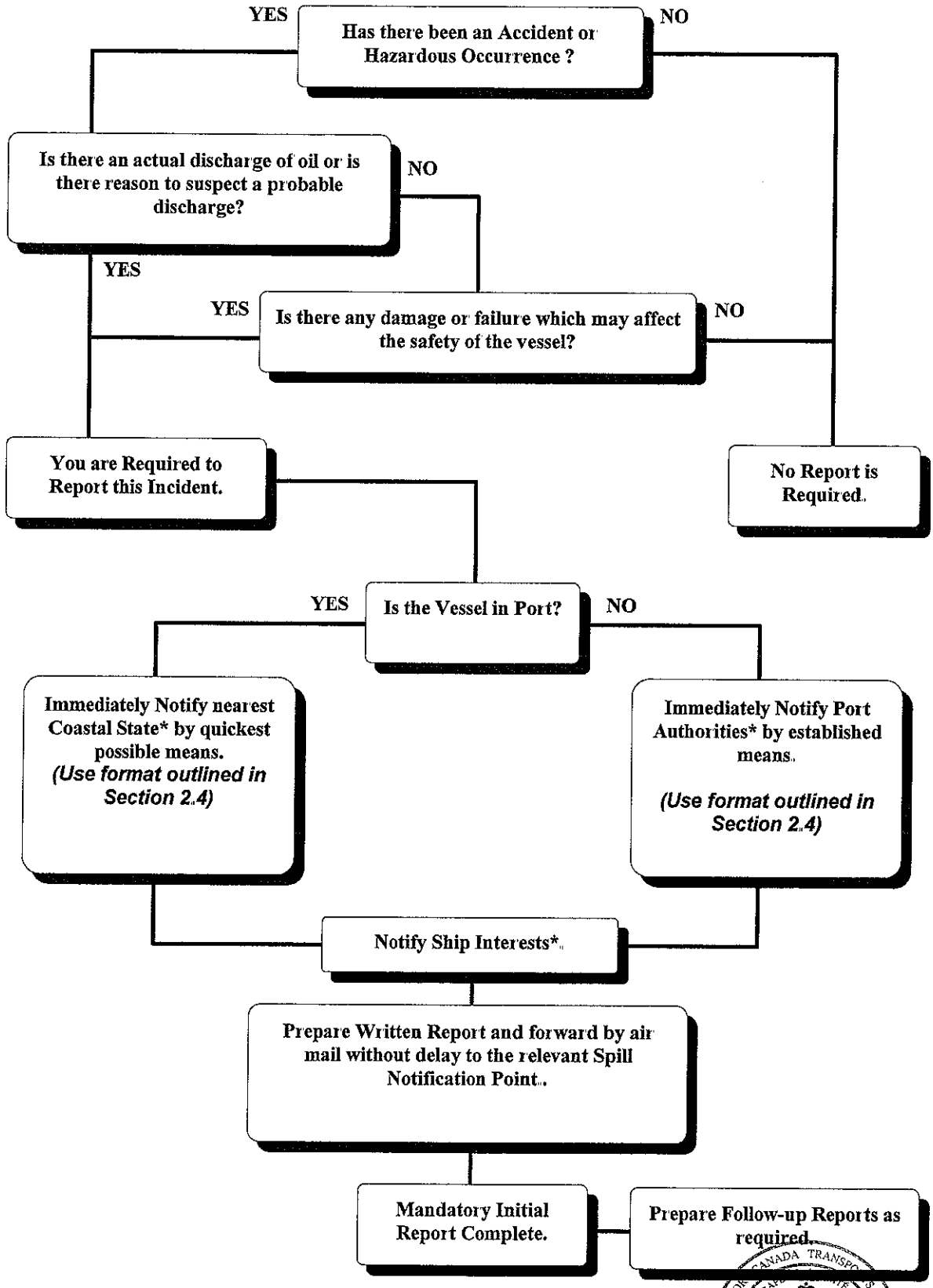
SEAMANSHIP MEASURES

- safety assessment and precautions
- advice on priority countermeasures
- damage stability and stress considerations
- ballast / deballasting
- internal cargo transfer operations
- emergency ship-to- ship transfers of cargo and/or bunkers
- set up shipboard responses for repairs, firefighting, cleanup operations, etc.

STEPS TO INITIATE EXTERNAL RESPONSE

- refer to coastal Port State listings for local help
- refer to Vessel Interests contact list
- external clean-up resources required
- continued monitoring of activities

REPORTING REQUIREMENTS (as per Section 2)



** contact information is located in Appendix 2.*

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CANADA
St. John's NL

APPENDIX 5 • Relevant Drawings

FOLLOWING ARE DRAWINGS RELEVANT TO THIS VESSEL

General Arrangement
Tank Capacity Plan
Arrangement of Cargo Tank Cleaning / Ballast Pumping System
Arrangement of Cargo / Stripping System
Fuel Oil Service System
Fuel Oil Transfer & Purifying System
Fuel Oil & Diesel Oil Filling System
Deck Scupper System

Examined under the provisions of Annex 1 of MARPOL 73/78 and the Canadian Oil Pollution Prevention Regulations (SOR/93-3) and found satisfactory.

W. S. Atkinson, Pollution Prevention Officer

SHIPBOARD OIL POLLUTION EMERGENCY PLAN

for

MT Tuvaq

11290 Gross Tons Register of St. John's, NL

PREPARED BY: ***Poseidon Marine Consultants Limited***
391 Stavanger Drive
St. John's NL A1A 5G1
TELEPHONE: (709) 739-4321
TELEFAX: (709) 739-4421

PREPARED FOR: ***Coastal Shipping***
Suite 502,
139 Water St. (Fortis Bldg.)
St. John's NL
A1C 1B2

Issued: April 2003
Job Number: 03-009

Change Number

Official Stamp Examined by Date

Change Number

Official Stamp Examined by Date

Change Number

Official Stamp Examined by Date

RECORD OF CHANGES

Amendment Number	Section and Page Affected	Date Entered	Remarks	Name and Position of Person Making Entry

RECORD OF OIL POLLUTION EMERGENCY DRILLS

DATE	TYPE OF OIL POLLUTION DRILL	LOCATION	REMARKS MASTER'S SIGNATURE

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A3	Vessel Stress and Stability Calculations
A4	Relevant Drawings

TRANSPORT CANADA TRANSPORTS CANADA MARINE SAFETY SÉCURITÉ MARITIME CANADA St. John's, NF

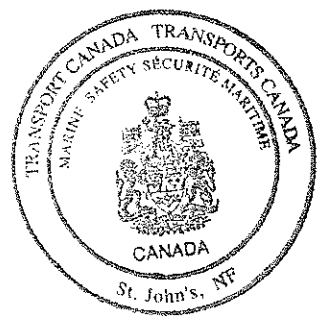
SHIP'S PARTICULARS

PRINCIPAL PARTICULARS

Vessel Name:	IUVAQ ex. Tiira
Flag / Port of Registry:	Canada / St. John's, NL
Call Sign:	OIHO
DNV Number:	10520
IMO Number:	7421966
Gross Registered Tonnage:	11290
Net Registered Tonnage:	5941
Length, Overall:	164.2 m
Length, B.P.:	150 m
Breadth, Max at Deck:	22.2 m
Depth:	12.00 m
Design Draft (Loadline Summer):	9.5 m
Built:	Werft Nobiskrug GMBH. Rendisburg, Germany
Year of Build:	1977
Complement:	21
Propulsion Power:	2 Wartsila 6L46B engines totaling 15368 BHP

CARGO PARTICULARS

Tank Capacities:	Water Ballast -	6247.30 m^3 @100%
	Heavy Fuel Oil -	1532.90 m^3
	Diesel Oil -	410.40 m^3
	Cargo-	16542.61 m^3 @100%
	Slops -	664.20 m^3 @ 100%
Cargo Pumps:	Deep well hydraulically Driven Frank Mohn	
Cargo Manifolds:	Four (4) 250 mm ID cargo lines per side	



INTRODUCTION

1. This Plan is written in accordance with the Canadian Oil Pollution Prevention Regulations and also in accordance with the requirements of regulation 26 of annex I of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 thereto.

2. The purpose of the Plan is to provide guidance to on board operating personnel the vessel with respect to the steps to be taken when a pollution incident has or is likely to occur.

3. The Plan contains all information and operational instructions required by the guidelines. The appendices contain names, telephone, telex numbers, etc. of all contacts referenced in the Plan, as well as other reference material.

4. This Plan has been examined by the Canadian Board of Steamship Inspection, (hereinafter referred to as "the Board") and, except as provided below, no alteration or revision shall be made to any part of it without prior approval of the Board.

5. Changes to Section 5 and the appendices will not be required to be approved by the Board. The appendices should be maintained up to date by the Owners, Operators, and Managers.

6. For the purposes of this Plan, the Master is taken to be that person who is a member of the vessel's operational personnel and to which is given senior responsibility for the vessel and any circumstances pertaining thereto.

7. Before entering a port of call, the Master should be aware of local emergency response proceedures and organisations and have up to date contact information readily available.

SECTION 1 • Preamble

1.1 PURPOSE AND INTENT OF THIS PLAN

This Shipboard Oil Pollution Emergency Plan is intended to assist the vessel's officers, crew and management personnel in dealing with an unexpected discharge of oil. Its primary purpose is to set in motion the necessary actions to stop or minimize the discharge and to mitigate its effects.

1.2 SUPPORT BY VESSEL'S MANAGEMENT

In accordance with the plans and policies of the vessel's management organization, management personnel will support the vessel's crew with additional resources, i.e. personnel and materials, as the situation warrants.

1.3 PERSONNEL TRAINING AND EXERCISES

1. ***It is the responsibility of the Vessel's Management to ensure that, through training and exercises, all officers and crew are capable of confidently and safely carrying out their assigned duties.***

   Officers responsible for maintaining the trim of the vessel and ordering transfers of ballast and/or cargo should be fully aware of the consequences of their actions and are expected to comply with the regulations and any documentation aboard the vessel which prescribes conditions of trim and stability , e.g. "Approved Stability Booklet".

   Officers and crew responsible for cargo and or bunkering operations should also be fully aware of the consequences of their actions and are expected to comply with the regulations and any documentation aboard the vessel which prescribes methods of operation.

   Officers and crew assigned additional responsibilities for fire fighting or emergency response should have appropriate training as per the regulations and should participate in specific drills and exercises to maintain their abilities and be fully familiar with appropriate vessel systems.

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MARINE SAFETY SÉCURITÉ MARITIME
CANADA
St. John's, NF

2. ***The vessel's management and operating personnel should become familiar with this document and its format so that should an emergency occur, the response of the officers and crew and the vessel's management personnel will be carried out in a structured, logical and timely manner.***

In order to ensure that the crew and management are completely familiar with this document and its prescribed procedures, training should be offered and oil pollution emergency drills should be carried out regularly.

A blank "Record of Oil Pollution Emergency Drills" form is provided at the beginning of this Plan to document the dates and results of such training exercises. This documentation is to be in addition to normal record keeping and log book entries.

3. ***All crew members should become familiar with the fundamentals of the ship's mechanical and electrical systems in order to be more confident and capable during an emergency.***

It is the responsibility of the vessel's senior officers to ensure that engineering fundamentals are taught to the crew and that the crew remain familiar with them through regular drills. Drawings detailing the various mechanical and electrical systems are carried aboard the vessel. Any drawing (e.g. "Natural Vents", "Engine Room Ventilation", "One Line Electrical Diagram", "Fuel Oil Transfer Diagram") can be obtained for study from the Engineering Document Library located in the Chief Engineer's Office. These drawings are thoroughly catalogued and easily referenced.

In order to ensure a fundamental familiarity with the various engineering systems, oil pollution emergency drills should include such exercises as:

- isolating and sealing off accommodations and/or machinery spaces using louvres and fan shut-offs to prevent ingress of dangerous fumes; and
- isolating, at the distribution panels, various electrical circuits, e g lighting, panel feeds, in order to reduce or eliminate sources of ignition in areas of risk.

1.4 PLAN FORMAT

This plan is divided into five sections as follows:

Section 1 provides an introduction for this document and highlights some important considerations regarding the spillage of oil at sea.

Section 2 outlines the procedure and requirements for making a report to authorities in the event of a discharge or probable discharge of oil.

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Section 4 outlines procedures for national and local coordination of response efforts.

Section 5 outlines procedures for ship to ship transfer operations

Section 6 deals with non-mandatory provisions such as oil spill response materials onboard, media information, and plan review.

Following the main body of this plan are appendices which provide contact information and/or useful forms. Appendix 1 is an example of an unofficial facsimile report, the use of which is outlined in Section 2. Appendix 2 provides contact information for coastal authorities and ship interests. Appendix 3 is a blank calculation form for vessel stress and stability which can be filled out by an officer of the vessel and sent to the vessel owners for calculation. The use of this calculation form is described in Section 3. Appendix 4 contains relevant ship's drawings.

1.5 OIL DISCHARGE MONITORING SYSTEM

In accordance with MARPOL 73/78 Annex 1 Regulation 16 this ship is fitted with an Oilcon MK4 monitoring system by STC International Marine Limited which gives an impulse when any of the following occurs

- Flow rate of discharge is greater than ordered
- Impurities exceed 15ppm
- Total of maximum oil output limit is reached

IMPORTANT:

1. ANY OIL SPILLAGE SHOULD BE TREATED AS AN EMERGENCY.

2. IN RESPONDING TO AN OIL SPILLAGE, THE MASTER'S PRIORITY WILL BE TO ENSURE THE SAFETY OF THE CREW AND OF THE VESSEL, AND TO TAKE ACTION TO PREVENT ESCALATION OF THE INCIDENT. IMMEDIATE CONSIDERATION SHOULD BE GIVEN TO MEASURES AIMED AT PREVENTING FIRE AND EXPLOSION.

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St. John's, NF

SECTION 2 • Reporting Requirements

Coast guard of nearest coastal State (see Appendix 2) is to be notified whenever there is:

a) **an actual discharge of oil**

b) **reason to suspect a probable discharge of oil due to fire, grounding, list, loss of power, collision, flooding, explosion, structural failure, etc.**

c) **any damage or failure which may affect the safety of the vessel, such as failure or breakdown of the electrical generating system, or essential shipborne navigational aids.**

2.1 DISCHARGE OF OIL

When reporting a discharge of oil, the Master is to provide all relevant information (as per section 2.4) to:

a) Coast Guard of nearest coastal State, or

b) Port Authorities, and also to

c) Vessel Interest Contacts.

A discharge of oil, for the purposes of this plan, refers to:

a) a discharge of oil, resulting from damage to the vessel or its equipment, or for the purpose of securing the safety of a vessel or saving life at sea; or

b) a discharge during the operation of the vessel of oil in excess of the quantity or instantaneous rate permitted under the present Convention.

2.2 PROBABLE DISCHARGE OF OIL

The Master must use good judgment to assess any circumstance which might be cause for probable discharge of oil. When making such judgment the following factors must be taken into account:

a) the nature of the damage, failure, or breakdown of the vessel, machinery, or equipment;

b) vessel location and proximity to land or other navigational hazards;

c) weather, tide, current, and sea state;

d) traffic density; and

e) morale, health and ability of crew onboard to deal with situation.

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St. John's, NF

2.3 DAMAGES AND/OR FAILURES

The Master must report any damage which may affect the safety of the vessel: collision, fire, grounding, explosion, cargo shifting, list, etc. The Master must also report any failure or breakdown of essential machinery which results in impairment of the safety of navigation: i.e. electrical generating system or essential vessel-borne navigational aids.

2.4 INITIAL REPORT

An initial report is to be made by radio communication without delay to one of the following Canadian radio ship reporting stations; Canadian Coast Guard Radio Station, Canadian Vessel Traffic Service Centre, St. Lawrence Seaway Authority marine radio station, or Canadian harbour radio station. The report is to be made following the format given below. Where the report cannot be communicated by radio, it shall be communicated by telephone to the local Canadian radio ship reporting station or to the Canadian Coast Guard Operations Centre in Ottawa. Contact information is provided in Appendix 2.

FOLLOW-UP REPORTS

Follow-up reports should be made at regular intervals to keep the coastal State and other concerned parties informed of developments including, but not limited to, change of course or position, change in quantity, rate or probability of oil discharge, injuries or casualties, or effects of actions taken to control discharge or assure safety of the vessel and crew. Follow-up reports should be made in the same format as the initial report.

WRITTEN REPORT

Within 24 hours of the incident, or as soon as possible thereafter, a written report on the incident, including a statement as to its probable cause, shall be forwarded by air mail without delay to the Chief, Marine Casualty Investigations, Department of Transport, Ottawa.

UNOFFICIAL FACSIMILE REPORT

An unofficial facsimile report is included in Appendix 1. This may be sent to any concerned parties but is not consistent with IMO Resolution A 648(16) for reporting of incidents involving dangerous goods, harmful substances and/or marine pollutants, and therefore cannot constitute an official report to the coastal State.

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FORMAT AND INFORMATION REQUIRED FOR OFFICIAL REPORT

AA VESSEL NAME, CALL SIGN, FLAG

BB DATE AND TIME (GMT) OF INCIDENT: 111935 meaning 11th of month at 7:35 pm.

CC SHIPS POSITION: 2230N 0600E meaning 22 deg. 30 min. N, 6 deg. E

or

DD SHIPS POSITION BY TRUE BEARING (3 DIGITS) AND DISTANCE FROM CLEARLY IDENTIFIED LANDMARK.

EE TRUE COURSE (3 DIGITS)

FF SPEED IN KNOTS AND TENTHS OF A KNOT (3 DIGITS)

LL ROUTE INFORMATION - INTENDED TRACK

MM RADIO STATIONS AND FREQUENCIES GUARDED

NN TIME OF NEXT REPORT (same as in BB)

OO DRAFT (4 DIGITS - meters and centimeters)

PP TYPES AND QUANTITIES OF CARGO AND BUNKERS ON BOARD

QQ BRIEF DETAILS OF DAMAGE, LIMITATIONS ETC. (must include condition of vessel and ability to transfer cargo, ballast, or fuel)

RR BRIEF DETAILS OF ACTUAL POLLUTION (oil type, estimate of quantity discharged, whether discharge continues, cause, estimate of slick movement)

SS WEATHER AND SEA CONDITIONS (wind force/direction, relevant tidal and/or current information)

TT NAME, ADDRESS, TELEX, FAX, TELEPHONE NUMBERS OF VESSEL OWNER OR REPRESENTATIVE

UU DETAILS OF LENGTH, BREADTH, TONNAGE, AND TYPE OF VESSEL

WW TOTAL NUMBER OF PERSONS ON BOARD

XX MISC. DETAILS (This includes brief details of incident, actions taken, injuries sustained and assistance required. If no outside assistance is required, then this should be clearly stated.)

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2.5 WHO TO CONTACT

Contact information for coastal State and other concerned parties (port contacts, vessel interest contacts) is located in Appendix 2.

2.6 ARRANGED RESPONSE ORGANIZATION(S)

The vessel, in accordance with the regulations, has onboard a **declaration** that the vessel's management has, in accordance with 660.2(2) of the Canada Shipping Act, entered into an arrangement with a response organization to which a certificate of designation has been issued pursuant to subsection 660.4(1) in respect of the quantity of oil that is carried both as fuel and cargo on board the vessel.

The person or persons identified in the **declaration** shall be responsible for contacting and mobilizing the response organization.

SECTION 3 • Steps to Control Discharge

In cases of small spills on deck, the vessel's crew should take whatever actions are necessary to prevent oil from escaping over the side. Once the spill is contained on deck, the crew will need to take action to clean up the oil. SPILLED OIL SHOULD NOT BE WASHED OVER THE SIDE. Once oil is in the water, the crew's ability to respond in a practical manner is greatly reduced.

3.1 OPERATIONAL SPILLS

In the event of an operational spill which occurs during bunkering or cargo operations, it is important that the bunkering party terminate any and all bunkering operations and close all manifold valves.

Before closing any manifold valves, the bunkering / cargo party must immediately inform the terminal / loading master so that they may take action to eliminate the possibility of over-pressurization of the shore side transfer components.

After dealing with the cause of the spill, it may be necessary to obtain permission from local authorities and/or the terminal before resuming bunkering or cargo operations.

If the possibility of fire or explosion exists, nonessential air intakes to accommodations and machinery spaces should be closed and all sources of sources of ignition should be eliminated. See Section 1.3.3 of this Plan.

In accordance with Section 1.3.3 of this Plan, all members of the vessel's crew should be familiar with the fundamentals of the ship's vital systems including the ventilation and electrical systems. Crew members should be able to: isolate the accommodation and/or machinery spaces using the louvres and fan shut-offs; and, from the distribution panels, isolate electrical circuits in areas of risk. Please refer to Section 1.3.3 of this Plan for additional details.

Care must be taken to consider stability and stress when taking action to mitigate the spillage of oil. Internal transfers should be undertaken only with a full appreciation of the likely impact on the vessel's overall stress and stability. Please refer to the "Approved Stability Booklet" carried on board.

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1. PIPE LEAKAGE

In the event of a oil pipe leakage, the Chief Engineer must ensure that the following actions are taken:

a) Stop oil flow and close manifold and other valves.

b) Sound Emergency Alarm and initiate emergency response procedures as posted aboard the vessel.

c) Locate the source and repair if possible.

d) Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.

e) Drain affected section of pipe into empty or slack tank if possible.

f) If oil is overboard, report to proper authorities immediately (as per section 2 of this plan).

g) If oil is in bilges, pump through oil/water separator as per approved procedures.

2. TANK OVERFLOW

In the event of an oil tank overflow, the Chief Engineer must ensure that the following actions are taken:

a) Stop oil flow and close manifold and other valves.

b) Sound Emergency Alarm and initiate emergency response procedures as posted aboard the vessel.

c) Place drain buckets under overflow pipes to contain possible spills.

d) Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.

e) Drain or transfer oil to slack or empty tanks if possible with due consideration paid to vessel stability. If no slack or empty tanks are available then oil may be pumped back ashore through delivery line, having first gained permission to do so.

f) If oil is overboard, report to proper authorities immediately (as per section 2 of this plan).

g) If oil is in bilges, pump through oil/water separator as per approved procedures.

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3. HULL LEAKAGE

If oil is noticed on the water near the vessel during normal operations and cannot be accounted for, the possibility of hull leakage should be suspected.

In the event of a hull leakage, the Master must ensure that the following actions are taken:

a) Sound Emergency Alarm and initiate emergency response procedures as posted aboard the vessel.

b) Stop any and all transfer or bunkering operations.

c) Identify damage and report to proper authorities immediately (as per section 2 of this plan).

d) If possible, contain spill using materials on hand

e) Transfer fuel away from suspected leaks to empty or slack tanks if possible or to a ballast tank if necessary. If in port, arrangements can be made to pump oil ashore to tank or truck. Due consideration is to be paid to vessel stress and stability.

f) Locate and repair if possible.

g) Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.

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3.2 SPILLS RESULTING FROM CASUALTIES

ALL CASUALTIES ARE TO BE REPORTED BY THE MASTER AS PER SECTION 2.

The Master's priority, when responding to a casualty, will be to ensure the safety of personnel and the vessel and to take action to prevent escalation of the incident.

In casualties involving spills, immediate consideration should be given to measures aimed at preventing fire and explosion, such as altering course so that the vessel is upwind of the slick, shutting down nonessential air intakes, etc.
If the vessel is aground, and therefore cannot maneuver, all possible sources of ignition should be eliminated and action taken to prevent flammable vapors entering accommodation and engine room spaces. Please refer to Section 1.3.3.

In accordance with Section 1.3.3 of this Plan, all members of the vessel's crew should be familiar with the fundamentals of the ship's vital systems including the ventilation and electrical systems. Crew members should be able to isolate the accommodation and/or machinery spaces using the louvres and fan shut-offs; and, from the distribution panels, isolate electrical circuits in areas of risk. Please refer to Section 1.3.3 of this Plan for additional details.

Prior to considering remedial action, the Master will need to obtain detailed information on the damage sustained by the vessel. A visual inspection should be carried out and all bunker tanks and other compartments sounded. However, due regard should be paid to the indiscriminate opening of ullage plugs or sighting ports, especially when the vessel is aground, as loss of buoyancy could result. The Master shall also ensure that all covers, doors, vents, and hatches to any and all holds, ballast tanks, and fuel tanks are sealed tightly and remain sealed to prevent possible loss of buoyancy. Having assessed the damage sustained by the vessel, the Master will be in a position to decide what action should be taken to prevent or minimize further spillage.

Great care must be taken to consider stability and stress when taking action to mitigate the spillage of oil or to free the vessel if aground. Internal transfers should be undertaken only with a full appreciation of the likely impact on the vessel's overall stress and stability. Please refer to the "Approved Stability Booklet" carried on board.

Should the damage sustained be extensive, the impact of internal transfers on stress and stability may be impossible for the vessel's personnel to assess. In such cases, Appendix 3 of this plan is to be filled out as completely as possible and forwarded to the Owner's to ensure the appropriate calculations can be done.

When it is possible to maneuver, the Master, in conjunction with the proper shore authorities, may consider moving the vessel to a more suitable location in order, for example, to facilitate emergency repair work or lightening operations, or to reduce the threat posed to any particularly sensitive shoreline areas. Such maneuvering may be subject to coastal state jurisdiction.

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1. GROUNDING

If the vessel grounds, the Master must ensure that the following actions are taken:

a) Sound Emergency Alarm and muster crew.

b) Eliminate all avoidable sources of ignition and ban smoking on board. Action must be taken to prevent inflammable vapors from entering accommodation and machinery spaces. See Section 1.3.3.

c) Identify damage by means of a visual inspection.

d) Take soundings around vessel to determine nature and gradient of seabed.

e) Check differences in tidal ranges at grounding site.

f) Evaluate tidal current in grounding area.

g) Take soundings of all tanks on shell and compare with departure soundings.

h) Determine probability and/or quantity of oil released.

i) If oil release is determined or is probable, this is to be included in the casualty report.

At this point, determine risk of additional damage to vessel by attempting to refloat. If remaining aground is determined to be less of a risk then:

a) Use anchors to prevent vessel movement.

b) Take in ballast in empty tanks, with due consideration paid to stress and stability. Please refer to the "Approved Stability Booklet."

c) Consider transfer of fuel from damaged tanks, with due consideration paid to stress and stability. Please refer to the "Approved Stability Booklet."

d) Reduce longitudinal stress on hull by transfer of cargo internally. Please refer to the "Approved Stability Booklet."

e) If the change in stability and stress cannot be calculated on board, contact the Vessel's management to arrange for the necessary calculations. Refer to Appendix 3 for information which should be provided.

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2. FIRE / EXPLOSION

If a fire or explosion occurs on board, the vessel's fire control party must ensure that the following actions are taken:

a) Sound Emergency Alarm and muster crew.

b) Determine extent of damage and what damage control measures can be taken.

c) Determine whether there are casualties.

d) Request assistance as deemed necessary

e) Assess possibility of oil leakage.

f) If there is a discharge or possible discharge of oil, this is to be included in the casualty report.

g) Should abandonment be necessary, the Master must ensure that every effort is made to maneuver survival craft upwind of any oil spill.

3. COLLISION

If a collision occurs, the Master must ensure that the following actions are taken:

a) Sound Emergency Alarm and muster crew.

b) Determine whether there are casualties.

c) If there is a possibility of fire or explosion, eliminate all avoidable sources of ignition and ban smoking on board. Action should be taken to prevent inflammable vapors from entering accommodation and machinery spaces. See Section 1.3.3.

d) Decide whether separation of vessels may cause or increase spillage of oil.

e) If any oil tanks are penetrated, isolate the penetrated tank or transfer oil to slack or empty tanks with due attention paid to stress and stability of the vessel. Please refer to the "Approved Stability Booklet."

f) If there is an oil spill, make a report as per section 2.

4. HULL FAILURE including ice damage

If the vessel suffers structural hull failure, the Master must ensure that the following actions are taken:

a) Sound Emergency Alarm and muster crew.

b) Reduce speed or stop to minimize stress on hull.

c) Assess immediate danger of sinking or capsizing.

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d) Initiate damage control measures.

e) If oil has spilled, or if it is necessary to jettison oil to maintain stability, make a report as per section 2.

f) If the change in stability and stress cannot be calculated on board, contact the Vessel's management to arrange for the necessary calculations.

g) Consider forecast weather conditions and their effect on the situation.

h) Should abandonment be necessary, the Master must ensure that every effort is made to maneuver survival craft upwind of any oil spill.

5. EXCESSIVE LIST

If excessive list occurs rapidly and unexpectedly, it may be due to:

a) Failure of hull plating.

b) Failure of internal bulkhead between compartments.

c) Shift of cargo.

d) Damage through grounding or collision.

e) Incorrect operating condition. Refer to "Approved Stability Booklet."

f) Flooding in Engine Room, where free surface can cause a list.

The Master must ensure the following steps are taken immediately:

a) Stop any cargo, bunkering, or ballast operations in progress.

b) Sound Emergency Alarm and muster crew.

c) Determine whether there are casualties.

d) If under way, reduce speed or stop.

e) Establish reason for list. See above.

f) Sound all tanks and compare with departure soundings.

g) If oil has spilled, or it is necessary to jettison oil to maintain stability, make a report as per section 2.

h) If possible, take corrective action to rectify the situation with due consideration paid to vessel stress and stability. Please refer to the "Approved Stability Booklet."

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SECTION 4 • National and Local Coordination

1. The Master will advise the Coast Guard of nearest coastal state regarding any oil spill. Vessel Interest Contacts must also be notified of any such incident. See Appendix 2 for details.

2. The Master will be the point of contact on the vessel for coordinating shipboard activities with national and local authorities, act as the Company's on-scene representative, and will be responsible for overseeing the action of any salvage or spill contractors employed until such time as he/she has been FORMALLY relieved of these responsibilities by the Company.

3. The person or persons identified in the declaration shall be responsible for contacting and mobilizing the response organization(s). These organizations will coordinate and conduct the response. It is not normally practical for vessel's personnel to be directly involved in cleanup activities. Therefore, their primary role will be to provide as much information as necessary to assist the response and to cooperate with cleanup personnel. However, where no local response is forthcoming, or is delayed, the Master should consider the use of available shipboard materials to clean up or contain the spilled oil by, for example, using ship-stocked absorbent materials or utilizing mooring ropes or air-filled hoses as makeshift booms.

4. Dispersants or degreasers should not be used on oil spilled in the water as their use may contravene local regulations. However, dispersants may be used if they are approved by Environment Canada specifically for a given incident. Environment Canada will allow and approve the use of dispersants on a case by case basis only

SECTION 5 • Ship to Ship Transfer Operations

Should a situation such as lightening due to grounding require a ship to ship transfer of petroleum products, the Master must take into account but not limited to the following:

1. Proper lines of communication between ships including language and radio working frequency;
2. Current and forecasted weather conditions for the intended area of transfer;
3. The compatibility of the vessels involved with regards to size, freeboard, manifold location, list, trim, etc.
4. The elimination of all possible ignition sources;
5. Oil spill clean up equipment and procedures in place;
6. Contingency planning for emergency situations in place.

For detailed procedures concerning ship to ship transfer of petroleum products, please refer to ***The Ship to Ship Transfer Guide (Petroleum)****, published by The International Chamber of Shipping Oil Companies International Marine Forum, 3rd edition, 1997. A copy of which is to be kept on board the ship at all times.*

SECTION 6 • Additional Information (Non-Mandatory)

This section provides for additional information that local authorities, insurance underwriters, or Vessel Management may wish to include, but is not mandatory. (Regulation 26, Annex I, Marpol 73/78)

MEDIA INFORMATION

In the event of an oil spill or other related casualty, the Master is to direct any Coastal Radio station being worked that inquiries from any of the various media nodes are to be directed to the Vessel Management, who will handle such incidents shore-side. This will enable the Master to concentrate on the matter at hand.

PLAN REVIEW

This plan is to be reviewed at regular intervals by the Vessel Management and Master such that the information contained herein is current. Changes should be incorporated in the plan as and when they occur and the changes noted and by whom. Reviews should be conducted annually to reflect changes in local laws or policies, contact names or numbers, vessel characteristics, or company policy.

Reviews should also be conducted after any use of the plan in response to an incident, in order to evaluate its effectiveness and make any modifications deemed prudent at that time.

APPENDIX 1 • Report Format and Content

The report should contain the following:

AA VESSEL NAME, CALL SIGN, FLAG

BB DATE & TIME (GMT) OF INCIDENT: 111935 meaning 11th of month at 7:35 pm.

CC SHIPS POSITION: 2230N 0600E meaning 22 deg. 30 min. N, 6 deg. E

or

DD SHIPS POSITION BY TRUE BEARING (3 DIGITS) AND DISTANCE FROM CLEARLY IDENTIFIED LANDMARK.

EE TRUE COURSE (3 DIGITS)

FF SPEED IN KNOTS AND TENTHS OF A KNOT (3 DIGITS)

LL ROUTE INFORMATION - INTENDED TRACK

MM RADIO STATIONS AND FREQUENCIES GUARDED

NN TIME OF NEXT REPORT (same as in BB)

OO DRAFT (4 DIGITS - meters and centimeters)

PP TYPES AND QUANTITIES OF CARGO AND BUNKERS ON BOARD

QQ BRIEF DETAILS OF DAMAGE, LIMITATIONS ETC. (must include condition of vessel and ability to transfer cargo, ballast, or fuel)

RR BRIEF DETAILS OF ACTUAL POLLUTION (oil type, estimate of quantity discharged, whether discharge continues, cause, estimate of slick movement)

SS WEATHER AND SEA CONDITIONS (wind force/direction, relevant tidal and/or current information)

TT NAME, ADDRESS, TELEX, FAX, TELEPHONE NUMBERS OF VESSEL OWNER OR REPRESENTATIVE

UU DETAILS OF LENGTH, BREADTH, TONNAGE, AND TYPE OF VESSEL

WW TOTAL NUMBER OF PERSONS ON BOARD

XX MISC. DETAILS (brief details of incident, actions taken, injuries, assistance required)

UNOFFICIAL OIL POLLUTION EMERGENCY REPORT BY FACSIMILE

Vessel Name Call Sign Flag

Date and Time of Event

Vessel Position (Latitude & Longitude, Bearing & Distance from Landmark)

Course Speed

Intended Track

Radio Station

Date and Time of Next Report

Type and Quantity of Oil On board

Brief Details of Damage

Brief Details of Pollution

Details of Weather & Sea Conditions (Wind Speed/Direction, Swell Height/Direction)

Names of Vessel's Owner

Vessel Size and Type

Any Other Additional Information as Determined by Master

APPENDIX 2 • Who to Contact

In accordance with the Canadian Pollutant Discharge Reporting Regulations, the Master or Owner of a ship must report, without delay, any discharge or anticipated discharge of a pollutant in Canadian waters or fishing zones, to a Pollution Prevention Officer (PPO). Reports must be made in the manner described in Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants, TP 9834, or "General Principles for Ship Reporting Systems and Ship Reporting Requirements, including Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants" adopted by the IMO by Resolution A 648(16). These initial reports can be made to a Vessel Traffic Service Centre (VTS) or any other Canadian Coast Guard Radio Station (CGRS), on the frequencies listed in the publication, Radio Aids to Marine Navigation (RAMN).

In addition to the above process for reporting a spill from a vessel to a PPO through a CGRS or VTS, the Canadian Coast Guard maintains a 24 hour Operations Centre which can be contacted at:

Canadian Coast Guard Operations Centre
344 Slater Street
Ottawa, Ontario
K1A 0N7

Tel: (613) 990-5600 Fax: (613) 995-4700 Tlx: (613) 053 3128

Within Canada, administrative inquiries related to pollution prevention, compliance and enforcement, vessel regulations, design and construction should be directed to:

Director General, Marine Safety
Transport Canada
Mailstop: AMS
330 Sparks Street
Ottawa, Ontario
K1A 0N5

Tel: (613) 998-0610 Fax: (613) 954-1032

Inquiries relating to pollution response should be directed to:

Director General, Rescue and Environmental Response
Canadian Coast Guard
344 Slater Street
Ottawa, Ontario
K1A 0N7

Tel: (613) 990-3110 Fax: (613) 996-8902

VESSEL INTEREST CONTACTS

VESSEL MANAGEMENT

Coastal Shipping Limited (Owners)
P.O. Box 913
Happy Valley-Goose Bay, Labrador
A0P 1S0

Office: (709) 896 - 2421
Fax: (709) 896 - 5028

24 HOUR CONTACT

The following phone numbers are provided
for 24 hour contact, year round:

Cell:	(709) 682 - 0826	Kevin Brewer or Gerry Burgess
Home:	(709) 227 - 2600	Kevin Brewer
	(709) 745 - 2684	Gerry Burgess

APPENDIX 3 • Vessel Stress and Stability Calculations

VOYAGE PARTICULARS

Departure Port

Departure Date

Time (GMT)

VESSEL CONDITION IMMEDIATELY BEFORE CASUALTY

Mean Draft Forward

Mean Draft Aft

KG(solid)

KG(fluid)

LCG of Vessel

#	COMPARTMENT	S.G.	TONNES

#	Compartment	S.G.	Tonnes

DATA RELATING TO VESSEL AFTER CASUALTY

Nature of Casualty: Collision / Grounding (Fixed / Free) / Fire
Explosion / Heavy Weather / Other

Casualty Date Report Time (GMT)

Geographical Location of Casualty: LAT
LONG

Conditions at Site at Time of Casualty Report

Weather

Sea State

Tidal State

Tidal Range

Forecast

S.G. of Surrounding Water

Position of Vessel relative to Wind, Waves, Tides, etc.

Drafts Measured Port and Starboard:

Drafts at Fwd Marks/F.P.(Best Estimate)
Drafts at Aft Marks/A.P.(Best Estimate)
Drafts at Midships (Best Estimate)
Angle of Heel (Port / Starboard)

Best Estimate of Depth of Water (for Grounding)

Location	Port	Starboard

REPORTED DAMAGE

Details of each damaged compartment known to be open to the sea, including those damaged above the present waterline

Compartment	Estimated Cargo Weight (tonnes)	Permeability of Cargo (%)	Comments

Extent and location of structural damage in way of above compartments. (Attach sketch)

Extent of additional damage to pipes, valves, hatches, doors, etc. and list of compartments which may be subject to progressive flooding as a result.

Soundings from or estimates of amounts of flood water in spaces not directly open to sea.

PROPOSED ACTION AND REQUIREMENTS

Any other relevant information, details of action being undertaken or proposed course of action, salvage operation etc.

APPENDIX 4 • Relevant Drawings

FOLLOWING ARE DRAWINGS RELEVANT TO THIS VESSEL

General Arrangement Drawing
Tank Capacity Plan
Cargo Piping Diagram

Appendix B: Transport Canada Guideline TP- 9834E

Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and /or Marine Pollutants

Transport Canada Transports Canada

TP 9834E
(07/2009)

Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants

2ND EDITION
JULY 2009

TC-1003421

Canada

Responsible Authority	Approval
The Director Operations and Environmental Programs is responsible for this document, including any change, correction, or update.	Director Operations and Environmental Programs Marine Safety

Original Date Issued: December, 1995 **Date Revised: July, 2009**

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TP 9834E
(07/2009)

TC-1003421

DOCUMENT INFORMATION

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	Ottawa, Ontario K1A 0N8	**URL**	http://www.tc.gc.ca/MarineSafety

REVISIONS

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1	**July 2009**	**All**	**T. Morris**	Updated to reflect the *Canada Shipping Act, 2001* and the amendments to IMO Resolution A.851(20) in Resolution MEPC.138(53).

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INTRODUCTION

These Guidelines comply as far as practicable with the general principles and standard reporting format procedures described in Resolution A.851(20) of the 20th Session of the Assembly of the International Maritime Organization (IMO), adopted 27 November 1997, as amended by Resolution MEPC.138(53).

The intent of these Guidelines is to enable the proper authorities to be informed without delay so that appropriate action may be taken when:

1. any incident occurs involving the loss, or likely loss, overboard of packaged dangerous goods in the sea; or
2. any incident occurs giving rise to pollution, or threat of pollution to the marine environment, as well as of assistance and salvage measures; or
3. any oil pollution incident occurs involving the loading or unloading of oil to or from a vessel at an oil handling facility.

The *Pollutant Discharge Reporting Regulations, 1995* stipulate that a vessel's master or owner must make reports required under the Regulations in the manner described in these Guidelines or IMO Resolution A.851(20). The Regulations also stipulate that the operator of an oil handling facility must make reports in a manner described in these Guidelines. These Guidelines should then be used in conjunction with the *Pollutant Discharge Reporting Regulations, 1995* when harmful substances and/or marine pollutants are involved. Where any discrepancy exists between the regulations and the Guidelines, the requirements of the regulations shall prevail.

1. ABBREVIATIONS

HF	High Frequency
IMO	International Maritime Organization
MARPOL	*The International Convention for the Prevention of Pollution from Ships*, 1973, and the *Protocols* of 1978 and 1997, as amended from time to time
MF	Medium Frequency
UN	United Nations
UTC	Coordinated Universal Time
VHF	Very High Frequency

2. DEFINITIONS

2.1 In these Guidelines,

"dangerous goods" means goods that by reason of their nature, quantity or mode of stowage are either singly or collectively liable to endanger the lives of the passengers or imperil the vessel and includes all substances determined by the Governor in Council, in regulations made by him, including the *Cargo, Fumigation and Tackle Regulations*, to be dangerous goods; *(marchandises dangereuses)*

"harmful substance in packaged form" means any substance which is identified as a marine pollutant in the International Maritimes Dangerous Goods Code (IMDG Code); *(substance nuisible en colis)*

"in bulk" means in a hold or tank that is part of the structure of the vessel, without any intermediate form of containment; *(en vrac)*

"incident" includes the discharge of a pollutant, a dangerous good or a harmful substance in packaged form or their anticipated discharge; (*incident)*

"marine safety inspector" means a person appointed as a marine safety inspector under section 11 of the *Canada Shipping Act, 2001; (inspecteur de la sécurité maritime)*

"marine communications and traffic services officer" means a person designated as a marine communications and traffic services officer by the Minister of Fisheries and Oceans under subsection 126(2) of the *Canada Shipping Act, 2001; (fonctionnaire chargé des services de communications et de trafic maritimes)*

"packaged form" means the forms of containment specified for harmful substances or dangerous goods in the International Maritimes Dangerous Goods Code (IMDG Code); *(en colis)*

"pollution prevention officer" means a person designated as a pollution prevention officer pursuant to section 14 of the *Arctic Waters Pollution Prevention Act*; *(fonctionnaire chargé de la prévention de la pollution)*

"waters under Canadian jurisdiction" means the internal waters of Canada as described in section 6 of the *Oceans Act*, the territorial sea of Canada as described in section 4 of the *Oceans Act* and the exclusive economic zone of Canada as described in section 13 of the *Oceans Act*, , and includes the shipping safety control zones prescribed pursuant to section 11 of the *Arctic Waters Pollution Prevention Act*. *(eaux de compétence canadienne)*

3. HOW TO MAKE A REPORT

3.1 The report should be transmitted in the following manner:

1. when an incident occurs involving a vessel in waters under Canadian jurisdiction, the report shall be made with the highest possible priority and using the quickest means available to a marine safety inspector, or for incidents occurring in a shipping safety control zone, to a pollution prevention officer;
2. when the vessel referred to in paragraph 3.1.1 is in a radio telecommunications area that is covered by Canadian Coast Guard Marine Communications and Traffic Services, the report should, where expedient, be routed through that system to a marine communications and traffic services officer;
3. when an incident occurs involving a Canadian vessel outside waters under Canadian jurisdiction, the report should be made to the nearest coastal State through an appropriate coast station, preceded by the safety signal (if the incident affects the safety of navigation), or by the urgency signal (if the incident affects the safety of the vessel or persons);
4. on appropriate frequencies (in the bands 405-525 kHz, 1605-2850 kHz or 156-174 MHz);
5. when the vessel is not within reach of a MF or VHF coast station, to the most appropriate HF coast station or on the relevant maritime satellite communication system;
6. when the vessel is within or near an area for which a vessel reporting system has been established, to the designated shore establishment responsible for operation of that system;
7. the format and procedures should, when practicable, comply with the relevant requirements of Section A2 in the Appendix, *Standard Reporting Format and Procedures*; and
8. in addition to any report referred to in paragraph 3.1.1, when an oil pollution incident occurs involving a vessel at a designated oil handling facility, the operator of the oil handling facility shall:
    1. report with the highest possible priority and using the quickest means available, to the federal emergency telephone number identified in the facility's oil pollution emergency plan;
    2. report in writing any incident involving oil to the Transport Canada Marine Safety office nearest to the facility; and
    3. report, when practicable, in compliance with the relevant requirements of Section A2 of the Appendix, *Standard Reporting Format and Procedures*.

4. CONTENT OF REPORT

4.1 Reports should contain the specific information listed in Section A3 of the Appendix, *Detailed Reporting Requirements*.

5. SUPPLEMENTARY REPORT

5.1 Particulars not immediately available should be inserted in a supplementary message or messages.

5.2 When harmful substances and/or marine pollutants are involved, a supplementary message should follow immediately or as soon as possible after the initial report. Information that is essential for the protection of the marine environment, as appropriate to the incident, should be included. That information should include Items P, Q, R, S and X, as listed in Section A2 of the Appendix.

6. PROBABILITY OF DISCHARGE

6.1 The probability of a discharge resulting from damage to the vessel or its equipment is a reason for making a report. In judging whether there is such a probability and whether a report should be made, the following factors, among others, should be taken into account:

1. the nature of the damage, failure or breakdown of the vessel, machinery or equipment; and
2. sea and wind state and also traffic density in the area at the time and place of the incident.

6.2 It is recognized that it would be impracticable to lay down precise definitions of all types of incidents involving probable discharge which would warrant an obligation to report. Nevertheless as a general guideline, the master of the vessel should make reports in cases of:

1. damage, failure or breakdown which affects the safety of vessels. Examples of such incidents are collision, grounding, fire, explosion, structural failure, flooding, cargo shifting; and
2. failure or breakdown of machinery or equipment which results in the impairment of the safety of navigation. Examples of such incidents are failure or breakdown of steering gear, propulsion plant, electrical generating system, essential shipborne navigational aids.

7. REPORT ON ASSISTANCE OR SALVAGE

7.1 The master of any vessel engaged in or requested to engage in an operation to render assistance or undertake salvage should report, as far as practicable, Items A, B, C (or D), E, F, L, M, N, P, Q, R, S, T, U, X of the *Standard Reporting Format* (Appendix). The Master should ensure that the coastal State is kept informed of developments.

APPENDIX

A1. PROCEDURES

A1.1 Reports should be sent as follows:

Dangerous Goods Report - Packaged form (DG)	When an incident takes place involving loss, or likely loss overboard of packaged dangerous goods, including those in freight containers, portable tanks, road and rail vehicles and shipborne barges, into the sea.
Harmful Substances Report in Bulk (HS)	When an incident takes place involving the discharge or probable discharge of oil (Annex I of MARPOL) or noxious liquid substances in bulk (Annex II of MARPOL).
Harmful Substances Report - packaged form (MP)	In the case of loss or likely loss overboard of harmful substances in packaged form, including those in freight containers, portable tanks, road and rail vehicles and shipborne barges, identified in the *International Maritime Dangerous Goods Code* as marine pollutants (Annex III of MARPOL).

A2. STANDARD REPORTING FORMAT AND PROCEDURES

A2.1 Sections of the reporting format which are inappropriate should be omitted from the report.

A2.2 Where language difficulties may exist, the languages used should include English, using where possible the *Standard Marine Navigational Vocabulary.*

A2.3 Alternatively, the *International Code of Signals* may be used to send detailed information. When the International Code is used, the appropriate indicator should be inserted in the text, after the alphabetical index.

A2.4 For route information, latitude and longitude should be given for each turn point, expressed as in Item C below, together with type of intended track between these points, for example “RL” (rhumb line), “GC” (great circle) or “coastal”, in the case of coastal sailing the estimated date and time of passing significant points expressed by a 6 digit group as in Item B below.

Telegraphy	**Telephone (alternative)**	**Function**	**Information Required**
Name of system (e.g., AMVER/ MAREP/ ECAREG/ NORDREG/ WESTREG)	Name of system (e.g., AMVER/ MAREP/ ECAREG/ NORDREG/ WESTREG)	System Identifier	Ship Reporting system or nearest appropriate coast radio station
DG	Dangerous goods report – packaged form	Type of report	Dangerous goods report – packaged form

Telegraphy	Telephone (alternative)	Function	Information Required
HS	Harmful substances report - in bulk	Type of report	Harmful substances report - in bulk
MP	Harmful substances report - packaged from	Type of report	Harmful substances report - packaged from
A	Vessel (alpha)	Vessel identity	Name, call sign or ship station identity, and flag
B	Time (bravo)	Date and time of event	A 6 digit group giving day of month (first two digits), hours and minutes (last four digits). If other than UTC state time zone used
C	Position (charlie)	Position	A 4 digit group giving latitude in degrees and minutes suffixed with N (north) or S (south) and a 5 digit group giving longitude in degrees and minutes suffixed with E (east) or W (west); or
D	Position (delta)	Position	True bearing (first 3 digits) and distance (state distance) in nautical miles form a clearly identified landmark (state landmark)
E	Course (echo)	True course	A 3 digit group
F	Speed (foxtrot)	Speed in knots & tenths of knots	A 3 digit group
G	Departed (golf)	Port of departure	Name of last port of call
H	Entry (hotel)	Date, time and point of entry into System	Entry time expressed as in (B) and entry position expressed as in (C) or (D)
I	Destination and ETA (india)	Destination and estimated time of arrival	Name of port and date time group expressed as in (B)
J	Pilot (juliet)	Pilot	State whether a deep sea or local Pilot is on board
K	Exit (kilo)	Date, time and point of exit from system or arrival at the vessel's destination	Exit time expressed as in (B) and exit position expressed as in (C) or (D)
L	Route (lima)	Route information	Intended track
M	Radio communications (mike)	Radio communications	State in full names of stations/frequencies guarded

Telegraphy	**Telephone (alternative)**	**Function**	**Information Required**
N	Next report (november)	Time of next report	Date time group expressed as in (B)
O	Draught (oscar)	Maximum present static drought in metres	4 digit group giving metres and centimetres
P	Cargo (papa)	Cargo on board	Cargo and brief details of any dangerous cargoes as well as harmful substances and gases that could endanger persons or the environment (See *Detailed Reporting Requirements*)
Q	Defect, damage, deficiency, limitations (quebec)	Defects/damage deficiencies/ other limitations	Brief details of defects, damage, deficiencies or other limitations (See *Detailed Reporting Requirements*)
R	Pollution/ dangerous goods lost overboard (romeo)	Description of pollutant or dangerous goods lost overboard	Brief details of type of pollution (oil, chemicals, etc.) or dangerous goods lost overboard; position expressed as in (C) or (D) (See *Detailed Reporting Requirements*)
S	Weather (sierra)	Weather conditions	Brief details of weather and sea conditions prevailing
T	Agent (tango)	Vessel's representative and/or owner	Details of name and particulars of vessel's representative or owner or both for provision of information (See *Detailed Reporting Requirements*)
U	Size and type (uniform)	Vessel size and type	Details of length, breadth, tonnage, and type etc. as required
V	Medic (victor)	Medical personnel	Doctor, physician's assistant, nurse, no-medic
W	Persons (whiskey)	Total number of persons on board	State number
X	Remarks (x-ray)	Miscellaneous	Any other information - including as appropriate brief details of incident and of other vessels involved either in incident, assistance or salvage (See *Detailed Reporting Requirements*)

Telegraphy	Telephone (alternative)	Function	Information Required
Y	Relay (yankee)	Request to relay report to another system e.g., AMVER, AUSREP, JASREP, MAREP etc.	Content of report
Z	End of report (zulu)	End of report	No further information required

A3. DETAILED REPORTING REQUIREMENTS

A3.1 Dangerous Goods Reports - Packaged Form (DG)

A3.1.1 Primary report should contain Items, A, B, C (or D), M, Q, R, S, T, U, X of the *Standard Reporting Format*; details for Item R should be as follows:

R

1. Correct technical name or names of goods.
2. UN number or numbers.
3. IMO Hazard class or classes.
4. Names of manufacturers of goods when known, or consignee or consignor.
5. Types of packages including identification marks. Specify whether portable tank or tank vehicle, or whether vehicle or freight container or other cargo transport unit containing packages. Include official registration marks and numbers assigned to the unit.
6. An estimate of the quantity and likely condition of the goods.
7. Whether loss floated or sank.
8. Whether loss is continuing.
9. Cause of loss.

A3.1.2 If the condition of the vessel is such that there is danger of further loss of packaged dangerous goods into the sea, items P and Q of the *Standard Reporting Format* should be reported; details for P should be as follows:

P

1. Correct technical name or names of goods.
2. UN number or numbers.
3. IMO Hazard class or classes.
4. Names of manufacturers of goods when known, or consignee or consignor.
5. Types of packages including identification marks. Specify whether portable tank or tank vehicle, or whether vehicle or freight container or other cargo transport unit containing packages. Include official registration marks and numbers assigned to the unit.
6. An estimate of the quantity and likely condition of the goods.

A3.1.3 Particulars not immediately available should be inserted in a supplementary message or messages.

A3.2 Harmful Substances Reports - In Bulk (HS)

A3.2.1 In the case of actual discharge, primary HS reports should contain Items A, B, C (or D), E, F, L, M, N, Q, R, S, T, U, X of the *Standard Reporting Format*. In the case of probable discharge, item P should also be included. Details for P, Q, R, T and X should be as follows:

P

1. Type of oil or the correct technical name of the noxious liquid substances on board.
2. UN number or numbers if available.
3. Pollution category (X, Y or Z), for noxious liquid substances.
4. Names of manufacturers of substances if appropriate and known, or consignee or consignor.
5. Quantity.

Q

1. Condition of the vessel as relevant.
2. Ability to transfer cargo/ballast/fuel.

R

1. Type of oil or the correct technical name of the noxious liquid substances discharged into the sea.
2. UN number or numbers if available.
3. Pollution category (X, Y or Z), for noxious liquid substances.
4. Names of manufacturers of substances if appropriate and known, or consignee or consignor.
5. An estimate of the quantity of the substances.
6. Whether loss floated or sank.
7. Whether loss is continuing.
8. Cause of loss.
9. Estimate of the movement of the discharge or loss, giving current conditions if known.
10. Estimate of the surface area of the spill if possible.

T

1. Name, address, telex and telephone number of the vessel's owner and representative (charterer, manager or operator of the vessel or their agent).

X

1. Action being taken with regard to the discharge and the movement of the vessel.
2. Assistance or salvage efforts which have been requested or which have been provided by others.
3. The master of an assisting or salvaging vessel should report the particulars of the action undertaken or planned.

A3.2.2 Particulars not immediately available should be inserted in a supplementary message or messages.

A3.3 Harmful Substance Reports - Packaged Form (MP)

A3.3.1 In the case of actual discharges, primary MP reports should contain Items A, B, C (or D), M, Q, R, S, T, U, X of the *Standard Reporting Format*. In the case of probable discharge, Item P should also be included. Details of P, Q, R, T and X should be as follows:

P

1. Correct technical name or names of goods.
2. UN number or numbers.
3. IMO Hazard class or classes.
4. Names of manufacturers of goods when known, or consignee or consignor.
5. Types of packages including identification marks. Specify whether portable tank or tank vehicle, or whether vehicle or freight container or other cargo transport unit containing packages. Include official registration marks and numbers assigned to the unit.
6. An estimate of the quantity and likely condition of the goods.

Q

1. Condition of the vessel as relevant.
2. Ability to transfer cargo/ballast/fuel.

R

1. Correct technical name or names of goods.
2. UN number or numbers.
3. IMO Hazard class or classes.
4. Names of manufacturers of goods when known, or consignee or consignor.
5. Types of packages including identification marks. Specify whether portable tank or tank vehicle, or whether vehicle or freight container or other cargo transport unit containing packages. Include official registration marks and numbers assigned to the unit.
6. An estimate of the quantity and likely condition of the goods.
7. Whether lost goods floated or sank.
8. Whether loss is continuing.
9. Cause of loss.

T

1. Name, address, telex and telephone number of the vessel's owner and representative (charterer, manager or operator of the vessel or their agent).

X

1. Actions being taken with regard to the discharge and movement of the vessel.
2. Assistance or salvage efforts which have been requested or which have been provided by others.
3. The master of an assisting or salvaging vessel should report the particulars of the action undertaken or planned.

A3.3.2 Particulars not immediately available should be inserted in a supplementary message or messages.

A4. PRIMARY REPORT FORMS

A4.1 Dangerous Goods Report - Packaged Form (DG)

Function		**Report**
DG	Type of report	/DG//
A	Vessel identity	A/ /__ __ __ __//
B	Date and time of event	B/ __ __ __ __ __ __ Z //
C	Position	C/__ __ __ __N S __ __ __ __ __ E W//
D*	Position	D/ //
M	Radio communications	M/ //
P**	Cargo on board	P/*** //
Q**	Defect, damage, deficiency, other limitations	Q/ //
R	Description of dangerous goods lost overboard	R/*** //
S	Weather conditions	S/ //
T	Agent	T/ //
U	Vessel size and type	U/ //
X	Remarks	X/ //

* Report either Item C or D.

** Include if the condition of the vessel is such that there is danger of further loss of packaged dangerous goods into the sea.

*** See *Detailed Reporting Requirements* (Appendix A3.1).

A4.2 Harmful Substances Report - In Bulk (HS)

Function		**Report**
HS	Type of report	/HS//
A	Vessel identity	A/ /__ __ __ __//
B	Date and time of event	B/ __ __ __ __ __ __ Z //
C	Position	C/__ __ __ __N S __ __ __ __ __ E W//
D*	Position	D/ //
E	True course	E/ __ __ __ //
F	Speed in knots and tenths of knots	F/ __ __ __ //
L	Route information	L/ //
M	Radio communications	M/ //
N	Next report	N/__ __ __ __ __ __ Z//
P**	Cargo on board	P/*** //
Q	Defect, damage, deficiency, other limitations	Q/*** //
R	Description of dangerous goods lost overboard	R/*** //
S	Weather conditions	S/ //
T	Agent	T/*** //
U	Vessel size and type	U/ //
X	Remarks	X/*** //

* Report either Item C or D.

** Include in the case of a probable discharge.

*** See *Detailed Reporting Requirements* (Appendix A3.2).

A4.3 Harmful Substances Report - Packaged Form (MP)

Function		**Report**
MP	Type of report	/MP//
A	Vessel identity	A/ /__ __ __ __//
B	Date and time of event	B/ __ __ __ __ __ __ Z //
C	Position	C/__ __ __ __N S __ __ __ __ __ E W//
D*	Position	D/ //
M	Radio communications	M/ //
P**	Cargo on board	P/*** //
Q	Defect, damage, deficiency, other limitations	Q/*** //
R	Description of dangerous goods lost overboard	R/*** //
S	Weather conditions	S/ //
T	Agent	T/*** //
U	Vessel size and type	U/ //
X	Remarks	X/*** //

* Report either Item C or D.

** Include in the case of a probable discharge.

*** See *Detailed Reporting Requirements* (Appendix A3.3).

MEADOWBANK GOLD PROJECT

Spill Contingency Plan

Meadowbank Mine Site
All Weather Private Access Road (AWPAR)
Baker Lake Facilities

In Accordance with Water License 2AM-MEA0815

Prepared by:
Agnico-Eagle Mines Limited – Meadowbank Division

Version 3
July 2012

EXECUTIVE SUMMARY

This document presents the Spill Contingency Plan for Agnico-Eagle Mines Limited (AEM) Meadowbank Mine Site, All Weather Private Access Road (AWPAR) and Baker Lake Facilities, which is a requirement of the Meadowbank Gold Project Type A Water License No. 2AM-MEA0815 issued on June 09, 2008. 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 AWPAR.

IMPLEMENTATION SCHEDULE

As required by Water License 2AM-MEA0815, Part B, Item 16, the proposed implementation schedule for this Plan is effective immediately (December 2011) 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 – Project Construction Manager

AEM – Site Services 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 AWPAR map and Spill KIT Location Map
3	12/07/25			Update of the hazardous materials stored on site

Table 1 - Document Control

Version 2:

Prepared By:

Jeffrey Pratt
Environment Coordinator

Approved By:

Kevin Buck
Environmental Superintendent

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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 hazardous materials include:

- Hydrocarbon liquids such as diesel fuel, gasoline, hydraulic oil;
- Soluble solids such as ammonium nitrate prill;
- Soluble liquids, such as glycols, acids, and paints;
- 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.
- 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.*
- 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, and the 110 kilometer All Weather Private Access Road (AWPAR) from Baker Lake to the Meadowbank Mine Site **(Figure 2)**. The Meadowbank mine site consists of the process plant, sewage treatment plant, water intake, accommodation buildings, power plant, tank farm, warehouse, truck shop, emulsion plant, and the open pit **(Figure 2.2**). The fuel farm at the Meadowbank mine site consists of a single 5.6 million liter tank. The Baker Lake Marshalling Area consists of a laydown transfer area to temporarily store materials prior to the delivery to the Meadowbank mine site. A fuel tank farm is located at Baker Lake marshalling facility which consists of six, 10 million liter tanks and fuel is delivered in bulk by sealift to the fuel farm **(Figure 2.3)**. From there, fuel is hauled to the Meadowbank mine site by tanker trucks on the AWPAR. 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 response is to take actions to prevent the spill from occurring. Transport, transfer and storage of materials are performed by trained personnel using secondary containment, with well-maintained equipment and containers. Refuelling stations in Baker Lake and at the mine site are equipped with a lined area to contain any minor leaks or spills while refuelling. 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.

AEM supports the following general principles for spill prevention:

- Provide up to date and accessible Material Safety Data Sheets (MSDS) for all hazardous materials
- Daily 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
- Provide adequate spill response materials at storage areas (details of spill prevention equipment are outlined in Section 8).

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 impact. The emergency response team must be notified immediately of a major spill or emergency. A tanker truck overturn on the AWPAR is considered a major spill for the purpose of this plan and Section 7 provides response procedures for an incident of this type.

A minor spill is defined as any hazardous chemical spill that does not involve highly toxic, highly reactive, or explosive chemicals in a situation that is not life threatening. Furthermore, this type of spill presents a manageable physical or health hazard to personnel who, when wearing proper personal protective equipment, will not be exposed to any chemical at a level that exceeds any recognized action level or permissible exposure limit. Minor or simple spills are still to be reported to the Environment Department but they are not expected to involve emergency responders.

3.2 MATERIALS AND REPORTABLE SPILLS ON SITE

As a precaution, if there is any doubt as to whether the quantity spilled meets the minimum reportable thresholds listed in **Table 2**, the spill incident will be reported. Furthermore, AEM will maintain a detailed log of all spills of hazardous materials, including non-reportable spills. 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 encourage all employees to communicate non-reportable spill incidents.

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 2 - 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

Note: L = litre; kg = kilogram; PCB = polychlorinated biphenyls; ppm = parts per million.

SECTION 4 • RESPONSE ORGANIZATION

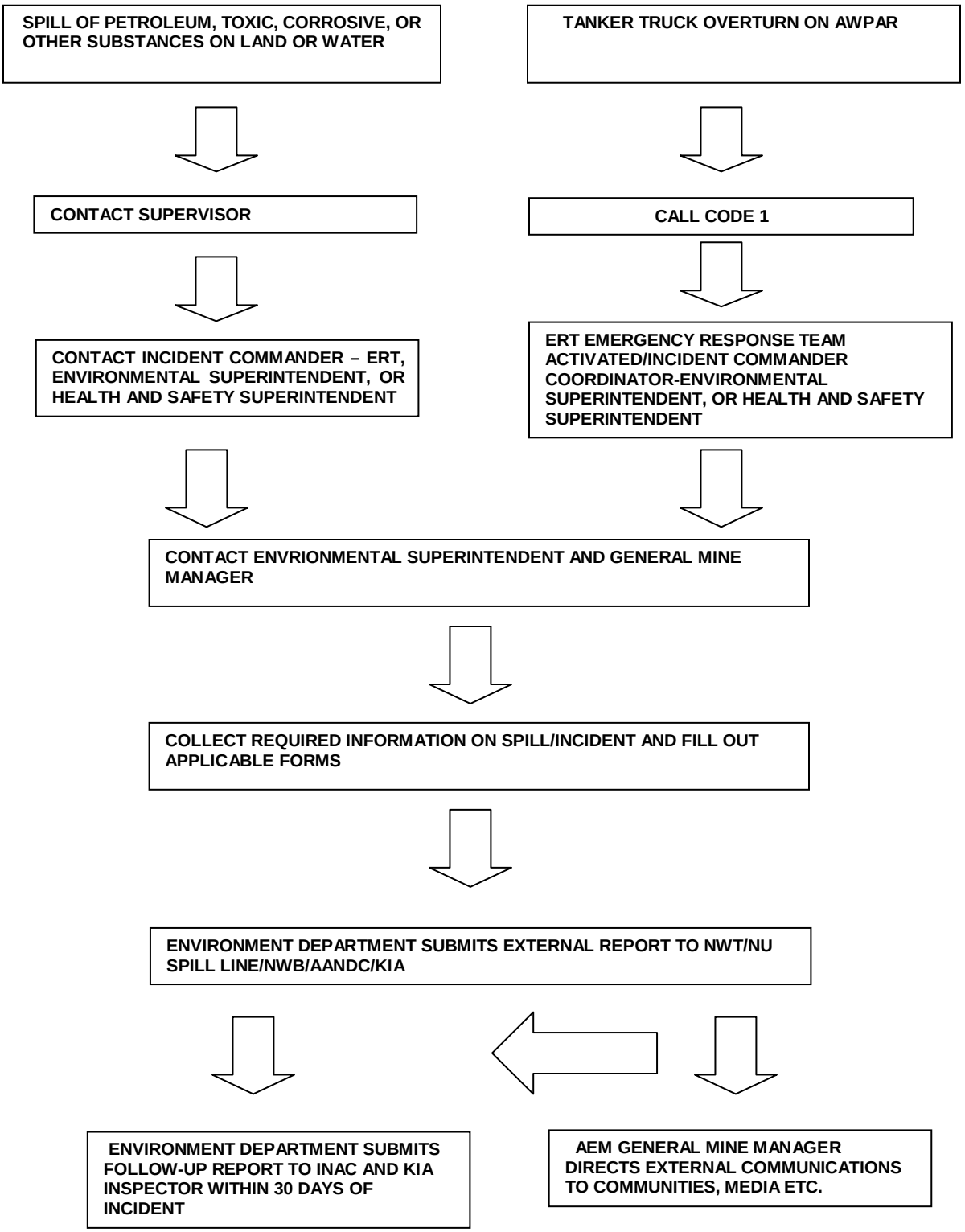
This section addresses the response organization and the responsibilities of each individual during response to an incident.

Figure 4.1 illustrates AEM's Spill Reporting Procedure in the event of a 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 (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 environment department for a minor spill. If a Code 1 is initiated, the incident commander will respond to any tanker truck overturns along AWPAR in conjunction with the ERT. Major responsibilities such as initial coordination, spill clean-up and mobilizing the Emergency Response Team (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 VP, 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' involving tanker truck overturns that require media communications will be the responsibility of AEM General Mine Manager or alternate.

Figure 1: Spill/Incident Reporting Procedure



4.1 FIRST RESPONDER

The person who has caused a spill or is 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.
- 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.
- Gathers facts about the spill.
- 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.

- 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 large 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.
- Ensure that all spill response personnel receive adequate training to fulfil 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 A 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.
- 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 facility malfunction causing a 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.
- 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.
- 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.
- 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 4.2 for all AEM personnel involved in spill recovery and subsequent reporting. Table 4.3 provides contact information for AEM contractors present at the mine site. Important external contacts such as regulatory agencies and health organizations are listed in Table 4.4. Table 4.5 provides contact information for external contractors should incident warrant assistance from outside sources.

Table 3 - Internal Contacts

Title	Name	Telephone No.
Vice President, Environment and Sustainable Development	Louise Grondin	416-847-8656 Cell:819-724-2020
General Mine Manager	Dominique Girard	867.793.4610 ext.6910 Cell: 819.856.7863
Health and Safety Superintendent or Assistant Superintendent	Len Kutchaw Or Norm Ladouceur	867.793.4610 ext.6720
Emergency Response Team	Len Kutchaw/Andre Rouleau	867.793.4610 ext.6809
Environmental Superintendent	Kevin Buck	867.793.4610 ext. 6838 Cell: 819.856.1956
Environmental Coordinator Or Environmental Department	Jeffrey Pratt Or Environmental Technicians	867.793.4610 ext. 6728 Or 867.793.4610 ext. 6747
Incident Commander	Jeffrey Pratt/ Kevin Buck	867-793-4610 ext. 6728
On site Medics	On-site Nurses	867.793.4610 ext.6734
Site Security	On-site Security	867.793.4610 ext.6748

Table 4 - Contractor Contacts

Title	Telephone No.
Nolinor Aviation Services	Protocol Agent 867.793.4610 ext. 6808
First Air	867.446.1744
Calm Air	867.793.2873
Dyno Nobel Explosives Ltd.	867.793.4610 ext.6804
Woodward Group of Companies (Shipping)	709.896.2421 or 709.896.6569

Table 5 - 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	867-979-8637	867-979-8501
Kivalliq Inuit Association	867-645-5725	867-645-2348
Nunavut Water Board	867-360-6338	867-360-6369
AANDC Inspector	867-975-4548	867-979-6445
Environment Canada, Enforcement Branch	867-975-4644	867-975-4594
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 (Health Centre)	867-793-2816	867-793-2813
Baker Lake Hamlet Office	867-793-2874	
Baker Lake Fire Emergency	867-793-2900	N/A

Table 6 - External Spill Response Contractor Phone Numbers

Contractor	Telephone No.	Area of expertise
Local		
Baker Lake Contracting & Supplies	867.793.2831	General Contracting and repairs
Peter's Expediting	867.793.2703	Transportation
NWT Ltd (Arctic Fuel)	867.793.2311	Fuel Transportation

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.
- Spills resulting from accidents during transportation.

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.
- 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 Respond Safely

- 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 vapours might ignite – allow them to evaporate.
- 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

- Obtain all necessary information to complete the external reportable spill. External reportable spills 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.
- A detailed spill report, no later than 30 days after reporting the spill, will be submitted to the AANDC Water License Inspector and the KIA Land's Inspector by AEM Environment Staff. 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 hazardous material lost. The MSDS 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 the general procedures detailed in the following section. The main spill control techniques involve the use of two types of barriers: dykes 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 fuel and will also serve as containment to allow recovery of the fuel.

Depending on the volume spilled, the site of the spill as well as available material, a dyke may be built with soil, booms, lumber, snow, etc. A plastic liner should be placed at the foot of and over the dykes

to protect the underlying soil or other material and to facilitate recovery of the fuel. Construct dykes 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 fuel 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 large quantities of absorbent materials to recover important volumes of fuel 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. 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 the general procedures provided in the following section. Various containment, diversion and recovery techniques are discussed in the following sections. 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
- seasonal considerations (open-water, freeze-up, break-up, frozen)

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, a 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 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

All contaminated spill pads, and booms are placed within Quatrex bags and contaminated water is placed within drums for shipment to an approved disposal facility. All contaminated soil is placed in a temporary site to be treated later on.

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 B to G provide General Response Procedures for Spilled Chemical Substances.

Table 7 identifies the predominant hazardous materials transported, stored and generated at the site.

Table 7- 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 c-cans	Inventory Lay down
Activated Carbon	350 MT	10 mt per c-can	Inventory Lay down and Process Plant lay down
Ammonium Nitrate	10 000 MT	20 mt per c-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 c-can	Inventory Lay down, garage
Trojan Boosters (Blasting Systems)	34 000 KG	15 mt per c-cans	Emulsion plant
Borax, Anhydrous	7 500KG	3 375KG per c-cans	Inventory Lay down and Process Plant lay down
Calcium Chloride	600 000L	10 000L per c-cans	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 c-can	
Copper Sulphate	500 MT	20 MT Per c-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 c-cans	Emulsion plant

Nonel EZTL	1 400 KG	15 mt per c-cans	Emulsion plant
Nonel MS	1 800 KG	15 mt per c-cans	Emulsion plant
Ethylene Glycol	60 000L	10 000L per c-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 B Fuel	20 000L	11 000L Tanker	Tank, tarmac
Lead Acid Batteries	500L	500L per c-can	Warehouse
Magnafloc 10 (Flocculant)	300 MT	15 MT per c-can	Inventory Lay down
Nitric Acid	120 000L	8 000L per c-can	Inventory Lay down
Portland Cement	3 500 mt	20 mt per c-can	Dyke and
Sodium Cyanide	1 300 MT	19 mt per c-can	Inventory Lay down and Process Plant lay
Sodium Hydroxide	10 KG	10 kg in c-can	Warehouse
Sodium Nitrate	10.2 MT	5.1 MT per c -can	Inventory Lay down
Sulphuric Acid			
Sulfur	4 600MT	20 MT per c-can	Inventory Lay down
Unleaded Gasoline	50 000L	40 000L tanker	Tank farm
Varsol	4 000L	2000 L per c-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

Hazardous products spilled: Diesel 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 transportation that will be used under an emergency situation are:

- Aircraft (fixed wing or helicopter)
- 4-wheel drive vehicles
- Snowmobiles
- Boats

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. 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:

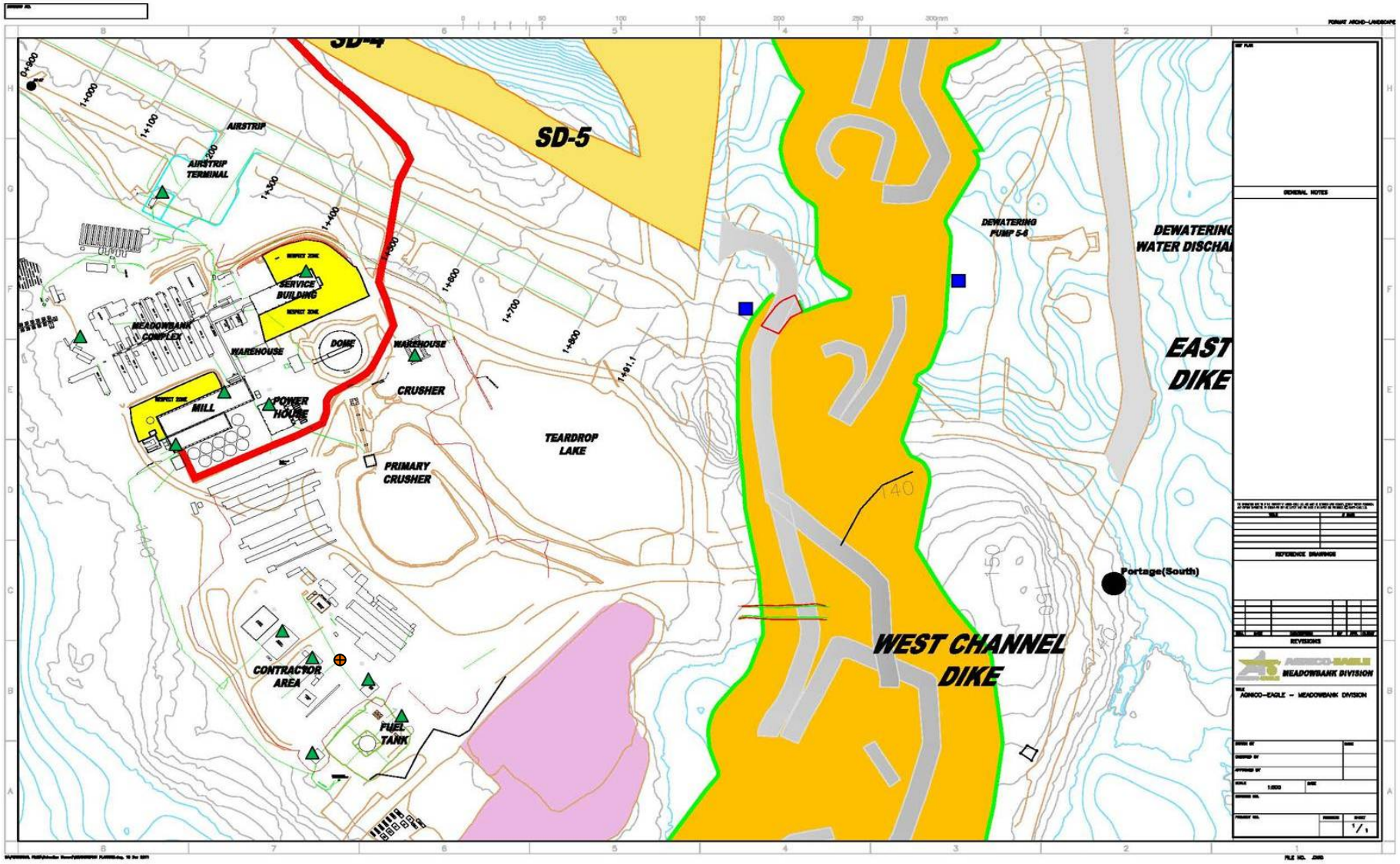
- Pump Elastec
- Pump accessories
- Vaccum ends
- 45 gallons top
- Tubing 2 inches diameter
- Tubing 3 or 4 inches diameter?
- Diesel Fuel jerry can (place on a miniberm)
- Spill kit accessory (red box)
- Drums opener
- Wescot (to open empty drum screw)
- Empty drums
- 2 drums berm
- 4 drums berm 4x8
- 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. 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 absorbant
- 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 6.



Spill Kits Large Spill Kits for Mine OPs Emergency Response Trailer

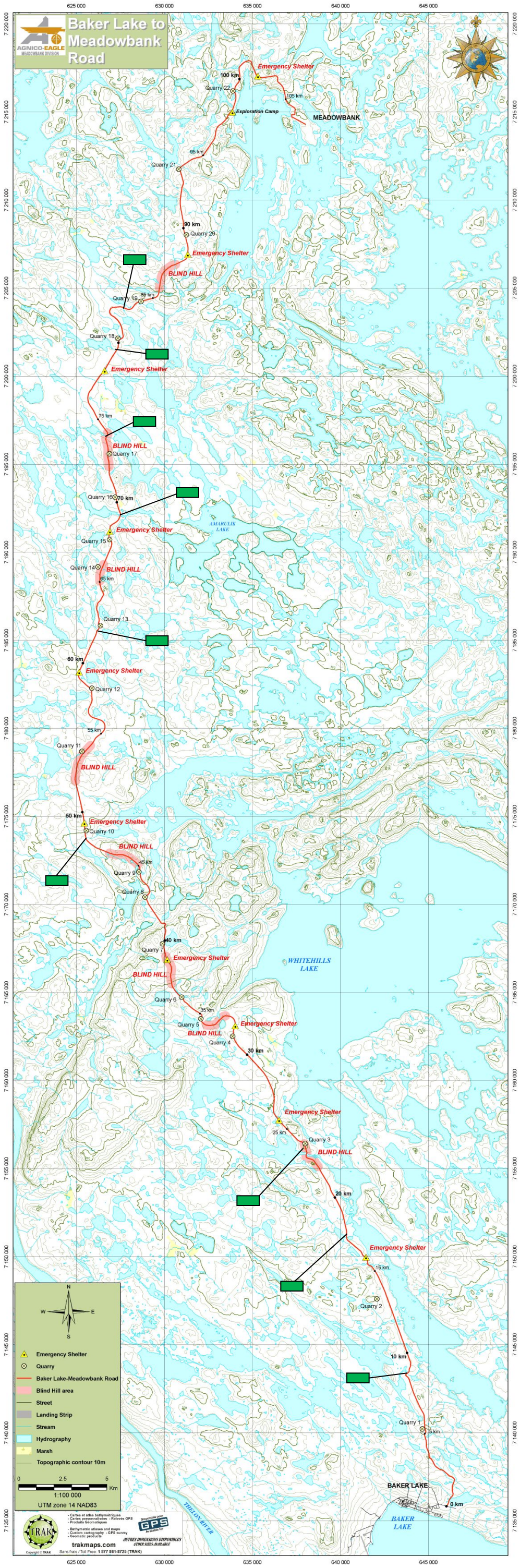


Figure 3 - Map of AWAPR Including Locations of Environmental Emergency Seacans

Environmental Emergency Seacans

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 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.
- 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 Environmental Department regularly attends tool-box sessions to provide information on spill response and 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
INAC Indian and Northern Affairs 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

NWT/NU Spill Report Form

Canada

NT-NU SPILL REPORT

OIL, GASWNE, GHEI.!ICM.S AND OIHEIR HAZARDOUS MATERI.US

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Appendix B

General Response Procedures for Spilled Chemical Substances

Explosives

B.1 Ammonium Nitrate
B.2 Ammonium Nitrate Fuel Oil (ANFO)

B.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).
- 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 the 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**

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.

B.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.
- 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 C

General Response Procedures for Spilled Chemical Substances

C.1 Compressed Gases

C.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.

7) Isolate area until gas has dispersed. On-Scene Coordinator to verify safe conditions.

Appendix D

General Response Procedures for Spilled Chemical Substances

D.1 Flammable and Combustible Liquids

D.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.

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 (if present) 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 dissolve 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 E

General Response Procedures for Spilled Chemical Substances

Oxidizing Substances

E.1 Liquids
E.2 Solids

E.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.**

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.

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.

E.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.

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.

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 F

General Response Procedures for Spilled Chemical Substances

Poisonous and Toxic Substances

F.1 Sodium Cyanide

F.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:
e. Gloves **as recommended by the MSDS or glove manufacturer.**
f. Safety glasses or goggles.
g. Lab coat.
h. Half mask air-purifying respirator **as recommended by the MSDS or respirator manufacturer**.

Note: For worker safety, maintain readily accessible supply of cyanide antidote kits on site.

4) Ventilate area of spill or leak.

5) Avoid exposure to acids, water or weak alkalies 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.

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.

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 G

General Response Procedures for Spilled Chemical Substances

Corrosive Substances

G.1 Acids, Liquids
G.2 Acids, Solids
G.3 Bases/Alkali, Liquids
G.4 Bases/Alkali, Solids

G.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.

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.

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.

G.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.

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.

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.

G.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.

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.

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.

G.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.

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.

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

Woodward Group of Company Spill Contingency Plans

SCHEDULE E

PRODUCT DISCHARGE AND DISTRIBUTION PROCEDURES

Advance Preparation

At least two months prior to delivery confirm with the customer the following:

- ✓ Determine the time that the ship is expected to arrive.
- ✓ Arrange for berthing availability.
- ✓ Verify space available in storage tanks.
- ✓ Ensure preventative maintenance checks are conducted and any deficiencies or problems identified are corrected.
- ✓ Ensure any major maintenance work, that may in some way inhibit normal operations during transfer of product, is completed.

Before Discharge from Tanker Vessel

Prior to receiving product from tanker, a Woodward's Oil representative will ensure the following is conducted:

- ✓ A safety meeting is held to review and discuss local safety regulations and operating procedures, facilities contingency plan, ship emergency procedures, location of fire alarms, closing down of operations, closing of valves and disconnection of hoses or metal arms.
- ✓ The deployment and checking of all safety equipment, such as portable fire extinguishers, portable fire pumps, hoses, absorbent booms and absorbent pads to ensure that they are ready for use.
- ✓ Portable communications equipment is agreed upon by vessel, berth and tank field personnel, and equipment is tested.
- ✓ Storage tanks are properly prepared prior to measuring so that if water is found to be present, the water is removed, if possible, transfer to other tanks have been made, and if tank can be isolated during discharge, close all suction valves on tanks to be gauged.

- ✓ Check on pipeline is made to determine if pipeline is full or not. If pipeline is empty or partially full then vent and fill line with appropriate product prior to measuring the tanks, open all lever check valves, and patrol the line to detect leakage, physical damage, and in line failure. When the line has been filled, place the open level check valves in the normal position for receiving cargo and close the marine line valve of the storage tanks.

- ✓ All shore tanks are gauged and a record is kept of the number of liters on-hand. For non-isolated tanks suspend all transfer activity prior to gauging. Ensure that suction valves on tanks to be gauged are in the closed position.

- ✓ Readings are recorded from dispenser units.

- ✓ Quality Control procedures for all shore tanks are conducted.

- ✓ Calculations of quantities of products to be received must be re-checked and verified. A cut-off point for each tank to receive products must be determined and agreed upon by both shore and ship personnel.

- ✓ A review and an evaluation of the results of the Quality Control checks is completed, and if all tests are verified as passing then discharge may commence.

During Cargo Discharge

Ship and shore personnel are jointly responsible for controlling cargo discharge and both must adhere to the following:

- ✓ Since discharging cargo from ship to shore tanks is a remote control operation it requires good communication to coordinate the work of ship and shore personnel. The methods of communication used during pumping operations shall be portable radios, when a fixed system is not available or a flag and whistle system, when telephone/portable radios are not available. Communications must be maintained at all times throughout discharging operations to ensure immediate response to emergency situations to reduce pumping rates as cut-off points are neared.

- ✓ Before starting to pump all connections must be checked to ensure that they are properly made. Shore, line and ship manifold valves must have settings checked to ensure that they are in correct position.

Bonded drip pans must be placed under ship and shore connections to catch minor leaks.

- ✓ Review method of communication and pumping schedule to ensure that both are clearly understood by ship and shore personnel.

- ✓ Periodic checks must be made on all connections throughout pumping operations to ensure that no leaks have occurred.

- ✓ Shore personnel must ensure sufficient notice is supplied to ship personnel to alert them about switching shore tanks, discontinuing or altering cargo discharge or topping shore tanks.

- ✓ The most vulnerable part of the system is the ship to shore connection. Throughout the pumping operations, ensure that no abrupt changes occur in the flow rate. The main cause of surge pressure in pipelines is the valve closing quickly against the flow of product, either partially or completely. When shore tanks are switched, open the valve to the tank receiving the product at the proper time before closing the valve on the tank which had been receiving product.

- ✓ Discontinue discharging if: an electrical storm occurs; fire breaks out; leakage exists and cannot be stopped; the product spills, because of system failure or tank overfill; conditions develop that jeopardize the mooring hold of the ship; all product required has been transferred.

- ✓ Once pumping has stopped the discharge hose will be pigged to push through any product left in the hose and then the sea hose will be disconnected from the shore manifold and retrieved.

Completing Cargo Discharge

After the cargo has been discharged ship and shore personnel should:

- ✓ Close and lock all valves in the system from berth to tankage.

- ✓ Measure and record all compartments of the ship containing product for ullage, water, and average temperature. Calculate amount of product transferred from ship to shore tanks.

- ✓ Gauge all shore tanks into which the ship has discharged product, thus determining the amount of product received. Be sure to allow a minimum settling time of thirty minutes prior to gauging.

✓ Take readings of all dispenser meters if product was dispensed during the discharge operation.

✓ Determine from measurements taken actual quantity of product received.

✓ Perform Quality Control checks on all shore tanks.

✓ Prepare report on the re-supply operation and submit to AEM.

SHIPBOARD OIL POLLUTION EMERGENCY PLAN

for

MT DORSCH

6720Gross Tons Register of St. John's, NL

PREPARED BY:

Poseidon Marine Consultants Ltd.
391 Stavanger Drive
St. John's NL A1A 5G1
Telephone: (709) 739-4321
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PREPARED FOR:

Coastal Shipping Ltd.
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Issued: June 2005
Job Number: 05-037

Change Number

Examined under the provisions of Annex 1 of MARPOL 73/78 and the Canadian Oil Pollution Prevention Regulations (SOR/93-3) and found satisfactory.

Clifford Harvey/PPO July 8/06 Date

TRANSPORT CANADA TRANSPORTS CANADA MARINE SAFETY SECURITE MARITIME CANADA St. John's, NL

Change Number

Official Stamp Examined by Date

Change Number

Official Stamp Examined by Date

RECORD OF CHANGES

Amendment Number	Section and Page Affected	Date Entered	Remarks	Name and Position of Person Making Entry

RECORD OF OIL POLLUTION EMERGENCY DRILLS

DATE	TYPE OF OIL POLLUTION DRILL	LOCATION	REMARKS MASTER'S SIGNATURE

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SHIP'S PARTICULARS

PRINCIPAL PARTICULARS

Vessel Name:	Dorsch
Flag / Port of Registry:	Canada / St John's, NL
GL Number:	16648
IMO Number:	8007195
Gross Registered Tonnage:	6720 (ITC69)
Net Registered Tonnage:	3548 (ITC69)
Length, Overall:	130 72 m
Length, B.P.:	122 0 m
Breadth, Max. at Deck:	18.5 m
Depth to Main Deck:	10.6 m
Design Draft (Summer):	7.2 m
Built:	Berner Schiffswerft GmbH & Co. KG
Year of Build:	1980
Complement:	18
Propulsion Power:	Krupp Mak 8 MU 552 AK 4410kW @ 480RPM

CAPACITIES

Fresh Water	Approx. 118m^3
Fuel Oil (MDO)	Approx. 171m^3
Fuel Oil (HFO)	Approx. 452m^3
Ballast Water	Approx 2459m^3
Cargo Hold (Incl. Slop Tanks)	Approx. 12153m^3

INTRODUCTION

1 This Plan is written in accordance with the Canadian Oil Pollution Prevention Regulations and also in accordance with the requirements of regulation 26 of annex I of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 thereto.

2. The purpose of the Plan is to provide guidance to on board operating personnel the vessel with respect to the steps to be taken when a pollution incident has or is likely to occur

3. The Plan contains all information and operational instructions required by the guidelines. The appendices contain names, telephone, telex numbers, etc. of all contacts referenced in the Plan, as well as other reference material

4. This Plan has been examined by the Canadian Board of Steamship Inspection, (herein after referred to as "the Board") and, except as provided below, no alteration or revision shall be made to any part of it without prior approval of the Board.

5. Changes to Sections 6, 7, 8, and the appendices will not be required to be approved by the Board. The appendices should be maintained up to date by the Owners, Operators, and Managers.

6. For the purposes of this Plan, the Master is taken to be that person who is a member of the vessel's operational personnel and to which is given senior responsibility for the vessel and any circumstances pertaining thereto.

7. Before entering a port of call, the Master should be aware of local emergency response procedures and organizations and have up to date contact information readily available.

SECTION 1 • Preamble

1.1 PURPOSE AND INTENT OF THIS PLAN

This Shipboard Oil Pollution Emergency Plan is intended to assist the vessel's officers, crew and management personnel in dealing with an unexpected discharge of oil Its primary purpose is to set in motion the necessary actions to stop or minimize the discharge and to mitigate its effects.

1.2 SUPPORT BY VESSEL'S MANAGEMENT

In accordance with the plans and policies of the vessel's management organization, management personnel will support the vessel's crew with additional resources, i e. personnel and materials, as the situation warrants.

1.3 PERSONNEL TRAINING AND EXERCISES

1 ***It is the responsibility of the Vessel's Management to ensure that, through training and exercises, all officers and crew are capable of confidently and safely carrying out their assigned duties.***

Officers responsible for maintaining the trim of the vessel and ordering transfers of ballast and/or cargo should be fully aware of the consequences of their actions and are expected to comply with the regulations and any documentation aboard the vessel which prescribes conditions of trim and stability , e.g. "Approved Stability Booklet"

Officers and crew responsible for cargo and or bunkering operations should also be fully aware of the consequences of their actions and are expected to comply with the regulations and any documentation aboard the vessel which prescribes methods of operation

Officers and crew assigned additional responsibilities for fire fighting or emergency response should have appropriate training as per the regulations and should participate in specific drills and exercises to maintain their abilities and be fully familiar with appropriate vessel systems.

The vessel's management and operating personnel should become familiar with this document and its format so that should an emergency occur, the response of the officers and crew and the vessel's management personnel will be carried out in a structured, logical and timely manner.

In order to ensure that the crew and management are completely familiar with this document and its prescribed procedures, training should be offered and oil pollution emergency drills should be carried out regularly.

A blank "Record of Oil Pollution Emergency Drills" form is provided at the beginning of this Plan to document the dates and results of such training exercises. This documentation is to be in addition to normal record keeping and log book entries.

3. ***All crew members should become familiar with the fundamentals of the ship's mechanical and electrical systems in order to be more confident and capable during an emergency.***

It is the responsibility of the vessel's senior officers to ensure that engineering fundamentals are taught to the crew and that the crew remain familiar with them through regular drills. Drawings detailing the various mechanical and electrical systems are carried aboard the vessel. Any drawing (e.g. "Natural Vents", "Engine Room Ventilation", "One Line Electrical Diagram", "Fuel Oil Transfer Diagram") can be obtained for study from the Engineering Document Library located in the Chief Engineer's Office. These drawings are thoroughly catalogued and easily referenced

In order to ensure a fundamental familiarity with the various engineering systems, oil pollution emergency drills should include such exercises as:

isolating and sealing off accommodations and/or machinery spaces using louvers and fan shutoffs to prevent ingress of dangerous fumes; and

isolating, at the distribution panels, various electrical circuits, e g. lighting, panel feeds, in order to reduce or eliminate sources of ignition in areas of risk.

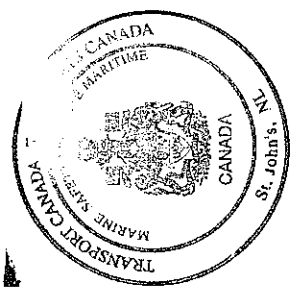
1.4 PLAN FORMAT

This plan is divided into five sections as follows:

Section 1 provides an introduction for this document and highlights some important considerations regarding the spillage of oil at sea.

Section 2 outlines the procedure and requirements for making a report to authorities in the event of a discharge or probable discharge of oil.

Section 3 provides a checklist of steps to be taken in the event of various operational or casualty related spills.



Section 4 outlines procedures for national and local coordination of response efforts.

Section 5 outlines procedures for ship to ship transfer operations

Section 6 outlines safety precautions for bunkering operations

Section 7 deals with non-mandatory provisions such as oil spill response materials onboard, media information, and plan review

Section 8 outlines the responsabilities of the Oil Pollution Prevention Team

Following the main body of this plan are appendices which provide contact information and/or useful forms. Appendix 1 is an example of an unofficial facsimile report, the use of which is outlined in Section 2. Appendix 2 provides contact information for coastal authorities and ship interests. Appendix 3 is a blank calculation form for vessel stress and stability which can be filled out by an officer of the vessel and sent to the vessel owners for calculation. The use of this calculation form is described in Section 3 Appendix 4 contains flowcharts and checklists for use in the event of an emergency. Appendix 5 contains relevant ship's drawings.

1.5 OIL DISCHARGE MONITORING SYSTEM

In accordance with MARPOL 73/78 Annex 1 Regulation 16 this ship is fitted with a Jowa Oil-A Triosep and Duosep bilge water separator and Jawa M-87 and M-93 ballast water monitors, both manufactured by Jowa AB, Sweden. The oil content meters associated with these units are fitted with 15ppm oil content alarms.

IMPORTANT:

1. **ANY** OIL SPILLAGE SHOULD BE TREATED AS AN EMERGENCY.

2. IN RESPONDING TO AN OIL SPILLAGE, THE MASTER'S PRIORITY WILL BE TO ENSURE THE SAFETY OF THE CREW AND OF THE VESSEL, AND TO TAKE ACTION TO PREVENT ESCALATION OF THE INCIDENT. IMMEDIATE CONSIDERATION SHOULD BE GIVEN TO MEASURES AIMED AT PREVENTING FIRE AND EXPLOSION

SECTION 2 • Reporting Requirements

Coast guard of nearest coastal State (see Appendix 2) is to be notified whenever there is:

a) **An actual discharge of oil**
b) **Reason to suspect a probable discharge of oil due to fire, grounding, list, loss of power, collision, flooding, explosion, structural failure, etc.**
c) **Any damage or failure which may affect the safety of the vessel, such as failure or breakdown of the electrical generating system, or essential shipborne navigational aids.**

2.1 DISCHARGE OF OIL

When reporting a discharge of oil, the Master is to provide all relevant information (as per section 2.4) to:

a) Coast Guard of nearest coastal State, or
b) Port Authorities, and also to
c) Vessel Interest Contacts.

A discharge of oil, for the purposes of this plan, refers to:

a) A discharge of oil, resulting from damage to the vessel or its equipment, or for the purpose of securing the safety of a vessel or saving life at sea; or
b) A discharge during the operation of the vessel of oil in excess of the quantity or instantaneous rate permitted under the present Convention.

2.2 PROBABLE DISCHARGE OF OIL

The Master must use good judgment to assess any circumstance which might be cause for probable discharge of oil. When making such judgment the following factors must be taken into account:

a) The nature of the damage, failure, or breakdown of the vessel, machinery, or equipment;
b) Vessel location and proximity to land or other navigational hazards;
c) Weather, tide, current, and sea state;
d) Traffic density; and
e) Morale, health and ability of crew onboard to deal with situation

2.3 DAMAGES AND/OR FAILURES

The Master must report any damage which may affect the safety of the vessel: collision, fire, grounding, explosion, cargo shifting, list, etc. The Master must also report any failure or breakdown of essential machinery which results in impairment of the safety of navigation: i.e electrical generating system or essential vessel-borne navigational aids

2.4 INITIAL REPORT

An initial report is to be made by radio communication without delay to one of the following Canadian radio ship reporting stations; Canadian Coast Guard Radio Station, Canadian Vessel Traffic Service Center, St. Lawrence Seaway Authority marine radio station, or Canadian harbour radio station. The report is to be made following the format given below. Where the report cannot be communicated by radio, it shall be communicated by telephone to the local Canadian radio ship reporting station or to the Canadian Coast Guard Operations Center in Ottawa. Contact information is provided in Appendix 2.

FOLLOW-UP REPORTS

Follow-up reports should be made at regular intervals to keep the coastal State and other concerned parties informed of developments including, but not limited to, change of course or position, change in quantity, rate or probability of oil discharge, injuries or casualties, or effects of actions taken to control discharge or assure safety of the vessel and crew. Follow-up reports should be made in the same format as the initial report.

WRITTEN REPORT

Within 24 hours of the incident, or as soon as possible thereafter, a written report on the incident, including a statement as to its probable cause, shall be forwarded by air mail without delay to the Chief, Marine Casualty Investigations, Department of Transport, Ottawa.

UNOFFICIAL FACSIMILE REPORT

An unofficial facsimile report is included in Appendix 1. This may be sent to any concerned parties but is not consistent with IMO Resolution A 648(16) for reporting of incidents involving dangerous goods, harmful substances and/or marine pollutants, and therefore cannot constitute an official report to the coastal State.

FORMAT AND INFORMATION REQUIRED FOR OFFICIAL REPORT

AA VESSEL NAME, CALL SIGN, FLAG

BB DATE AND TIME (GMT) OF INCIDENT: 111935 meaning 11th of month at 7:35 pm.

CC SHIPS POSITION: 2230N 0600E meaning 22 deg. 30 min. N, 6 deg. E

or

DD SHIPS POSITION BY TRUE BEARING (3 DIGITS) AND DISTANCE FROM CLEARLY IDENTIFIED LANDMARK.

EE TRUE COURSE (3 DIGITS)

FF SPEED IN KNOTS AND TENTHS OF A KNOT (3 DIGITS)

LL ROUTE INFORMATION - INTENDED TRACK

MM RADIO STATIONS AND FREQUENCIES GUARDED

NN TIME OF NEXT REPORT (same as in BB)

OO DRAFT (4 DIGITS - meters and centimeters)

PP TYPES AND QUANTITIES OF CARGO AND BUNKERS ON BOARD

QQ BRIEF DETAILS OF DAMAGE, LIMITATIONS ETC. (must include condition of vessel and ability to transfer cargo, ballast, or fuel)

RR BRIEF DETAILS OF ACTUAL POLLUTION (oil type, estimate of quantity discharged, whether discharge continues, cause, estimate of slick movement)

SS WEATHER AND SEA CONDITIONS (wind force/direction, relevant tidal and/or current information)

TT NAME, ADDRESS, TELEX, FAX, TELEPHONE NUMBERS OF VESSEL OWNER OR REPRESENTATIVE

UU DETAILS OF LENGTH, BREADTH, TONNAGE, AND TYPE OF VESSEL

WW TOTAL NUMBER OF PERSONS ON BOARD

XX MISC DETAILS (This includes brief details of incident, actions taken, injuries sustained and assistance required. If no outside assistance is required, then this should be clearly stated.)

2.5 WHO TO CONTACT

Contact information for coastal State and other concerned parties (port contacts, vessel interest contacts) is located in Appendix 2

2.6 ARRANGED RESPONSE ORGANIZATION(S)

The vessel, in accordance with the regulations, has onboard a **declaration** that the vessel's management has, in accordance with 660 2(2) of the Canada Shipping Act, entered into an arrangement with a response organization to which a certificate of designation has been issued pursuant to subsection 660.4(1) in respect of the quantity of oil that is carried both as fuel and cargo on board the vessel

The person or persons identified in the **declaration** shall be responsible for contacting and mobilizing the response organization.

SECTION 3 • Steps to Control Discharge

In cases of small spills on deck, the vessel's crew should take whatever actions are necessary to prevent oil from escaping over the side. Once the spill is contained on deck, the crew will need to take action to clean up the oil. SPILLED OIL SHOULD NOT BE WASHED OVER THE SIDE. Once oil is in the water, the crew's ability to respond in a practical manner is greatly reduced.

3.1 OPERATIONAL SPILLS

In the event of an operational spill which occurs during bunkering or cargo operations, it is important that the bunkering party terminate any and all bunkering operations and close all manifold valves.

Before closing any manifold valves, the bunkering / cargo party must immediately inform the terminal / loading master so that they may take action to eliminate the possibility of over-pressurization of the shore side transfer components.

After dealing with the cause of the spill, it may be necessary to obtain permission from local authorities and/or the terminal before resuming bunkering or cargo operations

If the possibility of fire or explosion exists, nonessential air intakes to accommodations and machinery spaces should be closed and all sources of sources of ignition should be eliminated. See Section 1 3 3 of this Plan.

In accordance with Section 1.3.3 of this Plan, all members of the vessel's crew should be familiar with the fundamentals of the ship's vital systems including the ventilation and electrical systems. Crew members should be able to: isolate the accommodation and/or machinery spaces using the louvers and fan shutoffs; and, from the distribution panels, isolate electrical circuits in areas of risk. Please refer to Section 1 3 3 of this Plan for additional details.

Care must be taken to consider stability and stress when taking action to mitigate the spillage of oil. Internal transfers should be undertaken only with a full appreciation of the likely impact on the vessel's overall stress and stability. Please refer to the "Approved Stability Booklet" carried on board.

Operational Spill Checklist

Action Considered	Designated Person	Completed
Sound emergency alarm	Person Discovering Incident	Y / N
Initiate emergency response procedures	Chief Officer	Y / N
Cease all bunkering operations	Chief / 2nd Engineer	Y / N
Locate source of leakage	Chief / 2nd Engineer	Y / N
Operate manifold valves	Chief / 2nd Engineer	Y / N
Close all nonessential vent intakes and tank vents as required	Chief / 2nd Engineer	Y / N
Stop or reduce outflow	Chief / 2nd Engineer	Y / N
Assess fire risk	Chief Officer	Y / N
Commence clean up	Chief Officer	Y / N
Assess Stress / Stability	Master / Chief Officer	Y / N
Transfer fuel from damaged area to slack tanks or other containment space	Chief / 2nd Engineer	Y / N
Request outside assistance if required	Master	Y / N
Counter excessive list if required / possible	Chief Officer	Y / N

1. PIPE LEAKAGE

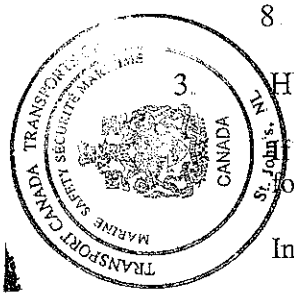
In the event of an oil pipe leakage, the Chief Engineer must ensure that the following actions are taken:

1. Stop oil flow and close manifold and other valves.
2. Sound Emergency Alarm and initiate emergency response procedures as posted aboard the vessel.
3. Locate the source and drain affected section into an available empty or slack tank. Repair if possible.
4. If there is any possibility of released vapours entering an engine room or the accommodation intake, appropriate preventative steps must be taken quickly.
5. Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.
6. If oil is overboard, report to proper authorities immediately (as per section 2 of this plan).
7. If oil is in bilges, pump through oil/water separator as per approved procedures.

2. TANK OVERFLOW

In the event of an oil tank overflow, the Chief Engineer must ensure that the following actions are taken:

1. Stop oil flow and close manifold and other valves.
2. Sound Emergency Alarm and initiate emergency response procedures as posted aboard the vessel.
3. Place drain buckets under overflow pipes to contain possible spills.
4. If there is any possibility of released vapours entering an engine room or the accommodation intake, appropriate preventative steps must be taken quickly.
5. Drain or transfer oil to slack or empty tanks if possible with due consideration paid to vessel stability. If no slack or empty tanks are available then oil may be pumped back ashore through delivery line, having first gained permission to do so.
6. Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.
7. If oil is overboard, report to proper authorities immediately (as per section 2 of this plan).
8. If oil is in bilges, pump through oil/water separator as per approved procedures.



3. HULL LEAKAGE

If oil is noticed on the water near the vessel during normal operations and cannot be accounted for, the possibility of hull leakage should be suspected.

In the event of a hull leakage, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm and initiate emergency response procedures as posted aboard the vessel.
1. Stop any and all transfer or bunkering operations.
2. Identify damage and report to proper authorities immediately (as per section 2 of this plan); consider a diver if necessary and possible.
3. If possible, contain spill using materials on hand and dispose of oil-soaked materials in an appropriate container.
4. If there is any possibility of released vapours entering an engine room or the accommodation intake, appropriate preventative steps must be taken quickly.

5. Transfer fuel away from suspected leaks to empty or slack tanks if possible or to a ballast tank if necessary. If in port, arrangements can be made to pump oil ashore to tank or truck Due consideration is to be paid to vessel stress and stability
6. If it is not possible to identify the leaking tank, reduce level in all tanks in vicinity, giving due consideration to vessel stress and stability.

4. SPILLS CAUSED BY EQUIPMENT IN MACHINERY SPACES

1. If operational spills are caused by a failure of equipment in machinery spaces, any further operations of this equipment should be stopped immediately and measures are to be taken to avoid a spill.
2. Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.
3. Do not restart equipment until problem has been rectified.

3.2 SPILLS RESULTING FROM CASUALTIES

ALL CASUALTIES ARE TO BE REPORTED BY THE MASTER AS PER SECTION 2.

The Master's priority, when responding to a casualty, will be to ensure the safety of personnel and the vessel and to take action to prevent escalation of the incident

In casualties involving spills, immediate consideration should be given to measures aimed at preventing fire and explosion, such as altering course so that the vessel is upwind of the slick, shutting down nonessential air intakes, etc.
If the vessel is aground, and therefore cannot maneuver, all possible sources of ignition should be eliminated and action taken to prevent flammable vapors entering accommodation and engine room spaces Please refer to Section 1.3.3

In accordance with Section 1.3.3 of this Plan, all members of the vessel's crew should be familiar with the fundamentals of the ship's vital systems including the ventilation and electrical systems. Crew members should be able to isolate the accommodation and/or machinery spaces using the louvers and fan shutoffs; and, from the distribution panels, isolate electrical circuits in areas of risk. Please refer to Section 1.3.3 of this Plan for additional details.

Prior to considering remedial action, the Master will need to obtain detailed information on the damage sustained by the vessel. A visual inspection should be carried out and all bunker tanks and other compartments sounded. However, due regard should be paid to the indiscriminate opening of ullage plugs or sighting ports, especially when the vessel is aground, as loss of buoyancy could result. The Master shall also ensure that all covers, doors, vents, and hatches to any and all holds, ballast tanks, and fuel tanks are sealed tightly and remain sealed to prevent possible loss of buoyancy. Having assessed the damage sustained by the vessel, the Master will be in a position to decide what action should be taken to prevent or minimize further spillage.

Great care must be taken to consider stability and stress when taking action to mitigate the spillage of oil or to free the vessel if aground Internal transfers should be undertaken only with a full appreciation of the likely impact on the vessel's overall stress and stability. Please refer to the "Approved Stability Booklet" carried on board.

Should the damage sustained be extensive, the impact of internal transfers on stress and stability may be impossible for the vessel's personnel to assess. In such cases, Appendix 3 of this plan is to be filled out as completely as possible and forwarded to the Owners to ensure the appropriate calculations can be done.

When it is possible to maneuver, the Master, in conjunction with the proper shore authorities, may consider moving the vessel to a more suitable location in order, for example, to facilitate emergency repair work or lightening operations, or to reduce the threat posed to any particularly sensitive shoreline areas Such maneuvering may be subject to coastal state jurisdiction.

Oil Spill Resulting from Casualty (Grounding, Collision, Fire, or Explosion)

Action Considered	Designated Person	Completed
Sound emergency alarm	Chief Officer / OOW	Y / N
Initiate emergency response procedures	Master / Chief Officer	Y / N
Close all nonessential vent intakes and tank vents as appropriate	Chief Officer / Chief Engineer	Y / N
Assess further danger to ship or personnel such as capsize or sinking	Master	Y / N
Cease all nonessential operations	Chief Officer / Chief Engineer	Y / N
Assess whether oil has actually been spilt / probability of spill	Chief Officer / Chief Engineer	Y / N
Sound all ER compartments to determine extent of damage	2nd Engineer	Y / N
Sound around vessel if grounded	Chief Officer	Y / N
Where possible transfer fuel away from damaged compartments	Chief Officer	Y / N
Request outside assistance if required	Master	Y / N
Contain / reduce oil outflow with resources on hand	Chief Officer / 2nd Engineer	Y / N
Commence Cleanup if possible	Chief Officer	Y / N

1. GROUNDING

If the vessel grounds, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm and muster crew.
2. Eliminate all avoidable sources of ignition and ban smoking on board. Action must be taken to prevent hazardous vapours from entering accommodation and machinery spaces. See Section 1.3.3.
3. Identify damage by means of a visual inspection.
4. Take soundings around vessel to determine nature and gradient of seabed.
5. Check differences in tidal ranges at grounding site.
6. Evaluate tidal current in grounding area.
7. Take soundings of all tanks on shell and compare with departure soundings.
8. Determine probability and/or quantity of oil released
9. If oil release is determined or is probable, this is to be included in the casualty report
10. Determine other possible hazards to the vessel, such as sliding off the grounding site, further damage from the seas / swell, and torsion forces.

At this point, determine risk of additional damage to vessel by attempting to refloat. If remaining aground is determined to be less of a risk then:

1. Use anchors to prevent vessel movement.
2. Take in ballast in empty tanks, with due consideration paid to stress and stability. Please refer to the "Approved Stability Booklet."
3. Consider transfer of fuel from damaged tanks, with due consideration paid to stress and stability. Please refer to the "Approved Stability Booklet."
4. Reduce longitudinal stress on hull by transfer of cargo internally. Please refer to the "Approved Stability Booklet."
5. If the change in stability and stress cannot be calculated on board, contact the Vessel's management to arrange for the necessary calculations. Refer to Appendix 3 for information which should be provided

2. FIRE / EXPLOSION

If a fire or explosion occurs on board, the vessel's fire control party must ensure that the following actions are taken:

1. Sound Emergency Alarm and muster crew.
1. Determine extent of damage and what damage control measures can be taken.
2. Determine whether there are casualties
3. Request assistance as deemed necessary.
4. Take necessary actions to prevent smoke and other hazardous vapours from entering the accommodation and machinery spaces.
5. Assess possibility of oil leakage.
6. Determine possible actions to control the discharge of oil. This will depend largely on the damage to the ship and cargo.
7. If there is a discharge or possible discharge of oil, this is to be included in the casualty report.
8. Should abandonment be necessary, the Master must ensure that every effort is made to maneuver survival craft upwind of any oil spill.

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3 COLLISION

If a collision occurs, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm and muster crew.
2. Determine whether there are casualties.
3. If there is a possibility of fire or explosion, eliminate all avoidable sources of ignition and ban smoking on board Action should be taken to prevent flammable vapours from entering accommodation and machinery spaces. See Section 1.3.3.
4. Decide whether separation of vessels may cause or increase spillage of oil, or increase the risk of sinking.
5. If any oil tanks are penetrated, isolate the penetrated tank or transfer oil to slack or empty tanks with due attention paid to stress and stability of the vessel. Please refer to the "Approved Stability Booklet."
6. If there is an oil spill, make a report as per section 2
7. If possible to maneuver, the Master, in conjunction with the appropriate shore authorities, should consider moving his ship to a more suitable location in order to facilitate emergency repair work or lightening operations, or to reduce the threat posed to any sensitive shoreline areas.

4. HULL FAILURE (INCLUDING ICE DAMAGE)

If the vessel suffers structural hull failure, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm and muster crew.
2. Reduce speed or stop to minimize stress on hull.
3. Assess immediate danger of sinking or capsizing.
4. Initiate damage control measures if possible.
5. If lightening is required, all efforts should be made to wait for a barge or other ship to receive the cargo.
6. If oil has spilled, or if it is necessary to jettison oil to maintain stability, make a report as per section 2.
7. If the change in stability and stress cannot be calculated on board, contact the Vessel's management to arrange for the necessary calculations
8. Consider forecast weather conditions and their effect on the situation.
9. Should abandonment be necessary, the Master must ensure that every effort is made to maneuver survival craft upwind of any oil spill

5. EXCESSIVE LIST

If excessive list occurs rapidly and unexpectedly, it may be due to:

1. Failure of hull plating
2. Failure of internal bulkhead between compartments
3. Shift of cargo.
4. Damage through grounding or collision.
5. Incorrect operating condition. Refer to "Approved Stability Booklet."
6. Flooding in Engine Room, where free surface can cause a list.

The Master must ensure the following steps are taken immediately:

1. Stop any cargo, bunkering, or ballast operations in progress.
2. Sound Emergency Alarm and muster crew
3. Determine whether there are casualties.
4. If under way, reduce speed or stop
5. Establish reason for list. See above.
6. Sound all tanks and compare with departure soundings
7. Close all openings and vent pipes.
8. Prepare ballast and transfer pumps for possible remedial action.
9. If lightening is required, all efforts should be made to wait for a barge or other ship to receive the cargo.
10. If oil has spilled, or it is necessary to jettison oil to maintain stability, make a report as per section 2.
11. If possible, take corrective action to rectify the situation with due consideration paid to vessel stress and stability. Please refer to the "Approved Stability Booklet "

SECTION 4 • National and Local Coordination

1 The Master will advise the Coast Guard of nearest coastal state regarding any oil spill. Vessel Interest Contacts must also be notified of any such incident. See Appendix 2 for details.

2. The Master will be the point of contact on the vessel for coordinating shipboard activities with national and local authorities, act as the Company's on-scene representative, and will be responsible for overseeing the action of any salvage or spill contractors employed until such time as he/she has been FORMALLY relieved of these responsibilities by the Company.

3. The person or persons identified in the declaration shall be responsible for contacting and mobilizing the response organization(s). These organizations will coordinate and conduct the response. It is not normally practical for vessel's personnel to be directly involved in cleanup activities. Therefore, their primary role will be to provide as much information as necessary to assist the response and to cooperate with cleanup personnel However, where no local response is forthcoming, or is delayed, the Master should consider the use of available shipboard materials to clean up or contain the spilled oil by, for example, using ship-stocked absorbent materials or utilizing mooring ropes or air-filled hoses as makeshift booms.

4. Dispersants or degreasers should not be used on oil spilled in the water as their use may contravene local regulations However, dispersants may be used if they are approved by Environment Canada specifically for a given incident. Environment Canada will allow and approve the use of dispersants on a case by case basis only

SECTION 5 • Ship to Ship Transfer Operations

Should a situation such as lightening due to damage require a ship to ship transfer of petroleum products, the Master must take into account but not limited to the following:

1. Proper lines of communication between ships including language and radio working frequency;
2. Current and forecasted weather conditions for the intended area of transfer;
3. The compatibility of the vessels involved with regards to size, freeboard, manifold location, list, trim, etc
4. The elimination of all possible ignition sources;
5. Oil spill clean up equipment and procedures in place;
6. Contingency planning for emergency situations in place
7. The need to notify and obtain the agreement of any responsible authority.
8. Site conditions such as available shelter, water depth, and available anchorage.
9. Traffic density.

For detailed procedures concerning ship to ship transfer of petroleum products, please refer to ***The Ship to Ship Transfer Guide (Petroleum)****, published by The International Chamber of Shipping Oil Companies International Marine Forum, 3rd edition, 1997 A copy of which is to be kept on board the ship at all times.*

SECTION 6 • Safety Precautions For Bunkering Operations

NO SMOKING THROUGHOUT BUNKERING OPERATION

Before beginning refuelling operations:

1. The spill control equipment should be in the immediate vicinity and readily accessible should it be required in the event of a fuel spillage. Note that the tanker or refueling station should also have its own spillage control kit.

2. Ensure that the approximate amount of fuel required is known. This can be confirmed from the Chief Engineer, Captain, or Vessel Manager.

3. The location and ready access to the nearest fire extinguishers should be confirmed

4. All save-alls must be empty and drain holes plugged.

5. Check that no *hot work* is being carried out in the vicinity

6. Check position (Open) of interconnecting valves.

7 Establish communication with tanker or fueling station operator using portable radios.

8. Check mooring lines are secure, to prevent the vessel hanging up on the hoses.

9. Confirm system alarms are activated.

10. Bunkering should take place with the vessel upright and with a minimal trim.
During refueling operations:

11. Tank fluid levels are to be closely monitored through soundings or some other means of accurately reading instantaneous volume.

12. A close watch must be maintained on the tank vents. In the event of foaming from the vent pipe, stop bunkering operations

13. Keep close watch on the trim of the vessel. As much as possible, minimize heel and trim by loading fuel in a symmetrical order.

After refueling operations:

1. Clean up any spills with available spill equipment.

2. Ensure all save-alls are clean and empty, then remove plugs.

SECTION 7 • Additional Information (Non-Mandatory)

This section provides for additional information that local authorities, insurance underwriters, or Vessel Management may wish to include, but is not mandatory. (Regulation 26, Annex I, Marpol 73/78)

MEDIA INFORMATION

In the event of an oil spill or other related casualty, the Master is to direct any Coastal Radio station being worked that inquiries from any of the various media nodes are to be directed to the Vessel Management, who will handle such incidents shore-side. This will enable the Master to concentrate on the matter at hand.

PLAN REVIEW

This plan is to be reviewed at regular intervals by the Vessel Management and Master such that the information contained herein is current. Changes should be incorporated in the plan as and when they occur and the changes noted and by whom. Reviews should be conducted annually to reflect changes in local laws or policies, contact names or numbers, vessel characteristics, or company policy.

Reviews should also be conducted after any use of the plan in response to an incident, in order to evaluate its effectiveness and make any modifications deemed prudent at that time.

COMPANY POLICY

The Master is responsible for maintaining the vessel's plans and technical information, in addition to the drawings contained in this plan, in an orderly and readily accessible fashion. The Master is to satisfy himself to the fact that the vessel's Chief Engineer complies in similar fashion as regards to plans and technical information in his possession.

DIAGRAMS AND DRAWINGS

Should the Master or Chief Engineer discover that crucial plans or manuals covering the operation of essential parts of the vessel are not on board, they are to request the company's head office in writing, to supply such plans and manuals.

RECORD KEEPING

As stated elsewhere in this plan, the Master shall use every effort to retain all records of a pollution incident and responses thereto, for later review by the company's technical department in conjunction with the crew. Such record keeping should include actual samples of oil spilled.

ONBOARD SPILL RESPONSE EQUIPMENT

Absorbent rags and boom are stored in the SOPEP store room at the aft stbd. side of the Main Deck. It is the responsibility of the Chief Engineer to keep inventory and maintain an adequate stock of equipment

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SECTION 8 • Oil Pollution Prevention Team

The master of the vessel is to appoint an Oil Pollution Prevention Team on board, to initiate recovery or cleanup procedures, and to secure the ship immediately if an incident occurs

The OPPT consists of the following crew members:

Master
Chief Officer
Chief Engineer

In the event of an emergency, the team should be called out immediately.

The team should be given necessary training in the use of such equipment as oil absorbents that the vessel may carry All members of the OPPT should be aware of their duties should an oil spill occur.

Instructions to the Oil Pollution Prevention Team

8.1 Master

In overall charge.
Informs terminal authorities or coastal authorities of incident.
Informs the local agent and requests agent to inform the local underwriter's representative.
Advises the company's head office of the situation. Keeps everyone updated at regular intervals and advises of any changes in status of the emergency
Keeps log of all events and progress of actions.

8.2 Chief Officer

In charge of deck / cargo operations.
In charge of lifeboats if required.
Keeps the Master informed and updated on the situation and of the results of steps taken to contain any spills and limit outflow.
Insures all openings in the deck and superstructure are closed to limit vapour entry

8.3 Chief Engineer

In charge of bunkering operations.
Organizes distribution of oil spill detergents if required.
Stops bunkering operations if applicable.
Stops pumps and any unnecessary pieces of machinery

Other Personnel

Deck Officer on duty
- Alerts and informs Chief Officer / Chief Engineer on the situation.
- Mobilize off duty crew as necessary.

Engineer on duty
- Assists the Chief Engineer.
- Prepare for fire fighting.
- Ensure sufficient power and water to deck.
- Organizes onboard clean up equipment.

Deck Officer off duty

Under the direction of the Master, responsible for the reporting and record keeping of all events.

On duty Ratings

Alerts the Officer on duty of any leakage.

Position sorbent / clean up material to prevent any fluid escape.

Off duty personnel

Assist as required

APPENDIX 1 • Report Format and Content

The report should contain the following:

AA VESSEL NAME, CALL SIGN, FLAG

BB DATE & TIME (GMT) OF INCIDENT: 111935 meaning 11th of month at 7:35 pm.

CC SHIPS POSITION: 2230N 0600E meaning 22 deg. 30 min. N, 6 deg. E

or

DD SHIPS POSITION BY TRUE BEARING (3 DIGITS) AND DISTANCE FROM CLEARLY IDENTIFIED LANDMARK

EE TRUE COURSE (3 DIGITS)

FF SPEED IN KNOTS AND TENTHS OF A KNOT (3 DIGITS)

LL ROUTE INFORMATION - INTENDED TRACK

MM RADIO STATIONS AND FREQUENCIES GUARDED

NN TIME OF NEXT REPORT (same as in BB)

OO DRAFT (4 DIGITS - meters and centimeters)

PP TYPES AND QUANTITIES OF CARGO AND BUNKERS ON BOARD

QQ BRIEF DETAILS OF DAMAGE, LIMITATIONS ETC (must include condition of vessel and ability to transfer cargo, ballast, or fuel)

RR BRIEF DETAILS OF ACTUAL POLLUTION (oil type, estimate of quantity discharged, whether discharge continues, cause, estimate of slick movement)

SS WEATHER AND SEA CONDITIONS (wind force/direction, relevant tidal and/or current information)

TT NAME, ADDRESS, TELEX, FAX, TELEPHONE NUMBERS OF VESSEL OWNER OR REPRESENTATIVE

UU DETAILS OF LENGTH, BREADTH, TONNAGE, AND TYPE OF VESSEL

WW TOTAL NUMBER OF PERSONS ON BOARD

XX MISC. DETAILS (brief details of incident, actions taken, injuries, assistance required)

UNOFFICIAL OIL POLLUTION EMERGENCY REPORT BY FACSIMILE

Vessel Name Call Sign Flag

Date and Time of Event

Vessel Position (Latitude & Longitude, Bearing & Distance from Landmark)

Course Speed

Intended Track

Radio Station

Date and Time of Next Report

Type and Quantity of Oil On board

Brief Details of Damage

Brief Details of Pollution

Details of Weather & Sea Conditions (Wind Speed/Direction, Swell Height/Direction)

Names of Vessel's Owner

Vessel Size and Type

Any Other Additional Information as Determined by Master

APPENDIX 2 • Who to Contact

In accordance with the Canadian Pollutant Discharge Reporting Regulations, the Master or Owner of a ship must report, without delay, any discharge or anticipated discharge of a pollutant in Canadian waters or fishing zones, to a Pollution Prevention Officer (PPO). Reports must be made in the manner described in Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants, TP 9834, or "General Principles for Ship Reporting Systems and Ship Reporting Requirements, including Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants" adopted by the IMO by Resolution A 648(16). These initial reports can be made to a Vessel Traffic Service Center (VTS) or any other Canadian Coast Guard Radio Station (CGRS), on the frequencies listed in the publication, Radio Aids to Marine Navigation (RAMN).

In addition to the above process for reporting a spill from a vessel to a PPO through a CGRS or VTS, the Canadian Coast Guard maintains a 24 hour Operations Center which can be contacted at:

Canadian Coast Guard Operations Center
344 Slater Street
Ottawa, Ontario
K1A 0N7

Tel: (613) 990-5600 Fax: (613) 995-4700 Tlx: (613) 053 3128

Alternatively, spills may be reported to the appropriate regional center or nearest Vessel Traffic Service Center:

Newfoundland

St. John's	Tel:	1-709-772-2083
		1-800-563-2444 (24 hr.)
	Fax:	1-709-772-5369
	Tlx:	016-4044
Placentia Bay	Tel:	1-709-227-2182
	Fax:	1-709-227-5637
Port Aux Basques	Tel:	1-709-695-2167
	Fax:	1-709-695-7784
Goose Bay	Tel:	1-709-896-2252
	Fax:	1-709-896-8455
St. Anthony	Tel:	1-709-454-3852
	Fax:	1-709-454-3716

Nunavut

Nordreg Canada	Tel:	1-867-979-5724
P.O. Box 189	Fax:	1-867-979-2464
Iqaluit, NU		
X0A 0H0		

Nova Scotia

Halifax	Tel:	(902) 426-9750 (MCTS Operations)
		(902) 426-9738 (Officer in charge)
	Fax:	(702) 426-4483
Sydney	Tel:	(902) 564-7751 (MCTS Operations)
		(902) 564-7752 (Officer in charge)
	Fax:	(702) 564-7662

New Brunswick

Saint John	Tel:	(506) 636-4696 (MCTS Operations)
		(506) 636-4269 (Officer in charge)
	Fax:	(506) 636-5000

Quebec

Quebec City	Tel:	(418) 648-4427 (MCTS Operations)
		(418) 648-7459 (Officer in charge)
	Fax:	(418) 648-7244
Montreal	Tel:	(450) 928-4544 (MCTS Operations)
		(450) 928-4547 (Officer in charge)
	Fax:	(450) 928-4547
Riviere-Au-Renard	Tel:	(418) 269-5686 (MCTS Operations)
		(418) 269-7718 (Officer in charge)
	Fax:	(418) 269-5514

Greenland

Spill Notification Point	Tel:	+299-101111
Groenlands Kommando	Fax:	+299-10112
Maritime Rescue Coordination Center Gronnedal	Tlx:	90502 GLK GD
KK-3930 Gronnedal		

Competent National Authority	Tel:	+45-31 578310
National Agency of Environmental Protection		+45-86 123099 (24 hr)
Strandgade 29	Fax:	+45-31 572449/+45-86 181140
DK-1401 Copenhagen	Tlx:	31209 MILJOE DK

Note:

The following contacts have been included as they are within the expected range of operation of the Vessel. Due to the nature of the Vessel's voyages and varied ports of call this list should not be considered exhaustive. For this reason space has been included at the end of this section for addenda.

Within Canada, administrative inquiries related to pollution prevention, compliance and enforcement, vessel regulations, design and construction should be directed to:

Director General, Marine Safety
Transport Canada
Mailstop: AMS
330 Sparks Street
Ottawa, Ontario
K1A 0N5
Tel: (613) 998-0610 Fax: (613) 954-1032

Inquiries relating to pollution response should be directed to:

Director General, Rescue and Environmental Response
Canadian Coast Guard
344 Slater Street
Ottawa, Ontario
K1A 0N7

Tel: (613) 990-3110 Fax: (613) 996-8902

Additional Contact Information

Region	
Spill Notification Point	Contact Numbers

Region	
Spill Notification Point	Contact Numbers

Region	
Spill Notification Point	Contact Numbers

Region	
Spill Notification Point	Contact Numbers

VESSEL INTEREST CONTACTS

VESSEL MANAGEMENT

Coastal Shipping Ltd.
P.O. Box 913
Happy Valley-Goose Bay, NL
A0P 1S0

Telephone: (709) 896-2421
Facsimile: (709) 896-5028

24 HOUR CONTACT

The following phone numbers are provided
for 24 hour contact, year round:

Kevin Brewer	(709) 682-0826	(Cellular)
	(709) 227-2600	(Home)
Gerry Burgess	(709) 745-2684	(Home)

APPENDIX 3 • Vessel Stress and Stability Calculations

VOYAGE PARTICULARS

Departure Port

Departure Date

Time (GMT)

VESSEL CONDITION IMMEDIATELY BEFORE CASUALTY

Mean Draft Forward

Mean Draft Aft

KG(solid)

KG(fluid)

LCG of Vessel

#	COMPARTMENT	S.G.	TONNES

DATA RELATING TO VESSEL AFTER CASUALTY

Nature of Casualty: Collision / Grounding (Fixed / Free) / Fire
Explosion / Heavy Weather / Other

Casualty Date Report Time (GMT)

Geographical Location of Casualty: LAT
LONG

Conditions at Site at Time of Casualty Report

Weather

Sea State

Tidal State

Tidal Range

Forecast

S G. of Surrounding Water

Position of Vessel relative to Wind, Waves, Tides, etc

Drafts Measured Port and Starboard:

Drafts at Fwd Marks/F P (Best Estimate)
Drafts at Aft Marks/A P (Best Estimate)
Drafts at Midships (Best Estimate)
Angle of Heel (Port / Starboard)

Best Estimate of Depth of Water (for Grounding)

Location	Port	Starboard

REPORTED DAMAGE

Details of each damaged compartment known to be open to the sea, including those damaged above the present waterline.

Compartment	Estimated Cargo Weight (tonnes)	Permeability of Cargo (%)	Comments

Extent and location of structural damage in way of above compartments. (Attach sketch)

Extent of additional damage to pipes, valves, hatches, doors, etc and list of compartments which may be subject to progressive flooding as a result.

Soundings from or estimates of amounts of flood water in spaces not directly open to sea

PROPOSED ACTION AND REQUIREMENTS

Any other relevant information, details of action being undertaken or proposed course of action, salvage operation etc.

APPENDIX 4 • Flowcharts and Checklists

HULL LEAKAGE

In the event of a hull leakage, the MASTER must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

PIPE LEAKAGE

In the event of a pipe leakage, the CHIEF ENGINEER must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Locate the source and repair if possible	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain affected section of pipe into empty or slack tank if possible	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

TANK OVERFLOW

In the event of a tank overflow, the CHIEF ENGINEER must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

HULL FAILURE including Ice Damage

In the event of hull failure (including ice damage), the MASTER must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

GROUNDING

In the event of a grounding incident, the MASTER must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

FIRE / EXPLOSION

In the event of a fire or explosion, the FIRE CONTROL PARTY CHIEF must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

COLLISION

In the event of a collision, the MASTER must ensure that the following actions are taken:

Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

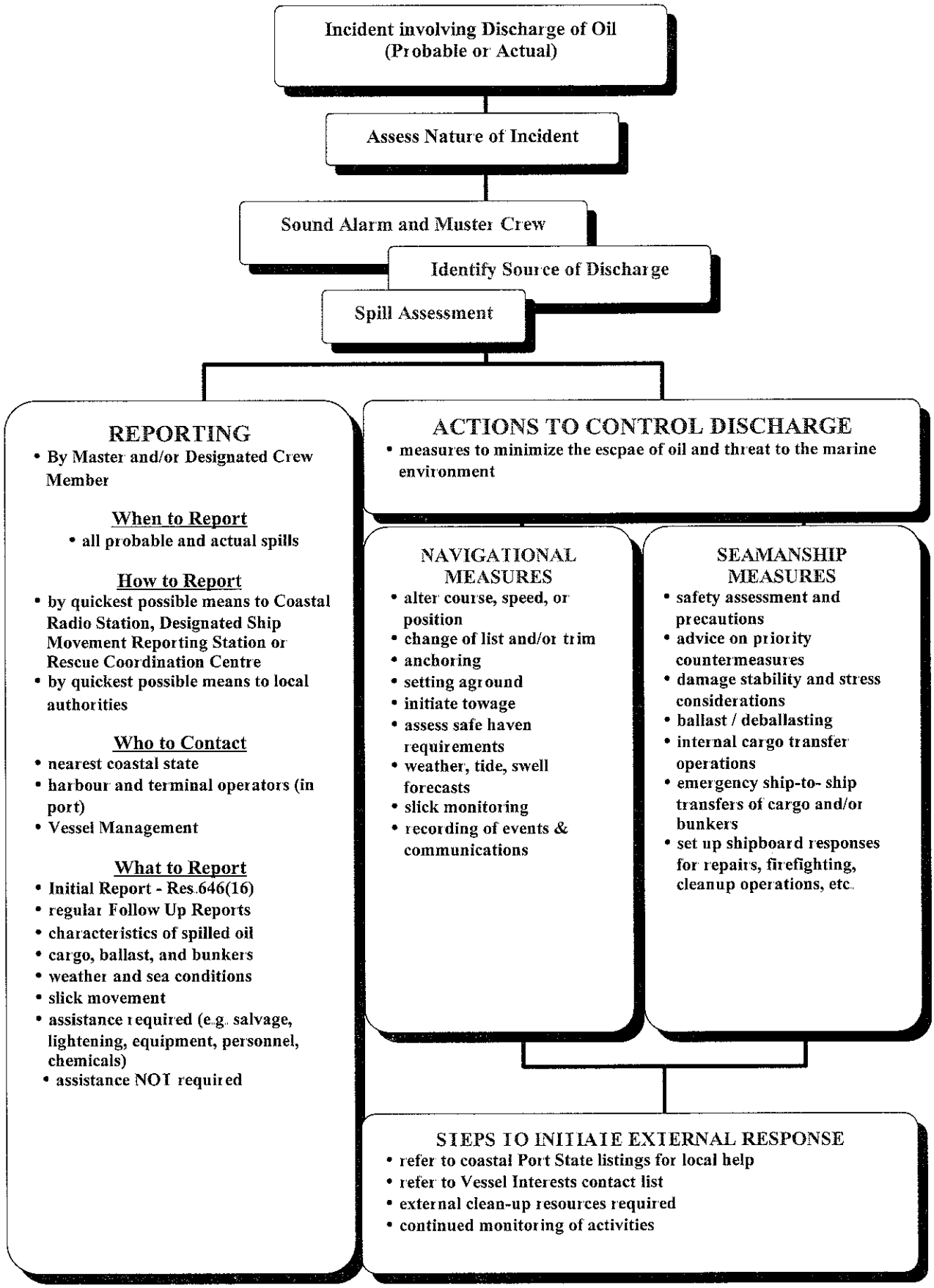
EXCESSIVE LIST

In the event of excessive listing, the MASTER must ensure that the following actions are taken:

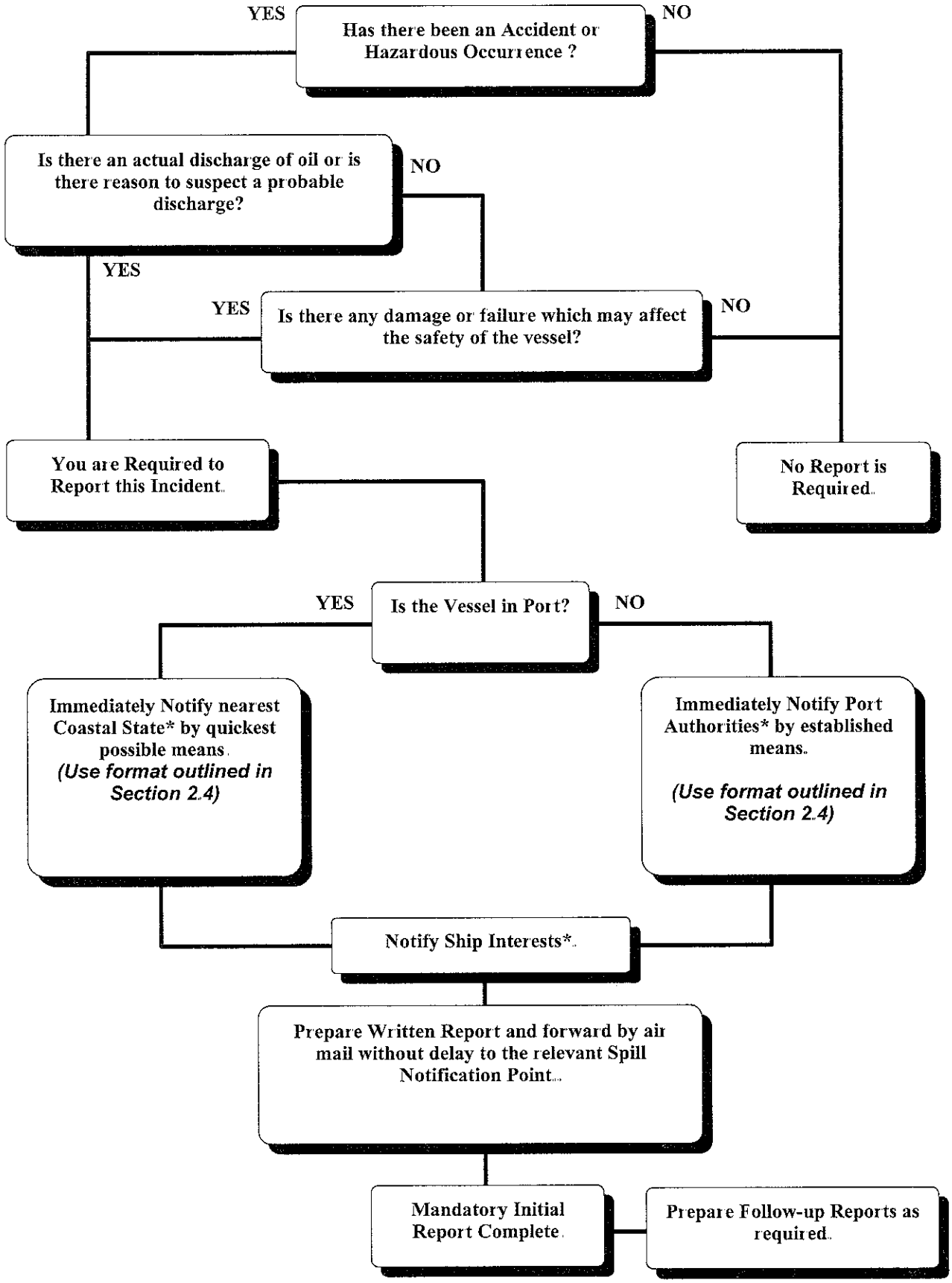
Stop Oil Flow	☐
Sound Emergency Alarm and initiate Emergency Response	☐
Place drain buckets under overflow pipes to contain possible spills	☐
Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container	☐
Drain or transfer oil into empty or slack tanks if possible or arrange for transfer to shore	☐
If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan	☐
If oil is in bilges, pump through oil/water separator	☐

✓ YES X NO NA Not Applicable

SUMMARY FLOWCHART



REPORTING REQUIREMENTS (as per Section 2)



** contact information is located in Appendix 2.*

APPENDIX 5 • Relevant Drawings

FOLLOWING ARE DRAWINGS RELEVANT TO THIS VESSEL

General Arrangement
Tank Capacity Plan
Bilge and Ballast System
Fuel Oil System
Cargo Handling System

SHIPBOARD OIL POLLUTION EMERGENCY PLAN

for

MT NANNY

6,544 Gross Tons Register of St. John's, NL

PREPARED BY:

Poseidon Marine Consultants Ltd.
391 Stavanger Drive
St. John's NL A1A 5G1
Telephone: (709) 739-4321
Fax: (709) 739-4421

PREPARED FOR:

Coastal Shipping Limited
The Fortis Building
139 Water Street
St. John's, NL
A1C 1B2

Issued: April 2009
Job Number: 2008-118

Change Number

Official Stamp Examined by Date

Examined under the provisions of Annex I and Annex II of MARPOL 73/78 and the Canadian Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals SOR/2007-86

Stan Gutt Pollution Prevention Officer

2009-05-06

Date

Change Number

Official Stamp Examined by Date

Change Number

Official Stamp Examined by Date

RECORD OF CHANGES

Amendment Number	Section and Page Affected	Date Entered	Remarks	Name and Position of Person Making Entry

RECORD OF OIL POLLUTION EMERGENCY DRILLS

DATE	TYPE OF OIL POLLUTION DRILL	LOCATION	REMARKS MASTER'S SIGNATURE

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TRANSPORT CANADA TRANSPORTS CANADA MARINE SAFETY SÉCURITÉ MARITIME CANADA St. John's NL

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A4 Flowcharts and Checklists
A5 Relevant Drawings

SHIP'S PARTICULARS

PRINCIPAL PARTICULARS

Vessel Name:	Nanny (ex. Nathalie SIF)
Flag / Port of Registry:	Canada / St John's, NL
Official Number:	833250
Det Norske Veritas Number:	18064
IMO Number:	9051399
Call Sign:	CFN 5289
Gross Registered Tonnage:	6544 (ITC69)
Net Registered Tonnage:	3081 (ITC69)
Length, Overall:	116.40 m
Length, B.P.:	110.56 m
Breadth, Max. at Deck:	19.001 m
Depth, Moulded:	10.10 m
Design Draft (Summer):	7 814 m
Deadweight:	9,176 metric tons
Built:	Hyundai Heavy Industries Co , Republic of Korea.
Year of Build:	1993
Complement (Maximum):	17
Complement (Safemanning):	10
Propulsion Power:	1 X MAK 6M552C 4050 KW @ 500 rpm

CAPACITIES

Pot Fresh Water	Approx. 69.0 m^3	18,227 Gallons
Technical Fresh Water	Approx. 332.4 m^3	87,810 Gallons
Fuel Oil (MDO)	Approx. 70 8m^3	18,703 Gallons
Fuel Oil (HFO)	Approx. 524.8 m^3	138,637 Gallons
Cargo Hold Incl. Slop Tanks	Approx 10,942.4 m^3	2,890,571 Gallons
Ballast Water	Approx. 3728 4 m^3	984,833 Gallons
Lube Oil	Approx 29 8 m^3	7,872 Gallons
F.O Overflow (S)	Approx. 31.4 m^3	8,295 Gallons
L.O. Drain (P)	Approx. 8.8 m^3	2,324 Gallons
Oily Bilge (S)	Approx 3 9 m^3	1,030 Gallons
F.W. Drain Tk (P)	Approx 3.3 m^3	872 Gallons
Bilge Holding Tk	Approx. 15.8 m^3	4,174 Gallons
Sludge Tk (S)	Approx 12.2 m^3	3,223 Gallons
Boiler Water Drain Tk (S)	Approx 2.4 m^3	634 Gallons
Chain Locker (P)	Approx. 22.7 m^3	5,997 Gallons
Chain Locker (S)	Approx. 22.7 m^3	5,997 Gallons
M/E L.O. Sump Tk. (C)	Approx. 8.4 m^3	2,219 Gallons

TRANSPORT CANADA TRANSPORTS CANADA
MARINE SAFETY SÉCURITÉ MARITIME
CANADA

INTRODUCTION

1. This Plan is written in accordance with the Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals and also in accordance with the requirements of regulation 37 of annex I of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 thereto.

2. The purpose of the Plan is to provide guidance to on board operating personnel the vessel with respect to the steps to be taken when a pollution incident has or is likely to occur.

3. The Plan contains all information and operational instructions required by the guidelines. The appendices contain names, telephone, fax numbers, etc of all contacts referenced in the Plan, as well as other reference material.

4 This Plan has been examined by the Transport Canada - Marine Safety, (herein after referred to as "the Board") and, except as provided below, no alteration or revision shall be made to any part of it without prior approval of the Board.

5 Changes to Sections 6, 7, 8, and the appendices will not be required to be approved by the Board The appendices should be maintained up to date by the Owners, Operators, and Managers.

6 For the purposes of this Plan, the Master is taken to be that person who is a member of the vessel's operational personnel and to which is given senior responsibility for the vessel and any circumstances pertaining thereto

7. Before entering a port of call, the Master should be aware of local emergency response procedures and organizations and have up to date contact information readily available.

SECTION 1 • Preamble

1.1 PURPOSE AND INTENT OF THIS PLAN

This Shipboard Oil Pollution Emergency Plan is intended to assist the vessel's officers, crew and management personnel in dealing with an unexpected discharge of oil. Its primary purpose is to set in motion the necessary actions to stop or minimize the discharge and to mitigate its effects. For quick reference the responsibilities of the Oil Pollution Prevention Team is contained in Section 8 on Page 28.

1.2 SUPPORT BY VESSEL'S MANAGEMENT

In accordance with the plans and policies of the vessel's management organization, management personnel will support the vessel's crew with additional resources, i.e. personnel and materials, as the situation warrants.

1.3 PERSONNEL TRAINING AND EXERCISES

1. ***It is the responsibility of the Vessel's Management to ensure that, through training and exercises, all officers and crew are capable of confidently and safely carrying out their assigned duties.***

   Officers responsible for maintaining the trim of the vessel and ordering transfers of ballast and/or cargo should be fully aware of the consequences of their actions and are expected to comply with the regulations and any documentation aboard the vessel which prescribes conditions of trim and stability , e.g. "Approved Stability Booklet".

   Officers and crew responsible for cargo and or bunkering operations should also be fully aware of the consequences of their actions and are expected to comply with the regulations and any documentation aboard the vessel which prescribes methods of operation.

   Officers and crew assigned additional responsibilities for fire fighting or emergency response should have appropriate training as per the regulations and should participate in specific drills and exercises to maintain their abilities and be fully familiar with appropriate vessel systems.

2. ***The vessel's management and operating personnel should become familiar with this document and its format so that should an emergency occur, the response of the officers and crew and the vessel's management personnel will be carried out in a structured, logical and timely manner.***

   In order to ensure that the crew and management are completely familiar with this document and its prescribed procedures, training should be offered and oil pollution emergency drills should be carried out regularly.

TRANSPORT CANADA TRANSPORTS CANADA MARINE SAFETY SÉCURITÉ MARITIME

A blank "Record of Oil Pollution Emergency Drills" form is provided at the beginning of this Plan to document the dates and results of such training exercises. This documentation is to be in addition to normal record keeping and log book entries.

3. ***All crew members should become familiar with the fundamentals of the ship's mechanical and electrical systems in order to be more confident and capable during an emergency.***

It is the responsibility of the vessel's senior officers to ensure that engineering fundamentals are taught to the crew and that the crew remain familiar with them through regular drills. Drawings detailing the various mechanical and electrical systems are carried aboard the vessel. Any drawing (e.g. "Natural Vents", "Engine Room Ventilation", "One Line Electrical Diagram", "Fuel Oil Transfer Diagram") can be obtained for study from the Engineering Document Library located in the Chief Engineer's Office These drawings are thoroughly catalogued and easily referenced.

In order to ensure a fundamental familiarity with the various engineering systems, oil pollution emergency drills should include but not limited to such exercises as:

- isolating and sealing off accommodations and/or machinery spaces using louvers and fan shutoffs to prevent ingress of dangerous fumes; and
- isolating, at the distribution panels, various electrical circuits, e.g. lighting, panel feeds, in order to reduce or eliminate sources of ignition in areas of risk

1.4 PLAN FORMAT

This plan is divided into Eight sections as follows:

Section 1 provides an introduction for this document and highlights some important considerations regarding the spillage of oil at sea.

Section 2 outlines the procedure and requirements for making a report to authorities in the event of a discharge or probable discharge of oil.

Section 3 provides a checklist of steps to be taken in the event of various operational or casualty related spills.

Section 4 outlines procedures for national and local coordination of response efforts.

Section 5 outlines procedures for ship to ship transfer operations

Section 6 outlines safety precautions for bunkering operations

Section 7 deals with non-mandatory provisions such as oil spill response materials onboard, media information, and plan review.

Section 8 outlines the responsabilities of the Oil Pollution Prevention Team.

Following the main body of this plan are appendices which provide contact information and/or useful forms. Appendix 1 is an example of an unofficial facsimile report, the use

of which is outlined in Section 2. Appendix 2 provides contact information for coastal authorities and ship interests. Appendix 3 is a blank calculation form for vessel stress and stability which can be filled out by an officer of the vessel and sent to the vessel owners for calculation. The use of this calculation form is described in Section 3. Appendix 4 contains flowcharts and checklists for use in the event of an emergency. Appendix 5 contains relevant ship's drawings.

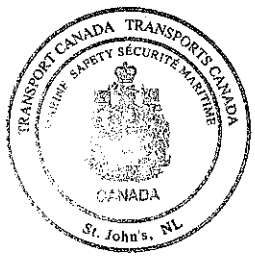
1.5 OIL DISCHARGE MONITORING SYSTEM

In accordance with MARPOL 73/78 Annex 1 Regulation 14 this ship is fitted with a Hanyoung OS-3 0 Capacity 3 m^3/hr oily water separator, manufactured by Hanyoung Engineering Ltd and Seres MKIII, S 663 ballast water monitor manufactured by Seres environment, France. The oil content meters associated with these units are fitted with 15ppm oil content alarms.

IMPORTANT:

1. **ANY** OIL SPILLAGE SHOULD BE TREATED AS AN EMERGENCY.

2. IN RESPONDING TO AN OIL SPILLAGE, THE MASTER'S PRIORITY WILL BE TO ENSURE THE SAFETY OF THE CREW AND OF THE VESSEL, AND TO TAKE ACTION TO PREVENT ESCALATION OF THE INCIDENT. IMMEDIATE CONSIDERATION SHOULD BE GIVEN TO MEASURES AIMED AT PREVENTING FIRE AND EXPLOSION



SECTION 2 • Reporting Requirements

Coast guard of nearest coastal State (see Appendix 2) is to be notified whenever there is:

a) **An actual discharge of oil**
b) **Reason to suspect a probable discharge of oil due to fire, grounding, list, loss of power, collision, flooding, explosion, structural failure, etc.**
c) **Any damage or failure which may affect the safety of the vessel, such as failure or breakdown of the electrical generating system, or essential shipborne navigational aids.**

*****See Reporting Requirement and Summary flowcharts in Appendix 4 for details*****

2.1 DISCHARGE OF OIL

When reporting a discharge of oil, the Master is to provide all relevant information (as per section 2.4) to:

a) Coast Guard of nearest coastal State, or
b) Port Authorities, and also to
c) Vessel Interest Contacts.

A discharge of oil, for the purposes of this plan, refers to:

a) A discharge of oil, resulting from damage to the vessel or its equipment, or for the purpose of securing the safety of a vessel or saving life at sea; or
b) A discharge during the operation of the vessel of oil in excess of the quantity or instantaneous rate permitted under the present Convention

2.2 PROBABLE DISCHARGE OF OIL

The Master must use good judgment to assess any circumstance which might be cause for probable discharge of oil. When making such judgment the following factors must be taken into account:

a) The nature of the damage, failure, or breakdown of the vessel, machinery, or equipment;
b) Vessel location and proximity to land or other navigational hazards;
c) Weather, tide, current, and sea state;
d) Traffic density; and
e) Morale, health and ability of crew onboard to deal with situation.

2.3 DAMAGES AND/OR FAILURES

The Master must report any damage which may affect the safety of the vessel: collision, fire, grounding, explosion, cargo shifting, list, etc. The Master must also report any failure or breakdown of essential machinery which results in impairment of the safety of navigation: i.e. electrical generating system or essential vessel-borne navigational aids.

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MARINE SAFETY SÉCURITÉ MARITIME
CANADA
St. John's, NL

2 4 INITIAL REPORT

An initial report is to be made by radio communication without delay to one of the following Canadian radio ship reporting stations; Canadian Coast Guard Radio Station, Marine Communication Traffic Services, St. Lawrence Seaway Authority marine radio station, or Canadian harbour radio station. The report is to be made following the format given in this section on the next page. Where the report cannot be communicated by radio, it shall be communicated by telephone to the local Canadian radio ship reporting station or to the Canadian Coast Guard Operations Center in Ottawa. Contact information is provided in Appendix 2.

FOLLOW-UP REPORTS

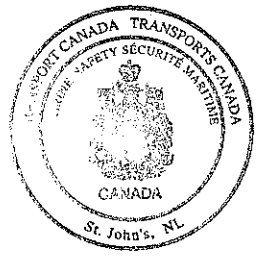
Follow-up reports should be made at regular intervals to keep the coastal State and other concerned parties informed of developments including, but not limited to, change of course or position, change in quantity, rate or probability of oil discharge, injuries or casualties, or effects of actions taken to control discharge or assure safety of the vessel and crew Follow-up reports should be made in the same format as the initial report

WRITTEN REPORT

Within 24 hours of the incident, or as soon as possible thereafter, a written report on the incident, including a statement as to its probable cause, shall be forwarded by air mail without delay to the Chief, Marine Casualty Investigations, Department of Transport, Ottawa.

UNOFFICIAL FACSIMILE REPORT

An unofficial facsimile report is included in Appendix 1. This may be sent to any concerned parties but is not consistent with IMO Resolution A 851(20) for reporting of incidents involving dangerous goods, harmful substances and/or marine pollutants, and therefore cannot constitute an official report to the coastal State



FORMAT AND INFORMATION REQUIRED FOR OFFICIAL REPORT

AA VESSEL NAME, CALL SIGN, FLAG

BB DATE AND TIME (GMT) OF INCIDENT: 111935 meaning 11th of month at 7:35 pm.

CC SHIPS POSITION: 2230N 0600E meaning 22 deg. 30 min. N, 6 deg. E

or

DD SHIPS POSITION BY TRUE BEARING (3 DIGITS) AND DISTANCE FROM CLEARLY IDENTIFIED LANDMARK.

EE TRUE COURSE (3 DIGITS)

FF SPEED IN KNOTS AND TENTHS OF A KNOT (3 DIGITS)

LL ROUTE INFORMATION - INTENDED TRACK

MM RADIO STATIONS AND FREQUENCIES GUARDED

NN TIME OF NEXT REPORT (same as in BB)

OO DRAFT (4 DIGITS - meters and centimeters)

PP TYPES AND QUANTITIES OF CARGO AND BUNKERS ON BOARD

QQ BRIEF DETAILS OF DAMAGE, LIMITATIONS ETC (must include condition of vessel and ability to transfer cargo, ballast, or fuel)

RR BRIEF DETAILS OF ACTUAL POLLUTION (oil type, estimate of quantity discharged, whether discharge continues, cause, estimate of slick movement)

SS WEATHER AND SEA CONDITIONS (wind force/direction, relevant tidal and/or current information)

TT NAME, ADDRESS, FAX, TELEPHONE NUMBERS OF VESSEL OWNER OR REPRESENTATIVE

UU DETAILS OF LENGTH, BREADTH, TONNAGE, AND TYPE OF VESSEL

WW TOTAL NUMBER OF PERSONS ON BOARD

XX MISC. DETAILS (This includes brief details of incident, actions taken, injuries sustained and assistance required If no outside assistance is required, then this should be clearly stated)

2 5 WHO TO CONTACT

Contact information for coastal State and other concerned parties (port contacts, vessel interest contacts) is located in Appendix 2

2 6 ARRANGED RESPONSE ORGANIZATION(S)

The vessel, in accordance with the regulations, has onboard a **declaration** that the vessel's management has, in accordance with 167 of the Canada Shipping Act 2001, entered into an arrangement with a response organization to which a certificate of designation has been issued pursuant to section 169 in respect of the quantity of oil that is carried both as fuel and cargo on board the vessel.

Four response organizations (RO) have been established in Canada. Although each of the RO's are independent Corporations they are linked together through various support and mutual aid agreements. Each of the RO's has a specific Geographic Area of Response (GAR) and a certified response capability of 10,000 tonnes. The following table provides a list of the RO's and a general description of their GAR's. A detailed description of the GAR for each of the RO's is provided in Item 3 5.

Response Organization	Geographic Area of Response (GAR)
• Western Canada Marine Response Corporation(WCMRC)	• In general the waters bordering British Columbia
• Eastern Canada Response Corporation Ltd. (ECRC)	• In general the waters of the Canadian Great Lakes, Quebec and the Atlantic Coast excluding areas covered by Alert and PTMS
• Atlantic Emergency Response Team ("ALERT") Inc.	• In general the Port of Saint John, New Brunswick and surrounding waters.
• Point Tupper Marine Services Limited (PTMS)	• In general the Port of Port Hawkesbury, Nova Scotia and surrounding waters .

Prior to commencing a voyage the master or his onboard designate is responsible to ensure that the necessary declarations for the intended voyage are onboard and necessary contact information has been inserted in the manual in Appendix 2: Who to contact under section " additional contact information".
As an example of whom to contact please refer to the page 34 for Eastern Canada Response Corporation (ECRC) call out sheet If conditions permit i.e. time, prevailing conditions , MASTER shall consult with vessel management contact prior to activation of any response organization.

SECTION 3 • Steps to Control Discharge

In cases of small spills on deck, the vessel's crew should take whatever actions are necessary to prevent oil from escaping over the side. Once the spill is contained on deck, the crew will need to take action to clean up the oil. SPILLED OIL SHALL NOT BE WASHED OVER THE SIDE. Once oil is in the water, the crew's ability to respond in a practical manner is greatly reduced.

3.1 OPERATIONAL SPILLS

In the event of an operational spill which occurs during bunkering or cargo operations, it is important that the bunkering party terminate any and all bunkering operations and close all manifold valves.

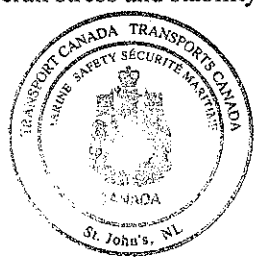
Before closing any manifold valves, the bunkering / cargo party must immediately inform the terminal / loading master so that they may take action to eliminate the possibility of over-pressurization of the shore side transfer components.

After dealing with the cause of the spill, it may be necessary to obtain permission from local authorities and/or the terminal before resuming bunkering or cargo operations

If the possibility of fire or explosion exists, nonessential air intakes to accommodations and machinery spaces should be closed and all sources of sources of ignition should be eliminated. See Section 1.3.3 of this Plan

In accordance with Section 1.3.3 of this Plan, all members of the vessel's crew should be familiar with the fundamentals of the ship's vital systems including the ventilation and electrical systems. Crew members should be able to: isolate the accommodation and/or machinery spaces using the louvers and fan shutoffs; and, from the distribution panels, isolate electrical circuits in areas of risk

Care must be taken to consider stability and stress when taking action to mitigate the spillage of oil. Internal transfers should be undertaken only with a full appreciation of the likely impact on the vessel's overall stress and stability. Please refer to the "Approved Stability Booklet" carried on board.



Operational Spill Checklist

Action Considered	Designated Person	Completed
Sound emergency alarm	Person Discovering Incident	Y / N
Mobilize Oil Pollution Prevention Team	Chief Engineer / Master	Y / N
Cease all bunkering operations	Chief / 2nd Engineer	Y / N
Locate source of leakage	Chief / 2nd Engineer	Y / N
Operate manifold valves	Chief / 2nd Engineer	Y / N
Close all nonessential vent intakes and tank vents as required	Chief / 2nd Engineer	Y / N
Stop or reduce outflow	Chief / 2nd Engineer	Y / N
Assess fire risk	Chief Officer	Y / N
Commence clean up	Chief Officer	Y / N
Assess Stress / Stability	Master / Chief Officer	Y / N
Transfer fuel from damaged area to slack tanks or other containment space	Chief / 2nd Engineer	Y / N
Request outside assistance if required	Master	Y / N
Counter excessive list if required / possible	Chief Officer	Y / N

1. PIPE LEAKAGE

In the event of an oil pipe leakage, the Chief Engineer must ensure that the following actions are taken:

1. Stop oil flow and close manifold and other valves.
2. Sound Emergency Alarm and Mobilize Oil Pollution Prevention Team.
3. Locate the source and drain affected section into an available empty or slack tank. Repair if possible.
4. If there is any possibility of released vapours entering an engine room or the accommodation intake, appropriate preventative steps must be taken quickly.
5. Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.
6. If oil is overboard, report to proper authorities immediately (as per section 2 of this plan)
7. If oil is in bilges, pump through oil/water separator as per approved procedures.

2. TANK OVERFLOW

In the event of an oil tank overflow, the Chief Engineer must ensure that the following actions are taken:

1. Stop oil flow and close manifold and other valves
2. Sound Emergency Alarm and Mobilize Oil Pollution Prevention Team
3. Place drain buckets under overflow pipes to contain possible spills.
4. If there is any possibility of released vapours entering an engine room or the accommodation intake, appropriate preventative steps must be taken quickly.
5. Drain or transfer oil to slack or empty tanks if possible with due consideration paid to vessel stability. If no slack or empty tanks are available then oil may be pumped back ashore through delivery line, having first gained permission to do so.
6. Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container
7. If oil is overboard, report to proper authorities immediately (as per section 2 of this plan)
8. If oil is in bilges, pump through oil/water separator as per approved procedures.

3. HULL LEAKAGE

If oil is noticed on the water near the vessel during normal operations and cannot be accounted for, the possibility of hull leakage should be suspected.

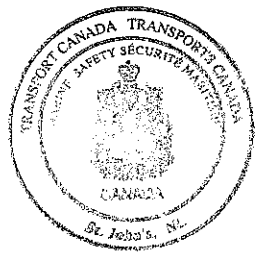
In the event of a hull leakage, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm and Mobilize Oil Pollution Prevention Team.
2. Stop any and all transfer or bunkering operations.
3. Identify damage and report to proper authorities immediately (as per section 2 of this plan); consider a diver if necessary and possible
4. If possible, contain spill using materials on hand and dispose of oil-soaked materials in an appropriate container.
5. If there is any possibility of released vapours entering an engine room or the accommodation intake, appropriate preventative steps must be taken quickly.
6. Transfer fuel away from suspected leaks to empty or slack tanks if possible or to a ballast tank if necessary. If in port, arrangements can be made to pump oil ashore to tank or truck. Due consideration is to be paid to vessel stress and stability.

7. If it is not possible to identify the leaking tank, reduce level in all tanks in vicinity, giving due consideration to vessel stress and stability.

4. SPILLS CAUSED BY EQUIPMENT IN MACHINERY SPACES

1. If operational spills are caused by a failure of equipment in machinery spaces, any further operations of this equipment should be stopped immediately and measures are to be taken to avoid a spill.
2. Sound Emergency Alarm and Mobilize Oil Pollution Prevention Team
3. Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.
4. Do not restart equipment until problem has been rectified.



3.2 SPILLS RESULTING FROM CASUALTIES

ALL CASUALTIES ARE TO BE REPORTED BY THE MASTER AS PER SECTION 2.

The Master's priority, when responding to a casualty, will be to ensure the safety of personnel and the vessel and to take action to prevent escalation of the incident.

In casualties involving spills, immediate consideration should be given to measures aimed at preventing fire and explosion, such as altering course so that the vessel is upwind of the slick, shutting down nonessential air intakes, etc.
If the vessel is aground, and therefore cannot maneuver, all possible sources of ignition should be eliminated and action taken to prevent flammable vapors entering accommodation and engine room spaces. Please refer to Section 1.3.3

In accordance with Section 1.3.3 of this Plan, all members of the vessel's crew should be familiar with the fundamentals of the ship's vital systems including the ventilation and electrical systems. Crew members should be able to isolate the accommodation and/or machinery spaces using the louvers and fan shutoffs; and, from the distribution panels, isolate electrical circuits in areas of risk. Please refer to Section 1.3.3 of this Plan for additional details.

Prior to considering remedial action, the Master will need to obtain detailed information on the damage sustained by the vessel. A visual inspection should be carried out and all bunker tanks and other compartments sounded. However, due regard should be paid to the indiscriminate opening of ullage plugs or sighting ports, especially when the vessel is aground, as loss of buoyancy could result. The Master shall also ensure that all covers, doors, vents, and hatches to any and all holds, ballast tanks, and fuel tanks are sealed tightly and remain sealed to prevent possible loss of buoyancy. Having assessed the damage sustained by the vessel, the Master will be in a position to decide what action should be taken to prevent or minimize further spillage

Great care must be taken to consider stability and stress when taking action to mitigate the spillage of oil or to free the vessel if aground. Internal transfers should be undertaken only with a full appreciation of the likely impact on the vessel's overall stress and stability. Please refer to the "Approved Stability Booklet" carried on board.

Should the damage sustained be extensive, the impact of internal transfers on stress and stability may be impossible for the vessel's personnel to assess. In such cases, Appendix 3 of this plan is to be filled out as completely as possible and forwarded to the Owners to ensure the appropriate calculations can be done.

When it is possible to maneuver, the Master, in conjunction with the proper shore authorities, may consider moving the vessel to a more suitable location in order, for example, to facilitate emergency repair work or lightening operations, or to reduce the threat posed to any particularly sensitive shoreline areas. Such maneuvering may be subject to coastal state jurisdiction.

Oil Spill Resulting from Casualty (Grounding, Collision, Fire, or Explosion)

Action Considered	Designated Person	Completed
Sound emergency alarm	Chief Officer / OOW	Y / N
Mobilize Oil Pollution Prevention Team	Master / Chief Officer	Y / N
Close all nonessential vent intakes and tank vents as appropriate	Chief Officer / Chief Engineer	Y / N
Assess further danger to ship or personnel such as capsize or sinking	Master	Y / N
Cease all nonessential operations	Chief Officer / Chief Engineer	Y / N
Assess whether oil has actually been spilt / probability of spill	Chief Officer / Chief Engineer	Y / N
Sound all compartments to determine extent of damage	2nd Engineer	Y / N
Sound around vessel if grounded	Chief Officer	Y / N
Where possible transfer fuel away from damaged compartments	Chief Engineer	Y / N
Request outside assistance if required	Master	Y / N
Contain / reduce oil outflow with resources on hand	2nd Engineer	Y / N
Initiate Cleanup (if possible)	Chief Officer	Y / N

1. GROUNDING

If the vessel grounds, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm, muster crew and Mobilize Oil Pollution Prevention Team.
2. Eliminate all avoidable sources of ignition and ban smoking on board. Action must be taken to prevent hazardous vapours from entering accommodation and machinery spaces See Section 1.3.3.
3. Identify damage by means of a visual inspection.
4. Take soundings around vessel to determine nature and gradient of seabed.
5. Check differences in tidal ranges at grounding site.
6. Evaluate tidal current in grounding area.
7. Take soundings of all tanks on shell and compare with departure soundings
8. Determine probability and/or quantity of oil released.
9. If oil release is determined or is probable, this is to be included in the casualty report.
10. Determine other possible hazards to the vessel, such as sliding off the grounding site, further damage from the seas / swell, and torsion forces.

At this point, determine risk of additional damage to vessel by attempting to refloat. If remaining aground is determined to be less of a risk then:

1. Use anchors to prevent vessel movement.
2. Take in ballast in empty tanks, with due consideration paid to stress and stability. Please refer to the "Approved Stability Booklet."
3. Consider transfer of fuel from damaged tanks, with due consideration paid to stress and stability. Please refer to the "Approved Stability Booklet."
4. Reduce longitudinal stress on the hull by transfer of fluids internally. Please refer to the "Approved Stability Booklet."
5. If the change in stability and stress cannot be calculated on board, contact the Vessel's management to arrange for the necessary calculations. Refer to Appendix 3 for information which should be provided

2. FIRE / EXPLOSION

If a fire or explosion occurs on board, the vessel's fire control party must ensure that the following actions are taken:

1. Sound Emergency Alarm muster crew and Mobilize Oil Pollution Prevention Team.
2. Determine extent of damage and what damage control measures can be taken.
3. Determine whether there are casualties.
4. Request assistance as deemed necessary.
5. Take necessary actions to prevent smoke and other hazardous vapours from entering the accommodation and machinery spaces.
6. Assess possibility of oil leakage
7. Determine possible actions to control the discharge of oil. This will depend largely on the damage to the ship and cargo.
8. If there is a discharge or possible discharge of oil, this is to be included in the casualty report.
9. Should abandonment be necessary, the Master must ensure that every effort is made to maneuver survival craft upwind of any oil spill.

3. COLLISION

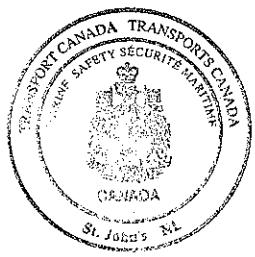
If a collision occurs, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm muster crew and Mobilize Oil Pollution Prevention Team
2. Determine whether there are casualties.
3. If there is a possibility of fire or explosion, eliminate all avoidable sources of ignition and ban smoking on board. Action should be taken to prevent flammable vapours from entering accommodation and machinery spaces See Section 1.3.3.
4. Decide whether separation of vessels may cause or increase spillage of oil, or increase the risk of sinking
5. If any oil tanks are penetrated, isolate the penetrated tank or transfer oil to slack or empty tanks with due attention paid to stress and stability of the vessel. Please refer to the "Approved Stability Booklet."
6. If there is an oil spill, make a report as per section 2.
7. If possible to maneuver, the Master, in conjunction with the appropriate shore authorities, should consider moving his ship to a more suitable location in order to facilitate emergency repair work or lightening operations, or to reduce the threat posed to any sensitive shoreline areas

4. HULL FAILURE (INCLUDING ICE DAMAGE)

If the vessel suffers structural hull failure, the Master must ensure that the following actions are taken:

1. Sound Emergency Alarm muster crew and Mobilize Oil Pollution Prevention Team
2. Reduce speed or stop to minimize stress on hull.
3. Assess immediate danger of sinking or capsizing.
4. Initiate damage control measures if possible.
5. If lightening is required, all efforts should be made to wait for a barge or other ship to receive the cargo.
6. If oil has spilled, or if it is necessary to jettison oil to maintain stability, make a report as per section 2.
7. If the change in stability and stress cannot be calculated on board, contact the Vessel's management to arrange for the necessary calculations.
8. Consider forecast weather conditions and their effect on the situation.
9. Should abandonment be necessary, the Master must ensure that every effort is made to maneuver survival craft upwind of any oil spill.



5. EXCESSIVE LIST

If excessive list occurs rapidly and unexpectedly, it may be due to:

1. Failure of hull plating.
2. Failure of internal bulkhead between compartments.
3. Shift of cargo
4. Damage through grounding or collision
5. Incorrect operating condition Refer to "Approved Stability Booklet"
6. Flooding in Engine Room, where free surface can cause a list.

The Master must ensure the following steps are taken immediately:

1. Stop any cargo, bunkering, or ballast operations in progress.
2. Sound Emergency Alarm muster crew and Mobilize Oil Pollution Prevention Team.
3. Determine whether there are casualties.
4. If under way, reduce speed or stop.
5. Establish reason for list. See above.
6. Sound all tanks and compare with departure soundings.
7. Close all openings and vent pipes.
8. Prepare ballast and transfer pumps for possible remedial action
9. If lightening is required, all efforts should be made to wait for a barge or other ship to receive the cargo.
10. If oil has spilled, or it is necessary to jettison oil to maintain stability, make a report as per section 2.
11. If possible, take corrective action to rectify the situation with due consideration paid to vessel stress and stability Please refer to the "Approved Stability Booklet."

SECTION 4 • National and Local Coordination

1. The Master will advise the Coast Guard of nearest coastal state regarding any oil spill. Vessel Interest Contacts must also be notified of any such incident. See Appendix 2 for details.

2 The Master will be the point of contact on the vessel for coordinating shipboard activities with national and local authorities, act as the Company's on-scene representative, and will be responsible for overseeing the action of any salvage or spill contractors employed until such time as he/she has been FORMALLY relieved of these responsibilities by the Company.

3 The person or persons identified in the declaration shall be responsible for contacting and mobilizing the response organization(s). These organizations will coordinate and conduct the response. It is not normally practical for vessel's personnel to be directly involved in cleanup activities. Therefore, their primary role will be to provide as much information as necessary to assist the response and to cooperate with cleanup personnel. However, where no local response is forthcoming, or is delayed, the Master should consider the use of available shipboard materials to clean up or contain the spilled oil by, for example, using ship-stocked absorbent materials or utilizing mooring ropes or air-filled hoses as makeshift booms.

4. Dispersants or degreasers should not be used on oil spilled in the water as their use may contravene local regulations. However, dispersants may be used if they are approved by Environment Canada specifically for a given incident. Environment Canada will allow and approve the use of dispersants on a case by case basis only.

SECTION 5 • Ship to Ship Transfer Operations

Should a situation such as lightening due to damage require a ship to ship transfer of petroleum products, the Master must take into account but not limited to the following:

1. Proper lines of communication between ships including language and radio working frequency;
2. Current and forecasted weather conditions for the intended area of transfer;
3. The compatibility of the vessels involved with regards to size, freeboard, manifold location, list, trim, etc.
4. The elimination of all possible ignition sources;
5. Oil spill clean up equipment and procedures in place;
6. Contingency planning for emergency situations in place.
7. The need to notify and obtain the agreement of any responsible authority.
8. Site conditions such as available shelter, water depth, and available anchorage
9. Traffic density.

For detailed procedures concerning ship to ship transfer of petroleum products, please refer to ***The Ship to Ship Transfer Guide (Petroleum)****, published by The International Chamber of Shipping Oil Companies International Marine Forum, 3rd edition, 1997*

SECTION 6 • Safety Precautions For Bunkering Operations

SHIP	DRIVER / SITE SUPERVISOR
1. International code flag BRAVO to be flown while fueling. 2. Ensure the vessel is adequately secured and has no excessive list or trim. 3. Plug all deck scuppers (openings) to ensure effective containment of a minor spill from tank vents, sounding pipes, manifolds and hose connections. 4. Support hose as necessary to prevent excessive strain. 5. Ensure overboards and other unused fuel manifold valves are closed and secured shut. 6. Monitor hose and connections on the vessel. 7. Monitor tanks, manifolds and vents. 8. Direct fuel to the designated tanks and allow for topping off of tanks. Request reduction in flow rate, when required, and always when topping off tanks. 9. Ship is responsible for and must report any pollutant discharge from the vessel. 10. Provide cleanup materials for minor shipboard spills.	1. Inspect and monitor hose and connections ashore. 2. Monitor truck tank and metering unit if used. 3. Reduce flow rate when requested. 4. Report spills from truck and hoses (If supplier becomes aware of a spill he/she should verify whether or not the spill has been reported. If it has not been reported he/she should do so). 5. Provide clean up materials for minor shore spills. 6. Locate hoses to minimize possibility of damage. Use safety cones to alert traffic if necessary.

COMMON

1. All personnel involved in the fueling operation must not be impaired for the duration of the fueling period. Impairment includes but is not limited to impairment by alcohol, drugs or fatigue.
2. Observe no smoking or open flame requirement for the area.
3. Establish and maintain effective voice communication. Prearrange signals for:
   - A - Standby to start transfer
   - B - start transfer
   - C - slow down transfer
   - D - standby to stop transfer
   - E - stop transfer
   - F - emergency stop of transfer
   - G - emergency shutdown of transfer
4. When fueling at night provide sufficient lighting for the area.
5. In case of emergency take all necessary measures to rectify or minimize the effects of the emergency. Dispersants must not be used without the approval of Environment Canada.
6. In the event of a spill, fueling will stop until relevant authorities have been notified. Containment and clean up measures must be taken at this time. Fueling process will recommence only when the cause of the spill has been determined and rectified unless prohibited by a recognized authority. The restarting of the fueling process must not interfere with the immediate, effective and sustained response to the spill incident.

TRANSPORT CANADA TRANSPORTS CANADA MARINE SAFETY SÉCURITÉ MARITIME CANADA

SECTION 7 • Additional Information (Non-Mandatory)

This section provides for additional information that local authorities, insurance underwriters, or Vessel Management may wish to include, but is not mandatory. (Regulation 37, Annex I, Marpol 73/78)

MEDIA INFORMATION

In the event of an oil spill or other related casualty, the Master is to direct any Coastal Radio station being worked that inquiries from any of the various media nodes are to be directed to the Vessel Management, who will handle such incidents shore-side. This will enable the Master to concentrate on the matter at hand.

PLAN REVIEW

This plan is to be reviewed at regular intervals by the Vessel Management and Master such that the information contained herein is current. Changes should be incorporated in the plan as and when they occur and the changes noted and by whom. Reviews should be conducted annually to reflect changes in local laws or policies, contact names or numbers, vessel characteristics, or company policy

Reviews should also be conducted after any use of the plan in response to an incident, in order to evaluate its effectiveness and make any modifications deemed prudent at that time. Any changes or revisions to the mandatory sections of this manual are to be resubmitted and approved by Transport Canada Marine Safety

COMPANY POLICY

The Master is responsible for maintaining the vessel's plans and technical information, in addition to the drawings contained in this plan, in an orderly and readily accessible fashion. The Master is to satisfy himself to the fact that the vessel's Chief Engineer complies in similar fashion as regards to plans and technical information in his possession.

DIAGRAMS AND DRAWINGS

Should the Master or Chief Engineer discover that crucial plans or manuals covering the operation of essential parts of the vessel are not on board, they are to request the company's head office in writing, to supply such plans and manuals.

RECORD KEEPING

As stated elsewhere in this plan, the Master shall use every effort to retain all records of a pollution incident and responses thereto, for later review by the company's technical department in conjunction with the crew. Such record keeping should include actual samples of oil spilled.

ONBOARD SPILL RESPONSE EQUIPMENT

Anchors, Buoys, Booms, Collapsible Tanks, Oil skimmer and Power pack with 100 feet of Hydraulic Hose, Air driven pump, Two 225 liter spill kits containing absorbent pads, booms, absorbant granular, spark proof shovels, protective clothing, etc., are stored onboard the vessel in the EQUIPMENT ROOM, Starboard side, main deck and readily accessible by the crew in case of spill . It is the responsibility of the Chief Engineer to keep inventory and maintain an adequate stock of equipment

SECTION 8 • Oil Pollution Prevention Team

The master of the vessel is to appoint an Oil Pollution Prevention Team (OPPT) on board, to initiate recovery or cleanup procedures, and to secure the ship immediately if an incident occurs.

The following is an example which can be used by the Master to aid in designating members of the OPPT. Should changes to the team be made, please make a record in this section :

Master
Chief Officer
Chief Engineer

In the event of an emergency, the team should be called out immediately

The team should be given necessary training in the use of such equipment as oil absorbents that the vessel may carry All members of the OPPT should be aware of their duties should an oil spill occur

Instructions to the Oil Pollution Prevention Team

8.1 Master

- In overall charge.
- Informs terminal authorities or coastal authorities of incident.
- Informs the local agent and requests agent to inform the local underwriter's representative.
- Advises the company's head office of the situation Keeps everyone updated at regular intervals. and advises of any changes in status of the emergency.
- Keeps log of all events and progress of actions

8.2 Chief Officer

- In charge of deck / cargo operations.
- In charge of lifeboats if required.
- Keeps the Master informed and updated on the situation and of the results of steps taken to contain any spills and limit outflow.
- Insures all openings in the deck and superstructure are closed to limit vapour entry

8.3 Chief Engineer

- In charge of bunkering operations.
- Organizes distribution of oil spill detergents if required.
- Stops bunkering operations if applicable.
- Stops pumps and any unnecessary pieces of machinery.

Other Personnel

Deck Officer on duty

- Alerts and informs Chief Officer / Chief Engineer on the situation.
- Mobilize off duty crew as necessary.

Engineer on duty

- Assists the Chief Engineer.
- Prepare for fire fighting
- Ensure sufficient power and water to deck.
- Organizes onboard clean up equipment.

Deck Officer off duty

- Under the direction of the Master, responsible for the reporting and record keeping of all events.

On duty Ratings

- Alerts the Officer on duty of any leakage.
- Position sorbent / clean up material to prevent any fluid escape

Off duty personnel

- Assist as required

APPENDIX 1 • Report Format and Content

The report should contain the following:

AA VESSEL NAME, CALL SIGN, FLAG

BB DATE & TIME (GMT) OF INCIDENT: 111935 meaning 11th of month at 7:35 pm

CC SHIPS POSITION: 2230N 0600E meaning 22 deg. 30 min. N, 6 deg. E

or

DD SHIPS POSITION BY TRUE BEARING (3 DIGITS) AND DISTANCE FROM CLEARLY IDENTIFIED LANDMARK.

EE TRUE COURSE (3 DIGITS)

FF SPEED IN KNOTS AND TENTHS OF A KNOT (3 DIGITS)

LL ROUTE INFORMATION - INTENDED TRACK

MM RADIO STATIONS AND FREQUENCIES GUARDED

NN TIME OF NEXT REPORT (same as in BB)

OO DRAFT (4 DIGITS - meters and centimeters)

PP TYPES AND QUANTITIES OF CARGO AND BUNKERS ON BOARD

QQ BRIEF DETAILS OF DAMAGE, LIMITATIONS ETC (must include condition of vessel and ability to transfer cargo, ballast, or fuel)

RR BRIEF DETAILS OF ACTUAL POLLUTION (oil type, estimate of quantity discharged, whether discharge continues, cause, estimate of slick movement)

SS WEATHER AND SEA CONDITIONS (wind force/direction, relevant tidal and/or current information)

TT NAME, ADDRESS, TELEX, FAX, TELEPHONE NUMBERS OF VESSEL OWNER OR REPRESENTATIVE

UU DETAILS OF LENGTH, BREADTH, TONNAGE, AND TYPE OF VESSEL

WW TOTAL NUMBER OF PERSONS ON BOARD

XX MISC. DETAILS (brief details of incident, actions taken, injuries, assistance required)

UNOFFICIAL OIL POLLUTION EMERGENCY REPORT BY FACSIMILE

Vessel Name Call Sign Flag

Date and Time of Event

Vessel Position (Latitude & Longitude, Bearing & Distance from Landmark)

Course Speed

Intended Track

Radio Station

Date and Time of Next Report

Type and Quantity of Oil On board

Brief Details of Damage

Brief Details of Pollution

Details of Weather & Sea Conditions (Wind Speed/Direction, Swell Height/Direction)

Names of Vessel's Owner

Vessel Size and Type

Any Other Additional Information as Determined by Master

APPENDIX 2 • Who to Contact

In accordance with the Canadian Pollutant Discharge Reporting Regulations, the Master or Owner of a ship must report, without delay, any discharge or anticipated discharge of a pollutant in Canadian waters or fishing zones, to a Pollution Prevention Officer (PPO) Reports must be made in the manner described in Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants, TP 9834, or "General Principles for Ship Reporting Systems and Ship Reporting Requirements, including Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants" adopted by the IMO by Resolution A.851(20) These initial reports can be made to Marine Communication and Traffic Service (MCTS) or any other Canadian Coast Guard Radio Station (CGRS), on the frequencies listed in the publication, Radio Aids to Marine Navigation (RAMN)

In addition to the above process for reporting a spill from a vessel to a PPO through a CGRS or MCTS, the Canadian Coast Guard maintains a 24 hour Operations Center which can be contacted at:

Canadian Coast Guard Operations Center
344 Slater Street
Ottawa, Ontario
K1A 0N7

Tel: (613) 990-5600 Fax: (613) 995-4700 Tlx: (613) 053 3128

Alternatively, spills may be reported to the appropriate regional center or nearest Vessel Traffic Service Center:

Newfoundland

St. John's	Tel:	1-709-772-2083
		1-800-563-2444 (24 hr.)
	Fax:	1-709-772-5369
Placentia Bay	Tel:	1-709-227-2182
	Fax:	1-709-227-5637
Port Aux Basques	Tel:	1-709-695-2167
	Fax:	1-709-695-7784
Goose Bay	Tel:	1-709-896-2252
	Fax:	1-709-896-8455
St. Anthony	Tel:	1-709-454-3852
	Fax:	1-709-454-3716

Nunavut

Nordreg Canada	Tel:	1-867-979-5724
P.O Box 189	Fax:	1-867-979-2464
Iqaluit, NU		
X0A 0H0		

Nova Scotia

Halifax	Tel:	1-902-426-9750 (MCTS Operations)
		1-902-426-9738 (Officer in Charge)
	Fax:	1-702-426-4483
Sydney	Tel:	1-902-564-7751 (MCTS Operations)
		1-902-564-7752 (Officer in Charge)
	Fax:	1-702-564-7662

New Brunswick

Saint John	Tel:	1-506-636-4696 (MCTS Operations)
		1-506-636-4269 (Officer in Charge)
	Fax:	1-506-636-5000

Quebec

Quebec City	Tel:	1-418-648-4427 (MCTS Operations)
		1-418-648-7459 (Officer in Charge)
	Fax:	1-418-648-7244
Montreal	Tel:	1-450-928-4544 (MCTS Operations)
		1-450-928-4547 (Officer in Charge)
	Fax:	1-450-928-4547
Riviere-Au-Renard	Tel:	1-418-269-5686 (MCTS Operations)
		1-418-269-7718 (Officer in Charge)
	Fax:	1-418-269-5514

Greenland

Spill Notification Point	Tel:	+299-101111
Groenlands Kommando	Fax:	+299-10112
Maritime Rescue Coordination Center Gronnedal		
KK-3930 Gronnndell		

Competant National Authority	Tel:	+45-31 578310
National Agency of Environmental Protection		+45-86 123099 (24hr)
Strandgade 29	Fax:	+45-31 572449/+45-86 181140
DK- 1401 Copenhagen		

Note:

The following contacts have been included as they are within the expected range of operation of the Vessel Due to the nature of the Vessel's voyages and varied ports of call this list should not be considered exhaustive For this reason space has been included at the end of this section for addenda.

Within Canada, administrative inquiries related to pollution prevention, compliance and enforcement, vessel regulations, design and construction should be directed to:

Director General, Marine Safety
Transport Canada
Mailstop: AMS
330 Sparks Street
Ottawa, Ontario
K1A 0N5
Tel: (613) 998-0610 Fax: (613) 954-1032

Inquiries relating to pollution response should be directed to:

Director General, Rescue and Environmental Response
Canadian Coast Guard
344 Slater Street
Ottawa, Ontario
K1A 0N7

Tel: (613) 990-3110 Fax: (613) 996-8902

Additional Contact Information

Region	
Spill Notification Point	Contact Numbers

Region	
Spill Notification Point	Contact Numbers

Region	
Spill Notification Point	Contact Numbers

Region	
Spill Notification Point	Contact Numbers

VESSEL INTEREST CONTACTS

Vessel Management
Coastal Shipping Limited (Owners)
P. O. Box 300, Station C
Happy Valley-Goose Bay, NL
A0P 1C0
Canada
Ph: (709) 896-2421
Fax: (709) 896-5028

Vessel Operations
Coastal Shipping Limited
139 Water Street, Suite 502
St John's, NL
A1C 1B2
Canada
Ph: (709) 579-6127
Fax: (709) 579-8103

24 Hour Emergency Contact

(709) 896-5036
(709) 896-9348

General Manager	Dennis White	(709) 896-2421 work (709) 896-1404 cell (709) 896-2870 home
Engineering Superintendent	Jim Babij	(709) 579-6127 work (709) 727-5065 cell (709) 576-0160 home
	Kevin Brewer	(709) 579-6127 work (709) 682-0826 cell (709) 227 2600 home
Designated Person Ashore	Philip Martin	(709) 579-6127 work (709) 727-4242 cell (709) 722-3781 home

Eastern Canada Response Corporation
Required Call Out Information

ECRC EMERGENCY NUMBER: 613 930-9690

CONTRACT NUMBER: _____

PROBLEM: _____

CURRENT STATUS: _____

CONDITIONS AT SPILL SITE: _____

THIS IS AN *(CIRCLE ONE)* EMERGENCY EXERCISE ALERT

R.O. RESPONSE REQUESTED BY *(PERSON S NAME)* _____

OF *(MEMBER COMPANY NAME)* _____ ON BEHALF OF

THE SHIP / FACILITY *(NAME)* _____

THE PRODUCT IS _____

SPILL VOLUME IS *(CIRCLE ONE)* _____ GAL / Litres / BBL /Tonnes

TOTAL VOLUME AT RISK IS *(STATE UNITS)* _____

LOCATED AT LATITUDE _____ LONGITUDE _____

OR GEOGRAPHIC LOCATION NAME IS _____

OR IT IS LOCATED _____km / miles (N / NE / E / SE / S / SW / W / NW) OF

(CITY NAME) _____

THE CLOSEST AIRPORT IS _____

I CAN BE REACHED AT THE FOLLOWING NUMBERS:

TEL: _____ CELL: _____ PAGER: _____

APPENDIX 3 • Vessel Stress and Stability Calculations

VOYAGE PARTICULARS

Departure Port

Departure Date

Time (GMT)

VESSEL CONDITION IMMEDIATELY BEFORE CASUALTY

Mean Draft Forward

Mean Draft Aft

KG(solid)

KG(fluid)

LCG of Vessel

#	COMPARTMENT	S.G.	TONNES

DATA RELATING TO VESSEL AFTER CASUALTY

Nature of Casualty: Collision / Grounding (Fixed / Free) / Fire
Explosion / Heavy Weather / Other

Casualty Date Report Time (GMT)

Geographical Location of Casualty: LAT
LONG

Conditions at Site at Time of Casualty Report

Weather

Sea State

Tidal State

Tidal Range

Forecast

S.G. of Surrounding Water

Position of Vessel relative to Wind, Waves, Tides, etc

Drafts Measured Port and Starboard:

Drafts at Fwd Marks/F.P. (Best Estimate)
Drafts at Aft Marks/A.P. (Best Estimate)
Drafts at Midships (Best Estimate)
Angle of Heel (Port / Starboard)

Best Estimate of Depth of Water (for Grounding)

Location	Port	Starboard

REPORTED DAMAGE

Details of each damaged compartment known to be open to the sea, including those damaged above the present waterline

Compartment	Estimated Cargo Weight (tonnes)	Permeability of Cargo (%)	Comments

Extent and location of structural damage in way of above compartments (Attach sketch)

Extent of additional damage to pipes, valves, hatches, doors, etc and list of compartments which may be subject to progressive flooding as a result.

Soundings from or estimates of amounts of flood water in spaces not directly open to sea.

PROPOSED ACTION AND REQUIREMENTS

Any other relevant information, details of action being undertaken or proposed course of action, salvage operation etc.

APPENDIX 4 • Flowcharts and Checklists

4A . OPERATIONAL SPILL CHECKLISTS

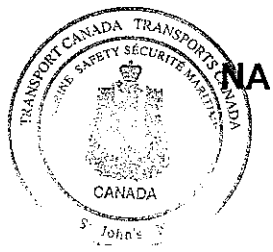
OPERATIONAL SPILL CHECKLIST

HULL LEAKAGE

In the event of a hull leakage, the MASTER must ensure that the following actions are taken:

Sound Emergency Alarm and	☐
Mobilize Oil Pollution Prevention Team	
Stop all transfers or bunkering operations	☐
Identify the damage and REPORT to proper	☐
authorities immediately as per Section 2 of this plan	
Absorb spill with any absorbent	☐
materials on hand and dispose of oil-soaked materials in an appropriate container	
Contain any spill vapours from entering	☐
Engine room or Accommodations	
Drain or transfer oil into empty or	☐
slack tanks if possible or arrange for transfer to shore	
If oil is in bilges, pump through	☐
oil/water separator	

✓ YES X NO NA Not Applicable



OPERATIONAL SPILL CHECKLIST

PIPE LEAKAGE

In the event of a pipe leakage, the CHIEF ENGINEER must ensure that the following actions are taken:

Stop Oil Flow and close manifold and other valves. ☐

Sound Emergency Alarm and Mobilize Oil Pollution Prevention Team ☐

Place drain buckets under overflow pipes to contain possible ☐

Locate the source and drain affected section into an available empty or slack tank. Repair. ☐

Contain any spill vapours from entering Engine room or Accommodations ☐

Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container ☐

If oil is overboard, REPORT to proper authorities immediately as per section 2 of this plan ☐

✓ YES X NO NA Not Applicable

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4B. CASUALTY SPILL CHECKLISTS

CASUALTY SPILL CHECKLIST

HULL FAILURE including Ice Damage

In the event of hull failure (including ice damage), the MASTER must ensure that the following actions are taken:

Sound Emergency Alarm and Muster Crew	☐
Mobilize the Oil Pollution Prevention Team	☐
Reduce Speed or Stop to Mimimize Hull Stress	☐
Assess Immediate Danger of Sinking/Capsizing	☐
Initiate Damage Control Measures with Due Care Paid to Vessel Strength and Stability	☐
REPORT to Proper Authorities Immediately as per Section 2 of this Plan	☐
Is Abandonment Necessary? **If YES then Ensure Every Effort is Made to Manoeuvre Survival Craft Upwind Of Any Oil Spill**	☐

✓ YES X NO NA Not Applicable

CASUALTY SPILL CHECKLIST

GROUNDING

In the event of a grounding incident, the MASTER must ensure that the following actions are taken:

Sound Emergency Alarm and Muster Crew	☐
Mobilize the Oil Pollution Prevention Team	☐
Eliminate All Avoidable Sources of Ignition and Ban Smoking on Board	☐
Identify Damage by Visual Inspection	☐
Take Soundings to Determine Nature and Gradient of Seabed	☐
Check Tidal Ranges at Grounding Site	☐
Evaluate Tidal Current at Grounding Site	☐
Take Sounding of All Tanks on Shell and Compare with Departure Soundings to Determine Probability and/or Quantity of Oil Released	☐
REPORT to Proper Authorities Immediately as per Section 2 of this Plan	☐
Determine Best Course of Action: Refloat or Remain Aground	☐
If Remaining Aground is Best, Take Additional Measures to Prevent Vessel Movement and Reduce Longitudinal Stress as per Section 3.1	☐

✓ YES X NO NA Not Applicable

CASUALTY SPILL CHECKLIST

FIRE / EXPLOSION

In the event of a fire or explosion, the FIRE CONTROL PARTY CHIEF must ensure that the following actions are taken:

Sound Emergency Alarm and Muster Crew ☐

Mobilize the Oil Pollution Prevention Team ☐

Determine Extent of Damage and Damage

☐

Control Measures to be Taken

Determine Whether there are Casualties ☐

Request Assistance as Necessary ☐

Assess Possibility of Oil Leakage ☐

REPORT to Proper Authorities Immediately as per Section 2 of this Plan ☐

Is Abandonment Necessary? ☐

If YES then Ensure Every Effort is Made to Manoeuvre Survival Craft Upwind Of Any Oil Spill

✓ YES X NO NA Not Applicable

CASUALTY SPILL CHECKLIST

COLLISION

In the event of a collision, the MASTER must ensure that the following actions are taken:

Sound Emergency Alarm and Muster Crew	☐
Determine Whether there are Casualties	☐
Mobilize the Oil Pollution Prevention Team	☐
Determine Whether Separation of Vessels May Cause or Increase Spillage of Oil	☐
Are Any Oil Tanks Penetrated? **If YES then Isolate Penetrated Tanks and/or Transfer Oil to Slack or Empty Tanks with Due Care Paid to Vessel Stress and Stability**	☐
REPORT to Proper Authorities Immediately as per Section 2 of this Plan	☐

✓ YES X NO NA Not Applicable

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CASUALTY SPILL CHECKLIST

EXCESSIVE LIST

In the event of excessive listing, the MASTER must ensure that the following actions are taken:

Sound Emergency Alarm and Muster Crew ☐

Stop any Cargo, Bunkering or Ballasting Operations in Progress ☐

Determine Whether there are Casualties ☐

If Under Way then Reduce Speed or Stop ☐

Establish Reason for Excessive List ☐

- ☐ *Failure of Hull Plating?*
- ☐ *Failure of Internal Bulkhead between Compartments?*
- ☐ *Shift of Cargo?*
- ☐ *Damage from Grounding or Collision?*
- ☐ *Incorrect Operational Procedures?*
- ☐ *Flooding in Engine Room with Resultant Free Surface?*
- ☐ *Other?* _____

Sound All Tanks and Compare with Departure Soundings ☐

REPORT to Proper Authorities Immediately as per Section 2 of this Plan ☐

Initiate Corrective Action with Due Care Paid to Vessel Strength and Stability ☐

Is Abandonment Necessary? ☐

If YES then Ensure Every Effort is Made to Manoeuvre Survival Craft Upwind Of Any Oil Spill

✓ YES X NO NA Not Applicable

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4C. FLOW CHARTS

SUMMARY FLOWCHART

Incident involving Discharge of Oil (Probable or Actual)

Assess Nature of Incident

Mobilize Oil Pollution Team

Sound Alarm and Muster Crew

Identify Source of Discharge

Spill Assessment

REPORTING

- By Master and/or Designated Crew Member

When to Report

- all probable and actual spills

How to Report

- by quickest possible means to Coastal Radio Station, Designated Ship Movement Reporting Station or Rescue Coordination Centre
- by quickest possible means to local authorities

Who to Contact

- nearest coastal state
- harbour and terminal operators (in port)
- Vessel Management

What to Report

- Initial Report - Res.A 851(20)
- regular Follow Up Reports
- characteristics of spilled oil
- cargo, ballast, and bunkers
- weather and sea conditions
- slick movement
- assistance required (e.g. salvage, lightening, equipment, personnel, chemicals)
- assistance NOT required

ACTIONS TO CONTROL DISCHARGE

- measures to minimize the escpae of oil and threat to the marine environment

NAVIGATIONAL MEASURES

- alter course, speed, or position
- change of list and/or trim
- anchoring
- setting aground
- initiate towage
- assess safe haven requirements
- weather, tide, swell forecasts
- slick monitoring
- recording of events & communications

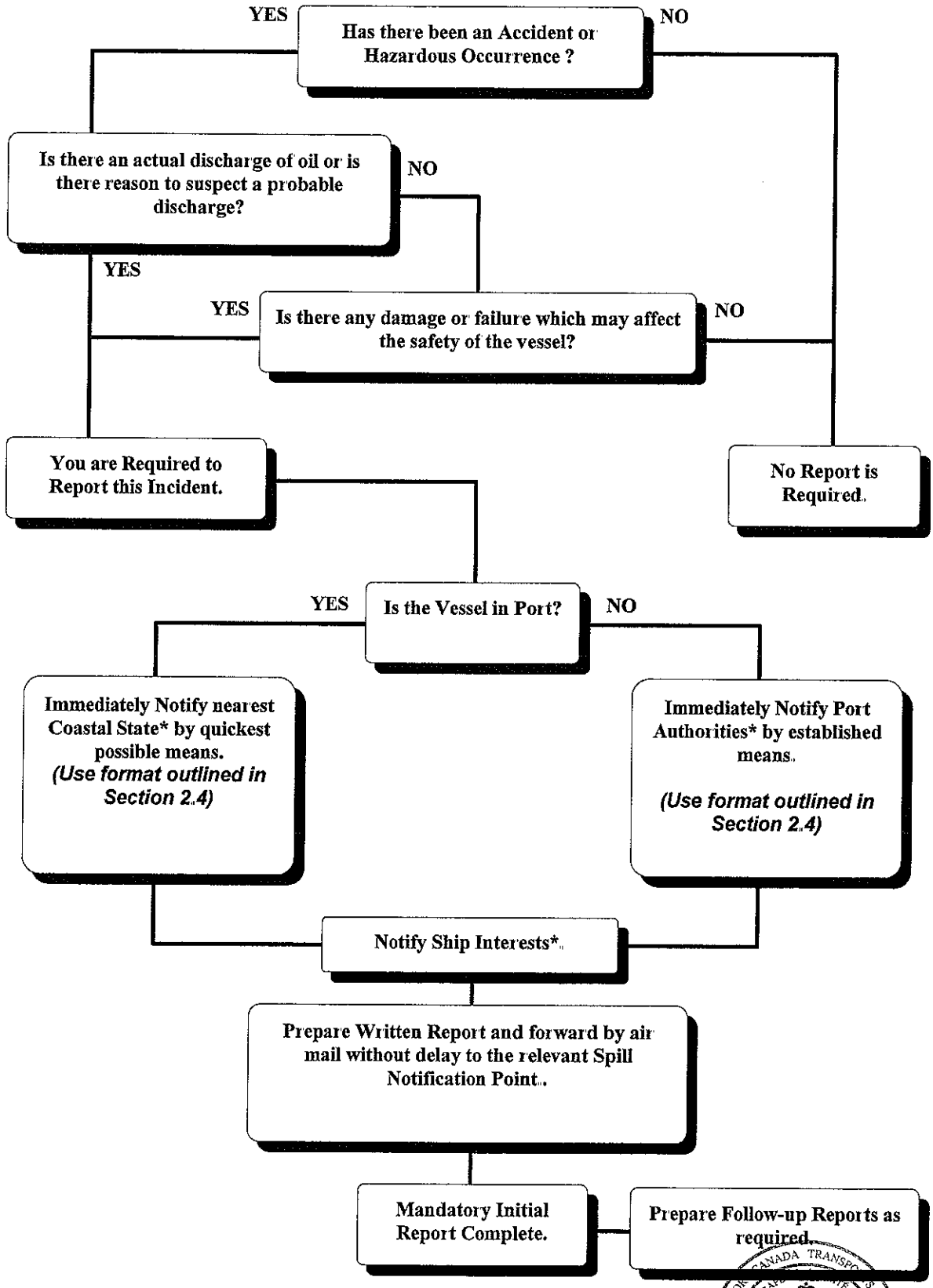
SEAMANSHIP MEASURES

- safety assessment and precautions
- advice on priority countermeasures
- damage stability and stress considerations
- ballast / deballasting
- internal cargo transfer operations
- emergency ship-to- ship transfers of cargo and/or bunkers
- set up shipboard responses for repairs, firefighting, cleanup operations, etc.

STEPS TO INITIATE EXTERNAL RESPONSE

- refer to coastal Port State listings for local help
- refer to Vessel Interests contact list
- external clean-up resources required
- continued monitoring of activities

REPORTING REQUIREMENTS (as per Section 2)



** contact information is located in Appendix 2.*

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St. John's NL

APPENDIX 5 • Relevant Drawings

FOLLOWING ARE DRAWINGS RELEVANT TO THIS VESSEL

General Arrangement
Tank Capacity Plan
Arrangement of Cargo Tank Cleaning / Ballast Pumping System
Arrangement of Cargo / Stripping System
Fuel Oil Service System
Fuel Oil Transfer & Purifying System
Fuel Oil & Diesel Oil Filling System
Deck Scupper System

Examined under the provisions of Annex 1 of MARPOL 73/78 and the Canadian Oil Pollution Prevention Regulations (SOR/93-3) and found satisfactory.

W. S. Atkinson, Pollution Prevention Officer

SHIPBOARD OIL POLLUTION EMERGENCY PLAN

for

MT Tuvaq

11290 Gross Tons Register of St. John's, NL

PREPARED BY: ***Poseidon Marine Consultants Limited***
391 Stavanger Drive
St. John's NL A1A 5G1
TELEPHONE: (709) 739-4321
TELEFAX: (709) 739-4421

PREPARED FOR: ***Coastal Shipping***
Suite 502,
139 Water St. (Fortis Bldg.)
St. John's NL
A1C 1B2

Issued: April 2003
Job Number: 03-009

Change Number

Official Stamp Examined by Date

Change Number

Official Stamp Examined by Date

Change Number

Official Stamp Examined by Date

RECORD OF CHANGES

Amendment Number	Section and Page Affected	Date Entered	Remarks	Name and Position of Person Making Entry

RECORD OF OIL POLLUTION EMERGENCY DRILLS

DATE	TYPE OF OIL POLLUTION DRILL	LOCATION	REMARKS MASTER'S SIGNATURE

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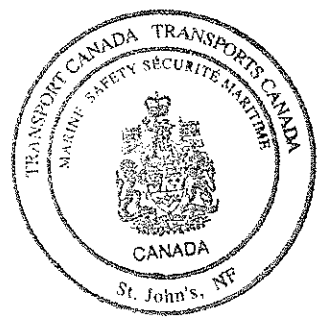
SHIP'S PARTICULARS

PRINCIPAL PARTICULARS

Vessel Name:	IUVAQ ex. Tiira
Flag / Port of Registry:	Canada / St. John's, NL
Call Sign:	OIHO
DNV Number:	10520
IMO Number:	7421966
Gross Registered Tonnage:	11290
Net Registered Tonnage:	5941
Length, Overall:	164.2 m
Length, B.P.:	150 m
Breadth, Max at Deck:	22.2 m
Depth:	12.00 m
Design Draft (Loadline Summer):	9.5 m
Built:	Werft Nobiskrug GMBH. Rendisburg, Germany
Year of Build:	1977
Complement:	21
Propulsion Power:	2 Wartsila 6L46B engines totaling 15368 BHP

CARGO PARTICULARS

Tank Capacities:	Water Ballast -	6247.30 m^3 @100%
	Heavy Fuel Oil -	1532.90 m^3
	Diesel Oil -	410.40 m^3
	Cargo-	16542.61 m^3 @100%
	Slops -	664.20 m^3 @ 100%
Cargo Pumps:	Deep well hydraulically Driven Frank Mohn	
Cargo Manifolds:	Four (4) 250 mm ID cargo lines per side	



INTRODUCTION

1. This Plan is written in accordance with the Canadian Oil Pollution Prevention Regulations and also in accordance with the requirements of regulation 26 of annex I of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 thereto.

2. The purpose of the Plan is to provide guidance to on board operating personnel the vessel with respect to the steps to be taken when a pollution incident has or is likely to occur.

3. The Plan contains all information and operational instructions required by the guidelines. The appendices contain names, telephone, telex numbers, etc. of all contacts referenced in the Plan, as well as other reference material.

4. This Plan has been examined by the Canadian Board of Steamship Inspection, (hereinafter referred to as "the Board") and, except as provided below, no alteration or revision shall be made to any part of it without prior approval of the Board.

5. Changes to Section 5 and the appendices will not be required to be approved by the Board. The appendices should be maintained up to date by the Owners, Operators, and Managers.

6. For the purposes of this Plan, the Master is taken to be that person who is a member of the vessel's operational personnel and to which is given senior responsibility for the vessel and any circumstances pertaining thereto.

7. Before entering a port of call, the Master should be aware of local emergency response proceedures and organisations and have up to date contact information readily available.

SECTION 1 • Preamble

1.1 PURPOSE AND INTENT OF THIS PLAN

This Shipboard Oil Pollution Emergency Plan is intended to assist the vessel's officers, crew and management personnel in dealing with an unexpected discharge of oil. Its primary purpose is to set in motion the necessary actions to stop or minimize the discharge and to mitigate its effects.

1.2 SUPPORT BY VESSEL'S MANAGEMENT

In accordance with the plans and policies of the vessel's management organization, management personnel will support the vessel's crew with additional resources, i.e. personnel and materials, as the situation warrants.

1.3 PERSONNEL TRAINING AND EXERCISES

1. ***It is the responsibility of the Vessel's Management to ensure that, through training and exercises, all officers and crew are capable of confidently and safely carrying out their assigned duties.***

   Officers responsible for maintaining the trim of the vessel and ordering transfers of ballast and/or cargo should be fully aware of the consequences of their actions and are expected to comply with the regulations and any documentation aboard the vessel which prescribes conditions of trim and stability , e.g. "Approved Stability Booklet".

   Officers and crew responsible for cargo and or bunkering operations should also be fully aware of the consequences of their actions and are expected to comply with the regulations and any documentation aboard the vessel which prescribes methods of operation.

   Officers and crew assigned additional responsibilities for fire fighting or emergency response should have appropriate training as per the regulations and should participate in specific drills and exercises to maintain their abilities and be fully familiar with appropriate vessel systems.

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2. ***The vessel's management and operating personnel should become familiar with this document and its format so that should an emergency occur, the response of the officers and crew and the vessel's management personnel will be carried out in a structured, logical and timely manner.***

In order to ensure that the crew and management are completely familiar with this document and its prescribed procedures, training should be offered and oil pollution emergency drills should be carried out regularly.

A blank "Record of Oil Pollution Emergency Drills" form is provided at the beginning of this Plan to document the dates and results of such training exercises. This documentation is to be in addition to normal record keeping and log book entries.

3. ***All crew members should become familiar with the fundamentals of the ship's mechanical and electrical systems in order to be more confident and capable during an emergency.***

It is the responsibility of the vessel's senior officers to ensure that engineering fundamentals are taught to the crew and that the crew remain familiar with them through regular drills. Drawings detailing the various mechanical and electrical systems are carried aboard the vessel. Any drawing (e.g. "Natural Vents", "Engine Room Ventilation", "One Line Electrical Diagram", "Fuel Oil Transfer Diagram") can be obtained for study from the Engineering Document Library located in the Chief Engineer's Office. These drawings are thoroughly catalogued and easily referenced.

In order to ensure a fundamental familiarity with the various engineering systems, oil pollution emergency drills should include such exercises as:

- isolating and sealing off accommodations and/or machinery spaces using louvres and fan shut-offs to prevent ingress of dangerous fumes; and
- isolating, at the distribution panels, various electrical circuits, e g lighting, panel feeds, in order to reduce or eliminate sources of ignition in areas of risk.

1.4 PLAN FORMAT

This plan is divided into five sections as follows:

Section 1 provides an introduction for this document and highlights some important considerations regarding the spillage of oil at sea.

Section 2 outlines the procedure and requirements for making a report to authorities in the event of a discharge or probable discharge of oil.

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Section 4 outlines procedures for national and local coordination of response efforts.

Section 5 outlines procedures for ship to ship transfer operations

Section 6 deals with non-mandatory provisions such as oil spill response materials onboard, media information, and plan review.

Following the main body of this plan are appendices which provide contact information and/or useful forms. Appendix 1 is an example of an unofficial facsimile report, the use of which is outlined in Section 2. Appendix 2 provides contact information for coastal authorities and ship interests. Appendix 3 is a blank calculation form for vessel stress and stability which can be filled out by an officer of the vessel and sent to the vessel owners for calculation. The use of this calculation form is described in Section 3. Appendix 4 contains relevant ship's drawings.

1.5 OIL DISCHARGE MONITORING SYSTEM

In accordance with MARPOL 73/78 Annex 1 Regulation 16 this ship is fitted with an Oilcon MK4 monitoring system by STC International Marine Limited which gives an impulse when any of the following occurs

- Flow rate of discharge is greater than ordered
- Impurities exceed 15ppm
- Total of maximum oil output limit is reached

IMPORTANT:

1. ANY OIL SPILLAGE SHOULD BE TREATED AS AN EMERGENCY.

2. IN RESPONDING TO AN OIL SPILLAGE, THE MASTER'S PRIORITY WILL BE TO ENSURE THE SAFETY OF THE CREW AND OF THE VESSEL, AND TO TAKE ACTION TO PREVENT ESCALATION OF THE INCIDENT. IMMEDIATE CONSIDERATION SHOULD BE GIVEN TO MEASURES AIMED AT PREVENTING FIRE AND EXPLOSION.

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SECTION 2 • Reporting Requirements

Coast guard of nearest coastal State (see Appendix 2) is to be notified whenever there is:

a) **an actual discharge of oil**

b) **reason to suspect a probable discharge of oil due to fire, grounding, list, loss of power, collision, flooding, explosion, structural failure, etc.**

c) **any damage or failure which may affect the safety of the vessel, such as failure or breakdown of the electrical generating system, or essential shipborne navigational aids.**

2.1 DISCHARGE OF OIL

When reporting a discharge of oil, the Master is to provide all relevant information (as per section 2.4) to:

a) Coast Guard of nearest coastal State, or

b) Port Authorities, and also to

c) Vessel Interest Contacts.

A discharge of oil, for the purposes of this plan, refers to:

a) a discharge of oil, resulting from damage to the vessel or its equipment, or for the purpose of securing the safety of a vessel or saving life at sea; or

b) a discharge during the operation of the vessel of oil in excess of the quantity or instantaneous rate permitted under the present Convention.

2.2 PROBABLE DISCHARGE OF OIL

The Master must use good judgment to assess any circumstance which might be cause for probable discharge of oil. When making such judgment the following factors must be taken into account:

a) the nature of the damage, failure, or breakdown of the vessel, machinery, or equipment;

b) vessel location and proximity to land or other navigational hazards;

c) weather, tide, current, and sea state;

d) traffic density; and

e) morale, health and ability of crew onboard to deal with situation.

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2.3 DAMAGES AND/OR FAILURES

The Master must report any damage which may affect the safety of the vessel: collision, fire, grounding, explosion, cargo shifting, list, etc. The Master must also report any failure or breakdown of essential machinery which results in impairment of the safety of navigation: i.e. electrical generating system or essential vessel-borne navigational aids.

2.4 INITIAL REPORT

An initial report is to be made by radio communication without delay to one of the following Canadian radio ship reporting stations; Canadian Coast Guard Radio Station, Canadian Vessel Traffic Service Centre, St. Lawrence Seaway Authority marine radio station, or Canadian harbour radio station. The report is to be made following the format given below. Where the report cannot be communicated by radio, it shall be communicated by telephone to the local Canadian radio ship reporting station or to the Canadian Coast Guard Operations Centre in Ottawa. Contact information is provided in Appendix 2.

FOLLOW-UP REPORTS

Follow-up reports should be made at regular intervals to keep the coastal State and other concerned parties informed of developments including, but not limited to, change of course or position, change in quantity, rate or probability of oil discharge, injuries or casualties, or effects of actions taken to control discharge or assure safety of the vessel and crew. Follow-up reports should be made in the same format as the initial report.

WRITTEN REPORT

Within 24 hours of the incident, or as soon as possible thereafter, a written report on the incident, including a statement as to its probable cause, shall be forwarded by air mail without delay to the Chief, Marine Casualty Investigations, Department of Transport, Ottawa.

UNOFFICIAL FACSIMILE REPORT

An unofficial facsimile report is included in Appendix 1. This may be sent to any concerned parties but is not consistent with IMO Resolution A 648(16) for reporting of incidents involving dangerous goods, harmful substances and/or marine pollutants, and therefore cannot constitute an official report to the coastal State.

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FORMAT AND INFORMATION REQUIRED FOR OFFICIAL REPORT

AA VESSEL NAME, CALL SIGN, FLAG

BB DATE AND TIME (GMT) OF INCIDENT: 111935 meaning 11th of month at 7:35 pm.

CC SHIPS POSITION: 2230N 0600E meaning 22 deg. 30 min. N, 6 deg. E

or

DD SHIPS POSITION BY TRUE BEARING (3 DIGITS) AND DISTANCE FROM CLEARLY IDENTIFIED LANDMARK.

EE TRUE COURSE (3 DIGITS)

FF SPEED IN KNOTS AND TENTHS OF A KNOT (3 DIGITS)

LL ROUTE INFORMATION - INTENDED TRACK

MM RADIO STATIONS AND FREQUENCIES GUARDED

NN TIME OF NEXT REPORT (same as in BB)

OO DRAFT (4 DIGITS - meters and centimeters)

PP TYPES AND QUANTITIES OF CARGO AND BUNKERS ON BOARD

QQ BRIEF DETAILS OF DAMAGE, LIMITATIONS ETC. (must include condition of vessel and ability to transfer cargo, ballast, or fuel)

RR BRIEF DETAILS OF ACTUAL POLLUTION (oil type, estimate of quantity discharged, whether discharge continues, cause, estimate of slick movement)

SS WEATHER AND SEA CONDITIONS (wind force/direction, relevant tidal and/or current information)

TT NAME, ADDRESS, TELEX, FAX, TELEPHONE NUMBERS OF VESSEL OWNER OR REPRESENTATIVE

UU DETAILS OF LENGTH, BREADTH, TONNAGE, AND TYPE OF VESSEL

WW TOTAL NUMBER OF PERSONS ON BOARD

XX MISC. DETAILS (This includes brief details of incident, actions taken, injuries sustained and assistance required. If no outside assistance is required, then this should be clearly stated.)

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2.5 WHO TO CONTACT

Contact information for coastal State and other concerned parties (port contacts, vessel interest contacts) is located in Appendix 2.

2.6 ARRANGED RESPONSE ORGANIZATION(S)

The vessel, in accordance with the regulations, has onboard a **declaration** that the vessel's management has, in accordance with 660.2(2) of the Canada Shipping Act, entered into an arrangement with a response organization to which a certificate of designation has been issued pursuant to subsection 660.4(1) in respect of the quantity of oil that is carried both as fuel and cargo on board the vessel.

The person or persons identified in the **declaration** shall be responsible for contacting and mobilizing the response organization.

SECTION 3 • Steps to Control Discharge

In cases of small spills on deck, the vessel's crew should take whatever actions are necessary to prevent oil from escaping over the side. Once the spill is contained on deck, the crew will need to take action to clean up the oil. SPILLED OIL SHOULD NOT BE WASHED OVER THE SIDE. Once oil is in the water, the crew's ability to respond in a practical manner is greatly reduced.

3.1 OPERATIONAL SPILLS

In the event of an operational spill which occurs during bunkering or cargo operations, it is important that the bunkering party terminate any and all bunkering operations and close all manifold valves.

Before closing any manifold valves, the bunkering / cargo party must immediately inform the terminal / loading master so that they may take action to eliminate the possibility of over-pressurization of the shore side transfer components.

After dealing with the cause of the spill, it may be necessary to obtain permission from local authorities and/or the terminal before resuming bunkering or cargo operations.

If the possibility of fire or explosion exists, nonessential air intakes to accommodations and machinery spaces should be closed and all sources of sources of ignition should be eliminated. See Section 1.3.3 of this Plan.

In accordance with Section 1.3.3 of this Plan, all members of the vessel's crew should be familiar with the fundamentals of the ship's vital systems including the ventilation and electrical systems. Crew members should be able to: isolate the accommodation and/or machinery spaces using the louvres and fan shut-offs; and, from the distribution panels, isolate electrical circuits in areas of risk. Please refer to Section 1.3.3 of this Plan for additional details.

Care must be taken to consider stability and stress when taking action to mitigate the spillage of oil. Internal transfers should be undertaken only with a full appreciation of the likely impact on the vessel's overall stress and stability. Please refer to the "Approved Stability Booklet" carried on board.

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St. John's, NF

1. PIPE LEAKAGE

In the event of a oil pipe leakage, the Chief Engineer must ensure that the following actions are taken:

a) Stop oil flow and close manifold and other valves.

b) Sound Emergency Alarm and initiate emergency response procedures as posted aboard the vessel.

c) Locate the source and repair if possible.

d) Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.

e) Drain affected section of pipe into empty or slack tank if possible.

f) If oil is overboard, report to proper authorities immediately (as per section 2 of this plan).

g) If oil is in bilges, pump through oil/water separator as per approved procedures.

2. TANK OVERFLOW

In the event of an oil tank overflow, the Chief Engineer must ensure that the following actions are taken:

a) Stop oil flow and close manifold and other valves.

b) Sound Emergency Alarm and initiate emergency response procedures as posted aboard the vessel.

c) Place drain buckets under overflow pipes to contain possible spills.

d) Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.

e) Drain or transfer oil to slack or empty tanks if possible with due consideration paid to vessel stability. If no slack or empty tanks are available then oil may be pumped back ashore through delivery line, having first gained permission to do so.

f) If oil is overboard, report to proper authorities immediately (as per section 2 of this plan).

g) If oil is in bilges, pump through oil/water separator as per approved procedures.

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3. HULL LEAKAGE

If oil is noticed on the water near the vessel during normal operations and cannot be accounted for, the possibility of hull leakage should be suspected.

In the event of a hull leakage, the Master must ensure that the following actions are taken:

a) Sound Emergency Alarm and initiate emergency response procedures as posted aboard the vessel.

b) Stop any and all transfer or bunkering operations.

c) Identify damage and report to proper authorities immediately (as per section 2 of this plan).

d) If possible, contain spill using materials on hand

e) Transfer fuel away from suspected leaks to empty or slack tanks if possible or to a ballast tank if necessary. If in port, arrangements can be made to pump oil ashore to tank or truck. Due consideration is to be paid to vessel stress and stability.

f) Locate and repair if possible.

g) Absorb spill with any absorbent materials on hand and dispose of oil-soaked materials in an appropriate container.

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3.2 SPILLS RESULTING FROM CASUALTIES

ALL CASUALTIES ARE TO BE REPORTED BY THE MASTER AS PER SECTION 2.

The Master's priority, when responding to a casualty, will be to ensure the safety of personnel and the vessel and to take action to prevent escalation of the incident.

In casualties involving spills, immediate consideration should be given to measures aimed at preventing fire and explosion, such as altering course so that the vessel is upwind of the slick, shutting down nonessential air intakes, etc.
If the vessel is aground, and therefore cannot maneuver, all possible sources of ignition should be eliminated and action taken to prevent flammable vapors entering accommodation and engine room spaces. Please refer to Section 1.3.3.

In accordance with Section 1.3.3 of this Plan, all members of the vessel's crew should be familiar with the fundamentals of the ship's vital systems including the ventilation and electrical systems. Crew members should be able to isolate the accommodation and/or machinery spaces using the louvres and fan shut-offs; and, from the distribution panels, isolate electrical circuits in areas of risk. Please refer to Section 1.3.3 of this Plan for additional details.

Prior to considering remedial action, the Master will need to obtain detailed information on the damage sustained by the vessel. A visual inspection should be carried out and all bunker tanks and other compartments sounded. However, due regard should be paid to the indiscriminate opening of ullage plugs or sighting ports, especially when the vessel is aground, as loss of buoyancy could result. The Master shall also ensure that all covers, doors, vents, and hatches to any and all holds, ballast tanks, and fuel tanks are sealed tightly and remain sealed to prevent possible loss of buoyancy. Having assessed the damage sustained by the vessel, the Master will be in a position to decide what action should be taken to prevent or minimize further spillage.

Great care must be taken to consider stability and stress when taking action to mitigate the spillage of oil or to free the vessel if aground. Internal transfers should be undertaken only with a full appreciation of the likely impact on the vessel's overall stress and stability. Please refer to the "Approved Stability Booklet" carried on board.

Should the damage sustained be extensive, the impact of internal transfers on stress and stability may be impossible for the vessel's personnel to assess. In such cases, Appendix 3 of this plan is to be filled out as completely as possible and forwarded to the Owner's to ensure the appropriate calculations can be done.

When it is possible to maneuver, the Master, in conjunction with the proper shore authorities, may consider moving the vessel to a more suitable location in order, for example, to facilitate emergency repair work or lightening operations, or to reduce the threat posed to any particularly sensitive shoreline areas. Such maneuvering may be subject to coastal state jurisdiction.

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1. GROUNDING

If the vessel grounds, the Master must ensure that the following actions are taken:

a) Sound Emergency Alarm and muster crew.

b) Eliminate all avoidable sources of ignition and ban smoking on board. Action must be taken to prevent inflammable vapors from entering accommodation and machinery spaces. See Section 1.3.3.

c) Identify damage by means of a visual inspection.

d) Take soundings around vessel to determine nature and gradient of seabed.

e) Check differences in tidal ranges at grounding site.

f) Evaluate tidal current in grounding area.

g) Take soundings of all tanks on shell and compare with departure soundings.

h) Determine probability and/or quantity of oil released.

i) If oil release is determined or is probable, this is to be included in the casualty report.

At this point, determine risk of additional damage to vessel by attempting to refloat. If remaining aground is determined to be less of a risk then:

a) Use anchors to prevent vessel movement.

b) Take in ballast in empty tanks, with due consideration paid to stress and stability. Please refer to the "Approved Stability Booklet."

c) Consider transfer of fuel from damaged tanks, with due consideration paid to stress and stability. Please refer to the "Approved Stability Booklet."

d) Reduce longitudinal stress on hull by transfer of cargo internally. Please refer to the "Approved Stability Booklet."

e) If the change in stability and stress cannot be calculated on board, contact the Vessel's management to arrange for the necessary calculations. Refer to Appendix 3 for information which should be provided.

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2. FIRE / EXPLOSION

If a fire or explosion occurs on board, the vessel's fire control party must ensure that the following actions are taken:

a) Sound Emergency Alarm and muster crew.

b) Determine extent of damage and what damage control measures can be taken.

c) Determine whether there are casualties.

d) Request assistance as deemed necessary

e) Assess possibility of oil leakage.

f) If there is a discharge or possible discharge of oil, this is to be included in the casualty report.

g) Should abandonment be necessary, the Master must ensure that every effort is made to maneuver survival craft upwind of any oil spill.

3. COLLISION

If a collision occurs, the Master must ensure that the following actions are taken:

a) Sound Emergency Alarm and muster crew.

b) Determine whether there are casualties.

c) If there is a possibility of fire or explosion, eliminate all avoidable sources of ignition and ban smoking on board. Action should be taken to prevent inflammable vapors from entering accommodation and machinery spaces. See Section 1.3.3.

d) Decide whether separation of vessels may cause or increase spillage of oil.

e) If any oil tanks are penetrated, isolate the penetrated tank or transfer oil to slack or empty tanks with due attention paid to stress and stability of the vessel. Please refer to the "Approved Stability Booklet."

f) If there is an oil spill, make a report as per section 2.

4. HULL FAILURE including ice damage

If the vessel suffers structural hull failure, the Master must ensure that the following actions are taken:

a) Sound Emergency Alarm and muster crew.

b) Reduce speed or stop to minimize stress on hull.

c) Assess immediate danger of sinking or capsizing.

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d) Initiate damage control measures.

e) If oil has spilled, or if it is necessary to jettison oil to maintain stability, make a report as per section 2.

f) If the change in stability and stress cannot be calculated on board, contact the Vessel's management to arrange for the necessary calculations.

g) Consider forecast weather conditions and their effect on the situation.

h) Should abandonment be necessary, the Master must ensure that every effort is made to maneuver survival craft upwind of any oil spill.

5. EXCESSIVE LIST

If excessive list occurs rapidly and unexpectedly, it may be due to:

a) Failure of hull plating.

b) Failure of internal bulkhead between compartments.

c) Shift of cargo.

d) Damage through grounding or collision.

e) Incorrect operating condition. Refer to "Approved Stability Booklet."

f) Flooding in Engine Room, where free surface can cause a list.

The Master must ensure the following steps are taken immediately:

a) Stop any cargo, bunkering, or ballast operations in progress.

b) Sound Emergency Alarm and muster crew.

c) Determine whether there are casualties.

d) If under way, reduce speed or stop.

e) Establish reason for list. See above.

f) Sound all tanks and compare with departure soundings.

g) If oil has spilled, or it is necessary to jettison oil to maintain stability, make a report as per section 2.

h) If possible, take corrective action to rectify the situation with due consideration paid to vessel stress and stability. Please refer to the "Approved Stability Booklet."

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SECTION 4 • National and Local Coordination

1. The Master will advise the Coast Guard of nearest coastal state regarding any oil spill. Vessel Interest Contacts must also be notified of any such incident. See Appendix 2 for details.

2. The Master will be the point of contact on the vessel for coordinating shipboard activities with national and local authorities, act as the Company's on-scene representative, and will be responsible for overseeing the action of any salvage or spill contractors employed until such time as he/she has been FORMALLY relieved of these responsibilities by the Company.

3. The person or persons identified in the declaration shall be responsible for contacting and mobilizing the response organization(s). These organizations will coordinate and conduct the response. It is not normally practical for vessel's personnel to be directly involved in cleanup activities. Therefore, their primary role will be to provide as much information as necessary to assist the response and to cooperate with cleanup personnel. However, where no local response is forthcoming, or is delayed, the Master should consider the use of available shipboard materials to clean up or contain the spilled oil by, for example, using ship-stocked absorbent materials or utilizing mooring ropes or air-filled hoses as makeshift booms.

4. Dispersants or degreasers should not be used on oil spilled in the water as their use may contravene local regulations. However, dispersants may be used if they are approved by Environment Canada specifically for a given incident. Environment Canada will allow and approve the use of dispersants on a case by case basis only

SECTION 5 • Ship to Ship Transfer Operations

Should a situation such as lightening due to grounding require a ship to ship transfer of petroleum products, the Master must take into account but not limited to the following:

1. Proper lines of communication between ships including language and radio working frequency;
2. Current and forecasted weather conditions for the intended area of transfer;
3. The compatibility of the vessels involved with regards to size, freeboard, manifold location, list, trim, etc.
4. The elimination of all possible ignition sources;
5. Oil spill clean up equipment and procedures in place;
6. Contingency planning for emergency situations in place.

For detailed procedures concerning ship to ship transfer of petroleum products, please refer to ***The Ship to Ship Transfer Guide (Petroleum)****, published by The International Chamber of Shipping Oil Companies International Marine Forum, 3rd edition, 1997. A copy of which is to be kept on board the ship at all times.*

SECTION 6 • Additional Information (Non-Mandatory)

This section provides for additional information that local authorities, insurance underwriters, or Vessel Management may wish to include, but is not mandatory. (Regulation 26, Annex I, Marpol 73/78)

MEDIA INFORMATION

In the event of an oil spill or other related casualty, the Master is to direct any Coastal Radio station being worked that inquiries from any of the various media nodes are to be directed to the Vessel Management, who will handle such incidents shore-side. This will enable the Master to concentrate on the matter at hand.

PLAN REVIEW

This plan is to be reviewed at regular intervals by the Vessel Management and Master such that the information contained herein is current. Changes should be incorporated in the plan as and when they occur and the changes noted and by whom. Reviews should be conducted annually to reflect changes in local laws or policies, contact names or numbers, vessel characteristics, or company policy.

Reviews should also be conducted after any use of the plan in response to an incident, in order to evaluate its effectiveness and make any modifications deemed prudent at that time.

APPENDIX 1 • Report Format and Content

The report should contain the following:

AA VESSEL NAME, CALL SIGN, FLAG

BB DATE & TIME (GMT) OF INCIDENT: 111935 meaning 11th of month at 7:35 pm.

CC SHIPS POSITION: 2230N 0600E meaning 22 deg. 30 min. N, 6 deg. E

or

DD SHIPS POSITION BY TRUE BEARING (3 DIGITS) AND DISTANCE FROM CLEARLY IDENTIFIED LANDMARK.

EE TRUE COURSE (3 DIGITS)

FF SPEED IN KNOTS AND TENTHS OF A KNOT (3 DIGITS)

LL ROUTE INFORMATION - INTENDED TRACK

MM RADIO STATIONS AND FREQUENCIES GUARDED

NN TIME OF NEXT REPORT (same as in BB)

OO DRAFT (4 DIGITS - meters and centimeters)

PP TYPES AND QUANTITIES OF CARGO AND BUNKERS ON BOARD

QQ BRIEF DETAILS OF DAMAGE, LIMITATIONS ETC. (must include condition of vessel and ability to transfer cargo, ballast, or fuel)

RR BRIEF DETAILS OF ACTUAL POLLUTION (oil type, estimate of quantity discharged, whether discharge continues, cause, estimate of slick movement)

SS WEATHER AND SEA CONDITIONS (wind force/direction, relevant tidal and/or current information)

TT NAME, ADDRESS, TELEX, FAX, TELEPHONE NUMBERS OF VESSEL OWNER OR REPRESENTATIVE

UU DETAILS OF LENGTH, BREADTH, TONNAGE, AND TYPE OF VESSEL

WW TOTAL NUMBER OF PERSONS ON BOARD

XX MISC. DETAILS (brief details of incident, actions taken, injuries, assistance required)

UNOFFICIAL OIL POLLUTION EMERGENCY REPORT BY FACSIMILE

Vessel Name Call Sign Flag

Date and Time of Event

Vessel Position (Latitude & Longitude, Bearing & Distance from Landmark)

Course Speed

Intended Track

Radio Station

Date and Time of Next Report

Type and Quantity of Oil On board

Brief Details of Damage

Brief Details of Pollution

Details of Weather & Sea Conditions (Wind Speed/Direction, Swell Height/Direction)

Names of Vessel's Owner

Vessel Size and Type

Any Other Additional Information as Determined by Master

APPENDIX 2 • Who to Contact

In accordance with the Canadian Pollutant Discharge Reporting Regulations, the Master or Owner of a ship must report, without delay, any discharge or anticipated discharge of a pollutant in Canadian waters or fishing zones, to a Pollution Prevention Officer (PPO). Reports must be made in the manner described in Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants, TP 9834, or "General Principles for Ship Reporting Systems and Ship Reporting Requirements, including Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants" adopted by the IMO by Resolution A 648(16). These initial reports can be made to a Vessel Traffic Service Centre (VTS) or any other Canadian Coast Guard Radio Station (CGRS), on the frequencies listed in the publication, Radio Aids to Marine Navigation (RAMN).

In addition to the above process for reporting a spill from a vessel to a PPO through a CGRS or VTS, the Canadian Coast Guard maintains a 24 hour Operations Centre which can be contacted at:

Canadian Coast Guard Operations Centre
344 Slater Street
Ottawa, Ontario
K1A 0N7

Tel: (613) 990-5600 Fax: (613) 995-4700 Tlx: (613) 053 3128

Within Canada, administrative inquiries related to pollution prevention, compliance and enforcement, vessel regulations, design and construction should be directed to:

Director General, Marine Safety
Transport Canada
Mailstop: AMS
330 Sparks Street
Ottawa, Ontario
K1A 0N5

Tel: (613) 998-0610 Fax: (613) 954-1032

Inquiries relating to pollution response should be directed to:

Director General, Rescue and Environmental Response
Canadian Coast Guard
344 Slater Street
Ottawa, Ontario
K1A 0N7

Tel: (613) 990-3110 Fax: (613) 996-8902

VESSEL INTEREST CONTACTS

VESSEL MANAGEMENT

Coastal Shipping Limited (Owners)
P.O. Box 913
Happy Valley-Goose Bay, Labrador
A0P 1S0

Office: (709) 896 - 2421
Fax: (709) 896 - 5028

24 HOUR CONTACT

The following phone numbers are provided
for 24 hour contact, year round:

Cell:	(709) 682 - 0826	Kevin Brewer or Gerry Burgess
Home:	(709) 227 - 2600	Kevin Brewer
	(709) 745 - 2684	Gerry Burgess

APPENDIX 3 • Vessel Stress and Stability Calculations

VOYAGE PARTICULARS

Departure Port

Departure Date

Time (GMT)

VESSEL CONDITION IMMEDIATELY BEFORE CASUALTY

Mean Draft Forward

Mean Draft Aft

KG(solid)

KG(fluid)

LCG of Vessel

#	COMPARTMENT	S.G.	TONNES

#	Compartment	S.G.	Tonnes

DATA RELATING TO VESSEL AFTER CASUALTY

Nature of Casualty: Collision / Grounding (Fixed / Free) / Fire
Explosion / Heavy Weather / Other

Casualty Date Report Time (GMT)

Geographical Location of Casualty: LAT
LONG

Conditions at Site at Time of Casualty Report

Weather

Sea State

Tidal State

Tidal Range

Forecast

S.G. of Surrounding Water

Position of Vessel relative to Wind, Waves, Tides, etc.

Drafts Measured Port and Starboard:

Drafts at Fwd Marks/F.P.(Best Estimate)
Drafts at Aft Marks/A.P.(Best Estimate)
Drafts at Midships (Best Estimate)
Angle of Heel (Port / Starboard)

Best Estimate of Depth of Water (for Grounding)

Location	Port	Starboard

REPORTED DAMAGE

Details of each damaged compartment known to be open to the sea, including those damaged above the present waterline

Compartment	Estimated Cargo Weight (tonnes)	Permeability of Cargo (%)	Comments

Extent and location of structural damage in way of above compartments. (Attach sketch)

Extent of additional damage to pipes, valves, hatches, doors, etc. and list of compartments which may be subject to progressive flooding as a result.

Soundings from or estimates of amounts of flood water in spaces not directly open to sea.

PROPOSED ACTION AND REQUIREMENTS

Any other relevant information, details of action being undertaken or proposed course of action, salvage operation etc.

APPENDIX 4 • Relevant Drawings

FOLLOWING ARE DRAWINGS RELEVANT TO THIS VESSEL

General Arrangement Drawing
Tank Capacity Plan
Cargo Piping Diagram

MEADOWBANK DIVISION

WILDLIFE PROTECTION AND RESPONSE PLAN

Prepared by:

Agnico-Eagle Mines Limited – Meadowbank Division

Version 2
August 2012

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DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
1	03/2011			Wildlife Protection and Response Plan
2	08/2012			Update Plan to include recommendations from GN

Table 1 - Document Control

Version 2:

Prepared By: _____

Jeffrey Pratt
Environment Coordinator

Approved By: _____

Kevin Buck
Environmental Superintendent

SECTION 1 – INTRODUCTION

As part of the Terrestrial Ecosystem Management Plan (2006), mitigation measures and monitoring initiatives have been proposed to lessen the likelihood that wildlife will become habituated to the Meadowbank Mine Site (the 'mine site') and its infrastructure. The TEMP identified measures to deter wildlife from obtaining food rewards, finding shelter around the mine site, gaining access to harmful substances present on the project site, being injured as a result of vehicle collisions, and damaging mine property.

Despite these mitigation measures, personnel may occasionally come into contact with wildlife that inhabits the Meadowbank area. To manage these incidents, a specific Wildlife Protection and Response Plan (WPRP) has been developed. Incidents must be managed to keep both humans and wildlife safe, using only humane control methods.

Furthermore, all staff must be familiar with the standard operating procedures and best practices aimed at ensuring human-wildlife conflicts are minimized during the life of the project. All personnel, including contractors, on site have a role to play in ensuring human safety, conservation of wildlife and documenting wildlife activities in the mine area.

The following WPRP provides information on general human-wildlife conflicts policies and regulations, species-specific response plans for ungulates and predatory mammals, and wildlife awareness.

SECTION 2 – HUMAN-WILDLIFE CONFLICTS

2.1 Overview

Wildlife encounters can take many forms. A conflict occurs when either human or wildlife health, and/or safety are put at risk. Human health and safety can be affected by contact or conflict with wildlife in several ways, including direct or indirect physical injury, and exposure to animal diseases that can infect humans (i.e., known as zoonotic diseases).

The most common conflict faced by wildlife is the increased risk of mortality from human encounters, which most often occurs when wildlife become habituated to human activity and lose their natural fear of people. The most serious form of habituation is directly correlated to the animal obtaining food, which is known as food conditioning. Food-conditioned animals become dependent on humans as sources of food. Because these human-induced habits become engrained in the animal, attempts to deter the habituated behavior generally fail with the end result usually the death of the animal. Loss of habitat effectiveness (how the animal uses its available habitat), and effects to wildlife movement (how the animal travels through its available habitat) can also result from wildlife in conflict with human development. Ultimately, this will affect both the health and safety of the wildlife species involved. While it is impossible to remove all risk to both human and wildlife health and safety, approaches to minimize the risk do exist. Reactive measures do have their place in stopping the conflicts when they occur, but proactive strategies are the most effective means of preventing potential conflicts.

2.2 Mine Policies and Regulations

The following summarizes the general rules regarding wildlife on the site and will form the basis of the Wildlife Awareness Orientation and Courses (see below).

Employees and contractors are advised to report all incidents of unauthorized activities on or in the vicinity of the mine site to the Environmental Department.

2.2.1 General Restrictions for Wildlife Protection

The following are general restrictions for mine site workers and contractors, intended to minimize the potential for negative project-related effects (e.g., increased mortality risk) on wildlife in and around the mine site.

- Wildlife shall have the right-of-way except where it is judged to be unsafe to do so. All species of wildlife (i.e., from small mammals to large carnivores, songbirds to raptors) when encountered by personnel on foot or in vehicles will be given the right-of way.
- Non-mine-registered firearms are not permitted on site,(i.e. carrying of firearms in private vehicles

to and from the project site on workdays).

- Feeding wildlife is prohibited at all times on or in the vicinity of the mine site, including during travel to and from the mine site.
- Harassment (defined as to kill, injure, seize, capture or trap, pursue and includes to stalk, track, search for, lie in wait for, or shoot at - for any of those purposes not authorized by the Environmental Department) of wildlife is prohibited at all times on or in the vicinity of the mine site, including during travel to and from the site.
- The deliberate destruction or disruption of wildlife nests, eggs, dens, burrows, and the like, is prohibited at all times on or in the vicinity of the mine site, including during travel to and from the site.
- Hunting and fishing is prohibited at all times on or in the vicinity of the mine site, including during travel to and from the site on workdays.
- Pets are prohibited at all times on or in the vicinity of the mine site, including during travel to and from the site on workdays.
- Maximum speed limit on all access roads is 50 km/h (30 mph).
- Traffic (including ATVs and snowmobiles) is restricted to designated access roads and trails.

The mine site refers to any mine facility present during the operations phase of the project, including but not limited to, outbuildings (e.g., machine shop, offices), pits, parking areas, tailings storage facilities and waste piles.

2.2.2 Wildlife Attractants

A list of potential wildlife attractants is provided below. The list is intended as a general summary of attractants but may not be comprehensive of all potential attractants.

- Food wastes and garbage;
- Chemicals (e.g., road salt) and their refuse (e.g., empty fuel containers);
- Wildlife carcasses (e.g., road kills, hunter kills);
- Movement and human activity (e.g., movement of people and equipment outdoors); and
- Roads, which may create preferential travel corridors for wildlife, can lead to vehicle collisions and increased exposure to wildlife encounters at the mine site.

General recommendations directed at minimizing wildlife concerns related to food wastes and garbage is presented under Section 2.2.3 (Garbage Management).

Protocols for dealing with chemical storage, disposal and spills are presented in Meadowbank's Hazardous Materials Management Plan and Spill Contingency Plan. These protocols will minimize the potential for adverse wildlife effects, and are referenced under Section 2.2.3 (Garbage Management) and Section 2.2.4 (Wildlife Health).

Requirements related to the reporting and removal of wildlife carcasses are presented under Section 2.2.6 (Reporting Wildlife Observations and Incidents).

2.2.3 Garbage Management

General recommendations directed at minimizing wildlife concerns related to food wastes and garbage is provided below.

- Littering is prohibited on and in the vicinity of the mine site and along access roads. All garbage (e.g., lunch bags) must be returned to temporary storage containers. Note: organic wastes (e.g., orange peels, apple cores) are included.
- Food related waste (including packaging) will be incinerated on a daily basis and general waste will be sent to the landfill and then buried.
- Wastes associated with mechanical maintenance and repairs (e.g., motor oil and antifreeze) will be disposed of as per the Hazardous Materials Management Plan.
- All temporary (small) storage containers for food waste garbage (yellow bin) will be wildlife protective (i.e. have bear proof lids).
- No open top buckets or anything similar will be tolerated outside buildings.
- Feeding wildlife is prohibited at all times on or in the vicinity of the mine site, including during travel to and from the site on workdays.
- Wildlife incidents related to garbage or human food attractants will be reported as soon as possible. See Section 2.2.6 (Reporting Wildlife Observations and Incidents) for more information.
- Improperly disposed of garbage, particularly food wastes, will be reported as soon as possible. See Section 2.2.6 (Reporting Wildlife Observations and Incidents) for more information.

While arctic fox tend to be the greatest concern with respect to access to garbage, other animals (e.g., wolverines, wolves and grizzly bears) may be attracted to uncontained garbage sources. Problem wildlife data at the Meadowbank mine to date indicate that Arctic fox and wolves are the most likely species to be attracted to the site

2.2.4 Wildlife Health

The following recommendations are intended to reduce potential mine-related effects on wildlife health (including non-vehicle related accidents and consumption of toxic substances).

- Feeding wildlife is prohibited at all times on or in the vicinity of the mine site, including during travel to and from the site. If caught feeding wildlife, an employee can be suspended and/or dismissed.
- Company procedures on the safe and prompt clean-up of any chemical spills will be followed. See Meadowbank's Spill Contingency Plan for a more detailed protocol.
- Any observations of wildlife in and around potential sources of contaminants (e.g., fuelling sites)

will be reported. See Section 2.2.6 (Reporting Wildlife Observations and Incidents) for details.

2.2.5 Wildlife and Vehicles

The following recommendations are intended to reduce the incidence of wildlife-vehicle collisions and near misses.

- Wildlife has the right-of-way except where it is judged to be unsafe to do so.
- Obey all traffics signs.
- Maximum speed limit on all access roads is 50 km/h (30 mph).
- Verbally report wildlife carcasses observed on and in the vicinity of the mine site, and along access roads, as soon as possible. See Section 2.2.6 (Reporting Wildlife Observations and Incidents) for more information.
- Restrict traffic (including ATVs and snowmobiles) to designated access roads and trails.
- Push the snow with a dozer when clearing the road to avoid build-up snow banks on the side of the road
- Report all wildlife-vehicle collisions that results in the death or injury of wildlife as soon as possible. See Section 2.2.6 (Reporting Wildlife Observations and Incidents) for details.
- A near miss between a vehicle and an animal should be reported as a wildlife 'incident'. See Section 2.2.6 (Reporting Wildlife Observations and Incidents) for details.

2.2.6 Wildlife and Buildings

The following recommendations are intended to reduce the risk of close encountering situations between wildlife and people

- Skirting will be add around the building to avoid having wildlife under the buildings
- Under building access ways must be closed at all time
- Keep c-can doors close at all time to avoid wildlife using them as shelter
- Open top bins and containers for food waste will not be permitted outside buildings. If needs be, a bear-resistant container shall be used.

2.2.7 Reporting Wildlife Observations and Incidents

2.2.7.1 Reporting Requirements of Project Workers and Contractors

Project workers and contractors are required to verbally notify the Environmental Department of the following wildlife observations or incidents as soon as possible.

- Signs of animal presence (e.g., tracks, scat, nests, burrows) in close proximity

(visible to the eye from within the mine site footprint to site facilities, vehicles, equipment, or areas frequented by workers.

- Sightings of animals in close proximity ((visible to the eye from within the mine site footprint to site facilities, vehicles, equipment, or areas frequented by workers.
- Aggressive or unusual wildlife behavior in and around site facilities.
- Instances of workers feeding wildlife.
- Instances of improper disposal of garbage or other waste materials.
- Observed maintenance issues (e.g., improper placement or maintenance of garbage containers).
- Instances of workers not following vehicle use guidelines (e.g. speed limits).
- Vehicle collisions with wildlife or near misses.
- Observations and locations of dead (e.g., road kill) or injured animals.

Following the verbal report of a wildlife incident or observation, completion of a Wildlife Incident Report form may be requested at the discretion of the Environmental Coordinator or designate (s).

2.2.7.2 Reporting Requirements of Wildlife Occurrences

Wildlife Incident Reports provide essential information that may identify: 1) potentially dangerous situations requiring intervention (e.g., problem wildlife); 2) situations that require notification of the Nunavut Department of Environment; 3) weaknesses in garbage-handling and problem wildlife prevention measures; and 4) areas that may require warning signs (e.g., poor visibility road corners). The Environmental Coordinator or designate(s) should ensure that records of wildlife observations and incidents are thoroughly documented. Reports should attempt to include the following information wherever possible:

- Identification and number of wildlife observed;
- Specific timing and location of the observation(s);
- Details regarding the animal behavior, including direction of approach and departure, what it was doing, any aggressive behavior, etc.
- Assessment of local attractants, such as garbage, odors, movement of people, other wildlife, etc;
- If local attractants are identified as a factor, determination of what steps were or will be taken to address/remove potential attractants;
- Identification of any potential mitigation measures available to deter wildlife or limit access and how they will be implemented (refer to Section 2.2.7 for additional information on dealing with problem wildlife); and
- If an animal is destroyed, a description of the lethal measures deployed (e.g., rifle), statement of the rationale for use of lethal measures (e.g., proximity to workers, repeated incidents,

observed condition of the animal, etc.), and indication of what previous non-lethal measures were employed (e.g., deterrents, hazing, trapping and relocating (with permission from GN) etc.).

2.2.8 Protocols for Dealing with Problem Wildlife

A problem wildlife situation may arise where animal acts in an aggressive manner and/or is a repetitive nuisance or threat to worker safety. The following protocols should be used to deal with problem wildlife:

- Immediately notify the Environmental Coordinator or designate(s) of any problem wildlife issue. Reporting wildlife incidents as they occur will ensure that proactive rather than reactive measures can be taken to prevent a serious outcome (e.g., human injury, destruction of the problem animal). See Section 2.2.6 (Reporting Wildlife Observations and Incidents) for details.
- If deemed necessary by the Environmental Coordinator, notify the Conservation Officer in the Hamlet of Baker Lake or other designated Government of Nunavut representative, inform them of the problem wildlife encountered on site, discuss appropriate aversive and mitigation actions, and determine timing when lethal methods should be implemented, if necessary.
- The Environmental Coordinator or designate(s) will initiate the appropriate actions in response to a problem wildlife issue, Recommended actions include:
    - Assess potential local attractants and address or remove all those identified, where practical;
    - Utilize non-lethal deterrents (e.g., aversive conditioning, hazing, trapping and relocating), projectiles (e.g., rubber bullets) or consider trapping and relocation of animals (e.g. arctic fox), where it is considered appropriate and safe to do so (refer to Sections 3 and 4 for species-specific deterrents); and
    - Use lethal measures. Lethal measures should only be considered as a last resort in the event of aggressive animal behavior and/or repeated nuisance animals that pose a threat to worker safety and/or site facilities.
- Only authorized personnel (Environment Department) are permitted to use lethal and non-lethal projectiles (e.g., rubber bullets) or deploy traps for problem wildlife interventions.
- Do not attempt to deal with a problem wildlife issue on your own. Problem wildlife can be dangerous.
- Conform to recommendations regarding predator safety. All staff should have received a predatory mammal (i.e., grizzly bear, wolverine, wolf and fox) awareness training orientation. See Section 5.

SECTION 3 – SPECIES-SPECIFIC RESPONSE PLANS

3.1 Purpose

Response plans specific to species groups (i.e., ungulates and predatory mammals) are required to ensure that all personnel at the Meadowbank Division are provided guidance on how to respond in a manner that is safe to both humans and wildlife should they encounter wildlife on or around the project site.

3.2 Species Groups Addressed

Ungulates (caribou and muskoxen) and predatory mammals (grizzly bear, wolverine, wolf and Arctic fox) have the highest potential for interactions with humans during the life of the mine, and thus require specific response plans. If other wildlife are encountered, adaptive management strategies will be implemented if mitigation techniques and the mine policies and regulations mentioned in this document are not effective for these species. The proposed wildlife monitoring program will be the preferred measure of identifying potential areas in need of new mitigation strategies, or changes in policies or regulations.

For each of the species groups described below, the seasonal activity in the project area is discussed, as well as the protocol in the event of an encounter.

3.2.1 Ungulates

3.2.1.1 Seasonal Activity in the Project Area

Results from baseline surveys indicate that caribou and muskoxen are present in the Meadowbank area in all four seasons, but are observed in greatest abundance in the fall (e.g., October) when 1,000's of animals may be present in the vicinity of the mine and access road, and in lowest abundance in the summer (see the 'Terrestrial Ecosystem Baseline Report' for more details). Calving or post-calving aggregations or movements of caribou have not been observed within the mine study areas since baseline studies were initiated in 1999.

3.2.1.2 Response to Encounters

Caribou

It is extremely rare for humans to have physical altercations with caribou. Caribou do rut in the fall when they are at relatively high numbers on the project site and the levels of aggression displayed, particularly by males, increases substantially. There is some anecdotal information suggesting that a

bull caribou may attack a person or vehicle during the rut.
. Therefore, a close encounter with caribou (during the fall) or muskoxen could be dangerous.

If you encounter a single or herds of caribou, the following actions should be taken:

- Back away slowly;
- Ensure animal(s) have an escape route;
- Do not make sudden movements;
- Do not make loud noises or attempt to scare the animal(s);
- Use radio/satellite phone to report presence of the animal(s) to the Environmental Department;
- Stay in radio/phone contact until the animal(s) moves away or you have returned to a safe area (e.g. inside vehicle or building); and
- Wait for the animal(s) to pass before continuing work in the area

Muskox

Although considered rare, muskoxen will charge humans if they are threatened (especially lone bulls). Being a sedentary species, the muskoxen will have the tendency to stand their ground when threatened, defending their territory or their young

If you encounter a single or herds of muskoxen the following actions should be taken:

- Back away slowly;
- Ensure animal(s) have an escape route;
- Do not make sudden movements;
- Do not make loud noises or attempt to scare the animal(s);
- Use radio/satellite phone to report presence of the animal(s) to the Environmental Department;
- Stay in radio/phone contact until the animal(s) moves away or you have returned to a safe area (e.g. inside vehicle or building); and
- Leave the area and wait for the animal(s) to go away before continuing work in the area

3.2.2 Predatory Mammals

3.2.2.1 Seasonal Activity in the Project Area

Grizzly Bear

Baseline surveys indicated limited use of the Meadowbank study area by grizzly bears, which are consistent with what would be expected for grizzly bears in the north, given their wide-ranging habits and low densities. In the fall, when caribou (a prey item) are more abundant, the Meadowbank area

may have higher value for grizzly bears (see the 'Terrestrial Ecosystem Baseline Report' for more details). Furthermore, increasing hunting and food caches along the Meadowbank access road in all seasons may also attract grizzly bears to the area.

Wolverine

Wolverines occur in the project area on a year-round basis. Records of wolverine sightings or their sign were infrequent in the Meadowbank area during baseline studies beginning in 1999. Similar to grizzly bears, the limited evidence for wolverine in the area is not surprising given their wide-ranging

movements and characteristically low population densities (see the 'Terrestrial Ecosystem Baseline Report' for more details). Only one occurrence (i.e., in 2011) of a habituated wolverine has reported at the Meadowbank site since baseline studies began in 1999.

Wolf

Although they do occur year round in the project area, wolves were observed infrequently throughout the project area during all survey sessions, but were most common in the fall, perhaps in response to the increased caribou abundance at that time of the year (see the 'Terrestrial Ecosystem Baseline Report' for more details). Wolves have been one of the most frequent problem wildlife species encountered since the Meadowbank mine became operational in 2009. The majority of problem wolves were single and emaciated.

Arctic Fox

Camp personnel have regularly observed Arctic foxes close to camp and in and around camp buildings during most months of operation, including winter (see the 'Terrestrial Ecosystem Baseline Report' for more details). Arctic foxes are the most common predatory mammal species to be encountered at the Meadowbank mine.

3.2.2.2 Response to Encounters

Predatory mammals (such as wolves, wolverine, arctic fox and bears) rarely attack people; however, they are extremely strong and vicious, and should be given respect. Members of the dog family (such as wolves and foxes) are more at risk of carrying rabies, and other zoonotic diseases, and therefore should be avoided. Arctic fox in particular is easily tamed, quickly losing their fear of humans and often approaching very close. Sick or injured animals may no longer be able to feed themselves, and could be in a state of starvation. Often they show few physical signs that something may be wrong, but typically act more aggressively or even 'friendly' towards humans. Therefore, a close encounter with a predatory mammal could be dangerous. All bites and scratches from wildlife should be reported immediately to Health & Safety department since animals can be vectors for rabies.

If you encounter a predatory mammal, the following actions should be taken:

- Back away slowly and do not turn your back on the animal;
- Do not make sudden movements;
- Do not make loud noises or attempt to scare the animal if it is simply traveling through the area;

- Use radio/satellite phone to report the presence of the animal to the Environmental department;
- Stay in radio/phone contact until the animal moves away or you have returned to a safe area. (e.g. inside vehicle or building); and
- Wait for the animal to pass before continuing work in the area.

If the predatory mammal does not back away, or shows interest in you:

- Continue to back away slowly and ensure a 10 m distance between yourself and the animal;
- Make sure the animal has a safe route of escape;
- Make noise to alert the animal of your presence or to scare it off;
- Avoid provoking it;
- Return to a safe area as soon as possible (e.g. inside a building or vehicle); and
- Keep the Environmental department informed of situation using the radio/phone.

If the predatory mammal still does not back away, call for deterrent action by the Environment Department

The Environment Department is to treat all predatory mammals that are threatening or aggressive as they would treat a grizzly bear, which is perceived to be most dangerous. All predatory mammals that are showing interest in a person or mine site facilities must be aggressively deterred to prevent habituation to the mine site. Detailed response recommendations are provided in Section 3.2.2.3 below. If an animal is not of an immediate safety concern, the Wildlife Response team should discuss options to deter or remove the animal with Government of Nunavut conservation personnel.

3.2.2.3 Environment Department Protocols for Managing Problem Predatory Mammals

As part of the detailed response plan, the Environment Department will follow the procedures included here when responding to predatory mammal sightings and encounters. It is assumed that the reporting person(s) has followed procedures for predatory mammal incidents, and has requested the Environment Department to be dispatched due to the failure of human presence to deter the predatory mammal. If an animal is not of an immediate safety concern, the Environment Department should discuss options to deter or remove the animal with Government of Nunavut conservation personnel. All wildlife problems are to be recorded in the wildlife database.

The Environment Department will:

- Collect all deterrent equipment and receive briefing from the Environmental Coordinator or delegate (s) on location and circumstances of the call.
- When firearms are to be used there will always be two individuals, one person with a firearm (12 gauge) for deterrent use, the other as back up with lethal force. No lethal force will be taken without consent from the Environmental Superintendent / Coordinator in conjunction with the consultation of the Government of Nunavut Wildlife Officer unless the situation is deemed to be life threatening.
- The appropriate less than lethal deterrent will be chosen and used in an effort to scare the

predatory mammal away.

- If the deterrent is successful, the incident will be recorded in the Wildlife database and should detail the type and level of deterrent used, information on the predatory mammal involved, and all information on the circumstances leading up to the incident.

If the deterrent is not effective and the predatory mammal continues to approach or doesn't move away from the area of human activity or project footprint.

- Increase deterrent efforts to less than lethal projectile (rubber bullet) if not already being employed.
- Ensure the animal has an open escape route.
- Continue aggressive use of less than lethal projectile deterrents to try and chase the animal away.

All but the most aggressive animals should have been deterred at this point. The situation is now extremely dangerous and the Environment Department must be ready to use lethal force.

The risk to human life or property is imminent since the predatory mammal has not responded to non-lethal deterrent options and the safety of the team or mine property is now compromised.

- Shoot with the intention of stopping the threat, using the buckshot or 1-ounce lead slugs, as appropriate, to kill the animal.
- Shots should be aimed at the chest area, not the head or hind quarters
- If lethal force has been used, the Environment Department must complete a full report detailing the event immediately.
- The GN conservation officers will be notified by phone. Direction will then be given to properly dispose of the carcass.
- Any wildlife showing signs of rabies will be killed (never shot in the head) and reported.

SECTION 4 – WILDLIFE AWARENESS INFORMATION AND ENCOUNTER STRATEGIES

This section deals with general predatory mammal (ie. Wolves, wolverines and grizzly bears) awareness information and encounter strategies. It does not replace the need for all personnel to take a recognized wildlife awareness course.

4.1 Factors that Influence a Predatory Mammal's Reaction

Wolverines, wolves and grizzly bears will react differently to chance encounters with humans, depending upon many factors, including each animal's past experience with humans. Their reaction is difficult to predict because of the variability of factors with each encounter.

- Female mammals may aggressively defend her young ones (for example: Female bears with cubs are more likely to attack than to flee).
- Wolverines or bears may defending a food cache (for example :. a bear's main objective is to eat from the time it leaves its den to the time it returns to a winter den. Hunting bears will cache food after eating part of it by covering the food with dirt, branches or leaves. They will often establish a daybed nearby and return later for another meal) . Animals will aggressively defend their food cache.
- Individual Space: All predatory mammals have a minimum distance surrounding them within which any intrusion is considered a threat. A cornered or surprised predatory mammal may be dangerous. If there is no cover to retreat to, their usual response to danger is to attack or to stand its ground.
- Old, wounded or predatory mammals with teeth malformations can be dangerous because they are very hungry or starving (e.g. Wolves observed on-site in 2009)• Wolverines, wolves, artic fox and bears are easily attracted to human food sources and may become aggressive to obtain it. Predatory mammals that have obtained food from humans become "human food habituated." These mammals are accustomed to humans and link people as sources for obtaining food.
- Young animals which are inexperienced hunters and/or recently weaned are also at a greater risk to take advantage of human food source opportunities.

4.2 Animal Encounters

Most of animal safety is prevention – avoiding an encounter is the best way to stay safe while working in the home ranges of artic fox, wolverines, wolves, and grizzly bears.

4.3. How to React to Animal Encounters

Your reaction should depend on circumstances and the behavior of the mammal.

1. Stop and assess the situation before you act.
2. Does the wolverine, wolf or bear know you are there?
3. How is the animal reacting to the nearby activity?
4. Remain calm.
5. Do not turn your back on the animal.

DO NOT RUN – You will trigger the animal's natural response to chase you. Wolverines, wolves and bears are extremely fast and you cannot outrun them.

Some Simple Rules:

- Respect them – they can kill you
- Be alert at all times
- Watch for sign
- Make noise – don't surprise animals
- Travel in groups when possible
- Be cautious in noisy areas (streams)
- Know the types of areas animals use during the year
- Do not approach them
- Never feed them
- Get trained and carry deterrents
- Remember carcass equals danger – look for ravens, strong odours
- Mentally rehearse encounters

4.3.1 Specific situations : Animal Encounters

Wolverine, wolf, or bear is not aware of you:

- Leave the area quietly in the same direction that you came from.
- Move while the predatory mammal is not aware of you and stop moving when the mammal lifts its head to check its surroundings.

- Stay downwind so the wolverine, wolf or bear will not pick up your scent.
- When you have moved a safe distance away and preferably to your truck or shop where you can watch and wait until the predatory mammal leaves. .
- Report event to Environmental department immediately
-

If the wolverine, wolf or bear is unaware of you and approaching:

- Allow the mammal the right of way. Make sure there is a safe escape route and that you are not in the way.
- Return to vehicle or building when available or allow animal a wide birth.
- Report event to Environmental department immediately

If you cannot leave undetected:

- , move upwind so animal can pick up your scent; this will help them identify you as human.
- If it is possible, try to keep the predatory mammal in your sight.
- Watch to see if the predatory mammal leaves when it smells that a person is nearby.
- Report event to Environmental department immediately

If the wolverine, wolf or bear is aware of you but in the distance:

- Continue walking at the same general pace and towards a safe area (vehicle or building)
- **DO NOT RUN.**

The wolverine, wolf or bear is aware of you and close:

- A predatory mammal will feel threatened in a close confrontation. Generally their natural tendency will be to reduce or to remove the threat. Assist the wolverine, wolf or bear by acting as non-threatening as possible.
- Do not make direct eye contact.
- Do not make any sudden moves.
- Do not run.
- In the case of a bear, they need to identify you as a person, so talk in low tones and slowly wave your arms over your head.
- Attempt to give the wolverine, wolf or bear an opportunity to leave. Be sure they have an open escape route.
- Try to back away slowly.
- If the mammal begins to follow you, drop your jacket, or pack or some other article (not food) to distract the wolverine, wolf or bear. This may distract the bear long enough for you to escape.
- Report to Environmental department immediately

The wolverine, wolf or bear is close and threatening:

- If you have a deterrent such as a bear banger or bear spray be prepared to use it depending on how close the predatory mammal is.
- If you do not have a deterrent, or if using the deterrent is not successful, act as non-threatening as possible.
- Talk to the predatory mammal in a calm authoritative tone of voice.
- Do not startle or provoke the predatory mammal by making sudden moves.
- Back slowly away from the wolverine, wolf or bear and drop a pack, jacket, or some other article in order to distract the mammal momentarily.
- Remember that the wolverine, wolf or bear may be defending their cubs that you have not yet seen or they may have a food cache nearby. Attempt to look as non-threatening as possible.
- Report to Environmental department immediately

The wolverine, wolf or bear is very close and approaching:

A distance of less than 50 meters in an open area is considered very close.

- If the predatory mammal continues to approach use your deterrent when in range.
- If the predatory mammal does not respond to the deterrent you must now **STAND YOUR GROUND**!
- Report to Environmental department immediately

The wolverine, wolf or bear charges:

In the case that you have done something that has provoked the wolverine, wolf or bear into showing signs of aggression towards you. It is often not clear to the person what they have done to provoke the mammal until after the attack. It is important that you act passively, humble your posture and do not look directly at the wolverine, wolf or bear. Always keep the mammal in sight.

- Never yell or throw things as these are obvious signs of aggression

When faced with a charging wolverine, wolf or bear :

1. First use your deterrent, either a banger or pepper spray. If authorized (only Environment Department representatives or local security personnel) to carry a firearm, shoot the predatory.

2. **DO NOT PLAY DEAD IF THE PREDATORY MAMMAL CONSIDERS YOU FOOD**.

3. You must defend yourself with whatever means are available, act aggressively towards the bear.

4. Stand up on something high and try to make yourself look bigger. Try to appear dominant. Try to frighten it. Yell, scream, shout and wave your arms. Jump up and down and fight back.

5. Hold your jacket or backpack over your head to make yourself look bigger

6. If being aggressively attacked in a predatory attack, fight back. Concentrate your efforts on the face, eyes and nose of the bear. Use whatever means you have, rocks, sticks, tools, hardhat, or simply kick and punch with all the strength you can muster.
7. Report to Environmental department immediately

***There are two types of bear attacks*.**

Provoked Attacks:

- You have done something that has provoked the bear into showing signs of aggression towards you. It is often not clear to the person what they have done to provoke the bear until after the attack.
- It is important that you act passively, humble your posture and do not look directly at the bear. Always keep the bear in sight.
- Lie down on the ground in the prone position (i.e. play dead as this is a sign of submission to the bear and shows the bear that you are no longer a threat to them).
- Never yell at the bear or throw things at the bear, these are obvious signs of aggression towards the bear.
- Report to Environmental department immediately

Predatory Attacks:

- The bear is hunting or stalking you! You are being treated as potential food. DO NOT PLAY DEAD IF THE BEAR CONSIDERS YOU FOOD
- You must defend yourself with whatever means are available, act aggressively towards the bear. Stand up on something high and try to make yourself look bigger.
- Try to appear dominant. Try to frighten the bear. Yell, scream, shout and wave your arms. Jump up and down and fight back. Hold your jacket or backpack over your head to make yourself look bigger.
- Use your deterrent; either a banger or pepper spray. If authorized to carry a firearm, shoot the bear.
- Report to Environmental department immediately

4.4 Wildlife Deterrents

4.4.1 Noise

- Pencil Flare Guns are highly portable but many people have received injuries from this type of

deterrent as the pen explodes while they are holding it. This deterrent is still sold and is not recommended. Canadian Conservation Officers no longer using pencil flares.

- Pyrotechnics, including bangers, screamers, whistlers and flares. Requires a magazine launcher. These launchers look like a small handgun. There are different types available, some carry only a single shot, and some will carry multiple cartridges. The bangers, screamers and whistlers are charges that will explode and emit a variety of different noises. The name of the device indicates the noise it will make.

4.4.2 Wildlife chemical Deterrents

Bear Sprays are highly effective but they must be used correctly to be effective. As with all deterrents they have their good points and their bad points.

- The main ingredient in bear spray is “Capsicum” an extract from hot peppers.
- Capsicum needs to strike the eyes, nose or mouth of the mammal, (open membranes) to be effective.
- These sprays can only be used at very close range, 3 to 8 m or 10 to 25 ft.
- You cannot discharge the bear spray too early – or it will be completely ineffective.
- If the predatory mammal comes within the range of the bear spray – aim directly into their face and spray.
- You must be aware of the wind direction. If you the wind is blowing towards you, the spray will be carried by the wind into your face.
- Bear spray may not be effective in sub-zero weather. (Spray cans do not fire well in very cold temperatures.) In colder weather you need to keep the can of bear spray warm in order for it to fire effectively.
- Bear spray will not be effective in the rain. When you fire a can of bear spray, the spray will create a billowing cloud of capsicum and propellant. Rain can/will wash the spray right out of the air before it strikes the bear in the face.
- If you have used your can of bear spray to deter a mammal, wash the nozzle off with soap and water to remove the scent. Replace your can of spray as soon as possible. You do not want to have another bear encounter with a half a can of spray left.
- Bear sprays have a shelf life. Always replace your bear spray when you are nearing the end of the shelf life. The Capsicum does not deteriorate over time; it is the canister seals that deteriorate over time.
- Do not test your can of spray before going out into the field. You need to take a full can of spray into the field, not a partially used one.

Wildlife chemical deterrents are only to be used for the purpose they are intended for. Misuse of wildlife deterrents such as chemical sprays, bangers, and pyrotechnics is considered a criminal offence.

SECTION 5 – TRAINING PROTOCOL

5.1 Scope

The Wildlife Training Protocol outlines recommended levels of training that specific groups of people at the Meadowbank division site should receive. It is important that human activity at the site does not result in wildlife encounters that put people or wildlife at risk. All personnel on site have a role to play in ensuring human safety, conservation of wildlife, and documenting wildlife activities in the project area.

5.2 Assumptions and Key Considerations

Meadowbank must assign overall accountability, recording and reporting responsibility to the Environmental Coordinator or designate(s) if the various wildlife response plans and training initiatives are to be effective.

The Environmental Coordinator or designates (s) will be responsible for ensuring that all employees, contractors and visitors at the Meadowbank Division receive wildlife training appropriate to their roles and responsibilities.

The Environment Department will be responsible for all deterrent action whenever it is necessary to deter wildlife from mine infrastructure or personnel. All members of the Environment Department will receive specialized training in various levels of deterrent use. Security personnel and the Environment Department will be the only onsite personnel to have access to a firearm.

5.3 Training

Mandatory wildlife awareness orientation for all staff will include the following:

5.3.1 Wildlife-Human Conflict

- General restrictions for wildlife protection
- Wildlife Attractants
- Garbage Management
- Wildlife Health
- Wildlife and Vehicles
- Preventing Problem Wildlife
- Dealing with Problem Wildlife
- Reporting Wildlife Observations and Incidents

5.3.2 Wildlife Awareness Training

This orientation will be aimed at providing awareness of potential wildlife encounters that may occur at the Meadowbank Mine. The course should review:

- Wildlife that commonly occur near the mine site
- Behavior of wildlife that may be encountered near the mine site
- Wildlife encounters
- Wildlife Deterrents

5.3.3 Environment Department

In addition to the required mine site orientation the Environment Department may require additional training. The following training is recommended, especially for those without experience in situations where wildlife occurrences are common.

Bear Safety Training

Provided by qualified contractor or Territorial, Provincial or Federal Wildlife Officer, this course will provide:

- Instruction on the use of lethal and non-lethal deterrents for emergency response to bear incidents;
- Techniques for euthanizing bears during an emergency response;
- Other types of deterrent options available in non-emergency situations;
- In depth aversive conditioning techniques;
- Live trapping techniques and protocols;
- Necropsy techniques, and biological sampling; and
- Practicum.

Carnivore Safety Training

Provided by qualified contractor or Territorial, Provincial or Federal Wildlife Officer to include:

- Biology, ecology and behavior of wolverine, wolf, Arctic fox;
- Rabies and other zoonotic diseases;
- Detailed deterrent and aversive conditioning techniques;
- Live trapping techniques;
- Instruction on the use of lethal and non-lethal deterrents for emergency response to incidents involving large carnivores;
- Necropsy techniques and biological sampling; and
- Practicum.

Appendix A

Peregrine Falcon Management and Protection Plan on the Meadowbank Gold Project Site

Peregrine Falcon Management and Protection Plan on the Meadowbank Gold Project Site

Version 2 - Updated June 18, 2012

Background and Purpose:

Since 2009, peregrine falcons have been observed along the All Weather Access Road occurring in three to five quarries (Q 2,3,7,18 and 21). In June 2012, for the first time, falcon activity was observed in the Portage Pit. Subsequently a falcon nest site was observed in the South Portage Pit. In response a general mine site peregrine falcon management and protection plan was developed in accordance with the Terrestrial Ecosystem Management Plan (TEMP).

The purpose of this plan is to protect peregrine falcons from mine activities by firstly preventing them from nesting within the perimeter of active mining Pits (Portage, Goose, or Vault pits) during operation. If falcons nest in the mine pits, operations will be adapted according to the management plan and monitoring will increase to ensure protection of the falcons and their nest(s). The peregrine falcon is listed as "may be at risk" by the Canadian Endangered Species Conservation Council (2001) and the Nunavut Government (Government of Nunavut, 2001). *Falco peregrinus tundrius*, the subspecies that breeds north of the treeline, is listed as being of special concern in Canada (COSEWIC, 2002). Therefore we must ensure all activities protect these species.

Throughout the year Meadowbank environment department staff routinely monitor the pit and other areas on site for birds to ensure their protection and that the management plan is being implemented. The following document outlines specific management and mitigative measures to protect peregrine falcons in accordance with the Meadowbank TEMP.

Deterrence and Protection Plan Prior to Nesting in Portage, Goose and Vault Pit:

Level 1) Prior to and during nesting season (May 25 – July 1) an inspection of the pit walls will be conducted daily. These inspections will include a visual assessment from the bottom of the pit looking up at the wall faces, and also from the top looking down the wall faces. Records shall be kept of the dates, times, and which individual(s) carried out the inspection.

Level 2) If falcons are reported to have been seen in the vicinity of the pit or are observed by environment department staff, inspections will increase to 3 times daily; once in early morning, once at mid-day, and once again in the later evening. All sightings shall be documented as to the date, time, location, and individual(s) spotting the falcons. Owl decoys will be erected in the area where the falcons

have been seen to attempt to deter the falcons from nesting in the pit areas. Noise cannons may also be utilized.

Level 3) If sightings become regular, inspections will increase to every 3 hours including incorporating a night shift to perform inspections.

Level 4) If perching is observed or if nests are being created within the pit, the following management measures will be under taken.

A. Shoot off a pistol banger (non-pyro technique) to ease them away from their location of perching. At no time will a banger be shot in the direction of the falcon, all bangers will be shot from a safe distance away to avoid any physical harm to the bird, i.e. hearing impairment.
B. When the bird flies away it will be observed. The reason for this is that Agnico-Eagle does not want any falcon to leave one active pit, ie., South Portage and move to North Portage or from either Portage pit to Bay Goose Pit. We must ensure the falcon is deterred from the active pit areas. If the falcon re-lands within one of the pit perimeters repeat step A.
C. If a nest is being constructed, each nest will be treated on a case by case basis depending on its location. One option at this level would be to roll or place wire mesh fencing over the nesting area to preventthe return of the falcon to the nesting area.

With protective measures in place, our goal is to never have to get beyond *Level 4:A*.

Portage, Goose and Vault Pit Nest Monitoring and Protection Plan

If a nest is established and/or eggs are observed blasts will be minimized within a protective zone of the nest. It is likely that the nest will occur near the top of the pit wall. Blast vibration and noise has not appeared to have deterred the falcons from nesting near pits at this time; therefore the greatest risk to the eggs and young would be from blast fly rock. To prevent falcon disruption, the frequency of blasts will be reduced, vehicle traffic and most importantly human traffic will be reduced within a radius of ~150m from the nest. Fly rock will be monitored by video to ensure no impacts. Through controlled blasts and video monitoring of fly rock in June and July AEM will ensure that fly rock is kept to a minimum height that does not exeed the height of the nests.

In accordance with the TEMP, daily monitoring by environmental staff will be conducted with binoculars or a scope from the west side of the pit and recorded. After all blasts, environmental staff will check on the nests and record observations. Portable motion sensor automatic cameras may also be installed to record movements in the nest on regular intervals.

Based on past monitoring results of the nests along the All Weather Road (2009-2011), there is no pattern that has indicated that some young have survived while others have not due to road or quarry operations. The activities in the pit need to continue to be protective of the nests and the environmental staff will continue to monitor the activity and nests daily between June and September if a nest is observed.

Portage, Goose and Vault Pit Mine Operation Mitigation

Blasting

As a protective measure, blasting in the south pit east wall will become less frequent with smaller controlled blasts. Over the past 6 months, blasting has been optimized to reduce dilution and control fly rock by modifying blast material density, timing and patterns.

Blasts should occur less frequently and should be minimized within 150m of the nest in June and July, operations will prevent blast fly rock from disturbing the nests and video record all blasts within a 150m radius. The blast vibration and noise does not appear to have deterred the falcons from nesting nearby. Through controlled blasts and video monitoring, fly rock will be monitored to ensure it has not flown towards the nests. If blasts occur within the radius, fly rock will not exceed 60m or the height of the nest in June and July.

Mine Operations and Reduced Vehicle Traffic

Traffic should be reduced within 150m radius of the nest to protect it from dust; if traffic can not be reduced, dust suppressant should be used.

If all above mentioned measures have failed and AEM environment are not able to conform to the TEMP, the Government of Nunavut Department of Environment will be contacted by the Environment Superintendent, Environment Biologist, or Environment Coordinator.

MEADOWBANK GOLD PROJECT

Incinerator Waste Management Plan

In Accordance with Water License 2AM-MEA0815

Prepared by:
Agnico-Eagle Mines Limited – Meadowbank Division

Version 4
November
2012

EXECUTIVE SUMMARY

This Incinerator Waste Management Plan (IWMP) describes the performance limits, waste management protocols, operation, monitoring and record keeping requirements for the incinerator, as part of the Agnico-Eagle Mines Limited (AEM) Meadowbank Gold Project in Nunavut. This plan was developed in support of AEM's application for a Type A Water License from the Nunavut Water Board (NWB). This updated IWMP is a component of the Meadowbank Environmental Management System. The IWMP will be reviewed annually by AEM and updated as needed. Any changes in operation/procedures are communicated to all applicable Meadowbank Departments.

The main objective of waste management relating to the primary incinerator and waste oil furnaces is to minimize the amount of waste to be incinerated by implementing an effective waste segregation and reuse (in the case of waste oil) program to ensure that only appropriate types of waste are incinerated. The primary objective of incineration is to eliminate materials from the landfill that could create odours, attracting wildlife to the landfill site or to the Meadowbank camp; as well as to avoid the generation of leachate caused by the decomposition of putrescible materials. The primary incinerator is a dual chamber, high- temperature incinerator and is used to dispose of solid waste from the accommodation camp, kitchen, shops, and offices that cannot be landfilled. The materials to be incinerated will be limited to putrescible waste such as paper, wood, food packaging and food waste. In addition, a series of small waste oil burning furnaces will be used for the disposal of used petroleum products such as heavy lubricants and engine oil. Ash produced from the incineration process will be disposed of in the on-site landfills. A protocol will be implemented for testing incinerator and waste oil burner ash and contingent measures for alternate disposal of ash if quality is unsuitable for landfilling.

AEM has purchased an incinerator from Eco Waste Solutions that complies with applicable regulations. The incinerator is designed to achieve compliance immediately upon attaining normal full scale operation. In addition to the incinerator technology, the implementation of a waste management and segregation plan will limit emissions of dioxins and furans from the incinerator. Compliance to the performance limits will be confirmed by periodic stack testing annual initially and if the results meet the Canadian Council of Ministers of the Environment (CCME) Canada-wide Standards for Dioxin and Furans (CCME, 2000a) and the CCME Canada-wide Standards for Mercury Emissions (CCME, 2000b), then biennial as long as our waste stream has not changed.

In order to demonstrate compliance with performance limits, an annual incineration management report will be prepared and submitted to the NWB (as part of the water license annual report), Government of Nunavut (GN), Environment Canada (EC), and NIRB. The quantity and type of materials incinerated on site during operations, together with results from stack emission and ash monitoring, will be included within the annual report.

This IWMP will be maintained by AEM to reflect the current operations at the Meadowbank Gold Project, permit requirements and regulatory setting. The IWMP will be reviewed on a regular basis and revised when necessary to ensure that the project staff, operators and regulatory bodies are kept aware of any changes to project operations.

IMPLEMENTATION SCHEDULE

As required by Water License 2AM-MEA0815, Part B, Item 16, the proposed implementation schedule for this Plan is outlined below.

This Plan will be immediately implemented (October 2012) subject to any modifications proposed by the NWB as a result of the review and approval process**.** This document will supersede the Incinerator Waste Management Plan Version 2 – 2009.

DISTRIBUTION LIST

AEM – General Mine Manager

AEM – Environment Superintendent

AEM – Environmental Coordinator

AEM – Environmental Technician

AEM – Site Services Superintendent

AEM – Field Services Supervisor

AEM – Incinerator Operator

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
1	08/10/08	3 & 6	5 & 13	Revised to consider best management practices for
		App 1		Technical specifications for primary incinerator
2	09/05/12	1; 3.3; 4.1	1; 7; 8	Revised to include regulatory comments
3	12/11/16			2012 Comprehensive Review
4	12/11/16	ES; 3.1, 6.1	II, 5, 13	Stack testing will be completed biennially
		5.5	12	Adjusted quantities for mass reduction
		APP III		Include Procedure for Loading Incinerator

Prepared by: _____
Jeffrey Pratt
Environmental Coordinator

Approved by: _____
Kevin Buck
Environment Superintendent

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SECTION 1 • INTRODUCTION

1.1 PROJECT OVERVIEW

This Incinerator Waste Management Plan (IWMP) describes the performance limits, waste management plans, operation, monitoring and record keeping requirements for the primary incinerator as part of the Meadowbank Gold Project operated by Agnico-Eagle Mines Limited Meadowbank Division.

This update to the initial IWMP 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 incineration of appropriate non-hazardous solid waste generated at the Meadowbank Mine;

2. To define acceptable/non-acceptable types of solid waste to be placed in the Meadowbank incinerator; and

3. To define operating and monitoring requirements for the incinerator and waste oil burning furnaces.

The original IWMP was submitted to the Nunavut Water Board in August of 2007 as a component of the Type A Water License application for the Meadowbank Project. Part F - Item 10 (page 17) of this water license requires the following update of the August 2007 IWMP:

> *The Licensee shall submit to the Board for approval, within three (3) months of License approval, a revised Incineration Management Plan. The Plan shall consider best management practices for ash disposal.*

An IWMP is also required to fulfill Nunavut Impact Review Board (NIRB) Project Certificate commitment number 70 which states *'prepare and implement an incinerator waste management plan'* (Letter from NIRB to Cumberland dated December 30, 2006). AEM will be responsible for managing and implementing this IWMP. Implementation of the IWMP will be the responsibility of the Meadowbank Site Services Superintendent.

The primary incinerator is required for environmental and pest control. The incinerator will dispose of solid waste from the accommodation camp, kitchen, shops, and offices that cannot be landfilled at the Meadowbank Gold Project Site. The incineration of waste will divert waste, which could create odours and potentially attract wildlife, from the proposed on-site landfill. The materials to be incinerated will be limited to putrescible waste such as paper, food packaging and food waste. A series of small waste oil burning furnaces, to provide space heating, will be used for the disposal of used petroleum products such as heavy lubricants and engine oil. The waste oil burning furnaces have been included within this IWMP.

Ash produced from the incineration process is disposed of within the on-site landfills according to the Environmental Guideline for Industrial Waste Discharges (D of SD, 2002). The incinerator and waste oil burn ash will be tested to confirm its suitability for landfill disposal (Section 3.3 and 6.3). If monitoring indicates the ash is not suitable for landfilling, it will be buried within the Tailings Storage Facility (TSF). Materials buried within the TSF are expected to freeze over a period of time, resulting in permafrost encapsulation (MMC, 2007a, Doc. No. 485).

The camp is currently accommodating ~520 persons on any given day during operations, and the expected life of operation of the incinerator is 10-15 years.

1.2 INCINERATOR LOCATION

The primary incinerator is located away from the plant site and accommodations complex, adjacent to the fuel storage facility. A series of small dedicated waste oil burners will be installed in the existing Workshop and Maintenance Shops to provide space heating (see Figure 1.1).

SECTION 2 • REGULATORY CONTEXT

The following section outlines the regulatory setting relating to solid waste incinerators and waste oil burners, and discusses how the regulations apply to the incinerator and waste oil burners at the Meadowbank site.

Provincial and/or territorial regulations that pertain to emissions from incinerators were not found for Nunavut or the Northwest Territories. Therefore, performance limits for the incinerator at Meadowbank will be in accordance with the emission regulations set out by the Canadian Council of Ministers of the Environment (CCME) Canada-wide Standards for Dioxin and Furans (CCME, 2000a) and the CCME Canada-wide Standards for Mercury Emissions (CCME, 2000b).

The management of used oil is regulated in the Northwest Territories according to the Used Oil and Waste Fuel Management Regulations, N.W.T. Reg. 064-2003 (NWT, 2003). In the absence of Nunavut guidance/regulations pertaining to used oil, these regulations will be adopted for the Meadowbank site.

Ash produced from the incineration and waste oil burning process will be disposed of according to the Nunavut Environmental Guideline for Industrial Waste Discharges (D of SD, 2002).

2.1 BACKGROUND INFORMATION

Dioxins and Furans

Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), commonly known as dioxins and furans, are toxic, persistent, bioaccumulative, and result predominantly from human activity. Due to the extraordinary environmental persistence and capacity to accumulate in biological tissues, dioxins and furans are slated for virtual elimination under the CEPA, the federal Toxic Substances Management Policy (TSMP) and the CCME Policy for the Management of Toxic Substances (CCME, 2000a).

Mercury

Mercury is a naturally occurring substance, which is transformed through biological processes to methyl mercury, a persistent substance which bioaccumulates in the food chain and is particularly toxic to humans and wildlife. Mercury levels originate from a combination of naturally-occurring mercury and anthropogenically emitted mercury. Under a variety of regional, national, bi-national and internal programs, treaties and agreements, mercury is being targeted for emissions reductions consistent with the CCME Policy for the Management of Toxic Substances, which identifies that mercury shall be managed through its lifecycle to minimize release (CCME, 2000b).

Used Oil and Waste Fuel

According to the Used Oil and Waste Fuel Management Regulations (NWT, 2003) ‘used oil’ means any oil, including lubrication oil, hydraulic fluids, metal working fluid and insulating fluid, that is

unsuitable for its intended purpose due to the presence of impurities or the loss of original properties, but does not include waste oil derived from animal or vegetable fat, a petroleum product spilled on land or water, or waste from a petroleum refining operation. 'Waste fuel' means a flammable or combustible petroleum hydrocarbon, with or without additives, that is unsuitable for its intended purpose due to the presence of contaminants or the loss of original properties, and includes gasoline, diesel fuel, aviation fuel, kerosene, naphtha and fuel oil, but does not include paint, solvent or propane.

SECTION 3 • PERFORMANCE LIMITS

3.1 PRIMARY INCINERATOR

AEM has selected a Camp Waste Incinerator (model no, ECO 1.75TN 1P MS 60L) from Eco Waste Solutions, which is designed to comply with the regulations in Table 3.1, where the maximum emissions are expressed as a concentration in the exhaust gas exiting the stack of the facility. The specifications of the incinerator are available in Appendix I. In addition to incinerator technology, the implementation of the waste management plan is designed to limit emissions of dioxins and furans from the incinerator.

Table 3.1: Emission Standards for Solid Waste Incinerators

Emissions	Sector	Units	Guideline Maximum	Reference guideline
Dioxins and Furans	Municipal Waste	pg I-TEQ/m^3	80	CCME, CWS 2000a
Dioxins and Furans	Sewage Sludge Incineration	pg I-TEQ/m^3	80	CCME, CWS, 2000a
Mercury	Municipal Waste	µg/Rm^3	20	CCME, CWS, 2000b
Mercury	Sewage Sludge Incineration	µg/Rm^3	70	CCME, CWS, 2000b

Notes: Stack concentrations are corrected for 11% oxygen

At Meadowbank, the primary incinerator may be subject to either Municipal or Sewage Sludge standards based upon the total amount of waste type incinerated (>50% as one type) or upon the territorial designation of facility type. According to the Canada Wide Standards “municipal solid waste’ includes any waste that might be disposed of in a non-secure landfill site if not incinerated (i.e., non-hazardous wastes regardless of origin), but does not include “clean” wood waste.

The incinerator at Meadowbank is expected to achieve compliance immediately upon attaining normal full scale operation. Compliance to these performance limits will be confirmed by stack testing performed by an external contractor biennially.

3.2 USED OIL

AEM manages used oil and waste fuel according to the Used Oil and Waste Fuel Management Regulations, NWT Reg. 064-2003, 2003.

Table 3.2 summarizes some main points of the regulations that pertain to waste oil generated on site, as per the Waste Oil and Waste Fuel Management Regulations (NWT, 2003).

Table 3.2: Summary of Used Oil and Waste Fuel Regulations

As per 'Used Oil and Waste Fuel Management Regulations'	
Disposal	Waste oil/Waste fuel will not be disposed of directly into the environment
Storage	Waste oil/Waste fuel is stored in specifically designed container for hydrocarbons, minimizing the risk of spills Waste oil/waste fuel containers are periodically inspected for leaks or potential leaks Waste oil/Waste fuel will be stored as per the *Hazardous Materials Management Plan* (Version 2, March 2012)
Sampling and Analysis	A sample of one month's feedstock of waste oil/waste fuel is required to be tested at least once a year Waste oil will be tested for: ***Flash point*** ***Existence and amount of each impurity Listed in Table 3.3***
Burning	Waste Oil/Waste Fuel will not be burned openly Waste oil will not be burned in residential areas Waste Oil with a flash point of <37.7 degrees Celsius (^{o}C) with not be burned or blended with other waste oil/waste fuels Waste Oil that exceeds guidelines will not be burned
	14 days' notice will be given for the burning of waste fuel
Records	The following is recorded in association with the incineration of used oil: ***Volume of Used oil generated*** ***Volume of used oil incinerated/consumed*** ***Name and Address of person in charge, management or control of the used oil*** ***A summary of maintenance performed on incinerator or processing equipment*** ***The destination of the used oil products shipped from the facility***

Table 3.3 summarizes the maximum level of contaminants in used oil that can be incinerated or consumed by the waste oil burning furnaces as stipulated within the NWT Used Oil and Waste Fuel Management Regulations (NWT, 2003). Under the regulations blending of used oil that exceeds one of more of the criteria listed in Table 3.3 is not allowed.

Table 3.3: Used Oil Impurity Limit

Impurity	Units	Maximum Level Allowed in Used Oil
Cadmium	ppm	2
Chromium	ppm	10
Lead	ppm	100
Total Organic Halogens (as chlorine)	ppm	1000
Polychlorinated biphenyls	ppm	2

3.3 INCINERATOR ASH

Ash resulting from the incineration of solid waste is disposed of in the landfill and tested for metals according to the Environmental Guideline for Industrial Waste Discharges (D of SD, 2002). Ash that does not meet these guidelines will be buried within the Tailings Storage Facility (TSF). Table 3.4 summarizes the guidelines for metals parameters based on leachate test results.

Table 3.4: Guidelines for Solid Waste/Process Residuals Suitable For Landfill

Parameter	Concentration maximum (mg/L)
Arsenic	2.5
Barium	100
Cadmium	0.5
Chromium	0.5
Lead	5
Mercury	0.1
Selenium	1
Silver	5
Zinc	500

NOTE: Standards based on leachate test results

SECTION 4 • INCINERATOR OPERATION

4.1 PRIMARY INCINERATION

A typical modern controlled-air batch (dual chamber) incinerator (as purchased for installation at Meadowbank) is based on the principals of pyrolysis (starved-air burning condition) and complete oxidation (high temperature, excess oxygen and sufficient time). The incineration system is a two-stage process. In the first stage, waste is converted to gas in the primary chamber at approximately 650 to 850 ^{o}C. At this temperature any potentially infectious material is destroyed. This process is self-fueling until the volume is reduced by 90%. Gasses from the primary chamber enter the secondary chamber of oxygen rich and turbulent conditions, which is typically at a higher temperature – around 1000 ^{o}C. Combustion is complete after a minimum retention time. A used oil burner is used in the secondary chamber to reduce the quantity of fuel needed for the operation of the incinerator.

Critical process parameters and process control data as per the incinerator operation specifications such as temperature, combustion air flow and burner output are computer controlled to maintain optimal combustion conditions. These records are kept for at least 2 years.

For an incinerator capacity suitable for the predicted volumes of waste to be generated at the Meadowbank site the total particulate matter (PM) generated is extremely low. Therefore dust collection technologies such as bag house filters are not be employed, and no fly ash is generated. Ash residual from the incinerator is generated and is removed daily as required by manual removal using a shovel emptied into a metal bin.

4.1.1 Emissions

The Eco Waste Solutions Incinerator used by AEM is designed to meet performance limits described in Section 3.1. The Primary incinerator has been designed by Eco Waste Solutions using good engineering practice to ensure required dispersion of gases to meet applicable air quality standards/objectives.

The incinerator stack design incorporates appropriate sampling ports (with caps where necessary) at appropriate locations to allow for stack testing to be undertaken during incinerator operation.

4.1.2 Dust/Odour Control Measures

Modern incinerators are commonly designed such that the non-turbulent atmosphere in the primary burn chamber reduces the formation of particulate matter. Therefore, the need for additional dust and /or odour control measures is not required.

4.1.3 Staffing and Equipment

The computerized incinerator requires one to operate with the equipment for approximately 1 to 1.5 hours per day (for ash removal, loading and start-up). Operators are not required to be in attendance during the rest of the operation, as it is a fully automated process. This incinerator is designed so that the operators are not exposed to high temperatures during loading or ash removal due to complete cool down after the burn cycle. Also, the waste is not allowed to combust until the chamber is sealed thus isolating the worker from smoke and high temperatures. The operating procedure for the incinerator loading can be found in Appendix III.

4.1.4 Operator Training

Operator training was initially provided by a suitably experienced technician from the incinerator supplier/manufacturer (Eco Waste Solutions). Training for operation of the incinerator is now given by the supervisor in charge of the incinerator, who was originally trained by Eco Waste Solutions.

4.2 USED OIL FURNACE

Used oil is used as auxiliary fuel at the secondary chamber at the incinerator. This used oil burner at the incinerator has the capacity to handle approximately 200,000 liters of used oil per year. This used oil burner will reduce the amount of fuel used in the incinerator.

Dedicated waste oil burners will be installed in the existing Workshop and Maintenance Shop (see Figure 1.1) to provide space heating. These waste oil burners will have an aggregate capacity to handle approximately 10,000 liters of waste oil per year, however more may be put in service to expand our waste reduction program and minimize the shipment of this material south each year. The source of the waste oil will be from oil changes on the mining equipment and light vehicles as well as oil changes to mechanical gearboxes within the mill. Used oil furnaces include a storage tank and a filter to recover sludge prior to burning. Sludge collected in the waste oil filter is drummed and shipped south, yearly, to a licensed disposal /recycling facility for treatment.

4.3 CLOSURE PLAN

In accordance with the Preliminary Closure and Reclamation Plan (MMC, 2007b, Doc. No. 511), salvageable buildings and surface structures, including the primary incinerator and used oil furnace, will be dismantled and demobilized from the site. No structural material will be incinerated during the closure phase of the mine.

SECTION 5 • WASTE MANAGEMENT

The amount of waste will be reduced through purchasing policies that focus on reduced packaging and on-site diversion and segregation programs. At Meadowbank the main objective of the waste management plan relating to incineration and the waste oil burning furnaces is to minimize the amount of solid waste to be incinerated by following an effective waste segregation and reduction program to ensure that only appropriate types of waste are incinerated.

Figure 2 provides a schematic diagram for the management of solid waste and used oil produced on site.

5.1 APPROACH

A waste segregation and reduction program is implemented at the site (i.e. the separation of non-food waste items suitable for storage and subsequent transport and disposal or recycling). This will allow materials that are unsuitable for incineration to be either landfilled on site or hauled offsite to a licensed disposal facility. The waste segregation program will also document the quantities and types of materials that are incinerated. In addition AEM are now incorporating a waste reduction strategy for materials that originally were being incinerated. For example styrofoam coffee cups and plastic lids will be eliminated from general site use in 2012 and replaced with stainless steel mugs and re-washable plastic cups. Other materials will be considered during the life of mine for elimination from the incinerator waste stream.

5.2 ACCEPTABLE WASTE FOR INCINERATION

Acceptable wastes for incineration, in the primary incinerator as per the operational instructions, include the following:

- Organic matter including food;
- Food containers and wrappings including plastics that are contaminated by food;
- Paper and cardboard; and
- Dead animals (small size only).

Acceptable wastes for incineration in the used oil furnaces include the following:

- Waste oils; and
- Flammable or combustible petroleum hydrocarbons unsuitable for its purpose due to the presence or contaminants or loss of original properties (such as gasoline, diesel fuel, aviation fuel, kerosene, naptha or fuel oil).

5.3 UNACCEPTABLE WASTE FOR INCINERATION

Materials that are not listed above are unacceptable for incineration. These materials include, but are not limited to:

- Uncontaminated plastics, including chlorinated plastics;
- Inert materials such as concrete, bricks, ceramics, ash;
- Bulky materials such as machinery parts or large metal goods such as appliances;
- Radioactive materials such as smoke detectors;
- Potentially explosive materials such as propane tanks, other pressurized vessels, unused or ineffective explosives;
- Other hazardous materials such as organic chemicals (PCBs, pesticides), other toxics (arsenic, cyanide);
- Electronics;
- Batteries;
- Asbestos;
- Dry wall;
- Vehicles and machinery;
- Fluorescent light bulbs;
- Whole tires; and
- Any materials containing mercury.

Unacceptable wastes for incineration in the used oil furnace include the following:

- Used oil that exceeds the Maximum Impurity Limits for parameters listed in Table 3.3;
- Waste oil with a flash point of less than 37.7 deg C;
- Paint;
- Solvents; and
- Propane.

5.4 WASTE VOLUMES

5.4.1 Solid Waste

The quantity of waste being incinerated is averaging 1750 kg per day during operations with a camp size of ~520 persons during operations.

5.4.2 Used Oil

The quantity of used oil generated from the servicing of machinery and generators is estimated at approximately 427,000 liters per year (Meadowbank Gold Project – 2011 Annual report).

5.4.3 Incineration Ash

The quantity of ash from the incinerator is approximately 240 tonnes/year, assuming that the incineration process results in a 63% reduction in mass. Assuming the ash has a total density of 1.2 tonnes / m^3, then a volume of approximately 200 m^3 / yr of ash will require disposal. Incinerator ash will be located in the Landfill in the Waste Rock Storage Facility. When the ash is placed in the landfill it will immediately have waste that is in landfill placed on top of the ash to disallow the material to be windblown.

5.5 WASTE INCINERATION RATE

The incinerator has an approximate incineration capacity of 1750 kg / h based on a 10 hour burn cycle. If this cannot be achieved the primary chamber can be used as storage. According to the Eco Waste Solution, the type of waste that is used will never exceed the weight limit. To ensure maximum efficiency, 3 quarters of the chamber has to be filled to ensure that the gas outlet of the primary chamber is never blocked.

The system has a sizable front door for easy access to manually load feed waste into the unit with a front end loader. Dry waste (paper, cardboard) and wet waste (organic matter including food) will be layered to ensure proper combustion and maximum efficiency according to the incinerator operational instructions.

The batch cycle for the Primary Chamber typically lasts approximately 8 hours for the burn cycle and is followed by a cool down of approximately 10 hours. The Secondary Chamber operates with a retention time of approximately 2 seconds.

SECTION 6 • MONITORING AND TESTING

The following presents the monitoring and testing plan for the incinerator.

6.1 INCINERATOR EMISSIONS TESTING

The incinerator stack design incorporates appropriate sampling ports at appropriate locations, in right angle configuration, to allow for stack testing to be undertaken during incinerator operation. Table 6.1 summarizes the frequency of testing that is completed.

Table 6.1: Summary Of Incinerator Emissions Testing

	Frequency	Number of Test Required	Relevant Guideline
Furans and Dioxins	Biennial	3	CCME, CWS 2000a
Mercury	Biennial	3	CCME, CWS 2000b

6.2 WASTE OIL TESTING

A sample of one month's feedstock of waste oil / waste fuel is tested each month. Waste oil that does not meet the regulation impurity limits is drummed and shipped off site each summer to a re-refining facility or licensed disposal facility.

6.3 ASH TESTING

Ash samples were collected from the incinerator on July 1, August 22, and September 21 of 2009; October 5, 2010; February 23, 2011 and September 13, 2011; and February 14, 2012 in accordance with AEM's previous 'Incinerator Waste Management Plan' (AEM, May 2009, v2). The purpose of sampling ash is to determine its acceptability for disposal in the landfill, pursuant to the Government of Nunavut (GN) Environmental Guidelines for Industrial Discharge (2002). The samples met all of the GN discharge guidelines and therefore demonstrate the incinerator ash is acceptable for disposal in the Meadowbank landfill.

Ash samples will be collected and tested annually, or upon a significant change in the source or type of material sent to the incinerator. If monitoring indicates the ash is above the guidelines and not suitable for landfilling, an investigation will be undertaken to identify the cause and eliminate the source for this exceedance. Ash with elevated metals concentrations will be buried within the Tailings Storage Facility (TSF); materials buried within the TSF are expected to freeze over a period of time, resulting in permafrost encapsulation (MMC, 2007a, Doc. No. 485). If deemed necessary, the ash will be packaged in drums and sent to a licensed hazardous waste disposal facility in the south.

SECTION 7 • MAINTENANCE

Annual maintenance of the incinerator is scheduled. This maintenance is preformed to evaluate the insulation and structural integrality of the incinerator. This is done to be sure the incinerator is functioning at its optimal standard.

When this maintenance is being performed 4 small single chambered incinerators will be used to incinerate the waste that would normally be disposed in the Eco Waste main unit, to prevent a back log of putrescible waste which would attract wildlife.

SECTION 8 • REPORTING

In order to demonstrate compliance with performance limits, an annual incineration management report will be submitted as an Appendix in the Meadowbank Gold Projects Annual Report to the NWB, Government of Nunavut (GN), Environment Canada (EC), and NIRB. The quantity and type of materials incinerated on site during operations, together with results from periodic stack emission and ash monitoring, are to be included within the annual report.

8.1 NATIONAL POLLUTANT RELEASE INVENTORY

The NPRI is a Canadian database containing information on the annual on-site release of specific substances to the air, water and land from industrial and institutional sources (EC, 2007). The NPRI provides a list of tracked substances and requirements for reporting incinerator emissions. Table 7.1 lists the substances under the NPRI that Meadowbank is required to report annually. In addition, there are certain substances as indicated in Table 7.1 that may require reporting depending on the quantity of incinerator emissions. Whether or not reporting is necessary will depend on results of the periodic stack emission testing data and the quantity of annual emissions calculated with emission factors.

Table 8.1: NPRI Incineration Reportable Substance List

Substance Name	Notes
Hexachlorobenzene	Required to Report
Dioxins and Furans	
Carbon Monoxide	Required to Report if released to air from facility in a quantity of 20 tonnes or more per annum
Oxides of nitrogen	
Sulphur dioxide	
Total Particulate matter with diameter <100 microns	
Particulate matter with diameter less than or equal to 10 microns (PM10)	Required to Report if released to air from facility in a quantity of 0.5 tonnes or more per annum

Particulate matter with diameter less than or equal to 2.5 microns (PM2.5)	Required to Report if released to air from facility in a quantity of 0.3 tonnes or more per annum

8.2 GREENHOUSE GAS EMISSIONS

AEM is committed to reporting greenhouse gas emissions (GHG) in support of Canada's Voluntary Challenge Registry; currently termed the Canadian GHG Challenge Registry. AEM will develop a baseline and monitoring system for GHG to evaluate and report on progress in improving efficiency and reductions in GHG.

SECTION 9 • PLAN REVIEW AND CONTINUAL IMPROVEMENT

This Incinerator Waste Management Plan will be maintained by AEM to reflect the current operations at the Meadowbank Gold Project, permit requirements and regulatory setting. The Plan will be reviewed on a regular basis and revised when necessary to ensure that the project staff, operators and regulatory bodies are kept aware of any changes to operational procedures.

The up to date Incinerator Waste Management Plan will be made available at all times by AEM for review by the NWB, Government of Nunavut, and Environment Canada.

SECTION 10 • REFERENCES

CEPA, 1999. Canadian Environmental Protection Act. March 31, 1999

Canadian Council of Ministers of the Environment (CCME), 2000a. Canada-Wide Standards for Dioxins and Furans, May, 2000

Canadian Council of Ministers of the Environment (CCME), 2000b. Canada-Wide Standards for Mercury Emissions, June 2000

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Letter from Nunavut Impact Review Board to Cumberland Resources Ltd, dated December 30, 2006 Re: Meadowbank Gold Mine Project Certificate; Nunavut Land Claims Agreement Article 12.5.12.

Meadowbank Mining Corporation (MMC), 2007a. Type A Water License Application. Doc. No. 485, dated August 2007.

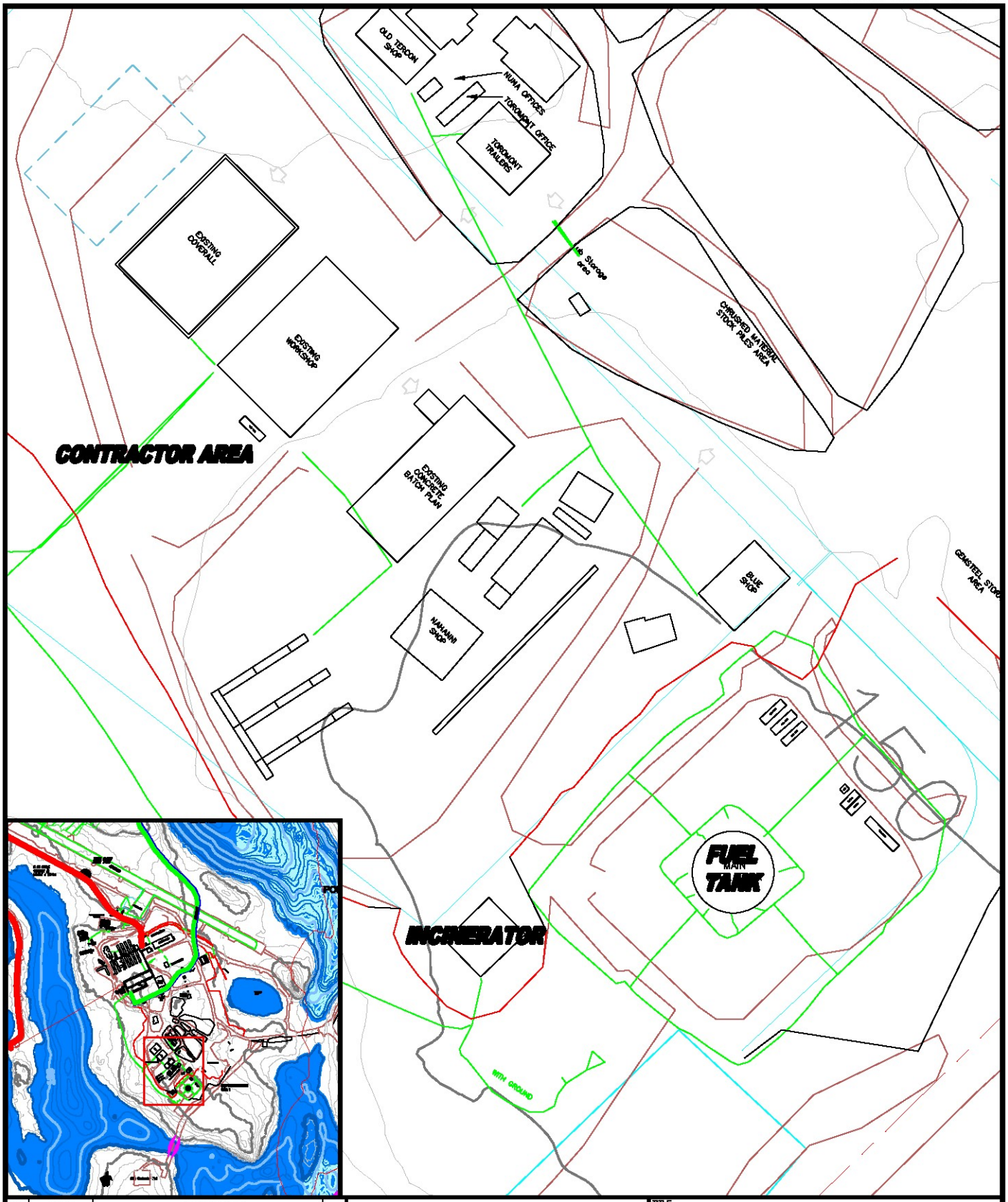
Meadowbank Mining Corporation (MMC), 2007b. Meadowbank Gold Project Preliminary Closure & Reclamation Plan. Doc. No. 511, dated August 2007.

Meadowbank Mining Corporation (MMC), 2007c. Meadowbank Gold Project Hazardous Materials Management Plan. Doc. No. 457, dated August 2007.

Meadowbank Mining Corporation (MMC), 2007d. Meadowbank Gold Project Water Quality and Flow Monitoring Plan. Doc. No. 450, dated August 2007.

National Guidelines for Hazardous Waste Incineration Facilities - Design and Operating Criteria, Volume 1, March 1992, (CCME).

NWT, 2003. Used Oil and waste fuel management regulations, 2004, NWT Reg 064-2003. January 1, 2003.



REV	DATE	DESCRIPTION	BY

REVISIONS

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AGNICO-EAGLE

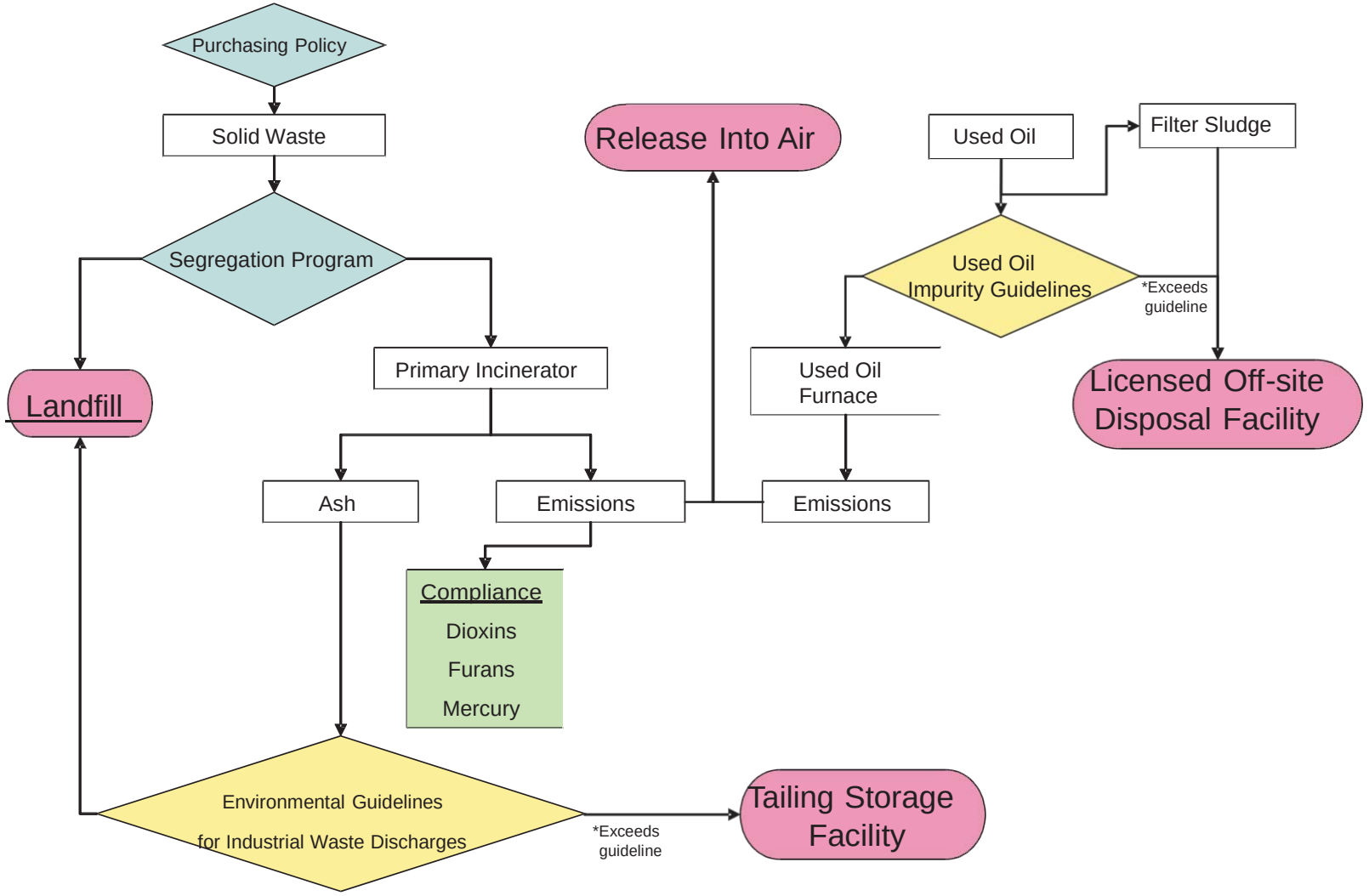
TITLE
AGNICO–EAGLE – MEADOWBANK DIVISION
FIG.1.1 INCINERATOR & WASTE OIL BURNERS LOCATION

PROJECT No.	DATE 05/2009
DRAWN BY	SHEET 1/1
APPROVED BY	
DRAWING NO.	AE.\ISION

N:\Drowings\r.IEADOWBANK PL.ANNING.dwg, 02 Jun 2009

FILE NO. .DWG

DRAWING DATE: 07-Dec-07 COREL FILE: N:\Bur-Graphics\Projects\2007\1413\07-1413-0047\Drafting\6000\0714130047-6000-A_03.cdr



KEY:
Yellow fill indicates where a particular test is required
Pink fill Indicates final disposal or release
Blue fill indicates waste management practices/decisions to be made
Green fill indicates where compliance testing is required

PROJECT

AEM

AGNICO-EAGLE MINES LIMITED
MEADOWBANK DIVISION

TITLE

PROCESS FLOW CHART FOR WASTE INCINERATION

Golder Associates

PROJECT No. 07-1413-0047			FILE No.	
DESIGN	LL	07DEC07	SCALE NTS	REV.
CADD	LL/GG	07DEC07	FIGURE 2	
CHECK				
REVIEW				

APPENDIX I

TECHNICAL SPECIFICATIONS:
ECO WASTE SOLUTIONS INCINERATOR
MODEL NO. ECO 1.75TN 1P MS 60L

TECHNICAL DATA SHEET

Technical Data

Supply all technical data for each item applicable, in the format shown on the following pages. Include drawings necessary for a technical evaluation of each item.

Equipment Number	TBD
Equipment Description	Camp Waste Incinerator
Manufacturer	Eco Waste Solutions
Model Number	ECO 1.75TN 1P MS 60L
Total Installed Weight, kg	44,500 kg (estimated with building)
1 Waste Incinerator	
Waste classification: (TYPES)	1. Camp Waste
	2. Sewage Sludge
	3. Waste Oil
Mixed waste charge classification: Break-down of each type of waste (%)	1. Camp Waste - 75%
	2. Sewage Sludge - 25%
	3. Waste Oil - N/A charged into secondary
****Emissions:**	
SO_2 (mg/m^3)	50 mg/m^3
CO (mg/m^3)	7 mg/m^3
NOx (ppm)	< 50 ppm
VOCs $\mu g/m^3$	50 - 2000 $\mu g/m^3$
Particulate (mg/m^3)	20 mg/m^3
PM_{10} (g/s)	N/A
Dioxins/Furan (pg I-TEQ/m^3)	< 80
Mercury ($\mu g/Rm^3$)	N/A - Materials cotaining Mercury to be excluded from incinerator waste stream
Flue Gas Temperature (°C)	1000°C
Flue Gas Flow Rate (kg/s)	1.996 kg/s (max)
Incineration capacity: (kg/h)	175 kg/h (10 hour burn)
Charge per cycle: (kg)	1750kg
Burning rate: (kg/h)	175 kg/hr average
Off-time per cycle: (h)	6 hr cool down
Heat value: (kJ/kg or BTU/lb)	5125 BTU/lbs (Solid and Sewage sludge mixed waste)

**The emission estimates provided are given as volumetric concentrations or pollutants; as per test reporting standards. Estimates are based on previous air emission tests.

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	Fuel mixing ratio with waste oil (if applicable)	N/A
	Capability to burn waste oil with loading rate (kg/h)	60.6 kg/h (8 hour liquid burn)
	Applicable auxiliary burner.	N/A
	Incinerator to bear CSA label?	All electrical components CSA or UL approved. Approval of complete incinerator package at additional cost..
	Temperature: Primary chamber (°C):	705°C
	Temperature: Secondary chamber (°C):	1000°C
	Burner Efficiency:	High
	Internal Volume of Primary Chamber:	2.43(l) x 2.43(w) x 2.29(h) m
	Internal Volume of Secondary Chamber:	1.83 (dia) x 5.49(l) m
	Destruction efficiency	95% DRE
	Tested Emission results (rates)	- See Section 1 (Emissions)
	Stack internal diameter (mm)	965mm
	Height of Stack (m)	7.62m
	Stack materials of construction	Refractory Lined - Mild Steel (44W HSLA)
	Spark Arrester length (mm)	1092mm
	Spark Arrester open area (m^2)	0.425m^2
	Burner System	Primary Burner - Riello RL28/2
		Secondary Burner - Qty(2) Riello RL100/M
		Liquid Waste Burner - Eco Waste Solution Liquid Waste Oxidizer
	Valve Train	N/A - Integrated in Burners
	Charging System	N/A - Batch System
	Charging opening size	1.78m (w) x 1.43m(h)
	Charging Chute size	N/A - no chute
	Ash Removal System	N/A - Manual
	Expected ash production per cycle (kg)	200kg (estimated)
	Maximum Capacity of ash removal system	N/A
2.	**Materials of Construction**	
	External Casing	Mild Steel (44W HSLA)
	Spark Arrester	Stainless Steel (SS 304)
	Insulation in Primary Chamber	Walls - Ceramic Fibre Blocks (152mm (6") Thick)
		Floor, Door Sills & Breech entrance - Castble (101 - 152mm (4-6") Thick)
	Insulation in Secondary Chamber	Walls - Ceramic Fibre Blocks (152mm (6") Thick)
		Breech exit & Stack Entrance - Castable - (76 -152mm (3-6") Thick)
	Insulation in Stack (materials and thickness)	Insulating Castable (76mm (3") Thick)
	Charging Chute	N/A
	Paint System Used	Carboline - Silicon Zinc Primer, Silicon Finish
	Dry Film Thickness of Paint	Primer - 2 mils (50 micron)
		Final Coat - 2 mils (50 micron)
	Primary Chamber Burner Rating	(663 - 1266)x10^3 KJ/hr
	Secondary Chamber Burner Rating	(1582 - 6119)x10^3 KJ/hr
3.	**BLOWERS**	
	Blower Manufacturer	New York Blower
	Primary Chamber Blower Capacity (m^3/hr)	2696
	Primary Blower Pressure (kPag)	0.25
	HP/ RPM	1.15 hp @ 2200rpm
	Secondary Chamber Blow Capacity (m^3/hr)	4247
	Secondary Blower Pressure (kPag)	0.5
	HP/ RPM	1.9hp @ 4900 RPM
4.	**CONTROL SYSTEM**	
	Please list all instrumentation and details including	- Please See Appendix A (Attached)
	CSA approval and labelling:	

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5.	**INCINERATOR BUILDING (if applicable)**	
	Overall Length (mm)	12 192mm
	Overall Width (mm)	12 192mm
	Overall Height (mm)	6420 mm
	Shipping Dimensions (mm)	6660 x 3050 x 914 mm
6.	**DIMENSIONS**	
	Overall Length (mm)	6 858 mm
	Overall Width (mm)	7 188 mm
	Overall Height (mm)	11 049 mm
	Shipping Dimensions (mm)	**Largest Pieces (L x W x H) mm**
		Primary Chamber - 3403 x 3225 x 2895
		Secondary Chamber - 6172 x 2413 x 2794
		Shipping Container - 12 000 x 2438 x 2591
7.	**WEIGHTS (KG)**	
	Incinerator	20 275 kg
	Stack	4082 kg
	Blowers & Burners	400 kg (Blowers) 580 kg (Burners)
	Total Weight	25 337kg

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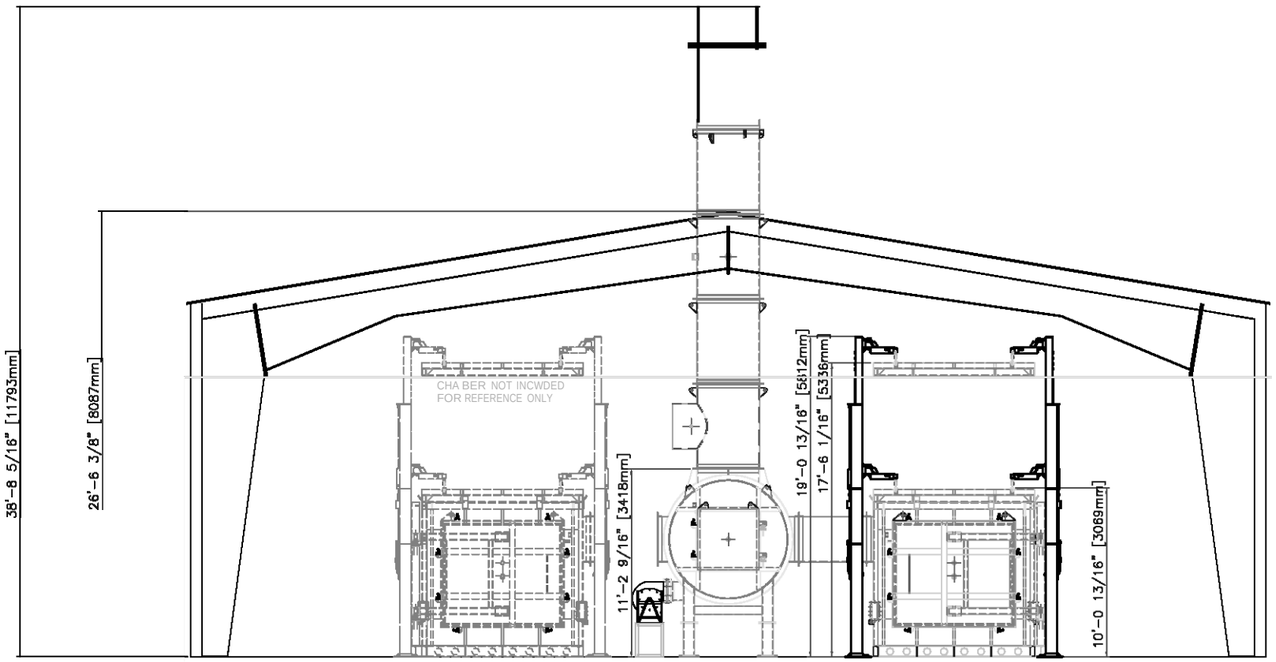
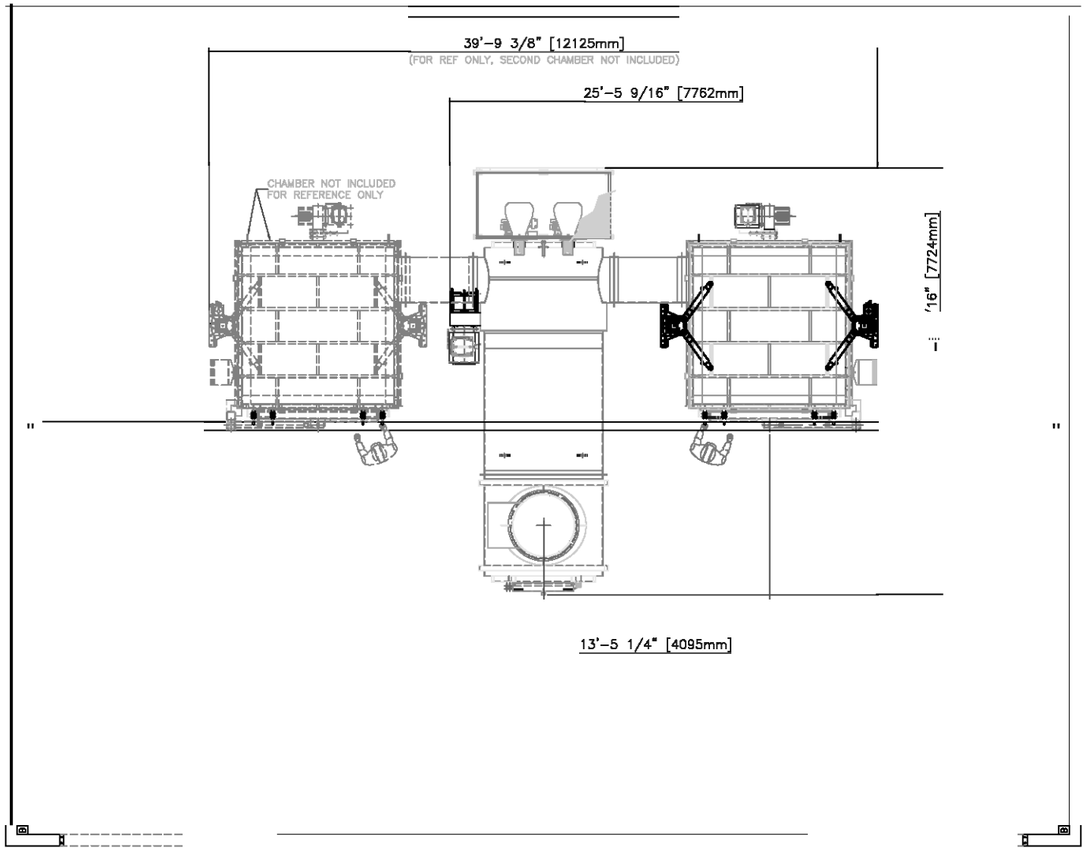
FOR: REVIEW ONLY.

BILL OF MATERIAL		
11M. QIY.	DESCRII'TION	WEIGHT kg.





REV.	DESCRII'TION	APPROVED

THIS DOCU ENT IS THE PROPERTY OF ECO BURN INC. AIID SHALI. NOT BE USED, COPIED DR TRANSFERRED TO OTHER DOCUMENTS WITHOUT PRIOR WRITIEN PERMISSIOII OF ECO W>.S1E SOLUTIONS.

DRAWN: J.S.	DAIE: 19-08-0B	BCO WASTE !, !: TIONS
CHECKED:	DAIE:	
PROJECT NAL.E: HATCH — MEADOWBANK		CUSTOLIER P.O.
PROJECT NUMBER: MDB-S-268		CUSTOMER EQUIPMENT. T
SCALE:	JOB .NO: OB-2MS	TITLE: BUILDING DRAWING HATCH MEADOWBANK
THIRD ANII.E -$8		DWG. NO. MDB-EC01.75TN1PMS60L-XXX REV.

APPENDIX II

ANNUAL COMPLIANCE AND REPORTING TEMPLATE

Appendix 2
Annual Report for
Incinerated Waste Management

Contact Information			
Company Name:			
Contact Name:		**Position**	
Contact Email:			
Address			
City/Town:		**Province:**	
Postal Code:			
Telephone:		**Fax:**	

Incinerator Data and Information

Name of Emission Unit	

Type of Process	

Description of Process	

Description of Material Produced from incineration	

Manufacturer of Emission Unit	

Model No.	

Dates of Commencing:	**Date**
Construction	
Operation	
Modification	

Operating Information	**Hour/day**	**Days/week**	**Weeks/year**
Maximum Operating hours			
Average Operating hours			

Annual Throughput	Dec-Feb (%)	Mar-May (%)	Jun-Aug (%)	Sep-Nov (%)

Incinerator Charging Rate	Maximum (kg/day)	Average (kg/day)	Annual (tonnes/year

Appendix 2
Annual Report for
Incinerated Waste Management

Waste Description	Maximum Rates		Average Rates	
Type of Waste Material	kg/day	tonnes/year	kg/day	tonnes/hour

Fuel Usage Data	Maximum	Typical
Firing rate		

Fuel Type	

Sector Determination:	Check Applicable Box
Municipal Waste Incineration	
Sewage Sludge Incineration	

Stack Emissions Tests For Compliance (must be corrected for 11% oxygen)

	Date	Test 1	Test 2	Test 3	Average	**Compliance (check)**
Furans and Dioxins						
Mercury						

Provide Test method details:

Appendix 2
Used Oil Impurity Limits

Contact Information			
Company Name:			
Contact Name:		**Position**	
Contact Email:			
Address			
City/Town:		**Province:**	
Postal Code:			
Telephone:		**Fax:**	

Volume of Used Oil Generated:	

Volume of Used Oil incinerated/Cons	

Sample Analysis:

Flash Point:	

Impurity	**Units**	**Maximum Level Allowed**	**Sample #**			
Cadmium	ppm	2				
Chromium	ppm	10				
Lead	ppm	100				
Total Organic Halogens (as chlorine)	ppm	1000				
Polychlorinated biphenyls	ppm	2				
Ash content	%	-				

Volume of Products Produced from Used Oil Use:

Maintenance Performed on Incinerator:

Destination of Used Oil not Incinerated:

Appendix 2
Guidelines for Ash Testing
Environmental Guidelines for Industrial Waste Discharges

Parameter	Concentration maximum (mg/L)	Sample Number		
Ammonia Sulphide	100			
Benzidine	100			
Benzyl Chloride	100			
Enthalamine	100			
Ethylenediamine	100			
Maleic Anhydride	100			
Potassium Permanganate	100			
Quinoline	100			
Strychnine	100			
Tetrachloroethanes	100			
Arsenic	2.5			
barium	100			
Cadmium	0.5			
Carbon tetrachloride	0.5			
Chromium	0.5			
Cyanide (free)	20			
DDT	3			
Endrin	0.02			
Heptachlor + Heptachlor epoxide	0.3			
Lead	5			
Lindane	0.4			
Mercury	0.1			
Methoxychlor	10			
Methyl ethyl Ketone	200			
Metolachlor	5			
PCBs	50*			
Selenium	1			
Silver	5			
Tetrachloroethylene	3			
Toxaphene	0.5			
Trialomethanes	10			
2, 4, 5-TP (Silvex)	1			
Zinc	500			

* based on concentration by mass

APPENDIX III

MBK-SIT-0011 – INCINERATOR LOADING

Incinerator Loading

	PROCEDURE NUMBER:	**MBK-SIT-0011**	
People concerned	• **Agnico-Eagle employees working on the AWPR**	**Prepared by**	Site Services
		Approved by	Roger Sauvé, Site Services General Foreman
Issuing date :	2011-11-30		
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 load the incinerator

Concerned departments:

Site services

Required equipment

- Proper Protective Equipment: mask, glasses, fire retardant coveralls, welding gloves, rechargeable mask, face shield

Impacts

Health & Safety

Process/Quality

Costs

Environment

Incinerator Loading

Procedure	Risks/ Impacts
1. There are 2 BLUE ash bins, one of which has an ORANGE spray on it. There is a sign on the yard which indicates a cold and hot side. The one with the cold side could be dumped into the roll off. 24 hours after ash deposition	Prevent incident and /or accident
2. After the dumping of the ash bin, inspect the roll off bin to ensure there is no red hot ash that will start a fire	
3. If there is smoke or red ash seen, ask the team leader to arrange for the small water truck located in the incinerator to give it a good spray of water to avoid a fire	
4. Bring empty ash bin into the incinerator building for the new batch	
5. Go outside of the incinerator and move the ash bin from the hot side to the cold side	
6. Close the breaker switch to the OFF position for the primary chamber and lock it using Ensure a “Zero State of Energy” and follow lock-out- Tag out Standard MBK- HSS-0010	
7. Turn on the primary chamber exhaust vacuum system	
8. Open the door and make sure the burn is good; If not: call the supervisor or team leader	
9. Tie the door in the open position for safety	

10. Empty the chamber and remove all ashes using large shovels into the ash bin	
11. When taking out the fresh ash bin, make sure to put on the hot side of the sign	
12. Once the chamber is completely cleaned, load the bottom row with medium wet bags	
13. Put two layers of contaminated cardboards and contaminated rags	
14. Put one row of dry garbage bags	
15. Put two more layers of cardboard and rags	
16. Put one row of dry to wet bags	
17. Continue the same way and finish with the wet bags on top and no cardboards (this will help keep the flames from coming up and also prolong the life of the chamber since the flames are not in direct contact with the top wall of the chamber, it will also cut down on having to reset the burner which is caused by the flame being high at the top)	
18. Close the door and make sure all the locking latches are in proper position	

19. Turn off the primary chamber exhaust vacuum system	
20. Unlock the primary chamber breaker and turn it to the ON position	
21. Start the burning cycle - Never open the door after the start - If the burner does not start, call team leader or supervisor	
22. Do not store any flammable products around the primary and secondary chambers within the marked area - Never add any accelerant into the chamber to help the start	

MEADOWBANK GOLD PROJECT

Operation & Maintenance Manual
Sewage Treatment Plant

In Accordance with Water License 2AM-MEA0815 & 8BC-TEH0809

Prepared by:
Agnico-Eagle Mines Limited – Meadowbank Division

Version 3
February 2013

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.

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-MEA0815, Part B, Item 16, the proposed implementation schedule for this Plan is outlined below.

This Plan will be immediately implemented (April 2012) 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

Prepared By: _____
Environmental Department

Approved by: _____
Kevin Buck Environment Superintendent

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Section 3 – Operation and Maintenance 12

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Appendix B: Nordikeau RBC Operations Manual……51
Appendix C: Sample Daily/Monthly Record Sheets……..133
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SECTION 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-MEA0815, Part D, Item 19, 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 (2017). 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	867-796-4610 ext 6724
STP Operator	867-796-4610 ext 6758
Environmental coordinator	867-796-4610 ext 6728

SECTION 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.

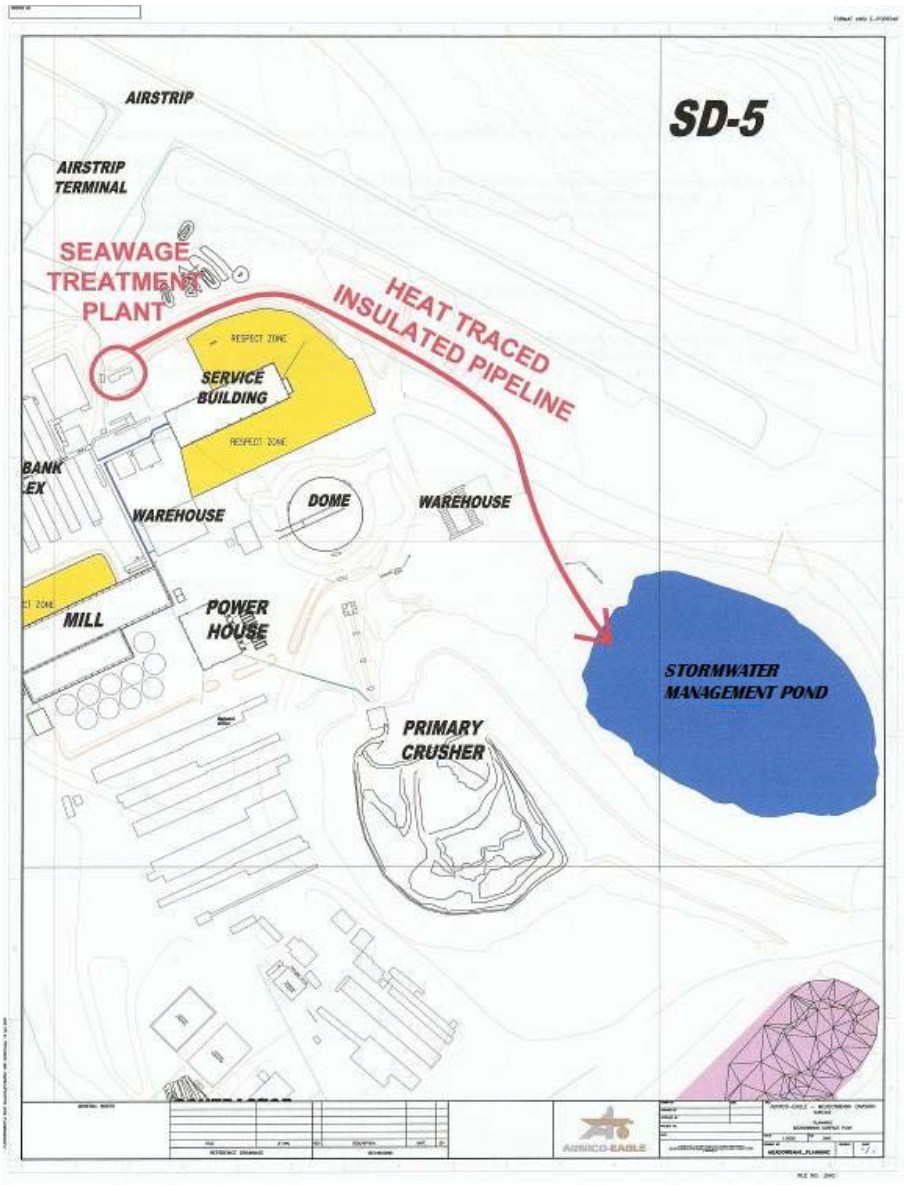

Figure 1 – Flow Diagram

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 is monitored monthly and the composition water exiting the units is monitored monthly (to determine plant efficiencies). Average results for 2011 are presented in Table 2 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	310
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

SECTION 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
- 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 co-disposed with the mill tailings (TSF) or placed in the camp incinerator.
- 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
- 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.

Effluent sampling of the final discharge from the Seprotech and Biodisk RBC units is conducted weekly. Parameters include,

- Ammonia
- Biological Oxygen Demand (BOD_5)
- COD
- Nitrate
- Nitrite
- Faecal Coliforms
- Total Coliforms
- pH
- Total Suspended Solids
  Total Phosphorus

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; and
- Working with sewage requires adequate protection for operators. This includes wearing steel toed boots, hard hat, safety vest, protective glasses and protective gloves.
- 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.

SECTION 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*" prepared by AEM in October 2008 and revised in March 2012.

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*" prepared by AEM in August 2008 and revised in December 2011.

4.3 PLANT MALFUNCTION

In the event of a failure of one of the three operating RBC's (ie 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; and
- Shut down all water use in the camp until the repairs are complete.
- 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

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INSTALLATION, OPERATION AND MAINTENANCE MANUAL

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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)

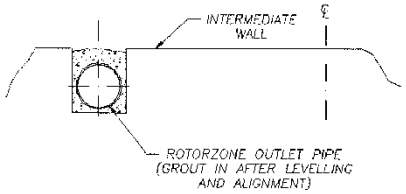


Figure a - **ROTORDISK®** tank outlet through intermediate wall between settlement tank chambers.

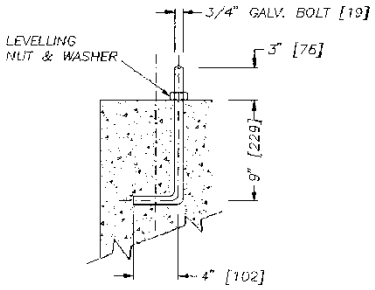
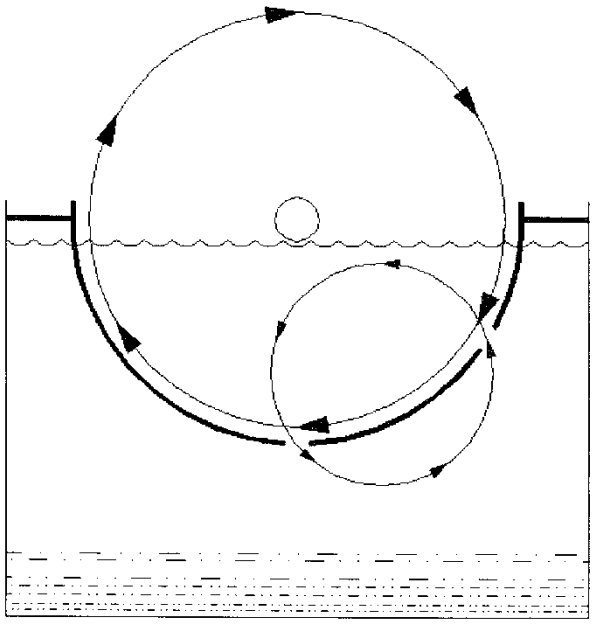


Figure b - anchor bolt detail for **ROTORDISK®** tank.

1.2 - DIRECTION OF SHAFT ROTATION



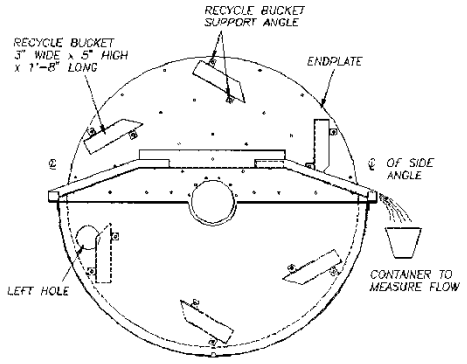
The direction of shaft rotation should be such that disks mounted on shaft will enter water on the side where inlet to "Rotorzone" is located. The electric motor driving the shaft should be wired accordingly.

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 6 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.

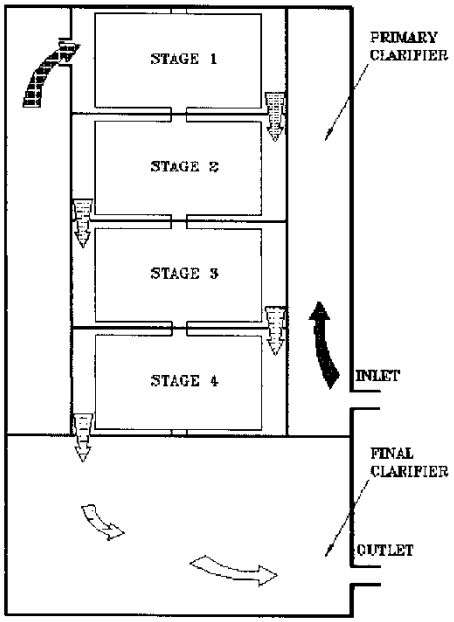
The rotation of the disks in and out of the water provides a mean of air and heat transfer from the ambient air to the water. The transfer of air to the water is important for aerobic bacteria to remove BOD and ammonia. The transfer of heat to the water is important to maintain the water at an optimum 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

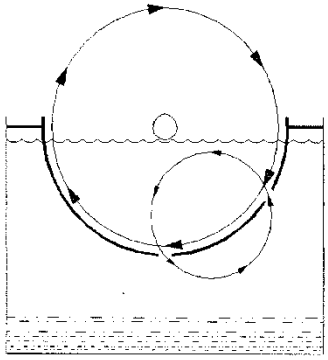


Figure c-unit operating at maximum sludge storage levels. Neither influent flows, nor re-circulating flows, disturb sludge blanket.

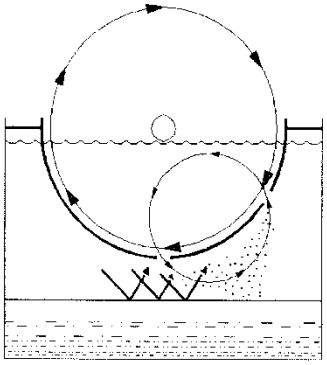


Figure d- unit operating with excess accumulations. Influent flows may disturb sludge blanket and increase BOD and solids loads to Rotorzone to levels above treatment design.

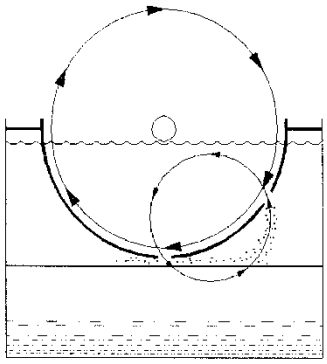


Figure e-Unit operating with excess sludge accumulated to base of Rotorzone. Both influent flows and re-circulation flows will disturb and carry sludge solids. Increase in BOD and solids loads entering Rotorzone will be substantially above design treatment levels, increase accumulated masses on rotating 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.

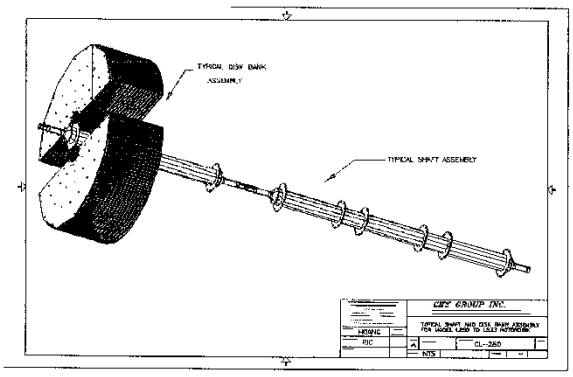


Figure f - typical mounting of disk banks on the shaft(s).

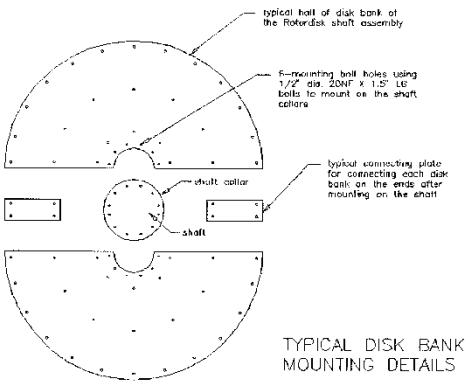


Figure g - exploded view of disk bank mounting parts.

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.

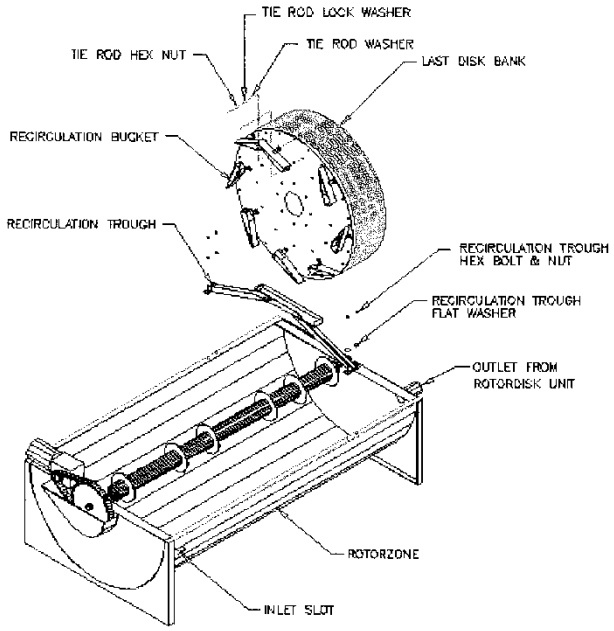
6. Mount small sprocket/coupling hubs on reducer output shaft (whichever is applicable).

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. Fit 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 ($^1/_8$" - $^1/_2$" 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:

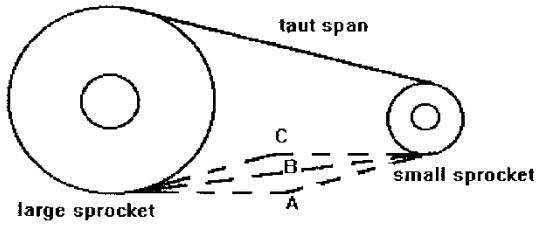
a) Parallel shaft alignment: Shafts should be parallel and level.
b) Axial sprocket alignment: Sprocket axial alignment can be checked with a straight edge, which will extend across the finished sides of the two sprockets.

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.

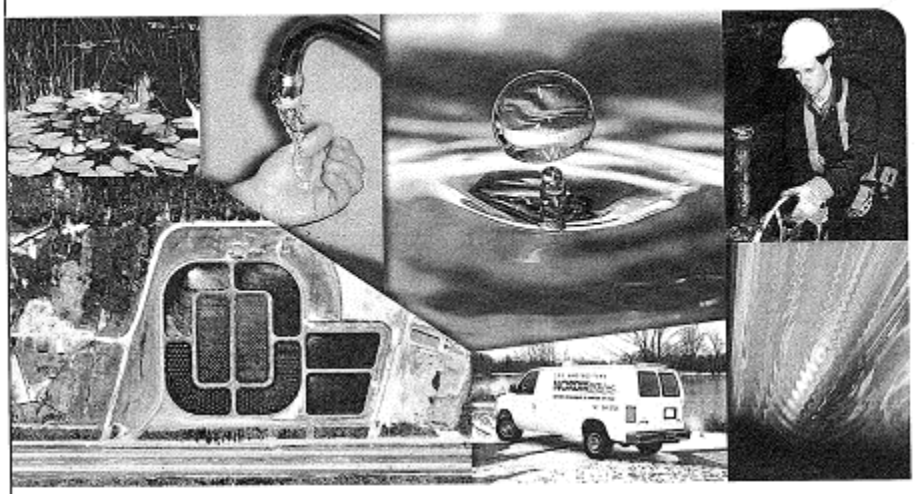
Appendix B : NORDIKeau Technical Support Manual

ORIGINAL

AEM

Agnico-Eagle Mines

TECHNICAL SUPPORT
SECTION 2



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50255 / JUNE 2010

ORIGINAL

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Agnico-Eagle Mines

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5025S / JUNE 2010

AGNICO EAGLE

TECHNICAL SUPPORT
SECTION 2

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June 30th, 2010
(N/Réf. : 50255)

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU

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NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU

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:

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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.

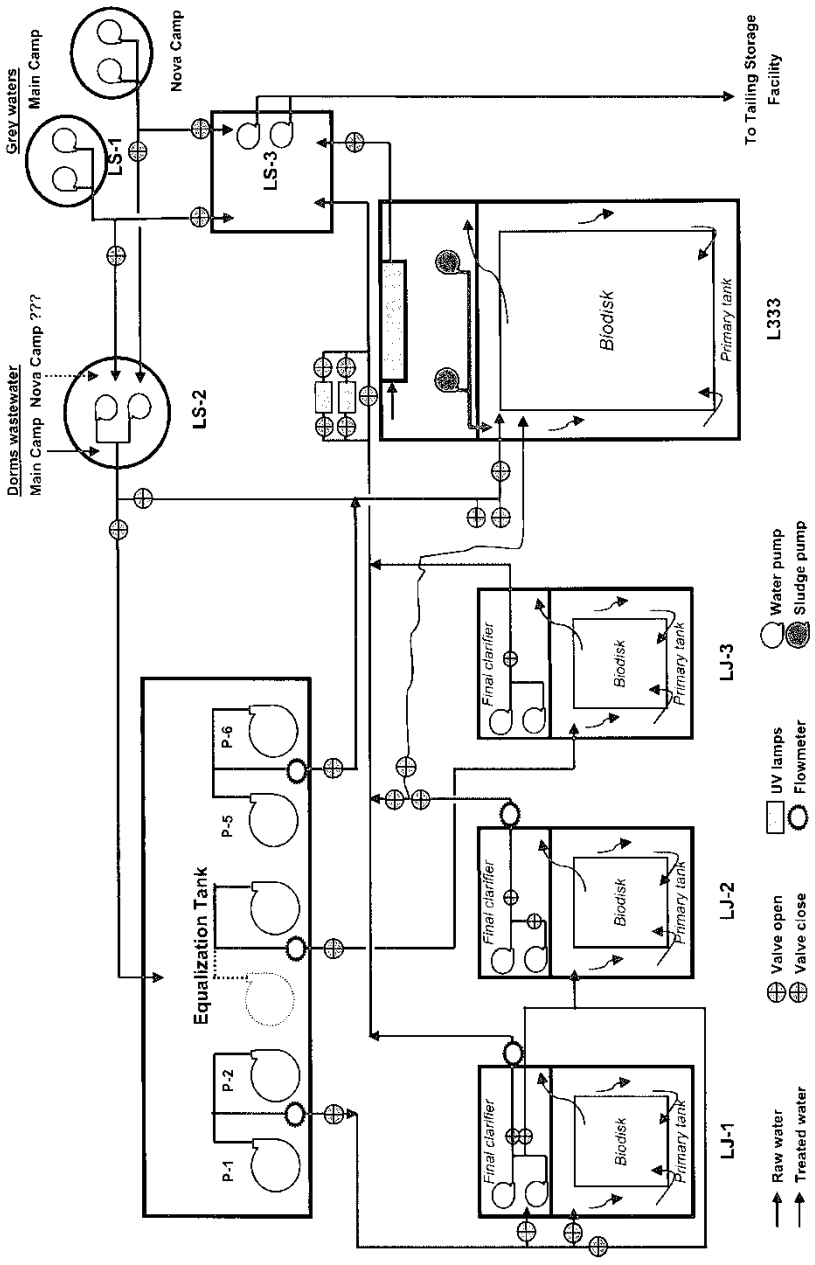


FIGURE 3.1: FLOWSHEET

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).

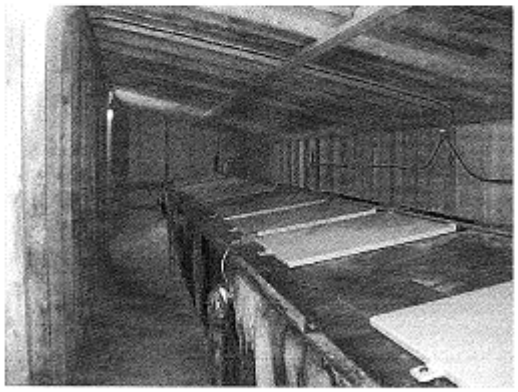
This station is equipped with two (2) MYERS submersible pumps that discharge the wastewater in the EQT. There are level floats to control stop, and start cycles of pumps. Each pump has a check valve on their discharge pipe.

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.

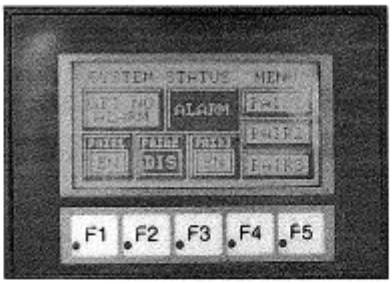
In automatic mode, the control sequence is currently the following:

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.

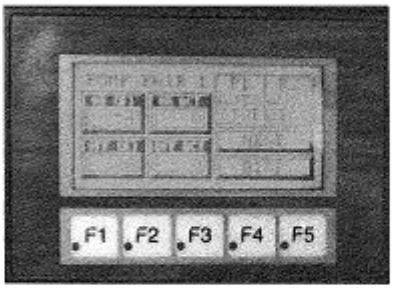
If the water level in the EQT remains low, it indicates that the current controls of the pumps operating time are too high and, consequently, the tank's equalization function is useless.

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.

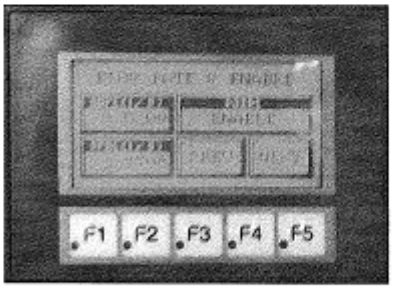
To change the ON/OFF setting cycles of each pair of pumps, you need to follow the step below. The example is for pumps 1 and 2.



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

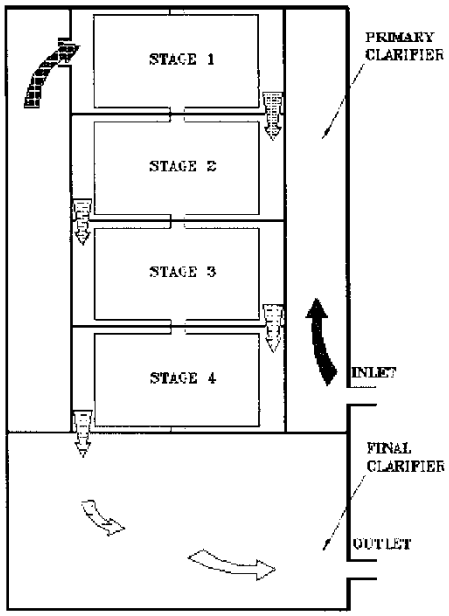
Rotating Biological Contactors (RBC) is a secondary treatment plant designed to remove organic material. It is composed of the primary settling tank (PST), the Biozone tank, and the final clarifier.

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.

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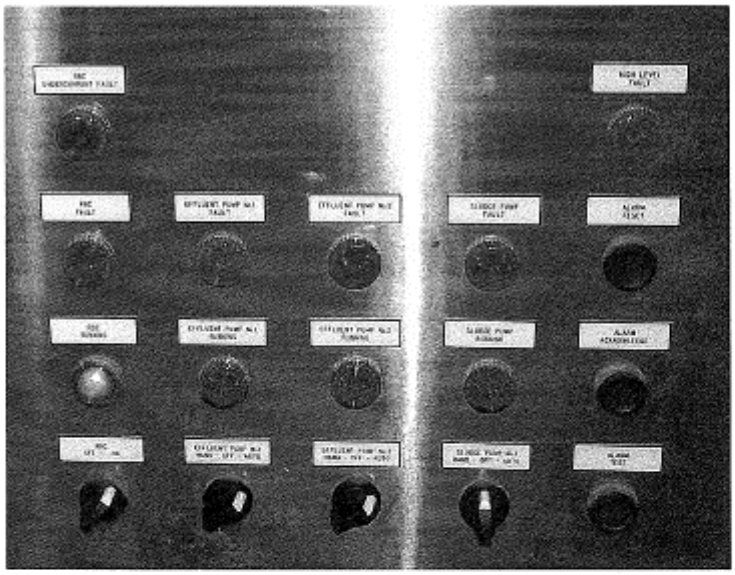
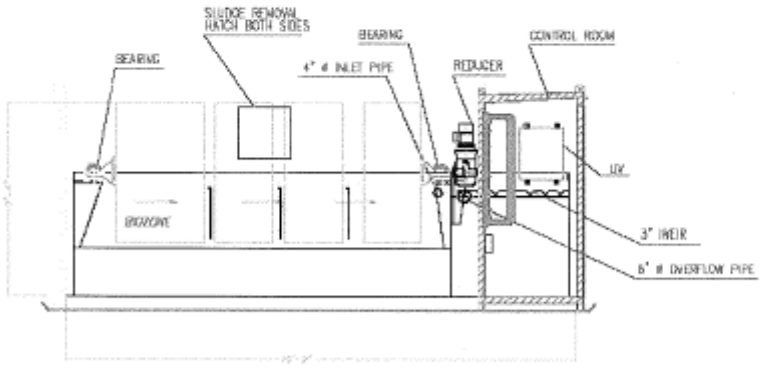


LJ-100 Electrical Panel



SECTION VIEW

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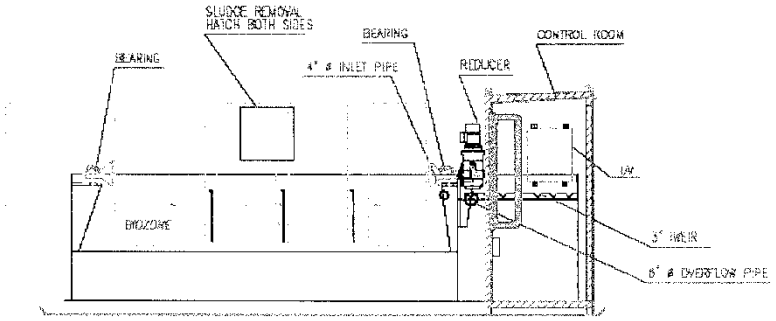
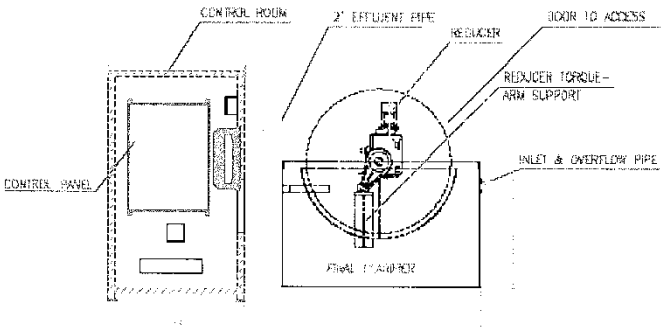
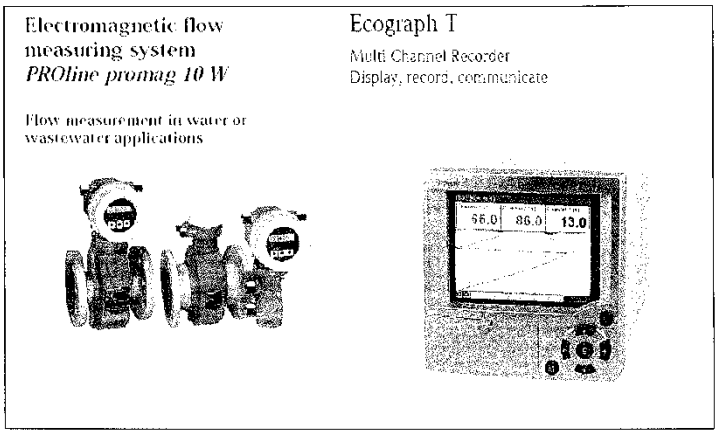


SECTION VIEW



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.

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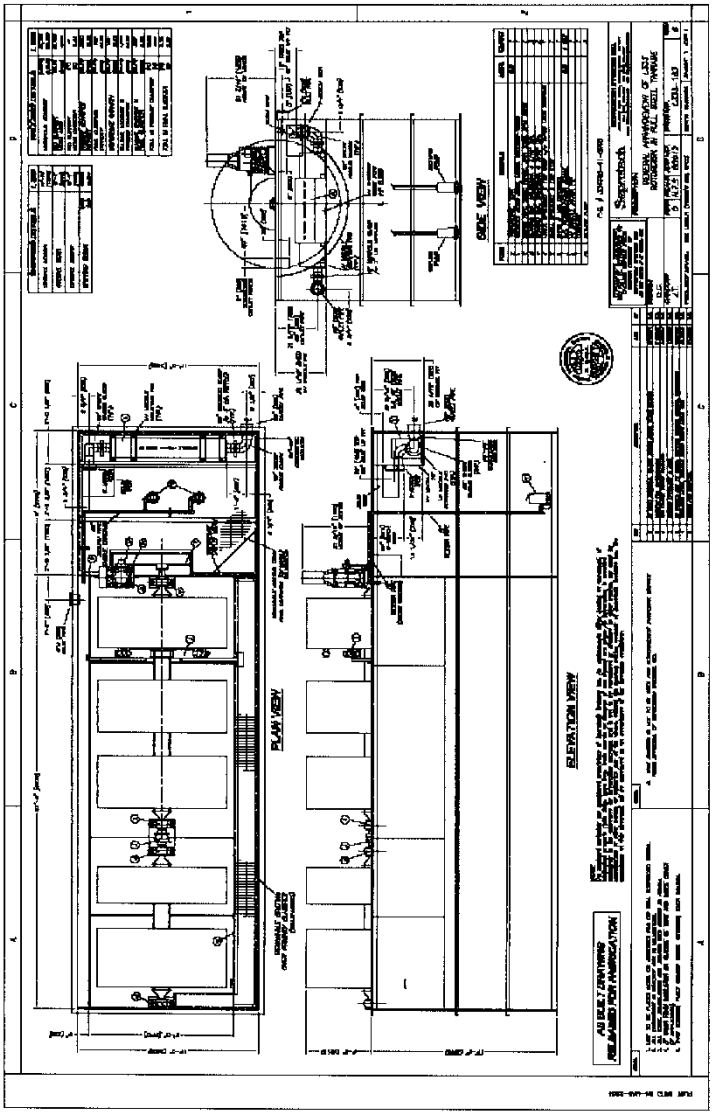
EXPERTS TECHNIQUES EN GESTION DE L'EAU



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.

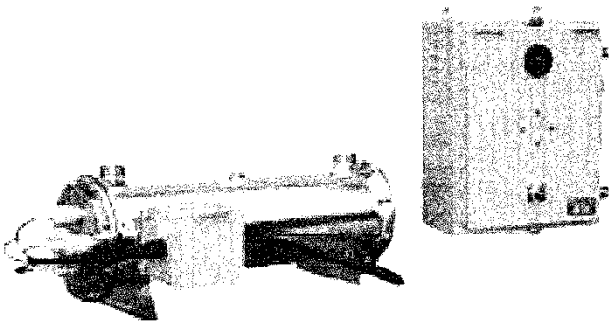
The UV disinfection system must not exceed the following effluent quality limits:

- 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)

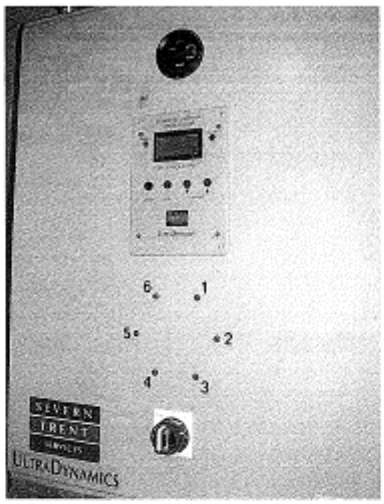
B) Equipment description

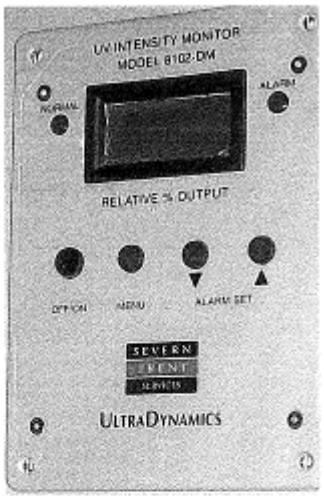
Ultraviolet disinfection performance is monitored with the UV Intensity Monitoring System. The Ultraviolet Intensity Monitoring System includes a monitor with digital display and indicator alarms mounted in a remote cabinet and a sensor assembly located at the lamp source.

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.

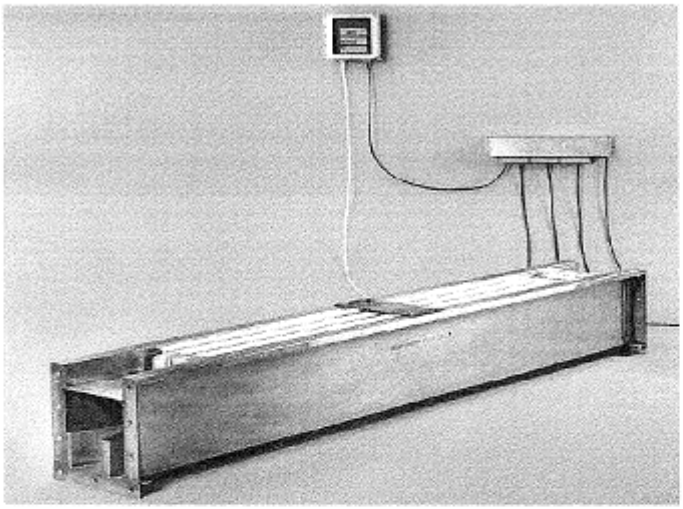
Cleaning the Quartz Jacket:

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.

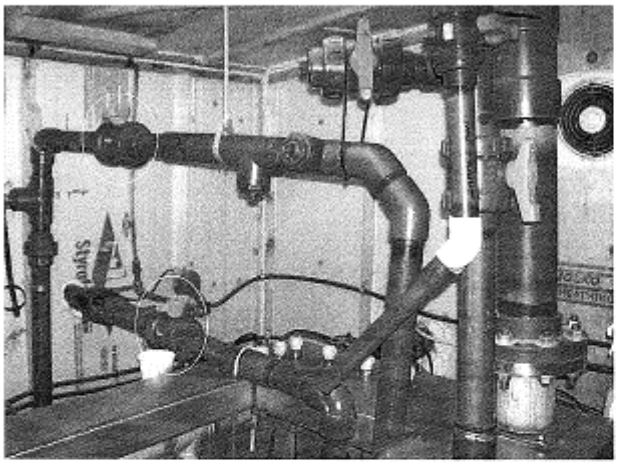
3.2.6 Lifting station n° 3

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)

$$\text{Organic Load} = \frac{\text{(240 mg/L) x (55 m}^3\text{/d)}}{\text{(3390 m}^2\text{)}}$$

$$\text{Organic Load} = 3{,}9 \text{ g BOD/day/m}^2$$

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)

$$\text{Organic Load} = \frac{\text{(280 mg/L) x (78 m}^3\text{/d)}}{\text{(4851m}^2\text{)}}$$

$$\text{Organic Load} = 4{,}5 \text{ g BOD/day/m}^2$$

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 sufur-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.

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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-28

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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 reaeration or contact stabilization mode.	pg III-15
			4) Refer to Probable Causes B-1, B-2, and C-2 above.	

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ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 3 — SOLIDS WASHOUT/BILLOWING 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

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-30 & 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.		

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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.		pg II-93 & IV-18
	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.	
		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.	

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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.		

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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.

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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.

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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.	(1) Dry tails and face of seal.
	2. Nicks or cuts in heating cable sheath, with moisture present.	(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.
	3. Kinked or crushed heating cable.	
	4. Arcing created by damage to the heating cable.	(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.
	5. Physical damage to heating cable is causing a direct short.	
	6. Presence of moisture in terminations or connections.	(6) Dry out cold lead and/or connections and replace termination if necessary.
	7. Damaged termination.	(7) Replace termination

Symptom	Probable Causes	Corrective Action
Circuit breaker trips	1. Circuit breaker undersized.	(1) Recalculate circuit load current. Resize breaker as required.
	2. Defective circuit breaker.	(2) Repair or replace breaker.
	3. Short circuit in electrical connections.	(3, 4) Eliminate short circuit. Thoroughly dry connections. Install conduit drains as required.
	4. Excessive moisture in connection boxes.	(5, 6) Repair damaged section or replace heating cable.
	5. Nicks or cuts in heating cable sheath, moisture present.	(7) Replace undersized GFPD with 30mA GFPD. Check the GFPD wiring instructions.
	6. Kinked or crushed heating cable.	
	7. Ground-fault protection device (GFPD) is undersized (5mA used instead of 30mA) or miswired.	

Note: *If the corrective actions above do not resolve the problem, verify that the installation is as per design.*

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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

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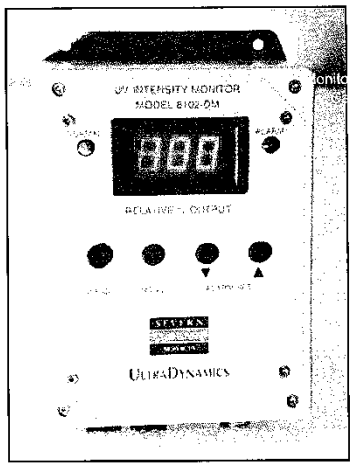
Maintenance:

(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, April 2011

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							
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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)
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31																				

Appendix D : Site Services Protocols and Procedures

Version 1
Project No. AE-10-03
December 2012

Core Receiving Environment Monitoring Program (CREMP): Design Document 2012

Meadowbank Division, Nunavut

Prepared for:

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VERSION 1

Core Receiving Environment Monitoring Program (CREMP): Design Document 2012

Meadowbank Mine

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Figure 10. Estimates of BACI power for detecting a significant decrease (one-tailed, alpha = 0.05) in a given benthic invertebrate community variable (Total N or Total taxa) and effect size (rows) by station (columns) as a function of sampling years (after period) and the number of sub-samples per year (see legend).

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DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
1	2012-12	All	All	Core Receiving Environmental Monitoring Program (CREMP) Design; updates portions of document Core Receiving Environmental Monitoring Program (CREMP) 2010 Plan Update - Meadowbank Gold Project (Version 1)

Version 1:
Reviewed/approved by:

Ryan VanEngen
Environmental Biologist- Meadowbank

Approved by:

Kevin Buck
Environmental Superintendent

1. INTRODUCTION AND OBJECTIVE

This document presents a revised design for the Core Receiving Environment Monitoring Program (CREMP). The CREMP, which was formerly referred to as the Aquatic Effects Management Program (AEMP) for Agnico-Eagle Mines' (AEM) Meadowbank Gold Mine and was included as part of the Environmental Assessment (EA) for the project in 2005 (AEMP 2005), has been formally implemented since 2006. The Type A water license (2AM-MEA0815) for the project issued by the Nunavut Water Board (NWB) in 2008 required a revised AEMP, and specified some of the requirements for that revision. Most importantly, while the 2005 AEMP was focused only on receiving environment studies at the level of basins and lakes, the revised AEMP (Azimuth 2012) 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

[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.

renamed the Core Receiving Environment Monitoring Program (CREMP) to minimize confusion.

The CREMP is the core, broad scale program that is aimed at detecting potential impacts at the scale of lakes or basins. It is intended to monitor large-scale basin-wide changes in physical and biological variables to evaluate potential impacts from all mine related stressors to the receiving environment. It therefore serves as the most important monitoring program for evaluating short-term and long-term potential impacts, for which other programs provide additional support and verification. In 2011, AEM submitted an updated CREMP design (Azimuth, 2010), which superseded the original design (AEMP 2005). At the same time, AEM commissioned Azimuth to begin a thorough review of the historical data to ensure that the CREMP design would be able to detect potential mine-related impacts and would address most of the requirements in the Type A water license listed above.

This document presents the revised CREMP design, which aims to ensure that the data generated from the CREMP will be adequate for detecting potential mine-related impacts in a timely manner, and to determine whether management actions (i.e., further assessment or mitigation) are warranted. The document is organized as follows:

- **Section 2** briefly describes the components of the CREMP and the available data.
- **Section 3** describes the methodology for development of criteria for action (i.e., determining when action should be taken based on results of monitoring), and applies that methodology to the components of the CREMP.
- **Section 4** presents the experimental design for evaluating CREMP data, and applies that design to current data to determine optimal sampling intensities.
- **Section 5** summarizes the implications for CREMP sampling of the analyses in Section 4.
- **Section 6** discusses links to the broader AEMP including how CREMP findings are used in identifying whether management actions are warranted.

Note to reader: the majority of the statistical analyses conducted for this report were conducted on data collected through part or all of 2010. Some components (e.g., zooplankton) included data through 2011.

2. CREMP COMPONENTS AND DATA

2.1. CREMP Components and Monitoring Variables

The components (and associated parameters) of the CREMP are derived from conditions specified in the Nunavut Water Board A Licence # 2AM-MEA0815 and Nunavut Impact Review Board Project Certificate – NIRB- 004 for the Meadowbank Gold Mine, which is based on the following:

- Nuvavut Water Board (NWB; i.e., board decision after public hearings).
- Baseline AEMP approach (AEMP, 2005) (i.e., the approach for monitoring presented during the Nunavut Impact Review Board [NIRB] environmental impact assessment process).

The CREMP includes the following components and variables:

- Water chemistry – All parameters required by the Type A water license for the receiving environment water (Schedule I, Table 1, Group 4). This list includes total metals, dissolved metals, several anions and nutrients, and several conventional parameters. Water chemistry is the foundation of the CREMP as it is the first indicator of potential effects to the receiving environment. Furthermore, water chemistry results collected during the CREMP are very important as the results are assessed collectively in the AEMP (Azimuth 2012) together with other mine-related surface water sampling (i.e., NWB license A and MMER) and groundwater sampling data.
- Sediment chemistry – Sediment chemistry is an important CREMP component because many contaminants are more likely to be associated with sediment than with water. In particular, sediment chemistry trends can also be an important indicator of longer-term patterns. While the main focus is on metals for which federal (CCME) guidelines exist (i.e., arsenic, cadmium, chromium, copper, lead, mercury, and zinc), data for other metals are also reported. Phytoplankton – Phytoplankton data are collected as part of the CREMP as they are a key indicator of pelagic primary productivity. Specific metrics including total biomass and total number of species (as a measure of richness) are measured and used for monitoring purposes.
- Benthic invertebrate community – Benthic invertebrate community data are collected as an indicator of potential effects on the benthic environment. Specific metrics including total abundance and richness (as total taxa) are measured and used for monitoring purposes.
- Zooplankton – Zooplankton, an indicator of secondary productivity, were initially excluded from the program (AEMP 2005) due to high variability. They were then

added to the CREMP for 2010 and 2011 to formally assess their suitability as a monitoring endpoint. Specific metrics including total biomass and richness are measured and used for monitoring purposes.

- Periphyton – Periphyton, which represent primary productivity on hard substrates, were initially included in the program to characterize baseline conditions across the project lakes. The available data were included herein to formally assess their utility as a monitoring tool. As with phytoplankton, specific metrics including total biomass are measured and used for monitoring purposes.

2.2. CREMP Stations and Control/Impact Designations

The location of CREMP stations for Meadowbank and Baker Lake are shown in **Figure 1** and **Figure 2**, respectively. **Table 1** summarizes the years for which data are available for each station, and distinguishes general designations for 'control' and 'impact' data. Given that TSS has been the major driver distinguishing 'control' data from potential 'impact' data, more detail is provided for 2008 and 2009 in **Table 2**. Some key observations regarding the stations are as follows:

- Collection of data at Baker Lake began in 2008, and activities that could cause potential impacts were already present in that year. Therefore, there are no true 'before' data for Baker Lake stations. To reduce uncertainties in the analyses, an additional reference station was added in 2012.
- There are two reference stations for Meadowbank (INUG and PDL) that are removed from the mine area and could be expected to function as controls in perpetuity, but data collection for PDL began only in 2009. Two other stations are currently used as controls but could potentially be impacted in the future – TPS is currently an internal control in Third Portage Lake, while TEFF is currently a far-field station that has not been impacted.
- A reference station for Wally Lake has not been established. While the characteristics of Wally Lake are somewhat unique (it is much shallower than other lakes), further evaluation of the advantages and disadvantages of establishing a separate reference station (versus using existing reference stations) is needed in advance of the commencement of construction activities at Wally Lake.

The designation of a station as 'control' or 'impact' in a given time period is dependent on the variable[5] being analyzed and the type of analysis. For example, a given station

[5] In general, we refer to any measured entity (e.g., cadmium concentration or phytoplankton biomass) as a variable. In some cases, this term can be used interchangeably with others (e.g., "parameter" is commonly

may be considered as 'impact' for one time period, but as 'control' for subsequent time periods if recovery occurs. If recovery occurs quickly for one variable (e.g., surface water TSS) and more slowly for another variable (e.g., benthic community abundance) then a given station/month or station/year combination may be 'control' for some variables and 'impact' for other variables. Furthermore, even if a station/month or station/year combination is conceptually considered to be 'impact' for a particular variable, if the data shows no impacts then data for that station/month or station/year combination may be pooled with 'control' data to strengthen the data set. This approach has been used in this report occasionally (**Section 4**), but will be less important in future years when the data set is larger.

2.3. Data Summary

This section summarizes the data that were available and were used for analyses to support the CREMP design revision. In general, the data that were analyzed as part of the design process included data from 2006-2010 collected specifically for the CREMP re-design.

- Water chemistry data up to and including May 2010 are summarized in **Table 3**. Of the 352 total samples, 76 were depth replicates (i.e., bottom or integrated samples collected at the same time/location as the standard surface sample) and 30 were duplicate samples (a second sample collected at the same time, location and depth as the standard sample). The intensity of sampling was increased beginning in May 2009, in part to develop a better understanding of the sources of variability in these data. The water chemistry data are discussed in more detail in **Section 4.3**.
- Sediment chemistry data up to and including 2009 are summarized in **Table 4**. In this case, the limited number of duplicate samples are not included in the table, but are discussed in **Appendix B**. Importantly, the sediment data include both core sample data (i.e., sediment cores where the top 1 cm of a core is submitted for analysis) and grab sample data (i.e., Petite-Ponar grab samples with a penetration depth of 5 cm or more). While both sets of data are considered, the core results are more relevant for monitoring because it is the thin surface layer of sediment where potential mining-related impacts are most likely to be detected. Some of the core sample data reflected in the table were collected as part of the East Dike Effects Assessment Study (EAS), rather than for the CREMP

used for water quality concentrations and "endpoint" for biological values). In other contexts (e.g., statistical modelling where "variables" [e.g., dependent and independent] and "parameters" [e.g., slope and intercept] have different meanings) they are not interchangeable.

specifically – these data are included as they are comparable and help to augment the limited CREMP data set.

- The phytoplankton monitoring data set is similar to the water chemistry data set, with a total of 308 samples collected for the CREMP from 2006 through to September 2010 (see **Table 5**; not including field duplicate samples and depth replicates).
- Benthic invertebrate monitoring data have been collected as part of the CREMP once each year in August from 2006 to 2010. There have been 242 'standard' samples collected (see **Table 6**), which excludes a few samples because of differences in mesh size, sampling procedures, and inadequate sample preservation.
- The zooplankton monitoring data for the CREMP are limited to 45 samples collected in August 2010 (see **Appendix E**).
- The periphyton data for the CREMP are limited to 70 samples (5 spatial replicates at each of 7 Meadowbank stations in 2007 and 2008; see **Appendix F**).

3. DEVELOPMENT OF CRITERIA FOR ACTION

Implementation of the Management Response Plan for the AEMP requires the development of criteria for action for the CREMP and other AEMP programs.

3.1. Conceptual Early Warning Framework

For the CREMP, criteria for action have been developed with the assumption that action will be considered *before* certain monitored parameters reach levels that cause or have the potential to cause adverse effects to aquatic biota. The criteria for action should provide an early warning framework under which management responses may be considered, taking into account findings from other AEMP component programs. Two types of criteria are developed:

- *Thresholds* – license limits, regulatory guidelines or other discrete benchmarks, below which unacceptable adverse effects are not expected and above which unacceptable adverse effects may occur. If thresholds do not exist or are not used for a particular variable, then early warning triggers will be developed *without* thresholds.
- *Triggers*- site specific early warning criteria that lead to action. In cases where thresholds are established, the triggers are set at values that are more conservative than the thresholds. Triggers ensure that action is taken before a threshold has

been reached. . For variables where no thresholds exist, the triggers are set using statistical methods based on existing data.

The conceptual framework of thresholds and triggers is applied to each of the monitoring variables listed in the subsections below.

3.2. Water Chemistry

3.2.1. Methods for Development of Thresholds and Triggers

At a federal level, the CCME has established water quality guidelines for key water chemistry variables. The CCME guidelines are generally appropriate for use as thresholds because they have a toxicological basis and are relatively conservative. Where CCME guidelines do not exist, or where the underlying science is outdated or not applicable, published guidelines or standards in other jurisdictions can be considered.

Where CCME water quality guidelines have been developed for metals, the guidelines are assumed to apply to total metals (i.e., dissolved and particulate-bound metals) if not explicitly stated in CCME documents. This approach is conservative, since most toxicological studies use metal compounds that are more soluble and therefore more bioavailable than metals in typical waterbodies. The guidelines are not explicitly applied as thresholds for dissolved metals (which is unnecessary if they already apply to total metals). However, any evaluation of the potential effects of a metal would consider the metal in dissolved or particulate forms.

The method of developing thresholds and triggers for water chemistry parameters is shown in **Figure 3**. Application of the triggers is also shown in the figure but is not discussed in detail until **Section 4.3**. There are three methods of trigger development as follows:

1. When a threshold (e.g., CCME guideline) is 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 is not established, the trigger was set equal to the 95th percentile of the baseline data ("Method B"), except in cases where less than 5% of the data exceeded the current detection limit (DL) – in the latter case, the trigger was set equal to two times the DL ("Method C").

There were exceptions to the above approach for a few special cases, specifically t-Al, t-Cd, t-Mn, t-Zn, d-Al, ammonia-N, t-P, pH and TSS. These exceptions are explained in detail in **Appendix A**.

The data set upon which triggers were developed excluded duplicates and depth replicates. The rationale for restricting the data set in these ways is two-fold. First, variation among duplicates and depth replicates is small compared to variation among samples and stations, therefore inclusion of duplicates and depth replicates results in little gain in our ability to detect potential impacts. More importantly, duplicates and depth replicates are considered as pseudoreplicates in the experimental design framework used for data analysis (see detailed discussion in **Appendix A**). In addition, individual data points for which values were below DL but for which the DL was higher than usual were excluded. Remaining data points with values below the usual DL were set equal to the DL.

3.2.2. Results for Thresholds and Triggers

Thresholds were established for 22 variables based on water quality guidelines – these are listed in **Table 7**. Triggers for total metals, dissolved metals and nutrients/conventionals are summarized in **Table 8**, **Table 9**, and **Table 10** respectively. Importantly, in some cases the 95th percentile of baseline data is above the threshold, in which case the trigger is developed using Method B and is greater than the threshold.

Separate thresholds and triggers are developed for Meadowbank and Baker Lake where appropriate, because Baker Lake is influenced by seawater and is therefore fundamentally different from the Meadowbank lakes. This is evidenced in many of the variables that reflect seawater such as Na, Cl, Ca, Mg, hardness, conductivity.

Further differentiation of triggers beyond the Baker/Meadowbank distinction is not pursued. As discussed in **Appendix A**, there are some notable differences among stations for some variables, with Wally Lake in particular having higher values for some variables. These differences could be used as rationale for development of station-specific triggers. We don't believe this is warranted, for two reasons. First, we would expect that a range for a variable that is normal for one of the project lakes is unlikely to cause effects in another nearby lake, even if the second lake has naturally lower levels of that variable. Ecological data for all of the project lakes suggests that they are all functioning with reasonably similar primary, secondary and fish species assemblages. Second, while the data set includes stations with higher natural concentrations of some variables (e.g. Wally Lake), those are balanced to some degree by stations with lower natural levels (e.g., INUG), thus we do not expect that the data are biased. Nevertheless, the derived triggers may be somewhat less or more conservative than planned for any given station. This is not an issue for variables with thresholds for which triggers are developed using Method A, because in those cases triggers will serve their early-warning purpose regardless. However, under Method B the 95th percentile of baseline data would vary depending on which stations are included in the baseline data. Since the use of the 95th percentile for Method B is somewhat arbitrary anyway, we don't think it is of critical importance that the triggers are somewhat less or more conservative for particular

stations, particularly since the CREMP water chemistry data are not evaluated in isolation – other components of the CREMP (e.g., biological effects variables) and other AEMP programs are also used to detect potential mine-related impacts on the receiving environment. In short, the complexity associated with developing, tracking and applying several hundred station-specific, variable-specific triggers does not seem warranted.

3.2.3. Time Frame for Trigger Application

The water license currently requires monthly sampling at CREMP stations including external reference stations during the open water season, and at a smaller number of representative stations near the mine site in the winter (through ice). Water chemistry is expected to demonstrate natural seasonal variation, which would be captured by monthly year-round sampling. However, the statistical power to detect effects using a BACI approach does not improve much beyond 6 months of water chemistry data, and therefore the value of monthly sampling year round is diminished. Furthermore, there are several seasonal constraints on sampling that include:

- The major mine-related contaminant inputs are expected to be from effluent discharges and dust (blasting and general), both of which are expected to occur during the open water season (i.e., mid-July through early October). While the generation and deposition of dust will occur year round, the two-meter ice cap will prevent contact with water for most of the year. Changes in water quality related to dust would be expected to be highest in the spring (at TPE and SP based on proximity to blasting and prevailing wind direction), but possibly offset by runoff-related dilution.
- Winter sampling of reference areas presents significantly higher risks to the sampling team due to darkness, lack of air (helicopter) support, and the need to cover long distances via tundra buggy. Furthermore, transport via tundra buggy is often impractical in the shoulder seasons when snowpacks are marginal (e.g., November, March).
- Lack of sampling of reference areas during winter months diminishes the value of collecting any winter data. Not having paired data (i.e., collection of data at both reference and exposure areas) reduces the ability to distinguish between potential naturally-occurring seasonal effects and mine-related effects (i.e., any observed effects must be assumed due to the mine, when in fact they may be reflective of natural variation. . Furthermore, un-paired winter data provide no statistical improvement for the BACI model. Currently, the available winter data for reference areas are extremely limited, and would continue to be limited due to the safety concerns.
- Sampling in June, October and early November is highly dangerous due to thin ice conditions.

In light of the above, we propose to collect and analyze 6 months (April, May, July, Aug, Sept, plus November or December) of full water chemistry data for the annual period of paired sampling to support BACI analyses. This will maintain adequate statistical power to detect potential impacts at the scale of lakes or basins in the receiving environment while ensuring safe sampling conditions. In any given year the actual number of samples that would be collected may range from 4 to 6 events.

Nevertheless, there is a current licence requirement for monthly sampling throughout the year (including in winter through the ice) at a subset of the CREMP areas nearest to the mine-site. This will continue as it is recognized that failing to sample for a period of several months during the winter could be problematic if there are serious changes (e.g., low oxygen, changes to stratification, etc.) that might be slow to manifest but be related to mine activities. Consequently, basic field water quality data will be collected at near-field areas (i.e., TPN, TPE, SP and eventually Wally) at least once mid-winter. These data would not add to the statistical power of the CREMP analyses, but would reduce uncertainty regarding potential changes during the winter period. Qualified technicians or biologists will collect all field data and if changes are observed, they may collect the full suite of water chemistry parameters for comparison to the triggers at that time.

The implications of monitoring water quality six times per year is explored in **Appendix A** and **Section 4.3**. In **Figure 3**, the application of trigger values to data for one month and annual (based on six months) is depicted, whereby an exceedance for one month is a flag and an exceedance for an annual (six-month) mean is the early warning trigger for action.

3.3. Sediment Chemistry

3.3.1. Methods for Development of Thresholds and Triggers

At federal level, the CCME has established sediment quality guidelines for the seven metals which are formally evaluated in the CREMP. The CCME guidelines are generally appropriate for use as thresholds because they have a toxicological basis and are relatively conservative.

The method of developing thresholds and triggers for water quality variables is shown in **Figure 3**. Application of the triggers is also shown in the figure but is not discussed in detail until **Section 4.3**. Since all sediment chemistry parameters had thresholds, trigger development is more straight forward than for water chemistry. For each sediment chemistry parameter, 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").

The data set upon which triggers were developed focused on core samples[6], with duplicates excluded. In addition, individual data points for which values were below DL but for which the DL was higher than usual were excluded. Remaining data points with values below the usual DL were set equal to the DL. **Appendix B** summarizes the data.

3.3.2. Results for Thresholds and Triggers

Thresholds were established for 22 variables based on water quality guidelines – these are listed in **Table 11**. Triggers are summarized in **Table 12**. Importantly, in some cases the 95th percentile of baseline data is above the threshold, in which case the trigger is developed using Method B and is greater than the threshold. Separate thresholds and triggers are developed for Meadowbank and Baker Lake where appropriate.

Further differentiation of triggers beyond the Baker/Meadowbank distinction is not pursued. As discussed in **Appendix B** (and similar to analysis for water chemistry in the previous section), there are some notable differences among stations for some parameters; these differences could be used as rationale for development of station-specific triggers. We don't believe this is warranted, for the same reasons stated in **Section 3.2.2**

3.3.3. Time Frame for Trigger Application

Sediment chemistry data are not expected to vary in the manner that would be expected for water chemistry. Changes to sediment chemistry may occur as a result of limited duration events, but those changes would not be expected to dissipate quickly as they might with water chemistry. Consequently, sampling frequency for sediment chemistry as part of the CREMP should be less frequent. We propose that sampling take place approximately every three years. To maximize the potential utility of the data, sampling could be aligned with the sampling times for benthic invertebrates required for the EEM program. Thus, sediment chemistry cores were collected in 2012 (because there have been no core data collected since 2009), and would in future be matched to the envisioned EEM sampling years which are 2014 and then every three years (depending on results in 2014). During each sampling event, there should be multiple subsamples in each monitoring area (see **Section 4.4**).

[6] Sediment chemistry is also measured in grab samples to support benthic invertebrate community monitoring (i.e., benthos findings from grab samples are matched to chemistry grab samples).

3.4. Biological Effects Variables

3.4.1. Thresholds and Triggers

There are no established guidelines for biological variables that can be used directly as absolute thresholds and triggers for the Meadowbank Gold Mine. Unlike water or sediment, where environmental quality guidelines can be used to develop thresholds or triggers, there are no universal benchmarks for biological variables such as abundance, biomass or diversity. Rather, the magnitude of change or difference relative to expected conditions must be used to establish "critical effect sizes" (CES) for biological variables.

In a review of methods for deriving CES, Munkittrick et al. (2009) noted that "the ideal method for setting CES would be to define the level of protection that prevents ecologically relevant impacts". The authors concluded that there are very few examples of CES being developed on the basis of ecological relevance. They summarize alternative methods, which include identifying values that would represent the extreme of natural variability among or within reference areas. Recent guidance for metal mines under EEM (Environment Canada 2012a) attempts to define CES for fish and for benthic invertebrates that would be associated with effects. For fish endpoints, the CES are expressed as a percentage deviation from the reference mean (e.g., 10% for condition factor; 25% for other variables). For benthic invertebrate community endpoints (e.g., density, richness), the CES are defined as +/- two standard deviations where the standard deviation is derived from within-reference-area data.

The CREMP should aim to define CES that are ecologically relevant. There is precedent for defining ecologically relevant CES in related applications in Canada:

- CCME water quality guideline derivation process – CCME (2007) defined thresholds for "no effect" (i.e., an effect on 10% or less of exposed individuals) and "negative effect" (i.e., an effect level on more than 15–20% of the exposed individuals of a species).
- General risk assessment practice in Canada – ecological risk assessments often involve the quantification of adverse effects related to environmental contamination in aquatic environments. Common effect measures are *in vitro* toxicity tests or *in situ* biological studies (e.g., field-based metrics related to benthic invertebrates or fish). Recent draft guidance for the Federal Contaminated Sites Action Plan (Environment Canada 2012b) does not specify acceptable CES for any endpoints, largely to provide flexibility and to allow for site-specific considerations (e.g., local biology, input from regulators or stakeholders). Effects to non-listed (i.e., not threatened or endangered) species in Ontario (2005) are assessed relative to a lowest observable effects level (LOEL; usually defined as the lowest effect statistically significant from the control group); by definition this may actually represent a range of effect magnitudes, but could be well above

20%. In British Columbia (SAB, 2008), site-specific toxicity tests are typically interpreted based on a 20% effect size (e.g., an inhibition concentration [IC_{20}] that corresponds to a 20% reduction in a continuous endpoint relative to the control or to reference samples). Measured or predicted effects are generally reported relative to the 20% effect threshold (i.e., below which risks would be considered "acceptable") and possibly to higher levels (e.g., 50% effects) if warranted to distinguish degrees of unacceptability (e.g., between marginally and clearly unacceptable, which may be communicated as moderate to high risk). Confidence in the effect sizes is usually addressed through a discussion of uncertainty on a site specific basis.

For purposes of exploring the statistical power of the CREMP, a 50% effect size was defined as the threshold of interest and a 20% effect size as the trigger. However, the terms "threshold" and "trigger" for biological variables are not used as strictly as for water and sediment chemistry parameters , because:

1) *Statistical Power* - For most biological variables, natural variability can make it difficult (if not impossible) to statistically detect effect sizes as low as 20%. It is more realistic to detect larger effect sizes such as 50%.

2) *Causality* – Even if statistically-significant changes are documented (at whatever effect size), the cause of the change needs to be understood in order to effectively manage the situation. For the Meadowbank biological data, effect sizes exceeding 50% have been observed due to natural causes in the baseline data.

Nevertheless, although effect sizes of 20% may be easily observed by chance, it is worth evaluating biological data in more detail whenever small effect sizes such as 20% are observed. The method of developing thresholds and triggers for biological variables is shown in **Figure 3**. Application of the triggers is also shown in the figure but is not discussed in detail until **Section 4.3**. **Appendices C to F** summarize the data and present analyses of four sets of biological variables: phytoplankton, benthic invertebrate community, zooplankton, and periphyton. Results for the analyses of statistical design are provided in **Section 4.5**.

3.4.1.1. Comparison of CREMP and EEM Benthic Invertebrate Effect Sizes

Given their different purposes and application, critical effect sizes may differ between an EEM program and a CREMP (INAC 2009). Nevertheless, it is important to understand the differences so that the findings from CREMP and EEM studies can be interpreted together..The MMER defines CES for fish on the basis of percentage change (10% or 25% depending on the variable), and for benthos on the basis of +/- two (within-reference area) standard deviations from the reference mean. The CREMP, meanwhile, defines CES for all biological variables on the basis of percentage change (50%, with 20% as an

early warning trigger). Furthermore, the CREMP does not include fish, and EEM does not include other biological components of the CREMP such as phytoplankton .Thus, the only component of overlap for Meadowbank EEM and CREMP monitoring is benthic invertebrate monitoring.

The CREMP uses percent change rather than standard deviations for benthos, in an effort to maintain a transparent (fixed) effect size that is more likely to be ecologically relevant. Where natural variability is high, use of two standard deviations for benthos could potentially mean that large and ecologically-relevant effects could occur to some endpoints without being higher than the CES. On the other hand, the limitation of using percentage change to define the CES for benthos when variability is high is reduced statistical power to detect change. However, this disadvantage is not nearly as important when the experimental designs for EEM and CREMP are compared. The experimental design for EEM is fundamentally a control-impact (CI) design, with no before-after (BA) temporal component. The intent of EEM is to have a design that will detect effects in a given study (year), and if effects are detected in two consecutive monitoring events (36 months apart) then the cause must be investigated. The fundamental weakness of the CI design is the underlying assumption that any differences between C and I areas are considered an effect. Based on data evaluation for Meadowbank and our experience at other sites, this assumption is weak and can lead to erroneous conclusions regarding natural differences between C and I areas (i.e., falsely concluding that a difference between areas is mine related). Before-after-control-impact (BACI) designs are more robust in that they track changes in C and I areas over time; the target effect is differential change at I relative to C over time. Many EEM programs do not collect 'before' data as they only become subject to MMER after mine-related discharge occurs. In the BACI framework, the power to detect differences is greater when there are more monitoring events in the B and A periods included in the analysis[7].

In summary, EEM data are evaluated for a particular period (year), using a CI design that assumes that all differences between the two areas are mine-related (unless proven otherwise, such as by incorporating a physical covariate such as grain size). EEM's CES (+/- 2SD) typically results in reasonable statistical power, but may do so at the cost of allowing large and ecologically-relevant effects to occur In contrast, the CREMP started

[7] From a statistical standpoint, the CI design treats replicate samples in an area as true replicates. In a BACI design, where natural differences among areas or over time are acknowledged, the replicate samples collected in an area in a given time period are pseudoreplicates because each area in each time period is a replicate. The high power achieved by CI designs is therefore false if we admit that areas may differ naturally. For statistical tests, in the CI design the degrees of freedom will be based at least in part on the number of samples in an area, whereas for the BACI design the degrees of freedom will be based on the number of areas and time periods without consideration for the number of samples taken in a given area in a given period.

prior to mining, thus allowing the incorporation of baseline data into a BACI design that effectively characterizes natural spatial and temporal variability. Overall, the CREMP is capable of detecting large impacts in a short time period, but requires longer time periods to detect more subtle effects.

3.4.2. Time Frame for Trigger and Threshold Application

The time frame for trigger and threshold application must vary according to the type of biological variables that are monitored. For phytoplankton, which we expect to respond to stresses on a relatively short-term basis, sampling will be similar to that for water chemistry parameters (see **Section 3.2.3**) – up to 6 months of sampling per year. For the benthic invertebrate community analysis, for which responses are more likely to integrate effects over reasonably long time periods, we propose continued sampling once per year in August. For zooplankton and periphyton, analyses below in **Section 4.5** show that data are extremely variable and monitoring would be almost incapable of detecting effects in a given year. Consequently, no further routine sampling of zooplankton or periphyton as part of the CREMP is recommended. Further rationale for the time frame for each of the biological variables is found in **Section 4.5**.

4. EXPERIMENTAL DESIGN AND STATISTICAL ANALYSES

4.1. Sources of Variability in CREMP Data

The receiving environment program involves measurement of numerous variables representing environmental chemistry and productivity. There are several potential sources of variability that contribute to overall variability in the data, including:

- Lake to lake or basin to basin variability – in the case of the CREMP, the sampling stations represent entire lakes or basins.
- Spatial variability within a waterbody – the receiving environment program targets waterbodies or large basins within waterbodies. There may be variability within a waterbody associated with spatial structure (e.g., edges may be more prone to influence of spring run-off), depth or other factors.
- Subsample variability – this reflects small-scale variability for 2 samples taken at the same place at the same time at the same depth.
- Measurement error – that is, variability associated with imprecision in lab techniques and/or variability associated with field collection methods (e.g, homogenization of sediment samples).

- Variability with depth – we might expect variability in water chemistry or measures of productivity associated with lake stratification, and we can expect differences in other variables as well (e.g., benthic community structure will differ in deep waters). Variability within the water column has been found to be less important in the project lakes as lake stratification is limited (e.g., during open water season).
- Inter-annual variability – we can expect natural variability due for example to annual differences in rainfall or other climatic variables.
- Seasonal variability – seasonal differences can be expected over the year, associated with events such as spring run-off or conditions such as ice cover.
- Day to day variability – There may be differences day to day, for example associated with storm events or other short-term conditions. This component of variation is unlikely to be measured directly via sampling and will contribute to residual error in any analyses.

Both inter-lake and inter-annual variability are expected and are taken into account through the general BACI design (i.e., use of 'before' data and 'control' stations). In some cases, spatial variability within a lake/basin, sub-sample variability and measurement error can be simultaneously characterized through the use of field replicates – that is, true field replicates taken in difference places within a lake/basin during the same sampling event. In contrast, field duplicates (i.e., taken at the same location at the same time and depth) will reflect only sub-sample variability and measurement error. Finally, lab replicates taken from the same water sample (i.e., split samples) can be used to characterize only lab measurement error.

Regarding temporal variability and variability associated with depth, the 2009 receiving environment program (and 2008 in the case of sediment chemistry) included significant replication in time (multiple sampling events in one year) and at depth. Those data will be analyzed in later subsections of this document to evaluate the importance of depth.

The implications of seasonal variation in monitoring variables were discussed earlier in **Section 3**.

4.2. Impact Hypotheses and Statistical Design

Two general classes of impacts are hypothesized for the Meadowbank mine:

1. Pulse events for which potential impacts would be high for a short time and they may dissipate relatively quickly (e.g., in the case of water chemistry) or not (e.g., in the case of sediment chemistry). Pulse events could be associated with any phase of the mine, but are more likely to be associated with particular activities such as dike construction.

2. Long-term cumulative impacts that may be associated with ongoing activities. Long-term cumulative impacts are more likely to be associated with ongoing activities of mine operations.

Since operations began in 2010, the focus of monitoring to date has been on detecting pulse events associated with construction. The appropriate framework for analysis is a before-after-control-impact (BACI) that is aimed at detecting a potential impact in a particular lake or basin in a particular time period. The BACI framework can also be used to evaluate long-term impacts, but other tools such as time series regression analysis may also be appropriate for evaluating long-term trends. For this design document, we focus on the use of the BACI framework, recognizing that other tools such as time series regressions may be useful at a future date once sufficient time series data are available[8].

The classic BACI (paired) design has before/after periods α_i (i = B, A; I = 2), control/impact sites β_j (j = C, I; J = 2), and a total of K paired sampling times τ_k that are nested within period. A statistical model for this design is given by (Smith, 2002; equation 2):

$$(1) \qquad X_{ijk} = \mu + \alpha_i + \tau_{k(i)} + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \ .$$

The key term is the interaction ($\alpha\beta$), which can be tested using an F test with F = MS[($\alpha\beta$)]/MS[Resid] and degrees of freedom = 1, K – 2. As discussed by Smith (2002), this is equivalent to simply taking the differences between the control and impact values across times and using a two-sample (before-after) t test (Stewart-Oaten et al., 1986).

Model (1) can be extended to include additional control sites (e.g., "asymmetric" designs; Underwood, 1994) and/or additional impact sites. To be valid, the additional sites must be replicates rather than subsamples (i.e., as controls, they should be spatially independent of each other but representative of the impact sites, while replicates for impacts need to be spatially independent and (ideally) affected by independent disturbances). So whereas j = (C, I) in the classic BACIP, j may compose any combination of J total sites, for example J = 4 where j = (C_1, C_2, C_3, I). The general test of ($\alpha\beta$) still applies, but with degrees of freedom = (J – 1), (K – 2)(J – 1) (e.g., see Table 1 of Underwood (1994) and Table 9 of Smith (2002)).

[8] In theory, a BACI analysis that is appropriately framed should be capable of detecting changes associated with long-term trends.

In addition, there may be *n* replicate subsamples *s* at each site/time combination (*jk*), as assumed in Table 1 of Underwood (1994). In this case, we modify equation (1) as:

$$(2) \qquad X_{ijks} = \mu + \alpha_i + \tau_{k(i)} + \beta_j + (\alpha\beta)_{ij} + (\tau\beta)_{k(i)j} + \varepsilon_{ijks} \ ,$$

where subsamples now permit estimation of times-by-site interactions ($\tau\beta$). The appropriate *F* ratio for ($\alpha\beta$) is now $F = \text{MS}[(\alpha\beta)]/\text{MS}[(\tau\beta)]$ with df = $(J - 1), (K - 2)(J - 1)$. As Underwood demonstrates, specific comparisons (interaction terms, such as the impact site versus either "period" or a specific "time" unit) can be examined by partitioning variation accordingly (e.g., Underwood Table 2[9]).

Importantly, the BACI design is necessary only when there is reason to suspect natural inter-annual variability. For some variables, in particular sediment chemistry, over a time span of several years we may not have reason to suspect any significant inter-annual variability across years. In such a case, the comparison of interest is simply between baseline (before) and impact (after) data for a given station. There is no need or use for a "control station" under this assumption – the value of a control is to specifically "control" for potential temporal variation. Thus, the model would become a simple **"BA"** comparison (a t-test) between baseline data (**B**efore data) and a new year of impact data (**A**fter data). This test will generally have much greater power to detect a difference (real or not) than a full BACI model (which inherently assumes that temporal variation may be present, both across stations and within stations).

The BA model has a simple design:

$$(3) \qquad X_{is} = \mu + \alpha_i + \varepsilon_{is}$$

where *X* is the variable measured for period *i* and subsample *s*, and the estimate of interest is the difference in means for the before and after periods, represented by α_i, which is tested via a t-test.

4.3. Analyses for Water Chemistry

4.3.1. Data Review

The water chemistry data were summarized in **Table 3**. Further description and all analyses of the water chemistry data are provided in **Appendix A**. Some key conclusions regarding the data are as follows:

- Duplicate samples are derived by collecting a separate water sample at the same location, station, depth and time as a standard sample. Differences between a

[9] We note that there are mistakes in the tables presented by Underwood (1994).

duplicate sample and its associated standard sample reflect the combined variability from subsample variation and measurement error associated with field collection methods and lab methods. Analysis of duplicate samples in water shows that the variability due to these factors is generally much lower than general sample variation. From a QA/QC perspective, this confirms that precision in field collection and lab methods is reasonable relative to the natural variability among the samples and stations. Duplicate samples were not included in the power analyses of water chemistry below because they are not independent of the standard samples and are therefore pseudoreplicates of the standard samples.

- Depth samples were collected in 2009-2010, to determine the potential importance of differences in measurements associated with depth. Analysis showed that bottom samples (and depth-integrated samples to a lesser degree) tended to have lower values than surface samples for many variables as there were statistically significant differences in values by depth. . However, the magnitude of differences associated with depth is minimal compared to the magnitude of differences that occurs naturally between samples and stations[10]. We conclude that future sampling should focus on surface samples[11], in order to take advantage of the most baseline data and to incorporate a more conservative approach for most water chemistry parameters which demonstrate lower concentrations at depth. Depth samples were not included in power analyses below – as with duplicate samples, the depth and integrated samples are pseudoreplicates of the surface samples.
- Baker / Meadowbank data differences, as discussed in **Section 3.2.2**, are significant and meaningful. and are mostly attributable to the influence of seawater on Baker Lake.

4.3.2. Power Analysis and Implications

Using the BACI framework presented in **Section 4.2**, the power to detect changes in water chemistry variables from current baseline levels to trigger levels was estimated under various scenarios for the 'after' period ranging from one to six months of data and from one to three subsamples per month. As discussed in **Section 3.2.3**, it is proposed to

[10] The Meadowbank study lakes typically lack stratification, which results in a well-mixed water column with consistent physical and chemical characteristics across depth zones.
[11] Samples at depth could be added in cases where there is reason to suspect potential for large depth-specific effects. Given that the CREMP is intended to monitor large-scale basin-wide changes, depth-specific sampling is less likely to be warranted for the CREMP than for other programs that have a finer scale of resolution.

use data for a single month as a flag, whereas triggers for action would be based on mean values over several months.

The BACI analysis focused on Meadowbank data. Baker Lake data have only been collected since 2008, thus inferences would be limited based on the small data set. Results from Meadowbank should be generalizable to Baker Lake, given that the BACI analyses for Meadowbank compare a single control to each potential impact station individually (the same scenario as for Baker, which has one control and two impact stations).

The BACI analysis for Meadowbank focused on estimation of power for stations SP, TPE and TPN compared to INUG (as control). Power was estimated for a limited number of variables, using simulation – values used in the simulations were based on fits of mixed-effects models to the 'before' period data (control data only, no impact data). All details are provided in **Appendix A**.

Results of power analysis for t-Al, t-Mn, ammonia-N and t-P are shown in **Figure 6**, while results for pH are shown in **Figure 7**. More details are provided in **Appendix A**. In general, with an exception for t-P, power is high (around 80% or higher) with six month means. In many cases power is almost 100%. Results show that the benefits of subsampling are limited, with some gains in power associated with two subsamples but little improvement associated with three subsamples. In terms of duration of sampling, the results show significant increases in power associated with 3 months of sampling, and smaller increases associated with moving from 3 to 6 months. Consequently, we would not expect significant limitations if fewer than six samples are collected due to sampling constraints discussed in **Section 3.2.3**. Furthermore, it may be reasonable to intentionally reduce sampling from 6 samples in some cases, for example as follows:

1. Sampling for PDL could be limited to open water seasons, to reduce the safety hazard associated with sampling PDL during spring. PDL data would still be used as control, but the sample size in a given year would be slightly lower. As long as INUG continues to be sampled whenever the impact stations are sampled, it will be possible to detect natural anomalous month-effects if they occur. Since trigger criteria for water are based on means over several months, and since natural anomalous month-effects are not generally expected, the PDL data should be just as useful as the INUG data even when under ice sampling is not included.

2. Baker Lake sampling could also be reduced to open water seasons. Given that impacts at Baker Lake would be expected primarily in open water months when barges are moving and cargo is being loaded/unloaded, there is little chance of missing major potential impacts by not sampling through the ice.

4.4. Analyses for Sediment Chemistry

4.4.1. Data Review

The sediment chemistry data were summarized in **Table 4**. Further description and all analyses of the sediment chemistry data are provided in **Appendix B**. Some key conclusions regarding the data are as follows:

- Data collected by coring are more useful than grab sample data for monitoring changes in sediment chemistry. This is because the former targets a thin surface layer, whereas the grab sample collection targets a thicker layer that may be less reflective of potential mine-related impacts and more reflective of historic (pre-mining) conditions.
- Duplicate samples – Field duplicates are different for core and grab samples. In the case of core samples, the duplicates are separate samples collected at the same location. In the case of grab samples, the duplicates are split samples – that is, a different aliquot of sample is taken from the composite sample. Thus, differences among core sample duplicates will reflect fine-scale spatial variation and sampling/lab precision (measurement error), whereas for grab sample duplicates, differences should reflect homogenization of sediment and sampling/lab precision. Analysis of duplicate samples in water shows that the variability due to these factors is generally much lower than general sample variation. From a QA/QC perspective, this confirms that precision in field collection and lab methods is reasonable relative to the natural variability among the samples and stations. Duplicate samples were not included in the power analyses of sediment chemistry below because they are not independent of the standard samples and are therefore pseudoreplicates of the standard samples.
- Baker / Meadowbank differences – as discussed in **Section 3.3.2**, there are significant and meaningful differences in baseline data between Baker Lake and the Meadowbank lakes.

4.4.2. Power Analysis and Implications

Power analysis for sediment chemistry variables is based on the assumption that we would not expect any significant natural inter-annual variability in sediment chemistry over a limited number of years. This is reasonable given the low rates of natural sediment deposition in the project lakes. Thus, a before-after (BA) modeling framework is appropriate for sediment chemistry.

Using the BA framework presented in **Section 4.2**, and the data for sediment core samples, the power to detect changes in sediment chemistry parameters from current baseline levels to trigger levels was estimated under various scenarios for the number of subsamples ranging from 5 to 25. The objective was to detect a difference from baseline

in a given (single) year. Analysis considered five of the seven sediment chemistry variables (As, Cr, Cu, Hg, Zn) at the near-field Meadowbank stations SP, TPE and TPN. Results from these variables/stations give a reasonable cross-section and should be generalizable to other variables and stations. Power was estimated using one-tailed t-tests assuming an effect size equal to a shift from baseline mean to a trigger. All details are provided in **Appendix B**.

Statistical power was basically 100% except for two cases (Cr for TPN and Zn for TPE) in which the mean of baseline data was close to the trigger value (see **Figure 8**).

Importantly, there was potential evidence that differences in "random selection" of sampling location resulted in significant differences between years (see **Appendix B**). This is explained by reviewing the field sampling methods between the two years for INUG (in one year, the field crew clearly followed a linear path and did not randomly sample). Given this evidence of spatial heterogeneity within lakes or basins, it seems reasonable to have 10 subsamples, even though 5 would probably be sufficient in most cases. In addition, it seems appropriate to continue to sample INUG as a control to maintain the option of applying BACI models over time rather than the simplified BA model. Consequently, we recommend that for every sediment core chemistry sampling event, 10 subsamples be collected at each impact station, with 5 submitted for analysis and the additional 5 to be archived. If there is evidence of potential impacts, or if uncertainty is high, the additional 5 samples could be analyzed. For INUG, only 5 subsamples should be collected and analyzed, because the value of control data lies only in potential use of BACI models, not BA models.

Although sediment core samples are the most appropriate for evaluating sediment chemistry, sediment grab samples should be continued (to be collected at the same time as benthic invertebrate samples) because some important monitoring variables (e.g., particle size) are not or may not be measured with the core samples due to volume limitations.

4.5. Analyses for Biological Effects Variables

4.5.1. Phytoplankton

4.5.1.1. Data Review

The phytoplankton data are similar to the water chemistry data, with a total of 308 samples collected for the CREMP from 2006 through to September 2010 (see **Table 5**; not including field duplicate samples and depth replicates). Some key conclusions regarding the data are as follows:

- Duplicate samples are derived by collecting a separate sample at the same location, station, depth and time as a standard sample. Differences between a duplicate sample and its associated standard sample reflect the combined variability from subsample variation and measurement error associated with field collection methods and lab methods. Analysis of duplicate samples for phytoplankton shows that the variability due to these factors is generally lower than general sample variation. From a QA/QC perspective, this confirms that precision in field collection and lab methods is reasonable relative to the natural variability among the samples and stations. Duplicate samples were not included in the power analyses of phytoplankton below because they are not independent of the standard samples and are therefore pseudoreplicates of the standard samples.
- Depth samples were collected starting in 2009, to determine the potential importance of differences in measurements associated with depth. Analysis shows that for almost all variables there is no difference associated with depth, and for the few exceptions the magnitude of differences associated with depth are minimal compared to the magnitude of differences that occur naturally between samples and stations[12]. We conclude that future sampling should focus on surface (3 m below surface) samples[13], in order to take advantage of the most baseline data. Depth samples were not included in power analyses below – as with duplicate samples, the depth samples are pseudoreplicates of the surface samples.

4.5.1.2. Power Analysis and Implications

Using the BACI framework presented in **Section 4.2**, the power to detect 20% and 50% reductions in phytoplankton variables from current baseline levels was estimated under various scenarios for the 'after' period ranging from one to six months of data and from one to three subsamples per month. As discussed in **Section 3.4.2**, it is proposed to use data for a single month as a flag, whereas triggers for action would be based on mean values over several months.

The BACI analysis focused on Meadowbank data. Baker Lake data have only been collected since 2008, thus inferences would be limited based on the small data set.

[12] The Meadowbank study lakes typically lack stratification, which results in a well-mixed water column with consistent physical and chemical characteristics across depth zones.
[13] Samples at depth could be added in cases where there is reason to suspect potential for large depth-specific effects. Given that the CREMP is intended to monitor large-scale basin-wide changes, depth-specific sampling is less likely to be warranted for the CREMP than for other programs that have a finer scale of resolution.

Results from Meadowbank should be generalizable to Baker Lake, given that the BACI analyses for Meadowbank compare a single control to each potential impact station individually (the same scenario as for Baker, which has one control and two impact stations).

The BACI analysis for Meadowbank focused on estimation of power for stations SP, TPE and TPN compared to INUG (as control). Power was estimated for two variables (total biomass and species counts), using simulation – values used in the simulations were based on fits of mixed-effects models to the 'before' period data. All details are provided in **Appendix C**.

Results of power analysis are shown in **Figure 9**. More details are provided in **Appendix C**. Results show that the power to detect 20% reductions in phytoplankton variables is much lower than power to detect 50% reductions. This is particularly true for total biomass, and we would expect power to be even lower for all other biomass variables (except Chrysophytes) given their higher variability. Results also show that the benefits of subsampling are limited, with very little gain in power associated with more than two subsamples. In terms of duration of sampling, the results show notable increases in power associated with 3 months of sampling, and smaller increases associated with moving from 3 to 6 months. Consequently, there may not be a large benefit associated with sampling phytoplankton under ice, since 3 samples collected during open water (July, August, September) would provide as much power. We propose to sample phytoplankton whenever water samples are collected (i.e., up to 6 months per year), but to only analyze the data for July to September while archiving the samples for other months.

4.5.2. Benthic Community

4.5.2.1. Data Review

Benthic invertebrates have been collected as part of the CREMP once each year in August from 2006 to 2010. Each sample is a composite of two Petite Ponar grabs, sieved using a 500 um mesh screen. If we exclude a few samples that were collected with a different mesh size (250 um) or that were based on single grabs rather than composites, and if we also exclude some 2006 data where samples were poorly preserved and denoted as not useful, there have been 242 samples collected (see **Table 6**). Of these, 162 were designated as control and 80 samples were designated as impact (shaded cells in the table). There were no duplicate samples collected for benthos.

4.5.2.2. Power Analysis and Implications

Using the BACI framework presented in **Section 4.2**, the power to detect 20% and 50% reductions in benthic invertebrate community variables from current baseline levels was

estimated under various scenarios for the 'after' period ranging from one to three years data and from 3 to 20 subsamples per month.

The BACI analysis focused on Meadowbank data. Baker Lake data have only been collected since 2008, thus inferences would be limited based on the small data set. Results from Meadowbank should be generalizable to Baker Lake, given that the BACI analyses for Meadowbank compare a single control to each potential impact station individually (the same scenario as for Baker, which has one control and two impact stations).

The BACI analysis for Meadowbank focused on estimation of power for stations SP, TPE and TPN compared to INUG (as control). Power was estimated for two variables (total abundance and total taxa), using simulation – values used in the simulations were based on fits of mixed-effects models to the 'before' period data. All details are provided in **Appendix D**.

Results of power analysis are shown in **Figure 10**. More details are provided in **Appendix D**. The presence of year-by-station effects (i.e., natural station-specific inter-annual variation) will make it very difficult to distinguish between impacts and natural variations given only one year of "impact" data (or even after several years for relatively minor effects). Results show that the power to detect 20% reductions in total abundance or total taxa for benthic invertebrates is generally not high even after 3 years and with many subsamples per year. Power is higher for detecting a 50% reduction, particularly for total taxa. Increasing the number of replicates (subsamples) from the current 5 replicates would not result in significant improvements to power or precision in most cases.

4.5.3. Zooplankton

The zooplankton data for the CREMP include 45 samples collected in August 2010 (5 spatial replicates at each of the 9 Meadowbank stations) and 90 samples collected in August 2011 (10 spatial replicates at each of the 9 stations; see **Appendix E**). Using the BACI framework presented in **Section 4.2**, the power to detect 20% and 50% reductions in zooplankton variables from current baseline levels was estimated under various scenarios for the 'after' period ranging from one to three years data and from 5 to 20 subsamples per sampling event. In addition, because there were only 2 years of 'before' data, additional 'before' data were simulated so that three scenarios could be considered (before years = 2, 3, or 4). The power analyses were conducted using a single control (INUG) as well as two controls (INUG and PDL), paired with one impact station (SP, TPE or TPN). Power was estimated for three variables (wet biomass, dry biomass and abundance) using simulation – all details are provided in **Appendix E**.

Results of power analysis are provided in **Appendix E**. Power is always low when trying to detect a 20% change, and when trying to detect a 50% change in one year (except a

couple of cases when there are a high number of subsamples). Power is only reasonable (around 0.7 or higher) for abundance and especially for dry biomass when detecting a 50% reduction with 2 or 3 years of 'after' period data. The number of spatial replicates (5, 10 or 20) appears somewhat less important than the number of years of 'after' period data. Overall, zooplankton variables are not realistically capable of detecting effects in a given year. Consequently, we do not recommend that zooplankton be included as a monitoring component of the CREMP. Zooplankton may still be useful (particularly dry biomass, which appears to be more sensitive than abundance) where focused EAS studies are warranted, for example using intensive spatial-gradient designs.

4.5.4. Periphyton

The periphyton data for the CREMP include 105 samples over the period 2007 to 2011 (see **Appendix F**). Most of the samples were collected in 2007 and 2008 (5 spatial replicates at each of 7 Meadowbank stations for a total of 35 samples each year). For 2009 to 2011 there were 5 spatial replicates collected in SP and also at reference (SP-DT)

Using the BACI framework presented in **Section 4.2**, the power to detect 20% and 50% reductions in periphyton biomass variables from current baseline levels was estimated under various scenarios for the 'after' period ranging from one to three years data and from 5 to 20 subsamples per sampling event. In addition, because there were only 2 years of 'before' data, additional 'before' data were simulated so that three scenarios could be considered (before years = 2, 3, or 4). The power analyses were conducted using a single control (INUG), paired with one impact station (SP, TPE or TPN). Power was estimated for three variables (Cyanobacteria biomass, diatom biomass and total biomass) using simulation – all details are provided in **Appendix F**.

Results of power analysis are provided in **Appendix F**. Power is generally low, except for detecting a 50% decrease in total biomass when there are multiple years of before and after data. The number of spatial replicates (5, 10 or 20) appears relatively unimportant, as power is driven mainly by the number of years of data in the 'before' and 'after' periods. Overall, periphyton variables are not realistically capable of detecting effects in a given year, and are even less powerful than zooplankton variables for detecting medium term trends (e.g., 2-3 years each of 'before' and 'after' data). The most useful variable, total biomass, does not achieve high (0.8) power with less than 4 years of 'after' data. Furthermore, collection of periphyton data is subject to bias because sampling crews must subjectively choose the rocks that are sampled – while efforts can be made to standardize this process, there is nevertheless a risk of year-to-year variability in field sample collection methods that is greater than for other monitoring variables. For all of these reasons, we do not recommend that periphyton be included as a monitoring component of the CREMP. Periphyton may still be useful where focused EAS studies are warranted, for example using intensive spatial-gradient designs.

5. SUMMARY OF IMPLICATIONS FOR THE CREMP

The previous sections of this design document have derived thresholds and triggers for action for CREMP water chemistry parameters and biological monitoring variables, and have evaluated the ability of alternative monitoring program designs to detect changes relative to those thresholds and triggers. The key implications of the analyses for CREMP sampling are as follows, and the program is summarized in **Table 13**:

- Water chemistry data will be collected up to 6 months per year (April, May, July, August, September and November/December) for the annual period of paired sampling to support BACI statistical analyses, recognizing that in any given year the actual number of samples that would be collected may range from four to six depending on logistical constraints (e.g., snow and ice conditions). Sampling will be limited to open water months only (July, August and September) for PDL and for the Baker Lake stations. It is recommended that two randomly located subsamples be collected at each station in each month. All samples should be surface samples (3 m from the surface). In addition to the core water chemistry program, basic water quality data 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 changes over winter.
- Sediment chemistry core sampling for the CREMP is intended to detect long term trends, therefore a sampling frequency of approximately every three years is recommended. To maximize the potential utility of the data, sampling will be aligned with the sampling times for benthic invertebrates required for the EEM program. Thus, sediment chemistry cores were collected in 2012 (because there have been no core data collected since 2009), and then matched to the envisioned EEM sampling years which are likely to be 2014 and then every three years (depending on results in 2014). Samples will be collected during open water (August) at potentially impacted stations as well as INUG and BAP. There is no need for sampling at PDL or other reference stations other than INUG and BAP. For each sampling event, 10 randomly[14] located subsamples should be collected at each impact station, with 5 submitted for analysis and the additional 5 archived. If there is evidence of potential impacts, or if uncertainty is high, the additional 5 samples could be analyzed. At INUG, only 5 subsamples should be collected and analyzed – there is no need to archive an additional 5 samples for INUG.
- Sediment grab sampling synoptically collected with benthic invertebrate samples (i.e., once per year) should also be continued to ensure collection of basic physical

[14] Importantly, the random locations should be selected in advance using random number generators and GIS software, and should not be selected by the sampling team in the field.

variables (e.g., particle size and organic carbon) not covered by sediment core sampling (due to volume limitations or lack of direct spatial compatibility with benthic sample replicates) but which may nevertheless affect benthic invertebrates.

- Phytoplankton data will be collected whenever the water chemistry data are collected, but only the open water samples (July to September) will be analyzed while it is recommended that the other samples be archived. It is recommended that two randomly located subsamples be collected at each station for each sampling event. All samples should be surface samples (3m from the surface).
- Benthic invertebrates should be collected once per year in August at all stations, with 5 subsamples per station.
- Zooplankton sampling (5 subsamples per station) should be discontinued for the CREMP, due to low power to detect effects.[15]
- Periphyton sampling should be discontinued for the CREMP, due to its low power to detect effects even with several years of data[16].

The above recommendations should be re-visited periodically based on accumulated data for the CREMP and updated power analyses for each group of variables.

6. LINKS TO AEMP

A management response plan (MRP) has been developed for the AEMP (Azimuth, 2012), of which the CREMP is one component. The general MRP for the Meadowbank Mine AEMP is shown in **Figure 11**. Following the integration of the results from each independent program, the response actions are based on the cumulative results of all programs. Therefore, while we expect management actions to be taken in cases where criteria for action are exceeded, the specific actions are not linked to outcomes of the CREMP alone because the CREMP is only one of the monitoring programs under the AEMP. In other words, it is not possible or appropriate to describe the specific management actions that will be taken when CREMP triggers or thresholds are exceeded.

Nevertheless, as shown in **Figure 3**, **Figure 4**, **Figure 5**, and **Figure 11**, there are two general classes of management actions – those aimed at further assessment and those aimed at mitigation. In general, exceedance of early warning triggers will trigger further

[15] Zooplankton and periphyton may still be useful where focused EAS studies are warranted, for example using intensive spatial-gradient designs.

[16] See previous footnote.

assessment, which may then lead to mitigation, whereas exceedances of thresholds could possibly lead directly to mitigation. It is expected that CREMP triggers will be exceeded occasionally due to chance (given the large number of variables that are monitored, particularly for water chemistry), therefore further assessment will almost always be important.

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 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 (see Azimuth, 2012).

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Table 1. CREMP Station Summary.

	Baker Lake			Meadowbank Lakes							Wally	
Year	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	
2006				0		0	0		0	0	0	0	Known
2007				0		0	0		0	0	0	0	
2008	0	1	1	0		Aug	Aug		0	0	0	0	
2009	0	1	1	0	0	1	1	0	Aug	March	March	0	
2010	0	1	1	0	0	1	1	0	1	1	0	0	
2011	0	1	1	0	0	1	1	0	1	1	0	0	
2012	0	1	1	0	0	1	1	?	1	1	?	0	Guess
2013	0	1	1	0	0	1	1	?	1	1	?	?	
2014	0	1	1	0	0	1	1	?	1	1	?	1	

Notes:

	Always "control"
	Far-field: possible "impact"; considered "control" until potential exposure occurs.
	Near-field: Impact (as of start of activities that could result in exposure; "control" prior to that).
Blank	denotes that the station was not part of the monitoring program that year.
0, 1	This denotes whether the station-year combination was considered "control" (0) or "impact" (1).
	Baker Lake stations to be compared to BAP control station.
	Meadowbank stations to be compared to INUG, PDL and TEFF (while "control").
	Wally Lake to be compared to new control lake.

Table 2. General TSS Conditions at Meadowbank CREMP Stations for 2008, 2009 and 2010.

	2008				2009					2010				
	July	**Aug**	**Sept**	**Oct - Dec**	**Jan - Jun**	**July**	**Aug**	**Sept**	**Oct - Dec**	**Jan - Jun**	**July**	**Aug**	**Sept**	**Oct - Dec**
Third Portage Lake														
North Basin (TPN)	Background	Background	Background	Background	Dewatering - no apparent TSS increase	Dewatering stopped	Background	Background	Background?	Dewatering, TSS < 1 mg/L	Dewatering, TSS < 1 mg/L	Dewatering, TSS < 1 mg/L	Dewatering, TSS < 1 mg/L	Dewatering, TSS < 1 mg/L
South Basin (TPS)	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background
East Basin (TPE)	Background	Background	Background	Background	Background	BG Dike construction starts	TSS concentrations gradually increase, but mostly at depth	Strong winds mix TSS throughout water column and basin; TSS source finished	TSS drops over time; still above HVH trigger by end of October	TSS increases again during causeway construction	TSS generally < 2 mg/L	TSS generally < 5 mg/L	TSS generally < 5 mg/L	TSS drops?
Second Portage Lake														
Main Basin (SP)	Background	ED construction starts; TSS rises dramatically in third week	TSS drops over time; meets targets by end of month	TSS drops?	TSS drops initially, then dewatering starts in March	Background	Some TSS input from BG dike construction, but low concentrations	TSS increases slightly, but limited spatially	TSS drops over time	TSS generally < 1 mg/L; 2 mg/L in Apr/May	TSS generally < 1 mg/L	TSS generally < 1 mg/L	TSS generally < 1 mg/L	TSS drops?
NW Arm	Background	TSS rises in parallel to main basin, but lower concentrations than main basin	TSS reduced, but rises again during WC Dike construction	TSS drops	TSS drops initially, then increases due to dewatering	TSS elevated due to dewatering activities; dewatering stops in early July	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated
Drilltrail Arm	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background
Tehek Lake														
Near-field Basin (TE)	Background	TSS rises during third week	TSS drops over time; meets targets by end of month	TSS drops?	TSS drops?	Background	Very slight increase in TSS	TSS slightly above background?	TSS drops over time?	TSS drops over time?	Background?	Background?	Background?	Background?
Far-field Basin (TEFF)	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background	Background

Notes: Shaded months indicate ice cover on lakes.
Acronyms: ED = East Dike; BG = Bay-Goose Dike; TSS = total suspended solids; DCM = dike construction monitoring.
"?" indicates uncertain condition.
CREMP stations shown in (), where applicable

Table 3. Water chemistry samples collected for the CREMP up to May 2010.

Notes: Shading denotes "impact" periods. Some of the data include field duplicates and depth replicates. See text for details.

Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul				1		1	1		1	1	1	1	7
	Aug				1		1	1		1	2	1	1	8
2007	Jul				1		1	2		1	1	1	1	8
	Aug				1		1	1		2	1	1	1	8
2008	Jul	1	1	1	1		1	1		1	1	1	2	11
	Aug	1	1	1	2		1	1		1	1	1	1	11
	Sep	2	1	1			1	1		1	4	1		12
2009	May				14		7	13		7	7			48
	Jul	3	4	3	7	3	3	8	2	3	4	3	4	47
	Aug	1	1	1	3	1	1	4	1	1	2	1	1	18
	Sep	3	3	4	7	3	4	7	3	4	3	3	4	48
	Nov				7		3	8		3	4			25
	Dec						1	3		2	1	3		10
2010	Jan						5	3		3	3	7		21
	Feb						2	3		1	1	3		10
	Mar						3	7		4	4	7		25
	Apr						1	3		2	1	3		10
	May						4	7		4	3	7		25
Total		11	11	11	45	7	41	74	6	42	44	44	16	352

Table 4. Core and grab sediment samples (excluding duplicates) collected for the CREMP program.

Notes: Core samples for July 2009 were collected for East Dike Effects Assessment Study, not for the CREMP, but have been included in the CREMP analysis. Shading denotes "impact" periods.

CORE		Baker			Meadowbank									
Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul													0
2007	Aug													0
2008	Jul				15		15	15		15	15	15	15	105
	Aug	15	6	15										36
2009	Jul				15		15	15		15				60
	Aug													0
Total		**15**	**6**	**15**	**30**	**0**	**30**	**30**	**0**	**30**	**15**	**15**	**15**	**201**

GRAB		Baker			Meadowbank									
Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul				1		1	1		1	1	1	1	7
2007	Aug				1		1	1		1	1	1	1	7
2008	Jul													0
	Aug	1	1	1	1		1	1		1	1	1	1	10
2009	Jul													0
	Aug	3	3	3	3	3	3	3	3	3	3	3	3	36
Total		**4**	**4**	**4**	**6**	**3**	**6**	**6**	**3**	**6**	**6**	**6**	**6**	**60**

Table 5. Phytoplankton samples collected for the CREMP.

Notes: Duplicates and depth replicates removed. Shading denotes "Impact" periods.

Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul				1		1	1		1	1	1	1	7
	Aug				2		2	2		2	2	2	2	14
	Sep				1		1	1		1	1	1	1	7
2007	Jul				1		1	1		1	1	1	1	7
	Aug				1		1	1		1	1	1	1	7
2008	Jul	1	1	1	1		1	1		1	1	1	1	10
	Aug	1	1	1	1		1	1		1	1	1	1	10
	Sep	1	1	1			1	1		1	1	1		8
2009	Jul	3	3	3	3	3	3	3	2	3	3	3	3	35
	Aug	1	1	1	1	1	1	1	1	1	1	1	1	12
	Sep	3	3	3	3	3	3	3	3	3	3	3	3	36
	Nov				3		3	3		3	3			15
	Dec						1	1		1	1	1		5
2010	Jan						3	2		3		3		11
	Feb						1	1		1	1	1		5
	Mar						3	3		3	3	3		15
	Apr						1	1		1	1	1		5
	May						3	3		3	3	3		15
	Jul	3	3	3	3	3	3	3	3	3	3	3	3	36
	Aug	1	1	1	1	1	1	1	1	1	1	1	1	12
	Sep	3	3	3	3	3	3	3	3	3	3	3	3	36
Total		17	17	17	25	14	38	37	13	38	35	35	22	308

Table 6. Summary of August benthic invertebrate samples for the CREMP (mesh size = 500 um).

Note: Shading denotes "Impact" periods.

Year	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006				6		6	4		6	3	6	6	37
2007				5		5	5		5	5	5	5	35
2008	5	5	5	5		5	5		5	5	5	5	50
2009	5	5	5	5	5	5	5	5	5	5	5	5	60
2010	5	5	5	5	5	5	5	5	5	5	5	5	60
Total	15	15	15	26	10	26	24	10	26	23	26	26	242

Table 7. Summary of thresholds for water variables.

Note: See text for derivation of triggers based on thresholds.

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 $\geq$ 6.5. See **Appendix A** for details.
t-Arsenic (As)	CCME	The CCME water quality guideline (aquatic life) for t-As is 0.005 mg/L.
t-Boron (B)	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)	CCME, EPA	The hardness-dependent CCME guideline for t-Cd (mg/L) is $0.001*10^{0.86*\log(H)-3.2}$ where H = hardness (mg/L $CaCO_3$). This guideline was deemed inappropriate. The EPA guideline for t-Cd of 0.0001 mg/L was used instead. See **Appendix A** for details.
t-Copper (Cu)	CCME	The CCME guideline for t-Cu is 0.002 mg/L for hardness < 120 mg/L $CaCO_3$.
t-Chromium (Cr)	CCME	The CCME guideline for hexavalent chromium (the most common form in surface waters) is 0.001 mg/L.
t-Iron (Fe)	CCME	The CCME guideline for t-Fe is 0.3 mg/L.
t-Lead (Pb)	CCME	The CCME guideline for t-Pb is 0.001 mg/L for hardness < 60 mg/L $CaCO_3$.
t-Manganese (Mn)	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 **Appendix A** for details.
t-Mercury (Hg)	CCME	The CCME guideline for total inorganic mercury is 26 ng/L (0.00026 mg/L).
t-Molybdenum (Mo)	CCME	The CCME guideline for t-Mo in water is 0.073 mg/L.
t-Nickel (Ni)	CCME	The CCME guideline for t-Ni is 0.025 mg/L for hardness < 60 mg/L $CaCO_3$.
t-Selenium (Se)	CCME	The CCME guideline for t-Se in water is 0.001 mg/L.
t-Thallium (Tl)	CCME	The CCME water quality guideline for t-Tl is 0.0008 mg/L.
t-Zinc (Zn)	CCME, EVS (2004)	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 **Appendix A** 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 as follows: $d\text{-}Al = e^{(1.6-3.327*pH + 0.402*K)}$ where $K = pH^2$. See **Appendix A** 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 **Appendix A** 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 **Appendix A** for details.

pH	CCME	The CCME guideline for pH is a range from 6.5 to 9.0. See **Appendix A** 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 **Appendix A** for details.

Table 8. Total metals in water: summary of trigger values for Meadowbank and Baker stations.

Notes: For each variable, thresholds are shown if applicable (see text for discussion); DL = current detection limit; N = sample measurements; >DL = number of measurements above DL; medians and 95th percentiles are shown for variables with at least one value >DL (with all values <DL set equal to DL); Method = method used to determine the trigger, where A = halfway from median (or DL if all values <DL) to threshold, B = 95th percentile, and C = 2*DL.

Variable	Threshold	DL	N	>DL	Median	95th	Trigger	Method
Aluminum (T)	0.1	0.005	120	85	0.0068	0.0127	0.053	A
Antimony (T)		0.0005	120	0			0.0010	C
Arsenic (T)	0.005	0.0005	120	0			0.0028	A
Barium (T)		0.02	120	0			0.04	C
Beryllium (T)		0.001	120	0			0.002	C
Boron (T)	1.2	0.1	120	0			0.65	A
Cadmium (T)	0.0001	0.000017	120	7	0.000017	0.000017	0.000059	A
Chromium (T)	0.001	0.001	120	0			0.001	A
Copper (T)	0.002	0.001	120	1	0.001	0.001	0.0015	A
Iron (T)	0.3	0.03	120	2	0.03	0.03	0.165	A
Lead (T)	0.001	0.0005	120	3	0.0005	0.0005	0.00075	A
Lithium (T)		0.005	120	0			0.010	C
Manganese (T)	See text	0.0003	120	114	0.0010	0.0025	0.32	See text
Mercury (T)	0.000026	0.00001	120	0			0.000018	A
Molybdenum (T)	0.073	0.001	120	0			0.037	A
Nickel (T)	0.025	0.001	120	0			0.013	A
Selenium (T)	0.001	0.001	120	0			0.001	A
Strontium (T)			6	6	0.0081	0.0089	0.0089	B
Thallium (T)	0.0008	0.0002	120	0			0.0005	A
Tin (T)		0.0005	120	0			0.0010	C
Titanium (T)		0.01	120	0			0.02	C
Uranium (T)		0.0002	120	0			0.0004	C
Vanadium (T)		0.001	120	0			0.002	C
Zinc (T)	See text	0.005	120	3	0.005	0.005	0.007	See text

Table 9. Dissolved metals in water: summary of trigger values for Meadowbank 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; medians and 95th percentiles for variables with at least one value >DL (with all values <DL set equal to DL); Method = method used to determine the trigger, where A = halfway from median (or DL if all values <DL) to threshold, B = 95th percentile, and C = 2*DL.

Variable	Threshold	DL	N	>DL	Median	95th	Trigger	Method
Aluminum (D)	See text	0.005	71	2	0.005	0.005	0.016	See text
Antimony (D)		0.0005	71	0			0.0010	C
Arsenic (D)		0.0005	71	0			0.0010	C
Barium (D)		0.02	71	0			0.04	C
Beryllium (D)		0.001	71	0			0.002	C
Boron (D)		0.1	71	0			0.2	C
Cadmium (D)		0.000017	71	0			0.000034	C
Chromium (D)		0.001	71	0			0.002	C
Copper (D)		0.001	71	0			0.002	C
Iron (D)		0.03	71	0			0.06	C
Lead (D)		0.0005	71	0			0.0010	C
Lithium (D)		0.005	71	0			0.010	C
Manganese (D)		0.0003	71	25	0.0003	0.0014	0.0014	B
Mercury (D)		0.00001	71	0			0.00002	C
Molybdenum (D)		0.001	71	0			0.002	C
Nickel (D)		0.001	71	0			0.002	C
Selenium (D)		0.001	71	0			0.002	C
Strontium (D)			6	6	0.0082	0.0092	0.0092	B
Thallium (D)		0.0002	71	0			0.0004	C
Tin (D)		0.0005	71	0			0.0010	C
Titanium (D)		0.01	71	0			0.02	C
Uranium (D)		0.0002	71	0			0.0004	C
Vanadium (D)		0.001	71	0			0.002	C
Zinc (D)		0.005	71	0			0.010	C

Table 10. Nutrients and conventional parameters in water: summary of trigger values for Meadowbank 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; medians and 95th percentiles for variables with at least one value >DL (with all values <DL set equal to DL); Method = method used to determine the trigger, where A = halfway from median (or DL if all values <DL) to threshold, B = 95th percentile, and C = 2*DL.

			Meadowbank (or both)						Baker (if different)					
Variable	Threshold	DL	T	N	Med	95th	Trigger	Method	T	N	Med	95th	Trigger	Method
Ammonia-N	0.126	0.02	120	47	0.020	0.052	0.073	A						
TKN		0.05	110	106	0.097	0.181	0.181	B	10	10	0.180	0.194	0.194	B
Nitrate-N	2.9	0.005	110	3	0.005	0.005	1.45	A	10	10	0.014	0.027	1.46	A
Nitrite-N	0.06	0.001	120	1	0.001	0.001	0.031	A						
Ortho-phosphate		0.001	108	8	0.0010	0.0011	0.002	C						
Total phosphorous	0.004	0.002	98	44	0.0020	0.0047	0.0047	B	10	10	0.0032	0.0061	0.0061	B
TOC			110	110	1.63	2.51	2.51	B	10	10	3.06	3.17	3.17	B
DOC			110	110	1.59	2.31	2.31	B	10	10	3.02	3.42	3.42	B
Reactive silica		1.0	99	0			2.0	C						
Bicarbonate alkalinity			98	98	4.60	9.42	9.42	B	10	10	9.00	9.46	9.46	B
Chloride		0.5	110	52	0.5	0.79	0.79	B	10	10	67.8	119.7	119.7	B
Carbonate alkalinity		2.0	108	0			4.0	C						
Conductivity			110	110	15.9	27.4	27.4	B	10	10	273.5	464.9	464.9	B
Hardness			110	110	5.7	12.3	12.3	B	10	10	32.6	49.5	49.5	B
Calcium			110	110	1.3	3.3	3.3	B	10	10	3.8	5.2	5.2	B
Potassium		2.0	120	2	2.0	2.0	4.0	C						
Magnesium			110	110	0.64	0.96	0.96	B	10	10	5.59	8.90	8.90	B
Sodium		2.0	110	0			4.0	C	10	10	36.2	65.1	65.1	B
Sulphate			110	110	1.43	2.61	2.61	B	10	10	9.53	17.31	17.31	B
pH (Upper)	9.0		110	110	6.80	8.00	8.00	B	10	10	7.17	7.59	8.09	A
pH (Lower)	6.5		110	110	6.80	6.47[a]	6.47	B	10	10	7.17	6.97[a]	6.84	A
Total alkalinity			98	98	4.60	9.42	9.42	B	10	10	9.00	9.46	9.46	B
TDS		10.0	110	62	11.0	19.0	19.0	B	10	10	138.5	245.8	245.8	B
TSS	5.0	1.0	120	8	1.0	1.6	3.0	A						

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

Table 11. Summary of CCME guidelines for sediment variables.

Variable	Source	Description of guidelines
t-Arsenic (As)	CCME	The CCME ISQG for As is 5.9 mg/kg.
t-Cadmium (Cd)	CCME	The CCME ISQG for Cd is 0.6 mg/kg.
t- Chromium (Cr)	CCME	The CCME ISQG for Cr is 37.3 mg/kg.
t-Copper (Cu)	CCME	The CCME ISQG for Cu is 35.7 mg/kg
t-Lead (Pb)	CCME	The CCME ISQG for Pb is 35 mg/kg.
t-Mercury (Hg)	CCME	The CCME ISQG for Hg is 0.17 mg/kg.
t-Zinc (Zn)	CCME	The CCME ISQG for Zn is 123 mg/kg.

Table 12. Summary of trigger values for sediment variables for Meadowbank and Baker stations.

Notes: For each variable, thresholds (guidelines) are shown (details for thresholds are in **Table 7**); DL = current detection limit; N = sample measurements; >DL = number of measurements above DL; medians and 95th percentiles for variables with at least one value >DL (with all values <DL set equal to DL); Method = method used to determine the trigger, where A = halfway from median (or DL if all values <DL) to threshold, and B = 95th percentile.

			Meadowbank (or both for Lead)						Baker					
Variable	Threshold	DL	N	>DL	Med	95th	Trigger	Method	N	>DL	Med	95th	Trigger	Method
Arsenic (As)	5.9	5.0	135	133	26.5	120.0	120.0	B	15	3	5.0	8.3	8.3	B
Cadmium (Cd)	0.6	0.50	135	64	0.50	1.10	1.10	B	15	0			0.55	A
Chromium (Cr)	37.3		135	135	76.5	114.3	114.3	B	15	15	16.7	20.3	27.0	A
Copper (Cu)	35.7		135	135	61.8	126.0	126.0	B	15	15	5.3	7.8	20.5	A
Lead (Pb)	35	30	150	11	30	32	32.5	A						
Mercury (Hg)	0.17	0.005	135	135	0.038	0.064	0.104	A	15	13	0.006	0.011	0.088	A
Zinc (Zn)	123		135	135	91.0	121.3	121.3	B	15	15	24.1	32.1	73.6	A

Table 13. Sampling frequency and intensity for CREMP components

Note: Wally is shown together with Meadowbank for simplicity, although intensive sampling for Wally has not yet begun.

	Baker Lake	Meadowbank / Wally
Water Chemistry for Annual Period Statistical Analysis (all samples at 3 m from surface)	• Open water months (July, Aug, Sept) at all stations • 2 randomly located subsamples per station per event	• Open water months (July, Aug, Sept) for PDL • All other stations: Up to 6 months per year (April, May, July, Aug, Sept, Oct/Nov) depending on logistical & safety constraints • 2 randomly located subsamples per station per event
Water Chemistry Mid-Winter (all samples at 3 m from surface)	• None	• Minimum one sampling event at stations TPN, TPE, SP, WAL
Sediment Chemistry Cores	• Sampling in 2012, 2014, and approximately every three years thereafter, always in open water (August) • All impact stations; for control stations only BAP and INUG • Analyze 5 subsamples per station per event, and (except for INUG and BAP) archive an additional 5 samples (to be used only if the initial 5 subsamples suggest differences)	
Phytoplankton	• Sample collection same stations and frequency and depth as water chemistry, but only open water (July, Aug, Sept) samples should be analyzed – all other samples to be archived • 2 randomly located subsamples per station per event	
Benthic Community	• Sample collection once per year in August at all stations • 5 subsamples per station per event	

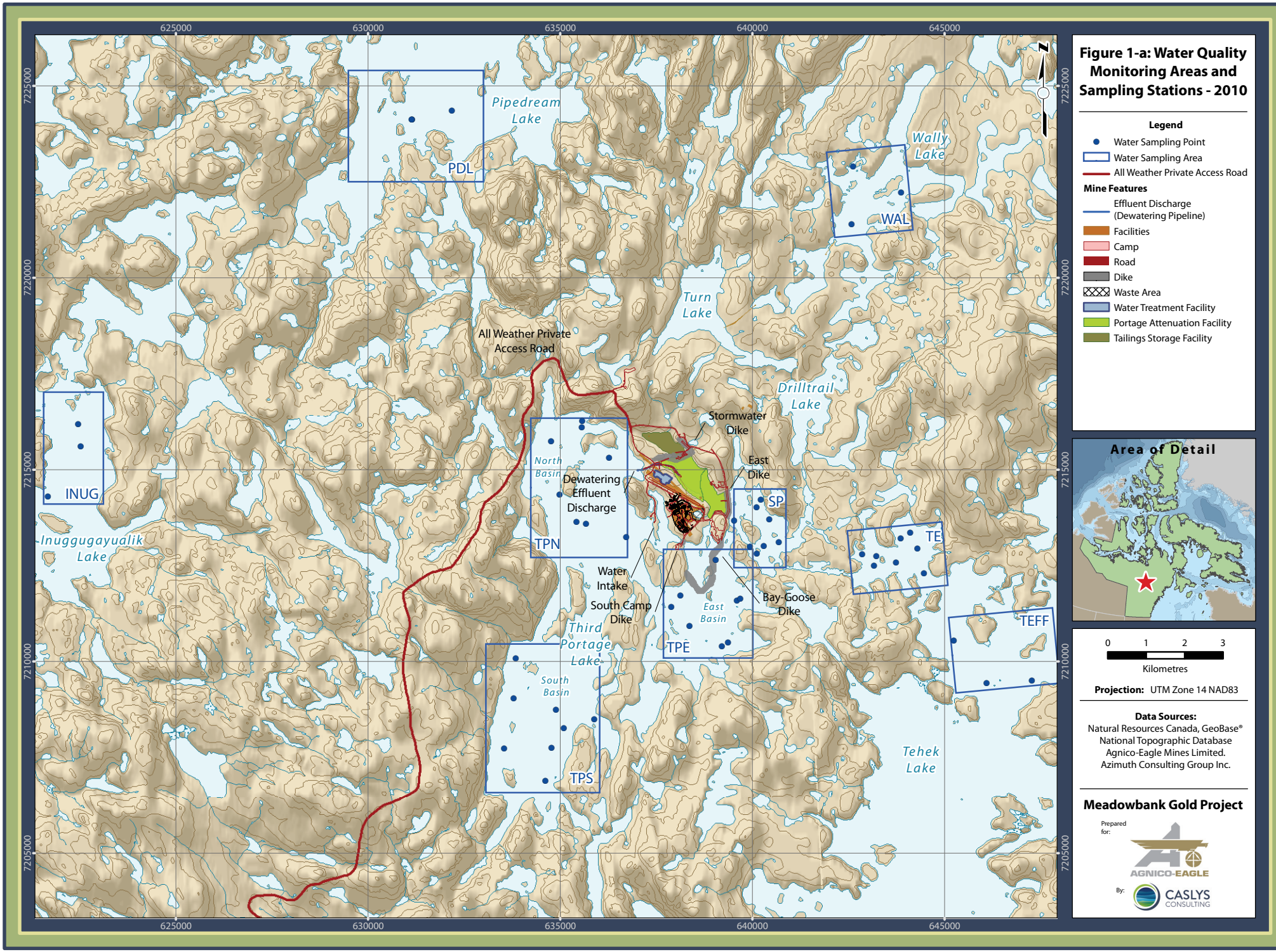


Figure 1-a: Water Quality Monitoring Areas and Sampling Stations - 2010

Legend

- Water Sampling Point
- Water Sampling Area
- All Weather Private Access Road

Mine Features

- Effluent Discharge (Dewatering Pipeline)
- Facilities
- Camp
- Road
- Dike
- Waste Area
- Water Treatment Facility
- 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

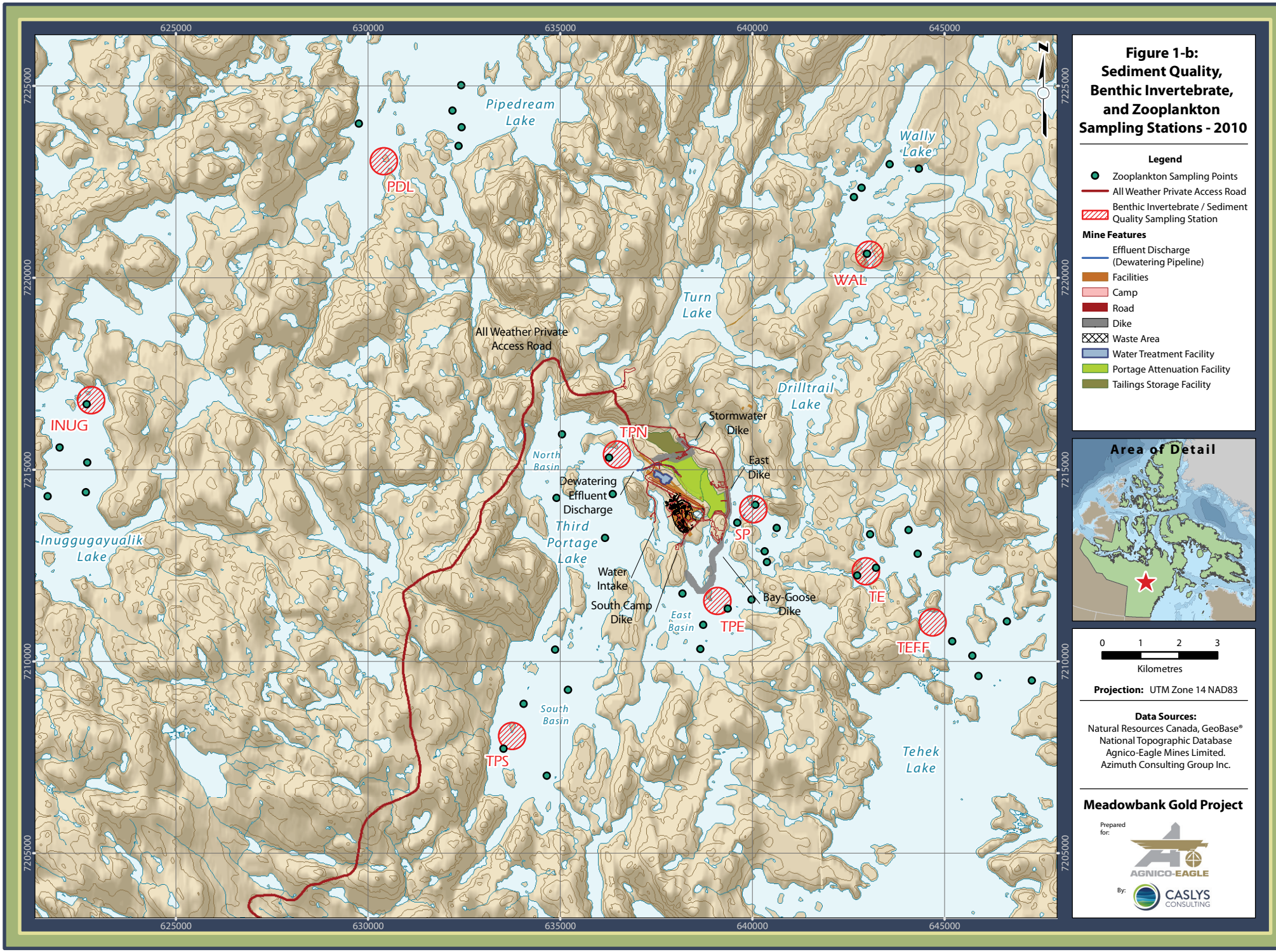


Figure 1-b: Sediment Quality, Benthic Invertebrate, and Zooplankton Sampling Stations - 2010

Legend

- Zooplankton Sampling Points
- All Weather Private Access Road
- Benthic Invertebrate / Sediment Quality Sampling Station

Mine Features

- Effluent Discharge (Dewatering Pipeline)
- Facilities
- Camp
- Road
- Dike
- Waste Area
- Water Treatment Facility
- Portage Attenuation Facility
- Tailings Storage Facility

Area of Detail

0 1 2 3

Kilometres

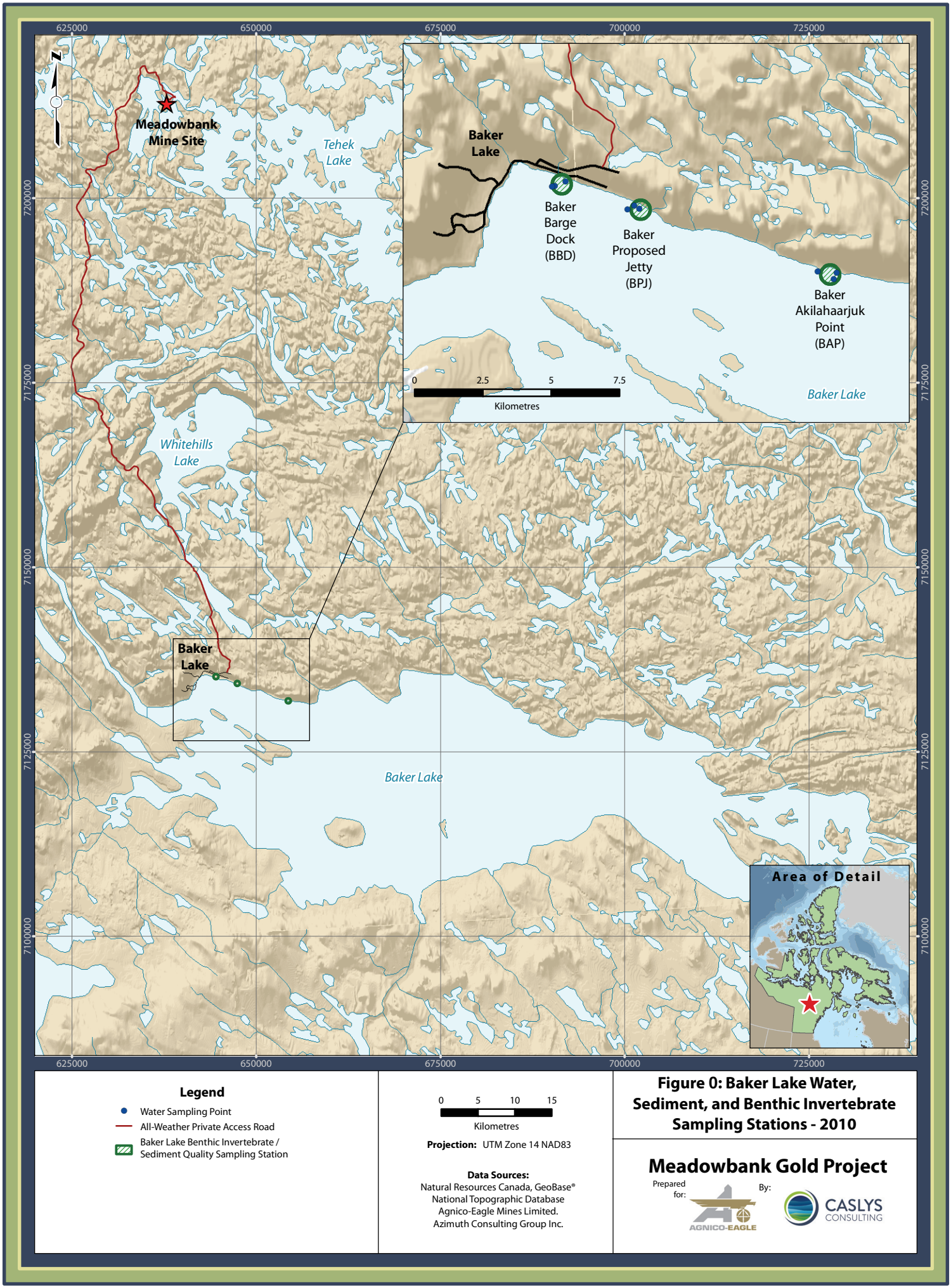
Projection: UTM Zone 14 NAD83

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

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

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.

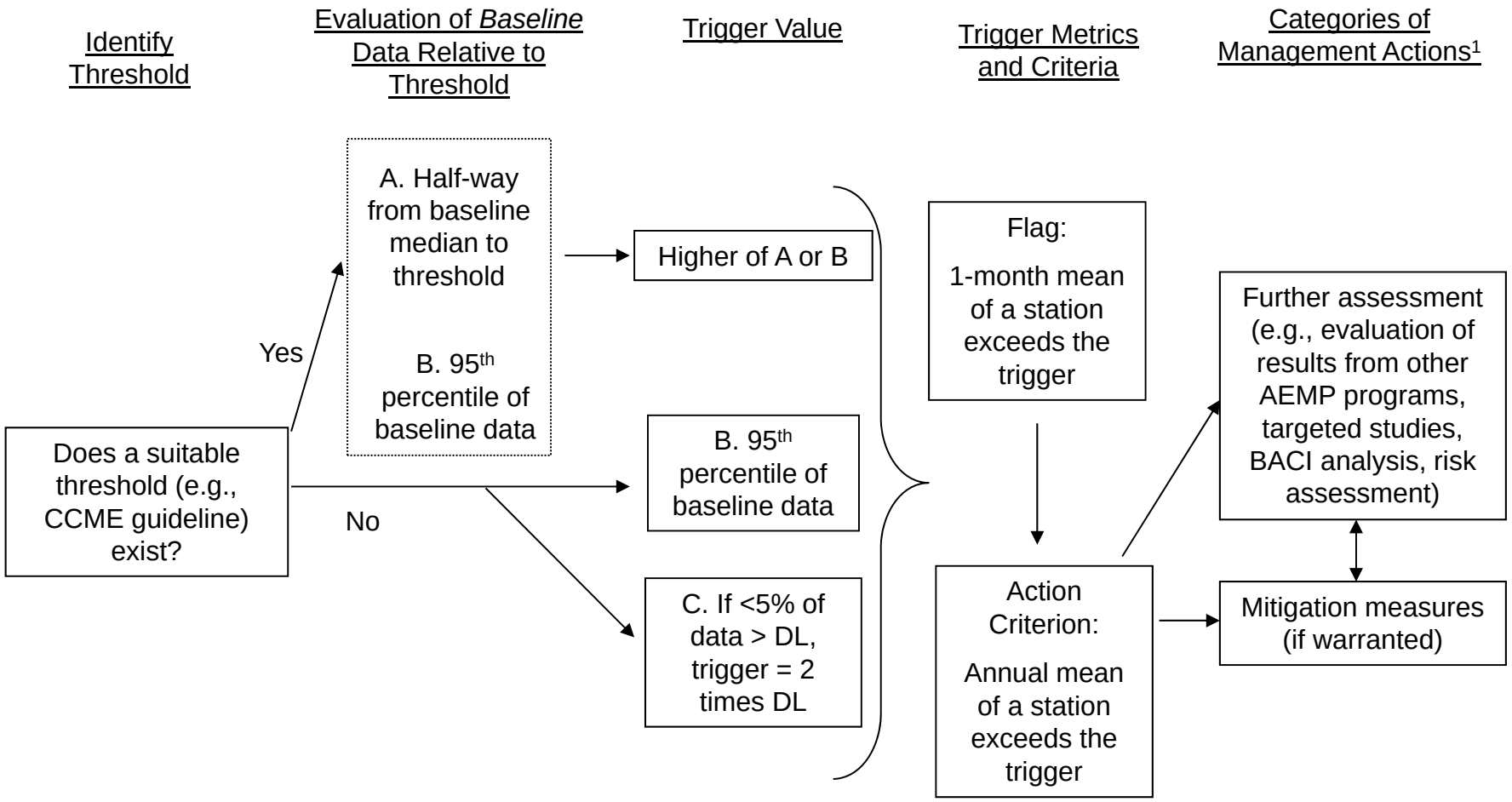
Figure 0: Baker Lake Water, Sediment, and Benthic Invertebrate Sampling Stations - 2010

Meadowbank Gold Project

Prepared for: AGNICO-EAGLE

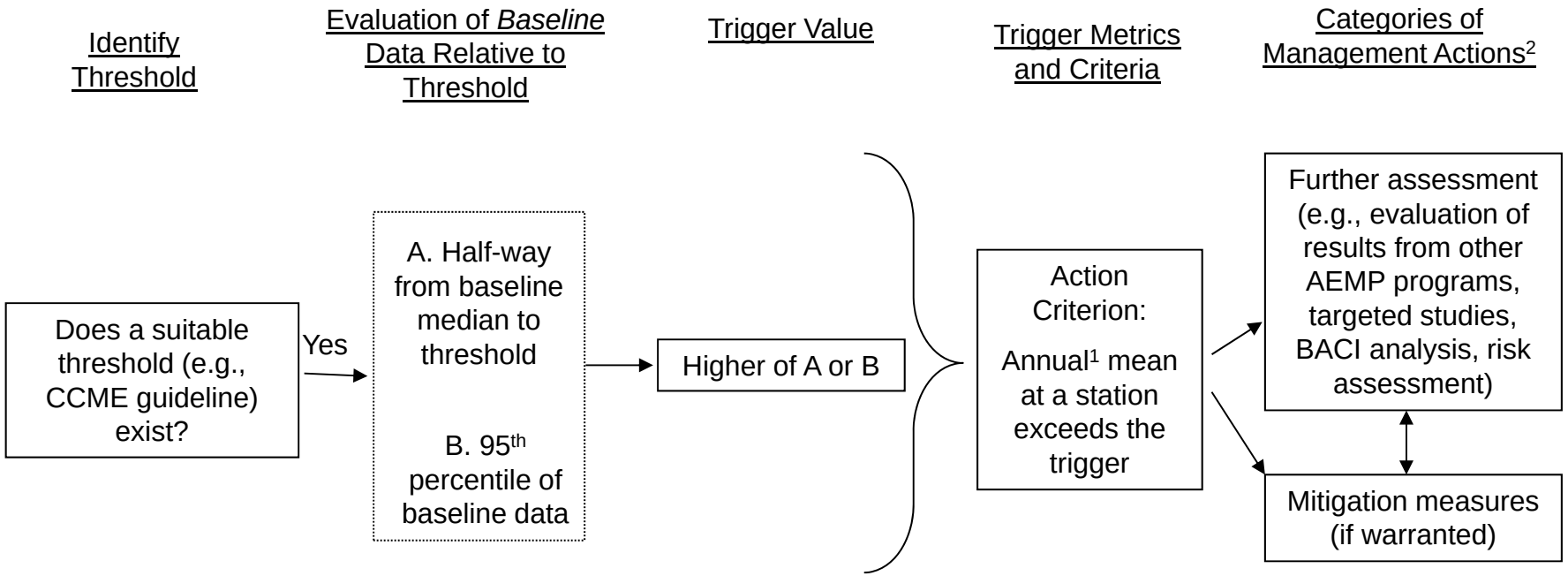
By: CASLYS CONSULTING

Figure 3. Development and Application of Monitoring Thresholds and Triggers for Water Chemistry Variables



[1] Potential management actions are considered as part of the broader AEMP, where results of the CREMP and other programs are considered together.

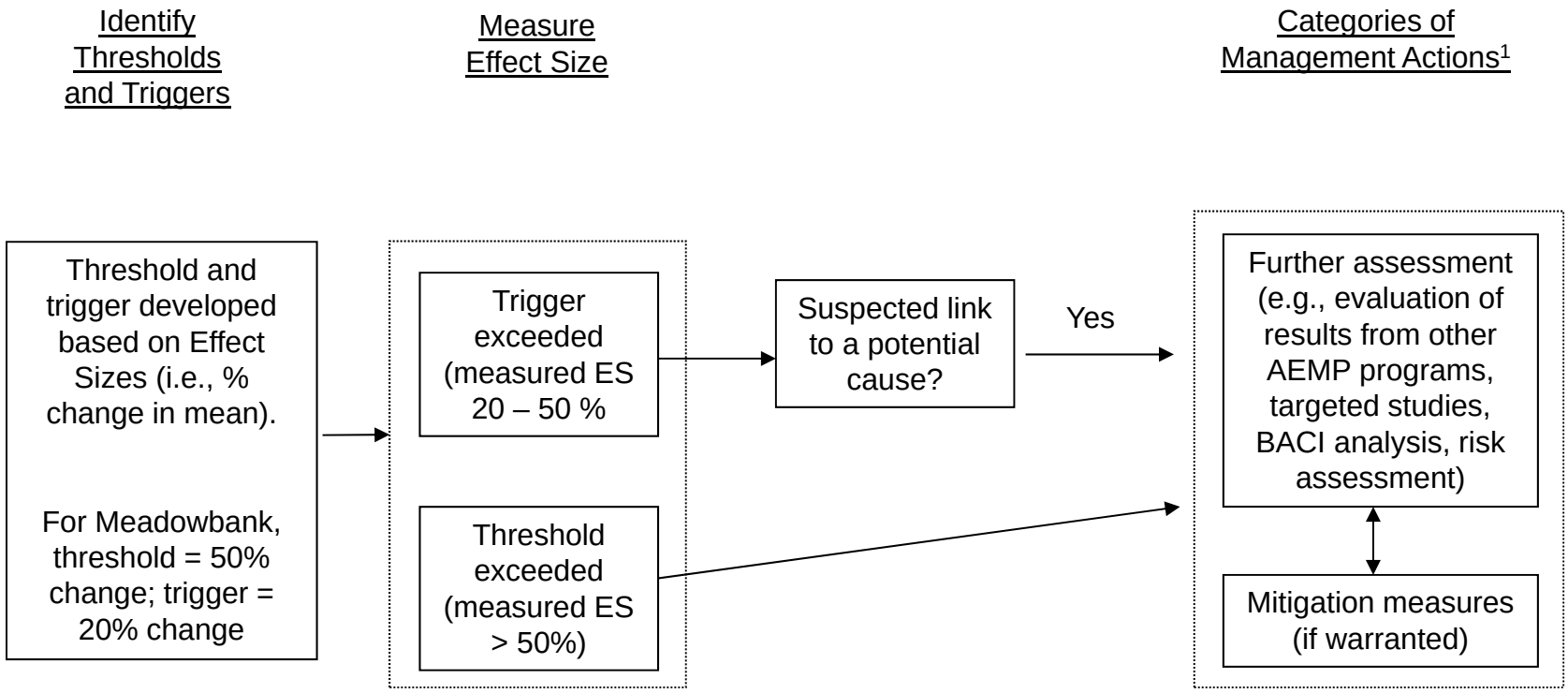
Figure 4. Approach for Development and Application of Monitoring Thresholds and Triggers for Sediment Chemistry Variables



[1] Annual means for sediment chemistry variables are calculated only in the years when sediment chemistry data are collected.

[2] Potential management actions are considered as part of the broader AEMP, where results of the CREMP and other programs are considered together.

Figure 5. Approach for Development and Application of Monitoring Thresholds and Triggers for Biological Effects Variables



[1] Potential management actions are considered as part of the broader AEMP, where results of the CREMP and other programs are considered together.

Figure 6. Estimates of BACI statistical power for detecting a significant increase (one-tailed test, alpha = 0.05) in a given water chemistry variable (rows) by station (columns) as a function of sampling months (after period) and the number of sub-samples per month.

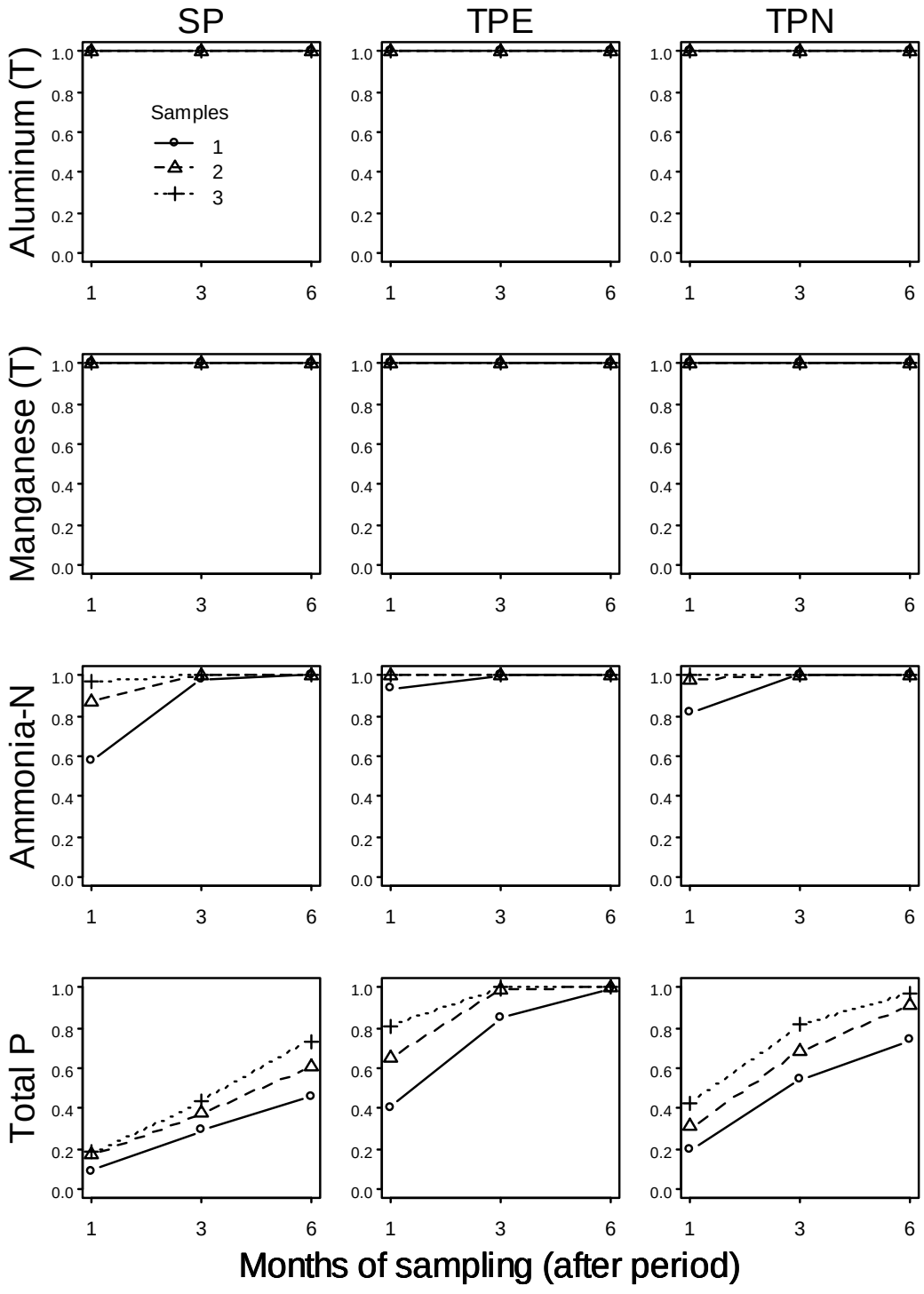
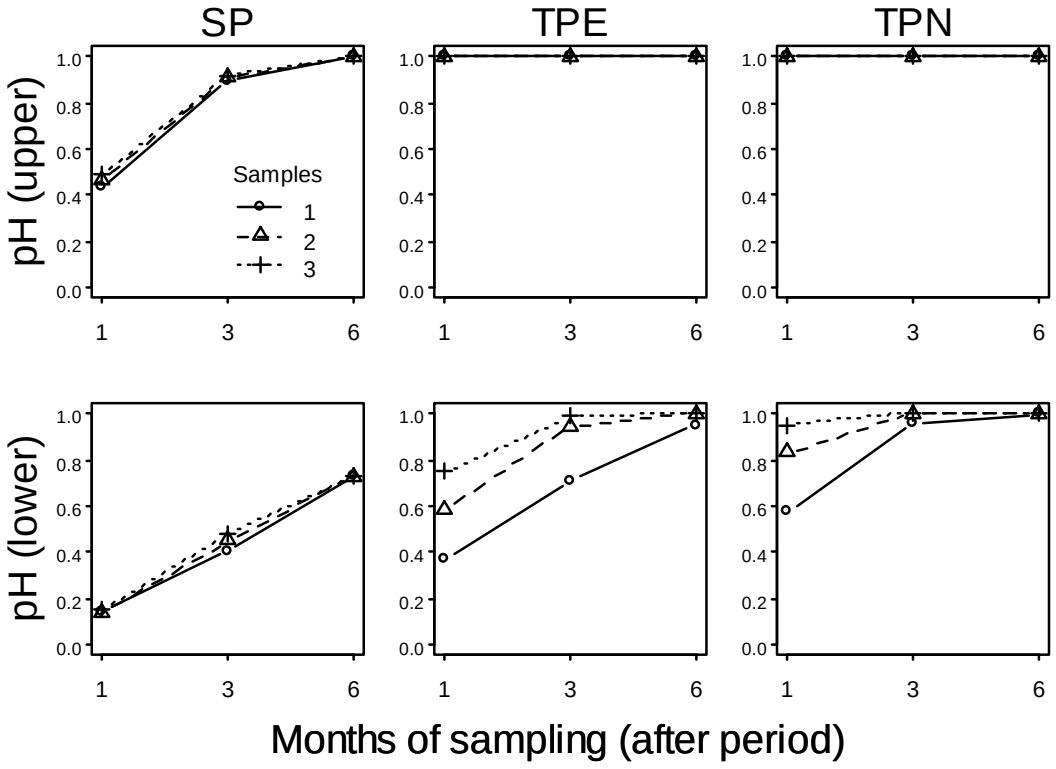


Figure 7. Estimates of BACI statistical power for detecting a significant increase in pH (top row) or decrease in pH (bottom row) by station (columns) for two-tailed tests (alpha = 0.05) as a function of sampling months (after period) and the number of sub-samples per month.



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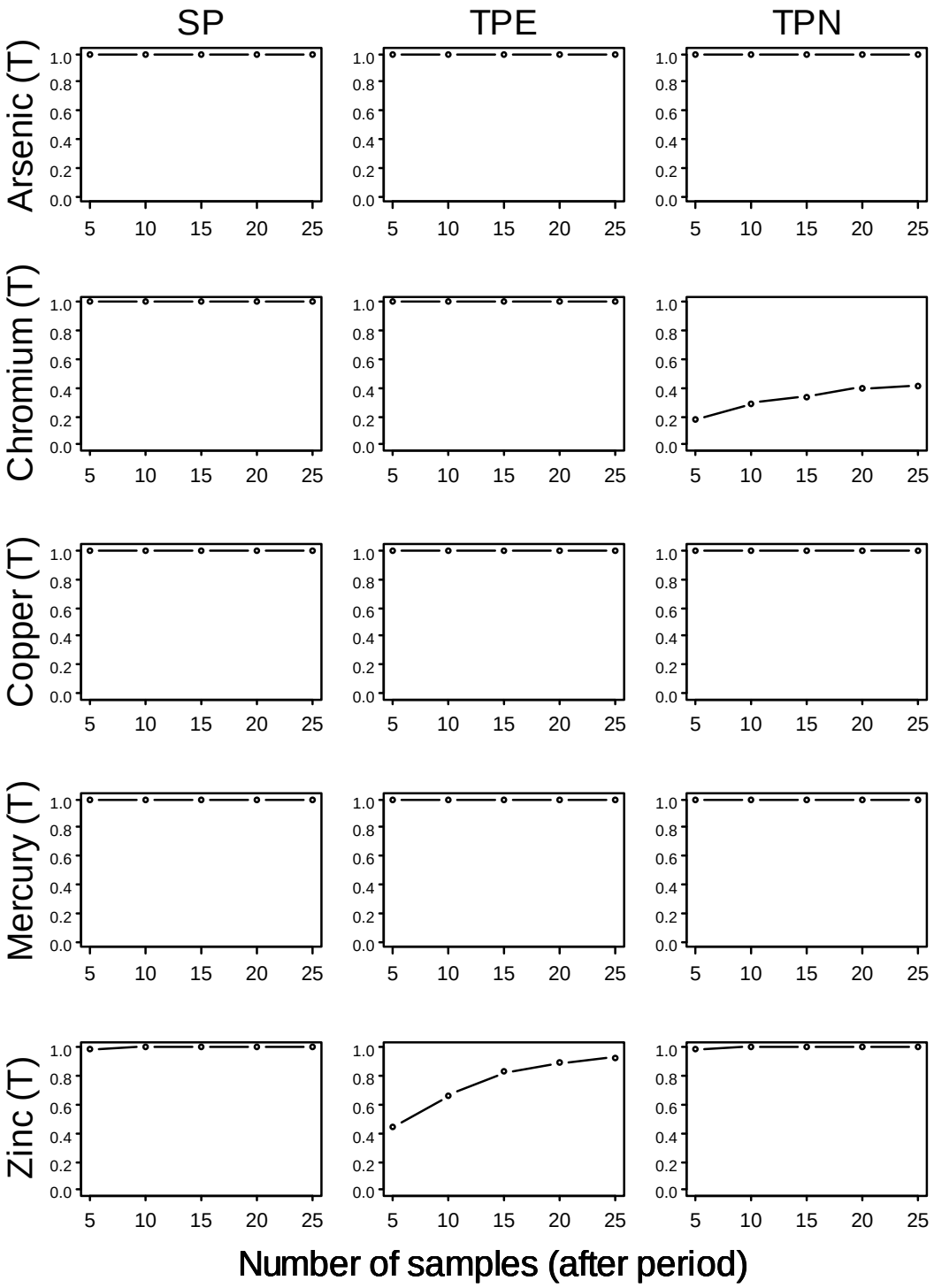

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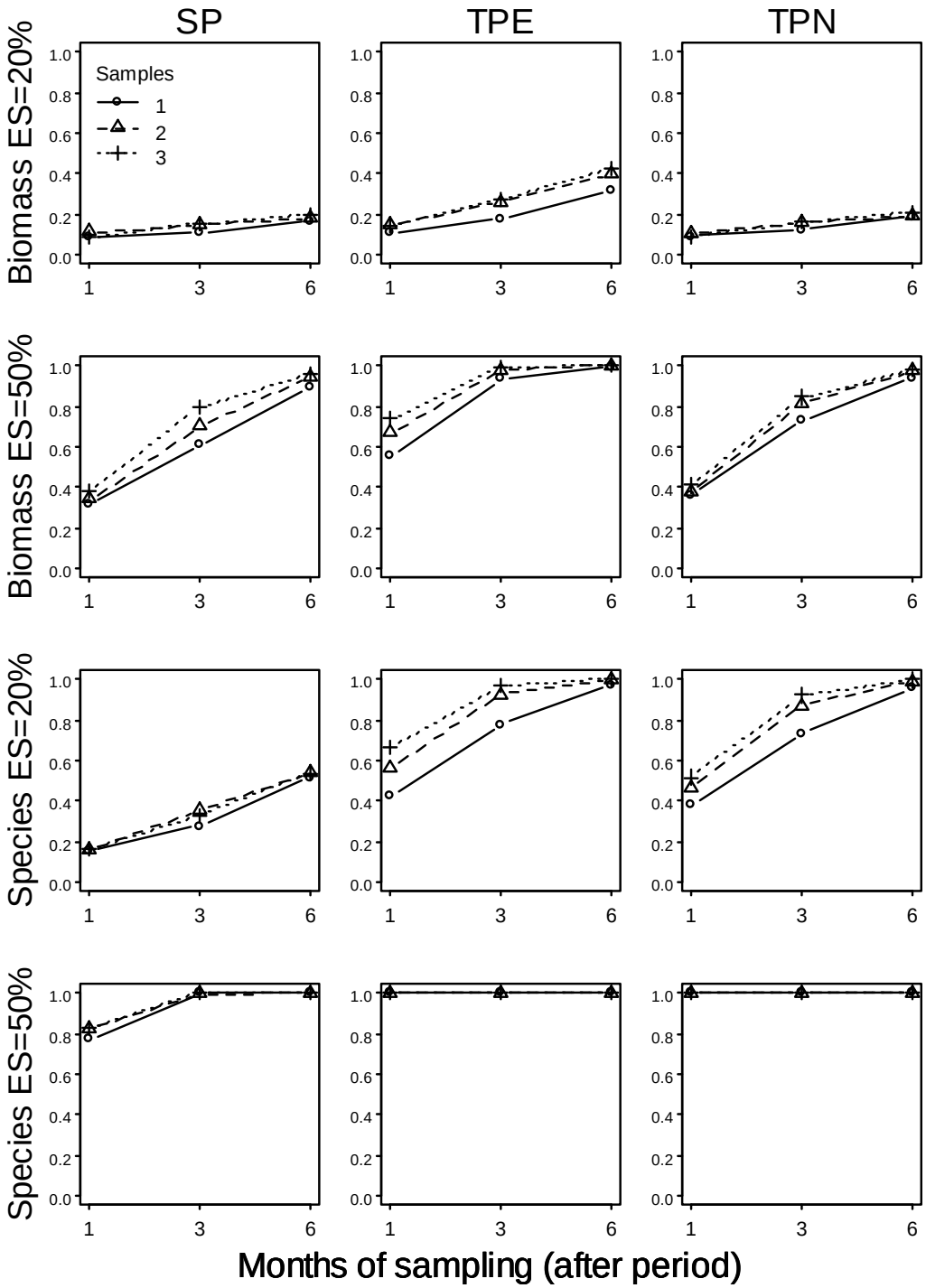

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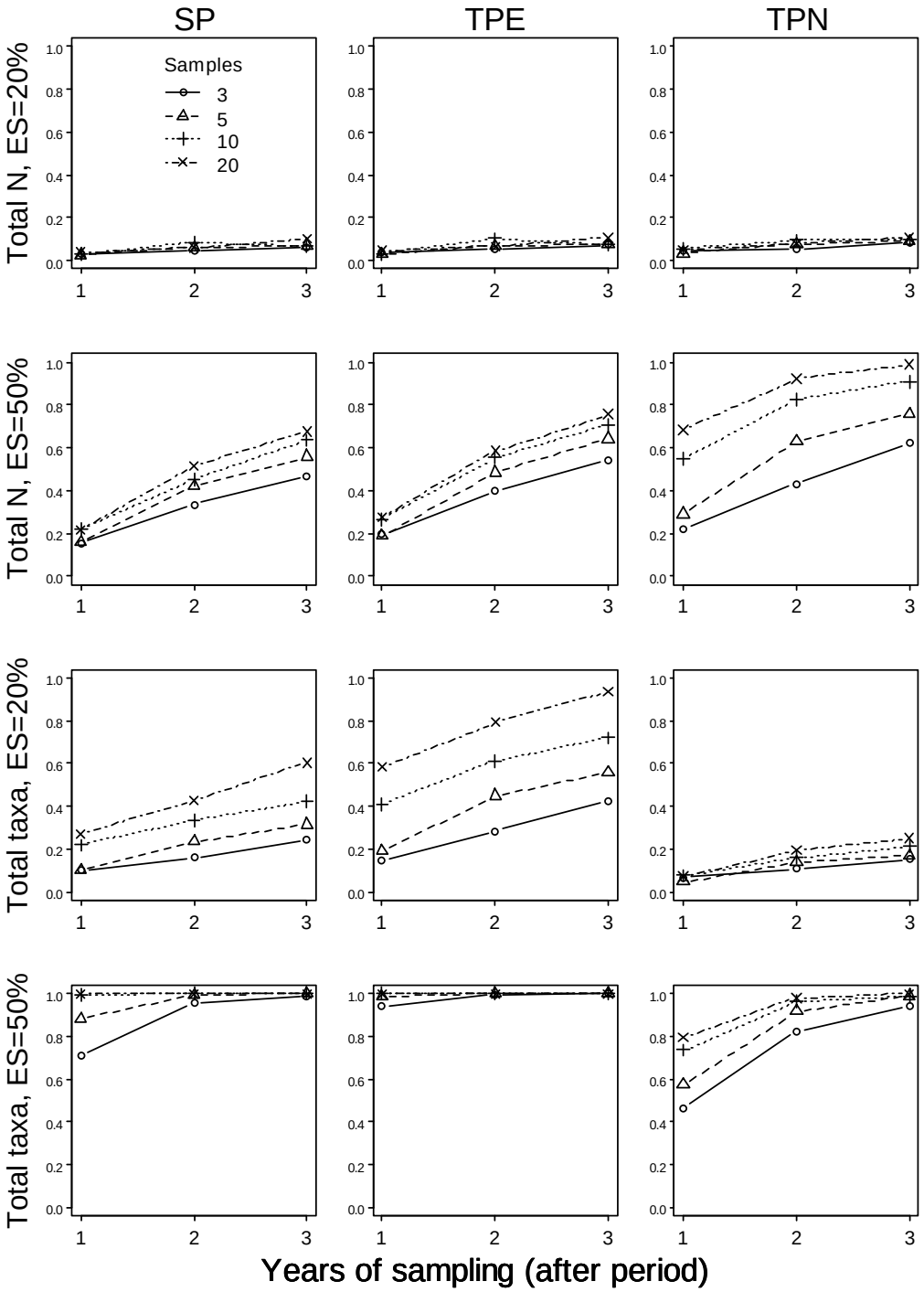

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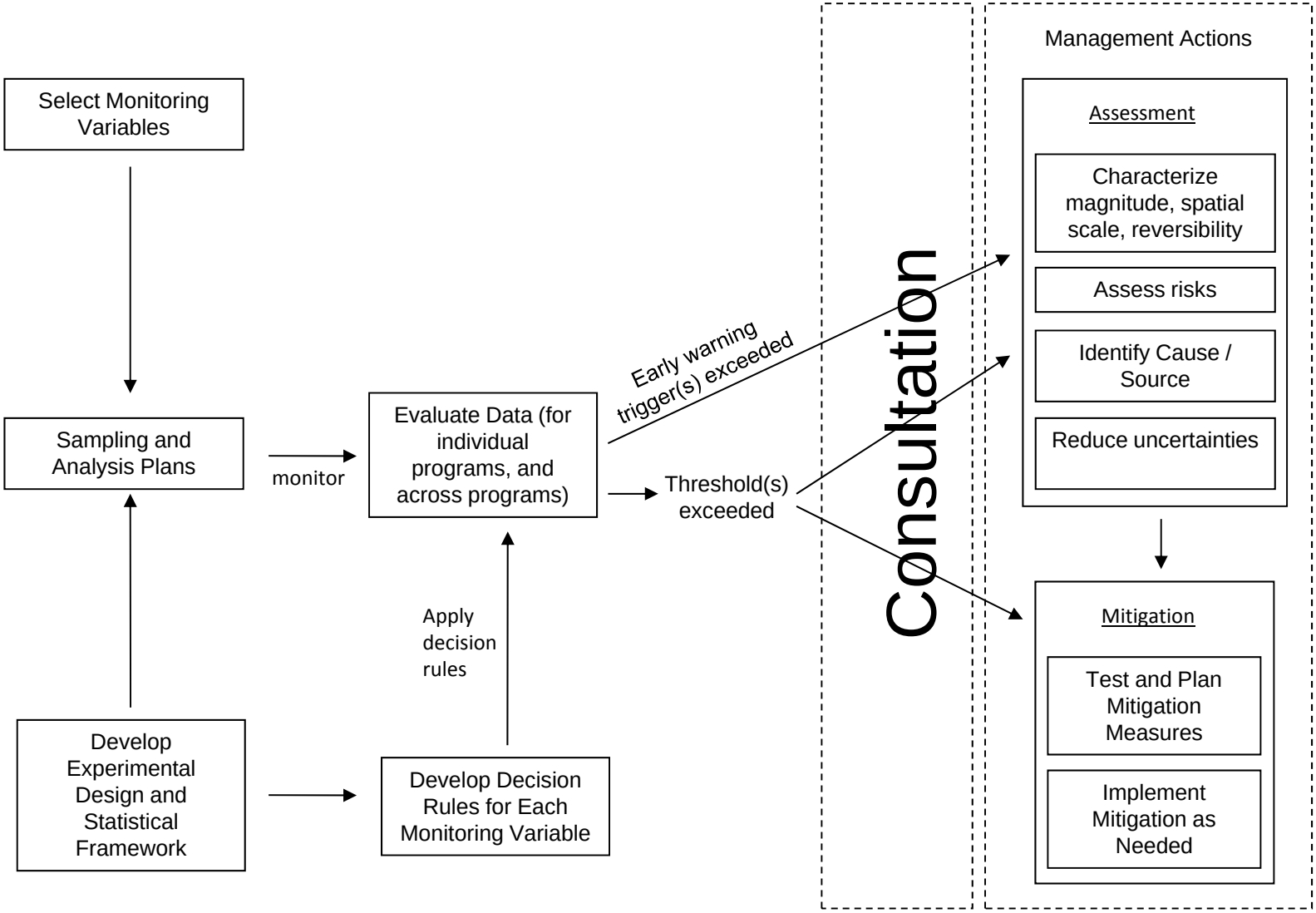

[1] Management responses under the AEMP are based on the combined results of individual monitoring programs including the CREMP.

APPENDIX A – STATISTICAL ANALYSES FOR WATER CHEMISTRY

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1. INTRODUCTION

This appendix contains the following analyses.

- Summary of CREMP water samples
- Analysis of field duplicates
- Analysis of depth
- Analysis of Baker/Meadowbank differences
- Determination of triggers
- Analysis of sampling design

Some text, tables and figures are repeated from the main document so that the analyses contained in this appendix can be read and understood without reference to the main document. The material in this appendix assumes understanding of basic statistical methods (Venables and Ripley 2002), mixed-effects models (Pinheiro and Bates 2000), before-after-control-impact (BACI) experimental design (Stewart-Oaten et al. 1986; Underwood 1994; Smith 2002), and use of simulation in statistical analysis (Gelman and Hill 2006).

2. SUMMARY OF CREMP WATER SAMPLES

There are three basic types of samples:

1. Standard samples – specific to a given location, month (a single sampling day), and depth (typically surface samples).
2. Depth replicates – collected at a given location and time (typically one surface, one bottom, and one integrated sample).
3. Duplicate samples – occasionally collected; these consisted of a second water sample specific to a given location, time, and depth.

For many station-month combinations, more than one "standard" sample was collected. These "sub-samples" represent spatial replication (a different location within the designated station). In addition, samples were designated as "control" or "impact" depending on operation activities near a given station (see main text for differentiation of control and impact).

For the CREMP program (current dataset), a total of 352 samples have been collected across 5 years (2006 up to and including May 2010) and 12 stations (Baker Lake and Meadowbank programs). The full data set is summarized in Table 1. Of the total of 352

samples, 242 were considered standard samples (i.e., unique location/day samples; **Table 2**); 76 were depth replicates of surface samples (i.e., either bottom or integrated samples; **Table 3**), and 30 were duplicate samples (**Table 4**). The distribution of samples by month and station are shown in **Tables 1-4** for total samples, standard samples, depth replicates, and duplicates; shaded areas indicate designated impact periods. Of the 242 standard samples, all were surface samples except for 15 integrated samples (collected mostly in July/August of 2007); 120 samples were designated control and 126 samples designated impact.

3. ANALYSIS OF FIELD DUPLICATES

Field duplicates are water samples collected at the same location, time and depth as a standard sample. If there is little difference between duplicates and the standard samples with which they are associated, then duplicates should be omitted when evaluating data because they are pseudo replicates of the standard samples. On the other hand, if the differences are large (i.e., similar to what is observed among standard samples), there may be rationale for including the duplicates when evaluating data. Presumably, differences among duplicates largely reflect field sampling error and lab precision (measurement error). This variation will be a component of the variation observed among station/month sub-samples. Thus, comparing the two provides insight into the extent of real sub-sample variation (due to differing locations within a station).

Data – Duplicates have been collected for about 10% of samples (n=30; see **Table 4**). We would not expect control and impact samples to differ in terms of duplicate measures, so all samples were examined (control = 9; impact = 21). Analysis was limited to variables with at least 30 sample measurements above detection limits (with 30 pairs of sample/duplicate values, the total number of possible measurements was 60). **Tables 5-7** summarize the number of measurements and values above detection limits for total metals (**Table 5**), dissolved metals (**Table 6**), and nutrients/conventional parameters (**Table 7**). For some samples, a given variable was not measured and hence n < 60. In total, there were 15 variables with at least 30 measurements above the detection limits: t-Al, t-Mn, TKN, t-P, TOC, DOC, bicarbonate alkalinity[1], Cl, conductivity, hardness, Ca, Mg, sulphate, pH and TDS.

Methods – For each variable, xy plots were produced using all data, with values below DL set equal to DL. For remaining analyses, data pairs (standard sample and its duplicate) were limited to those pairs with both values above DL. For each variable, we computed the median across all samples, the median absolute difference (MAD) between

[1] Total alkalinity was excluded as the values were identical to bicarbonate alkalinity

samples and duplicates, and Spearman rank correlation between samples and duplicates. In addition, we fit a mixed-effects model (Pinheiro and Bates 2000) of the form:

Log(y) ~ Location + Error

where y is the water quality variable, Location denotes random effects for sample pairs (variability among pairs due to sample location/month) and Error denotes the residual error (variability between samples and duplicates).

Results – Results of the analysis of duplicates are shown in **Figure 1** (xy plots) and **Table 8** (medians, MADs, and Spearman r). For most variables, the duplicates are very similar to the associated standard samples, with a notable exception for TKN, and occasional anomalous values for some variables. The standard deviations (SDs) resulting from the mixed-effect model show the relative variability due to sample location/month (SD.Location) versus duplicate variability (SD.Error). In most cases SD.Error is much smaller than SD.Location, which just reaffirms that duplicate measures are very precise compared to general sample variation (i.e., minimal measurement error or fine-scale spatial variation). In the case of TKN, however, the pattern is reversed, suggesting that measurement precision for TNK is quite poor (obvious from plot in **Figure 1**). Results for t-P and pH were also reversed, but not after removing the single anomalous data pair for each of those variables. These results suggests that while sample/duplicate measures are reasonably consistent for t-P and pH, there is potential for occasional large differences due to laboratory measurement error or fine-scale spatial variation.

4. ANALYSIS OF DEPTH

Most CREMP water samples have been collected near the surface. However, some data have been collected near the bottom or as integrated samples whereby the water is collected across a depth range. Evaluation of the importance of depth was needed in order to determine if surface samples are likely to be representative of the water column, and if not, to determine whether sampling at different depths is warranted in future.

The primary null hypothesis is that a given variable is the same across sample types for depth (i.e., surface, bottom, integrated); however, depth differences may be related to station and especially season. Potential stratification of the water column is expected to be much greater during "winter" months (November through May) than for "summer" months (July, August, September), though July may be more similar to winter conditions.

Data – In the there were 39 cases or "depth tests" where water samples were simultaneously collected at differing depths, with samples classified as surface (n = 39), bottom (n = 37), or integrated (n = 39). The total sample size was therefore 115. The

depth replicates (i.e., bottom and/or integrated samples) were summarized in **Table 3**, and can be further delineated as follows:

Type	INUG	TE	TPS	Total
Control	11		9	20
Impact		19		19
Total	11	19	9	39

Month/Year	INUG	TE	TPS	Total
May.09	4	4		8
Jul.09	2	2		4
Aug.09	1	1		2
Sep.09	2	2		4
Nov.09	2	2		4
Dec.09		1	1	2
Jan.10		1	2	3
Feb.10		1	1	2
Mar.10		2	2	4
Apr.10		1	1	2
May.10		2	2	4
Total	11	19	9	39

A more detailed summary of the 115 depth samples is presented in **Table 9.** Including impact samples doubles the sample size and provides contrast (via station TE) across months, consequently TE is included in the analyses below.

Methods – Analysis was limited to variables that had at least 40 of the 115 sample measurements above detection limits (for some samples, a given variable was not measured and hence n < 115). **Tables 5-7** summarize the number of measurements and values above detection limits for total metals (**Table 5**), dissolved metals (**Table 6**), and nutrients/conventional parameters (**Table 7**). In total, there were 14 variables with at least 40 measurements above the detection limits: t-Al, t-Mn, TKN, TOC, DOC, bicarbonate alkalinity[2], Cl, conductivity, hardness, Ca, Mg, sulphate, pH and TDS. For each variable, xy plots were produced using all data, with values below DL set equal to DL. In addition, we fit three mixed-effects models (Pinheiro and Bates 2000) of the following forms:

Model 1: Log(y) ~ Type + Location + Error

Model 2: Log(y) ~ Type + Station + Type*Station + Location + Error

Model 3: Log(y) ~ Type + Season + Type*Season + Location + Error

where "Type" (with fixed effects) is the key factor variable of interest denoting depth types (surface, bottom, integrated), "Station" is the CREMP sampling station (e.g., TPE)

[2] Total alkalinity was excluded as the values were identical to bicarbonate alkalinity

that is actually a broad area, and "Location" denotes unique sample locations (with random effects) that were sampled within a given station at a given time. In Models 2 and 3, the terms of interest are the interactions (fixed effects) between Type and Station (i.e., potential station-specific effects of depth) and Type and Season (potential season-specific effects of depth). Two options were examined for season models. First," Season" was defined as a factor variable with two levels separating Summer months (July, August, September) and Winter months (all others). In the second analysis, July was considered a Winter month. For all models, data were limited to those cases (locations) in which all three sample values >DL (i.e., each location had to include valid measures for surface, bottom, and integrated samples). This was done to ensure that consistent data were used to compare the three sample types. Thus, cases 24 and 25 (**Table 9**) were always omitted because they lacked "bottom" samples, providing a maximum sample N = 111. For Model 3 (Season) analysis, data for station TPS were excluded because no "summer" months were sampled (see Table 3; thus maximum n=84).

Results – The statistical significance for the key depth terms of models 1 to 3 is presented in **Table 10** (p-values, based on F tests). There were significant differences ($P < 0.05$) among depth samples (Type) for 8 of the 14 variables, but relatively few cases of significant interactions between depth type and station or season. Consequently, we focus initially on results for Model 1. **Table 11** shows depth type coefficients for Model 1. The coefficients were defined as "Bottom – Surface" and "Integrated – Surface" to make explicit comparisons with surface samples (the standard sample type). Since all data were log-transformed, the coefficient (X) has to be translated into a proportional effect size (ES) relative to (untransformed) surface samples[3]. The percentage ES for each variable is shown in **Table 11**. For example, for Aluminum (T), the estimated ES = -15.9% for bottom samples (i.e., Aluminum (T) in bottom samples was 15.9% less than that observed in surface samples, on average) and ES = 12.9% for integrated samples (i.e., 12.9% greater than for surface samples, on average). In general, the predominant pattern was toward lower values in bottom samples relative to surface samples (negative ES for 12 of 14 variables, $P < 0.05$ for 10 of these[4]). The trend was less clear for integrated samples, with only four significant coefficients, but these were also negative. **Figure 2** shows bottom v. surface and integrated v. surface measures for each variable (values < DL set equal to DL). Also shown are the implied differences (ES in **Table 11**) for which $P < 0.1$ (dashed lines, which in log-log scale are parallel lines to the 1:1 line).

[3] The following steps are needed for calculating ES: (1) X = log(Bottom) – log(Surface); (2) X = log(Bottom/Surface); (3) Exp(X) = Bottom/Surface; (4) ES = (Bottom – Surface)/Surface = Bottom/Surface – 1; (5) ES = Exp(X) – 1; (6) ES (%) = (Exp(X) – 1)*100.

[4] Removing one outlier for pH for the bottom-surface comparison reduces the p-value for pH from 0.562 to 0.018, though the ES is still marginal (-0.6%).

The key question of interest is how large are the significant depth differences compared to variation among locations and among depth replicates (sample types). As shown in **Figure 2**, differences between solid and dashed lines are minimal compared to the full data ranges. As an example, the variable with the largest depth effect was t-Al – its percent ES was -15.9%, yet the variation among surface samples / areas is an order of magnitude[5]. Importantly, most variables have effect sizes much lower than that of t-Al.

For model 2, there were two variables with significant depth interactions (**Table 10**): t-Al and TOC. Box-plots capture the marginal station-depth differences found in these data (**Figure 3**). For both variables, there are strong differences among stations but less so among depth types. For t-Al, the significant interaction for Type*Station was largely due to station TPS, for which integrated samples were clearly higher than surface/bottom samples, whereas for INUG and TE the general pattern was surface concentrations were higher than bottom concentrations, and surface and integrated samples were roughly similar. For TOC, the differences are subtle, but model coefficients reveal a significance pattern of surface > integrated > bottom, except for station TE, for which all depth types are similar.

For model 3, two variables had significant depth interactions (**Table 10**): t-Al when July was treated as a summer month, and bicarbonate alkalinity when July was a winter month. Again, box-plots capture the season-depth differences found in these data (**Figure 4**). There are strong differences among stations for both variables, and among seasons for bicarbonate alkalinity at station TE, but relatively minor differences among depth types. For t-Al, depth measures were similar in summer months but for winter, surface > bottom in winter, particularly driven by TE. For bicarbonate alkalinity, depth measures were similar in winter months but for summer, surface > bottom and integrated.

Conclusion – Analysis shows that for many variables there are statistically significant differences in values by depth, with bottom samples (and depth-integrated samples to a lesser degree) tending to have lower values than surface samples. However, the magnitude of differences associated with depth is minimal compared to the magnitude of differences that occur naturally between samples and stations. We conclude that future sampling should focus on surface samples, in order to take advantage of the most baseline data. This is somewhat conservative, as most variables demonstrate lower concentrations at depth. However, in cases where there is reason to suspect potential for large depth-specific effects, a bottom sample could be added occasionally to test for a hypothesized depth effect. Given that the CREMP is intended to monitor large-scale basin-wide changes, depth-specific sampling is less likely to be warranted for the

[5] The top panel of Figure 3 is actually more informative in this regard, as it shows variation in t-Al among surface samples at a given station. The ES of -15.9% is not large compared to variation among surface samples.

CREMP than for other programs that have a finer scale of resolution. Depth samples were not included in power analyses later in this appendix – as with duplicate samples, the depth samples are pseudo-replicates of the surface samples with which they are associated.

5. ANALYSIS OF BAKER/MEADOWBANK DIFFERENCES

Baker Lake and the Meadowbank area lakes are fundamentally different, because Baker Lake is connected to and influenced by salt water. Consequently, development of separate thresholds and triggers may be appropriate for the two areas for any variables that exhibit large differences.

Data – Potential differences between Baker/Meadowbank were examined by considering the control samples (i.e., potential impact stations removed), not including duplicate samples and depth replicates. This provided n=10 samples for Baker (station BAP) and n=110 across all Meadowbank stations (see **Table 2**).

Methods – Analysis was limited to the 18 variables for which at least 5 of the Baker measurements were above detection limits (see **Tables 5-7**). The variables included t-Al, t-Mn, ammonia-N, TKN, nitrate-N, t-P, TOC, DOC, bicarbonate alkalinity[6], Cl, conductivity, hardness, Ca, Mg, Na, sulphate, pH and TDS. In general, values below DLs were set equal to DLs, with a couple of exceptions[7]. Box-plots were produced for each variable to compare the Baker and Meadowbank samples. In addition, the Baker and Meadowbank data were compared using Mann-Whitney tests (on the raw data) and t-tests (using log data). The Mann-Whitney tests is more robust in this case as it is appropriate for non-normal data (which occurs when there are numerous values = DL).

Results – There are large differences between Baker and Meadowbank samples for several variables (**Figure 5** and **Table 12**). The percentage ES is calculated the same way as above for analysis of depth. There are relatively small differences for t-Al and ammonia-N. The difference for pH appears small (difference in medians = 0.4) but for pH that could be biologically quite meaningful. For all other variables there are large or very large differences between Baker and Meadowbank (ratio of medians ≥ 1.6 or ES ≥ 66%).

---

[6] total alkalinity was excluded because values were identical to bicarbonate alkalinity.

[7] Across the 18 test variables, Baker measures were <DL for a few cases of t-Al and ammonia-N These were set = DL. Meadowbank data for these two variables had different DLs in some cases. For t-Al, there were DLs greater than 0.005; these measurements were removed to be consistent with Baker. For Ammonia-N, there were DLs and valid measurements less than 0.02; these were all set = 0.02 to be consistent with Baker.

When considering "means" there is clearly a strong rationale for developing separate Baker/Meadowbank triggers for numerous variables. However, it is unclear how triggers based on maximums or 95th percentiles will reflect obvious differences in medians/means among Baker/Meadowbank measures. This is explored further in the next section.

6. THRESHOLDS AND TRIGGERS

Data – The data set upon which thresholds and triggers were developed was all standard control samples – duplicates and depth replicates were excluded as they are pseudo-replicates of "standard" samples. In addition, individual data points for which values were below DL but for which the DL was higher than usual were excluded. Remaining data points with values below the usual DL were set equal to the DL. For variables with very few values above DL, the reported medians will equal the DL, and so may 95th percentiles.

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

1. When a threshold (e.g., CCME guideline) is 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 is not established, the trigger was set equal to the 95th percentile of the baseline data ("Method B"), except in cases where less than 5% of the data exceeded the current detection limit (DL) – in the latter case, the trigger was set equal to two times the DL ("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.

There were exceptions to the above approach for a few special cases, specifically t-Al, t-Cd, t-Mn, t-Zn, d-Al, ammonia-N, t-P, pH and TSS. These exceptions are explained in detail below.

Different triggers were set for Baker and Meadowbank for many conventional parameters, for which there obvious differences between Meadowbank and Baker data (see earlier analysis above). However, for total metals and dissolved metals, the same triggers were set for Meadowbank and Baker stations (as discussed below, in cases where the data suggested different triggers could be appropriate, the most conservative or lowest value was used for both.

Results – Thresholds and triggers are summarized in **Tables 13-15** for total metals, dissolved metals, and nutrients/conventionals. Thresholds were established for 22 variables based on water-quality guidelines (**Table 16**). In most cases, the threshold was equal to a given guideline, but there were exceptions for a few variables as discussed below. It should be noted 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 be more extreme than the guideline (e.g., this occurs for total phosphorus and for the lower bound for pH) – 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.

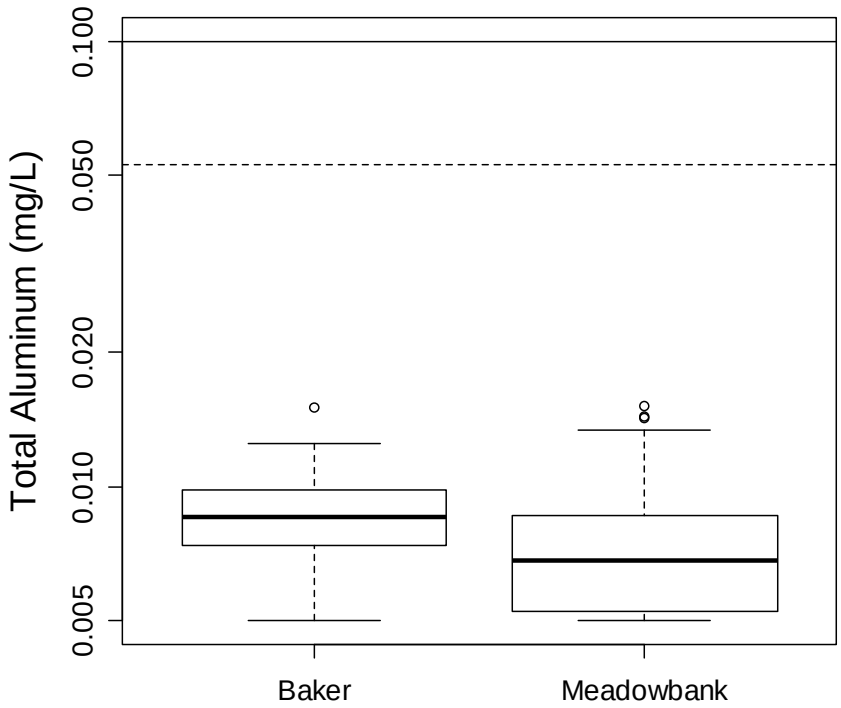
There were two cases where the water quality guideline was equal to the current DL. For these variables (t-Cr and t-Se), the trigger was set equal to the DL.

There are three variables (t-Cu, t-Pb, t-Ni) for which the water quality guidelines are specific to water hardness ranges below 120, 60, and 60 mg/L $CaCO_3$, respectively. Hardness levels for both Meadowbank and Baker samples were consistently below 60 mg/L $CaCO_3$. For example, as reported in **Table 15**, the 95th percentiles for hardness were 12.3 and 49.5 for Meadowbank and Baker samples, respectively. Thus for these three variables, the guidelines associated with low hardness ranges were used as thresholds.

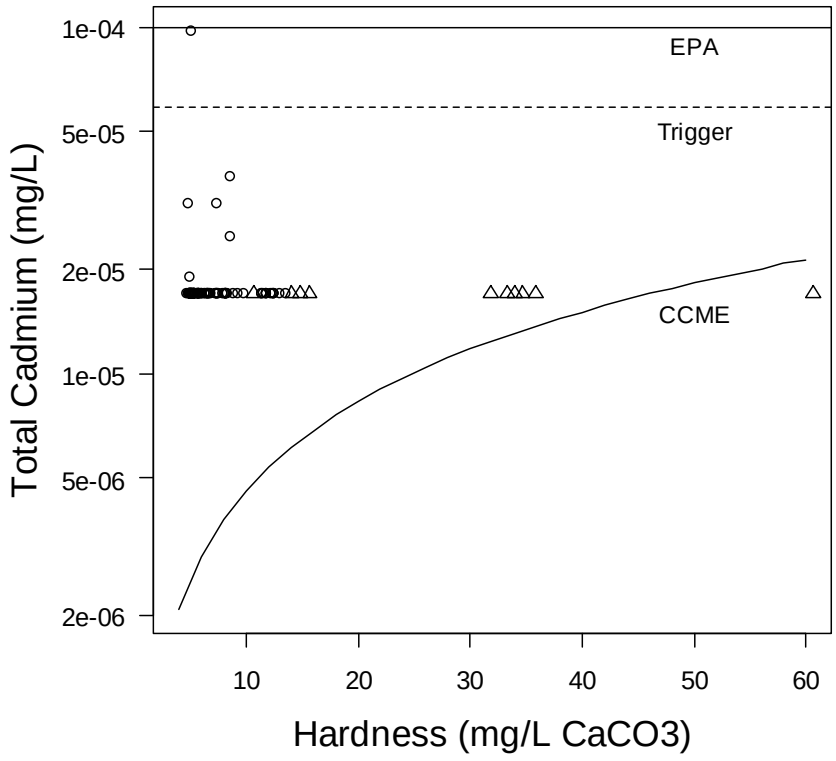
Special Cases – There were several special cases for which exceptions to the default approach to threshold and trigger development was warranted. These are discussed in the following pages.

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/Baker (n = 120), there were only 8 cases of pH < 6.5 (2 for station TPE and 6 for TPS), of which only three were below pH = 6.47 (values = 6.18, 6.20, and 6.34). For these 8 samples, only three t-Al measurements were above the current DL (0.005 mg/L), with a maximum value of 0.007 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 13**). Across the 120 samples, the median t-Al was 0.0068 mg/L and the 95th percentile was 0.0127 mg/L (**Table 13**). Based on Method A, the value halfway between the median t-Al and the threshold is 0.053 mg/L (i.e., [0.1 – 0.0068]/2 = 0.053), which is larger than the 95% percentile (Method B), and thus the proposed trigger for t-Al is 0.053 mg/L. As an example, the following figure shows box-plots of t-Al (in log scale) for each of Baker/Meadowbank, as well as the guideline (solid lines) and proposed trigger (dashed line).

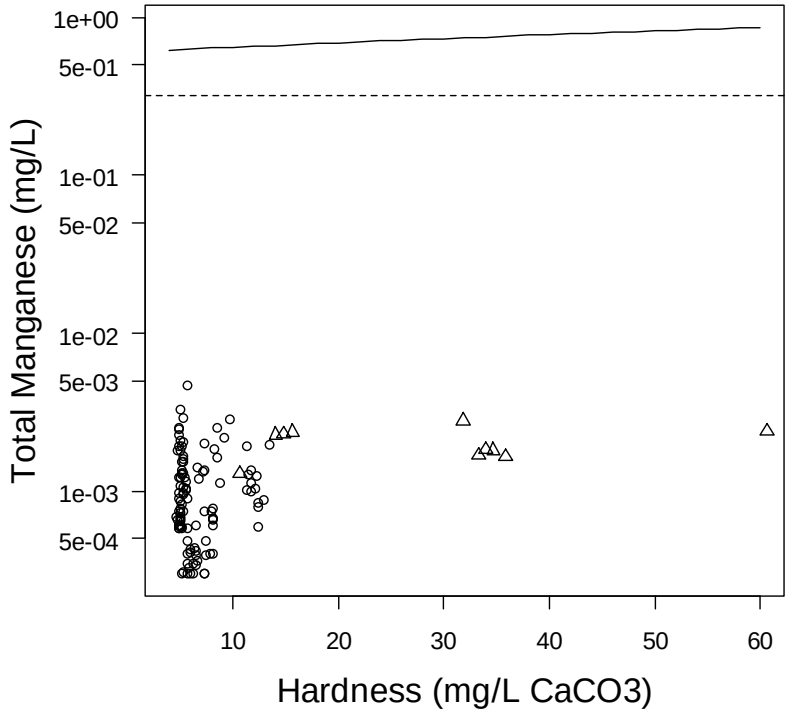


Total cadmium -- The hardness-dependent CCME guideline for t-Cd (mg/L) is $0.001*10^{0.86*\log10(H)-3.2}$ where H = hardness (mg/L $CaCO_3$). This relationship is illustrated in the figure below (solid curve) across the range of baseline observations of hardness for Baker (triangles) and Meadowbank (circles). Note that the CCME guideline is below the current DL for t-Cd (0.000017 mg/L) except at high hardness values > 46 mg/L $CaCO_3$. Moreover, several baseline t-Cd measurements exceeded the CCME guideline at low hardness. Consequently, the CCME guideline was deemed inappropriate for determining a threshold for Meadowbank/Baker data. The EPA water quality guideline for t-Cd (0.0001 mg/L, irrespective of hardness) was used instead (solid line in figure below). The corresponding trigger (based on Method A; **Table 13**) is 0.000059 mg/L (dashed line). One t-Cd baseline sample exceeded the proposed trigger (station TPE, hardness = 5.05, t-Cd = 0.000098 mg/L).



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 Baker (triangles) and Meadowbank (circles). The guideline greatly exceeds observed t-Mn values for either Meadowbank or Baker samples.

For simplicity, we propose a single, conservative t-Mn trigger for Meadowbank/Baker data regardless of sample hardness or lake. To compute the t-Mn trigger, we first computed the guidelines corresponding to the median values of hardness observed for Meadowbank samples (median hardness = 5.7, t-Mn guideline = 0.63) and Baker samples (median hardness = 32.6, t-Mn guideline = 0.75). (At this stage, separate values were computed for each lake in recognition of the significant differences between their hardness values; e.g., see **Table 12**.) The corresponding lake-specific triggers for t-Mn (using Method A) are 0.32 for Meadowbank and 0.38 for Baker. Thus, the proposed trigger for t-Mn is 0.32 mg/L, which is the lower (more conservative) of the two lake-specific values. This trigger is depicted as a dashed line in the figure below (note that although the trigger is halfway between the median and guideline for Meadowbank data, it appears much closer to the guideline because of the log-scale used for t-Mn).



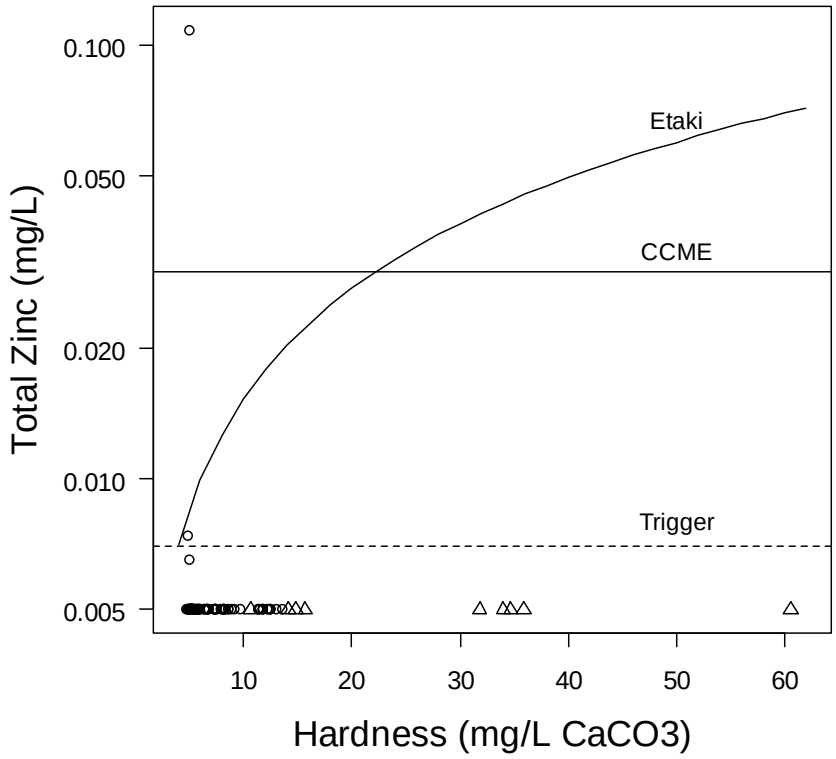
Total zinc -- The CCME water quality guideline for Zn is 0.030 mg/L. However, this guideline does not take into account hardness, and zinc toxicity is known to be hardness-dependent. An assessment for Ekati by EVS (2004) compiled data on species applicable to oligotrophic systems with low hardness, and 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 Baker (triangles) and Meadowbank (circles). 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 three baseline measurements of t-Zn have exceeded the current DL of 0.005 mg/L (the anomalous high value of t-Zn = 0.109 mg/L occurred for station TPS in July 2009).

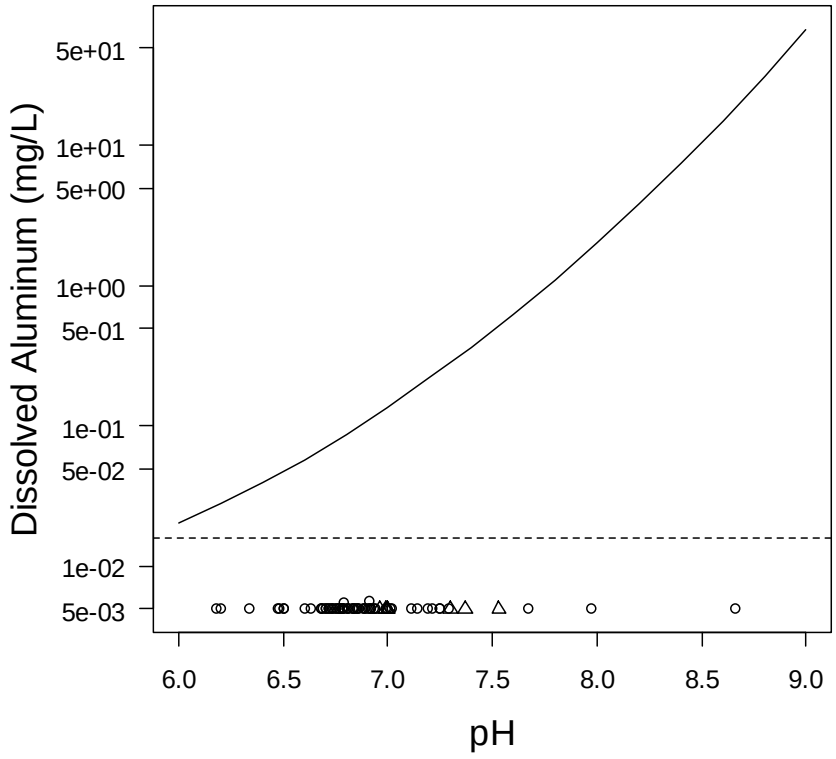
As for t-Mn, we propose a single t-Zn trigger for Meadowbank/Baker data regardless of sample hardness or lake. First, we computed the t-Zn benchmark (HC_5) corresponding to the median values of hardness observed for Meadowbank samples (median hardness = 5.7, t-Zn benchmark = 0.010) and Baker samples (median hardness = 32.6, t-Zn

benchmark = 0.041). However, for Baker, the lower CCME guideline of 0.03 mg/L was used instead as the Baker threshold. The corresponding lake-specific triggers for t-Zn (using Method A) are 0.007 for Meadowbank and 0.018 for Baker. Thus, the proposed trigger for t-Zn is 0.007 mg/L (dashed line in figure), which is the lower of the two lake-specific values.



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 as follows: $d\text{-}Al = e^{(1.6-3.327*pH + 0.402*K)}$ where $K = pH^2$. This relationship is illustrated in the figure below (solid curve) across the range of baseline observations of pH for Baker (triangles) and Meadowbank (circles). The BC MOE guideline greatly exceeds the observed values of d-Al. Only two baseline measurements of d-Al exceeded the current DL of 0.005 mg/L (maximum = 0.0057).

Again, we propose a single d-Al trigger for Meadowbank/Baker data regardless of sample pH or lake. Based on the minimum pH observed (6.02), the corresponding BC MOE guideline of d-Al is 0.027 mg/L. Via Method A, with median = 0.005 and threshold = 0.027, the proposed trigger for d-Al is computed as 0.016 mg/L (dashed line in figure).



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/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 a proposed trigger value of 0.073 mg/L (**Table 15**). 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 15**). Consequently, the proposed lake-specific triggers were set equal to these 95th percentiles (Method B, **Table 15**).

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 15**). The corresponding proposed triggers for pH were lake specific (given the significant differences in pH observed between lakes – see **Table 12**), with Meadowbank triggers based on Method B (the 95th percentile as the upper trigger and 5th percentile as the lower trigger) and Baker triggers based on Method A (the distance halfway from median to threshold). In the case of Meadowbank data, baseline pH levels are often below the lower threshold of 6.5, and as such, the lower pH trigger (6.47) is slightly lower as well (**Table 15**).

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 trigger, based on Method A, is 3.0 mg/L for both lakes (**Table 15**).

Evaluation of Triggers – The method of trigger development above was simplified in some ways. First, the same trigger was applied to Meadowbank and Baker programs for total and dissolved metals, although lake-specific triggers could be justified for total manganese (significant differences between lakes for t-Mn and hardness) and total zinc (due to hardness). Second, and more importantly, no allowance was made for potential differences in variables by season or (for Meadowbank only) by station. Therefore, it is important to examine the data more closely in relation to the proposed triggers.

To address this issue, we examined plots of month-specific and station-specific data relative to triggers.

Specific box plots are shown for Baker Lake data by station (**Figure 6**) and by month (**Figure 7**) and similarly for Meadowbank by station (**Figure 8**) and by month (**Figure 9**). Plots are limited to those variables with at least 40 of the 120 control observations above detection limits, and exclude duplicates and depth replicates. In addition, plots also include an additional 20 impact samples for Baker (versus 10 control) and 106 impact samples for Meadowbank (versus 110 control). In the plots, if a station median exceeds a trigger, it is likely that the trigger was exceeded in several months, and similarly if a monthly median exceeds a trigger, it is likely that the trigger was exceeded for several stations.

For Baker Lake, results show reasonably consistent measures across the three stations (one control, two impact). There is no case in which a station median exceeds a given trigger, and only a few cases where the median is quite close to the trigger (e.g., TKN and Bicarbonate alkalinity). However, for Baker months, there are numerous examples where the median (and often all three stations) exceeds the trigger. Clearly, September 2008 was unique – samples at all three stations exceed the trigger for eight variables (t-P, Cl, conductivity, Ca, hardness, Mg, sulphate, and TDS). This could represent higher sea water influence compared to other months. Obviously, there is high month-specific variation in these data, and so presumably the 95th percentile of monthly means (were there a lot of data) might suggest much higher triggers are justified to depict natural variation. Ultimately, however, it will be easy to identify such month-specific patterns as "natural" (given coherence across control/impact stations and across variables), whereas a 3-month or 6-month shift specific to a given impact station would indeed appear anomalous. Overall, then, the Baker triggers appear to be reasonable (based on the limited data).

For Meadowbank, triggers also appear reasonable overall. However, several variables appear much higher for Wally Lake (medians at or above triggers) compared to other control/impact stations, including bicarbonate alkalinity, conductivity, hardness, Ca, Mg, and sulphate. Consequently, it could be argued that some or all Wally data should have been omitted, and some triggers may be too high as a result. For some variables (e.g., t-Al, hardness, Mg), there is clearly a lot of station-specific variability, which may have

implications for triggers (but likely providing conservative triggers, that is, to the extent that control stations like INUG were heavily represented in the baseline data but had naturally lower concentrations than impact stations like SP and TPE). For months, there is a lot of variability and apparent trends as well (e.g., TOC and hardness), but very few instances of month-specific medians exceeding triggers (one case each for t-Al, t-P and upper pH). In the case of t-Al, all 120 baseline samples were < 0.02 mg/L, but many or most 'impact' samples for stations SP and TPE (across months for 2010) were in the range of 0.5 mg/L (the trigger is 0.053 mg/L) – this is not surprising because we expect t-Al to be high when TSS is high (associated with dike construction).

7. ANALYSIS OF SAMPLING DESIGN

Impact hypotheses and statistical design – Two general classes of impacts are hypothesized for the Meadowbank mine:

1. Pulse events for which potential impacts would be high for a short time but would then (in the case of water chemistry) dissipate relatively quickly. Pulse events could be associated with any phase of the mine, but are more likely to be associated with particular activities such as dike construction.
2. Long-term cumulative impacts that may be associated with ongoing activities. Long-term cumulative impacts are more likely to be associated with ongoing activities of mine operations.

As operations have just begun in 2010, the focus of monitoring to date has been on detecting pulse events associated with construction. The appropriate framework for analysis is a before-after-control-impact (BACI) that is aimed at detecting a potential impact in a particular lake or basin in a particular time period. The BACI framework can also be used to evaluate long-term impacts, but other tools such as time series regression analysis may also be appropriate for evaluating long-term trends. For this design document, we focus on the use of the BACI framework, recognizing that other tools such as time series regressions may be useful at a future date once sufficient time series data are available[8].

The classic BACI (paired) design has before/after periods α_i (i = B, A; I = 2), control/impact sites β_j (j = C, I; J = 2), and a total of K paired sampling times τ_k that are nested within period. A statistical model for this design is given by (Smith 2002, equation 2):

[8] In theory, a BACI analysis that is appropriately framed should be capable of detecting changes associated with long-term trends.

$$(1) \qquad X_{ijk} = \mu + \alpha_i + \tau_{k(i)} + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \ .$$

The key term is the interaction ($\alpha\beta$), which can be tested using an F test with F = MS[($\alpha\beta$)]/MS[Resid] and degrees of freedom = 1, $K - 2$. As discussed by Smith (2002), this is equivalent to simply taking the differences between the control and impact values across times and using a two-sample (before-after) t test (Stewart-Oaten et al. 1986).

Model (1) can be extended to include additional control sites (e.g., "asymmetric" designs; Underwood 1994) and/or additional impact sites. To be valid, the additional sites must be replicates rather than subsamples (i.e., as controls, they should be spatially independent of each other but representative of the impact sites, while replicates for impacts need to be spatially independent and (ideally) affected by independent disturbances). So whereas j = (C, I) in the classic BACIP, j may compose any combination of J total sites, for example $J = 4$ where $j = (C_1, C_2, C_3, I)$. The general test of ($\alpha\beta$) still applies, but with degrees of freedom = $(J - 1)$, $(K - 2)(J - 1)$ (e.g., see Table 1 of Underwood (1994) and Table 9 of Smith (2002)).

In addition, there may be n replicate subsamples s at each site/time combination (jk), as assumed in Table 1 of Underwood (1994). In this case, we modify equation (1) as:

$$(2) \qquad X_{ijks} = \mu + \alpha_i + \tau_{k(i)} + \beta_j + (\alpha\beta)_{ij} + (\tau\beta)_{k(i)j} + \varepsilon_{ijks} \ ,$$

where subsamples now permit estimation of times-by-site interactions ($\tau\beta$). The appropriate F ratio for ($\alpha\beta$) is now F = MS[($\alpha\beta$)]/MS[($\tau\beta$)] with df = $(J - 1)$, $(K - 2)(J - 1)$. As Underwood demonstrates, specific comparisons (interaction terms, such as the impact site versus either "period" or a specific "time" unit) can be examined by partitioning variation accordingly (e.g., Underwood Table 2[9]).

Methods – The analysis here assessed the expected precision and power of BACI estimates for different after-period (impact) durations and different numbers of sub-samples (random spatial samples collected each month). Formal analysis of the sampling design uses Meadowbank data. Baker Lake data have only been collected since 2008, thus inferences would be limited based on the small data set. Results from Meadowbank should be generalizable to Baker Lake given that the BACI analyses below for Meadowbank compare a single control to each potential impact station individually (the same scenario as for Baker, which has one control and two impact stations). Separate analyses were conducted for the three primary impact stations SP, TPE, and TPN. In each case, INUG was used as the control station. Separate analyses were conducted for **five** variables -- total aluminum, total manganese, total ammonia, total phosphorous, and pH. These variables were selected as they have definable thresholds and most data above

[9] We note that there are mistakes in the tables presented by Underwood (1994).

detection limits, therefore the results would be particularly meaningful. We assume that for the most part if the experimental design is adequate for five variables it is likely to be adequate for most variables. For a given variable, the effect size or ES (fixed across months) was equal to the change in mean from baseline (i.e., during the before period) to the trigger value. For example, if the before-period mean = 10 and trigger = 15, then ES = 5 (=15-10). In the case of pH, both upper and lower triggers were assessed (for the latter, this implies a reduction in mean). Thus, for all reported results, we are assessing the power and precision of BACI estimates under the assumption that the true effect size resulted in a new mean equal to the trigger value during the entire after period (of course, the observed after-period mean will differ somewhat from the trigger value due to simulated random variation).

For purposes of the BACI analyses, the before-period data included all available data except "impact" samples (summarized below). This assumes that these data, regardless of station or month, are reasonably representative of "natural" conditions. This assumption should be reasonable as all "impact" data are excluded.

After-period data were simulated using variances consistent with observed data. Specifically, the following mixed-effects model was fit to the "before data" for a given control-impact station pair:

$$X_{jks} = \beta_j + \tau_k + (\tau\beta)_{kj} + \varepsilon_{jks}$$

The fit provided estimates of before-period station means β_j, random-effects variances for month ($\sigma^2[\tau]$) and month-by-station ($\sigma^2[\tau\beta]$), and the residual variance for sub-samples ($\sigma^2[\varepsilon]$).

After-period data were simulated using after-period means (β_control, β _impact + **ES**) and the above variance estimates for three durations (1, 3, and 6 months) and three sub-sample scenarios (1, 2, and 3 subsamples per month). **Thus, a total of 9 scenarios of after-period duration and sub-sampling were examined.** In all cases, log-transformed data were used. For each scenario, 500 simulations were used.

Data summary – Sample numbers by station for the "before period" are shown in **Table 17**. Sample sizes (N) of valid measurements are shown in **Table 18** for each variable and station; a few total aluminum measurements were excluded (high detection limits), and six measures of total phosphorous were missing for each station. Among valid measurements, most were above the detection limit (DL) for t-Al and Mn (**Table 18**), whereas only two-thirds (roughly) were > DL for t-P, and only a third (roughly) for ammonia-N. All values < DL were set = DL for the remaining analysis. As noted above, values used in BACI simulations were obtained from fits of mixed-effects models to data

used to represent the "before period". These estimates are summarized in **Table 19**. In each case, data were paired with INUG samples (means for INUG, which were used as the after-period means, are of minor importance and are not shown). The metrics of interest are the effect sizes for log data, ES(log), and estimates of standard deviations (SD, log units). Power will be a function of ES(log) relative to the standard error of ES(log), which will depend firstly on SD(M x S) and secondarily on SD(Error). In relative terms, power will be high when ES(log) >> SD(M x S) and SD(Error) and low when the opposite is true.

Results – Estimates of statistical power are shown in **Tables 20 and 21**, and repeated in **Figures 10 and 11**. For all variables except pH **(Table 20; Figure 10)**, the *a priori* hypothesis is that impacts will result in increases, so power is based on one-tailed tests (alpha = 0.05 and 0.10 are both shown in **Table 20**; alpha = 0.05 for **Figure 10**). For pH, we are concerned about either increases or decreases, so power is for two-tailed tests **(Table 21; Figure 11)**. For example, for t-Al, power is 1.0 (100%) for all stations even when the after period data is a single sample (month = 1, sample = 1). This is because the specified effect size, ES(log), is very large compared to the key source of variation (SD for M x S and Error, see **Table 19**). In contrast, for t- P, power was generally low for small sample sizes in the after period because the specified effect size was low, especially for SP (**Table 19**). Results for pH (lower) illustrate another important factor affecting power. For station TPE, we observe useful increases in power for both an increase in months and samples. In this case, SD(M x S) is essentially zero (**Table 19**), so the driver is SD(Error). When SD(Error) is dominant, increasing sub-samples improves precision and power, especially when months = 1 or 3. In contrast, for SP, increasing months of sampling improves power somewhat, but increasing the number of sub-samples does very little. This is because SD(M x S) > SD(Error) in **Table 19**. In summary, for 6-month means, power is > 80% when alpha = 0.05 in all cases except total P and pH (lower) for station SP (for total P, high power is achieved at alpha = 0.10 for 6-month means with two subsamples per month; **Table 20**). In some cases, use of two subsamples provides important increases in power (e.g., **Figures 10-11**); however, relative improvements for three subsamples are typically minor.

A measure of precision for BACI estimates is shown in **Figures 12 and 13**. For log data, a useful measure of precision is the coefficient of variation (CV = SE[BACI estimate]/ [BACI estimate]). Results are averages across 500 trials, and do not depend on tails or alpha. These results mirror those for power. As a rough guide, power > 80% when CV < 35%.

Summary – Results show that the benefits of subsampling are limited, with some gains in power associated with two subsamples but little improvement associated with three subsamples. In terms of duration of sampling, the results show significant increases in

power associated with 3 months of sampling, and smaller increases associated with moving from 3 to 6 months. Implications of these findings are discussed in the main text.

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Table 1. Total water samples collected for the CREMP.

Note: Shading denotes "Impact" periods.

Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul				1		1	1		1	1	1	1	7
	Aug				1		1	1		1	2	1	1	8
2007	Jul				1		1	2		1	1	1	1	8
	Aug				1		1	1		2	1	1	1	8
2008	Jul	1	1	1	1		1	1		1	1	1	2	11
	Aug	1	1	1	2		1	1		1	1	1	1	11
	Sep	2	1	1			1	1		1	4	1		12
2009	May				14		7	13		7	7			48
	Jul	3	4	3	7	3	3	8	2	3	4	3	4	47
	Aug	1	1	1	3	1	1	4	1	1	2	1	1	18
	Sep	3	3	4	7	3	4	7	3	4	3	3	4	48
	Nov				7		3	8		3	4			25
	Dec						1	3		2	1	3		10
2010	Jan						5	3		3	3	7		21
	Feb						2	3		1	1	3		10
	Mar						3	7		4	4	7		25
	Apr						1	3		2	1	3		10
	May						4	7		4	3	7		25
Total		11	11	11	45	7	41	74	6	42	44	44	16	352

Table 2. Standard water samples collected for the CREMP.

Note: Shading denotes "Impact" periods.

Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul				1		1	1		1	1	1	1	7
	Aug				1		1	1		1	1	1	1	7
2007	Jul				1		1	1		1	1	1	1	7
	Aug				1		1	1		1	1	1	1	7
2008	Jul	1	1	1	1		1	1		1	1	1	1	10
	Aug	1	1	1	1		1	1		1	1	1	1	10
	Sep	1	1	1			1	1		1	4	1		11
2009	May				6		6	6		6	6			30
	Jul	3	3	3	3	3	3	3	2	3	3	3	3	35
	Aug	1	1	1	1	1	1	1	1	1	1	1	1	12
	Sep	3	3	3	3	3	3	3	3	3	3	3	3	36
	Nov				3		3	3		3	3			15
	Dec						1	1		1	1	1		5
2010	Jan						3	2		3	3	3		14
	Feb						1	1		1	1	1		5
	Mar						3	3		3	3	3		15
	Apr						1	1		1	1	1		5
	May						3	3		3	3	3		15
Total		10	10	10	22	7	35	34	6	35	38	26	13	246

Table 3. Depth replicates (Bottom and Integrated samples) collected for the CREMP.

Note: Shading denotes "Impact" periods.

Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul													0
	Aug													0
2007	Jul													0
	Aug													0
2008	Jul													0
	Aug													0
	Sep													0
2009	May				8			7						15
	Jul				4			4						8
	Aug				2			2						4
	Sep				4			4						8
	Nov				4			4						8
	Dec							2				2		4
2010	Jan							1				4		5
	Feb							2				2		4
	Mar							4				4		8
	Apr							2				2		4
	May							4				4		8
Total		0	0	0	22	0	0	36	0	0	0	18	0	76

Table 4. Duplicate samples collected for the CREMP.

Note: Shading denotes "Impact" periods.

Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul													0
	Aug										1			1
2007	Jul							1						1
	Aug									1				1
2008	Jul												1	1
	Aug				1									1
	Sep	1												1
2009	May						1			1	1			3
	Jul		1					1			1		1	4
	Aug							1			1			2
	Sep			1			1			1			1	4
	Nov							1			1			2
	Dec									1				1
2010	Jan						2							2
	Feb						1							1
	Mar									1	1			2
	Apr									1				1
	May						1			1				2
Total		1	1	1	1	0	6	4	0	7	6	0	3	30

Table 5. Total metals: summary of sample measurements (N) and values above detection limits (>DL) for duplicate samples (control/impact), depth replicates (control/impact), standard control samples (total for Baker and Meadowbank, excluding duplicates and depth replicates), and Baker Lake control samples.

	Duplicate		Depth		Control (total)		Baker (control)	
Variable	N	>DL	N	>DL	N	>DL	N	>DL
Aluminum (T)	60	51	115	102	120	85	10	9
Antimony (T)	60	0	115	0	120	0	10	0
Arsenic (T)	60	4	115	0	120	0	10	0
Barium (T)	60	1	115	0	120	0	10	0
Beryllium (T)	60	0	115	0	120	0	10	0
Boron (T)	60	0	115	0	120	0	10	0
Cadmium (T)	60	3	115	6	120	7	10	0
Chromium (T)	60	2	115	1	120	0	10	0
Copper (T)	60	2	115	5	120	1	10	0
Iron (T)	60	23	115	14	120	2	10	0
Lead (T)	60	0	115	8	120	3	10	0
Lithium (T)	60	0	115	0	120	0	10	0
Manganese (T)	60	58	115	111	120	114	10	10
Mercury (T)	60	0	115	0	120	0	10	0
Molybdenum (T)	60	0	115	0	120	0	10	0
Nickel (T)	60	2	115	0	120	0	10	0
Selenium (T)	60	0	115	0	120	0	10	0
Strontium (T)	2	2	11	11	6	6	0	0
Thallium (T)	60	0	115	0	120	0	10	0
Tin (T)	60	0	115	0	120	0	10	0
Titanium (T)	60	2	115	0	120	0	10	0
Uranium (T)	60	2	115	0	120	0	10	0
Vanadium (T)	60	0	115	0	120	0	10	0
Zinc (T)	60	0	115	5	120	3	10	0

Table 6. Dissolved metals: summary of sample measurements (N) and values above detection limits (>DL) for duplicate samples (control/impact), depth replicates (control/impact), standard control samples (total for Baker and Meadowbank, excluding duplicates and depth replicates), and Baker Lake control samples.

	Duplicate		Depth		Control (total)		Baker (control)	
Variable	N	>DL	N	>DL	N	>DL	N	>DL
Aluminum (D)	48	10	115	6	71	2	7	0
Antimony (D)	48	0	115	0	71	0	7	0
Arsenic (D)	48	2	115	0	71	0	7	0
Barium (D)	48	0	115	0	71	0	7	0
Beryllium (D)	48	0	115	0	71	0	7	0
Boron (D)	48	0	115	0	71	0	7	0
Cadmium (D)	48	0	115	4	71	0	7	0
Chromium (D)	48	0	115	0	71	0	7	0
Copper (D)	48	0	115	2	71	0	7	0
Iron (D)	48	1	115	0	71	0	7	0
Lead (D)	48	0	115	1	71	0	7	0
Lithium (D)	48	0	115	0	71	0	7	0
Manganese (D)	48	26	115	34	71	25	7	3
Mercury (D)	48	0	115	1	71	0	7	0
Molybdenum (D)	48	0	115	0	71	0	7	0
Nickel (D)	48	0	115	0	71	0	7	0
Selenium (D)	48	0	115	0	71	0	7	0
Strontium (D)	2	2	11	11	6	6	0	0
Thallium (D)	48	0	115	0	71	0	7	0
Tin (D)	48	0	115	0	71	0	7	0
Titanium (D)	48	0	115	0	71	0	7	0
Uranium (D)	48	0	115	0	71	0	7	0
Vanadium (D)	48	0	115	0	71	0	7	0
Zinc (D)	48	0	115	4	71	0	7	0

Table 7. Nutrients and conventional parameters: summary of sample measurements (N) and values above detection limits (>DL) for duplicate samples (control/impact), depth replicates (control/impact), standard control samples (total for Baker and Meadowbank, excluding duplicates and depth replicates), and Baker Lake control samples.

	Duplicate		Depth		Control (total)		Baker (control)	
Variable	N	>DL	N	>DL	N	>DL	N	>DL
Ammonia-N	60	17	115	31	120	47	10	6
TKN	60	56	115	101	120	116	10	10
Nitrate-N	60	27	115	37	120	13	10	10
Nitrite-N	60	1	115	1	120	1	10	1
Ortho-phosphate	54	5	92	4	108	8	10	0
Total phosphorous	54	31	92	33	108	54	10	10
TOC	60	60	115	115	120	120	10	10
DOC	60	60	115	115	120	120	10	10
Reactive silica	54	0	115	0	99	0	7	0
Bicarbonate alkalinity	54	54	92	92	108	108	10	10
Chloride	60	32	115	82	120	62	10	10
Carbonate alkalinity	54	0	92	0	108	0	10	0
Conductivity	60	60	115	115	120	120	10	10
Hardness	60	60	115	115	120	120	10	10
Calcium	60	60	115	115	120	120	10	10
Potassium	60	2	115	0	120	2	10	2
Magnesium	60	60	115	115	120	120	10	10
Sodium	60	4	115	0	120	10	10	10
Sulphate	60	60	115	115	120	120	10	10
pH	60	60	115	115	120	120	10	10
Total alkalinity	54	54	92	92	108	108	10	10
TDS	59	39	115	81	120	72	10	10
TSS	59	15	115	13	120	8	10	0

Table 8. Summary of statistical comparisons between sample/duplicate pairs.

Notes: Limited to pairs with both values above detection limits). N = total samples (pairs = N/2); Median = median of all samples; MAD = median absolute difference among sample/duplicate pairs; r = Spearman rank correlation among sample/duplicate pairs; SD = standard deviation of random effects for Location (variability among sample pairs) and residual errors (variability between samples and duplicates) fit to log-transformed data.

					Model SD (log data)	
Variable	N	Median	MAD	r	Location	Res. Error
Aluminum (T)	50	0.016	0.002	0.97	1.272	0.088
Manganese (T)	58	0.00121	0.00005	0.97	0.669	0.074
TKN	54	0.10	0.03	0.23	0.127	0.280
Total phosphorous	26	0.004	0.001	0.47	0.147	0.574
TOC	60	1.65	0.07	0.88	0.287	0.098
DOC	60	1.55	0.08	0.90	0.291	0.062
Bicarbonate alkalinity	54	6.35	0.20	0.93	0.309	0.122
Chloride	30	0.68	0.01	0.97	1.753	0.013
Conductivity	60	20.10	0.20	0.99	0.773	0.016
Hardness	60	7.90	0.10	0.97	0.514	0.033
Calcium	60	1.83	0.03	0.99	0.414	0.044
Magnesium	60	0.80	0.01	1.00	0.620	0.011
Sulphate	60	1.84	0.02	0.99	0.582	0.021
pH	60	6.87	0.04	0.74	0.000	0.065
TDS	28	17.0	2.0	0.55	0.862	0.148

Table 9. Summary of depth samples (N = 115) collected at 39 locations.

Notes: Depth (m) is shown for "Surface" and "Bottom" samples; depth range is shown for "Integrated" samples.

Case	Station/Sample	Date	Surface	Bottom	Integrated
1	INUG-1	3-May-09	2	12	2 to 8
2	INUG-2	3-May-09	2	5.5	2 to 4.5
3	INUG-1	28-May-09	3	7	3 to 7
4	INUG-2	28-May-09	2.5	5	2.5 to 4.5
5	INUG-4	24-Jul-09	3	9	0.5 to 9
6	INUG-5	24-Jul-09	3	9	0.5 to 9
7	INUG-7	19-Aug-09	3	6.7	0.5 to 6.7
8	INUG-8	16-Sep-09	3	7	0.5 to 7.0
9	INUG-9	16-Sep-09	3	10	0.5 to 10
10	INUG-11	28-Nov-09	3	5.5	2 to 5
11	INUG-12	28-Nov-09	3	4.5	2 to 4.5
12	TE-1	4-May-09	3	5	3 to 6
13	TE-2	4-May-09	3	10	3 to 8
14	TE-1	30-May-09	3	8	3 to 8
15	TE-2	30-May-09	3	4.5	2.5 to 4.5
16	TE-4	19-Jul-09	3	10	0.5 to 8
17	TE-5	19-Jul-09	3	10.5	0.5 to 8
18	TE-7	15-Aug-09	3	8	0.5 to 8
19	TE-8	12-Sep-09	3	7.5	0.5 to 7.5
20	TE-9	12-Sep-09	3	7.5	0.5 to 8.0
21	TE-11	26-Nov-09	3	7	3 to 7
22	TE-12	26-Nov-09	3	8	3 to 8
23	TE-14	21-Dec-09	3	12	3 to 12
24	TE-17	16-Jan-10	2.8		2.2 to 3.8
25	TE-18	26-Feb-10	3		3 to 5
26	TE-19	21-Mar-10	3	10	3 to 10
27	TE-20	21-Mar-10	2.5	4.5	2.5 to 4.5
28	TE-22	9-Apr-10	3	5	3 to 5
29	TE-23	21-May-10	3	5	2.5 to 5
30	TE-24	21-May-10	3	5	2.5 to 5
31	TPS-8	22-Dec-09	3	6.5	3 to 6.5
32	TPS-10	19-Jan-10	2.5	5	2.5 to 5
33	TPS-9	19-Jan-10	3	12	3 to 12
34	TPS-12	24-Feb-10	3	12	3 to 12
35	TPS-13	24-Mar-10	3	12	3 to 12
36	TPS-14	24-Mar-10	3	12	3 to 12
37	TPS-16	10-Apr-10	3	12	3 to 12
38	TPS-17	22-May-10	3	6	3 to 6
39	TPS-18	22-May-10	3	14	3 to 14

Table 10. P-values for F tests of the key fixed-effect terms for depth.

Notes: Models include Type (Model 1), Type*Station (Model 2), and Type*Season (Model 3; Seas1). Shaded cells denote $0.05 \leq P < 0.01$ (light shade) and $P \leq 0.01$ (dark shade). N = number of samples (locations = N/3).

		Type	Type*Station	Type*Season (Model 3)		
Variable	N	(Model 1)	(Model 2)	N	July summer	July winter
Aluminum (T)	90	0.000	0.001	72	0.003	0.081
Manganese (T)	99	0.204	0.062	75	0.940	0.889
TKN	87	0.303	0.451	72	0.212	0.067
TOC	111	0.000	0.007	84	0.335	0.601
DOC	111	0.003	0.346	84	0.372	0.437
Bicarbonate alk.	90	0.003	0.761	63	0.107	0.019
Chloride	72	0.052	0.995	69	0.569	0.836
Conductivity	111	0.001	0.479	84	0.123	0.296
Hardness	111	0.002	0.146	84	0.141	0.202
Calcium	111	0.060	0.917	84	0.656	0.896
Magnesium	111	0.000	0.361	84	0.169	0.313
Sulphate	111	0.001	0.553	84	0.638	0.367
pH	111	0.500	0.105	84	0.166	0.136
TDS	54	0.351	0.302	45	0.623	NA

Table 11. Summary of coefficients for Model 1 (log[y] ~ Type + Location).

Notes: Est = estimate; SE = standard error; P = P-value based on t-test; ES (%) = proportional effect size in untransformed units relative to surface samples, where ES (%) = (exp[Est] – 1)*100. Shaded cells denote $0.05 \leq P < 0.01$ (light shade) and $P \leq 0.01$ (dark shade).

	Bottom – Surface				Integrated - Surface			
Variable	Est	SE	P	ES (%)	Est	SE	P	ES (%)
Aluminum (T)	-0.174	0.061	0.006	-15.9%	0.122	0.061	0.051	12.9%
Manganese (T)	0.108	0.097	0.268	11.5%	0.174	0.097	0.079	18.9%
TKN	0.109	0.086	0.213	11.5%	0.123	0.086	0.158	13.1%
TOC	-0.071	0.018	0.000	-6.8%	-0.008	0.018	0.638	-0.8%
DOC	-0.060	0.022	0.008	-5.9%	0.014	0.022	0.516	1.4%
Bicarbonate alk.	-0.068	0.019	0.001	-6.6%	-0.040	0.019	0.040	-4.0%
Chloride	-0.047	0.019	0.016	-4.6%	-0.021	0.019	0.270	-2.1%
Conductivity	-0.048	0.012	0.000	-4.6%	-0.017	0.012	0.166	-1.7%
Hardness	-0.045	0.013	0.001	-4.4%	-0.033	0.013	0.013	-3.2%
Calcium	-0.036	0.016	0.029	-3.5%	-0.031	0.016	0.056	-3.1%
Magnesium	-0.054	0.011	0.000	-5.3%	-0.039	0.011	0.001	-3.8%
Sulphate	-0.061	0.015	0.000	-5.9%	-0.034	0.015	0.028	-3.4%
pH	-0.004	0.006	0.562	-0.4%	-0.007	0.006	0.241	-0.7%
TDS	-0.048	0.047	0.322	-4.6%	0.020	0.047	0.673	2.0%

Table 12. Summary of comparisons between Baker and Meadowbank control samples.

Notes: Ratio = median(Baker)/median(Meadow); MW test P = P-value for the Mann-Whitney test; Est = difference in means (Baker – Meadow) for log-transformed data; P = P-value based on t-test; ES (%) = proportional effect size in untransformed units relative to Meadowbank samples, where ES (%) = (exp[Est] – 1)*100.

	Sample size (N)		Medians			MW	t-test (log data)		
Variable	Baker	Meadow	Baker	Meadow	Ratio	test P	Est	P	ES (%)
Aluminum (T)	10	103	0.009	0.007	1.3	0.055	0.21	0.041	23%
Manganese (T)	10	110	0.002	0.001	2.4	0.000	0.81	0.000	126%
Ammonia-N	10	110	0.022	0.020	1.1	0.103	0.11	0.281	12%
TKN	10	110	0.180	0.097	1.9	0.000	0.51	0.000	66%
Nitrate-N	10	110	0.014	0.005	2.8	0.000	1.07	0.000	192%
Total phosphor.	10	98	0.003	0.002	1.6	0.000	0.59	0.000	80%
TOC	10	110	3.1	1.6	1.9	0.000	0.62	0.000	86%
DOC	10	110	3.0	1.6	1.9	0.000	0.65	0.000	92%
Bicarbonate alk.	10	98	9.0	4.6	2.0	0.000	0.52	0.000	69%
Chloride	10	110	67.8	0.5	135.5	0.000	4.44	0.000	8409%
Conductivity	10	110	273.5	15.9	17.3	0.000	2.47	0.000	1082%
Hardness	10	110	32.6	5.7	5.7	0.000	1.36	0.000	289%
Calcium	10	110	3.8	1.3	3.0	0.000	0.82	0.000	128%
Magnesium	10	110	5.6	0.6	8.8	0.000	1.87	0.000	549%
Sodium	10	110	36.2	2.0	18.1	0.000	2.52	0.000	1139%
Sulphate	10	110	9.5	1.4	6.7	0.000	1.57	0.000	379%
pH	10	110	7.2	6.8	1.1	0.000	0.04	0.017	5%
TDS	10	110	138.5	11.0	12.6	0.000	2.19	0.000	791%

Table 13. Total metals: summary of trigger values for Meadowbank 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; medians and 95th percentiles are shown for variables with at least one value >DL (with all values <DL set equal to DL); Method = method used to determine the trigger, where A = halfway from median (or DL if all values <DL) to threshold, B = 95th percentile, and C = 2*DL.

Variable	Threshold	DL	N	>DL	Median	95th	Trigger	Method
Aluminum (T)	0.1	0.005	120	85	0.0068	0.0127	0.053	A
Antimony (T)		0.0005	120	0			0.0010	C
Arsenic (T)	0.005	0.0005	120	0			0.0028	A
Barium (T)		0.02	120	0			0.04	C
Beryllium (T)		0.001	120	0			0.002	C
Boron (T)	1.2	0.1	120	0			0.65	A
Cadmium (T)	0.0001	0.000017	120	7	0.000017	0.000017	0.000059	A
Chromium (T)	0.001	0.001	120	0			0.001	A
Copper (T)	0.002	0.001	120	1	0.001	0.001	0.0015	A
Iron (T)	0.3	0.03	120	2	0.03	0.03	0.165	A
Lead (T)	0.001	0.0005	120	3	0.0005	0.0005	0.00075	A
Lithium (T)		0.005	120	0			0.010	C
Manganese (T)	See text	0.0003	120	114	0.0010	0.0025	0.32	See text
Mercury (T)	0.000026	0.00001	120	0			0.000018	A
Molybdenum (T)	0.073	0.001	120	0			0.037	A
Nickel (T)	0.025	0.001	120	0			0.013	A
Selenium (T)	0.001	0.001	120	0			0.001	A
Strontium (T)			6	6	0.0081	0.0089	0.0089	B
Thallium (T)	0.0008	0.0002	120	0			0.0005	A
Tin (T)		0.0005	120	0			0.0010	C
Titanium (T)		0.01	120	0			0.02	C
Uranium (T)		0.0002	120	0			0.0004	C
Vanadium (T)		0.001	120	0			0.002	C
Zinc (T)	See text	0.005	120	3	0.005	0.005	0.007	See text

Table 14. Dissolved metals: summary of trigger values for Meadowbank 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; medians and 95th percentiles for variables with at least one value >DL (with all values <DL set equal to DL); Method = method used to determine the trigger, where A = halfway from median (or DL if all values <DL) to threshold, B = 95th percentile, and C = 2*DL.

Variable	Threshold	DL	N	>DL	Median	95th	Trigger	Method
Aluminum (D)	See text	0.005	71	2	0.005	0.005	0.016	See text
Antimony (D)		0.0005	71	0			0.0010	C
Arsenic (D)		0.0005	71	0			0.0010	C
Barium (D)		0.02	71	0			0.04	C
Beryllium (D)		0.001	71	0			0.002	C
Boron (D)		0.1	71	0			0.2	C
Cadmium (D)		0.000017	71	0			0.000034	C
Chromium (D)		0.001	71	0			0.002	C
Copper (D)		0.001	71	0			0.002	C
Iron (D)		0.03	71	0			0.06	C
Lead (D)		0.0005	71	0			0.0010	C
Lithium (D)		0.005	71	0			0.010	C
Manganese (D)		0.0003	71	25	0.0003	0.0014	0.0014	B
Mercury (D)		0.00001	71	0			0.00002	C
Molybdenum (D)		0.001	71	0			0.002	C
Nickel (D)		0.001	71	0			0.002	C
Selenium (D)		0.001	71	0			0.002	C
Strontium (D)			6	6	0.0082	0.0092	0.0092	B
Thallium (D)		0.0002	71	0			0.0004	C
Tin (D)		0.0005	71	0			0.0010	C
Titanium (D)		0.01	71	0			0.02	C
Uranium (D)		0.0002	71	0			0.0004	C
Vanadium (D)		0.001	71	0			0.002	C
Zinc (D)		0.005	71	0			0.010	C

Table 15. Nutrients and conventional parameters: summary of trigger values for Meadowbank 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; medians and 95th percentiles for variables with at least one value >DL (with all values <DL set equal to DL); Method = method used to determine the trigger, where A = halfway from median (or DL if all values <DL) to threshold, B = 95th percentile, and C = 2*DL.

			Meadowbank (or both)						Baker (if different)					
Variable	Threshold	DL	T	N	Med	95th	Trigger	Method	T	N	Med	95th	Trigger	Method
Ammonia-N	0.126	0.02	120	47	0.020	0.052	0.073	A						
TKN		0.05	110	106	0.097	0.181	0.181	B	10	10	0.180	0.194	0.194	B
Nitrate-N	2.9	0.005	110	3	0.005	0.005	1.45	A	10	10	0.014	0.027	1.46	A
Nitrite-N	0.06	0.001	120	1	0.001	0.001	0.031	A						
Ortho-phosphate		0.001	108	8	0.0010	0.0011	0.002	C						
Total phosphorous	0.004	0.002	98	44	0.0020	0.0047	0.0047	B	10	10	0.0032	0.0061	0.0061	B
TOC			110	110	1.63	2.51	2.51	B	10	10	3.06	3.17	3.17	B
DOC			110	110	1.59	2.31	2.31	B	10	10	3.02	3.42	3.42	B
Reactive silica		1.0	99	0			2.0	C						
Bicarbonate alkalinity			98	98	4.60	9.42	9.42	B	10	10	9.00	9.46	9.46	B
Chloride		0.5	110	52	0.5	0.79	0.79	B	10	10	67.8	119.7	119.7	B
Carbonate alkalinity		2.0	108	0			4.0	C						
Conductivity			110	110	15.9	27.4	27.4	B	10	10	273.5	464.9	464.9	B
Hardness			110	110	5.7	12.3	12.3	B	10	10	32.6	49.5	49.5	B
Calcium			110	110	1.3	3.3	3.3	B	10	10	3.8	5.2	5.2	B
Potassium		2.0	120	2	2.0	2.0	4.0	C						
Magnesium			110	110	0.64	0.96	0.96	B	10	10	5.59	8.90	8.90	B
Sodium		2.0	110	0			4.0	C	10	10	36.2	65.1	65.1	B
Sulphate			110	110	1.43	2.61	2.61	B	10	10	9.53	17.31	17.31	B
pH (Upper)	9.0		110	110	6.80	8.00	8.00	B	10	10	7.17	7.59	8.09	A
pH (Lower)	6.5		110	110	6.80	6.47[a]	6.47	B	10	10	7.17	6.97[a]	6.84	A
Total alkalinity			98	98	4.60	9.42	9.42	B	10	10	9.00	9.46	9.46	B
TDS		10.0	110	62	11.0	19.0	19.0	B	10	10	138.5	245.8	245.8	B
TSS	5.0	1.0	120	8	1.0	1.6	3.0	A						

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

Table 16. Summary of thresholds for water variables; (CCME, 2007).

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 $\geq$ 6.5. See text for details.
t-Arsenic (As)	CCME	The CCME water quality guideline (aquatic life) for t-As is 0.005 mg/L.
t-Boron (B)	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)	CCME EPA	The hardness-dependent CCME guideline for t-Cd (mg/L) is $0.001*10^{0.86*\log(H)-3.2}$ where H = hardness (mg/L $CaCO_3$). This guideline was deemed inappropriate. The EPA guideline for t-Cd of 0.0001 mg/L was used instead. See text for details.
t-Copper (Cu)	CCME	The CCME guideline for t-Cu is 0.002 mg/L for hardness < 120 mg/L $CaCO_3$.
t-Chromium (Cr)	CCME	The CCME guideline for hexavalent chromium (the most common form in surface waters) is 0.001 mg/L.
t-Iron (Fe)	CCME	The CCME guideline for t-Fe is 0.3 mg/L.
t-Lead (Pb)	CCME	The CCME guideline for t-Pb is 0.001 mg/L for hardness < 60 mg/L $CaCO_3$.
t-Manganese (Mn)	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)	CCME	The CCME guideline for total inorganic mercury is 26 ng/L (0.00026 mg/L).
t-Molybdenum (Mo)	CCME	The CCME guideline for t-Mo in water is 0.073 mg/L.
t-Nickel (Ni)	CCME	The CCME guideline for t-Ni is 0.025 mg/L for hardness < 60 mg/L $CaCO_3$.
t-Selenium (Se)	CCME	The CCME guideline for t-Se in water is 0.001 mg/L.
t-Thallium (Tl)	CCME	The CCME water quality guideline for t-Tl is 0.0008 mg/L.
t-Zinc (Zn)	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 as follows: $d\text{-}Al = e^{(1.6-3.327*pH + 0.402*K)}$ where $K = pH^2$. 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.

Table 17. Samples by station used as the “before period” in BACI simulations. Shaded months denote periods designated as “impact” months by station (samples excluded).

Month	INUG	SP	TPE	TPN
Jul.06	1	1	1	1
Aug.06	1	1	1	1
Jul.07	1	1	1	1
Aug.07	1	1	1	1
Jul.08	1	1	1	1
Aug.08	1		1	1
May.09	6		6	
Jul.09	3		3	
Aug.09	1			
Sep.09	3			
Nov.09	3			
Total	**22**	**5**	**15**	**6**

Table 18. Number of valid measurements (N) and the percentage of N above detection limits (DL) by variable and station for data used as the “before-period” in BACI simulations.

Number of valid measurements (N)

	INUG	SP	TPE	TPN
Aluminum (T)	19	5	14	6
Manganese (T)	22	5	15	6
Ammonia-N	22	5	15	6
Total Phosphorous	16	5	9	6
pH	22	5	15	6

Percentage of N measurements > detection limit (DL)

	INUG	SP	TPE	TPN
Aluminum (T)	100%	100%	71%	67%
Manganese (T)	91%	100%	87%	100%
Ammonia-N	50%	60%	13%	33%
Total Phosphorous	69%	100%	33%	83%
pH	100%	100%	100%	100%

Table 19. Summary of "before-period" mixed-effects model estimates by variable and impact station (paired with control INUG).

Notes: The station mean, trigger, and effect size (ES = Trigger – Mean) are in raw units (e.g., mg/L). ES(log) denotes the effect size for log data (ES(log) = log[Trigger/Mean]). Estimates of the standard deviations (SD) for random-effects terms (Month and Month-by-Station, M x S) and residuals errors are for log-transformed data.

						SD (log data)		
Variable	Station	Mean	Trigger	ES	ES(log)	Month	M x S	Error
Aluminum (T)	SP	0.009	0.053	0.044	1.796	0.196	0.103	0.102
	TPE	0.008	0.053	0.045	1.857	0.164	0.167	0.092
	TPN	0.006	0.053	0.047	2.151	0.228	0.000	0.086
Manganese (T)	SP	0.001	0.320	0.319	5.513	0.636	0.000	0.133
	TPE	0.001	0.320	0.319	5.643	0.597	0.140	0.137
	TPN	0.001	0.320	0.319	6.142	0.594	0.215	0.133
Ammonia-N	SP	0.023	0.073	0.050	1.176	0.410	0.000	0.322
	TPE	0.020	0.073	0.053	1.286	0.466	0.000	0.261
	TPN	0.018	0.073	0.055	1.417	0.401	0.000	0.322
Total P	SP	0.003	0.005	0.002	0.448	0.132	0.000	0.330
	TPE	0.002	0.005	0.002	0.749	0.136	0.000	0.294
	TPN	0.003	0.005	0.002	0.586	0.139	0.000	0.331
pH (upper)	SP	7.00	8.00	1.00	0.134	0.018	0.041	0.018
	TPE	6.82	8.00	1.18	0.159	0.055	0.000	0.024
	TPN	6.83	8.00	1.17	0.159	0.058	0.000	0.016
pH (lower)	SP	7.00	6.47	-0.53	-0.078	0.018	0.041	0.018
	TPE	6.82	6.47	-0.35	-0.053	0.055	0.000	0.024
	TPN	6.83	6.47	-0.36	-0.054	0.058	0.000	0.016

Table 20. Estimates of BACI statistical power for detecting a significant increase (one-tailed test) in a given variable by station (SP, TPE, TPN) as a function of sampling months (after period) and the number of sub-samples per month.

Note: Power is shown for two levels of alpha (0.05 and 0.10).

			alpha = 0.05			alpha = 0.10		
Variable	Months	Samples	SP	TPE	TPN	SP	TPE	TPN
Aluminum (T)	1	1	1.00	1.00	1.00	1.00	1.00	1.00
		2	1.00	1.00	1.00	1.00	1.00	1.00
		3	1.00	1.00	1.00	1.00	1.00	1.00
	3	1	1.00	1.00	1.00	1.00	1.00	1.00
		2	1.00	1.00	1.00	1.00	1.00	1.00
		3	1.00	1.00	1.00	1.00	1.00	1.00
	6	1	1.00	1.00	1.00	1.00	1.00	1.00
		2	1.00	1.00	1.00	1.00	1.00	1.00
		3	1.00	1.00	1.00	1.00	1.00	1.00
Manganese (T)	1	1	1.00	1.00	1.00	1.00	1.00	1.00
		2	1.00	1.00	1.00	1.00	1.00	1.00
		3	1.00	1.00	1.00	1.00	1.00	1.00
	3	1	1.00	1.00	1.00	1.00	1.00	1.00
		2	1.00	1.00	1.00	1.00	1.00	1.00
		3	1.00	1.00	1.00	1.00	1.00	1.00
	6	1	1.00	1.00	1.00	1.00	1.00	1.00
		2	1.00	1.00	1.00	1.00	1.00	1.00
		3	1.00	1.00	1.00	1.00	1.00	1.00
Ammonia-N	1	1	0.58	0.93	0.82	0.81	0.98	0.94
		2	0.87	1.00	0.98	0.96	1.00	0.99
		3	0.96	1.00	1.00	0.99	1.00	1.00
	3	1	0.98	1.00	1.00	1.00	1.00	1.00
		2	1.00	1.00	1.00	1.00	1.00	1.00
		3	1.00	1.00	1.00	1.00	1.00	1.00
	6	1	1.00	1.00	1.00	1.00	1.00	1.00
		2	1.00	1.00	1.00	1.00	1.00	1.00
		3	1.00	1.00	1.00	1.00	1.00	1.00
Total P	1	1	0.09	0.41	0.19	0.26	0.59	0.37
		2	0.17	0.65	0.31	0.33	0.82	0.50
		3	0.18	0.81	0.43	0.43	0.93	0.67
	3	1	0.29	0.85	0.55	0.54	0.92	0.73
		2	0.38	0.99	0.68	0.64	1.00	0.88
		3	0.44	1.00	0.81	0.74	1.00	0.93
	6	1	0.46	0.99	0.74	0.67	1.00	0.89
		2	0.61	1.00	0.91	0.83	1.00	0.97
		3	0.73	1.00	0.97	0.93	1.00	1.00

Table 21. Estimates of BACI statistical power for detecting a significant increase in pH (upper trigger) or a significant decrease in pH (lower trigger) by station (SP, TPE, TPN) for two-tailed tests as a function of sampling months (after period) and the number of sub-samples per month.

Note: Power is shown for two levels of alpha (0.05 and 0.10).

			alpha = 0.05			alpha = 0.10		
pH Trigger	Months	Samples	SP	TPE	TPN	SP	TPE	TPN
Upper	1	1	0.18	0.99	1.00	0.43	1.00	1.00
		2	0.20	1.00	1.00	0.47	1.00	1.00
		3	0.21	1.00	1.00	0.49	1.00	1.00
	3	1	0.78	1.00	1.00	0.90	1.00	1.00
		2	0.78	1.00	1.00	0.91	1.00	1.00
		3	0.79	1.00	1.00	0.92	1.00	1.00
	6	1	0.97	1.00	1.00	1.00	1.00	1.00
		2	0.98	1.00	1.00	1.00	1.00	1.00
		3	0.99	1.00	1.00	1.00	1.00	1.00
Lower	1	1	0.04	0.20	0.38	0.15	0.37	0.58
		2	0.04	0.42	0.64	0.14	0.58	0.83
		3	0.04	0.54	0.86	0.15	0.75	0.95
	3	1	0.20	0.52	0.87	0.41	0.71	0.96
		2	0.23	0.88	0.98	0.45	0.95	1.00
		3	0.26	0.96	1.00	0.48	0.99	1.00
	6	1	0.49	0.90	0.99	0.73	0.95	1.00
		2	0.50	1.00	1.00	0.73	1.00	1.00
		3	0.51	1.00	1.00	0.73	1.00	1.00

Figure 1. Sample versus duplicate values of selected water variables (log-log scale).

Notes: Values below detection limits were set equal to the given detection limit. Solid line is the 1:1 line.

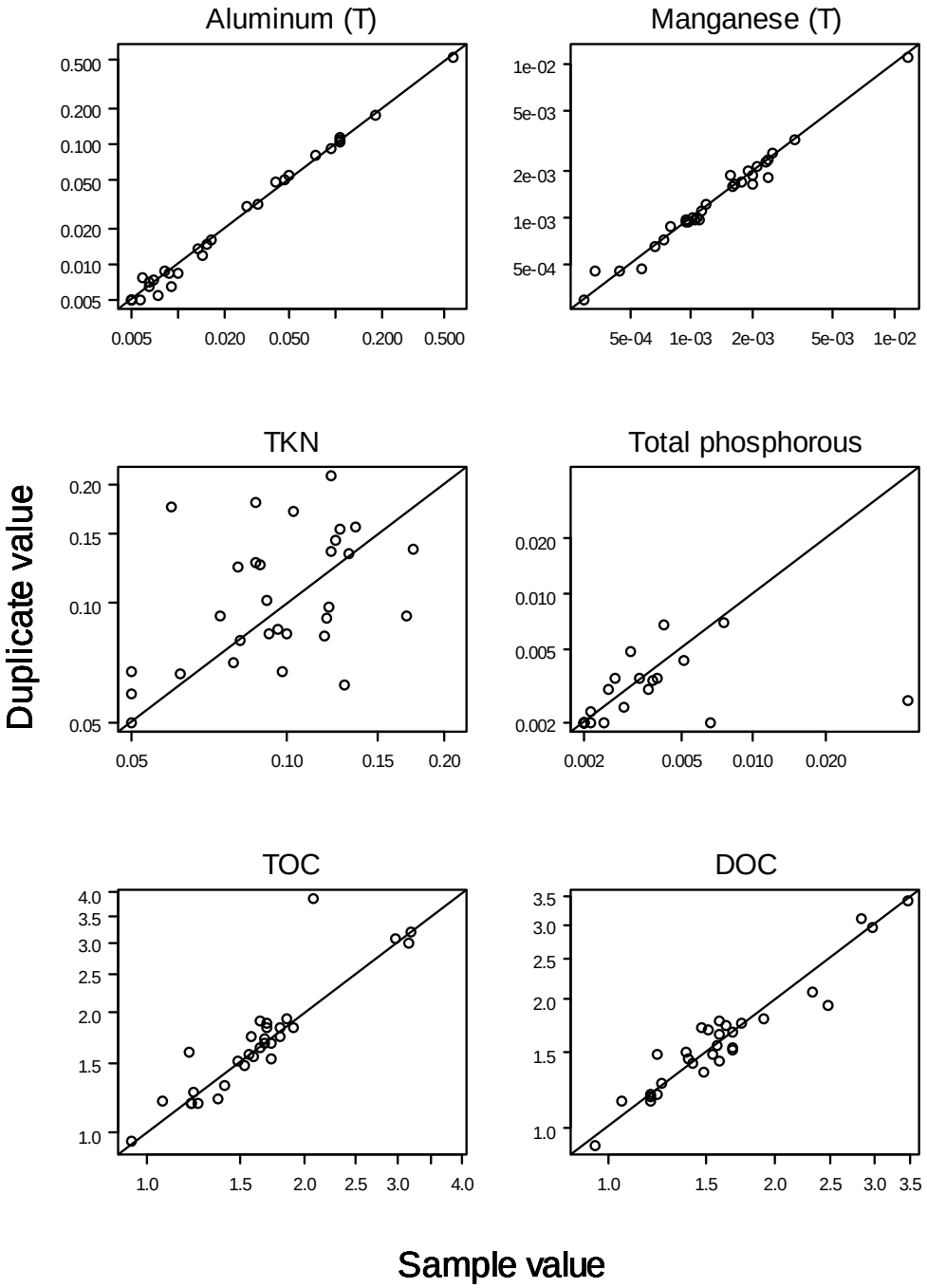


Figure 1 (page 2 of 3)

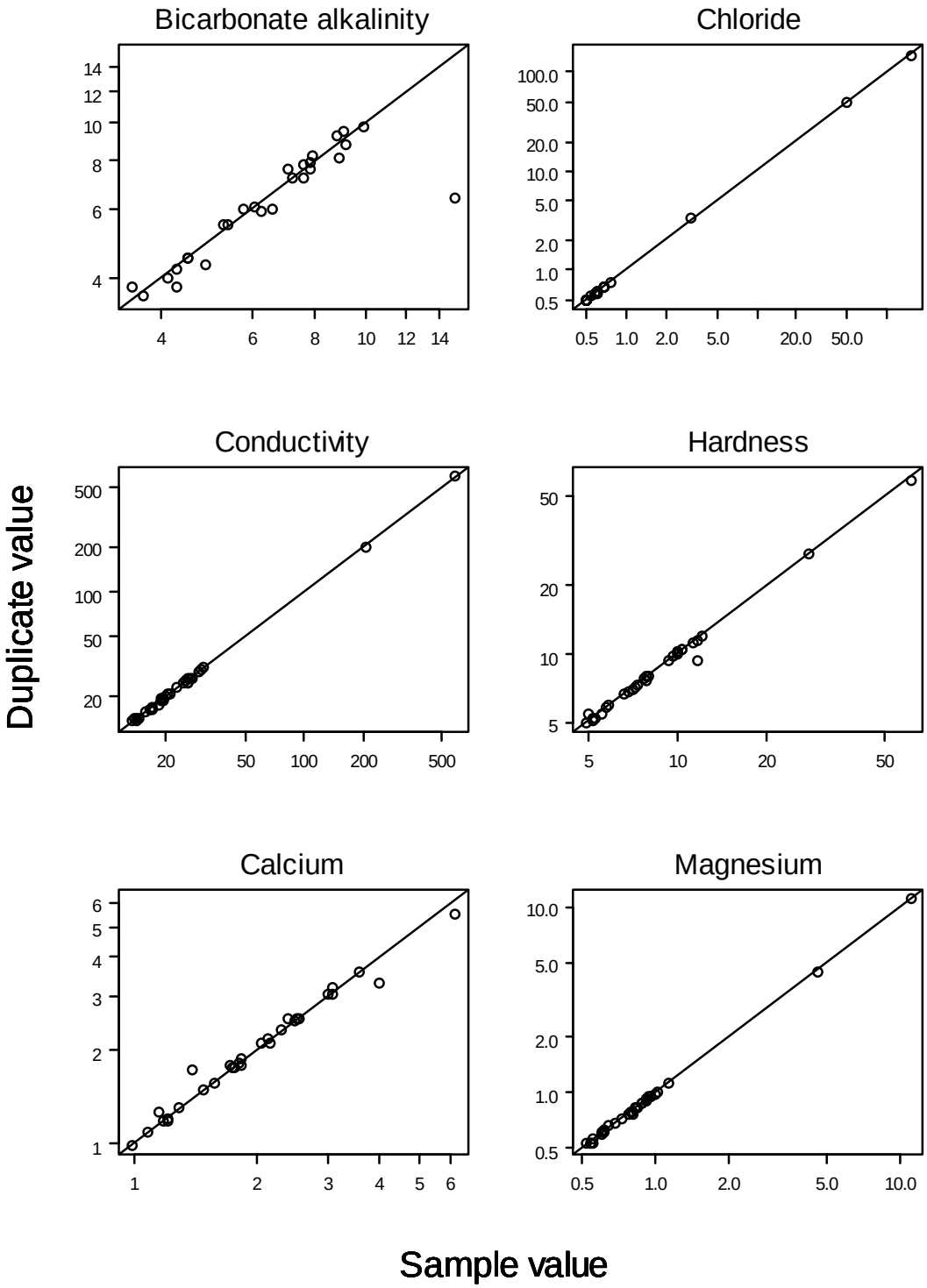


Figure 1 (page 3 of 3)

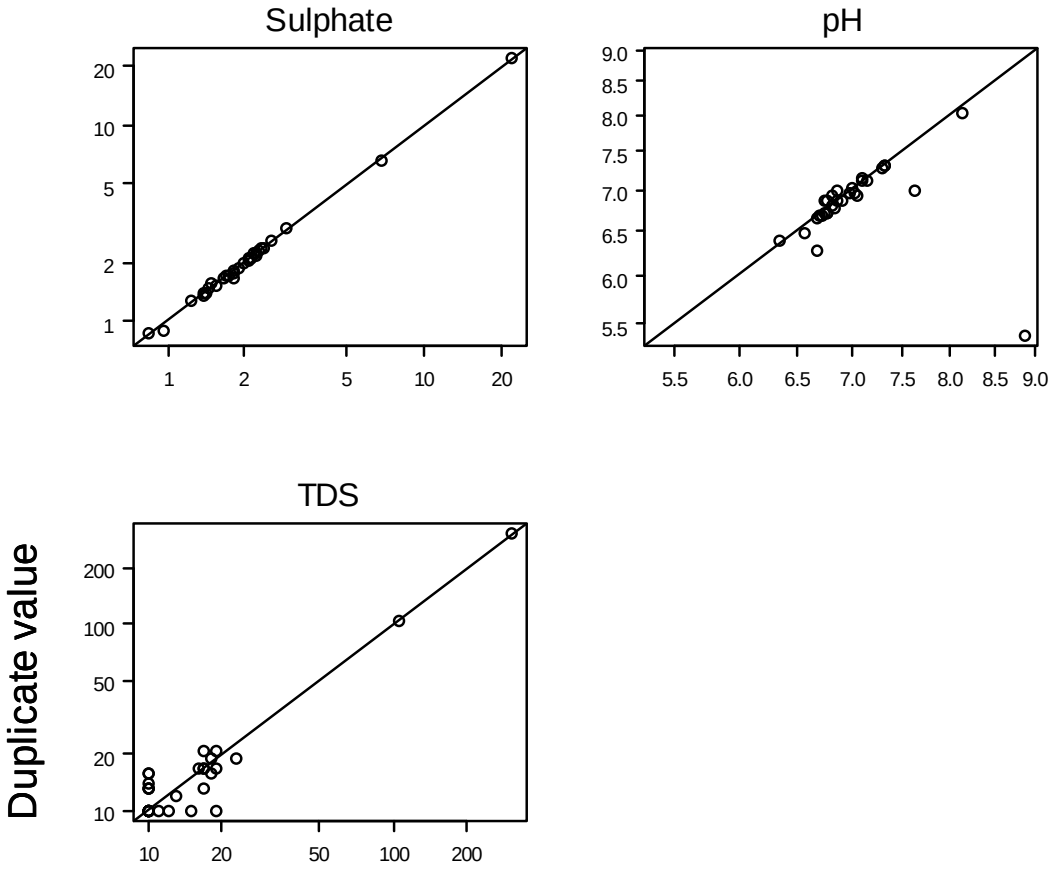


Figure 2. Surface versus Bottom samples (left side; circles) and Integrated samples (right side; triangles) for selected water variables (log-log scale).

Notes: Values < DL were set = DL. Dashed lines denote estimated differences (if P < 0.1) relative to Surface samples (see text). Solid line is the 1:1 line.

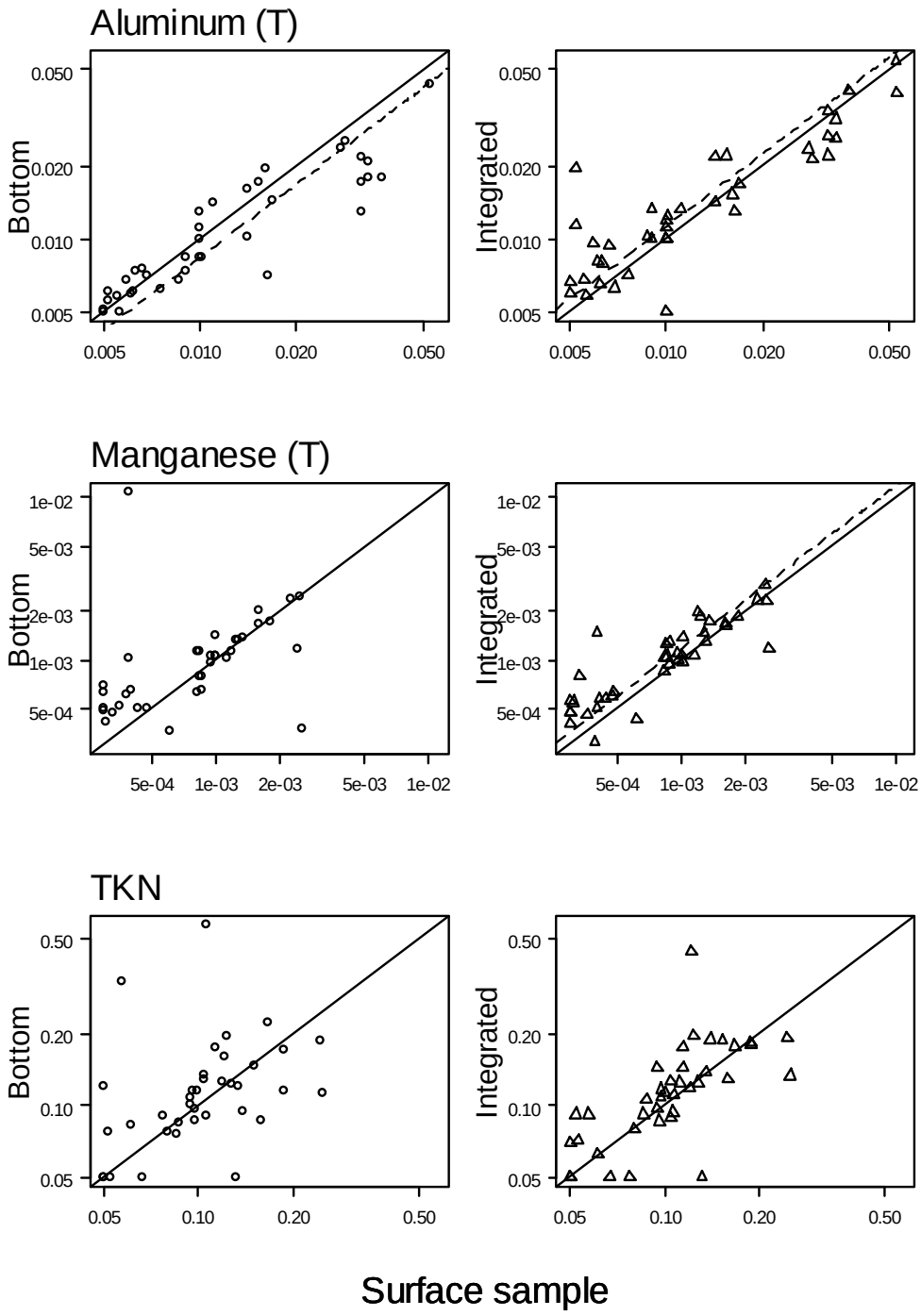


Figure 2 (page 2 of 5)

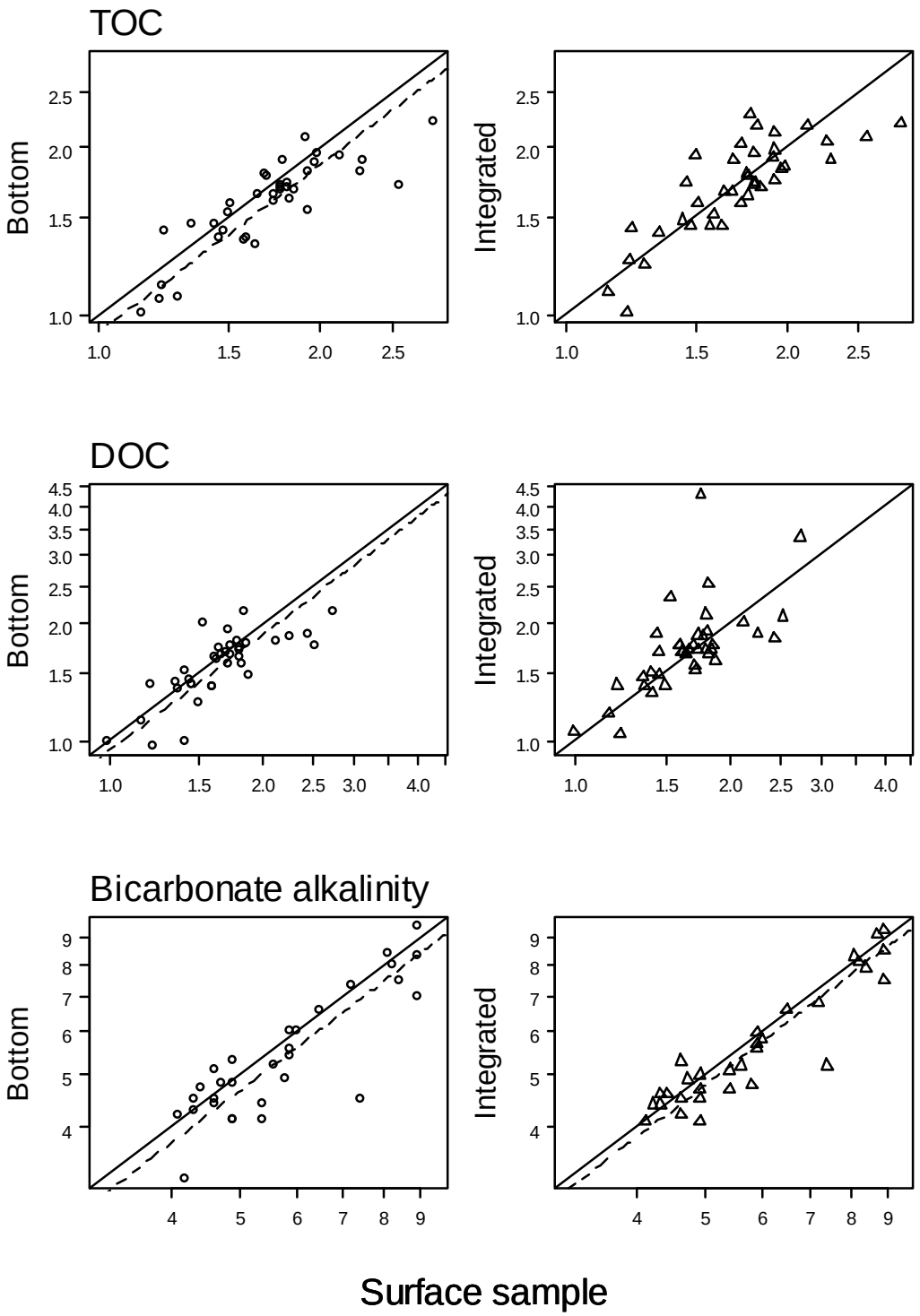


Figure 2 (page 3 of 5)

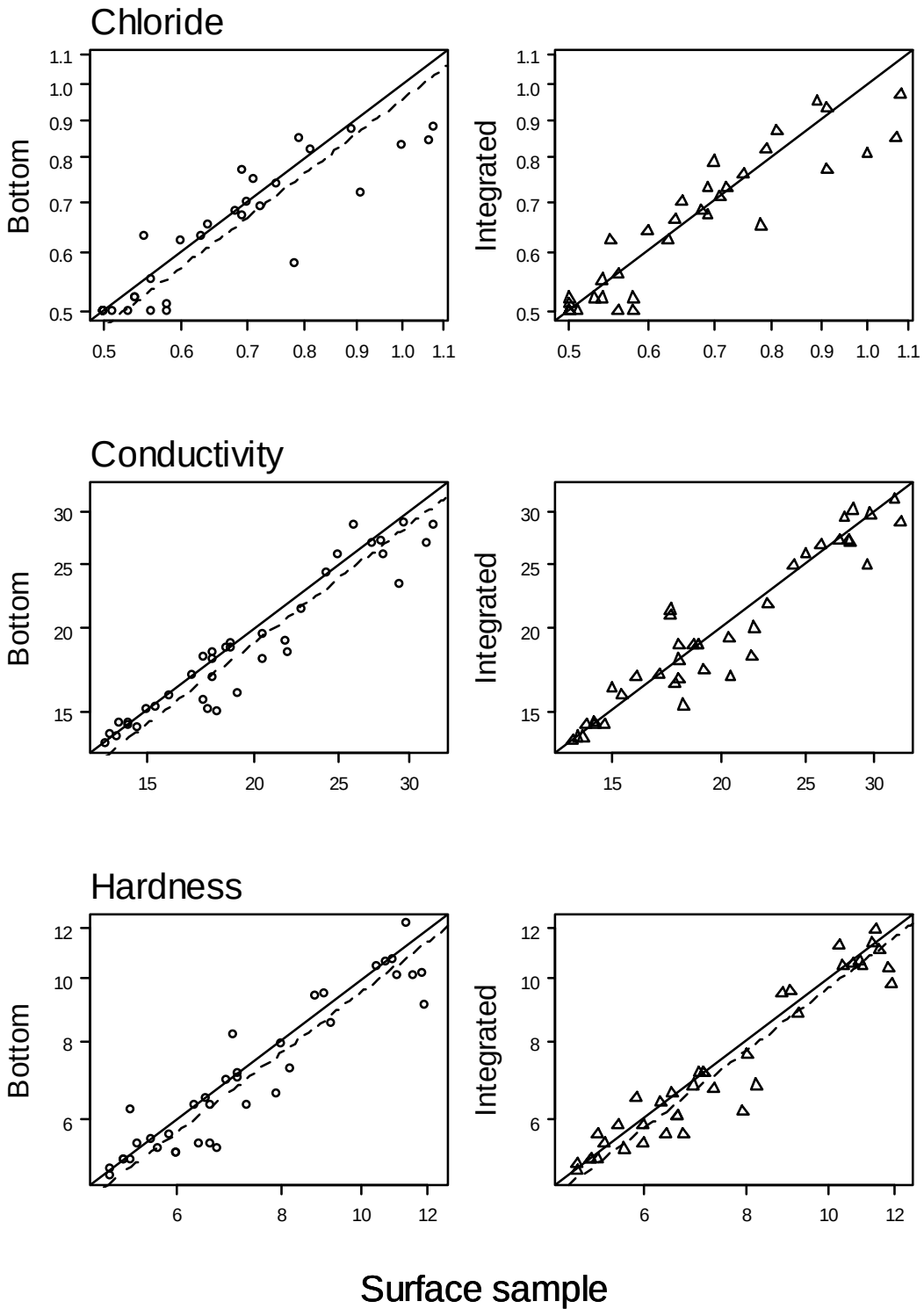


Figure 2 (page 4 of 5)

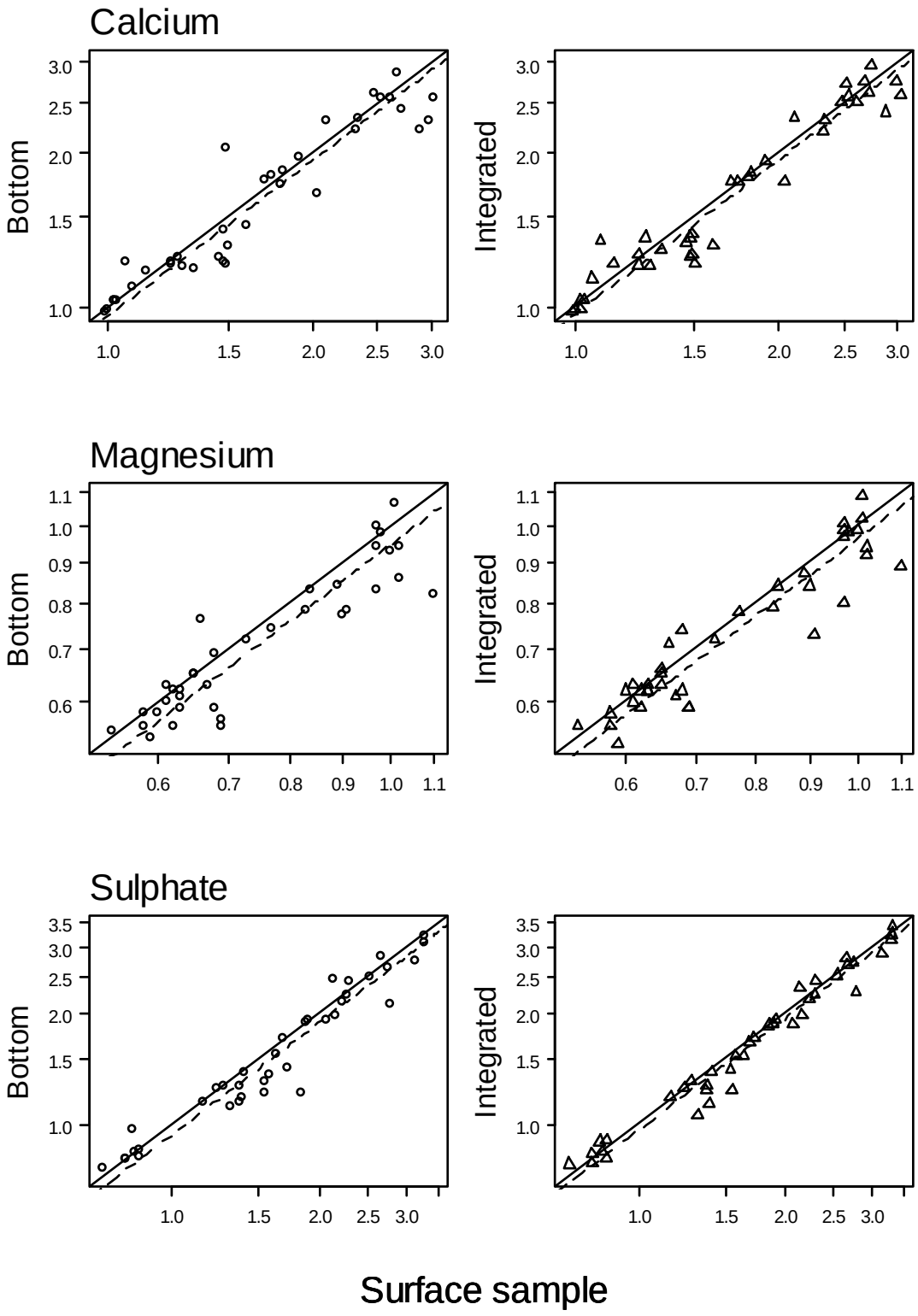
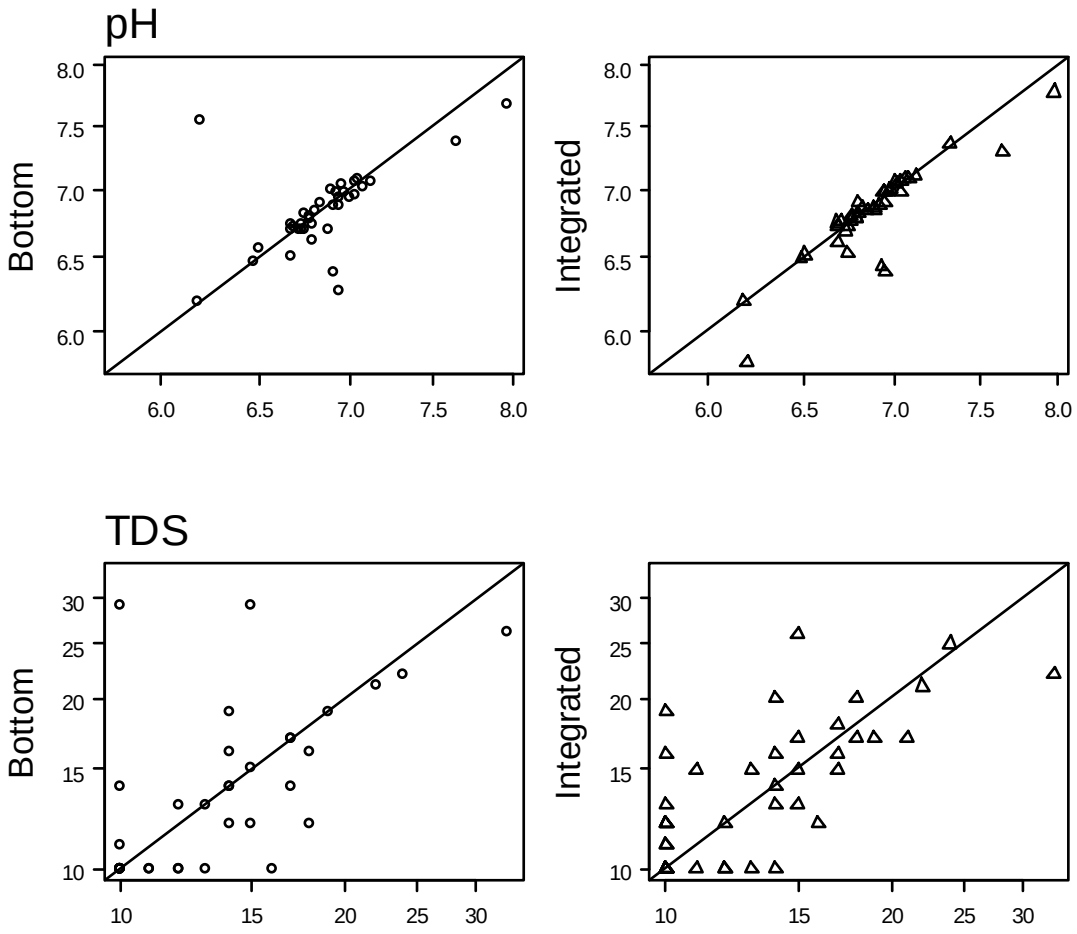


Figure 2 (page 5 of 5)



Surface sample

Figure 3. Box-plots of sample measurements by station (INUG, TE, and TPS) and depth type for total aluminum (top panel) and TOC (bottom panel).

Notes: S = surface, .B = bottom, and .Int = integrated.

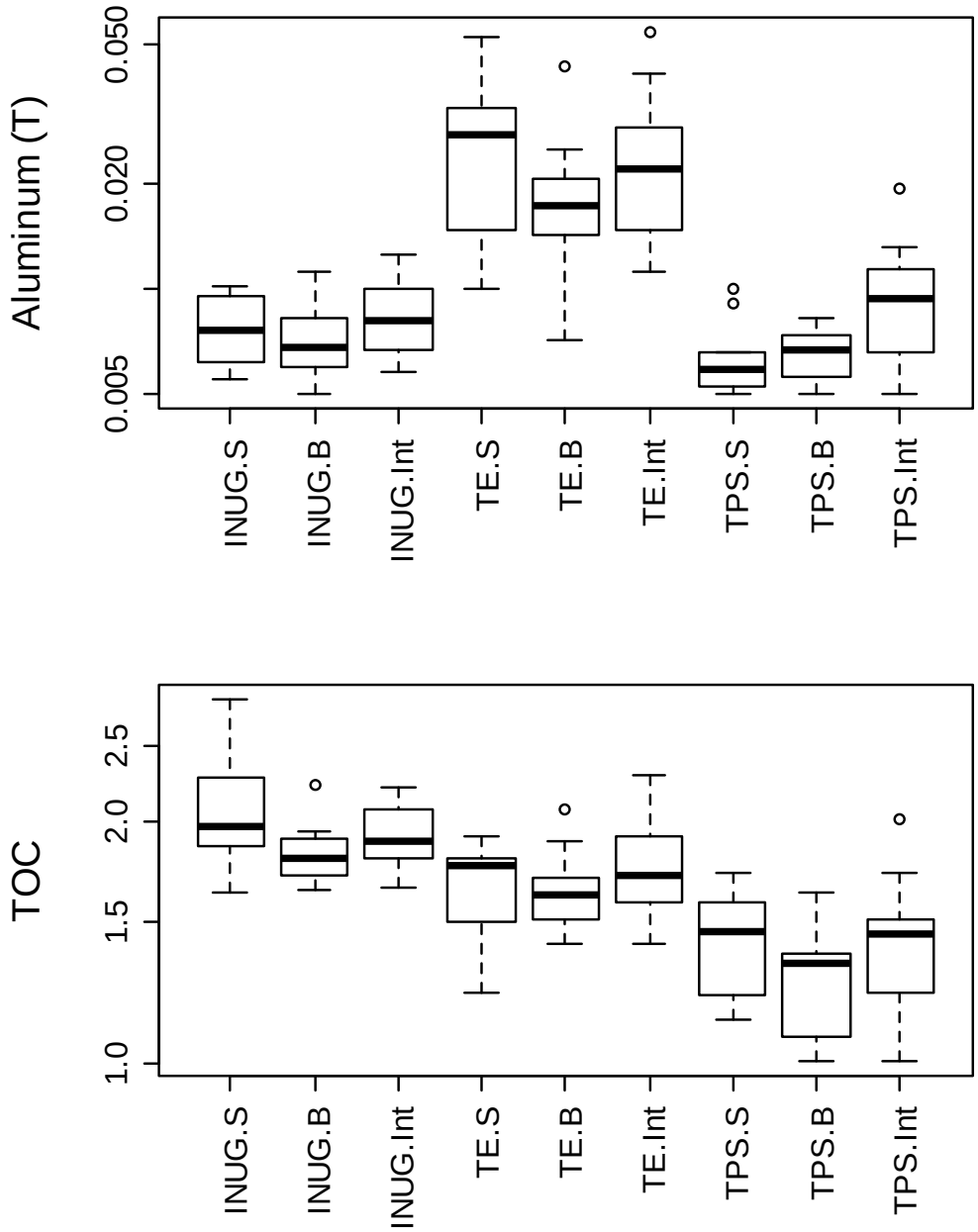


Figure 4. Box-plots of sample measurements by season (Summer or Winter) and depth type (.S = surface, .B = bottom, and .Int = integrated) for total aluminum (top panels) and Bicarbonate alkalinity (bottom panels), for each of stations INUG (left side) and TE (right side).

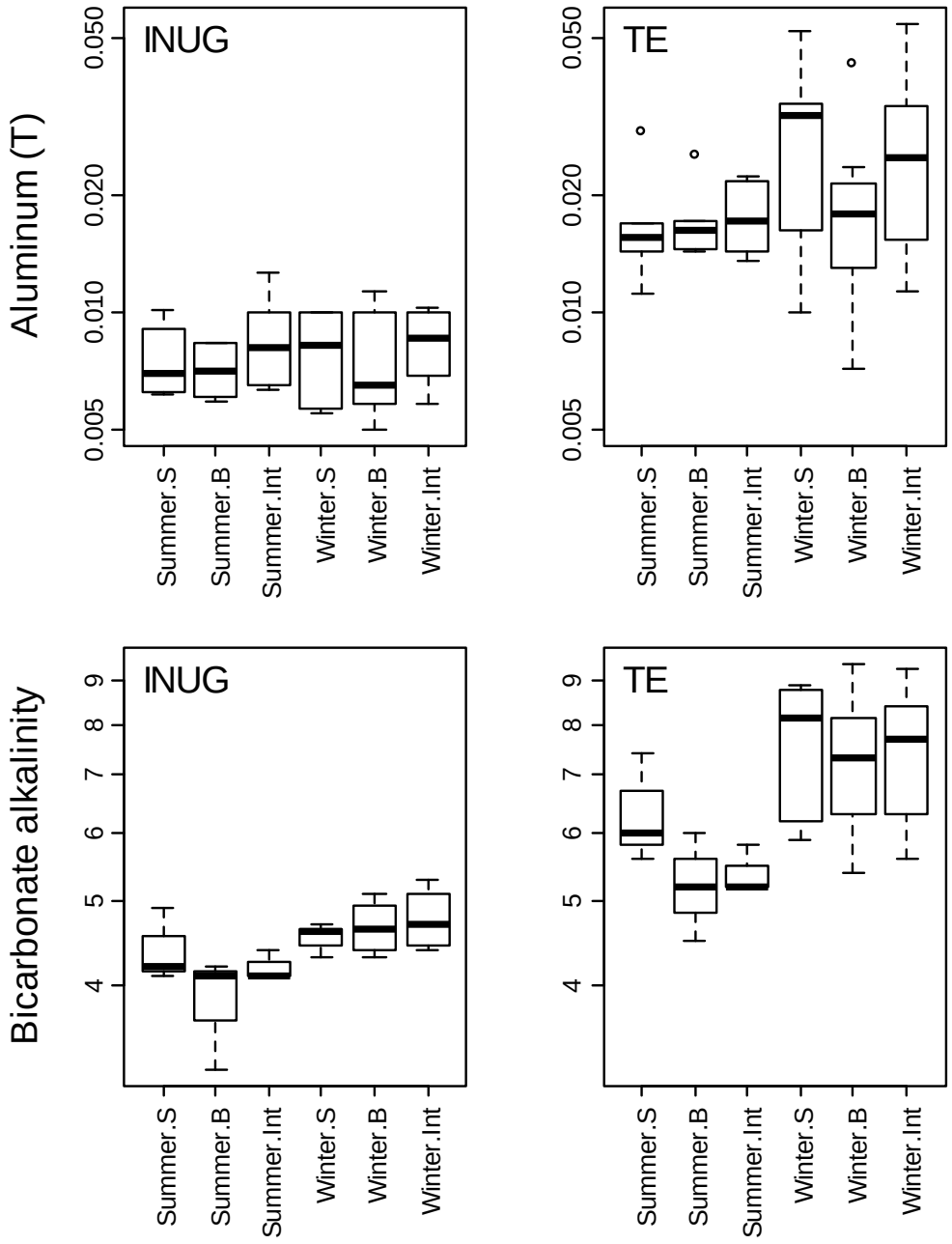


Figure 5. Box-plots of sample measurements (standard control samples) by project lake for selected water variables (log-log scale).

Notes: Values < DL were set = DL (see text for details).

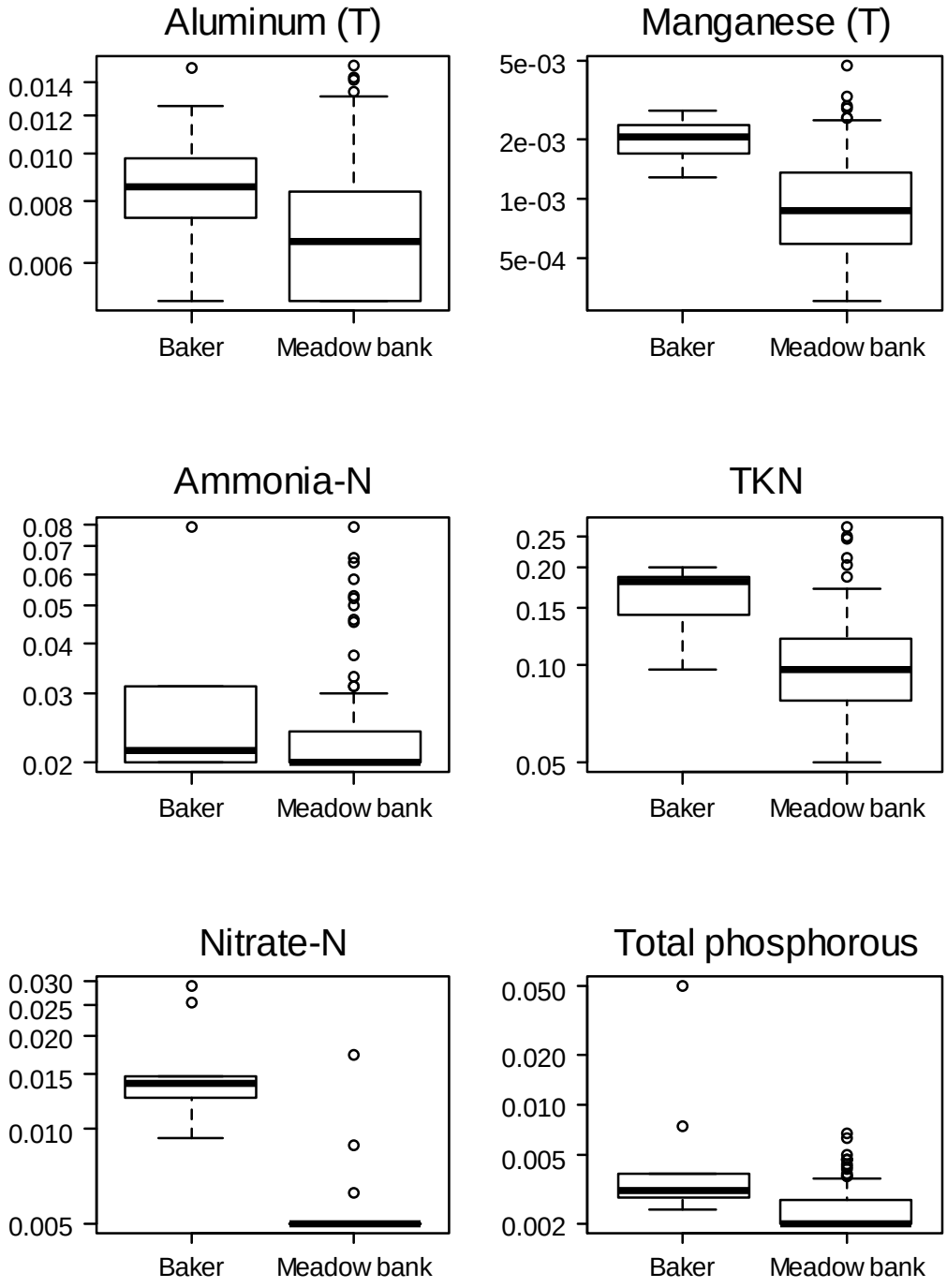


Figure 5 (page 2 of 3)

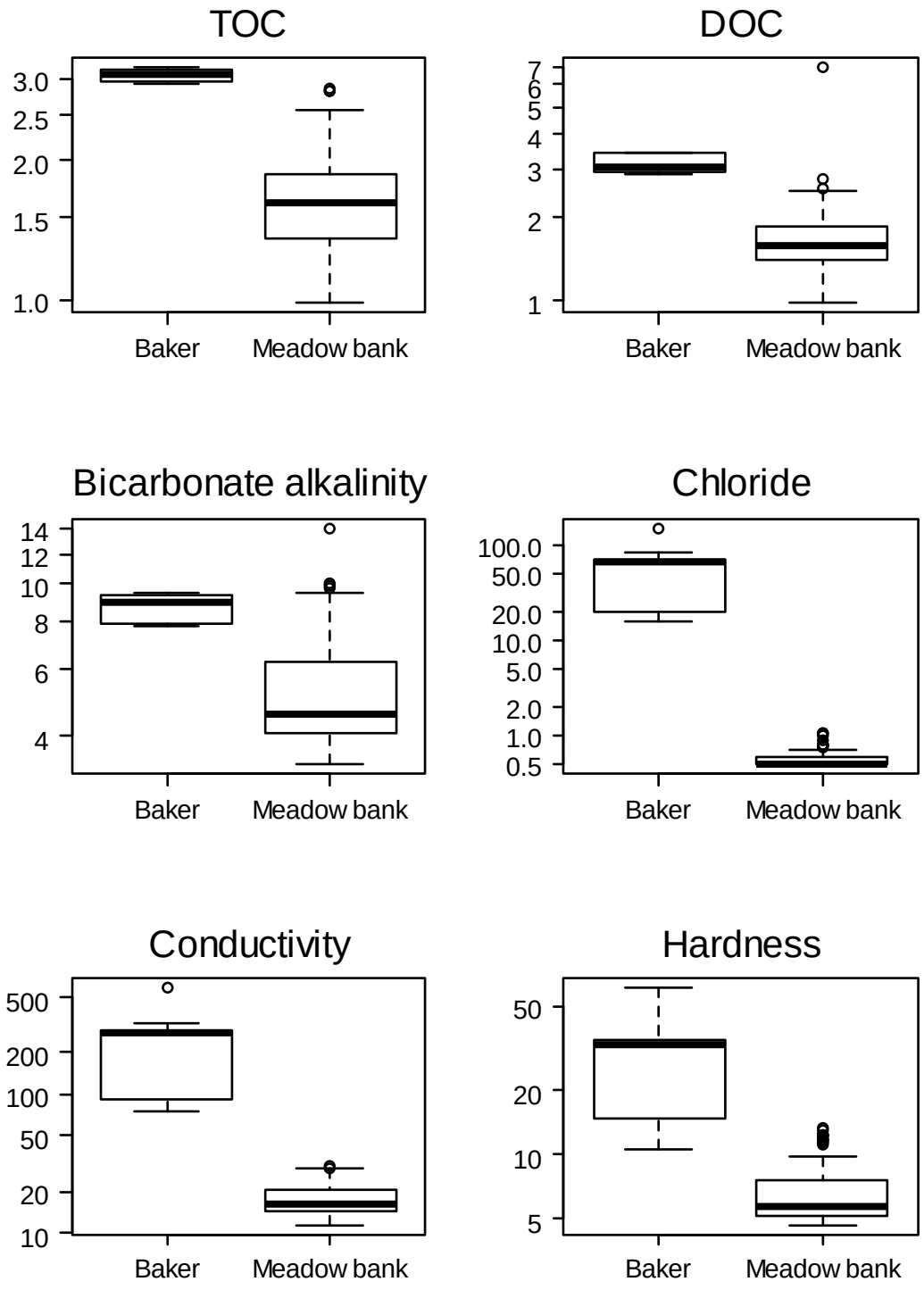


Figure 5 (page 3 of 3)

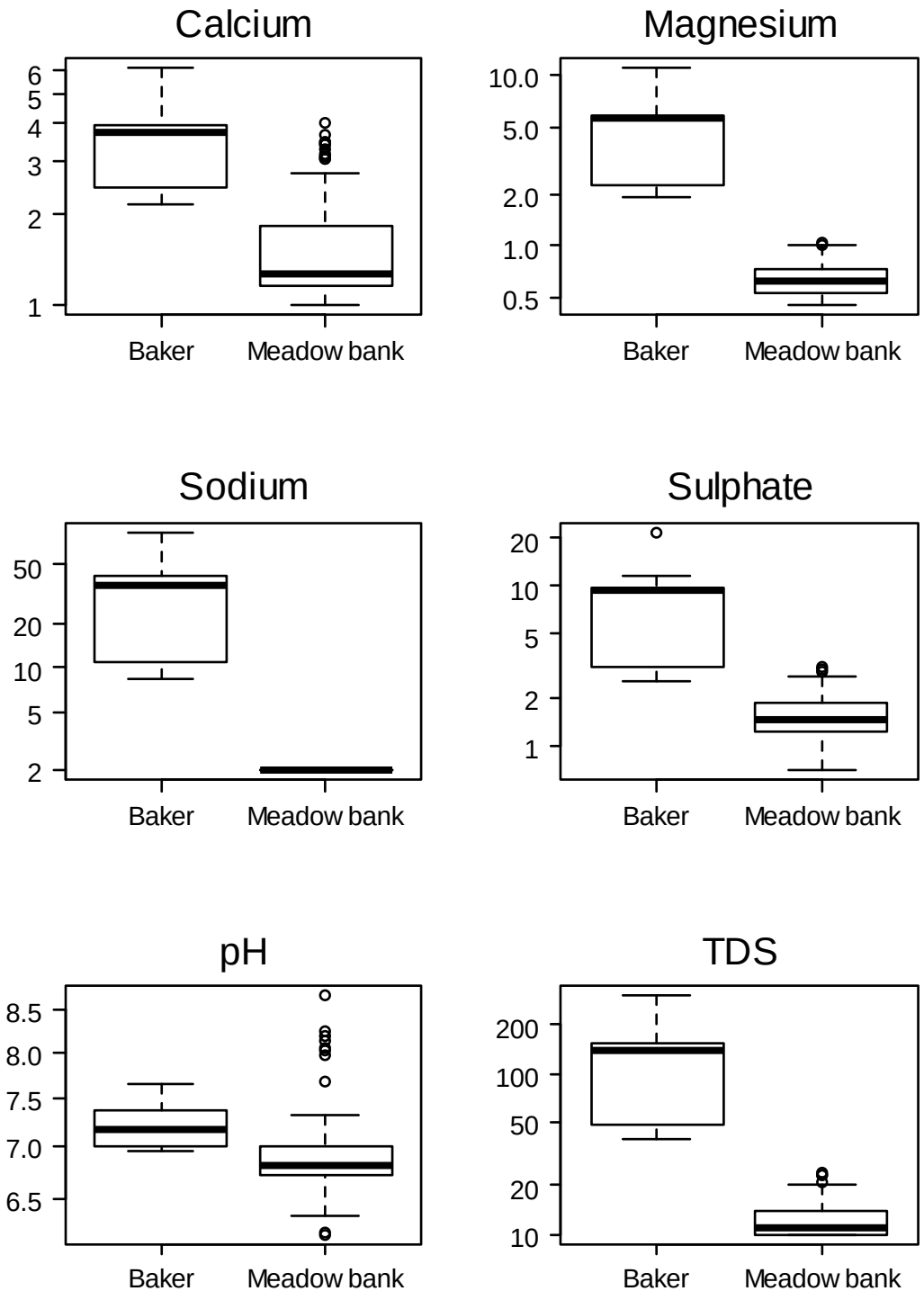


Figure 6. Box-plots of sample measurements for select variables for Baker Lake Stations.

Notes: See text for details

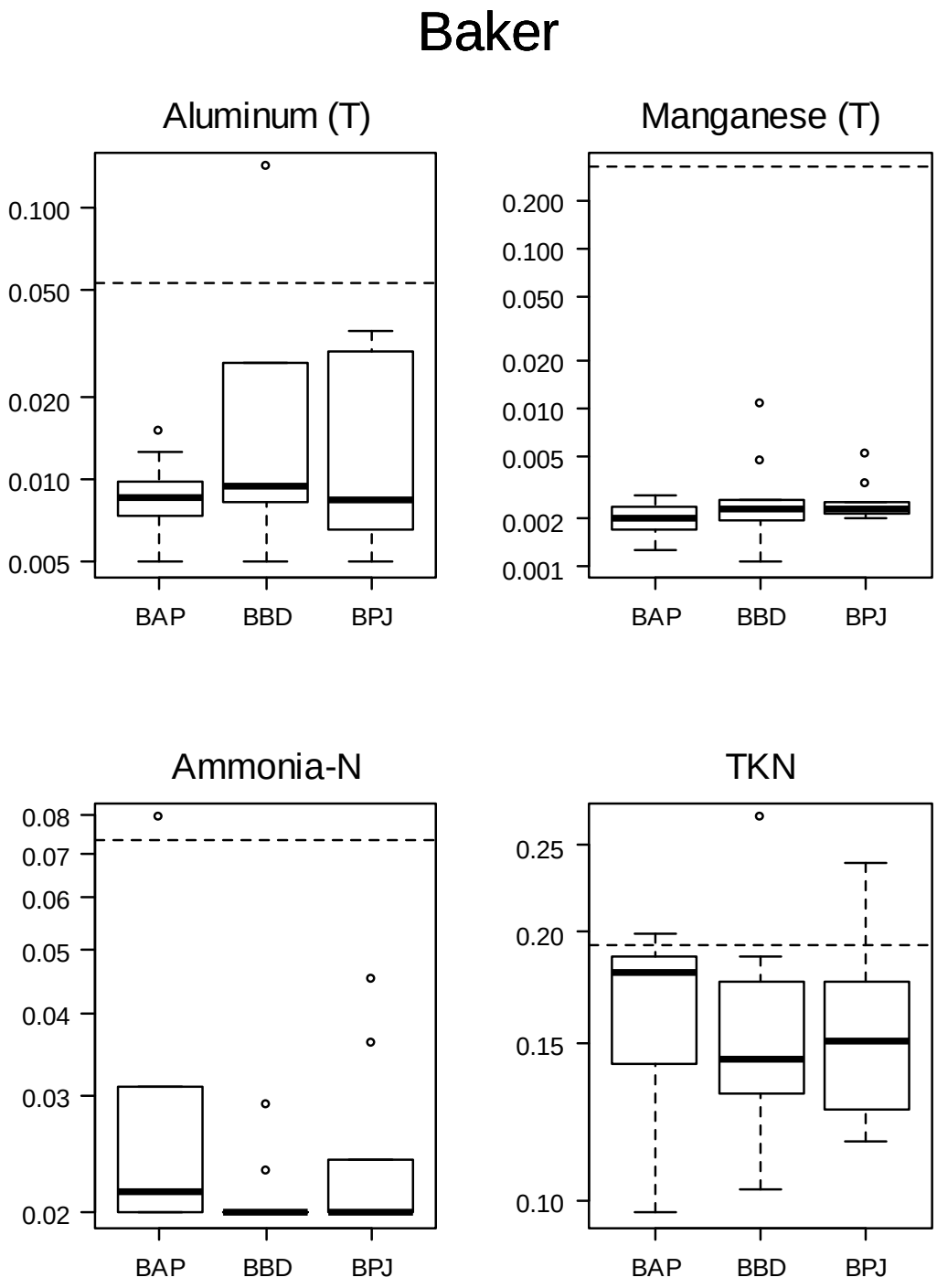


Figure 6 (page 2 of 4)

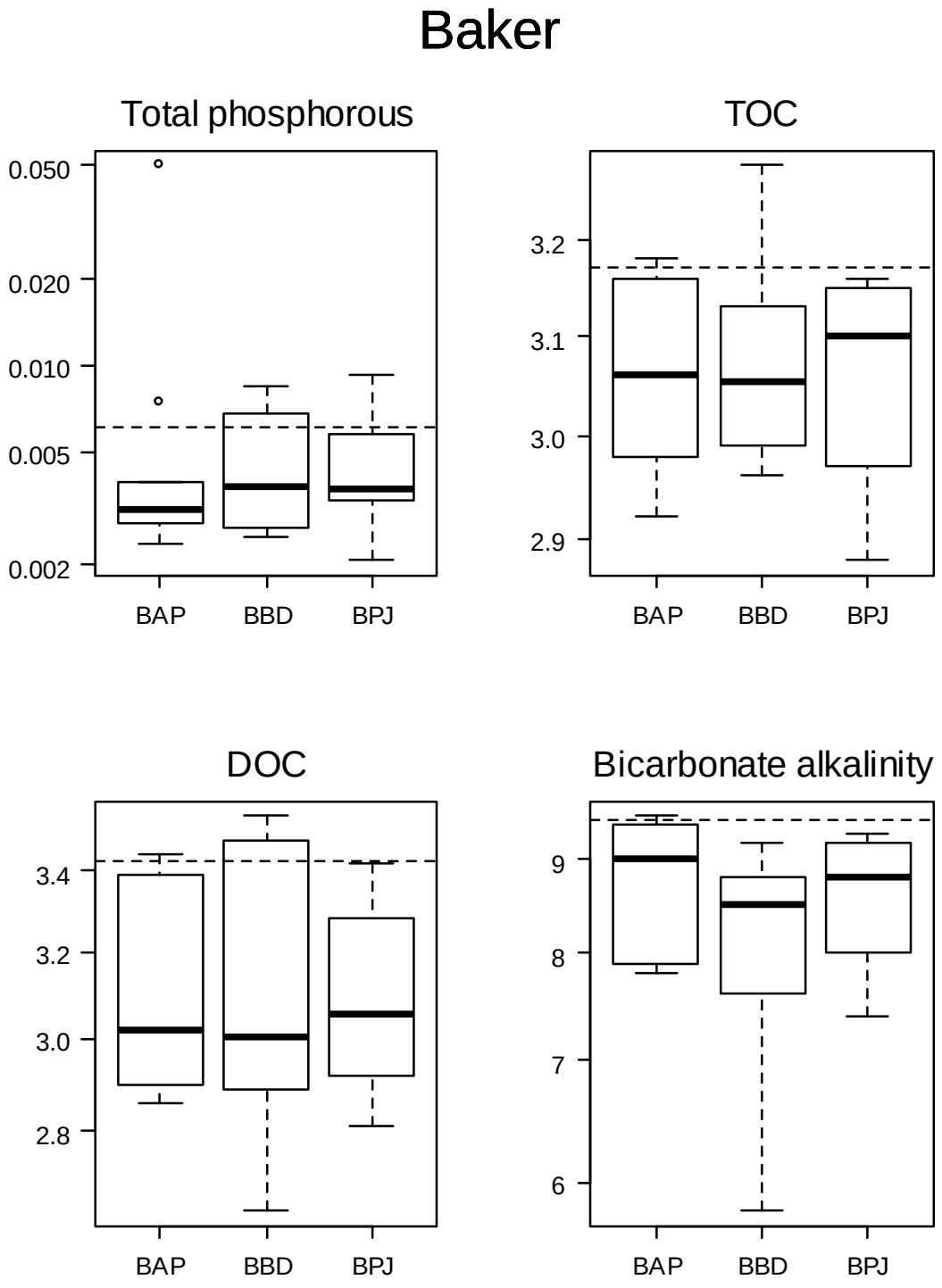


Figure 6 (page 3 of 4)

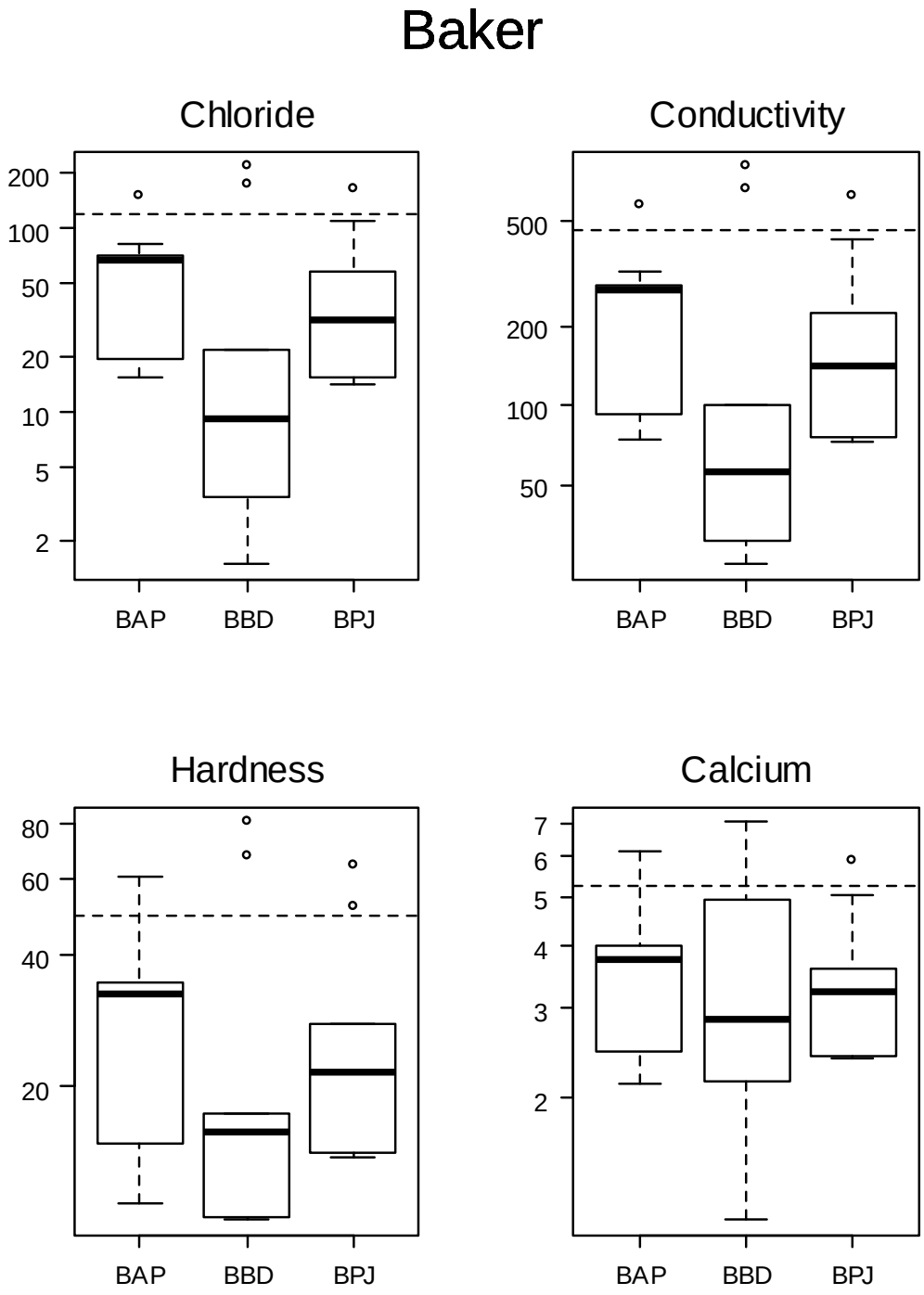


Figure 6 (page 4 of 4)

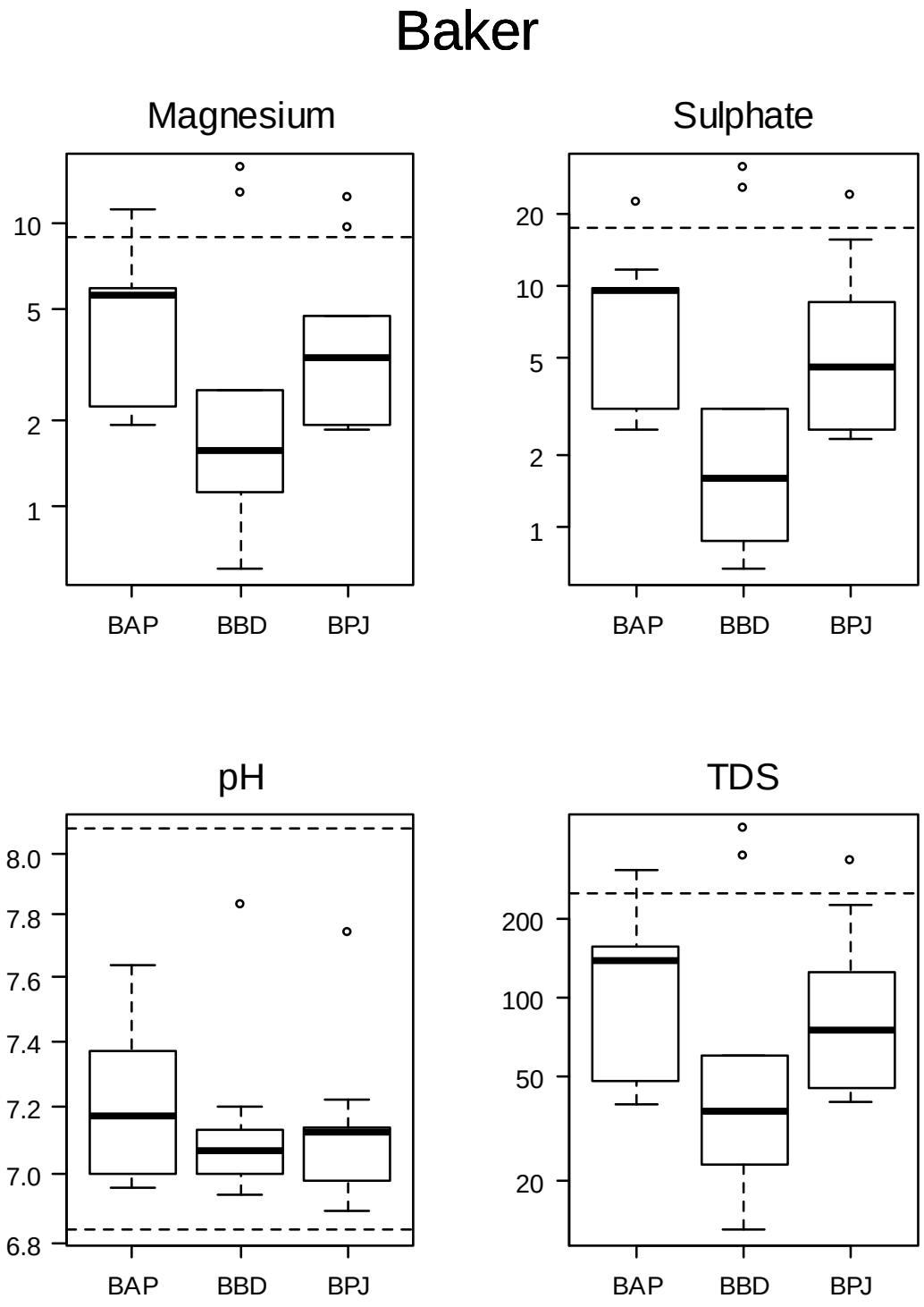


Figure 7. Box-plots of sample measurements for select variables for Baker Lake by Month

Notes: See text for details

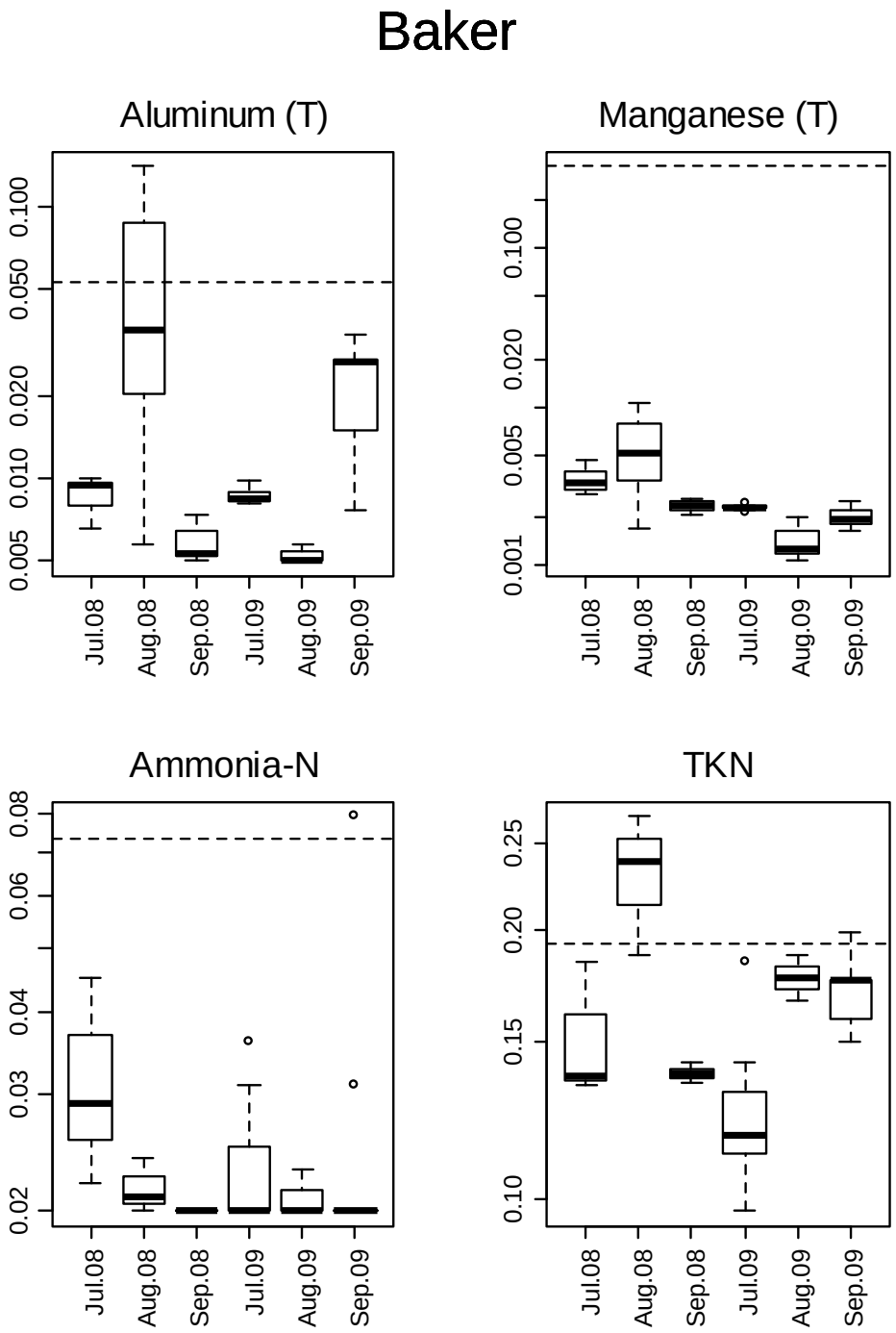


Figure 7 (page 2 of 4)

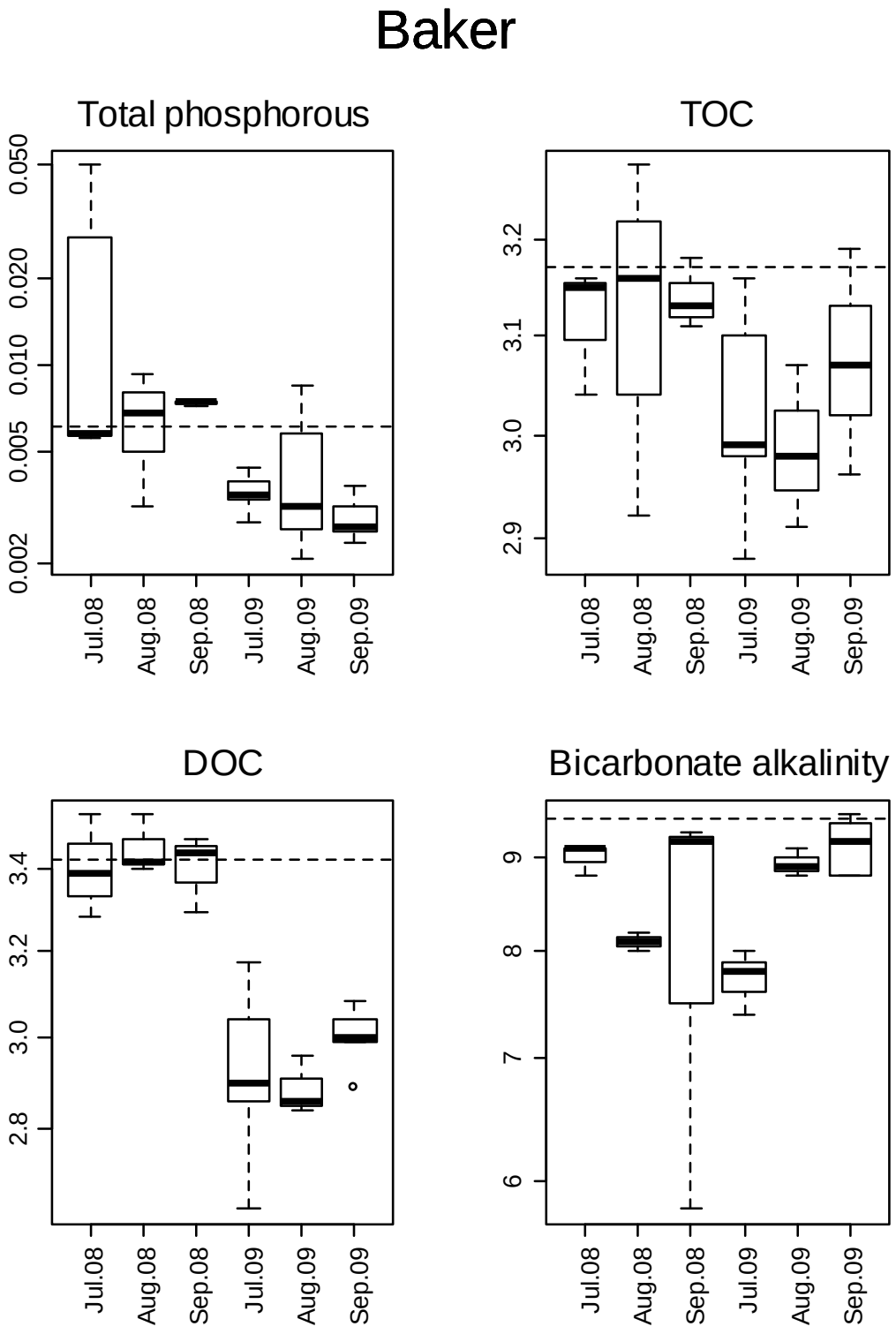
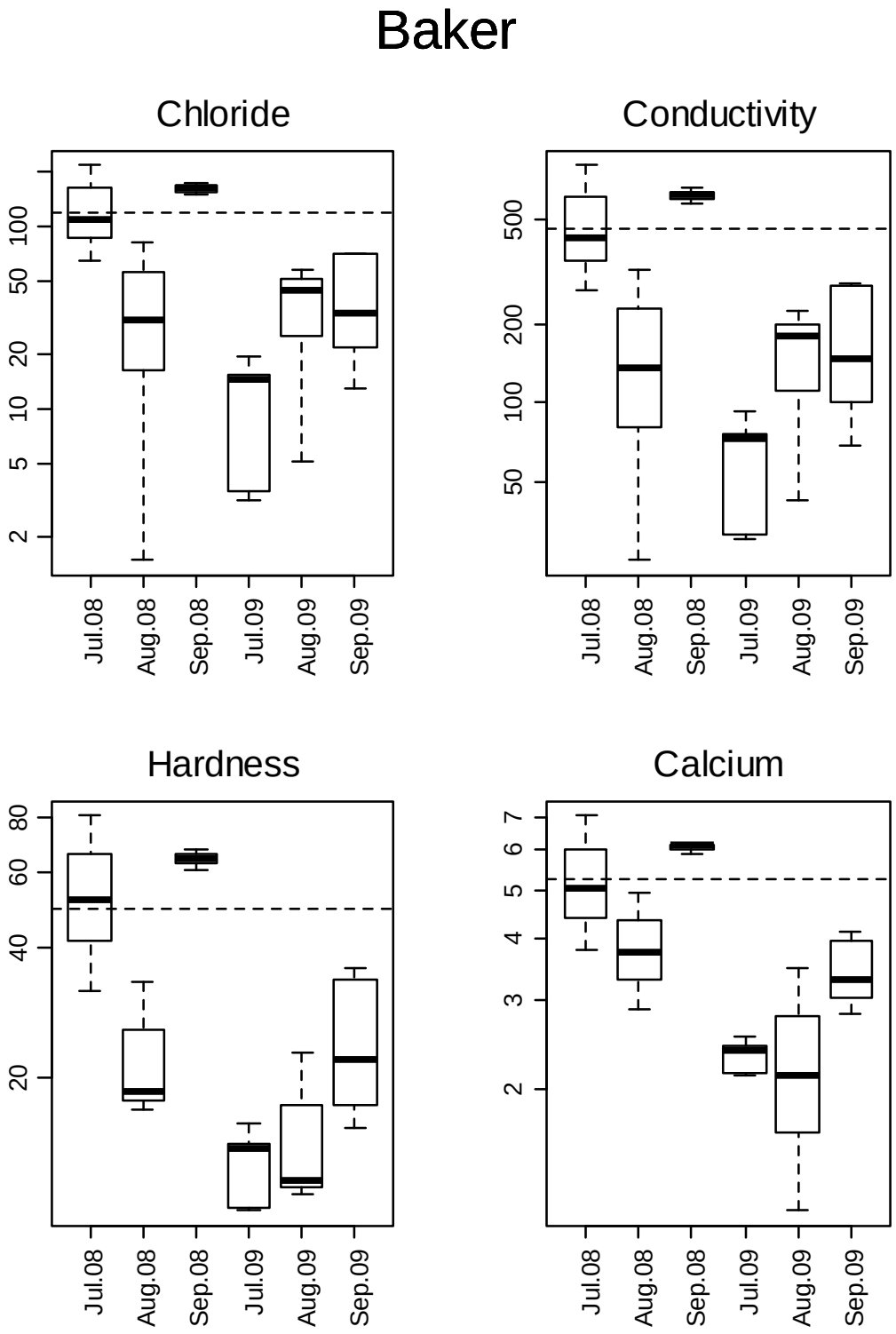


Figure 7 (page 3 of 4)



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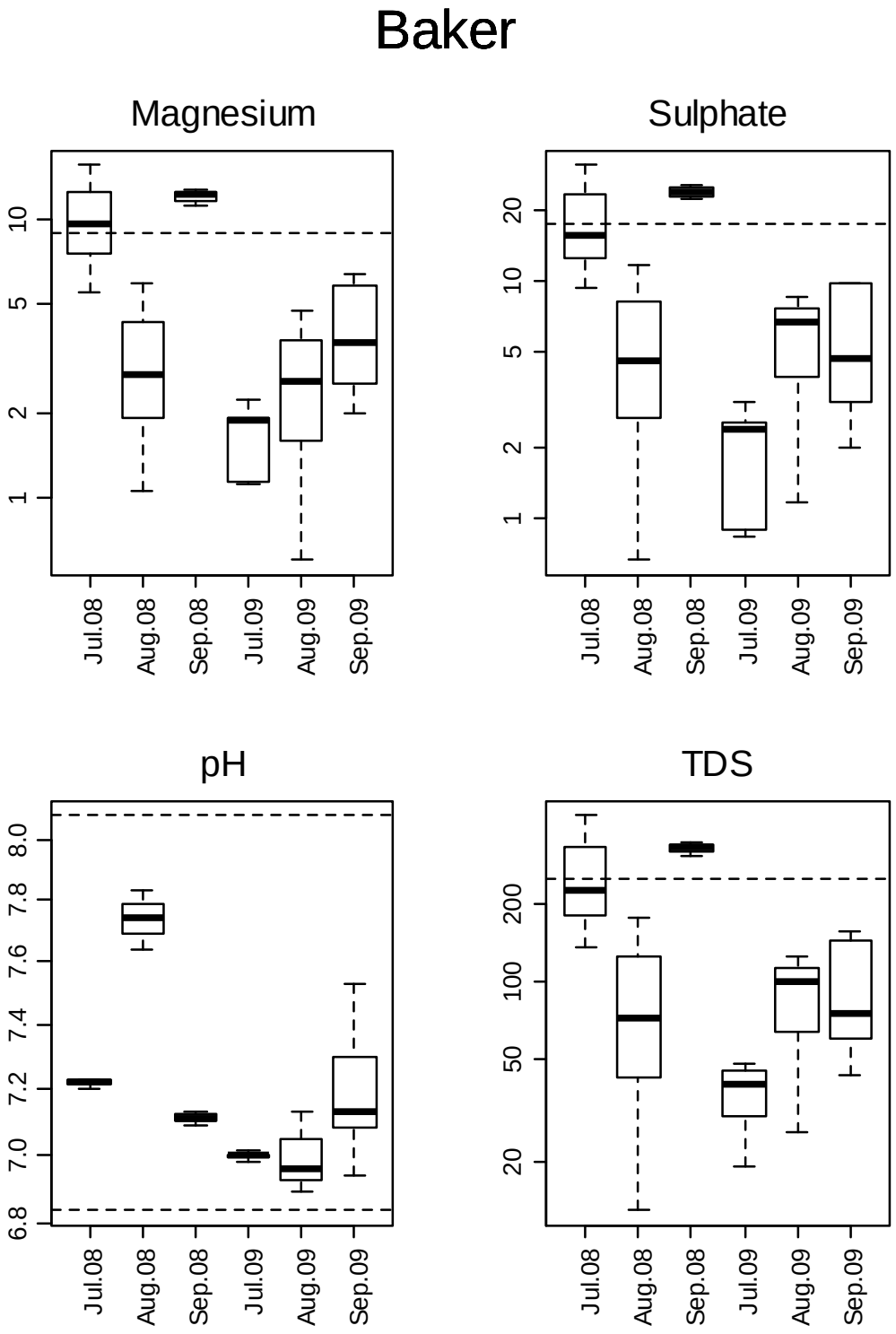
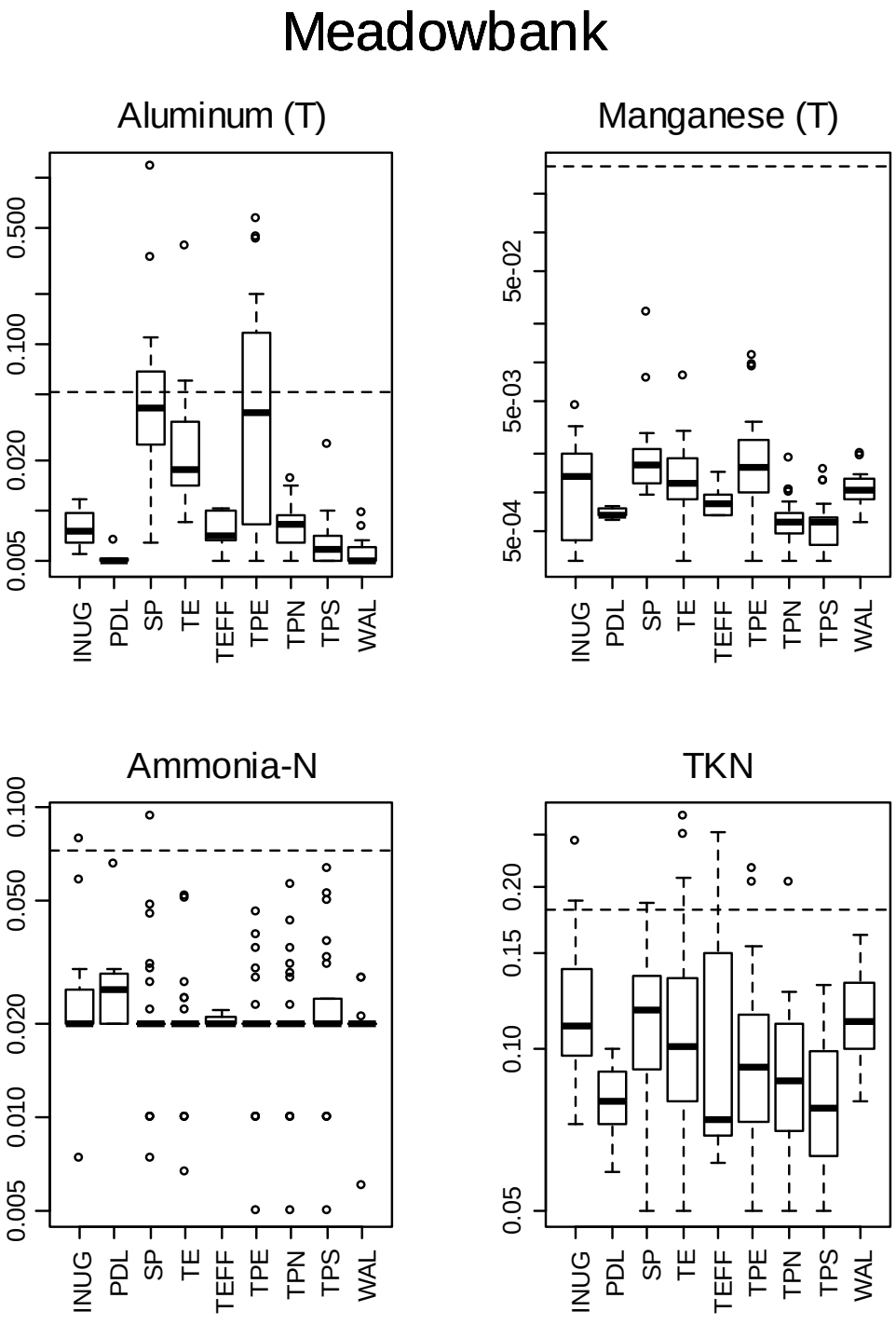


Figure 8. Box-plots of sample measurements for select variables for Meadowbank Stations.

Notes: See text for details



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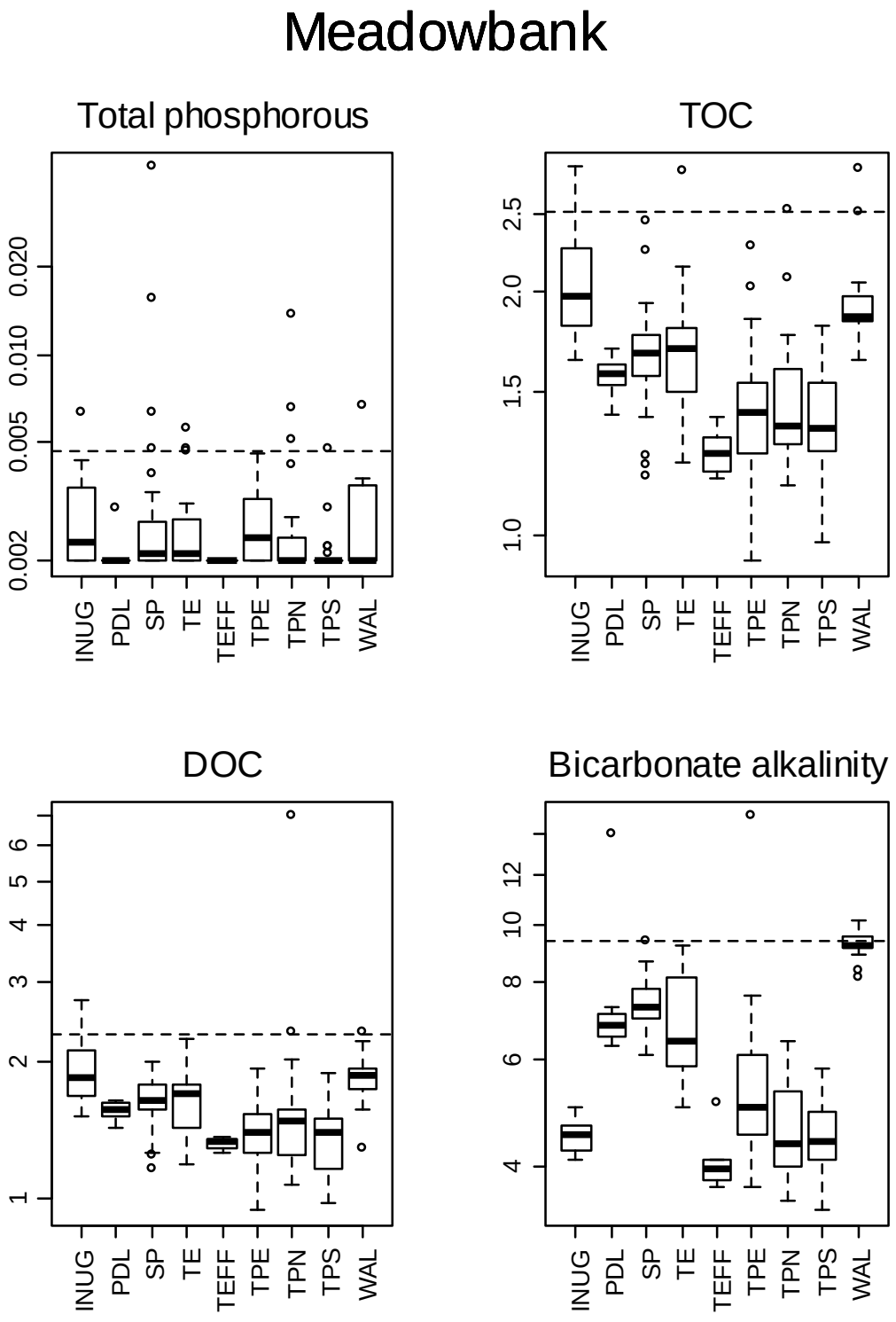

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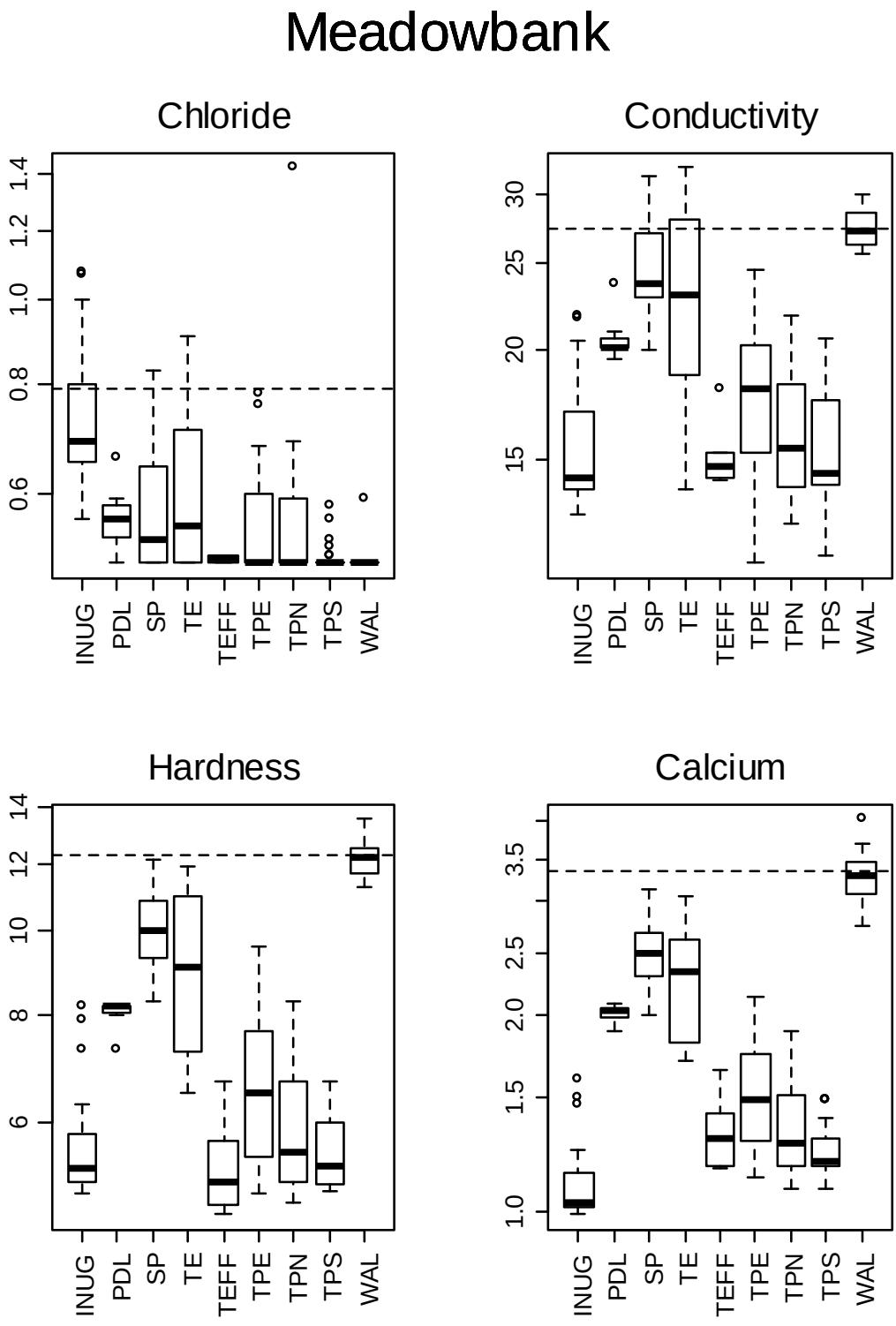

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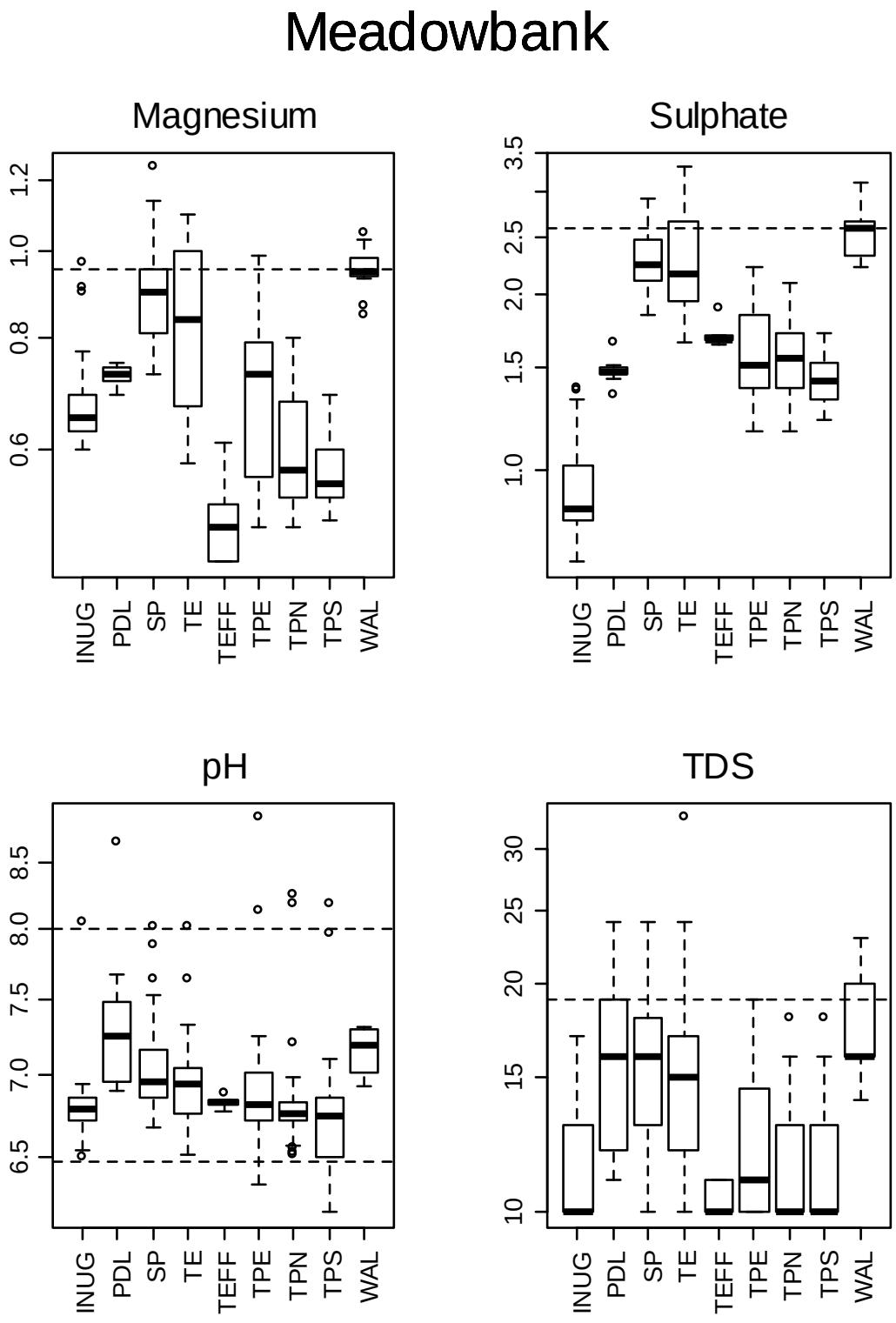

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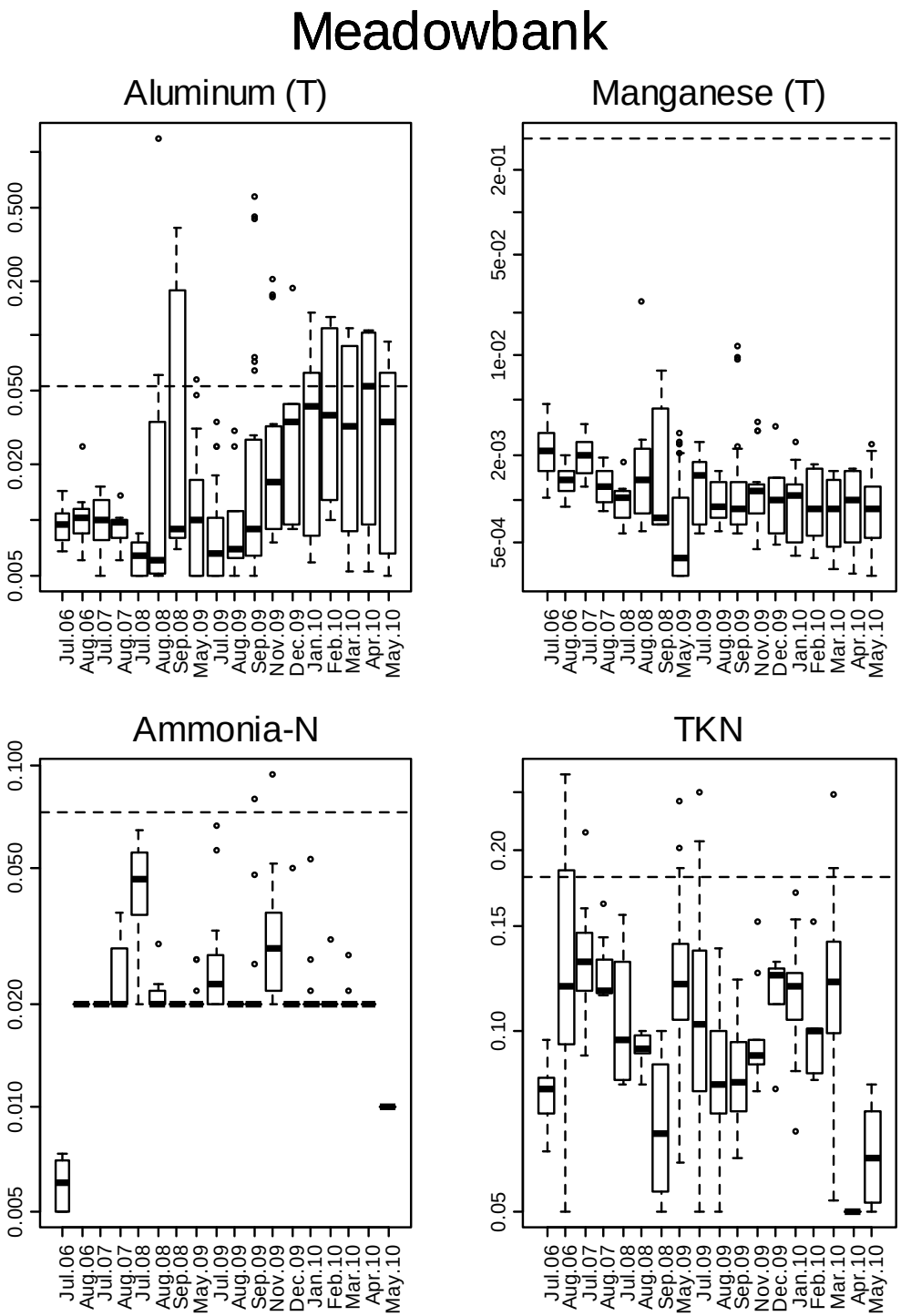
Notes: See text for details



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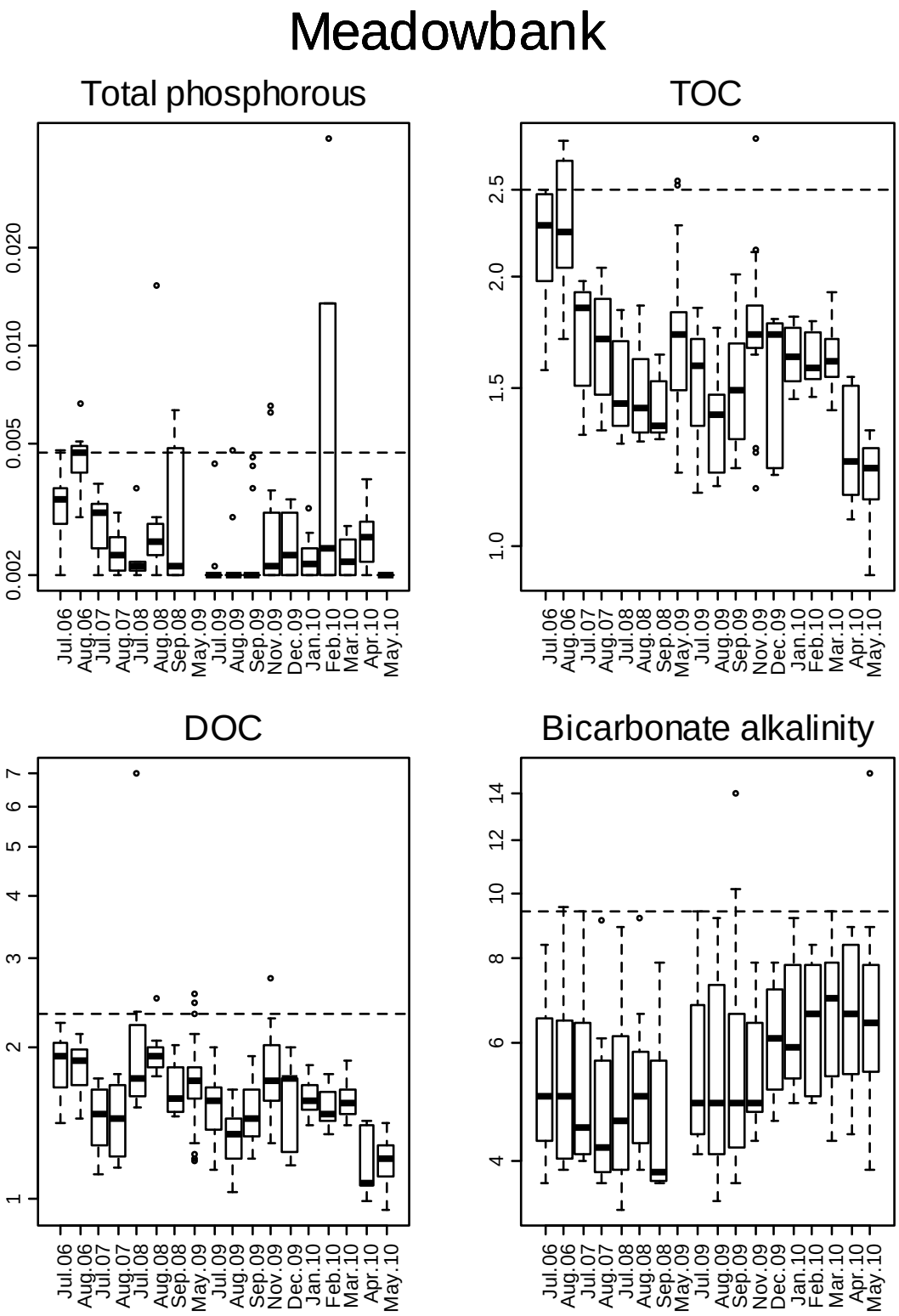

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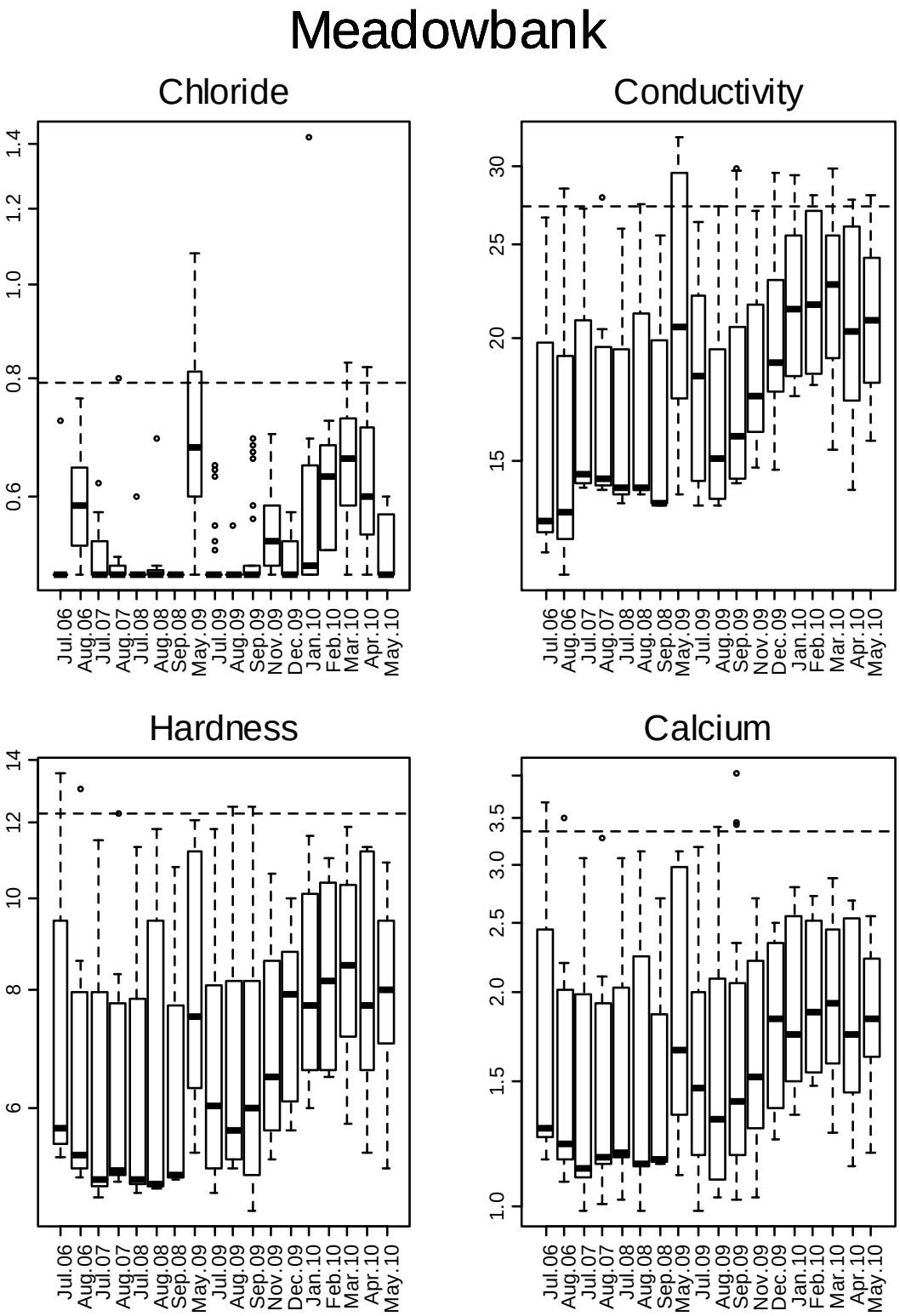

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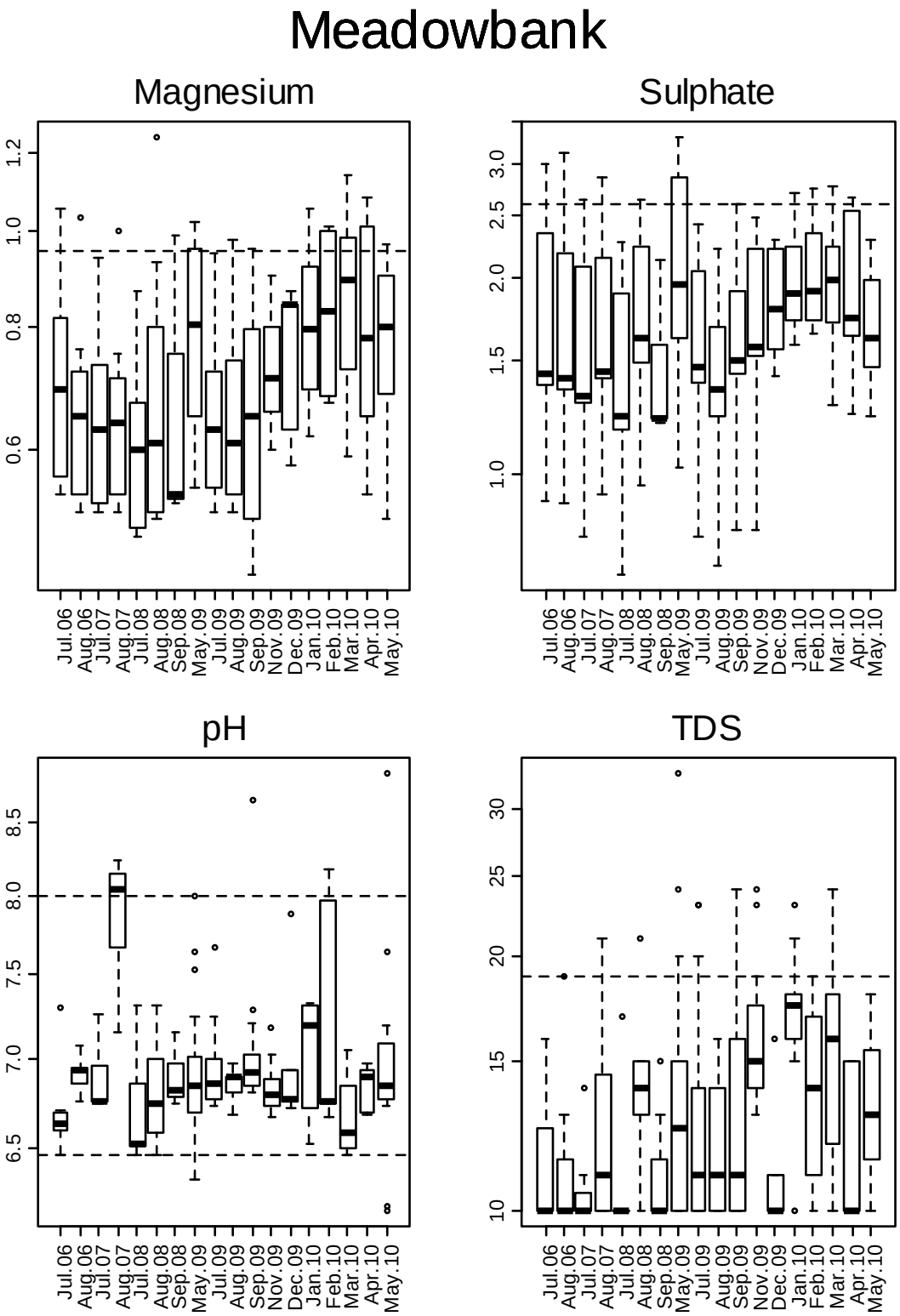
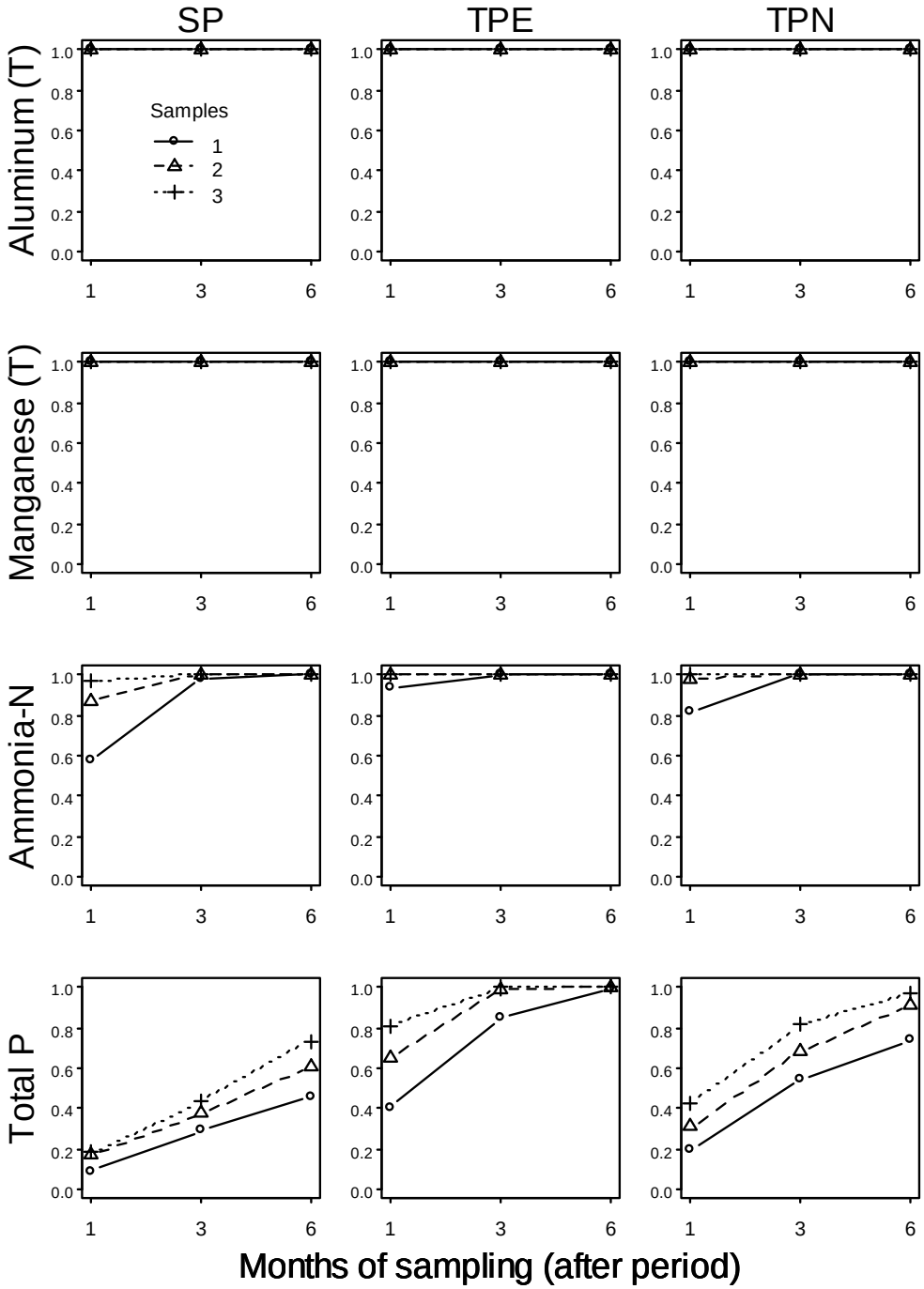


Figure 10. Estimates of BACI statistical power for detecting a significant increase (one-tailed test, alpha = 0.05) in a given variable (rows) by station (columns) as a function of sampling months (after period) and the number of sub-samples per month (see legend).



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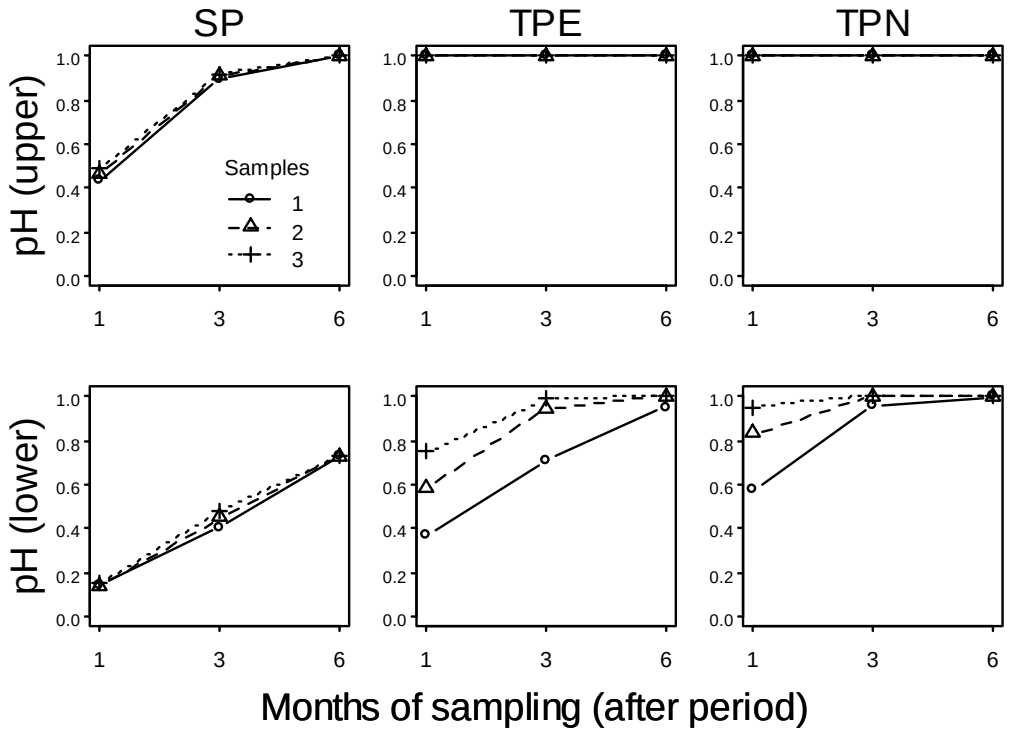

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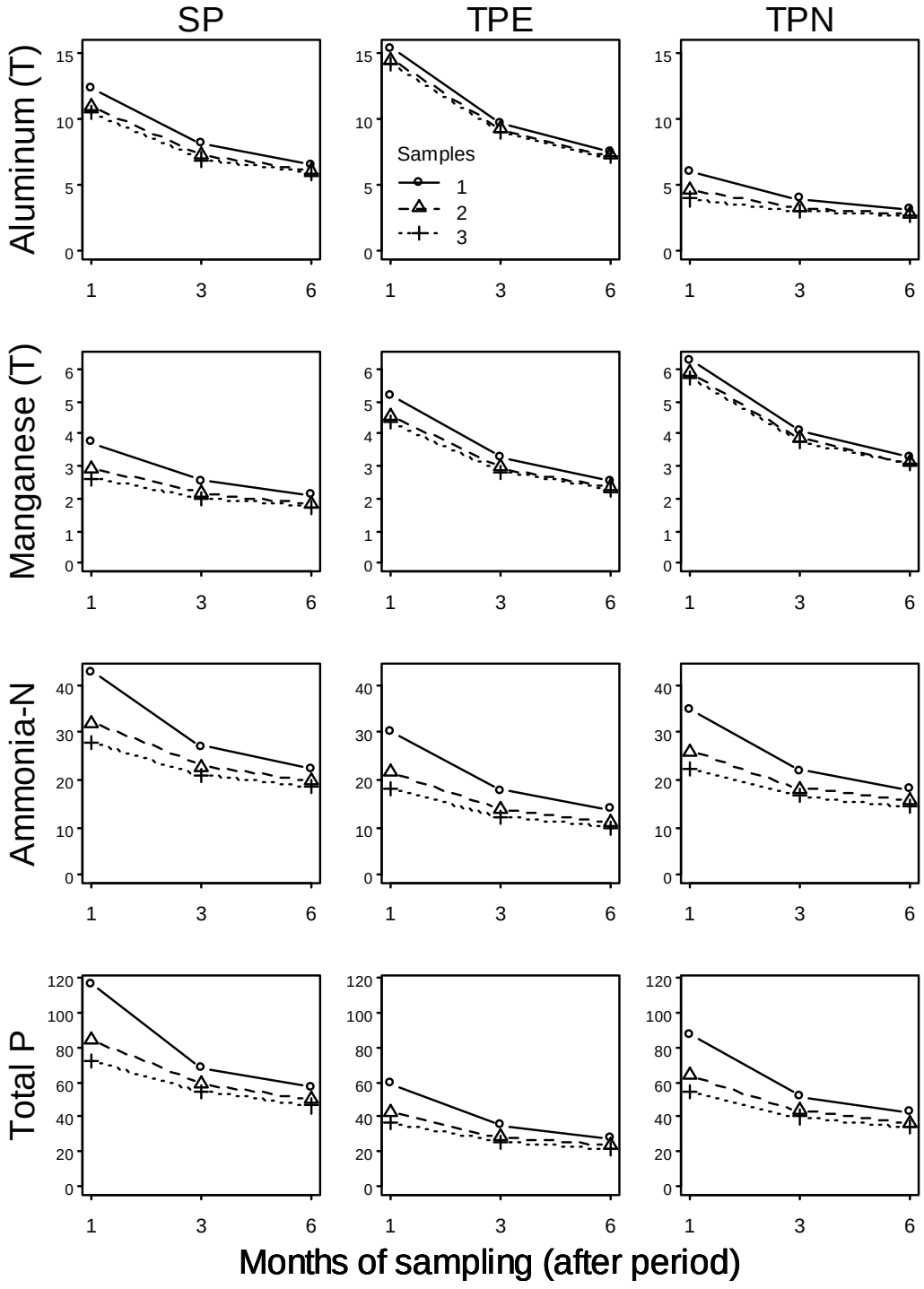

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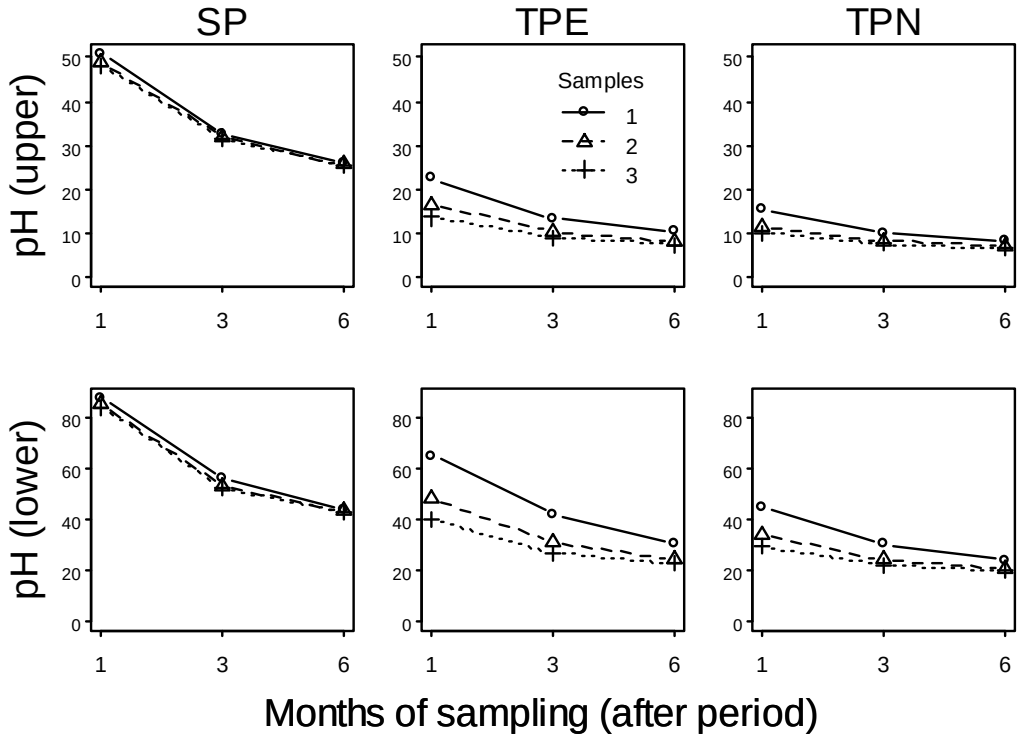

APPENDIX B – STATISTICAL ANALYSES FOR SEDIMENT CHEMISTRY

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1. INTRODUCTION

This appendix contains the following analyses.

- Summary of CREMP sediment samples (plus relevant samples from East Dike Effects Assessment Study)
- Analysis of field duplicates
- Comparison of core versus grab samples
- Analysis of Baker/Meadowbank differences
- Determination of triggers
- Analysis of sampling design

Some text, tables and figures are repeated from the main document so that the analyses contained in this appendix can be read and understood without reference to the main document. The material in this appendix assumes understanding of basic statistical methods (Venables and Ripley 2002), mixed-effects models (Pinheiro and Bates 2000), before-after-control-impact (BACI) experimental design (Stewart-Oaten et al. 1986; Underwood 1994; Smith 2002), and use of simulation in statistical analysis (Gelman and Hill 2006).

Analysis of sediment chemistry is limited to seven metals for which there are CCME sediment guidelines (As, Cd, Cr, Cu, Pb, Hg, Zn).

2. SUMMARY OF CREMP SEDIMENT SAMPLES

There are three basic types of samples:

1. Core samples – the top 1 cm specific to a discrete sample at a given location and month
2. Grab samples – composite of three spatial recplicates
3. Duplicate samples – occasionally collected; these consisted of a second sample collected in very close proximity to the base sample (in the case of core samples) or split samples from the same sample (in the case of grab samples).

For many station-month combinations, more than one core or grab sample was collected. These “sub-samples” represent spatial replication (a different location within the designated station). In addition, samples were designated as “control” or “impact” depending on operation activities near a given station (see main text for differentiation of control and impact).

The data set for core samples was expanded to include the July 2009 core samples collected as part of the East Dike Effects Assessment Study – those data are directly relevant as 'control' data. In total, there were 201 core samples from the CREMP program, an additional 60 from the East Dike program, plus 60 grab samples collected across the years 2006-2009 at Meadowbank and Baker Lake (see **Table 1**). An additional 17 duplicate samples were collected (13 core, 4 grab) – see **Table 2**.

3. ANALYSIS OF FIELD DUPLICATES

Field duplicates are different for core and grab samples. In the case of core samples, the duplicates are separate samples collected at the same location. In the case of grab samples, the duplicates are split samples – that is, a different aliquot of sample is taken from the composite sample. Thus, differences among core duplicates will reflect fine-scale spatial variation and sampling/lab precision (measurement error), whereas for grab duplicates, differences should reflect homogenization of sediment and sampling/lab precision.

Data – We would not expect control and impact samples to differ in terms of duplicate measures, so all duplicates were examined (for cores, there were 10 control and 3 impact; for grabs, all 4 duplicates were control). **Table 3** summarize the number of measurements and values above detection limits (DL) for all duplicates (core and grab). With 17 pairs of sample/duplicate values, N = 34. Lead was excluded from analysis because only one measure > DL.

Methods – For each variable, xy plots were produced using all data, with values below DL set equal to DL. For remaining analyses, data pairs (sample/duplicate) were limited to those pairs with both values above DL. For each variable, we computed the median across all samples, the median absolute difference (MAD) between samples and duplicates, and Spearman rank correlation between samples and duplicates. In addition, we fit a mixed-effects model (Pinheiro and Bates 2000) of the form:

$$\text{Log}(y) \sim \text{Location} + \text{Error}$$

where y is the sediment quality variable, Location denotes random effects for sample pairs (variability among pairs due to sample location/month) and Error denotes the residual error (variability between samples and duplicates).

Results – Results of the analysis of duplicates are shown in **Figure 1** (xy plots) and **Table 4** (medians, MADs, and Spearman r). For all variables, sample/duplicate values were reasonably similar, and there were no obvious differences in variability between core and grab duplicates. The most variable measures were for As and Cd (but sample size was low for Cd). The mixed-effects SDs reported in **Table 4** show the relative variability due

to sample location/month (SD Location) versus duplicate variability (SD Error). In relative terms, SD Error was highest for As and Cd. In all other cases, SD Error is much smaller than SD Location, which confirms that duplicate measures are fairly precise compared to general sample variation.

4. COMPARISONS OF CORE AND GRAB SAMPLES

Core and grab samples were compared graphically by station for years 2008 and 2009 (**Figure 2**; Pb omitted because most data < DL). Control and impact data were considered if consistent for grab/core samples; however, 2009 data for station TPE were omitted because the core data was collected in July and designated "control," while grab data was collected in August and designated "impact". Remaining data appear comparable, but comparisons are not perfect – for example, grab and core samples for SP and TE in 2009 were collected in different months (July versus August) and therefore potential for impacts would be different (see **Table 1**). In any case, in general, grab samples were reasonably consistent with core samples (e.g., grab measures were within the box/whiskers of core data) for As, Cr, Cu and Zn. For Cd, measures for grab samples did not exceed the DL (0.5 mg/kg) in 2008 or 2009 for any station, while values for numerous core samples exceeded 0.5 for several stations. For Hg, grab-sample measures tended to be at the low end of core-sample distributions in 2008 and for INUG in 2009. These general observations were not tested statistically (results would be weak given low sample sizes for grab samples). Differences for cadmium are obviously significant, and we have no explanation for those (possibly some kind of lab error).

5. ANALYSIS OF BAKER/MEADOWBANK DIFFERENCES

Baker Lake and the Meadowbank area lakes may exhibit differences in sediment chemistry due to their different characteristics. Consequently, development of separate thresholds and triggers may be appropriate for the two areas for any variables that exhibit large differences.

Data – Potential differences between Baker/Meadowbank were examined by considering the control core samples (with duplicates excluded, N=15 for Baker station BAP and N=135 across Meadowbank stations – see **Table 1**).

Methods – Analysis excluded Cd and Pb (no values > DL for Maker and less than half of Meadowbank samples > DL). Values below DLs were set equal to DLs. Box-plots were produced for each variable to compare the Baker and Meadowbank samples. In addition, the Baker and Meadowbank data were compared using Mann-Whitney tests (on the raw

data) and t-tests (using log data). The Mann-Whitney tests is more robust in this case as it is appropriate for non-normal data (which occurs when there are numerous values = DL).

Results – There are large differences between Baker and Meadowbank samples for all variables (**Figure 3** and **Table 5**), with concentrations much lower in Baker Lake compared to Meadowbank lakes. Since all data were log-transformed, the coefficient (X) has to be translated into a proportional effect size (ES) relative to (untransformed) samples[1]. For example, for As, Est = -1.67 and ES (%) = -81%. In other words, the difference in sample means (Baker log data – Meadow log data) was -1.67, which translates as a proportional effect size (raw units) with Baker data being -81% lower on average than Meadowbank data. In summary, there are much higher concentrations among Meadowbank core samples for the five sediment metals examined. For Cd, we would reach a similar conclusion simply based on proportions > DL (0 of 15 for Baker; 64 of 135 for Meadowbank; see **Table 4**). For Lead, there was no apparent difference, with few samples > DL for either lake (**Table 4**).

6. THRESHOLDS AND TRIGGERS

Data – The data set upon which thresholds and triggers were developed was all core control samples (which included the July 2009 data for the East Dike Effects Assessment Study), with duplicates excluded. Remaining data points with values below the usual DL were set equal to the DL. For Cd and Pb, there were a few samples with recorded detection limits greater than both the current DL as well as other valid sample values. These samples were removed, and then the remaining "<DL" values were set equal to the DL before computing medians and 95th percentiles.

Methods – The main text has described the rationale and approach for development of thresholds and triggers. Since all sediment variables had thresholds, 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"). 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. For variables with few values above DL (Pb, and As for Baker), the reported medians equal the DL. Different triggers were set for Meadowbank and Baker for all variables except Lead (see above analysis and 95th percentiles in **Table 6**).

[1] The following steps are needed for calculating ES: (1) X = log(Baker) – log(Mbk); (2) X = log(Baker / Mbk); (3) Exp(X) = Baker / Mbk; (4) ES = (Baker – Mbk)/ Mbk = Baker / Mbk – 1; (5) ES = Exp(X) – 1; (6) ES (%) = (Exp(X) – 1)*100.

Results – Triggers and thresholds are summarized in **Tables 6 and 7** respectively. It should be noted that in cases where 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 be more extreme than the guideline (e.g., this occurs for all variables except Pb and Hg at Meadowbank, and for As at Baker) – 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. For Pb, 9 of the 11 values above the DL were for Wally Lake, three of which were slightly above the CCME guideline of 35 mg/kg. Thus, development of separate triggers for Wally for Pb may be warranted (similarly, for Cu and possibly other variables, Wally-specific triggers could be developed).

Evaluation of Triggers – We next examined the data more closely in relation to the proposed triggers. Specific box plots are shown for Baker Lake data by station (**Figure 4**) Meadowbank control data by station (**Figure 5**) and data by year for four particular stations (INUG, SP, TE and TPE; Pb excluded (**Figure 6**)).

For **Baker** stations, the general pattern is for higher concentrations at impact station BPJ. These do not exceed Baker triggers except seriously for As (BPJ median ~ 20 mg/kg, trigger = 8.3). Given the high As levels observed for Meadowbank controls, it seems reasonable to question the validity of the low Baker trigger. However, given limited sample sizes at Baker station BAP to date, it may be simpler to defer more in-depth analysis of the Baker trigger for As until more data are available.

For **Meadowbank**, triggers look reasonable for As, Cd, Hg, and Zn. Wally has high levels of Cu and Pb (near the trigger), which suggests that the Cu and Pb triggers based on 95th percentiles are only strictly valid if Wally data are considered representative control data for Meadowbank stations, otherwise, triggers are somewhat high. In the case of Cu, the high values for Wally are balanced by the low values for INUG, and there is no reason to suspect that the trigger is generally too high. For Pb, detection limits, the trigger is set just barely above the DL so we are not concerned that it is set too high. For Cr, there is a lot of station-specific variation, which may suggest that station-specific triggers would be more appropriate. This possibility is discussed in the main text.

The two years of data for INUG, SP, TE, and TPE (**Figure 6**) illustrate two things. First, in only one case did impact data (July 2009 for SP and TE) appear to exceed a trigger: the median of Zn values for SP slightly exceeded the proposed trigger. Thus, there are no alarming findings among the impact data. Second, the two years of control data for INUG and TPE provide the best insight into possible inter-annual variation in sediment measures. For INUG, there was a significant difference between years for Cd ($p = 0.0005$ for Mann-Whitney test). For TPE, there were differences for Cr ($p = 0.0005$) and Zn ($p = 0.04$).

7. ANALYSIS OF SAMPLING DESIGN

Impact hypotheses and statistical design – Two general classes of impacts are hypothesized for the Meadowbank mine for the case of sediments:

1. Pulse events for which potential impacts would be high for a short time but may then dissipate relatively quickly (e.g., in the case of water) or not (e.g., in the case of sediment). Pulse events could be associated with any phase of the mine, but are more likely to be associated with particular activities such as dike construction.
2. Long-term cumulative impacts that may be associated with ongoing activities. Long-term cumulative impacts are more likely to be associated with ongoing activities of mine operations.

As operations have just begun in 2010, the focus of monitoring to date has been on detecting pulse events associated with construction.

In the case of sediment, a key assumption is that natural temporal variation is very limited; that is, you do not expect important fluctuations in sediment variables from to occur naturally from one year to the next at a given station. Under this assumption, the comparison of interest is simply between baseline (before) and impact (after) data for a given station. There is no need or use for a "control station" under this assumption – the value of a control is to specifically "control" for potential temporal variation. Thus, the primary model for these analyses was a simple **"BA"** comparison (a t-test) between baseline data (**B**efore data) and a simulated new year of impact data (**A**fter data). This test will generally have much greater power to detect a difference (real or not) than a full BACI model (which inherently assumes that temporal variation may be present, both across stations and within stations). For comparison, estimates/power for BACI models using impact station TPE and control station INUG were examined, both of which were sampled for two baseline years (**Table 1**) and thus provide the minimum of data required for the BACI model.

The BA model has a simple design:

$$X_{is} = \mu + \alpha_i + \varepsilon_{is} \quad (3)$$

Where X is the sediment variable measured for period i and subsample s, and the estimate of interest is the difference in means for the before and after periods, represented by α_i, which is tested via a t-test.

The BACI model is the same as that developed for water (see separate appendix) and is not repeated here.

Methods – The key analysis assessed the expected precision/power of BA estimates for different numbers of sub-samples (**s** = 5, 10, 15, 20, or 25) for a particular impact year

(random spatial samples collected in the after year). In other words, the objective is to detect a difference from baseline in a given (single) year. The analysis here included separate analyses for the three primary impact stations SP, TPE, and TPN. For TPE in which a BACI model was evaluated as a comparator, INUG was used as the control station. Separate analyses were conducted for **five** variables – As, Cr, Cu, Hg and Zn (Cd and Pb were excluded because many or most values < DL). For a given variable, the effect size (**ES)** was equal to the change in mean from baseline (i.e., during the before period) to the trigger value. For example, if the before-period mean = 10 and trigger = 15, then ES = 5 (=15-10). Thus, for all reported results, we are assessing the power/precision of BA estimates under the assumption that the true effect size resulted in a new annual mean equal to the trigger value (of course, the observed after-period mean will differ somewhat from the trigger value due to simulated random variation). In all cases, only the baseline (pre-impact) data were used to represent the "before period" dataset (July 2008 for SP and TPN, pooled July 2008 and 2009 data for TPE). For BA models, after-period data were simulated for a single year based on the ES and variance of the observed (before-period) data. For the TPE BACI simulations, after-period data were simulated based on estimates derived from the TPE-INUG data. Specifically, the following mixed-effects model was fit to the "before data" for the TPE-INUG station pair:

$$X_{jks} = \beta_j + \tau_k + (\tau\beta)_{kj} + \varepsilon_{jks}$$

The fit provided estimates of before-period station means β_j, random-effects variances for year ($\sigma^2[\tau]$) and year-by-station ($\sigma^2[\tau\beta]$), and the residual variance for sub-samples ($\sigma^2[\varepsilon]$).

After-period data were simulated using after-period means (β_control, β _impact + **ES**) and the above variance estimates. In all cases, log-transformed data were used. For each scenario, 500 simulations were used.

Data Summary – The focus was on sediment core samples for Meadowbank near-field impact stations (SP, TPE, TPN). For SP and TPN, the baseline ("before period") data consist of 15 samples for July 2008; for TPE, there are an additional 15 samples for July 2009 (pre-impact for that station; see **Table 1**). For each variable and station, the before-period estimates are summarized in **Table 8**. The metrics of interest are the effect sizes for log data, ES(log), and estimates of standard deviations (SD, log units). In relative terms, power will be high when ES(log) > SD. There are two cases where ES(log) < SD (Cr for TPN and Zn for TPE), which turn out below to be the only low power cases for the BA design.

Results – Estimates of BA statistical power are shown in **Table 9 and Figure 7.** For all variables, the *a priori* hypothesis is that impacts will result in increases, so power is based on one-tailed tests (α = 0.05 and 0.10 are both shown in Table 9; α = 0.05 for

Figure 7). Power was basically 100% except for two cases: Cr for TPN and Zn for TPE. In both cases, the mean of the baseline data was close to the trigger relative to the sample SD – see **Table 8** and box plots in **Figure 5**. The number of sub-samples makes the biggest difference for Zn for TPE, where for example s = 5 has power of 0.44 while s = 15 has power = 0.83.

A measure of precision for BACI estimates is shown in **Figure 8**. For log data, a useful measure of precision is the coefficient of variation (CV = SE[BA estimate]/ [BA estimate]). Results are averages across 500 trials, and do not depend on tails or alpha. As a rough guide, power > 80% when CV < 40%.

These limited comparisons make it difficult to recommend an optimal sub-sample size, in part because there is potential evidence that differences in "random selection" of sampling location resulted in significant differences between years (see results for INUG and TPE in **Figure 5**). This is potentially explained by reviewing the field sampling methods between the two years for INUG (in one year, the field crew clearly followed a linear path and did not randomly sample). Nevertheless, in our view, it seems reasonable to choose **s = 10**, which provides a decent sample number in case of severe spatial heterogeneity, high power in most cases, and marginal power in only two cases.

The BACI power estimates are compared to the BA estimates for TPE in **Table 10**. The results seem to be rather strange, with low power at alpha = 0.05 for all variables (except Cu) and dramatically higher power for some variables at alpha = 0.10. With only two years of before data and one year of after data, the test of the interaction effect (time period as before/after, and station type as control/impact) has only one degree of freedom, therefore the estimated effect must be very large in comparison to its standard error in order to achieve a low p-value.

Summary – Results of BA analysis show that subsampling to a moderate degree (e.g., 10) is worthwhile, given apparent spatial variability in sediment chemistry within lakes or basins. For sediment samples, the assumption that temporal variation does not matter is critical to the assessment of changes in variables by station. Without considerable replication across years, BACI models cannot be reliably applied. However, while the control data is not used in the BA analysis, the continued sampling of INUG is of high value to maintain the option of applying BACI models over time.

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Underwood, A. 1994. On beyond BACI: sampling designs that might reliably detect environmental disturbances. Ecological Applications 4(1): 3-15.

Table 1. Core and grab sediment samples (excluding duplicates) collected for the CREMP program (core samples for July 2009 are for the East Dike program).

Note: Shading denotes "Impact" periods.

CORE		Baker			Meadowbank									
Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul													0
2007	Aug													0
2008	Jul				15		15	15		15	15	15	15	105
	Aug	15	6	15										36
2009	Jul				15		15	15		15				60
	Aug													0
Total		**15**	**6**	**15**	**30**	**0**	**30**	**30**	**0**	**30**	**15**	**15**	**15**	**201**

GRAB		Baker			Meadowbank									
Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul				1		1	1		1	1	1	1	7
2007	Aug				1		1	1		1	1	1	1	7
2008	Jul													0
	Aug	1	1	1	1		1	1		1	1	1	1	10
2009	Jul													0
	Aug	3	3	3	3	3	3	3	3	3	3	3	3	36
Total		**4**	**4**	**4**	**6**	**3**	**6**	**6**	**3**	**6**	**6**	**6**	**6**	**60**

Table 2. Duplicate sediment samples collected for the AEMP program (core samples for July 2009 are for the East Dike program).

Note: Shading denotes "Impact" periods.

CORE		Baker			Meadowbank									
Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul													0
2007	Aug													0
2008	Jul				1		1	1		1	1	1	1	7
	Aug	1		1										2
2009	Jul				1		1	1		1				4
	Aug													0
Total		**1**	**0**	**1**	**2**	**0**	**2**	**2**	**0**	**2**	**1**	**1**	**1**	**13**

GRAB		Baker			Meadowbank									
Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul													0
2007	Aug										1			1
2008	Jul													0
	Aug										1			1
2009	Jul													0
	Aug					1						1		2
Total		**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**1**	**0**	**4**

Table 3. Summary of sample measurements (N) and values above detection limits (>DL) for duplicate samples (core/grab), Meadowbank core control samples, and Baker core control samples.

	Duplicates (core/grab)		Meadowbank (core control)		Baker (core control)	
Variable	N	>DL	N	>DL	N	>DL
Arsenic (T)	34	32	135	133	15	3
Cadmium (T)	34	13	135	64	15	0
Chromium (T)	34	34	135	135	15	15
Copper (T)	34	34	135	135	15	15
Lead (T)	34	1	135	11	15	0
Mercury (T)	34	33	135	135	15	13
Zinc (T)	34	34	135	135	15	15

Table 4. Summary of statistical comparisons between sediment core sample/duplicate pairs

Notes: Limited to pairs with both values above detection limits). N = total samples (pairs = N/2); Median = median of all samples; MAD = median absolute difference among sample/duplicate pairs; r = Spearman rank correlation among sample/duplicate pairs; SD = standard deviation of random effects for Location (variability among sample pairs) and residual errors (variability between samples and duplicates) fit to log-transformed data.

					Model SD (log data)	
Variable	N	Median	MAD	r	Location	Res. Error
Arsenic (T)	24	29.1	5.0	0.60	0.412	0.290
Cadmium (T)	8	0.85	0.18	0.80	0.245	0.155
Chromium (T)	26	72.9	3.5	0.97	0.563	0.075
Copper (T)	26	64.20	3.40	0.94	0.896	0.079
Mercury (T)	26	0.040	0.003	0.85	0.593	0.114
Zinc (T)	26	87.6	3.0	0.95	0.477	0.074

Table 5. Comparisons between core samples (controls) for Baker and Meadowbank programs.

Notes: Ratio = median(Baker)/median(Meadow); MW test P = P-value for the Mann-Whitney test; Est = difference in means (Baker – Meadow) for log-transformed data; P = P-value based on t-test; ES (%) = proportional effect size in untransformed units relative to Meadowbank samples, where ES (%) = (exp[Est] – 1)*100.

	Sample size (N)		Medians			MW	t-test (log data)		
Variable	Baker	Meadow	Baker	Meadow	Ratio	test P	Est	P	ES (%)
Arsenic (T)	15	135	5.0	26.5	0.19	<0.0001	-1.67	<0.0001	-81%
Chromium (T)	15	135	16.7	76.5	0.22	<0.0001	-1.48	<0.0001	-77%
Copper (T)	15	135	5.3	61.8	0.09	<0.0001	-2.46	<0.0001	-91%
Mercury (T)	15	135	0.006	0.038	0.17	<0.0001	-1.66	<0.0001	-81%
Zinc (T)	15	135	24.1	91.0	0.26	<0.0001	-1.29	<0.0001	-73%

Table 6. Summary of trigger values for sediment variables for Meadowbank and Baker stations.

Notes: For each variable, thresholds (guidelines) are shown (details for thresholds are in Table 7); DL = current detection limit; N = sample measurements; >DL = number of measurements above DL; medians and 95th percentiles for variables with at least one value >DL (with all values <DL set equal to DL); Method = method used to determine the trigger, where A = halfway from median (or DL if all values <DL) to threshold, and B = 95th percentile.

			Meadowbank (or both for Lead)						Baker					
Variable	Threshold	DL	N	>DL	Med	95th	Trigger	Method	N	>DL	Med	95th	Trigger	Method
Arsenic (As)	5.9	5.0	135	133	26.5	120.0	120.0	B	15	3	5.0	8.3	8.3	B
Cadmium (Cd)	0.6	0.50	135	64	0.50	1.10	1.10	B	15	0			0.55	A
Chromium (Cr)	37.3		135	135	76.5	114.3	114.3	B	15	15	16.7	20.3	27.0	A
Copper (Cu)	35.7		135	135	61.8	126.0	126.0	B	15	15	5.3	7.8	20.5	A
Lead (Pb)	35	30	150	11	30	32	32.5	A						
Mercury (Hg)	0.17	0.005	135	135	0.038	0.064	0.104	A	15	13	0.006	0.011	0.088	A
Zinc (Zn)	123		135	135	91.0	121.3	121.3	B	15	15	24.1	32.1	73.6	A

Table 7. Summary of CCME guidelines for sediment variables; (CCME, 2002).

Variable	Source	Description of guidelines
t-Arsenic (As)	CCME, 2002	The CCME ISQG for As is 5.9 mg/kg.
t-Cadmium (Cd)	CCME, 2002	The CCME ISQG for Cd is 0.6 mg/kg.
t- Chromium (Cr)	CCME, 2002	The CCME ISQG for Cr is 37.3 mg/kg.
t-Copper (Cu)	CCME, 2002	The CCME ISQG for Cu is 35.7 mg/kg
t-Lead (Pb)	CCME, 2002	The CCME ISQG for Pb is 35 mg/kg.
t-Mercury (Hg)	CCME, 2002	The CCME ISQG for Hg is 0.17 mg/kg.
t-Zinc (Zn)	CCME, 2002	The CCME ISQG for Zn is 123 mg/kg.

Table 8. Summary of "before-period" estimates by variable and impact station.

Notes: The station mean, trigger, and effect size (ES = Trigger – Mean) are in raw units (e.g., mg/kg). ES(log) denotes the effect size for log data (ES(log) = log[Trigger/Mean]). Estimates of the standard deviation (SD) for observations are for log-transformed data.

Variable	Station	Mean	Trigger	ES	ES(log)	SD
Arsenic	SP	31.3	120.0	88.7	1.345	1.012
	TPE	17.9	120.0	102.1	1.905	0.912
	TPN	27.3	120.0	92.7	1.480	1.046
Chromium	SP	64.9	114.3	49.4	0.566	0.162
	TPE	81.7	114.3	32.6	0.336	0.154
	TPN	98.4	114.3	15.9	0.150	0.222
Copper	SP	82.6	126.0	43.4	0.422	0.151
	TPE	57.6	126.0	68.4	0.782	0.190
	TPN	57.0	126.0	69.0	0.794	0.255
Mercury	SP	0.045	0.104	0.059	0.843	0.253
	TPE	0.029	0.104	0.075	1.271	0.302
	TPN	0.026	0.104	0.078	1.388	0.335
Zinc	SP	97.0	121.3	24.3	0.223	0.151
	TPE	107.3	121.3	14.0	0.123	0.161
	TPN	75.2	121.3	46.1	0.478	0.205

Table 9. Estimates of BA statistical power for detecting a significant increase (one-tailed test) in a given variable and impact year by station (SP, TPE, TPN) as a function of the number of sub-samples for the impact year.

Note: Power is shown for two levels of alpha (0.05 and 0.10).

		alpha = 0.05			alpha = 0.10		
Variable	Samples	SP	TPE	TPN	SP	TPE	TPN
Arsenic	5	1.00	1.00	1.00	1.00	1.00	1.00
	10	1.00	1.00	1.00	1.00	1.00	1.00
	15	1.00	1.00	1.00	1.00	1.00	1.00
	20	1.00	1.00	1.00	1.00	1.00	1.00
	25	1.00	1.00	1.00	1.00	1.00	1.00
Chromium	5	1.00	1.00	0.18	1.00	1.00	0.33
	10	1.00	1.00	0.29	1.00	1.00	0.45
	15	1.00	1.00	0.34	1.00	1.00	0.56
	20	1.00	1.00	0.40	1.00	1.00	0.61
	25	1.00	1.00	0.41	1.00	1.00	0.65
Copper	5	1.00	1.00	1.00	1.00	1.00	1.00
	10	1.00	1.00	1.00	1.00	1.00	1.00
	15	1.00	1.00	1.00	1.00	1.00	1.00
	20	1.00	1.00	1.00	1.00	1.00	1.00
	25	1.00	1.00	1.00	1.00	1.00	1.00
Mercury	5	1.00	1.00	1.00	1.00	1.00	1.00
	10	1.00	1.00	1.00	1.00	1.00	1.00
	15	1.00	1.00	1.00	1.00	1.00	1.00
	20	1.00	1.00	1.00	1.00	1.00	1.00
	25	1.00	1.00	1.00	1.00	1.00	1.00
Zinc	5	0.99	0.44	0.98	1.00	0.61	1.00
	10	1.00	0.67	1.00	1.00	0.84	1.00
	15	1.00	0.83	1.00	1.00	0.92	1.00
	20	1.00	0.90	1.00	1.00	0.95	1.00
	25	1.00	0.93	1.00	1.00	0.98	1.00

Table 10. Estimates of power for the BA versus BACI design for station TPE (with INUG as control) for detecting a significant increase (one-tailed test) in a given variable and impact year as a function of the number of sub-samples for the impact year.

Note: Power is shown for two levels of alpha (0.05 and 0.10).

		alpha = 0.05		alpha = 0.10	
Variable	Samples	BA	BACI	BA	BACI
Arsenic	5	1.00	0.00	1.00	0.26
	10	1.00	0.00	1.00	0.41
	15	1.00	0.00	1.00	0.53
	20	1.00	0.00	1.00	0.64
	25	1.00	0.00	1.00	0.66
Chromium	5	1.00	0.00	1.00	0.29
	10	1.00	0.00	1.00	0.45
	15	1.00	0.00	1.00	0.55
	20	1.00	0.00	1.00	0.67
	25	1.00	0.00	1.00	0.68
Copper	5	1.00	0.40	1.00	1.00
	10	1.00	0.97	1.00	1.00
	15	1.00	1.00	1.00	1.00
	20	1.00	1.00	1.00	1.00
	25	1.00	1.00	1.00	1.00
Mercury	5	1.00	0.01	1.00	0.96
	10	1.00	0.04	1.00	0.99
	15	1.00	0.08	1.00	0.99
	20	1.00	0.11	1.00	1.00
	25	1.00	0.11	1.00	1.00
Zinc	5	0.44	0.00	0.61	0.03
	10	0.67	0.00	0.84	0.03
	15	0.83	0.00	0.92	0.04
	20	0.90	0.00	0.95	0.08
	25	0.93	0.00	0.98	0.06

Figure 1. Sample versus duplicate values of selected sediment variables.

Notes: Values below detection limits were set equal to the given detection limit. Solid line is the 1:1 line.

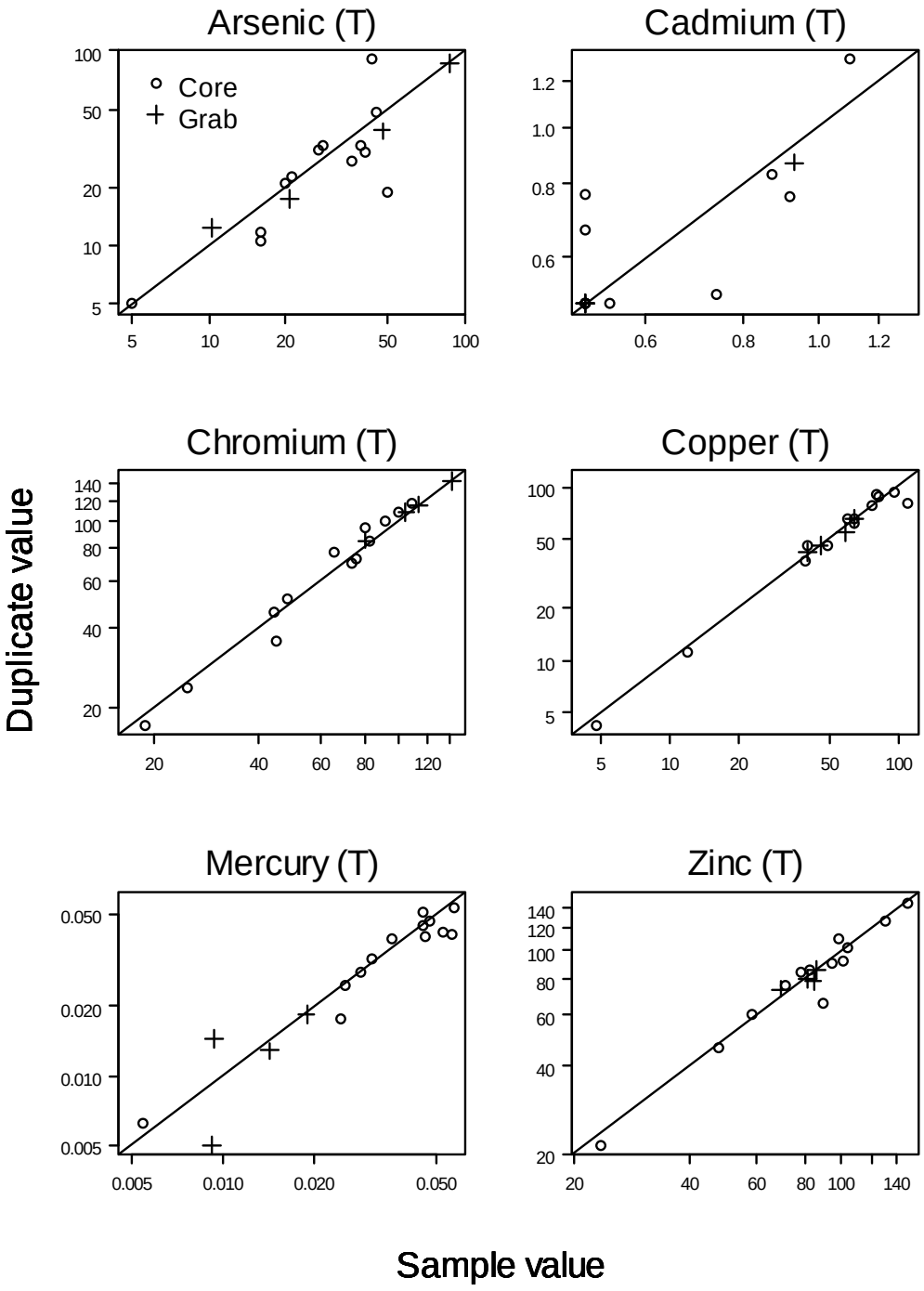
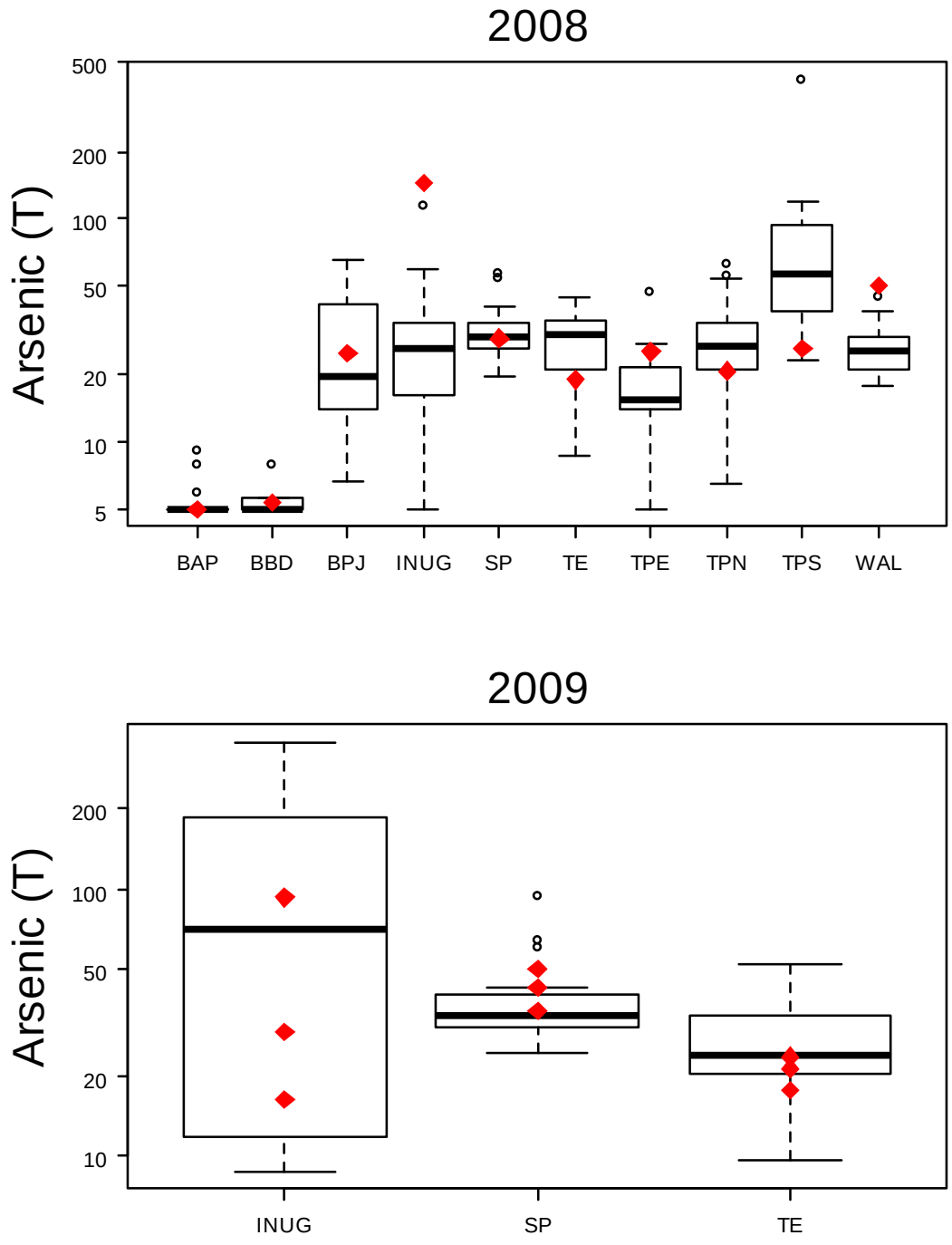


Figure 2. Box-plots of core samples by station for 2008 (top) and 2009 (bottom), with values for grab samples are superimposed (red diamonds).



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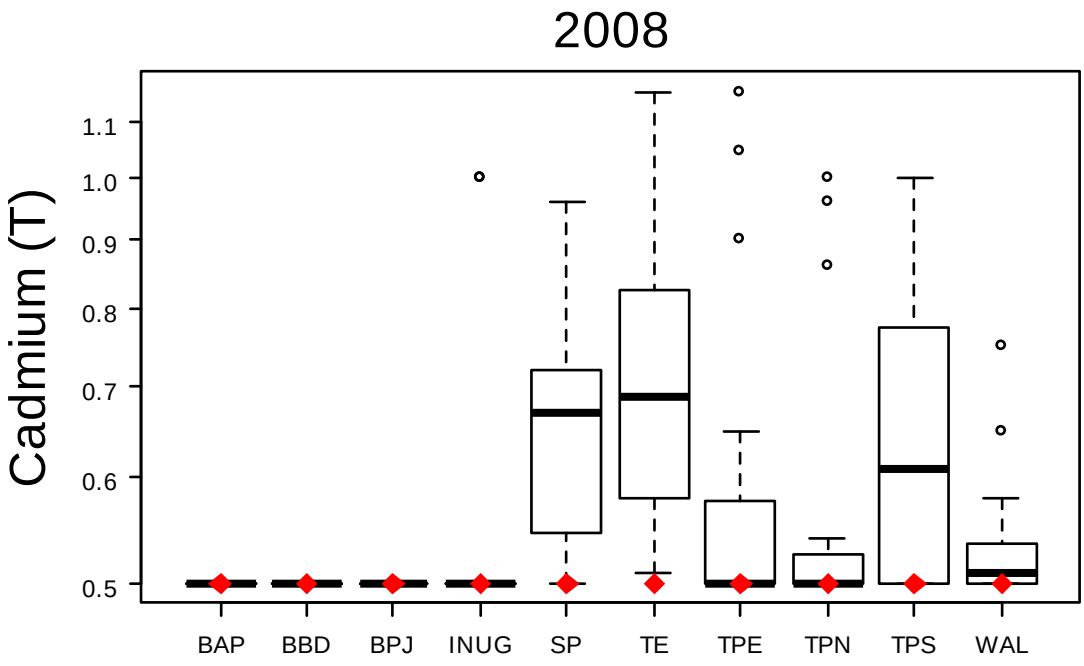

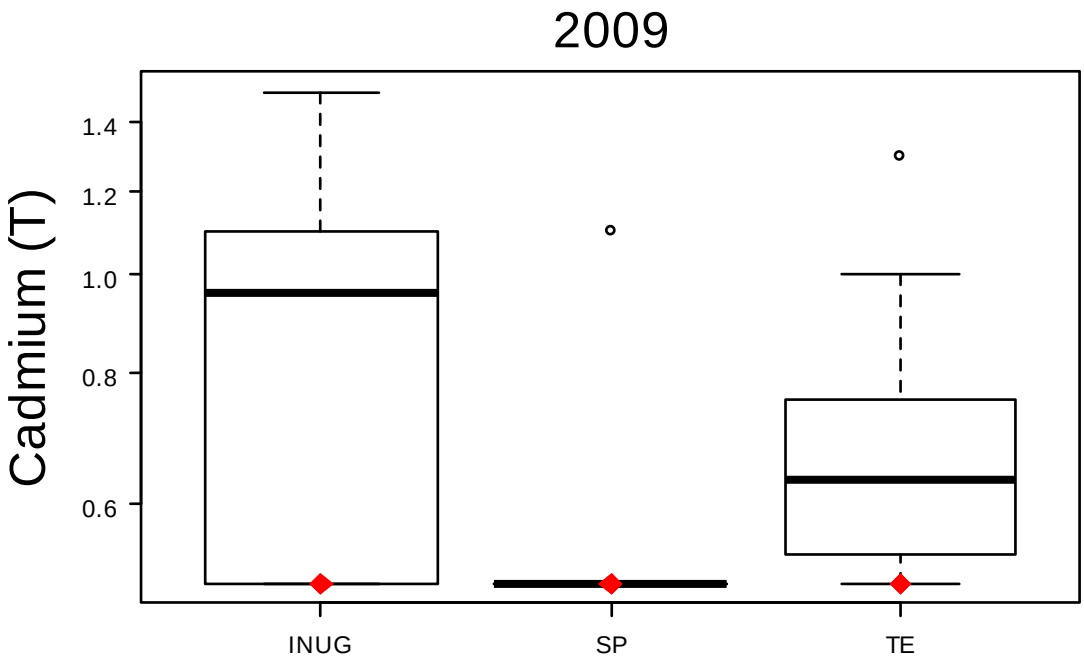

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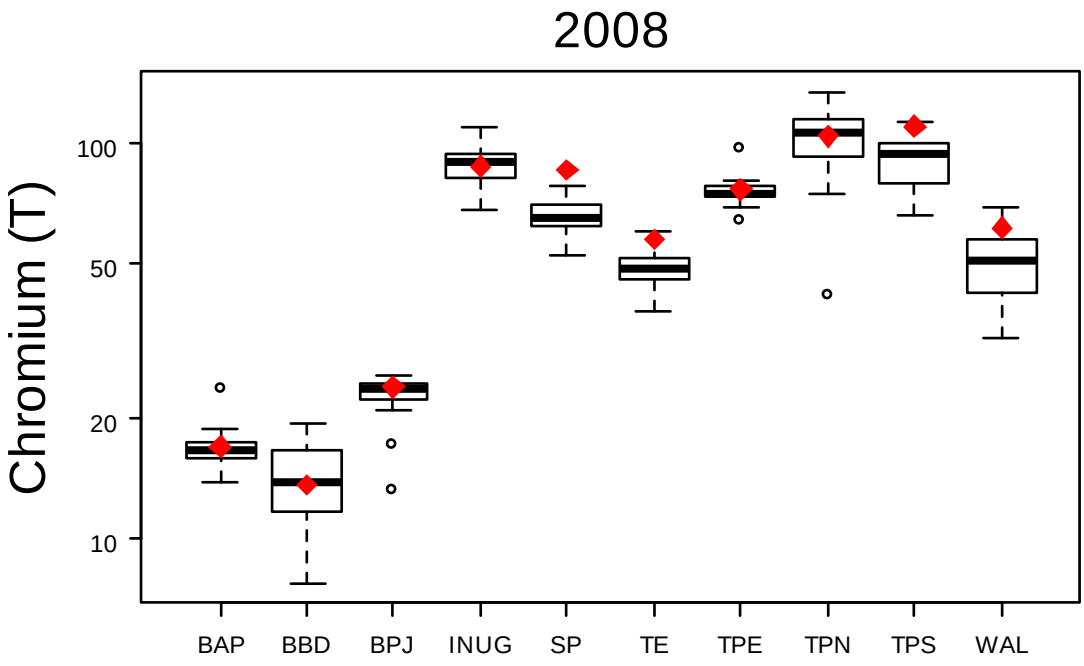

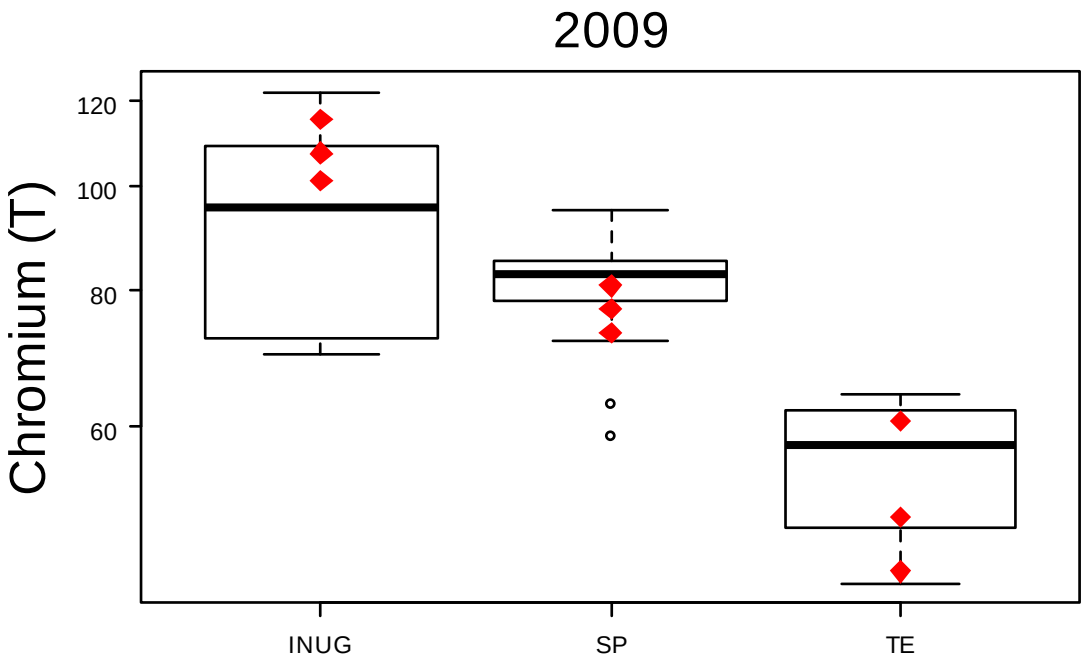

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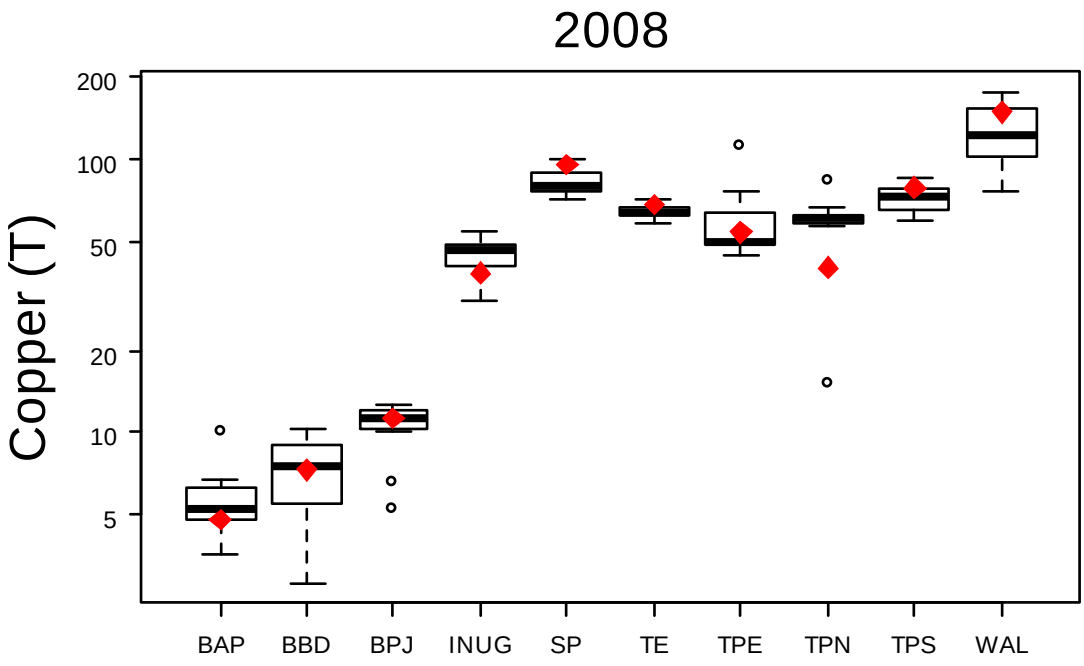

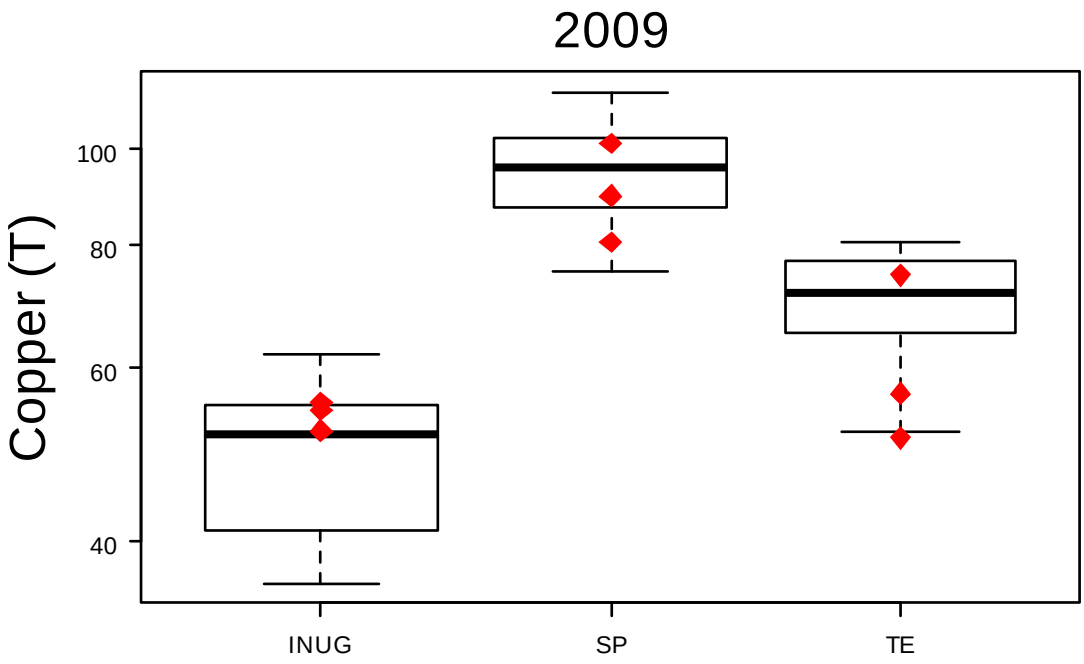

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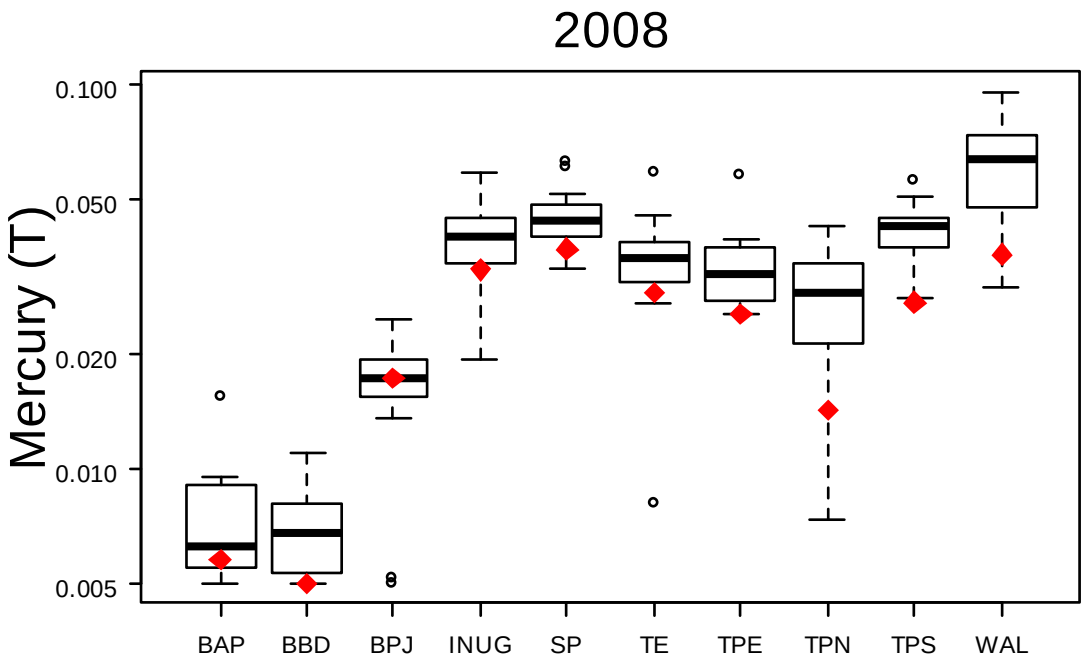

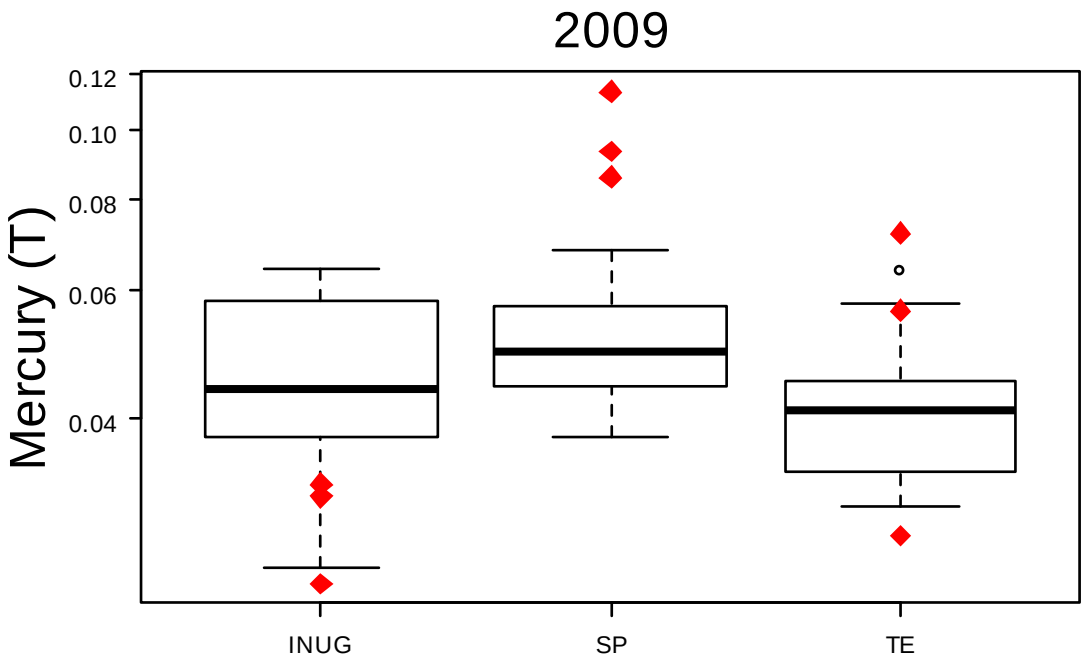

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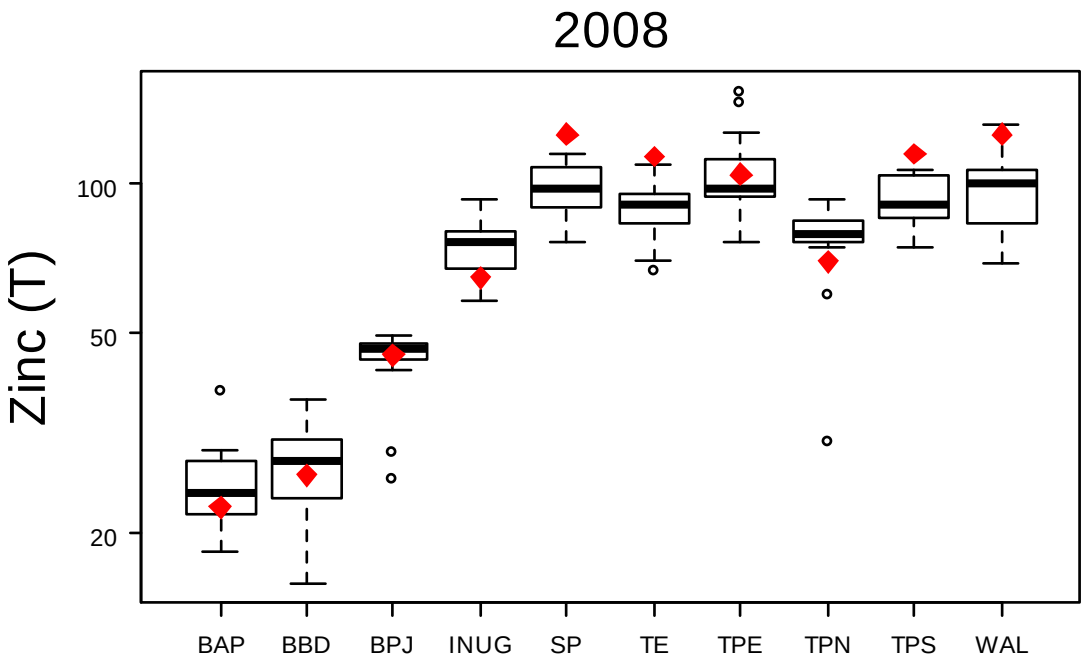


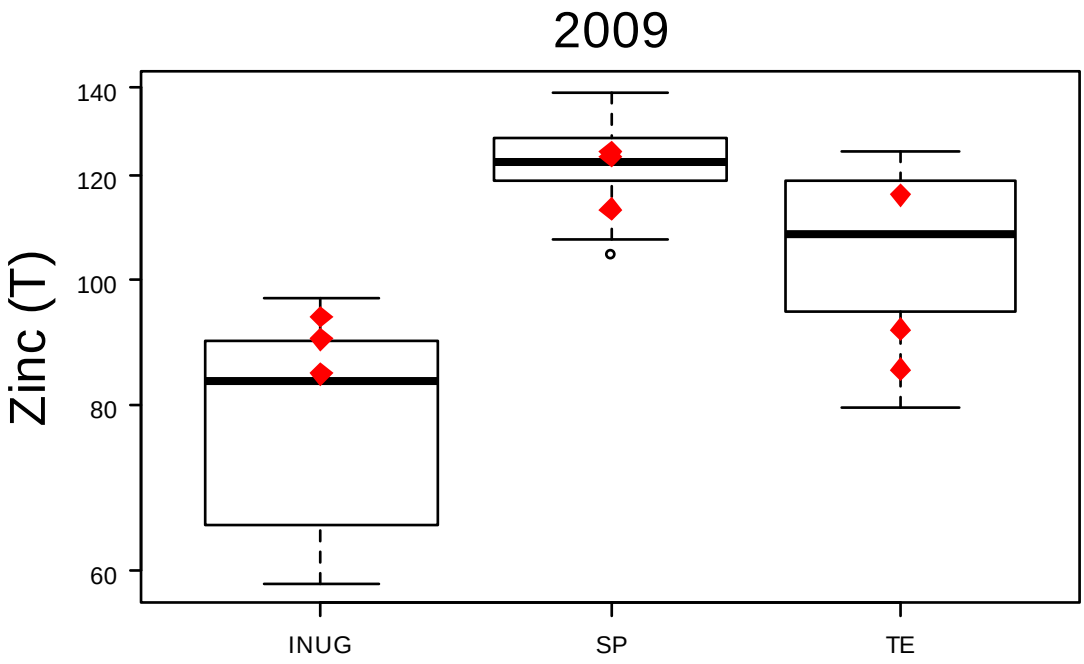


Figure 3. Box -plots of sample measurements (core control samples) by project lake for selected sediment variables (log-log scale).

Note: values < DL were set = DL.

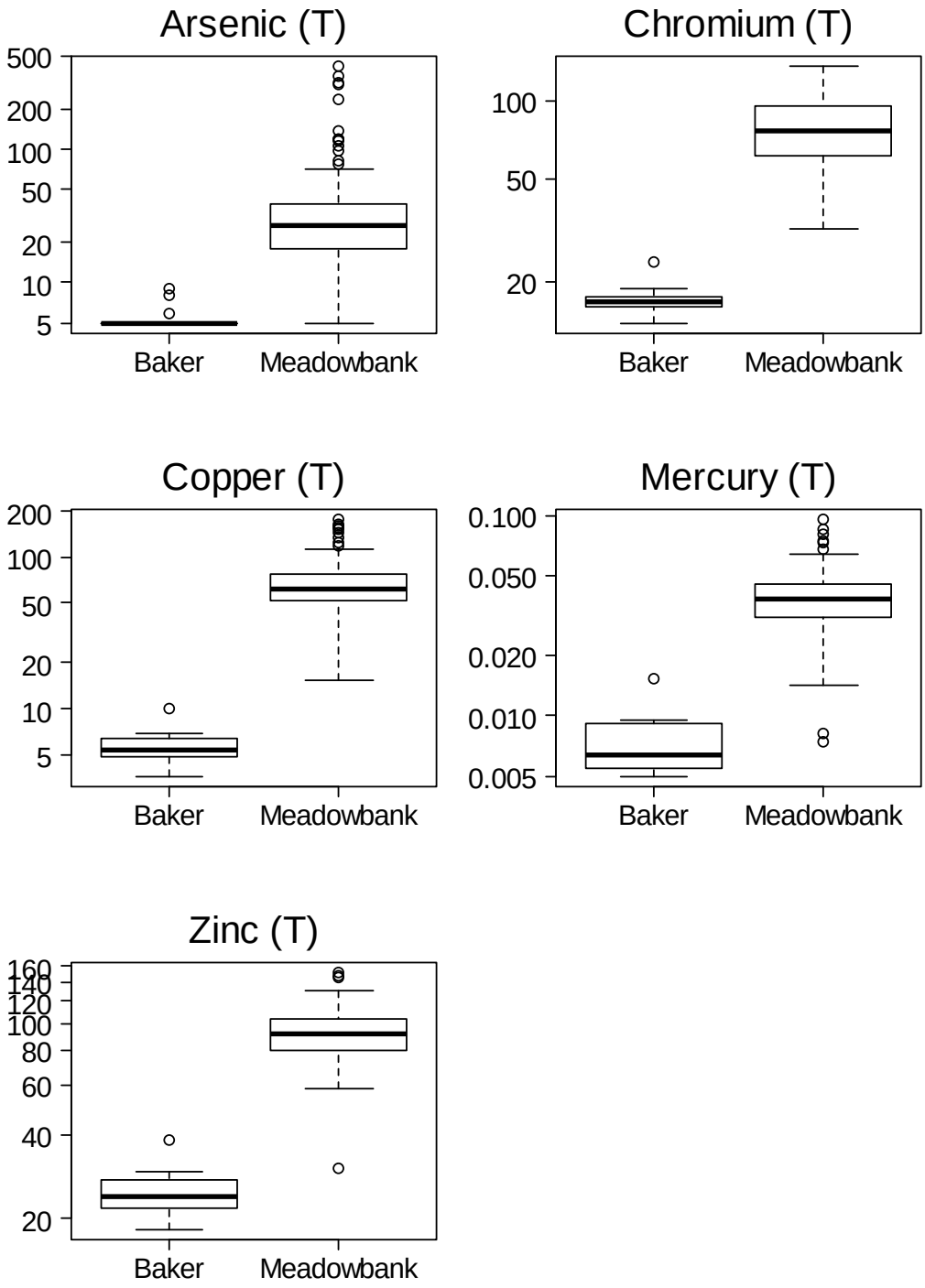
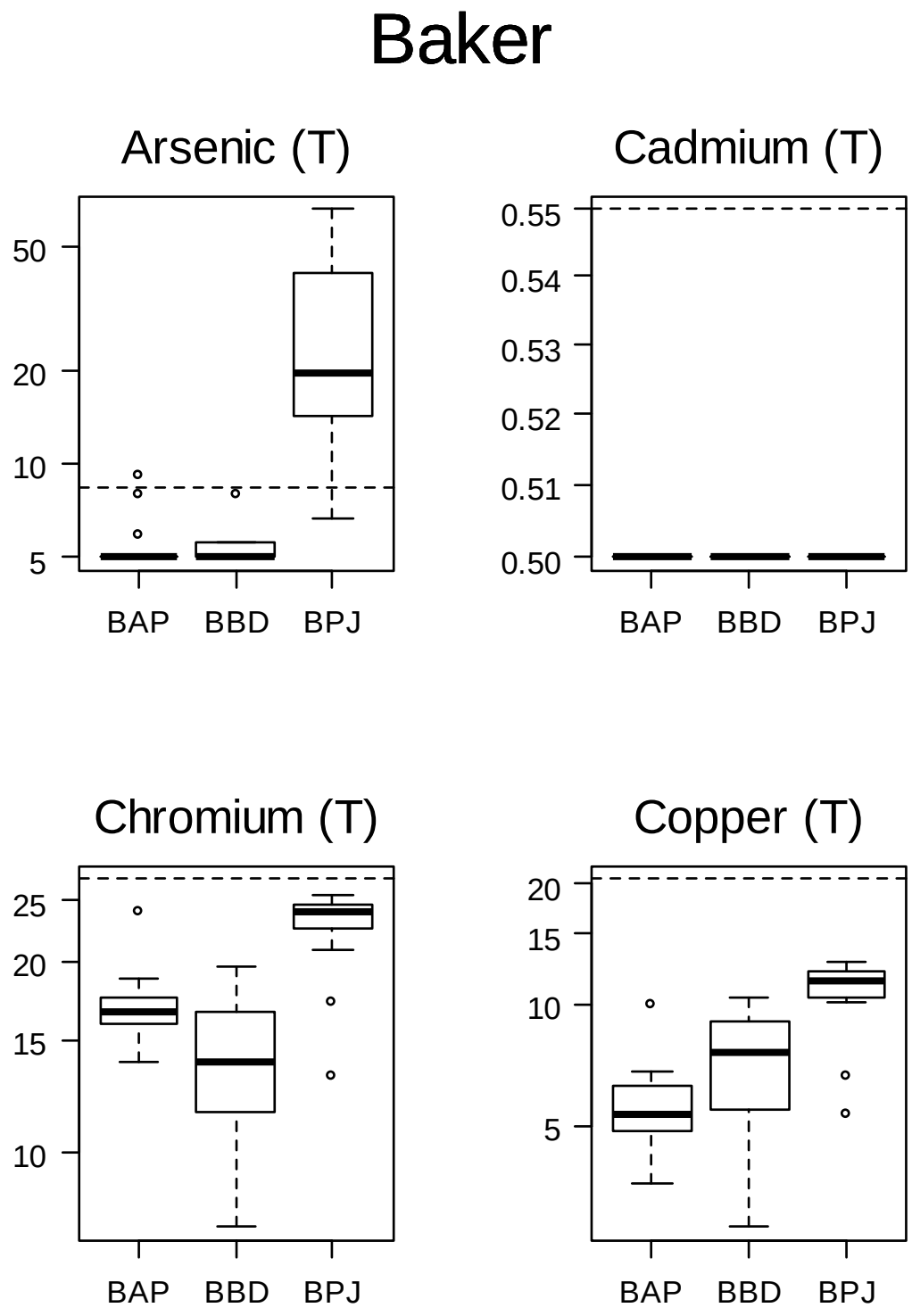


Figure 4. Box-plots of sample measurements by station for Baker Lake.



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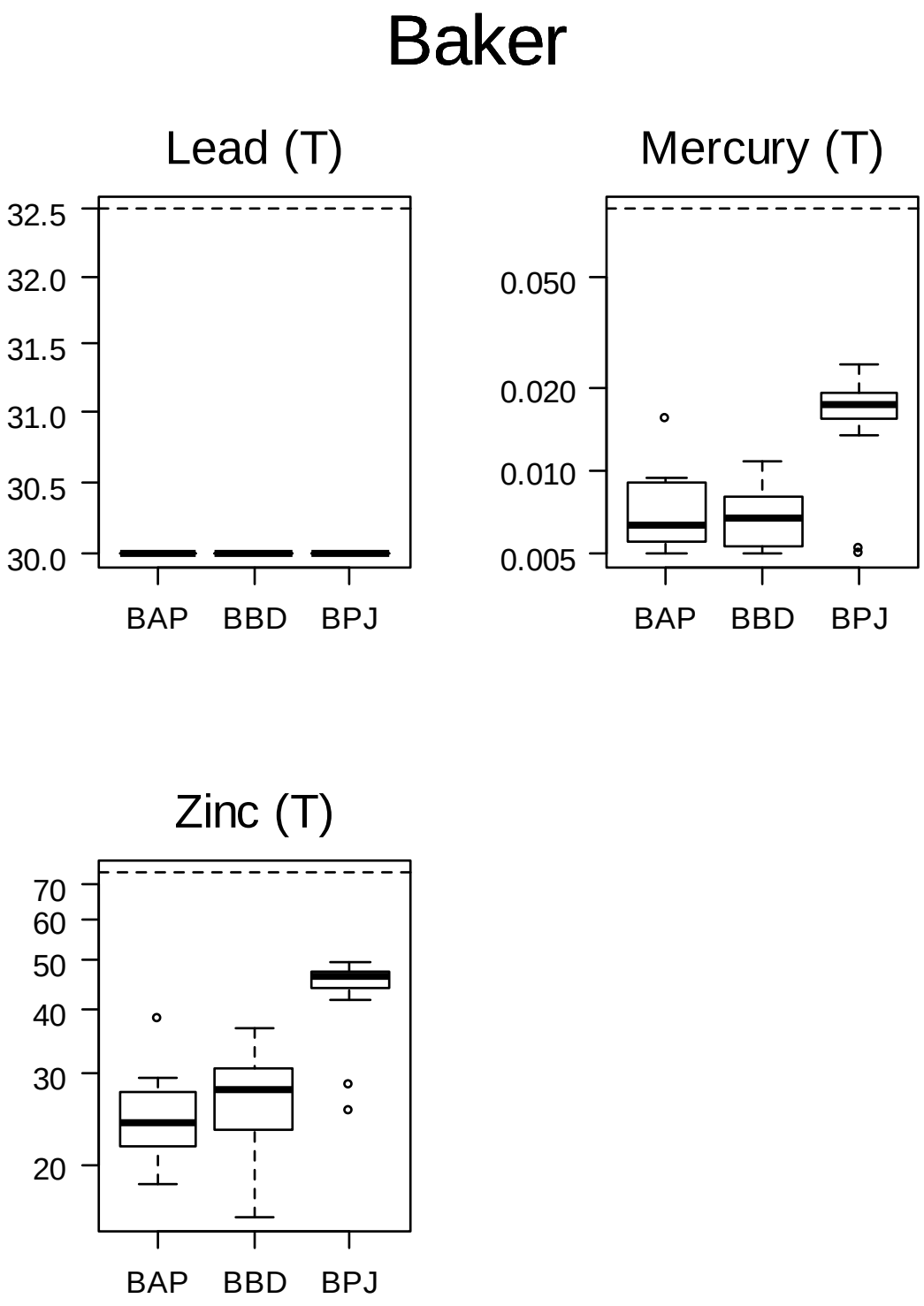
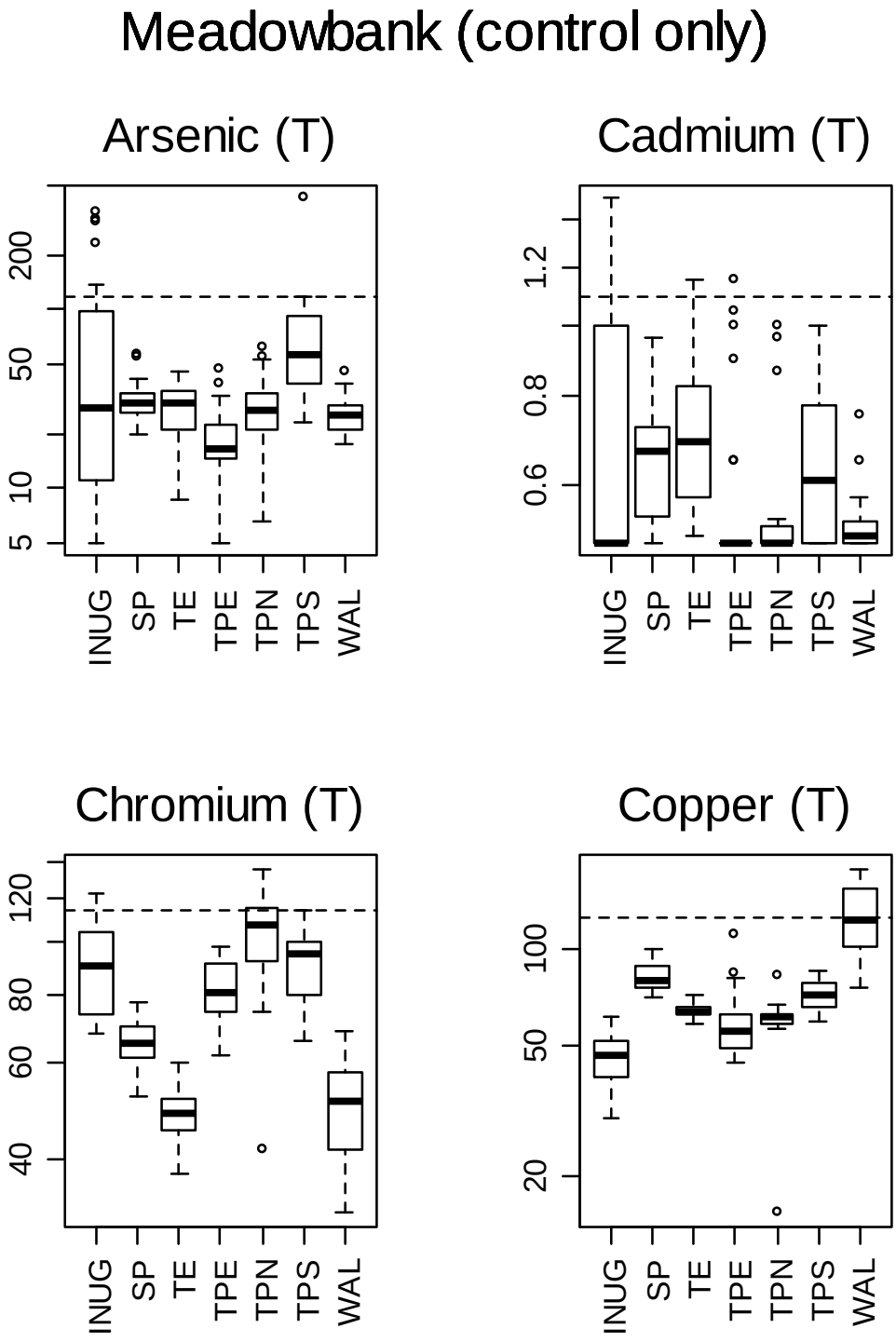


Figure 5. Box-plots of sample measurements by station for Meadowbank stations (control data only).



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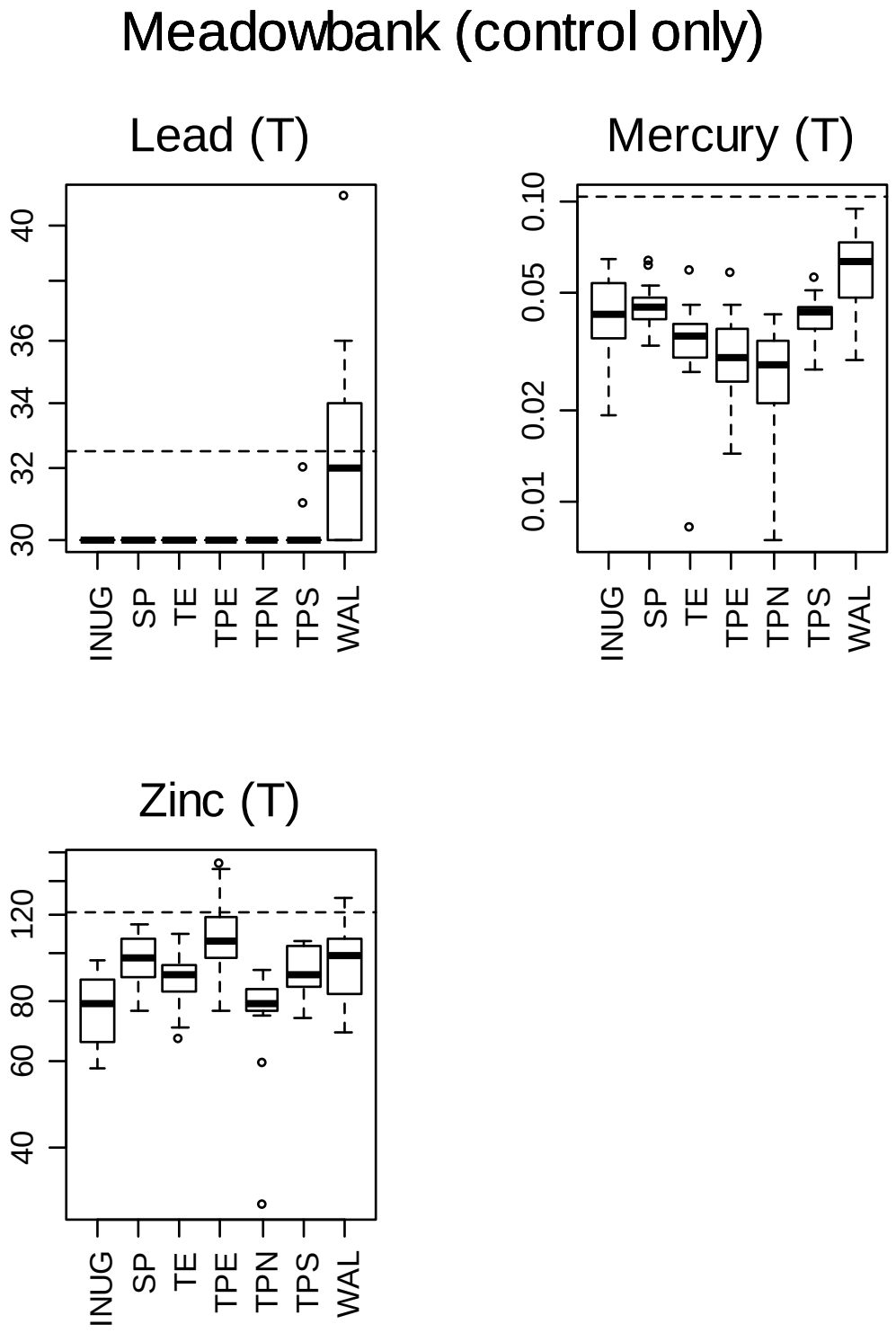
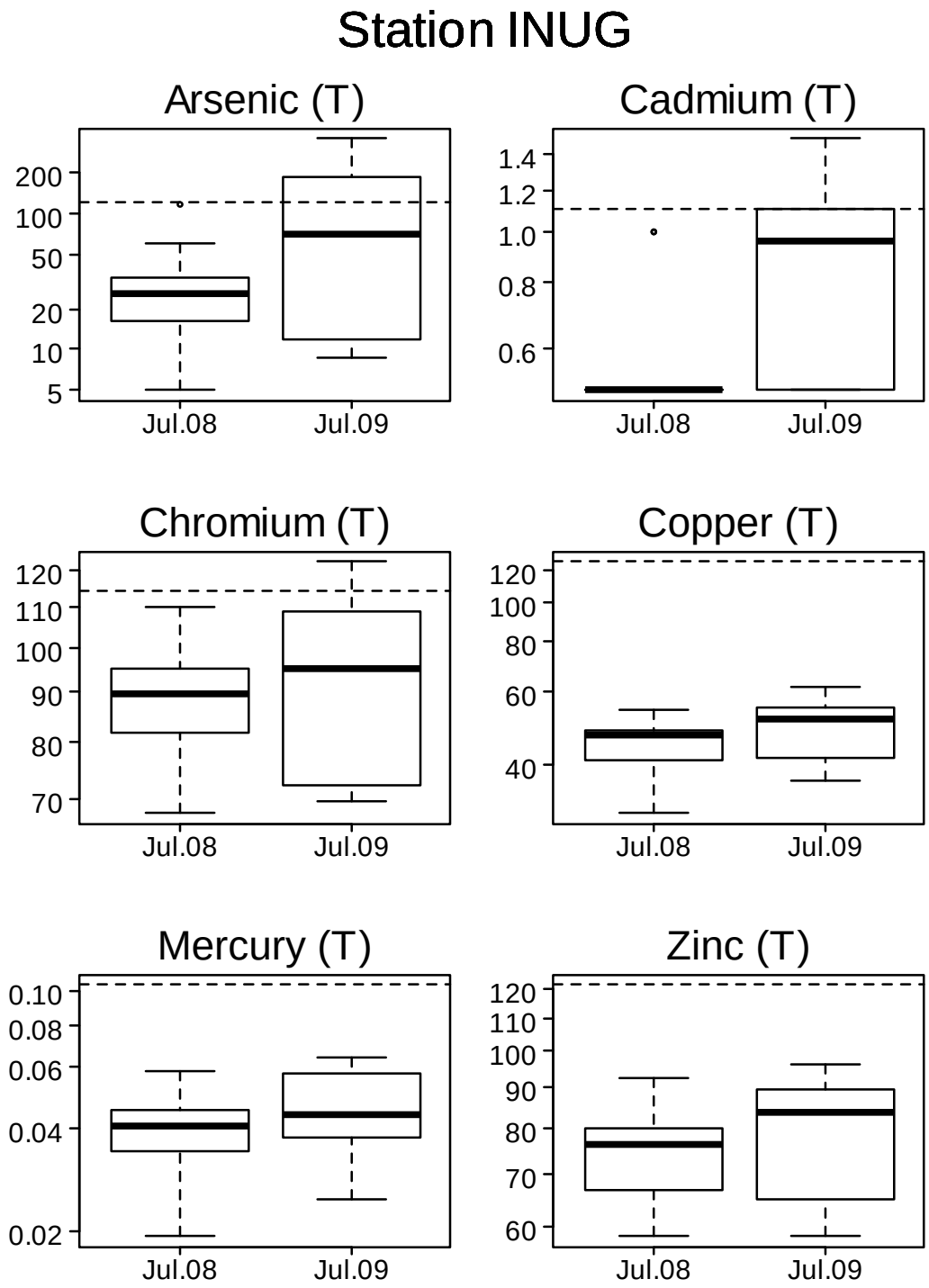


Figure 6. Box-plots of sample measurements by year for select Meadowbank stations.

Note: Pb excluded.



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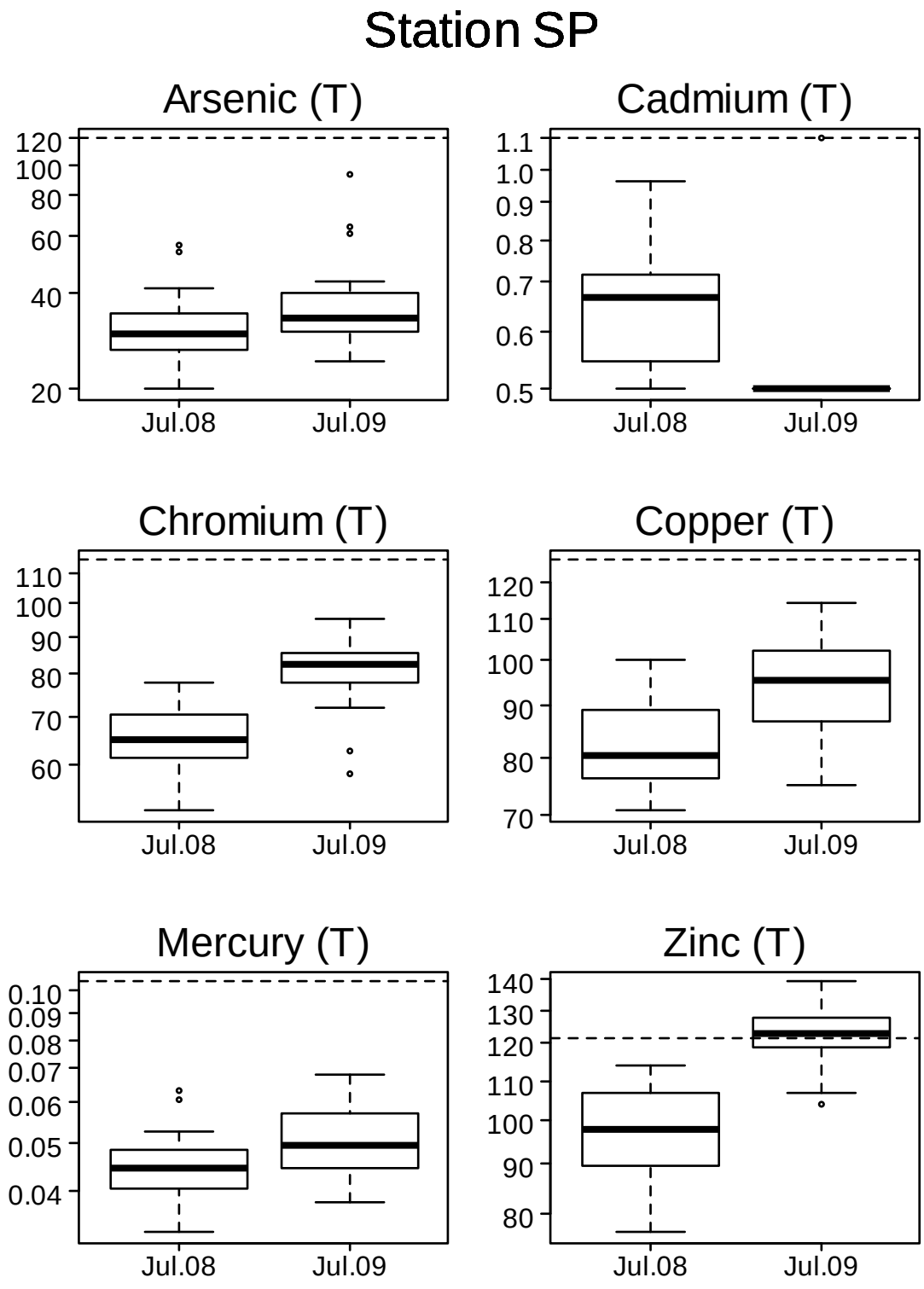

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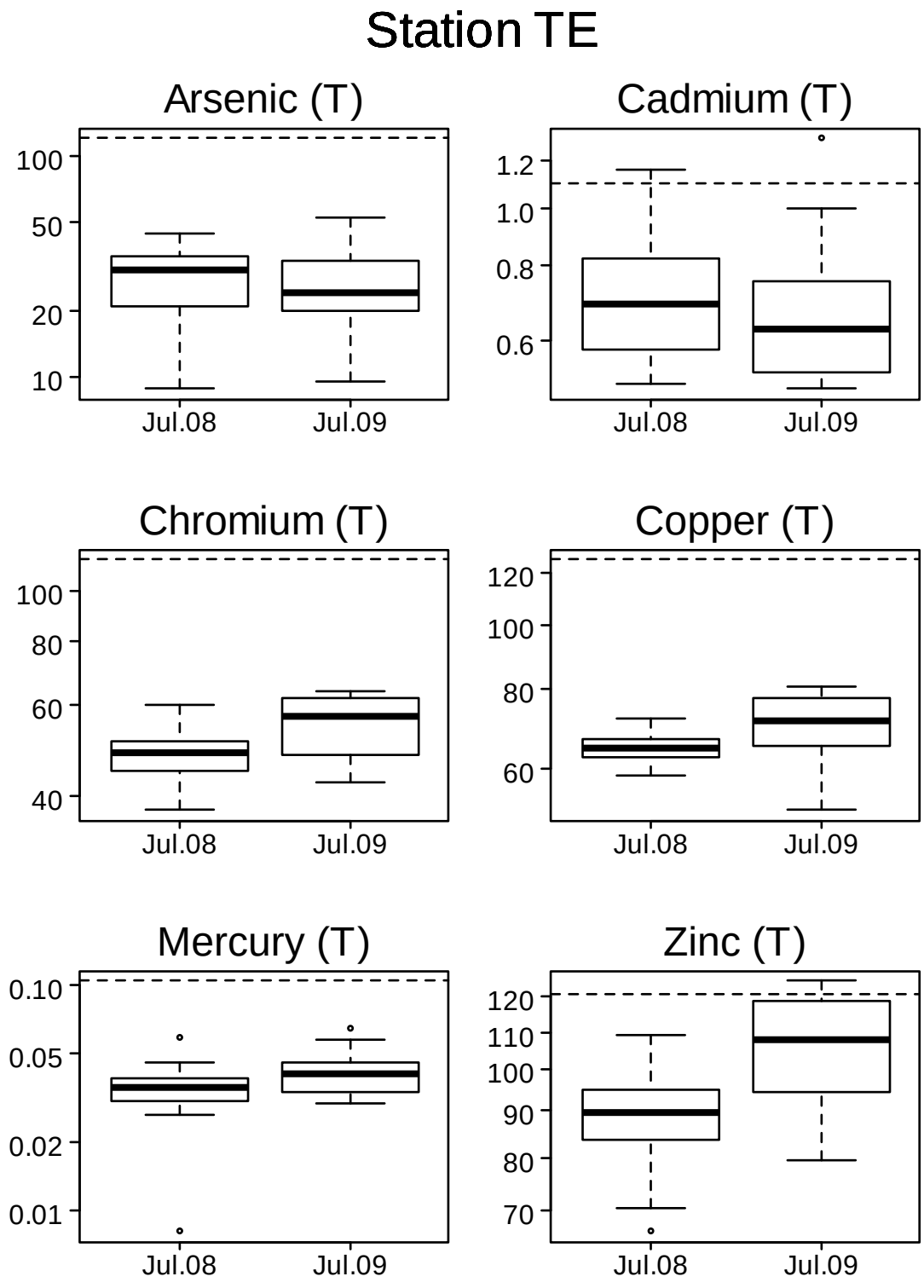

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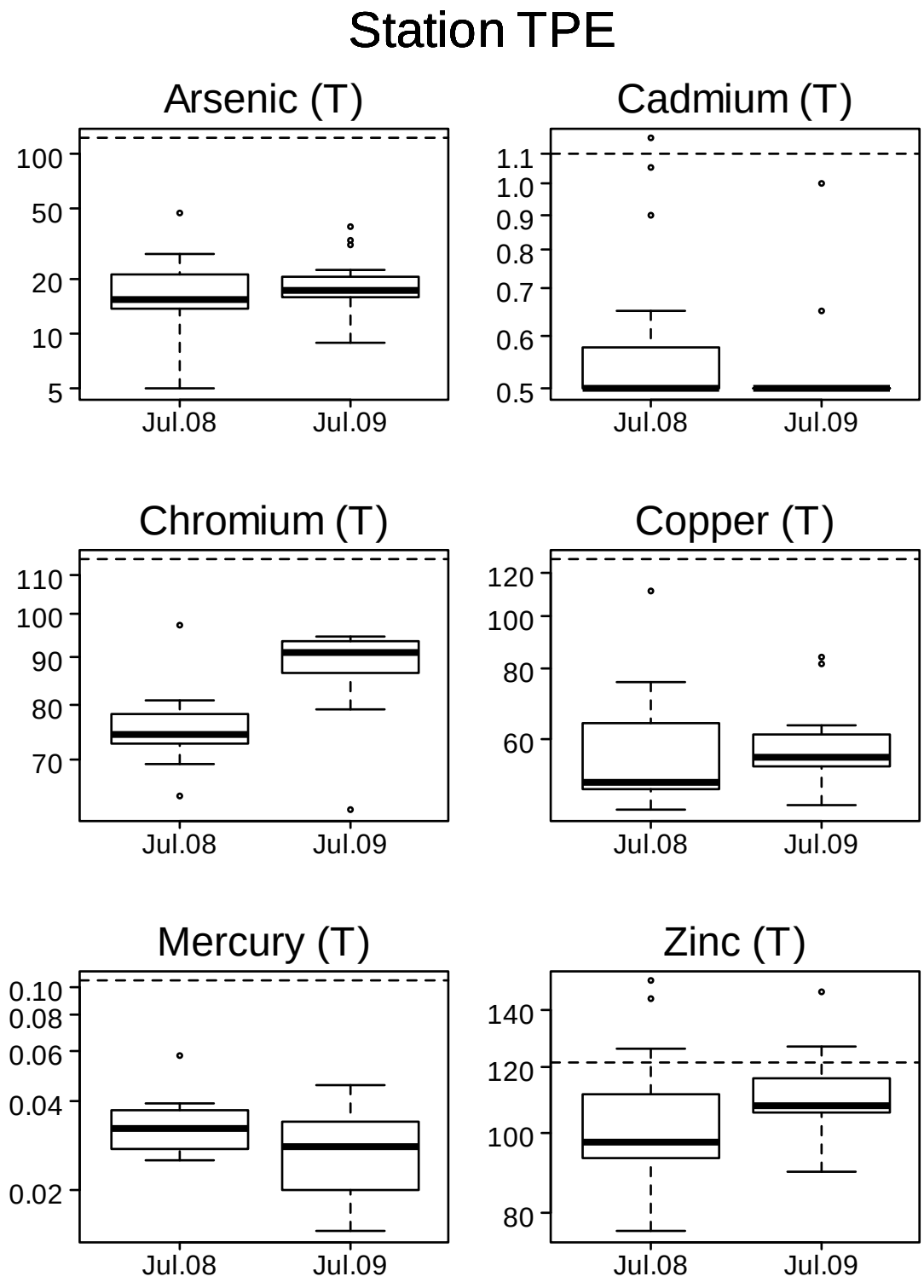


Figure 7. Estimates of BA statistical power for detecting a significant increase (one-tailed test, alpha = 0.05) in a given variable (rows) by station (columns) as a function of the number of sub-samples in the impact year (after period).

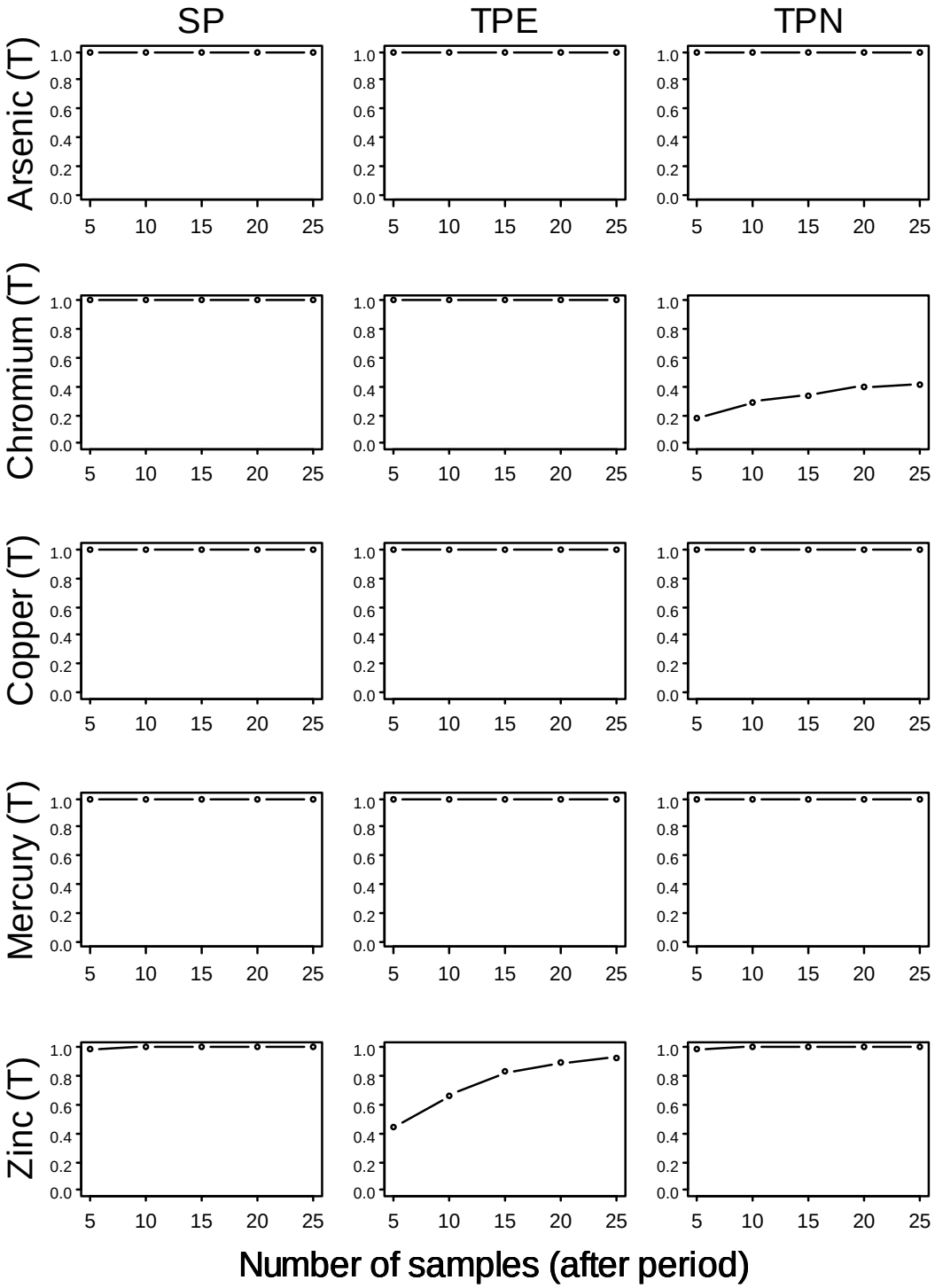
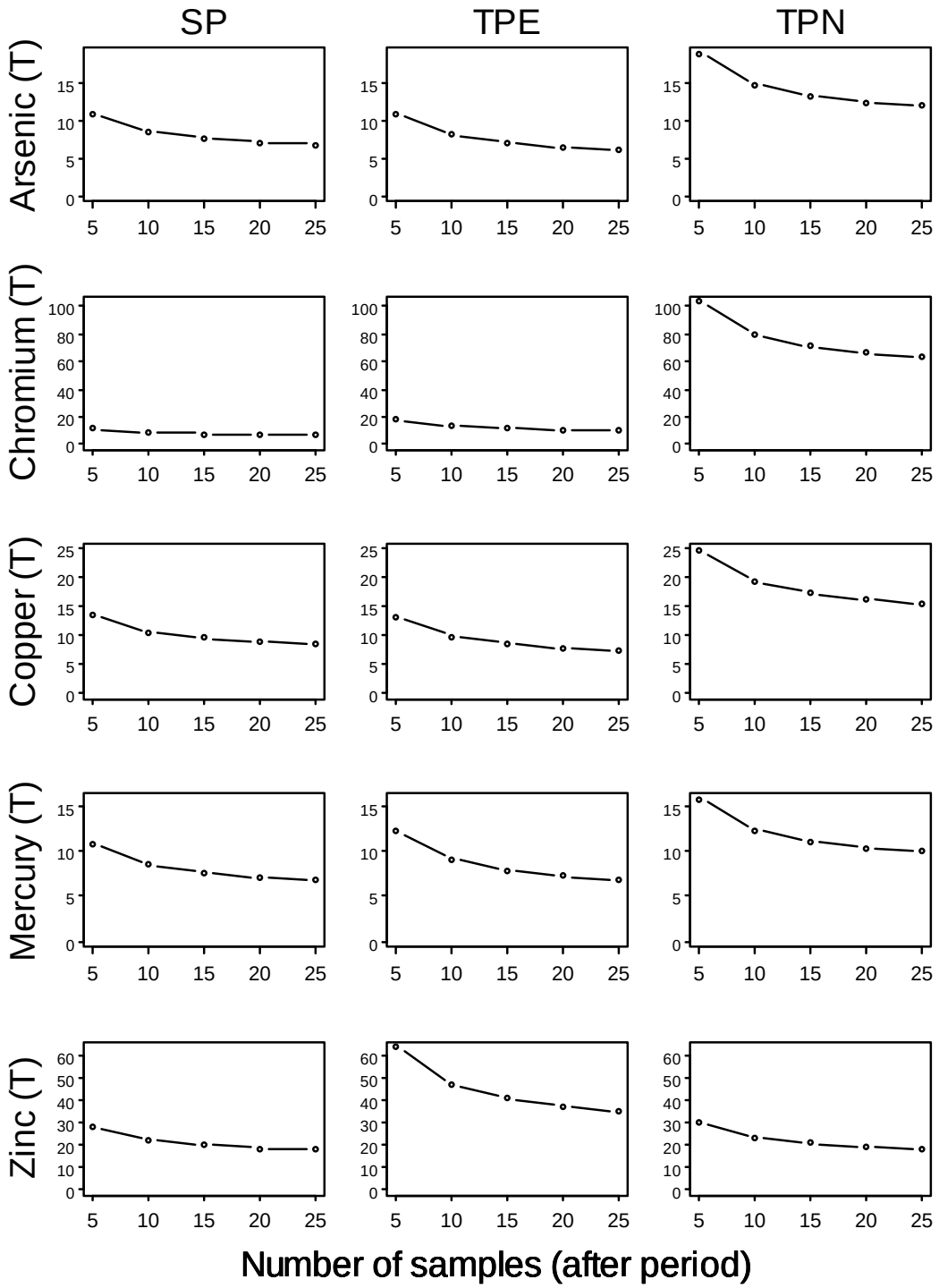


Figure 8. Coefficients of variation (%) for BA estimates by variable (row) and station (column) as a function of the number of sub-samples in the impact year (after period).



APPENDIX C – STATISTICAL ANALYSES FOR PHYTOPLANKTON

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1. INTRODUCTION

This appendix contains the following analyses.

- Summary of CREMP phytoplankton samples
- Analysis of field duplicates
- Analysis of depth
- Data evaluation
- Analysis of sampling design

Some text, tables and figures are repeated from the main document so that the analyses contained in this appendix can be read and understood without reference to the main document. The material in this appendix assumes understanding of basic statistical methods (Venables and Ripley 2002), mixed-effects models (Pinheiro and Bates 2000), before-after-control-impact (BACI) experimental design (Stewart-Oaten et al. 1986; Underwood 1994; Smith 2002), and use of simulation in statistical analysis (Gelman and Hill 2006).

2. SUMMARY OF CREMP PHYTOPLANKTON SAMPLES

Phytoplankton data include estimates of biomass by taxonomic group (in mg/m3), total biomass, species richness (i.e., a count of the number of unique species in a sample) and an estimate of diversity (Simpson's diversity). For the analysis here, matching chlorophyll-a data were also compiled from available water chemistry data (i.e., chlorophyll-a data collected at the same location and time as phytoplankton), and were used for some analyses.

There are three basic types of phytoplankton samples:

1. Standard samples – specific to a given location, month (a single sampling day), and depth.
2. Field duplicate samples – occasionally collected; these consisted of a second sample specific to a given location, time, and depth.
3. Depth replicates – collected at a given location and time (typically one surface, one bottom, and one integrated sample).

For many station-month combinations, more than one "standard" sample was collected. These "sub-samples" represent spatial replication (a different location within the designated station). In addition, samples were designated as "control" or "impact" depending on operation activities near a given station (see main text for differentiation of control and impact).

The field duplicate samples and depth replicates are evaluated in subsequent sections of this appendix. Not including the duplicates and depth replicates, there have been 308 samples collected for the CREMP including samples collected in the summer of 2010 (**Table 1**). Of these, 161 samples were designated as 'control' and 147 as 'impact' (shaded cells).

3. ANALYSIS OF FIELD DUPLICATES

Field duplicates are samples collected at the same location, time and depth as a standard sample. Presumably, differences among duplicates largely reflect field sampling error and lab precision (measurement error). This variation will be a component of the variation observed among station/month sub-samples. Thus, comparing the two provides insight into the extent of real sub-sample variation (due to differing locations within a station).

Data – Duplicates have been collected for 37 samples (14 control and 23 impact). Analysis excluded Euglenophytes because almost all counts of that group are zero.

Methods – For each variable, xy plots were produced and we computed the median across all samples, the median absolute difference (MAD) between samples and duplicates, and Spearman rank correlation between samples and duplicates. In addition, we fit a mixed-effects model (Pinheiro and Bates 2000) of the form:

$$\text{Log}(y) \sim \text{Location} + \text{Error}$$

where y is the water quality variable, Location denotes random effects for sample pairs (variability among pairs due to sample location/month) and Error denotes the residual error (variability between samples and duplicates). For all plots and analyses, if a variable had zero counts, then 0.1 was added to all values (this applied to a few biomass variables – see **Table 5**).

Results – Results of the analysis of duplicates are shown in **Figure 1** (xy plots) and **Table 2** (medians, MADs, and Spearman r). In general, there was more variability between samples and duplicates than was observed for water chemistry variables. The standard deviations (SDs) resulting from the mixed-effect model show the relative variability due to sample location/month (SD.Location) versus duplicate variability (SD.Error). In most cases SD.Error is smaller than SD.Location, which just reaffirms that duplicate measures are generally precise compared to general sample variation (i.e., minimal measurement error or fine-scale spatial variation). These results suggests that sample/duplicate measures are reasonably consistent for key measures such as Total biomass and species counts, and should thus provide useful data for tracking and comparing phytoplankton conditions across stations and months.

4. ANALYSIS OF DEPTH

Evaluation of the importance of depth is important to determine if phytoplankton samples collected at different depths are comparable, and if not, to determine whether sampling at different depths is warranted in future. The primary null hypothesis is that a given variable is the same across sample types for depth (i.e., surface, bottom, integrated); however, depth differences may be related to station and especially season. Potential stratification of the water column is expected to be much greater during "winter" months (November through May) than for "summer" months (July, August, September), though July may be more similar to winter conditions.

Data – There were 41 cases or "depth tests" where phytoplankton samples were simultaneously collected at differing depths. For one cases, no "bottom" sample was collected, therefore for consistency of comparisons this case was removed, providing 40 depth-test locations with total samples size of 120. These 40 cases can be summarized as follows:

	INUG	TE	TPS	Total
Control	12		9	21
Impact		19		19
Total	12	19	9	40

	INUG	TE	TPS	Total
Jul.09	2	2		4
Aug.09	1	1		2
Sep.09	2	2		4
Nov.09	2	2		4
Dec.09		1	1	2
Jan.10			2	2
Feb.10		1	1	2
Mar.10		2	2	4
Apr.10		1	1	2
May.10		2	2	4
Jul.10	2	2		4
Aug.10	1	1		2
Sep.10	2	2		4
Total	12	19	9	40

Methods – Analysis included all variables except Euglenophytes (that group had mostly zero counts). For each variable, xy plots were produced. In addition, we fit three mixed-effects models (Pinheiro and Bates 2000) of the following forms:

Model 1: Log(y) ~ Type + Location + Error

Model 2: Log(y) ~ Type + Station + Type*Station + Location + Error

Model 3: Log(y) ~ Type + Season + Type*Season + Location + Error

where "Type" (with fixed effects) is the key factor variable of interest denoting depth types (surface, bottom, integrated), "Station" is the CREMP sampling station (e.g., TPE) that is actually a broad area, and "Location" denotes unique sample locations (with random effects) that were sampled within a given station at a given time. In Models 2 and 3, the terms of interest are the interactions (fixed effects) between Type and Station (i.e., potential station-specific effects of depth) and Type and Season (potential season-specific effects of depth). Two options were examined for season models. First," Season" was defined as a factor variable with two levels separating Summer months (July, August, September) and Winter months (all others). In the second analysis, July was considered a Winter month. For Model 3 (Season) analysis, data for station TPS were excluded because no "summer" months were sampled.

Results – The statistical significance for the key depth terms of models 1 to 3 is presented in **Table 3** (p-values, based on F tests). There were significant differences ($P < 0.05$) among depth samples (Type) for only 2 of the 10 variables (Chrysophyte and Diatom biomass), only one significant interaction between depth type and station (Diatom biomass), and one significant interaction for season (Simpson's diversity). **Table 4** shows depth type coefficients for Model 1. The coefficients were defined as "Bottom – Surface" and "Integrated – Surface" to make explicit comparisons with surface samples (the standard sample type). Since all data were log-transformed, the coefficient (X) has to be translated into a proportional effect size (ES) relative to (untransformed) surface samples[1]. The percentage ES for each variable is also shown in **Table 4**. For example, for Diatom biomass, the estimated ES = 49.5% for bottom samples (i.e., biomass in bottom samples was 49.5% higher than that observed in surface samples, on average). In general, there was no consistent pattern across variables. **Figure 2** shows bottom v. surface and integrated v. surface measures for each variable. Also shown are the implied differences (ES in **Table 4**) for which $P < 0.1$ (dashed lines, which in log-log scale are parallel lines to the 1:1 line).

The key question of interest is how large are the significant depth differences compared to variation among locations and among depth replicates (sample types). As shown in **Figure 2**, differences between solid and dashed lines are minimal compared to the full data ranges. Even for Diatoms, where there is a significant 50% increase for bottom samples, it implies a change of 2 to 3, for example, while across locations, data range from 2 to 20 or more, and these differences are tracked in both bottom and surface samples.

[1] The following steps are needed for calculating ES: (1) X = log(Bottom) – log(Surface); (2) X = log(Bottom/Surface); (3) Exp(X) = Bottom/Surface; (4) ES = (Bottom – Surface)/Surface = Bottom/Surface – 1; (5) ES = Exp(X) – 1; (6) ES (%) = (Exp(X) – 1)*100.

For model 2 (Station), there was a significant depth interaction for Diatoms (p=0.002), while the next strongest station effect was for Dinoflagellatees (p-0.15; **Table 3**). Box-plots capture the marginal station-depth differences found in the Diatom data (**Figure 3**). There were clear differences at station TPS (bottom > surface or integrated), but no patterns for the other stations. Dinoflagellates were included in **Figure 3** for an additional comparison – minimal station-specific differences are observed.

For model 3 (Season), there was a significant depth interaction with season for Simpson's diversity (Table 3) when July was treated as a summer month or as a winter month. The next strongest season effects were for Diatoms and Dinoflagellates (P close to 0.05). Again, box-plots capture the season-depth differences found for Simpson's diversity (**Figure 4**), with Dinoflagellates also shown for an additional comparison. For Simpson's diversity, the data suggest lower diversity in bottom samples during winter months but little difference during summer months. For Dinoflagellates, the marginally significant seasonal differences among surface, bottom and integrated samples are subtle (minimal).

Conclusion – Analysis shows that for the few variables where there are statistically significant differences in values by depth, the magnitude of differences associated with depth is minimal compared to the magnitude of differences that occur naturally between samples and stations. We conclude that future sampling should focus on surface samples, to take advantage of the most baseline data. However, in cases where there is reason to suspect potential for large depth-specific effects, a bottom sample could be added occasionally to test for a hypothesized depth effect. Given that the CREMP is intended to monitor large-scale basin-wide changes, depth-specific sampling is less likely to be warranted for the CREMP than for other programs that have a finer scale of resolution. Depth samples were not included in power analyses later in this appendix – as with duplicate samples, the depth samples are pseudo-replicates of the surface samples with which they are associated.

5. DATA EVALUATION

Data are summarized here prior to analysis of the sampling design in the next section. Summary statistics for the data are provided in **Table 5** (excluding field duplicates and depth replicates). Biomass data are quite variable, while counts of total species and Simpson's diversity are much less variable. Total biomass is dominated by Chrysophytes. **Table 6** shows Spearman correlations among phytoplankton variables and Chlorophyll-a. Variation in total biomass reflects variation in Chrysophytes (r= 0.96), followed by Diatoms (r=0.73) and Dinoflagellates (r=0.68). Total biomass and species counts well correlated (0.77). Chlorophyll-a was only moderately correlated with Total biomass (r = 0.56) and Species counts (r = 0.55). **Tables 7-10** shows medians by station/month for Chlorophyll-a, total biomass, species counts, and Simpsons diversity, while **Figures 5-8**

show corresponding box-plots for stations INUG, SP, TPE, and TPN. Key findings include:

- Chlorophyll-a and total biomass are highest across Baker stations.
- In addition, total biomass and species counts are lower across winter months.
- There is generally high monthly variation relative to within-month sub-sample variation.
- There is some tendency for lower diversity in winter months
- Phytoplankton were clearly affected at SP in August 2008, as indicated by low values for total biomass, species counts and Simpson's diversity.

6. ANALYSIS OF SAMPLING DESIGN

Impact hypotheses and statistical design – Two general classes of impacts are hypothesized for the Meadowbank mine:

1. Pulse events for which potential impacts would be high for a short time but would then (in the case of phytoplankton) dissipate relatively quickly. Pulse events could be associated with any phase of the mine, but are more likely to be associated with particular activities such as dike construction.
2. Long-term cumulative impacts that may be associated with ongoing activities. Long-term cumulative impacts are more likely to be associated with ongoing activities of mine operations.

As operations have just begun in 2010, the focus of monitoring to date has been on detecting pulse events associated with construction. The appropriate framework for analysis is a before-after-control-impact (BACI) that is aimed at detecting a potential impact in a particular lake or basin in a particular time period. The BACI framework can also be used to evaluate long-term impacts, but other tools such as time series regression analysis may also be appropriate for evaluating long-term trends. For this design document, we focus on the use of the BACI framework, recognizing that other tools such as time series regressions may be useful at a future date once sufficient time series data are available[2].

The classic BACI (paired) design has before/after periods α_i (i = B, A; I = 2), control/impact sites β_j (j = C, I; J = 2), and a total of K paired sampling times τ_k that are

[2] In theory, a BACI analysis that is appropriately framed should be capable of detecting changes associated with long-term trends.

nested within period. A statistical model for this design is given by (Smith 2002, equation 2):

$$(1) \qquad X_{ijk} = \mu + \alpha_i + \tau_{k(i)} + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \ .$$

The key term is the interaction ($\alpha\beta$), which can be tested using an F test with F = MS[($\alpha\beta$)]/MS[Resid] and degrees of freedom = 1, $K - 2$. As discussed by Smith (2002), this is equivalent to simply taking the differences between the control and impact values across times and using a two-sample (before-after) t test (Stewart-Oaten et al. 1986).

Model (1) can be extended to include additional control sites (e.g., "asymmetric" designs; Underwood 1994) and/or additional impact sites. To be valid, the additional sites must be replicates rather than subsamples (i.e., as controls, they should be spatially independent of each other but representative of the impact sites, while replicates for impacts need to be spatially independent and (ideally) affected by independent disturbances). So whereas j = (C, I) in the classic BACIP, j may compose any combination of J total sites, for example $J = 4$ where j = (C_1, C_2, C_3, I). The general test of ($\alpha\beta$) still applies, but with degrees of freedom = $(J - 1)$, $(K - 2)(J - 1)$ (e.g., see Table 1 of Underwood (1994) and Table 9 of Smith (2002)).

In addition, there may be n replicate subsamples s at each site/time combination (jk), as assumed in Table 1 of Underwood (1994). In this case, we modify equation (1) as:

$$(2) \qquad X_{ijks} = \mu + \alpha_i + \tau_{k(i)} + \beta_j + (\alpha\beta)_{ij} + (\tau\beta)_{k(i)j} + \varepsilon_{ijks} \ ,$$

where subsamples now permit estimation of times-by-site interactions ($\tau\beta$). The appropriate F ratio for ($\alpha\beta$) is now F = MS[($\alpha\beta$)]/MS[($\tau\beta$)] with df = $(J - 1)$, $(K - 2)(J - 1)$. As Underwood demonstrates, specific comparisons (interaction terms, such as the impact site versus either "period" or a specific "time" unit) can be examined by partitioning variation accordingly (e.g., Underwood Table 2[3]).

Methods – The analysis here assessed the expected precision and power of BACI estimates for different after-period (impact) durations and different numbers of sub-samples (random spatial samples collected each month). Formal analysis of the sampling design uses Meadowbank data. Baker Lake data have only been collected since 2008, thus inferences would be limited based on the small data set. Results from Meadowbank should be generalizable to Baker Lake given that the BACI analyses below for Meadowbank compare a single control to each potential impact station individually (the same scenario as for Baker, which has one control and two impact stations). Separate analyses were conducted for the three primary impact stations SP, TPE, and TPN. In each case, INUG was used as the control station. Separate analyses were conducted for

[3] We note that there are mistakes in the tables presented by Underwood (1994).

two variables – total biomass and species counts. For each variable, the effect size or ES (fixed across months) was set at either a 20% reduction from baseline or a 50% reduction in baseline.

For purposes of the BACI analyses, the before-period data included all available control-impact paired data to represent the "before period" dataset. This assumes that these data, regardless of station or month, are reasonably representative of "natural" conditions. This provides a "worst-case" scenario because additional month-specific variation in the data caused by potential impacts at SP and TPE in particular are incorporated and assumed to be representative of baseline. If those impact cases were removed, month-specific variation would be expected be lower, and estimates of power would be expected to be higher. Therefore results for TPN should provide the best representation of power/precision.

After-period data were simulated using variances consistent with observed data. Specifically, the following mixed-effects model was fit to the "before data" for a given control-impact station pair:

$$X_{jks} = \beta_j + \tau_k + (\tau\beta)_{kj} + \varepsilon_{jks}$$

The fit provided estimates of before-period station means β_j, random-effects variances for month ($\sigma^2[\tau]$) and month-by-station ($\sigma^2[\tau\beta]$), and the residual variance for sub-samples ($\sigma^2[\varepsilon]$).

After-period data were simulated using after-period means (β_control, β _impact + **ES**) and the above variance estimates for three durations (1, 3, and 6 months) and three sub-sample scenarios (1, 2, and 3 subsamples per month). **Thus, a total of 9 scenarios of after-period duration and sub-sampling were examined.** In all cases, log-transformed data were used. For each scenario, 500 simulations were used.

<u>*Data summary*</u> – Given the methods above, when data were limited to paired data (months) with INUG, there were 25 samples for each station (**Table 11**). As noted above, values used in BACI simulations were obtained from fits of mixed-effects models to current data (the "before period"). These estimates are summarized in **Table 19**. In each case, data were paired with INUG samples (means for INUG, which were used as the after-period means, are of minor importance and are not shown). The metrics of interest are the effect sizes for log data, ES(log), and estimates of standard deviations (SD, log units). In relative terms, power will be high when ES(log) >> SD(M x S) and SD(Error), so we expect higher power for biomass and species counts at TPE.

<u>*Results*</u> – Estimates of statistical power are shown in **Table 13** and repeated in **Figure 9**. In all cases, the *a priori* hypothesis is that impacts will result in decreases, so power is

based on one-tailed tests (alpha = 0.05 and 0.10 are both shown in **Table 13**; alpha = 0.05 for **Figure 9**). For total biomass and ES = 20%, power was < 0.6 after 6 months of data (all stations). For Total biomass and ES = **50%**, power was > 0.6 after 3 months, and basically > 0.9 after 6 months. Power was higher for species counts than for total biomass. For ES = 20% and N = 2 sub-samples, power was > 0.8 after 3 months for TPE and TPN (but only around 0.5 for SP after 6 months). For ES = 50%, power was basically 100% at all stations after 3 months. In general, the number of sub-samples was not important in comparison to the number of months of sampling.

A measure of precision for BACI estimates is shown in **Figure 10**. For log data, a useful measure of precision is the coefficient of variation (CV = SE[BACI estimate]/ [BACI estimate]). Results are averages across 500 trials, and do not depend on tails or alpha. These results mirror those for power. As a rough guide, power > 80% when CV < 40%.

Conclusion – Results show that the power to detect 20% reductions in phytoplankton variables is much lower than power to detect 50% reductions. This is particularly true for total biomass, and we would expect power to be even lower for all other biomass variables (except Chrysophytes) given their higher relatively variability. Results also show that the benefits of subsampling are limited, with very little gain in power associated with more than two subsamples. In terms of duration of sampling, the results show notable increases in power associated with 3 months of sampling, and smaller increases associated with moving from 3 to 6 months.

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Table 1. Phytoplankton samples collected for the CREMP.

Notes: Duplicates and depth replicates removed. Shading denotes "Impact" periods.

Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006	Jul				1		1	1		1	1	1	1	7
	Aug				2		2	2		2	2	2	2	14
	Sep				1		1	1		1	1	1	1	7
2007	Jul				1		1	1		1	1	1	1	7
	Aug				1		1	1		1	1	1	1	7
2008	Jul	1	1	1	1		1	1		1	1	1	1	10
	Aug	1	1	1	1		1	1		1	1	1	1	10
	Sep	1	1	1			1	1		1	1	1		8
2009	Jul	3	3	3	3	3	3	3	2	3	3	3	3	35
	Aug	1	1	1	1	1	1	1	1	1	1	1	1	12
	Sep	3	3	3	3	3	3	3	3	3	3	3	3	36
	Nov				3		3	3		3	3			15
	Dec						1	1		1	1	1		5
2010	Jan						3	2		3		3		11
	Feb						1	1		1	1	1		5
	Mar						3	3		3	3	3		15
	Apr						1	1		1	1	1		5
	May						3	3		3	3	3		15
	Jul	3	3	3	3	3	3	3	3	3	3	3	3	36
	Aug	1	1	1	1	1	1	1	1	1	1	1	1	12
	Sep	3	3	3	3	3	3	3	3	3	3	3	3	36
Total		17	17	17	25	14	38	37	13	38	35	35	22	308

Table 2. Summary of statistical comparisons between sample/duplicate pairs for phytoplankton biomass variables.

Notes: N = total samples (pairs = N/2); Median = median of all samples; MAD = median absolute difference among sample/duplicate pairs; r = Spearman rank correlation among sample/duplicate pairs; SD = standard deviation of random effects for Location (variability among sample pairs) and residual errors (variability between samples and duplicates) fit to log-transformed data.

					Model SD (log data)	
Variable	N	Median	MAD	r	Location	Res. Error
Cyanophyte	74	0.19	0.17	0.46	0.728	1.058
Chlorophyte	74	4.2	1.4	0.71	0.892	0.716
Chrysophyte	74	99.2	15.4	0.87	0.820	0.265
Diatoms	74	8.6	1.5	0.93	1.672	0.343
Cryptophytes	74	8.6	3.3	0.71	0.672	0.415
Dinoflagellates	74	9.7	4.2	0.78	1.347	0.729
Total.biomass	74	148.1	14.7	0.89	0.659	0.221
Species	74	35	2	0.84	0.336	0.095
Simpsons.diversity	74	0.84	0.02	0.83	0.076	0.030

Table 3. P-values for F tests of the key fixed-effect terms for depth: Type (Model 1), Type*Station (Model 2), and Type*Season (Model 3; Seas 1).

Notes: Shaded cells denote $0.05 \leq P < 0.01$ (light shade) and $P \leq 0.01$ (dark shade). N = number of samples (locations = N/3).

		Type	Type*Station	Type*Season (Model 3)		
Variable	N	(Model 1)	(Model 2)	N	July summer	July winter
Chlorophyte	120	0.879	0.838	93	0.925	0.980
Chrysophyte	120	0.014	0.726	93	0.248	0.889
Diatoms	120	0.013	0.002	93	0.061	0.052
Cryptophytes	120	0.809	0.197	93	0.188	0.393
Dinoflagellates	120	0.098	0.154	93	0.057	0.727
Total.biomass	120	0.089	0.362	93	0.152	0.827
Species	120	0.098	0.963	93	0.456	0.097
Simpsons.diversity	120	0.471	0.836	93	0.021	0.019

Table 4. Summary of coefficients for Model 1 (log[y] ~ Type + Location).

Notes: Est = estimate; SE = standard error; P = P-value based on t-test; ES (%) = proportional effect size in untransformed units relative to surface samples, where ES (%) = (exp[Est] – 1)*100. Shaded cells denote $0.05 \leq P < 0.01$ (light shade) and $P \leq 0.01$ (dark shade).

	Bottom – Surface				Integrated - Surface			
Variable	Est	SE	P	ES (%)	Est	SE	P	ES (%)
Chlorophyte	0.037	0.163	0.823	3.7%	0.083	0.163	0.614	8.6%
Chrysophyte	-0.013	0.062	0.833	-1.3%	-0.167	0.062	0.009	-15.4%
Diatoms	0.402	0.133	0.003	49.5%	0.188	0.133	0.162	20.7%
Cryptophytes	-0.064	0.099	0.522	-6.2%	-0.023	0.099	0.820	-2.2%
Dinoflagellates	-0.309	0.213	0.151	-26.6%	-0.458	0.213	0.035	-36.7%
Total.biomass	-0.007	0.052	0.891	-0.7%	-0.104	0.052	0.049	-9.9%
Species	0.026	0.025	0.311	2.6%	-0.029	0.025	0.247	-2.9%
Simpsons div.	0.004	0.013	0.742	0.4%	0.015	0.013	0.236	1.5%

Table 5. Summary statistics for phytoplankton biomass variables across CREMP samples (control and impact).

Variable	N	N=0	Mean	Median	SD	CV
Chlorophyll a	243	0	0.46	0.38	0.31	0.67
Cyanophyte	308	145	0.62	0.05	1.19	1.93
Chlorophyte	308	1	6.62	4.77	9.04	1.37
Euglenophyte	308	302	0.02	0.00	0.20	8.23
Chrysophyte	308	0	110.7	100.0	72.8	0.66
Diatoms	308	8	15.5	11.3	17.3	1.12
Cryptophytes	308	0	10.7	7.5	10.5	0.99
Dinoflagellates	308	5	13.5	10.7	12.3	0.91
Total biomass	308	0	157.6	146.7	88.9	0.56
Total species	308	0	33.6	36.0	8.5	0.25
Simpsons diversity	308	0	0.82	0.85	0.09	0.11

Table 6. Spearman correlations among phytoplankton biomass and species variables (N = 308).

	Chloro.a	Cyano.	Chloro.	Eugleno.	Chryso.	Diatoms	Crypto.	Dino.	Tot.bio.	Species
Chlorophyll.a										
Cyanophyte	0.21									
Chlorophyte	0.41	0.42								
Euglenophyte	0.04	0.16	0.08							
Chrysophyte	0.50	0.08	0.29	0.03						
Diatoms	0.58	0.32	0.49	0.05	0.54					
Cryptophytes	0.09	-0.08	-0.09	-0.07	-0.14	-0.01				
Dinoflagellates	0.32	0.05	0.17	0.02	0.59	0.39	-0.12			
Total.biomass	0.56	0.15	0.39	0.01	0.95	0.68	0.00	0.61		
Total species	0.55	0.39	0.64	0.08	0.68	0.66	-0.09	0.43	0.74	
Simpsons div.	0.37	0.41	0.62	0.10	0.33	0.57	-0.19	0.16	0.38	0.64

Table 7. Medians of Chlorophyll-a by station and month (N = 243).

Note: Shading denotes "Impact" periods.

Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL
2006	Jul				0.40		0.19	0.13		0.24			0.40
	Aug				0.21		0.30	0.21		0.22	0.28	0.17	0.41
2007	Jul				0.52		0.60	0.46		0.36	0.37	0.40	0.53
	Aug				0.57		0.54	0.58		0.33	0.39	0.33	0.69
2008	Jul	0.93	0.44	0.80	0.51		0.34	0.31		0.40	0.36	0.39	0.56
	Aug	1.04	1.34	1.76	0.62		0.56	0.60		0.40	0.34	0.33	0.66
	Sep	0.97	0.94	0.85			0.65	1.11		0.71	0.52	0.60	
2009	May				0.34		0.56	0.34		0.13	0.37		
	Jul	0.82	1.11	1.21	0.36	0.47	0.69	0.51	0.33	0.38	0.21	0.32	0.62
	Aug	1.19	1.03	1.01	0.34	0.23	0.49	0.45	0.44	0.34	0.37	0.34	0.32
	Sep	1.19	1.05	1.41	0.54	0.47	0.52	0.28	0.16	0.20	0.29	0.27	0.33
	Nov				0.44		0.74	0.57		0.51	0.56		
	Dec						0.39	0.37		0.28	0.32	0.23	
2010	Jan						0.30	0.31		0.21	0.12	0.14	
	Feb						0.20	0.30		0.25	0.14	0.12	
	Mar						0.12	0.49		0.22	0.23	0.11	
	Apr						0.35	0.30		0.11	0.31	0.19	
	May						0.51	0.42		0.15	0.30	0.35	

Table 8. Medians of Total biomass by station and month (N = 308).

Note: Shading denotes "Impact" periods.

Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL
2006	Jul				230		142	103		142	109	107	141
	Aug				151		108	133		128	114	106	134
	Sep				216		283	202		170	127	146	326
2007	Jul				241		154	121		154	110	94	230
	Aug				121		99	111		145	109	154	203
2008	Jul	199	145	361	281		254	210		178	251	119	216
	Aug	241	213	337	173		37	144		185	174	122	168
	Sep	141	139	160			77	105		196	144	135	
2009	Jul	209	304	237	329	287	262	289	269	240	168	145	310
	Aug	316	468	184	190	122	248	144	196	262	168	224	141
	Sep	235	262	207	148	191	167	123	188	77	137	150	196
	Nov				161		144	122		97	49		
	Dec						60	105		36	48	23	
2010	Jan						46	52		39		34	
	Feb						25	85		19	28	15	
	Mar						37	91		56	33	23	
	Apr						29	36		28	30	26	
	May						89	52		35	85	22	
	Jul	337	253	283	190	296	175	179	172	98	73	73	201
	Aug	174	298	249	99	130	135	120	114	126	143	157	194
	Sep	149	146	131	162	215	246	151	110	168	162	123	167

Table 9. Medians of Species counts by station and month (N = 308).

Note: Shading denotes "Impact" periods.

Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL
2006	Jul				38		33	26		33	30	30	31
	Aug				38		35	37		34	28	35	39
	Sep				48		44	45		41	35	38	41
2007	Jul				41		37	33		36	30	30	41
	Aug				35		31	36		39	35	39	39
2008	Jul	34	32	39	37		34	36		36	37	33	38
	Aug	41	42	50	45		17	37		41	34	39	41
	Sep	37	39	37			41	36		38	38	39	
2009	Jul	39	40	39	40	39	38	36	37	38	37	34	40
	Aug	45	44	38	44	32	46	41	44	34	36	36	40
	Sep	41	42	44	40	39	44	40	40	31	37	33	45
	Nov				33		36	32		31	24		
	Dec						26	30		22	23	26	
2010	Jan						20	21		22		19	
	Feb						12	28		14	14	15	
	Mar						20	25		19	17	19	
	Apr						19	21		14	15	13	
	May						15	18		15	19	15	
	Jul	39	35	39	34	35	33	36	34	25	30	28	38
	Aug	35	37	37	38	31	34	41	31	28	34	34	44
	Sep	36	38	38	35	39	44	41	35	34	40	40	47

Table 10. Medians of Simpsons diversity by station and month (N = 308).

Note: Shading denotes "Impact" periods.

Year	Month	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL
2006	Jul				0.87		0.85	0.84		0.87	0.82	0.87	0.85
	Aug				0.91		0.83	0.85		0.85	0.84	0.87	0.85
	Sep				0.88		0.87	0.89		0.84	0.89	0.84	0.85
2007	Jul				0.80		0.79	0.84		0.78	0.80	0.82	0.79
	Aug				0.87		0.81	0.80		0.80	0.80	0.80	0.84
2008	Jul	0.83	0.87	0.89	0.84		0.77	0.87		0.86	0.64	0.85	0.89
	Aug	0.89	0.91	0.88	0.84		0.23	0.90		0.86	0.86	0.84	0.89
	Sep	0.87	0.88	0.90			0.92	0.83		0.87	0.85	0.86	
2009	Jul	0.85	0.84	0.85	0.88	0.90	0.80	0.80	0.83	0.85	0.85	0.85	0.82
	Aug	0.92	0.93	0.89	0.85	0.88	0.92	0.90	0.87	0.83	0.89	0.90	0.88
	Sep	0.92	0.89	0.91	0.90	0.88	0.90	0.89	0.89	0.89	0.90	0.88	0.89
	Nov				0.89		0.84	0.87		0.90	0.75		
	Dec						0.86	0.85		0.81	0.85	0.87	
2010	Jan						0.69	0.72		0.77		0.76	
	Feb						0.74	0.76		0.65	0.64	0.61	
	Mar						0.77	0.80		0.75	0.69	0.61	
	Apr						0.74	0.68		0.72	0.60	0.67	
	May						0.71	0.73		0.77	0.61	0.76	
	Jul	0.78	0.76	0.78	0.82	0.76	0.69	0.76	0.81	0.77	0.81	0.76	0.87
	Aug	0.88	0.85	0.82	0.89	0.84	0.86	0.89	0.83	0.84	0.86	0.84	0.90
	Sep	0.89	0.89	0.89	0.87	0.88	0.88	0.87	0.89	0.86	0.87	0.90	0.91

Table 11. Samples by station used as the "before-period" in BACI simulations.

Note: Shaded months denote periods currently designated as "impact" months (but treated as "control" data in the BACI analysis).

	INUG	SP	TPE	TPN
Jul.06	1	1	1	1
Aug.06	2	2	2	2
Sep.06	1	1	1	1
Jul.07	1	1	1	1
Aug.07	1	1	1	1
Jul.08	1	1	1	1
Aug.08	1	1	1	1
Jul.09	3	3	3	3
Aug.09	1	1	1	1
Sep.09	3	3	3	3
Nov.09	3	3	3	3
Jul.10	3	3	3	3
Aug.10	1	1	1	1
Sep.10	3	3	3	3
	25	**25**	**25**	**25**

Table 12. Summary of "before-period" mixed-effects model estimates by variable and impact station (paired with control INUG).

Notes: Station means are in raw units. Effect sizes (ES) are shown in raw and log units for ES = 20% and 50% reductions in mean. Estimates of the standard deviations (SD) for random-effects terms (Month and Month-by-Station, M x S) and residuals errors are for log-transformed data.

			ES = 20%		ES = 50%		SD (log data)		
Variable	Station	Mean	ES(raw)	ES(log)	ES(raw)	ES(log)	Month	MxS	Error
Total	SP	159.9	-32.0	-0.223	-80.0	-0.693	0.241	0.278	0.263
Biomass	TPE	144.5	-28.9	-0.223	-72.2	-0.693	0.252	0.162	0.197
	TPN	124.4	-24.9	-0.223	-62.2	-0.693	0.185	0.279	0.190
Species	SP	35.3	-7.1	-0.223	-17.7	-0.693	0.000	0.173	0.079
Counts	TPE	33.5	-6.7	-0.223	-16.8	-0.693	0.102	0.047	0.092
	TPN	33.0	-6.6	-0.223	-16.5	-0.693	0.084	0.068	0.082

Table 13. Estimates of BACI statistical power for detecting a significant decrease (one-tailed test) in a given variable by station (SP, TPE, TPN) as a function of sampling months (after period) and the number of sub-samples per month.

Note: Power is shown for two levels of alpha (0.05 and 0.10).

			alpha = 0.05			alpha = 0.10		
Variable	Months	Samples	SP	TPE	TPN	SP	TPE	TPN
Total biomass (ES = **20%**)	1	1	0.09	0.11	0.09	0.19	0.26	0.19
		2	0.11	0.15	0.11	0.20	0.25	0.21
		3	0.09	0.14	0.09	0.20	0.28	0.21
	3	1	0.11	0.18	0.13	0.21	0.31	0.23
		2	0.15	0.26	0.16	0.28	0.43	0.29
		3	0.16	0.28	0.16	0.27	0.46	0.28
	6	1	0.17	0.31	0.19	0.28	0.49	0.32
		2	0.18	0.40	0.19	0.35	0.59	0.39
		3	0.20	0.43	0.21	0.36	0.59	0.39
Total biomass (ES = **50%**)	1	1	0.32	0.55	0.37	0.47	0.71	0.51
		2	0.34	0.67	0.38	0.54	0.82	0.57
		3	0.38	0.74	0.41	0.56	0.86	0.58
	3	1	0.61	0.93	0.73	0.77	0.97	0.86
		2	0.70	0.97	0.81	0.87	1.00	0.91
		3	0.80	0.99	0.84	0.90	1.00	0.93
	6	1	0.89	0.99	0.94	0.95	1.00	0.98
		2	0.94	1.00	0.97	0.98	1.00	0.99
		3	0.95	1.00	0.98	0.98	1.00	0.99
Species counts (ES = **20%**)	1	1	0.16	0.43	0.38	0.29	0.57	0.55
		2	0.16	0.57	0.47	0.29	0.72	0.64
		3	0.16	0.66	0.52	0.30	0.80	0.70
	3	1	0.28	0.78	0.73	0.48	0.90	0.86
		2	0.36	0.93	0.87	0.50	0.97	0.95
		3	0.33	0.97	0.92	0.54	0.99	0.96
	6	1	0.51	0.97	0.96	0.71	0.99	0.98
		2	0.54	1.00	0.99	0.72	1.00	1.00
		3	0.54	1.00	1.00	0.71	1.00	1.00
Species counts (ES = **50%**)	1	1	0.77	1.00	1.00	0.88	1.00	1.00
		2	0.82	1.00	1.00	0.91	1.00	1.00
		3	0.83	1.00	1.00	0.92	1.00	1.00
	3	1	1.00	1.00	1.00	1.00	1.00	1.00
		2	0.99	1.00	1.00	1.00	1.00	1.00
		3	1.00	1.00	1.00	1.00	1.00	1.00
	6	1	1.00	1.00	1.00	1.00	1.00	1.00
		2	1.00	1.00	1.00	1.00	1.00	1.00
		3	1.00	1.00	1.00	1.00	1.00	1.00

Figure 1. Sample versus duplicate values of selected phytoplankton biomass variables (log-log scale).

Notes: If zeros were present, 0.1 was added to all values. Solid line is the 1:1 line.

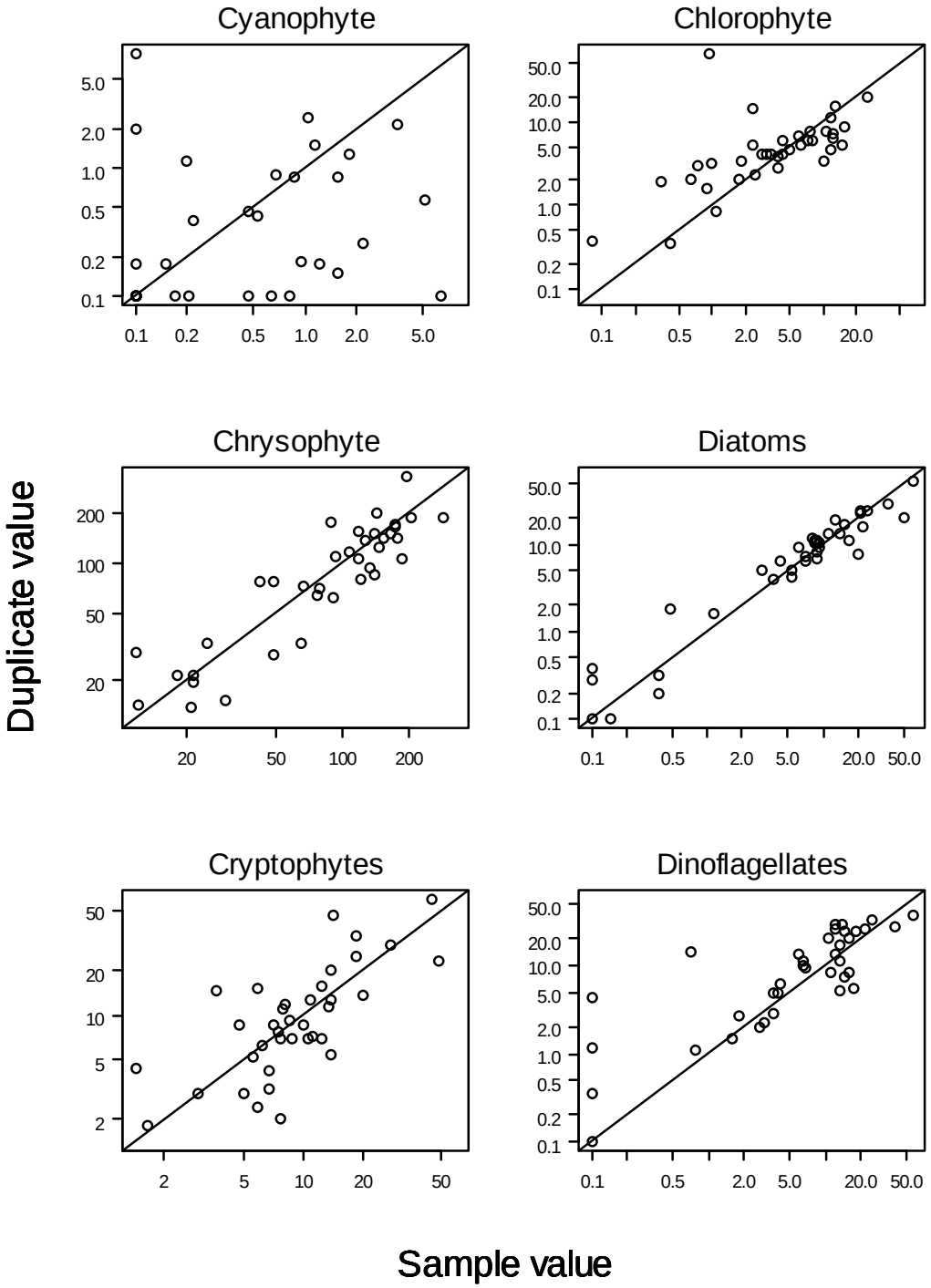


Figure 1 (page 2 of 2)

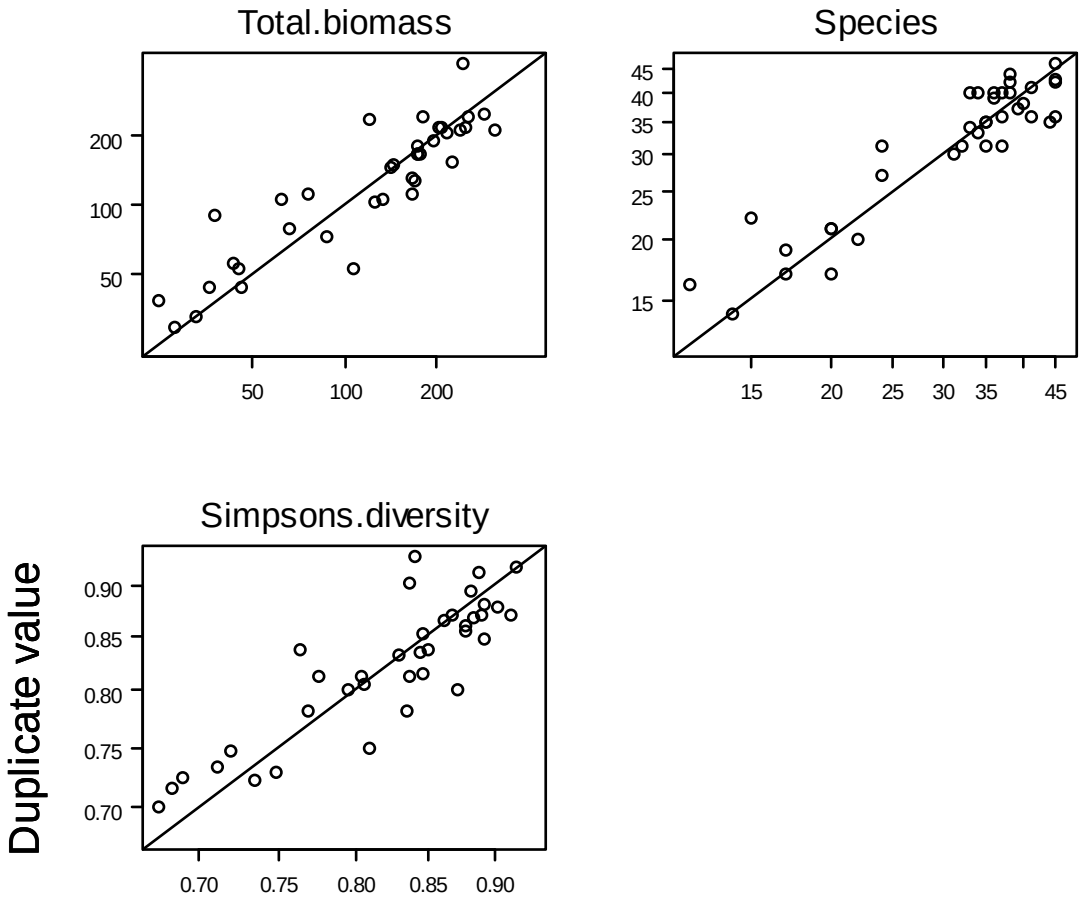


Figure 2. Surface versus Bottom samples (left side; circles) and Integrated samples (right side; triangles) for selected phytoplankton variables (log-log scale).

Notes: Dashed lines denote estimated differences (if $P < 0.1$) relative to Surface samples (see text). Solid line is the 1:1 line.

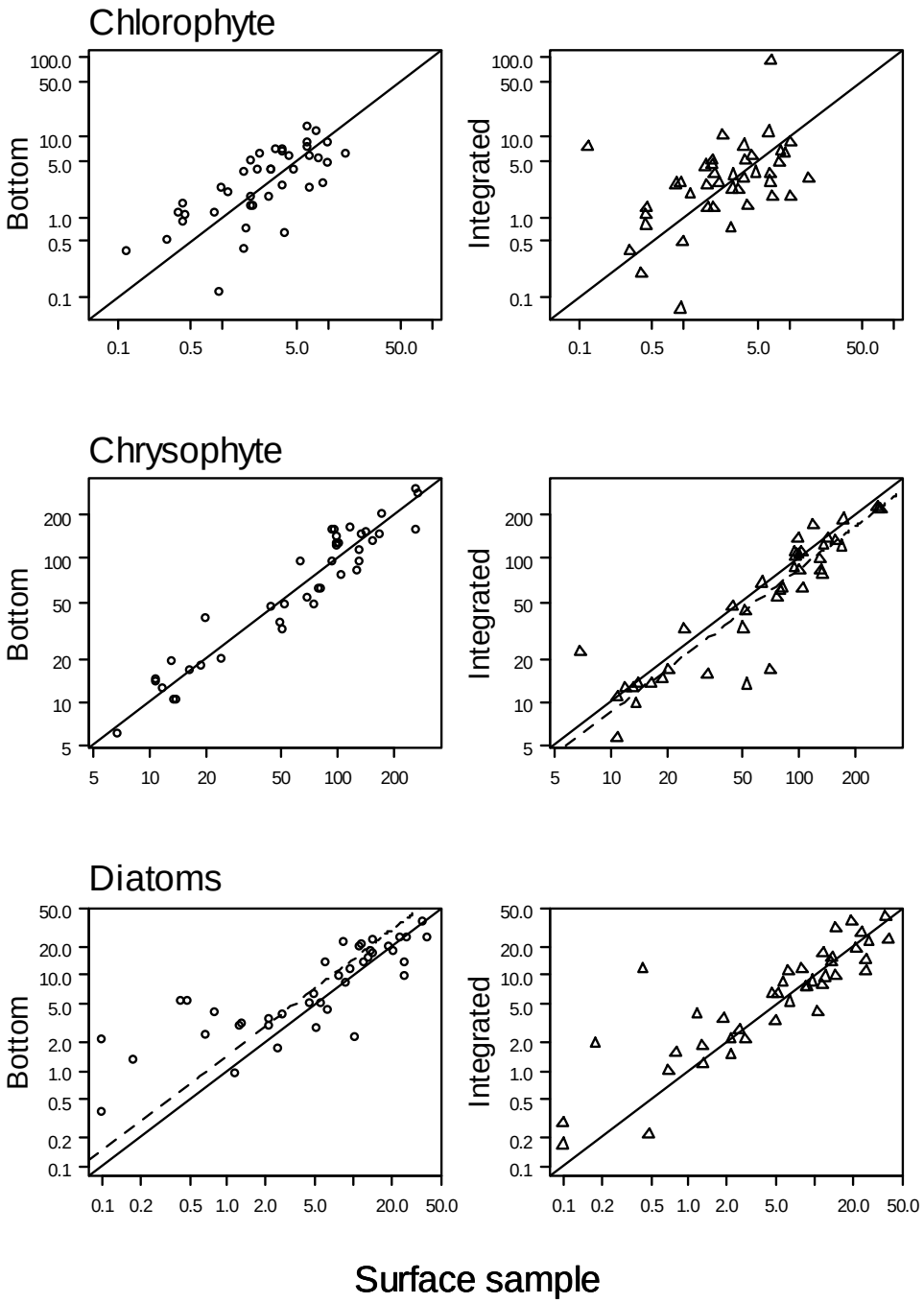


Figure 2 (page 2 of 3)

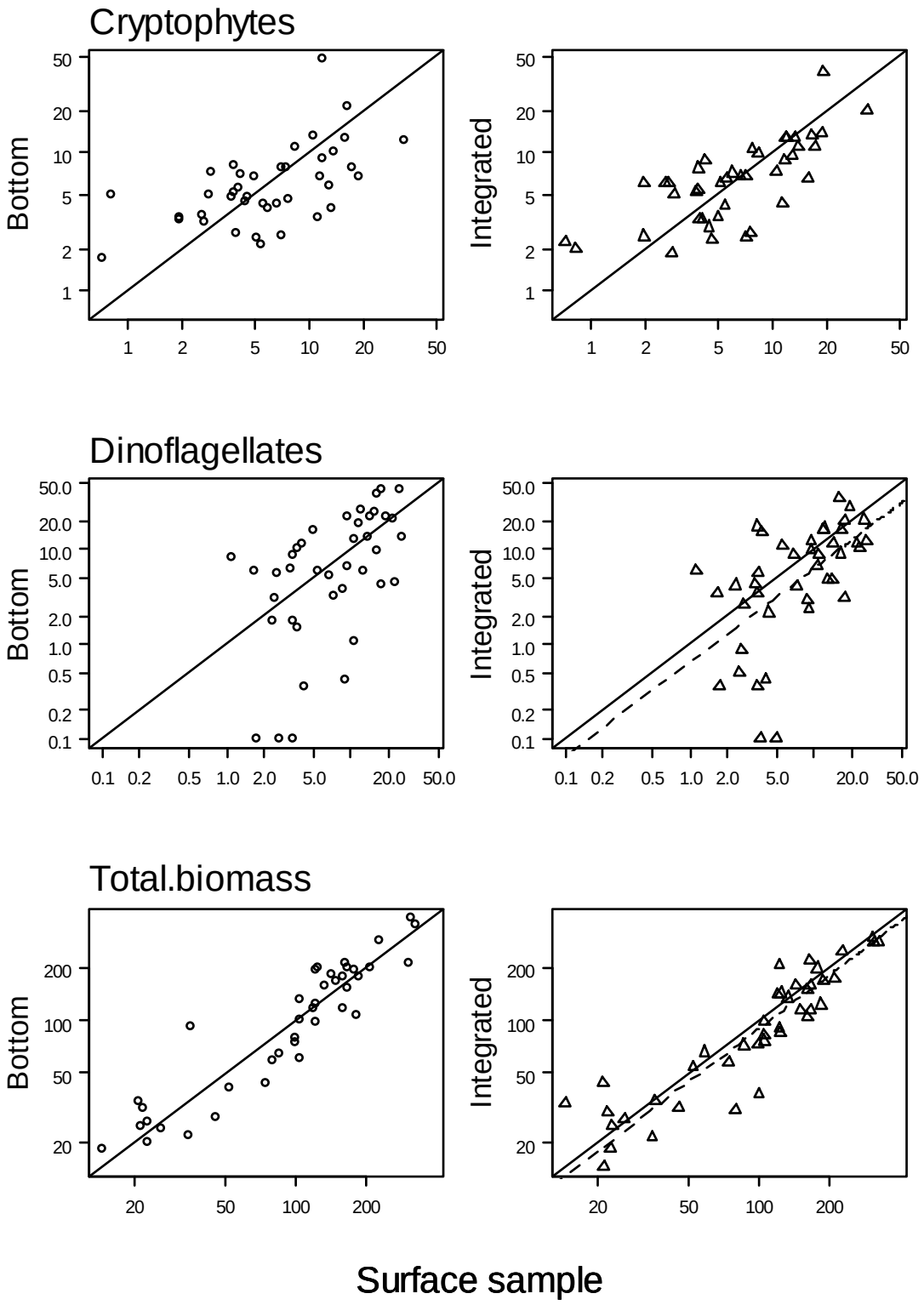
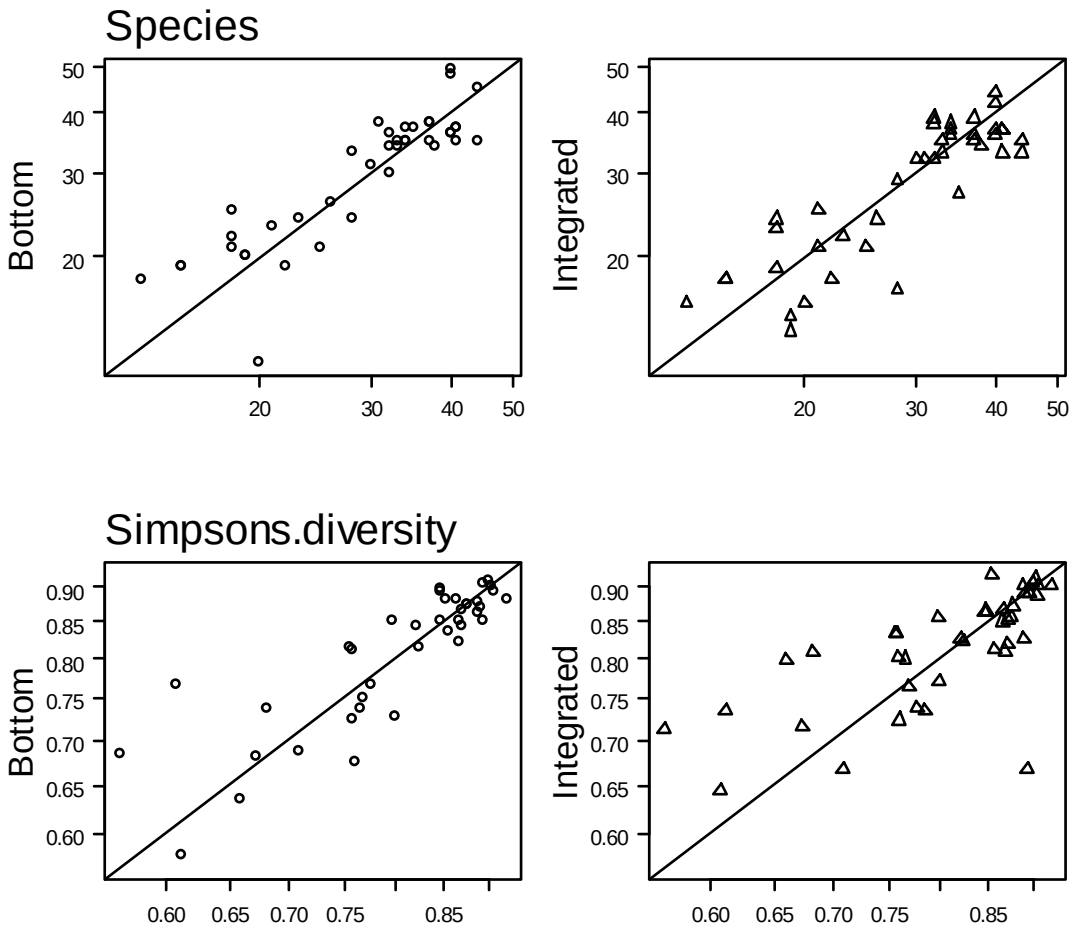


Figure 2 (page 3 of 3)



Surface sample

Figure 3. Box-plots of sample measurements by station (INUG, TE, and TPS) and depth type (.S = surface, .B = bottom, and .Int = integrated) for Diatom biomass (top panel) and Dinoflagellate biomass (bottom panel).

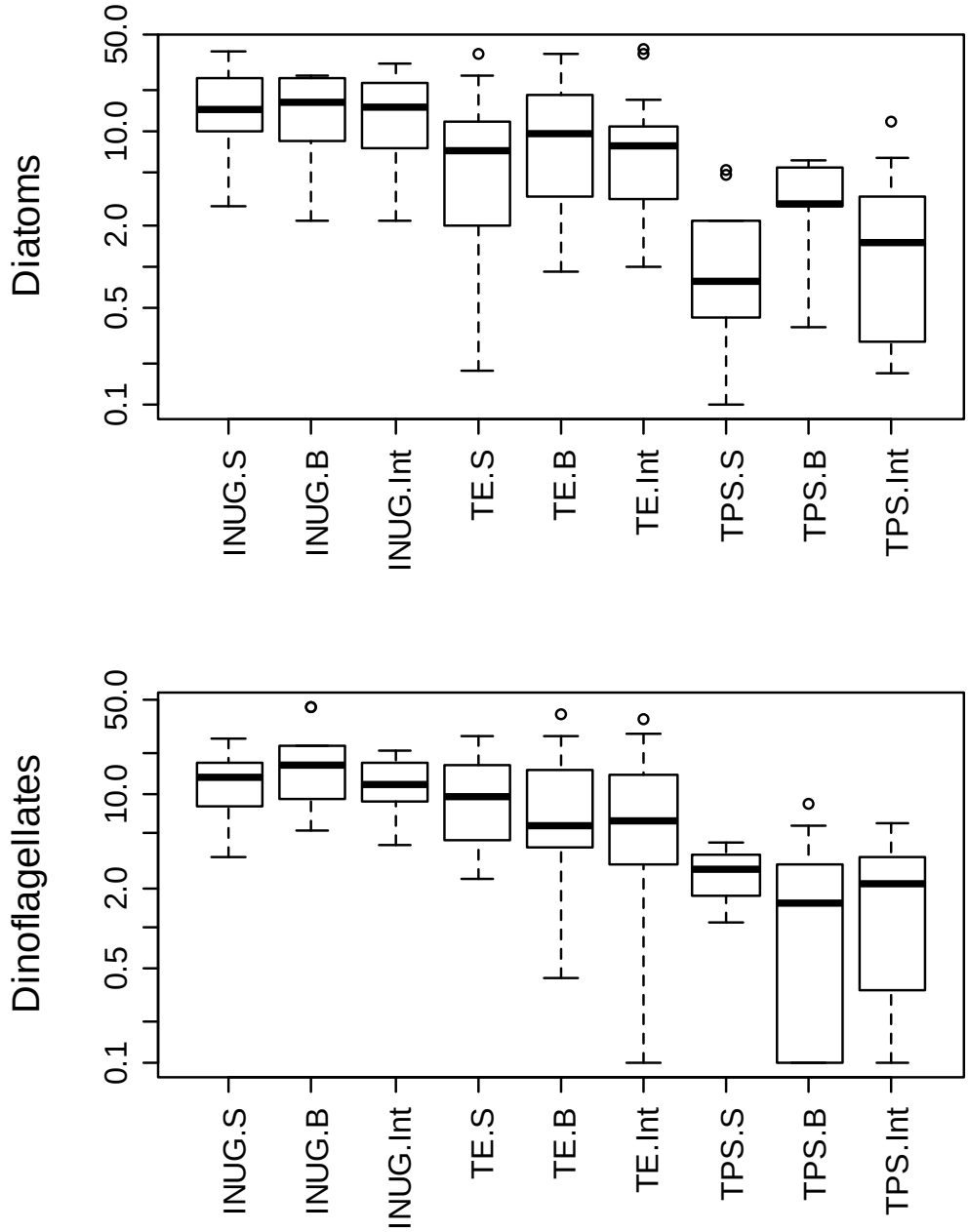


Figure 4. Box-plots of sample measurements by season (Summer or Winter) and depth type (.S = surface, .B = bottom, and .Int = integrated) for Simpson's diversity (top panels) and Dinoflagellate biomass (bottom panels).

Notes: Separate plots are shown for stations INUG (left side) and TE (right side).

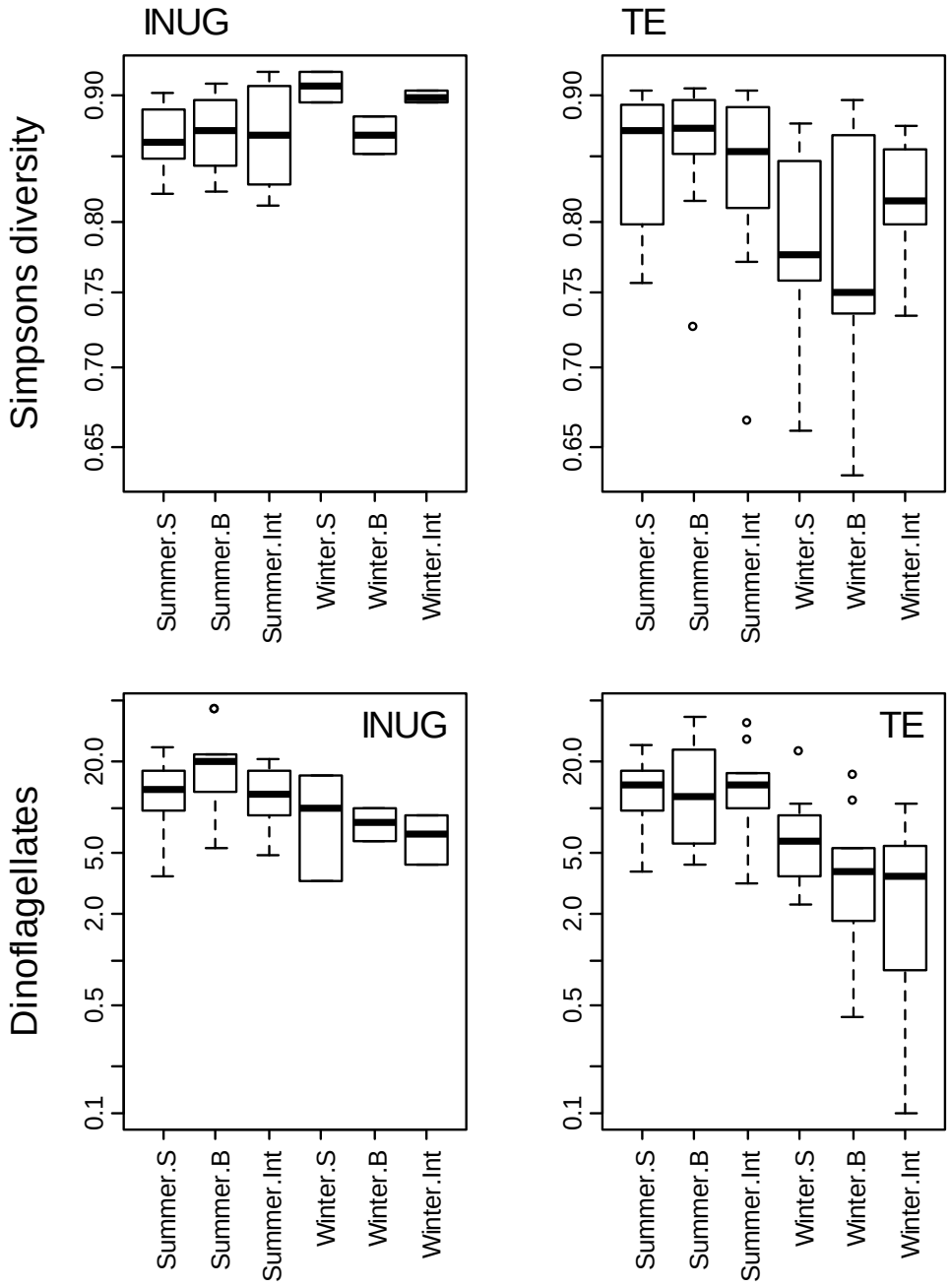


Figure 5. Box-plots of Chlorophyll-a by month for four stations (from top: INUG, SP, TPE, TPN).

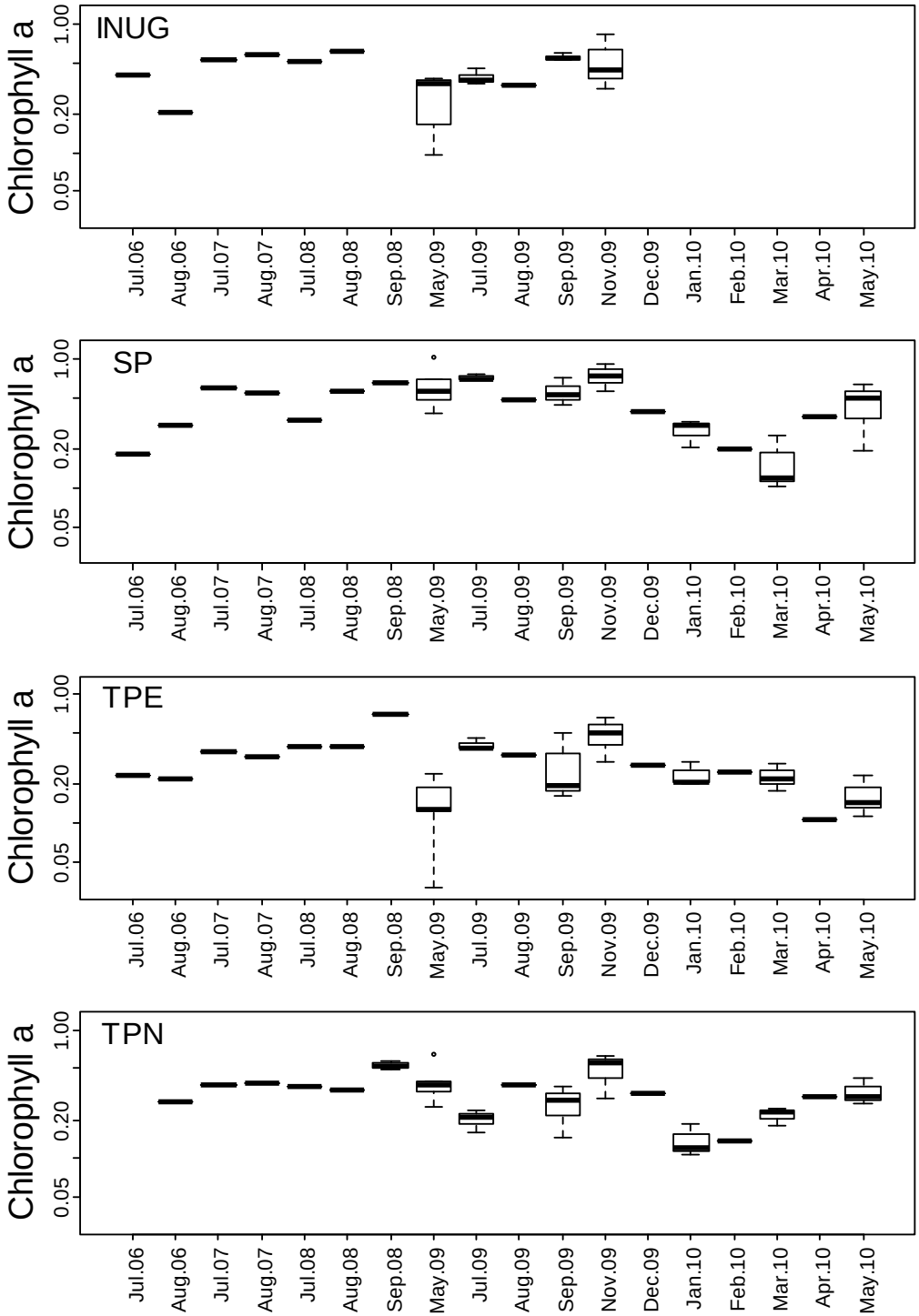


Figure 6. Box-plots of total biomass by month for four stations (from top: INUG, SP, TPE, TPN).

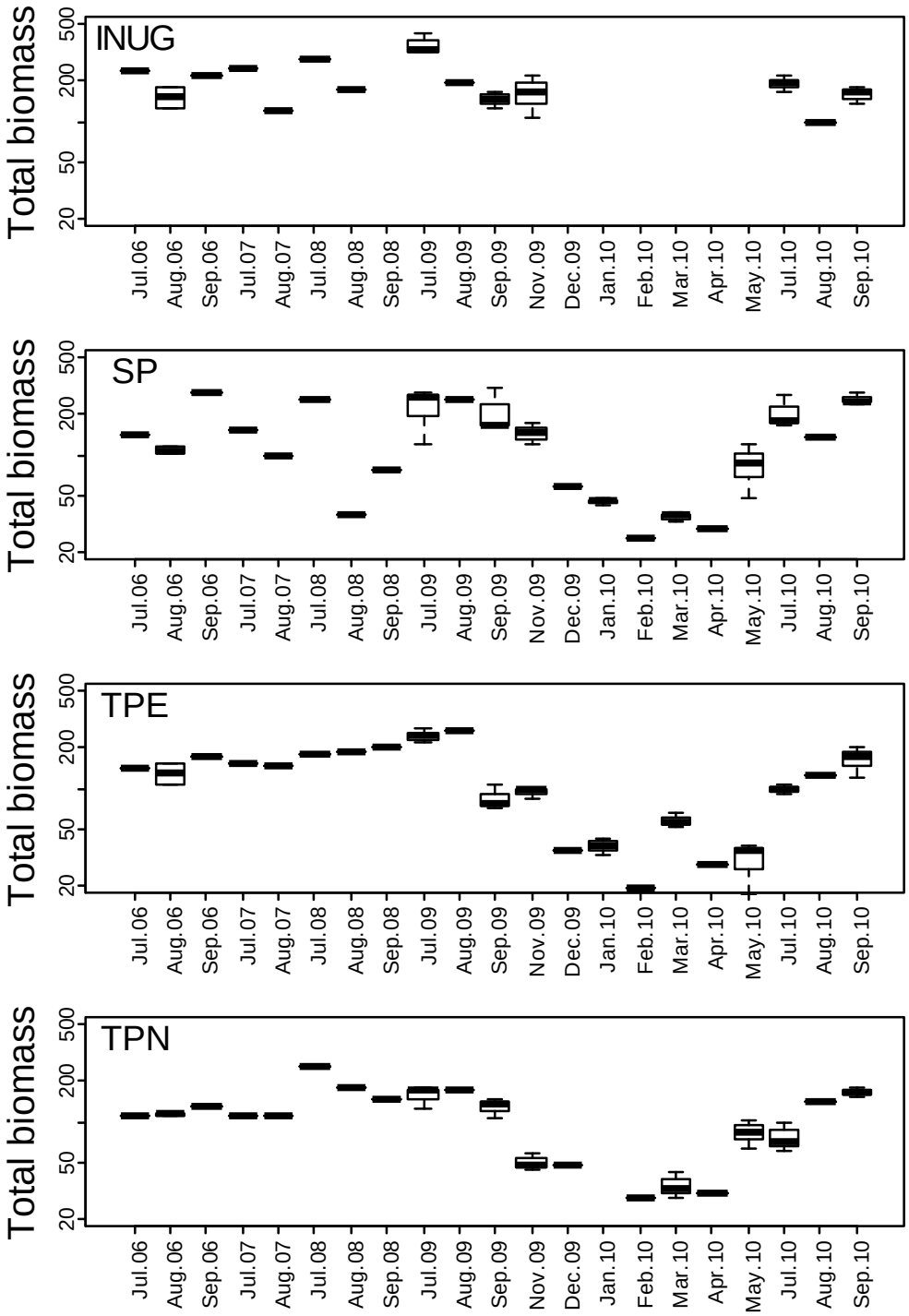


Figure 7. Box-plots of species counts by month for four stations (from top: INUG, SP, TPE, TPN).

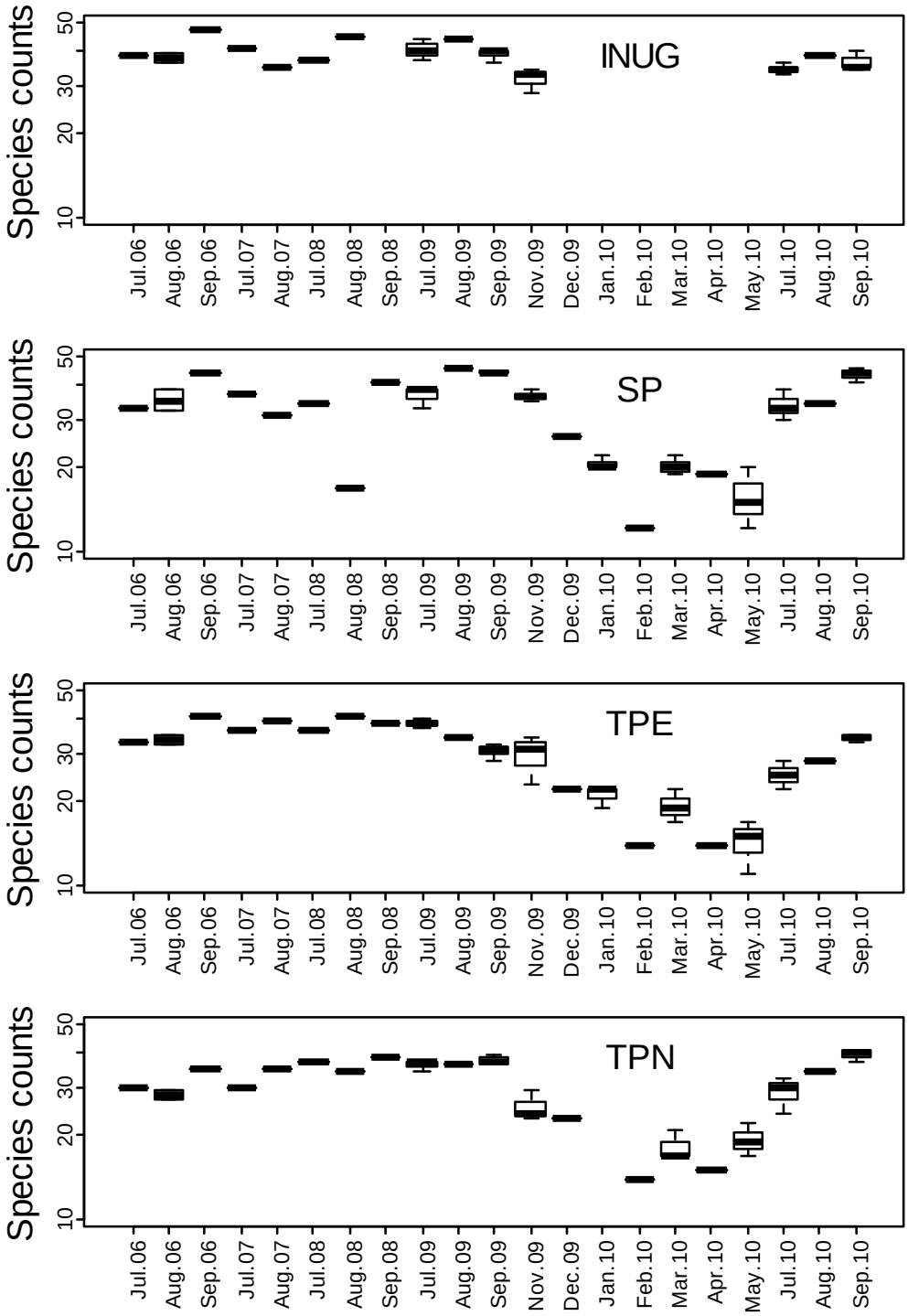


Figure 8. Box-plots of Simpsons diversity index by month for four stations (from top: INUG, SP, TPE, TPN).

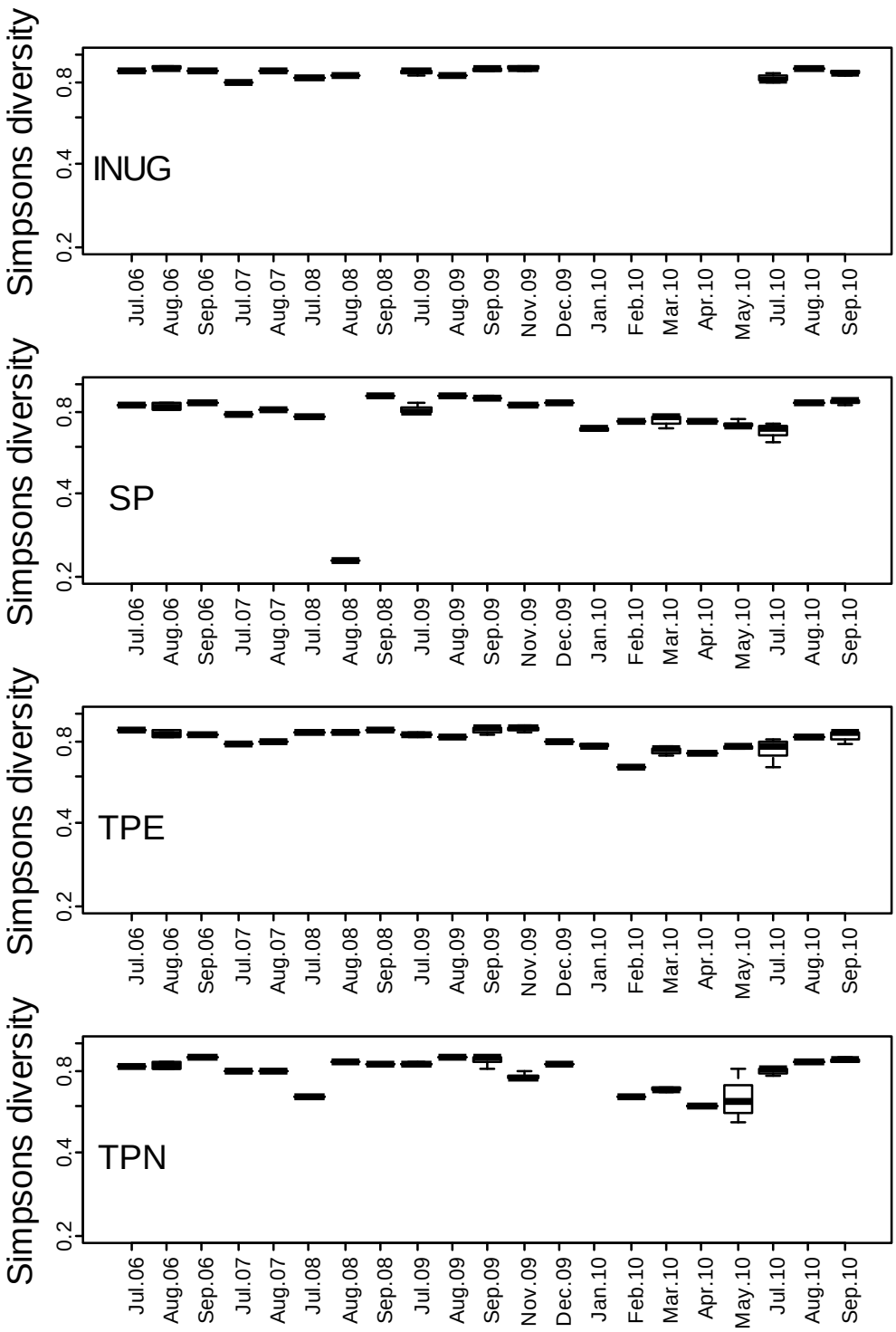


Figure 9. Estimates of BACI power for detecting a significant decrease (one-tailed, alpha = 0.05) in a given variable (Total biomass or Simpsons diversity) and effect size (rows) by station (columns) as a function of sampling months (after period) and the number of sub-samples per month (see legend).

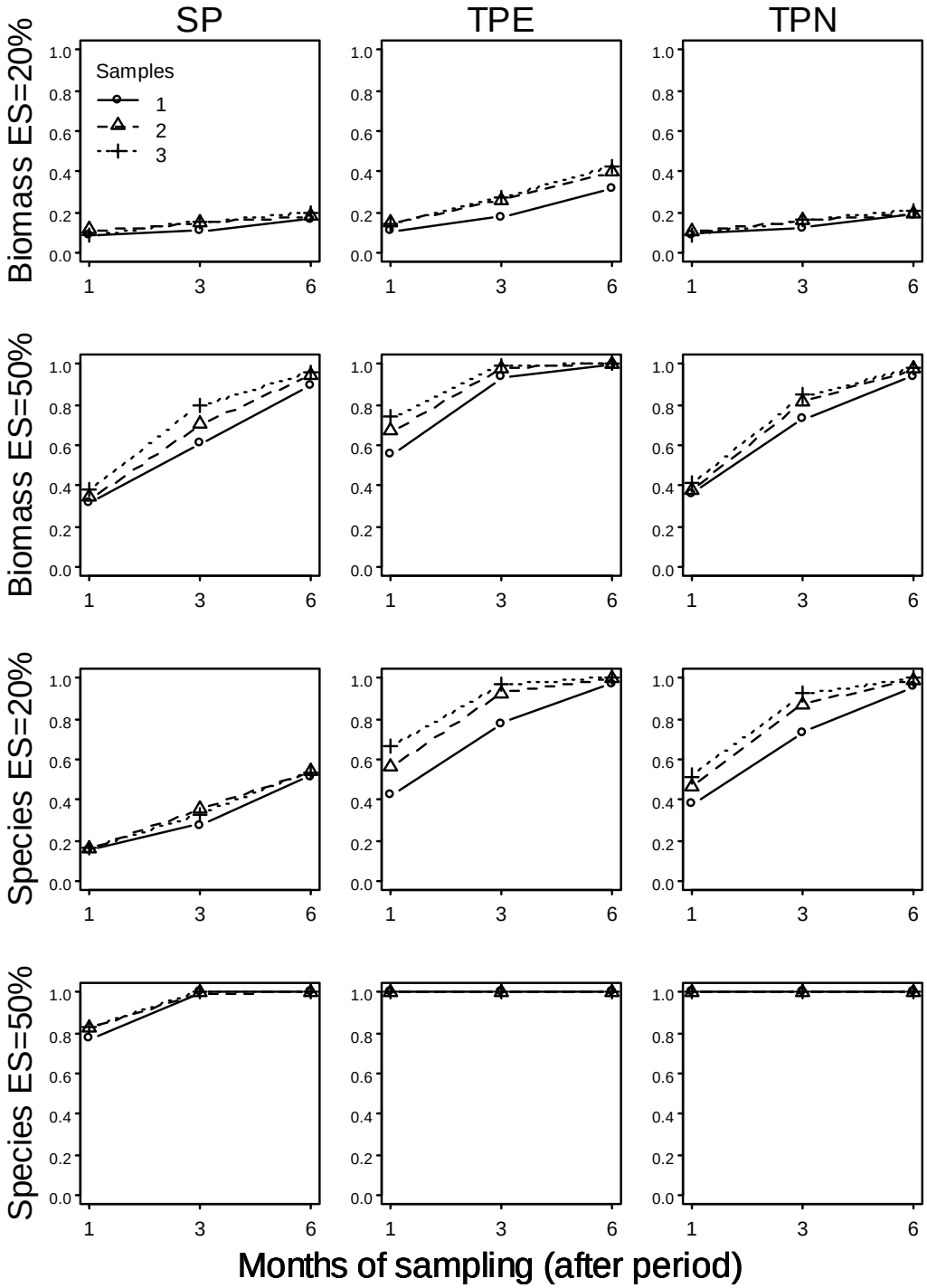
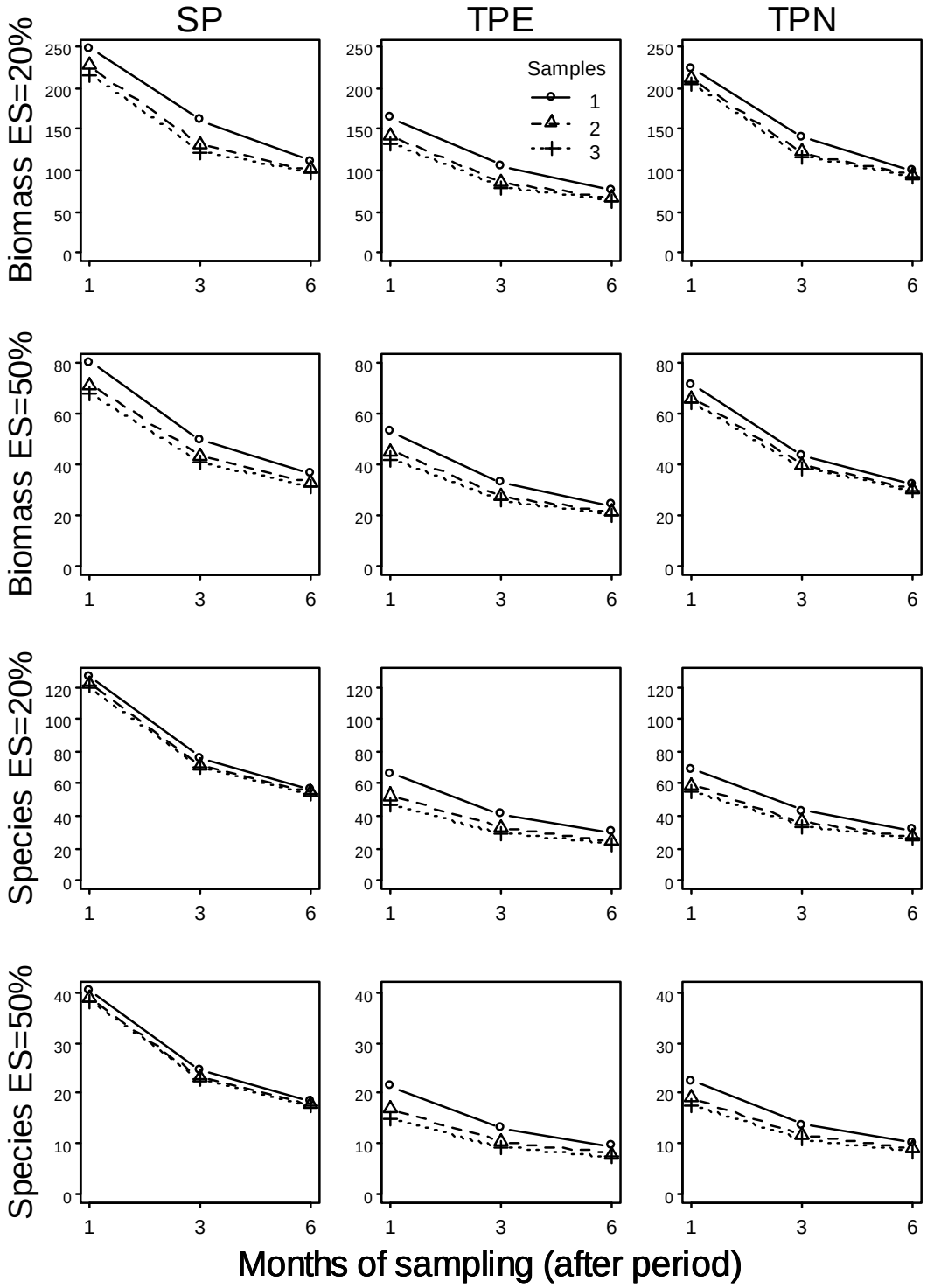


Figure 10. Coefficients of variation (%) for BACI estimates by variable (row) and station (column) as a function of sampling months (after period) and the number of sub-samples per month (see legend).



APPENDIX D – STATISTICAL ANALYSES FOR THE BENTHIC INVERTEBRATE COMMUNITY

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1. INTRODUCTION

This appendix contains the following analyses.

- Summary of CREMP benthic invertebrate samples
- Data evaluation
- Analysis of sampling design

Some text, tables and figures are repeated from the main document so that the analyses contained in this appendix can be read and understood without reference to the main document. The material in this appendix assumes understanding of basic statistical methods (Venables and Ripley 2002), mixed-effects models (Pinheiro and Bates 2000), before-after-control-impact (BACI) experimental design (Stewart-Oaten et al. 1986; Underwood 1994; Smith 2002), and use of simulation in statistical analysis (Gelman and Hill 2006).

2. SUMMARY OF CREMP BENTHIC INVERTEBRATE SAMPLES

Benthic invertebrates have been collected as part of the CREMP once each year in August from 2006 to 2010. Each sample is a composite of two Petite Ponar grabs, sieved using a 500 um mesh screen. In 2006, additional samples were collected to examine mesh size (250 um, 25 samples) and seasonal patterns (28 samples in July; 25 in September). An additional 20 replicates were collected in 2009 consisting of 1 grab per sample.

For the analyses here, we used only standard samples (August samples that were composites of two grabs and sieved with a 500 um mesh screen), except that five samples for 2006 were removed because they had been poorly preserved and were flagged in the benthos database as "do not use data.".

Thus, the data set includes 242 samples as summarized in **Table 1**. It should be noted that 2006 data include both early and late August samples. Of the total samples, 162 were designated as control and 80 samples were designated as impact (shaded cells in the table). There were no duplicate samples collected for benthos.

3. DATA EVALUATION

A summary of the variables used to represent the benthic invertebrate community is provided in **Table 2**. Abundance data (N, number/m^2) were quite variable (and dominated by insects), whereas counts of total taxa (i.e., richness) and Simpsons diversity index were much less variable. **Table 3** shows Spearman correlations among variables – across samples, variation in total abundance reflects mainly the abundance of insects (r= 0.96),

and variation in total taxa reflects mainly variation in insect taxa (r = 0.91). Total abundance and total taxa are well correlated (r = 0.74). **Tables 4-6** shows medians by station/year for total abundance, total taxa, and Simpson's diversity index, while **Figures 1-3** show corresponding box-plots for stations INUG, SP, TPE, and TPN. Baker control station (BAP) appears to have higher abundances than BBD and BPJ, but the key feature is high inter-annual variability across Baker stations (**Table 4**). BAP had a considerably higher median taxa count in all three years (**Table 5**), whereas Simpson's index was low across Baker stations in 2008 (**Table 6**). Similarly, for Meadowbank stations there is a lot of variability for total abundance and total taxa, particularly for Wally. Total abundance appears lower in 2010 than earlier years for many Meadowbank stations including INUG, SP, TE and TPE. In general, however, it is difficult to discern common patterns as there is clear inter-annual variation within and between stations.

4. ANALYSIS OF SAMPLING DESIGN

Impact hypotheses and statistical design – Two general classes of impacts are hypothesized for the Meadowbank mine:

1. Pulse events for which potential impacts would be high for a short time and then may or may not dissipate relatively quickly. Pulse events could be associated with any phase of the mine, but are more likely to be associated with particular activities such as dike construction.
2. Long-term cumulative impacts that may be associated with ongoing activities. Long-term cumulative impacts are more likely to be associated with ongoing activities of mine operations.

As operations have just begun in 2010, the focus of monitoring to date has been on detecting pulse events associated with construction. The appropriate framework for analysis is a before-after-control-impact (BACI) that is aimed at detecting a potential impact in a particular lake or basin in a particular time period. The BACI framework can also be used to evaluate long-term impacts, but other tools such as time series regression analysis may also be appropriate for evaluating long-term trends. For this design document, we focus on the use of the BACI framework, recognizing that other tools such as time series regressions may be useful at a future date once sufficient time series data are available[1].

The classic BACI (paired) design has before/after periods α_i (i = B, A; I = 2), control/impact sites β_j (j = C, I; J = 2), and a total of K paired sampling times τ_k that are

[1] In theory, a BACI analysis that is appropriately framed should be capable of detecting changes associated with long-term trends.

nested within period. A statistical model for this design is given by (Smith 2002, equation 2):

$$(1) \qquad X_{ijk} = \mu + \alpha_i + \tau_{k(i)} + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \ .$$

The key term is the interaction ($\alpha\beta$), which can be tested using an F test with F = MS[($\alpha\beta$)]/MS[Resid] and degrees of freedom = 1, $K - 2$. As discussed by Smith (2002), this is equivalent to simply taking the differences between the control and impact values across times and using a two-sample (before-after) t test (Stewart-Oaten et al. 1986).

Model (1) can be extended to include additional control sites (e.g., "asymmetric" designs; Underwood 1994) and/or additional impact sites. To be valid, the additional sites must be replicates rather than subsamples (i.e., as controls, they should be spatially independent of each other but representative of the impact sites, while replicates for impacts need to be spatially independent and (ideally) affected by independent disturbances). So whereas j = (C, I) in the classic BACIP, j may compose any combination of J total sites, for example $J = 4$ where j = (C_1, C_2, C_3, I). The general test of ($\alpha\beta$) still applies, but with degrees of freedom = ($J - 1$), ($K - 2$)($J - 1$) (e.g., see Table 1 of Underwood (1994) and Table 9 of Smith (2002)).

In addition, there may be n replicate subsamples s at each site/time combination (jk), as assumed in Table 1 of Underwood (1994). In this case, we modify equation (1) as:

$$(2) \qquad X_{ijks} = \mu + \alpha_i + \tau_{k(i)} + \beta_j + (\alpha\beta)_{ij} + (\tau\beta)_{k(i)j} + \varepsilon_{ijks} \ ,$$

where subsamples now permit estimation of times-by-site interactions ($\tau\beta$). The appropriate F ratio for ($\alpha\beta$) is now F = MS[($\alpha\beta$)]/MS[($\tau\beta$)] with df = ($J - 1$), ($K - 2$)($J - 1$). As Underwood demonstrates, specific comparisons (interaction terms, such as the impact site versus either "period" or a specific "time" unit) can be examined by partitioning variation accordingly (e.g., Underwood Table 2[2]).

Methods – The analysis here assessed the expected precision and power of BACI estimates for different after-period (impact) durations and different numbers of sub-samples (random spatial replicates collected at the same station during the sampling event each August). Formal analysis of the sampling design uses Meadowbank data. Baker Lake data have only been collected since 2008, thus inferences would be limited based on the small data set. Results from Meadowbank should be generalizable to Baker Lake given that the BACI analyses below for Meadowbank compare a single control to each potential impact station individually (the same scenario as for Baker, which has one control and two impact stations). Separate analyses were conducted for the three primary impact stations SP, TPE, and TPN. In each case, INUG was used as the control station. Separate analyses were conducted for two variables – total abundance and total taxa. For

[2] We note that there are mistakes in the tables presented by Underwood (1994).

each variable, the effect size or ES (fixed across months) was set at either a 20% reduction from baseline or a 50% reduction in baseline.

For purposes of the BACI analyses, the before-period data included all available control-impact paired data to represent the "before period" dataset. This assumes that these data, regardless of station or year, are reasonably representative of "natural" conditions. This provides a "worst-case" scenario because additional year-specific variation in the data caused by potential impacts at SP and TPE in particular (e.g., reduced abundance at SP in 2008 – see **Figure 1**) are incorporated and assumed to be representative of baseline. If those impact cases were removed, month-specific variation would be expected be lower, and estimates of power would be expected to be higher.

After-period data were simulated using variances consistent with observed data. Specifically, the following mixed-effects model was fit to the "before data" for a given control-impact station pair:

$$X_{jks} = \beta_j + \tau_k + (\tau\beta)_{kj} + \varepsilon_{jks}$$

The fit provided estimates of before-period station means β_j, random-effects variances for year ($\sigma^2[\tau]$) and year-by-station ($\sigma^2[\tau\beta]$), and the residual variance for sub-samples ($\sigma^2[\varepsilon]$).

After-period data were simulated using after-period means (β_control, β _impact + **ES**) and the above variance estimates for three durations (1, 2 and 3 years) and four sub-sample scenarios (3, 5, 10 and 20 subsamples per year). **Thus, a total of 12 scenarios of after-period duration and sub-sampling were examined.** In all cases, log-transformed data were used. For each scenario, 500 simulations were used.

Data summary – Given the methods above, the available before data included 26 samples for INUG, SP and TPE, and 23 samples for TPN (**Table 1**). As noted above, values used in BACI simulations were obtained from fits of mixed-effects models to current data (the "before period"). These estimates are summarized in **Table 7**. The metrics of interest are the effect sizes for log data, ES(log), and estimates of standard deviations (SD, log units). In relative terms, power will be high when ES(log) >> SD(Y x S) and SD(Error), so we expect relatively higher power for total abundance for station TPN, and for total taxa at stations SP and TPE.

Results – Estimates of statistical power are shown in **Table 8** for total abundance and **Table 9** for total taxa, and are repeated in **Figure 4**. In all cases, the *a priori* hypothesis is that impacts will result in decreases, so power is based on one-tailed tests (alpha = 0.05 and 0.10 are both shown in **Tables 8 and 9**; alpha = 0.05 for **Figure 4**).

For total abundance and ES = 20%, power was < 0.35 after 3 years of data regardless of station, number of samples, or α level (Table 8). For ES = 50% and $\alpha = 0.05$, power only exceeded 0.8 for TPN. For example, power = 0.82 after 2 years and samples = 10, or 0.92 for samples = 20. For ES = 50% but with a less stringent $\alpha = 0.10$, power exceeded > 0.8 after one year for TPN (but only for samples = 20) and after three years for SP and TPE (for most sample cases).

Power was higher for total taxa counts (**Table 9**, **Figure 4**). Nevertheless, it is still very difficult to detect an ES of 20% even after 3 years. For TPE, power > 0.8 after two years when $\alpha = 0.10$ and samples = 10. For ES = 50%, power > 0.8 or 0.9 after one year in most cases when samples =5 or more.

A measure of precision for BACI estimates is shown in **Figure 5**. For log data, a useful measure of precision is the coefficient of variation (CV = SE[BACI estimate]/ [BACI estimate]). Results are averages across 500 trials, and do not depend on tails or alpha. These results mirror those for power. As a rough guide, power > 80% ($\alpha = 0.05$) when CV < 40%.

Conclusion – Under the BACI model, the presence of year-by-station effects (i.e., natural station-specific inter-annual variation) will make it very difficult to distinguish between impacts and natural variations given only one year of "impact" data (or after several years for relatively minor effects such as ES = 20%). Additional sub-sampling (e.g., n = 10) may improve precision and power considerably in specific situations: that is, when year-by-station effects are relatively low compared to sub-sample variation (e.g., total abundance for TPN, where SD(YxS) = 0.098 and SD(Error) = 0.562; **Table 7**). Many plots for power and CV show useful improvements for n = 10 compared to n = 5. In general, the benthic program has limited power compared to some other programs, but it does have reasonable power to detect large changes in a given year (e.g., ES = 50% for total taxa).

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Table 1. Summary of August benthic invertebrate samples for the CREMP (mesh size = 500 um)

Note: Shading denotes "Impact" periods.

Year	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL	Total
2006				6		6	4		6	3	6	6	37
2007				5		5	5		5	5	5	5	35
2008	5	5	5	5		5	5		5	5	5	5	50
2009	5	5	5	5	5	5	5	5	5	5	5	5	60
2010	5	5	5	5	5	5	5	5	5	5	5	5	60
Total	15	15	15	26	10	26	24	10	26	23	26	26	242

Table 2. Summary statistics for benthic invertebrate variables across August CREMP samples (control and impact).

Note: CV = Coefficient of variation (SD/Mean).

Variable	N	N=0	Mean	Median	SD	CV
Total abundance (N)	242	0	2065	1174	2512	1.22
Oligochaete N	242	99	163	22	770	4.74
Insect N	242	0	1488	728	2181	1.47
Mollusc N	242	15	355	326	281	0.79
Total taxa	242	1	10.4	10.0	4.0	0.38
Oligochaete taxa	242	112	0.8	1.0	1.0	1.23
Insect taxa	242	1	7.5	7.0	3.2	0.42
Mollusc taxa	242	15	1.2	1.0	0.6	0.52
Simpson's diversity	240	0	0.8	0.8	0.1	0.16

Table 3. Spearman correlations among benthic invertebrate variables (N = 242).

	Total.N	Oligo.N	Insect.N	Mollusc.N	Tot.taxa	Oligo.taxa	Insect.taxa	Mollusc.taxa
Total.N								
Oligochaete.N	0.43							
Insect.N	0.96	0.37						
Mollusc.N	0.52	0.17	0.35					
Total.taxa	0.74	0.47	0.71	0.34				
Oligochaete.taxa	0.34	0.84	0.29	0.10	0.49			
Insect.taxa	0.71	0.29	0.73	0.24	0.91	0.26		
Mollusc.taxa	0.20	0.06	0.12	0.41	0.29	0.01	0.07	
Simpson's div.	-0.12	0.14	-0.08	-0.12	0.29	0.20	0.29	-0.05

Table 4. Medians of Total N (abundance/m^2) by station and year (N = 242).

Note: Shading denotes "Impact" periods.

Station	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL
2006				1109		674	1000		2620	2043	1163	11848
2007				848		978	870		1609	1326	1130	4478
2008	2935	6717	1891	1239		457	761		5261	1326	1674	587
2009	4761	174	326	1130	1348	804	848	1196	1826	1174	2022	1478
2010	8217	1000	457	630	1043	217	630	935	1152	1435	1587	1065

Table 5. Medians of Total taxa counts by station and year (N = 242).

Note: Shading denotes "Impact" periods.

Station	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL
2006				12		8	9		11	13	12	11
2007				12		10	10		10	11	9	13
2008	16	10	9	14		7	10		15	9	10	7
2009	20	6	7	15	11	7	7	11	12	9	11	10
2010	22	10	8	7	8	5	7	11	10	11	9	11

Table 6. Medians of Simpson's diversity by station and year (N = 242).

Note: Shading denotes "Impact" periods.

Station	BAP	BBD	BPJ	INUG	PDL	SP	TE	TEFF	TPE	TPN	TPS	WAL
2006				0.83		0.76	0.68		0.76	0.86	0.87	0.54
2007				0.86		0.82	0.77		0.81	0.81	0.83	0.72
2008	0.54	0.46	0.57	0.86		0.81	0.83		0.72	0.66	0.78	0.79
2009	0.89	0.88	0.90	0.88	0.81	0.77	0.79	0.84	0.83	0.78	0.84	0.79
2010	0.89	0.82	0.85	0.77	0.77	0.76	0.74	0.81	0.81	0.75	0.77	0.78

Table 7. Summary of "before-period" mixed-effects model estimates by variable and impact station (paired with control INUG).

Notes: Station means are in raw units. Effect sizes (ES) are shown in raw and log units for ES = 20% and 50% reductions in mean. Estimates of the standard deviations (SD) for random-effects terms (Year and Year-by-Station, Y x S) and residuals errors are for log-transformed data.

			ES = 20%		ES = 50%		SD (log data)		
Variable	Station	Mean	ES(raw)	ES(log)	ES(raw)	ES(log)	Year	YxS	Error
Total N	SP	548	-110	-0.223	-274	-0.693	0.278	0.268	0.447
	TPE	2086	-417	-0.223	-1043	-0.693	0.359	0.246	0.409
	TPN	1201	-240	-0.223	-600	-0.693	0.000	0.098	0.562
Total taxa	SP	6.6	-1.3	-0.223	-3.3	-0.693	0.214	0.000	0.310
	TPE	11.0	-2.2	-0.223	-5.5	-0.693	0.141	0.000	0.232
	TPN	9.5	-1.9	-0.223	-4.8	-0.693	0.000	0.135	0.298

Table 8. Total abundance: Estimates of BACI statistical power for detecting a significant decrease (one-tailed test) in total abundance/m^2 by station (SP, TPE, TPN) as a function of sampling years (after period) and the number of sub-samples per year.

Notes: Power is shown for two simulated effect sizes (ES = 20% and 50% reductions) and two levels of alpha (0.05 and 0.10). Light shading denotes power ≥ 0.8; dark shading denotes power ≥ 0.9.

Effect			**α = 0.05**			**α = 0.10**		
Size	Years	Samples	SP	TPE	TPN	SP	TPE	TPN
20%	1	3	0.03	0.04	0.05	0.12	0.13	0.16
		5	0.03	0.03	0.03	0.11	0.11	0.12
		10	0.03	0.03	0.05	0.13	0.14	0.21
		20	0.04	0.04	0.05	0.12	0.12	0.18
	2	3	0.05	0.05	0.05	0.15	0.16	0.19
		5	0.06	0.07	0.08	0.18	0.20	0.20
		10	0.09	0.10	0.09	0.18	0.19	0.25
		20	0.06	0.07	0.08	0.20	0.22	0.26
	3	3	0.06	0.07	0.08	0.18	0.19	0.21
		5	0.07	0.08	0.09	0.18	0.19	0.25
		10	0.06	0.07	0.09	0.20	0.23	0.28
		20	0.10	0.11	0.10	0.20	0.24	0.33
50%	1	3	0.15	0.19	0.22	0.36	0.41	0.42
		5	0.16	0.19	0.29	0.41	0.46	0.55
		10	0.22	0.27	0.55	0.47	0.53	0.76
		20	0.22	0.28	0.68	0.46	0.52	0.88
	2	3	0.33	0.40	0.43	0.58	0.66	0.67
		5	0.42	0.48	0.63	0.65	0.73	0.84
		10	0.45	0.55	0.82	0.71	0.76	0.95
		20	0.51	0.59	0.92	0.74	0.79	0.99
	3	3	0.47	0.54	0.62	0.74	0.80	0.80
		5	0.56	0.64	0.76	0.80	0.84	0.92
		10	0.64	0.71	0.91	0.82	0.88	0.98
		20	0.68	0.76	0.99	0.87	0.93	1.00

Table 9. Total taxa: Estimates of BACI statistical power for detecting a significant decrease (one-tailed test) in total taxa counts by station (SP, TPE, TPN) as a function of sampling years (after period) and the number of sub-samples per year.

Notes: Power is shown for two simulated effect sizes (ES = 20% and 50% reductions) and two levels of alpha (0.05 and 0.10). Light shading denotes power ≥ 0.8; dark shading denotes power ≥ 0.9.

Effect			**α = 0.05**			**α = 0.10**		
Size	Years	Samples	SP	TPE	TPN	SP	TPE	TPN
20%	1	3	0.10	0.15	0.07	0.23	0.32	0.19
		5	0.10	0.19	0.05	0.27	0.43	0.17
		10	0.22	0.41	0.08	0.47	0.65	0.22
		20	0.27	0.58	0.07	0.62	0.83	0.21
	2	3	0.16	0.28	0.11	0.35	0.51	0.24
		5	0.23	0.45	0.14	0.49	0.67	0.31
		10	0.33	0.61	0.16	0.61	0.84	0.36
		20	0.43	0.79	0.19	0.76	0.97	0.40
	3	3	0.24	0.43	0.15	0.47	0.64	0.31
		5	0.31	0.56	0.17	0.56	0.78	0.38
		10	0.42	0.72	0.21	0.69	0.92	0.46
		20	0.60	0.94	0.25	0.88	0.99	0.47
50%	1	3	0.71	0.94	0.46	0.88	0.98	0.73
		5	0.88	0.99	0.57	0.97	1.00	0.81
		10	0.99	1.00	0.74	1.00	1.00	0.90
		20	1.00	1.00	0.79	1.00	1.00	0.93
	2	3	0.96	1.00	0.82	0.99	1.00	0.92
		5	0.99	1.00	0.92	1.00	1.00	0.97
		10	1.00	1.00	0.96	1.00	1.00	1.00
		20	1.00	1.00	0.98	1.00	1.00	1.00
	3	3	0.99	1.00	0.94	1.00	1.00	0.99
		5	1.00	1.00	0.99	1.00	1.00	1.00
		10	1.00	1.00	0.99	1.00	1.00	1.00
		20	1.00	1.00	1.00	1.00	1.00	1.00

Figure 1. Box-plots of Total abundance for August benthic samples (stations INUG, SP, TPE, TPN).

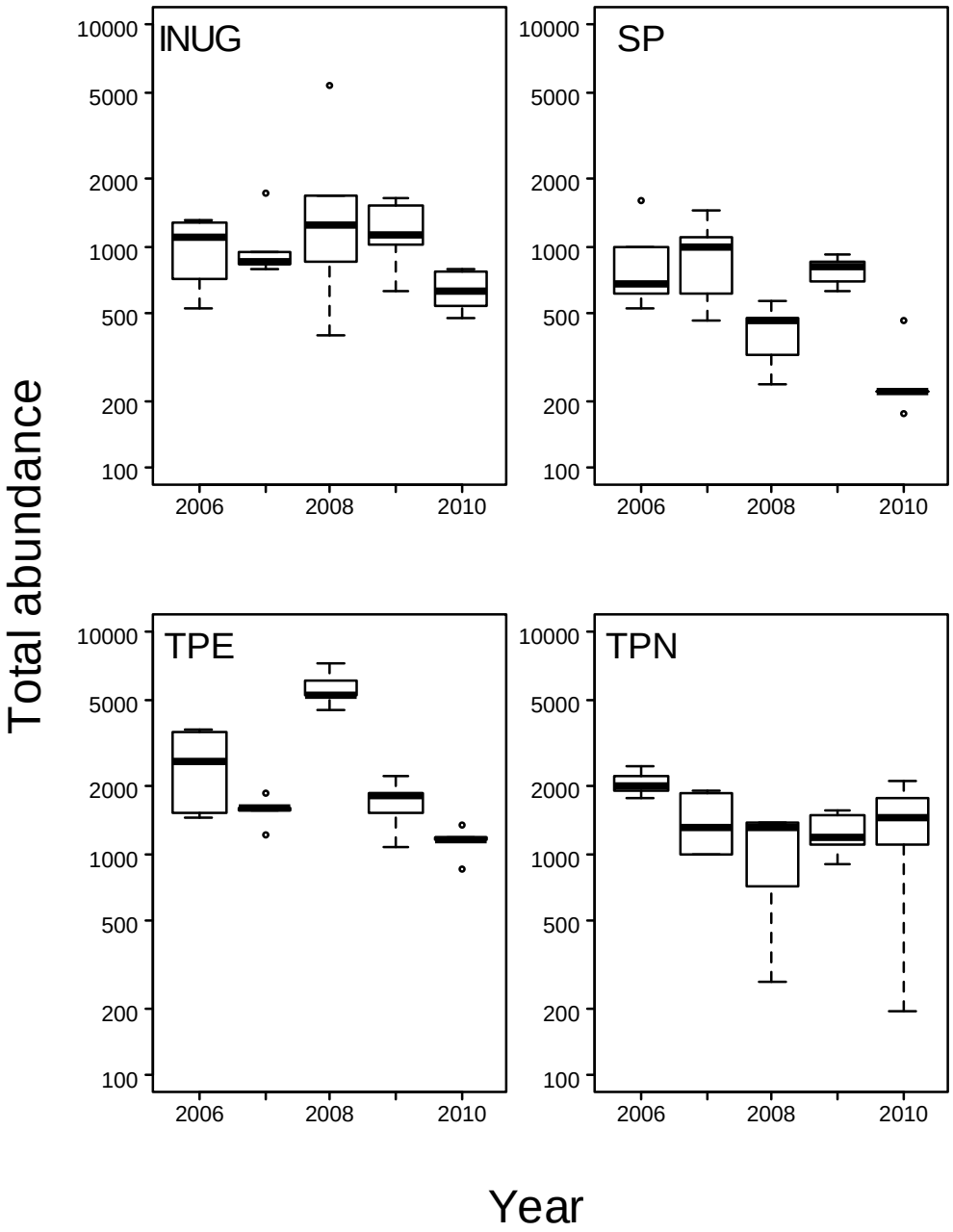


Figure 2. Box -plots of total taxa for August benthic samples (stations INUG, SP, TPE, TPN).

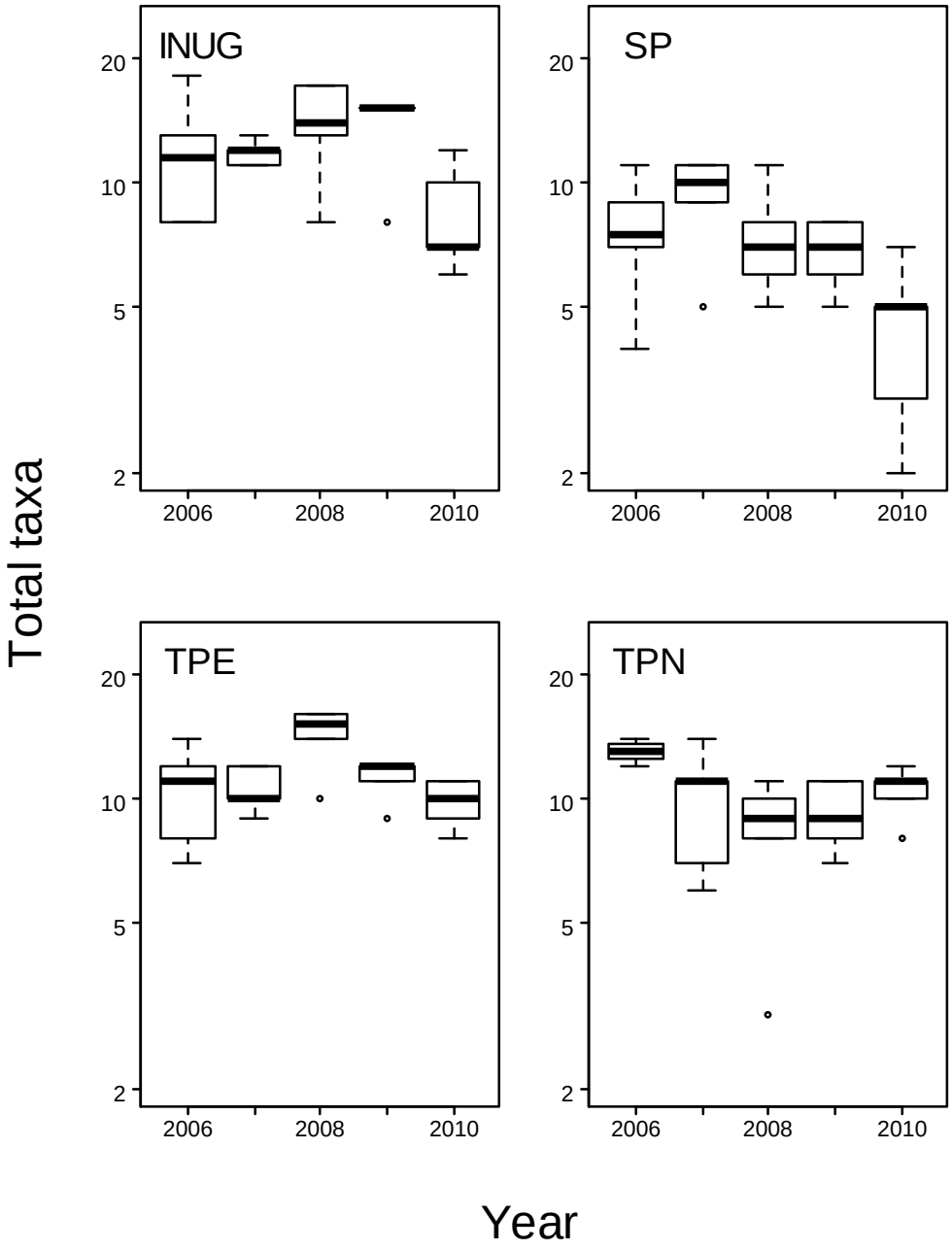


Figure 3. Box-plots of Simpson's diversity for August benthic samples (stations INUG, SP, TPE, TPN).

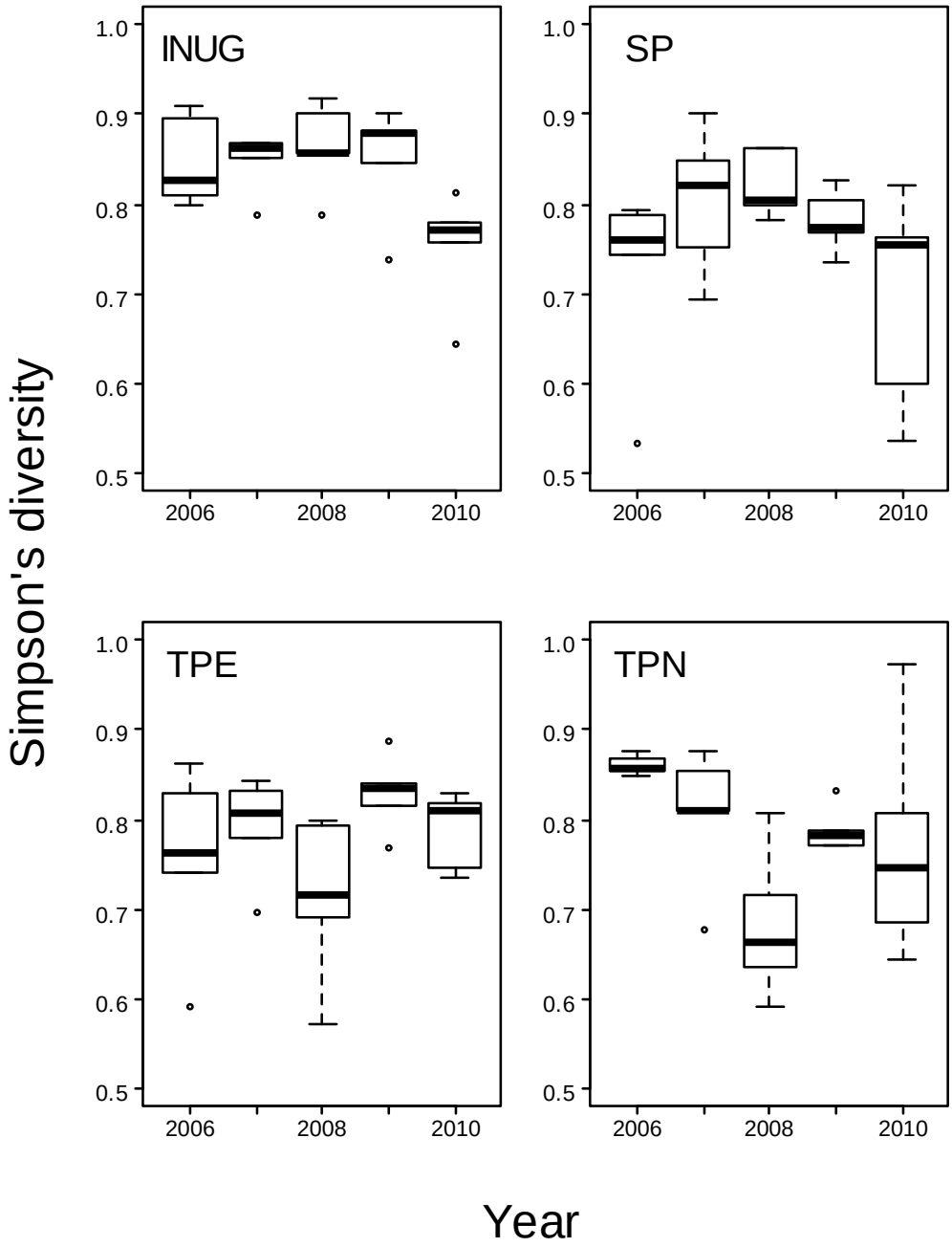


Figure 4. Estimates of BACI power for detecting a significant decrease (one-tailed, alpha = 0.05) in a given variable (Total N or Total taxa) and effect size (rows) by station (columns) as a function of sampling years (after period) and the number of sub-samples per year (see legend).

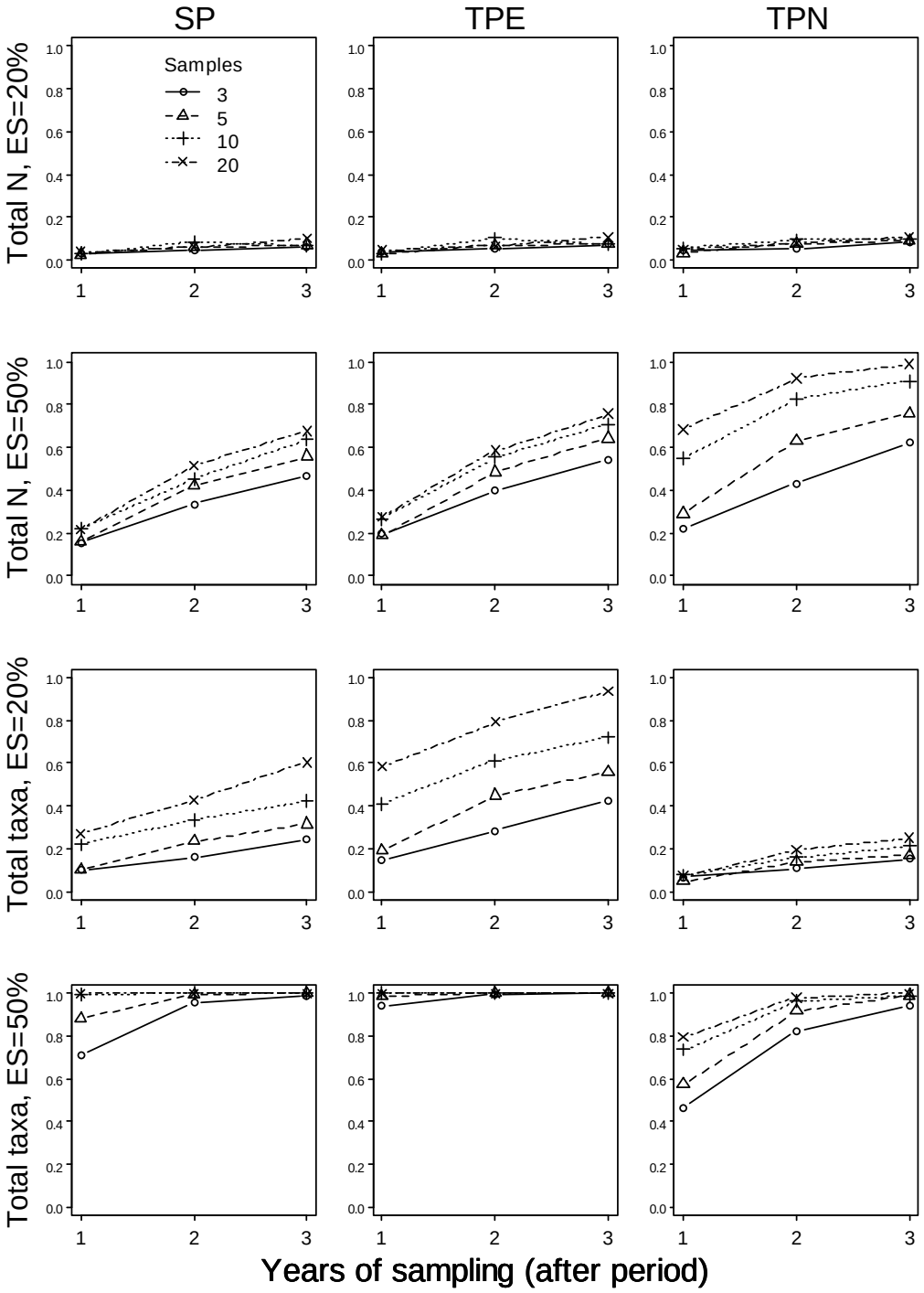
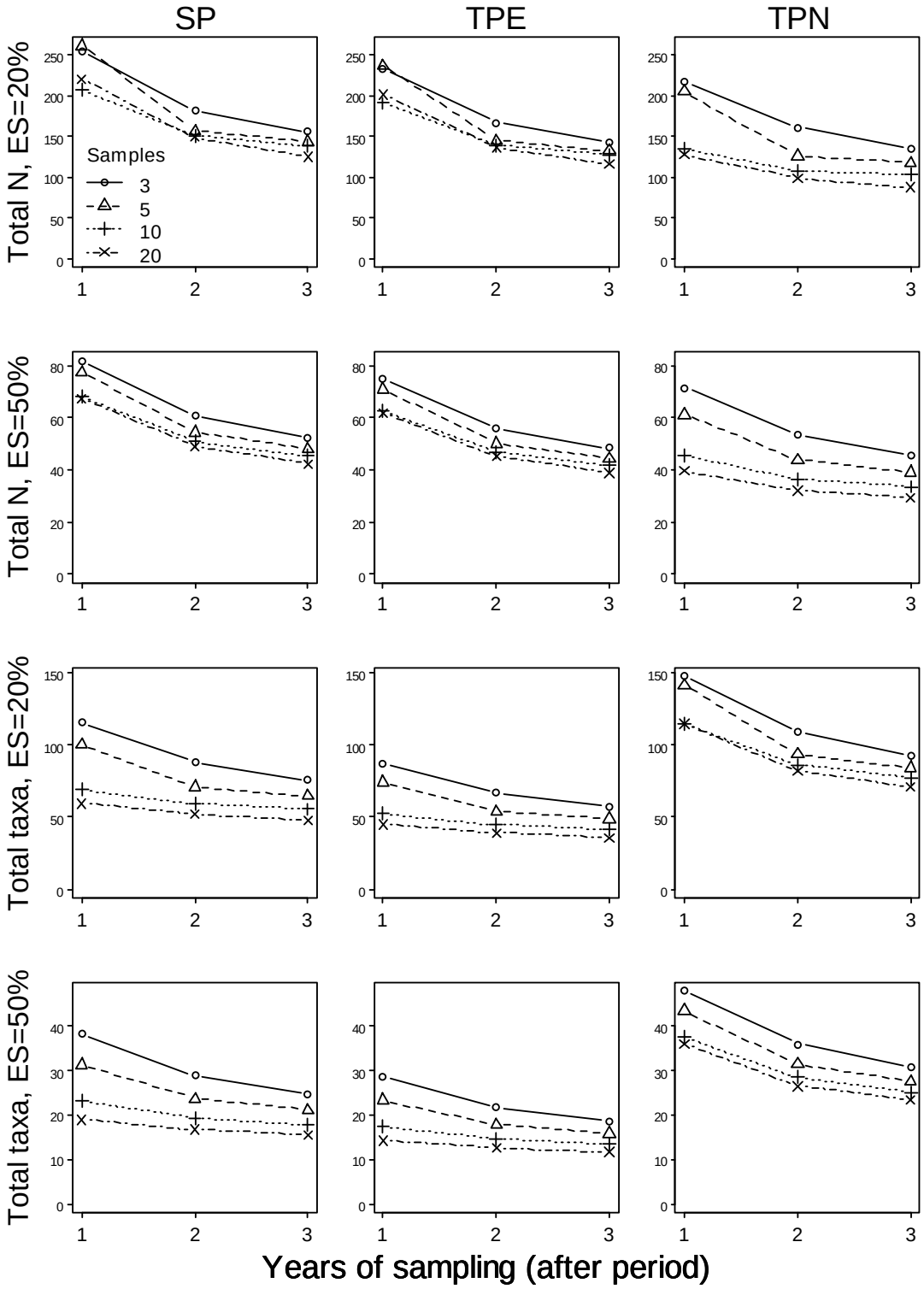


Figure 5. Coefficients of variation (%) for BACI estimates by variable (row) and station (column) as a function of sampling years (after period) and the number of sub-samples per year (see legend).



APPENDIX E – STATISTICAL ANALYSES FOR ZOOPLANKTON

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1. INTRODUCTION

This appendix contains the following analyses:

- Summary of CREMP zooplankton data
- Analysis of sampling design

Some text, tables and figures are repeated from the main document so that the analyses contained in this appendix can be read and understood without reference to the main document. The material in this appendix assumes understanding of basic statistical methods (Venables and Ripley 2002), mixed-effects models (Pinheiro and Bates 2000), before-after-control-impact (BACI) experimental design (Stewart-Oaten et al. 1986; Underwood 1994; Smith 2002), and use of simulation in statistical analysis (Gelman and Hill 2006).

2. SUMMARY AND EVALUATION OF CREMP ZOOPLANKTON DATA

The zooplankton data for the CREMP include 45 samples collected in August 2010 (5 spatial replicates at each of the 9 Meadowbank stations) and 90 samples collected in August 2011 (10 spatial replicates at each of the 9 stations). Three variables were examined (across all taxa): wet biomass (mg/m^3); dry biomass (mg/m^3); and abundance (total counts). The data can be summarized as follows:

Variable	N	N=0	Mean	Med	SD
wet.biomass	135	0	687	519	550
dry.biomass	135	0	27	25	13
abundance	135	0	7391	5701	6637

Across all samples (N = 135), these variables were moderately correlated (Spearman r):

Samples	wet.biomass	dry.biomass	abundance
wet.biomass			
dry.biomass	0.76		
abundance	0.53	0.64	

Figure 1 shows box-plots by station for each variable, while **Table 1** provides medians (raw data; same as thick line in each box-plot). As demonstrated in **Figure 1** and **Table 1**, there is considerable variation among stations (indicating the usefulness of the data to identify differences) but also among replicates (indicating the level of noise or sampling error in the data). There are general patterns as well as anomalies. All three measures

were generally higher across stations in 2011, with relatively high measures for INUG and WAL in both years. Values for PDL appear the least consistent: relatively low biomass in 2010, high biomass in 2011, but similar abundances for both years (**Figure 1**; **Table 1**).

An important consideration in the experimental design (discussed in next section) is the extent to which variation in a given zooplankton measure is due to differences among stations, years, and replicates. To estimate these components of variation, we fit a mixed-effects model to each variable of the form:

$$X_{jks} = \beta_j + \tau_k + (\tau\beta)_{kj} + \varepsilon_{jks}$$

where all Station (β) and Year (τ) terms (including the interaction term $\tau\beta$) were treated as random effects, X is the measured value of subsample s at Station j in Year k, and ε is the residual error for subsamples.

There were notable differences among variables in the results (**Table 2**). For wet biomass, little of the variation (7%) was accounted for by Station (i.e., differences among stations that were consistent in both years), while roughly equal proportions of variation (~30%) were accounted for by Year (differences between the two years), Station x Year (differences specific to each station-year combination), and Error (the residual variation among replicate samples). In contrast, there were much larger Station effects (>30%) and lower Station x Year effects (< 5%) estimated for dry biomass and wet biomass. For the experimental design explored in the next section, we would expect relatively low power to detect change for wet biomass due to high Station x Year variation (SD = 0.42), and the highest power to detect change for dry biomass abundance given low Station x Year variation (SD = 0.11). These results are uncertain given that there are only two years of data.

3. ANALYSIS OF SAMPLING DESIGN

Impact hypotheses and statistical design – Two general classes of impacts are hypothesized for the Meadowbank mine for the case of zooplankton:

1. Pulse events for which potential impacts would be high for a short time but may then (for zooplankton) dissipate. Pulse events could be associated with any phase of the mine, but are more likely to be associated with particular activities such as dike construction.

2. Long-term cumulative impacts that may be associated with ongoing activities. Long-term cumulative impacts are more likely to be associated with ongoing activities of mine operations.

As operations have just begun in 2010, the focus of CREMP monitoring to date has been on detecting pulse events associated with construction. The appropriate framework for analysis is a before-after-control-impact (BACI) that is aimed at detecting a potential impact in a particular lake or basin in a particular time period. The BACI framework can also be used to evaluate long-term impacts, but other tools such as time series regression analysis may also be appropriate for evaluating long-term trends. For this design document, we focus on the use of the BACI framework, recognizing that other tools such as time series regressions may be useful at a future date once sufficient time series data are available[1].

The classic BACI (paired) design has before/after periods α_i (i = B, A; I = 2), control/impact sites β_j (j = C, I; J = 2), and a total of K paired sampling times τ_k that are nested within period. A statistical model for this design is given by (Smith 2002, equation 2):

$$(1) \qquad X_{ijk} = \mu + \alpha_i + \tau_{k(i)} + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \ .$$

The key term is the interaction ($\alpha\beta$), which can be tested using an F test with F = MS[($\alpha\beta$)]/MS[Resid] and degrees of freedom = 1, K – 2. As discussed by Smith (2002), this is equivalent to simply taking the differences between the control and impact values across times and using a two-sample (before-after) t test (Stewart-Oaten et al. 1986).

Model (1) can be extended to include additional control sites (e.g., "asymmetric" designs; Underwood 1994) and/or additional impact sites. To be valid, the additional sites must be replicates rather than subsamples (i.e., as controls, they should be spatially independent of each other but representative of the impact sites, while replicates for impacts need to be spatially independent and (ideally) affected by independent disturbances). So whereas j = (C, I) in the classic BACIP, j may compose any combination of J total sites, for example J = 4 where j = (C_1, C_2, C_3, I). The general test of ($\alpha\beta$) still applies, but with degrees of freedom = (J – 1), (K – 2)(J – 1) (e.g., see Table 1 of Underwood (1994) and Table 9 of Smith (2002)).

In addition, there may be n replicate subsamples s at each site/time combination (jk), as assumed in Table 1 of Underwood (1994). In this case, we modify equation (1) as:

$$(2) \qquad X_{ijks} = \mu + \alpha_i + \tau_{k(i)} + \beta_j + (\alpha\beta)_{ij} + (\tau\beta)_{k(i)j} + \varepsilon_{ijks} \ ,$$

[1] In theory, a BACI analysis that is appropriately framed should be capable of detecting changes associated with long-term trends.

where subsamples now permit estimation of times-by-site interactions ($\tau\beta$). The appropriate F ratio for ($\alpha\beta$) is now F = MS[($\alpha\beta$)]/MS[($\tau\beta$)] with df = (J – 1), (K – 2)(J – 1). As Underwood demonstrates, specific comparisons (interaction terms, such as the impact site versus either "period" or a specific "time" unit) can be examined by partitioning variation accordingly (e.g., Underwood Table 2[2]).

Methods – To test for potential impacts on zooplankton in future years, a BACI design is warranted given natural inter-annual variation that is station-specific to some extent. The analysis assessed the expected precision and power of BACI estimates for different after-period (impact) durations and different numbers of sub-samples (random spatial replicates collected at the same station during the sampling event each August). Separate analyses were conducted for the three primary impact stations SP, TPE, and TPN, compared against either one control (INUG) or two controls (INUG and PDL). Separate analyses were conducted for wet biomass, dry biomass and abundance (all data log-transformed). For each variable, the effect size or ES (fixed across months) was set at either a 20% reduction from baseline or a 50% reduction in baseline.

For purposes of the BACI analyses, the two years (2010-2011) of available control-impact paired data were used to represent the "before period" dataset. We also examined scenarios in which one or two additional "before" years of data were simulated prior to impacts, providing three scenarios (before years = 2, 3, and 4). The additional before-period data were simulated with variances equal to those estimated for observed data across all stations (**Table 2**), using the model specified in **Section 2** above[3]. After-period data were simulated using after-period means (β_control, β_impact + **ES**) for three durations (1, 2, and 3 years) and three sub-sample scenarios (5, 10, and 20 replicates per station per year), again using variances derived from the observed data (**Table 2**). In the case of the BACI model with two control stations (INUG and PDL), an additional random-effects term (station) is added to the model to allow for differences in means between control stations. For each scenario, 500 simulations were used. Power was computed for one-tailed tests (based on the a priori assumption that impacts will reduce biomass or abundance) using two alpha levels (0.05 and 0.10).

Results for Single Control Station – Estimates of statistical power for the case of a single control (INUG) are reported in **Tables 3-5** and displayed in **Figures 2-7**. The tables report power for both alpha levels (0.05 and 0.10) but omit results for "Before" years = 2 (very low power). The figures only show power for alpha = 0.05 but include "Before" years = 2. Power was low for wet biomass across all scenarios (**Table 3**; **Figures 2-3**).

[2] We note that there are mistakes in the tables presented by Underwood (1994).

[3] Data were insufficient to justify estimation of variances specific to each impact station paired to control (as was done for water chemistry), therefore variances were derived based on pooled data for all stations.

High power (> 0.8) was estimated for dry biomass for ES = 50% under various scenarios (**Table 4**; **Figures 4-5**). These included conditions not shown: "Before" years = 2, "After" years = 2, and alpha = 0.10 (power > 0.8 for all stations and sample replicates). Two key points are illustrated by the results for dry biomass (ES = 50%). First, when "Before" years = 2 (i.e., the current data), it is virtually impossible to detect a difference with only one "After" year of impact data. In this scenario, the degrees of freedom (DF) associated with the estimated effect is DF = 1, and the t-statistic must exceed 6.3 for a one-tailed test with alpha = 0.05. However, with an extra before year or after year, DF = 2 and the critical t-value drops to 2.9. So at these low sample sizes (years), power is driven as much or more by degrees of freedom than by improved precision. Second, increasing sample replication (n) from 5 to 10 appears important to improve power in certain circumstances. For example, high power is achieved for n = 10 (but not n = 5) when before years = 3, after years = 1, and alpha = 0.10, or when before years = 3, after years = 2, and alpha = 0.05. Power was intermediate for abundance (**Table 5**, **Figures 6-7**). With few exceptions, high power was only achieved for ES = 50% when the combination of before/after years totaled 5 or more years and alpha = 0.10 (**Table 5**).

Results for Two Control Stations – In theory, adding a second control station (PDL) can improve power by increasing sample sizes. In particular, the degrees of freedom for testing the BACI interaction increases because additional station-by-year units exist for estimating this random-effects component (the denominator in the F-test of the BACI interaction). However, data for PDL exhibit strong differences between 2010 and 2011 (especially for wet and dry biomass), and such Station x Year effects (high variance term) may offset or reduce power despite increases in sample size. Estimates of BACI statistical power for the case of two controls case are reported in **Table 6-8** and displayed in **Figures 8-13**. Again, the tables report power for both alpha levels (0.05 and 0.10) but omit results for "Before" years = 2, and the figures only show power for alpha = 0.05 but include "Before" years = 2. As before, power was low for wet biomass across all scenarios (**Table 6**; **Figures 8-9**). For dry biomass and abundance, power was generally higher under the two-control test than the single-control case (more specifically, there was a slightly broader range of scenarios under which high power was achieved). For example, power was greatly improved for dry biomass (ES = 50%) when "Before" years =2 and "After" years = 1 (compare top panels **of Figures 5 and 11**). For these scenarios, power was roughly 0.8 or greater when $\alpha = 0.10$ and sample replication = 10 or 20.

Conclusions – Estimates of power for short-term experimental designs are most promising for dry biomass (ES = 50%), in particular with n = 10 or more replicates, but less so for abundance and particularly for wet biomass. The key factor driving these results was the observed/simulated variances for Station x Year effects, which was lowest for dry biomass (**Table 2**). If this variance term is underestimated, then estimates of power are too optimistic. For example, the results for PDL are concerning (**Table 1** and

Figure 1) because between-year fluctuations in dry biomass were much greater than observed across other stations. However, incorporating PDL as a second control (with 2010 and 2011 data present in the "before" period) did not adversely affect estimates for power for dry biomass or abundance.

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Table 1. Summary of medians (raw data) by station and year for zooplankton variables collected in August 2010 (5 samples per station) and August 2011 (10 samples per station).

	Wet biomass		Dry biomass		Abundance	
Station	2010	2011	2010	2011	2010	2011
INUG	834	932	45.1	41.6	3752	14120
PDL	186	1485	8.0	25.7	1298	1591
SP	358	528	21.2	27.9	2500	9404
TE	298	420	17.7	17.3	1944	6423
TEFF	303	698	12.4	21.2	2488	8496
TPE	194	554	11.5	29.6	4672	10942
TPN	325	433	15.9	23.0	1672	5496
TPS	211	497	21.2	27.4	1458	5639
WAL	528	1251	36.3	38.9	6976	16533
Mean	360	756	21.0	28.1	2973	8738
SD	207	385	12.2	7.9	1865	4632
CV	0.57	0.51	0.58	0.28	0.63	0.53

Table 2. Estimates of standard deviation (SD) and percent of variation explained for each term in the mixed-effects models fit to (log) zooplankton variables.

	SD Estimate (log data)			Percent of variation		
Term	Wet biomass	Dry biomass	Abundance	Wet biomass	Dry biomass	Abundance
Station	0.21	0.33	0.64	7%	31%	35%
Year	0.48	0.28	0.70	36%	23%	42%
Station x Year	0.42	0.11	0.21	28%	3%	4%
Error (reps)	0.44	0.39	0.46	30%	43%	19%
Sum				100%	100%	100%

Table 3. Wet biomass: Statistical power for BACI tests (one tailed) by station (SP, TPE, TPN) as a function of years sampled in the before/after periods and the number of replicate samples (Reps) per year. Power is shown for two effect sizes (ES = 20% and 50% reductions) and alpha levels (0.05 and 0.10).

Effect	Years sampled			Power (α = 0.05)			Power (α = 0.10)		
Size	Before	After	Reps	SP	TPE	TPN	SP	TPE	TPN
20%	3	1	5	0.19	0.06	0.09	0.38	0.18	0.22
			10	0.20	0.06	0.11	0.38	0.23	0.29
			20	0.25	0.12	0.16	0.42	0.26	0.31
	3	2	5	0.16	0.08	0.10	0.27	0.20	0.22
			10	0.16	0.11	0.13	0.31	0.22	0.24
			20	0.16	0.13	0.14	0.30	0.25	0.27
	3	3	5	0.15	0.11	0.11	0.29	0.24	0.24
			10	0.17	0.13	0.14	0.28	0.24	0.26
			20	0.14	0.11	0.12	0.27	0.22	0.23
	4	1	5	0.19	0.12	0.13	0.35	0.25	0.26
			10	0.22	0.15	0.17	0.32	0.25	0.28
			20	0.22	0.15	0.17	0.36	0.29	0.32
	4	2	5	0.22	0.15	0.16	0.38	0.28	0.30
			10	0.20	0.16	0.18	0.35	0.29	0.30
			20	0.23	0.18	0.19	0.34	0.31	0.32
	4	3	5	0.15	0.12	0.13	0.31	0.26	0.28
			10	0.17	0.14	0.14	0.29	0.27	0.28
			20	0.17	0.14	0.14	0.31	0.29	0.30
50%	3	1	5	0.35	0.14	0.18	0.51	0.38	0.40
			10	0.38	0.19	0.23	0.59	0.42	0.47
			20	0.41	0.23	0.29	0.58	0.45	0.49
	3	2	5	0.38	0.26	0.29	0.56	0.46	0.48
			10	0.40	0.31	0.33	0.57	0.52	0.52
			20	0.41	0.35	0.37	0.58	0.53	0.55
	3	3	5	0.47	0.41	0.43	0.64	0.59	0.60
			10	0.45	0.39	0.40	0.61	0.57	0.58
			20	0.46	0.42	0.43	0.61	0.59	0.59
	4	1	5	0.34	0.23	0.27	0.52	0.41	0.45
			10	0.37	0.28	0.30	0.54	0.45	0.48
			20	0.39	0.31	0.33	0.56	0.49	0.51
	4	2	5	0.46	0.40	0.42	0.62	0.56	0.57
			10	0.44	0.39	0.40	0.59	0.55	0.56
			20	0.43	0.40	0.40	0.60	0.56	0.57
	4	3	5	0.46	0.43	0.44	0.63	0.59	0.60
			10	0.46	0.43	0.44	0.65	0.61	0.62
			20	0.48	0.44	0.45	0.64	0.61	0.62

Table 4. Dry biomass: Statistical power for BACI tests (one tailed) by station (SP, TPE, TPN) as a function of years sampled in the before/after periods and the number of replicate samples (Reps) per year. Power is shown for two effect sizes (ES = 20% and 50% reductions) and alpha levels (0.05 and 0.10). Light shading denotes power ≥ 0.8; dark shading denotes power ≥ 0.9.

Effect	Years sampled			Power (α = 0.05)			Power (α = 0.10)		
Size	Before	After	Reps	SP	TPE	TPN	SP	TPE	TPN
20%	3	1	5	0.07	0.03	0.00	0.23	0.17	0.11
			10	0.11	0.07	0.05	0.29	0.24	0.20
			20	0.18	0.15	0.11	0.41	0.37	0.33
	3	2	5	0.12	0.09	0.05	0.33	0.26	0.20
			10	0.17	0.15	0.11	0.36	0.33	0.29
			20	0.27	0.25	0.23	0.49	0.46	0.45
	3	3	5	0.23	0.18	0.12	0.41	0.36	0.32
			10	0.25	0.25	0.22	0.46	0.43	0.42
			20	0.34	0.33	0.31	0.52	0.51	0.50
	4	1	5	0.12	0.07	0.05	0.29	0.23	0.18
			10	0.18	0.14	0.12	0.38	0.35	0.31
			20	0.27	0.24	0.22	0.44	0.42	0.41
	4	2	5	0.24	0.19	0.13	0.40	0.37	0.31
			10	0.25	0.23	0.19	0.43	0.39	0.39
			20	0.35	0.33	0.31	0.53	0.50	0.50
	4	3	5	0.25	0.22	0.17	0.43	0.40	0.34
			10	0.30	0.28	0.26	0.51	0.50	0.46
			20	0.41	0.40	0.39	0.58	0.56	0.56
50%	3	1	5	0.51	0.34	0.23	0.76	0.67	0.63
			10	0.72	0.59	0.56	0.90	0.85	0.85
			20	0.85	0.77	0.79	0.96	0.93	0.95
	3	2	5	0.81	0.73	0.67	0.92	0.89	0.90
			10	0.90	0.84	0.85	0.97	0.95	0.95
			20	0.93	0.91	0.92	0.98	0.98	0.98
	3	3	5	0.91	0.87	0.87	0.98	0.96	0.97
			10	0.98	0.96	0.96	1.00	0.99	0.99
			20	0.98	0.98	0.98	1.00	1.00	1.00
	4	1	5	0.64	0.53	0.47	0.82	0.76	0.73
			10	0.81	0.73	0.74	0.92	0.88	0.90
			20	0.89	0.84	0.87	0.96	0.94	0.95
	4	2	5	0.88	0.83	0.83	0.96	0.93	0.94
			10	0.95	0.92	0.92	0.99	0.99	0.98
			20	0.98	0.97	0.97	1.00	1.00	1.00
	4	3	5	0.95	0.92	0.94	0.97	0.97	0.97
			10	0.98	0.97	0.98	0.99	0.99	0.99
			20	0.99	0.99	0.99	1.00	1.00	1.00

Table 5. Abundance: Statistical power for BACI tests (one tailed) by station (SP, TPE, TPN) as a function of years sampled in the before/after periods and the number of replicate samples (Reps) per year. Power is shown for two effect sizes (ES = 20% and 50% reductions) and alpha levels (0.05 and 0.10). Light shading denotes power ≥ 0.8; dark shading denotes power ≥ 0.9.

Effect	Years sampled			Power (α = 0.05)			Power (α = 0.10)		
Size	Before	After	Reps	SP	TPE	TPN	SP	TPE	TPN
20%	3	1	5	0.08	0.01	0.08	0.23	0.10	0.24
			10	0.10	0.02	0.10	0.26	0.13	0.28
			20	0.16	0.06	0.16	0.36	0.21	0.37
	3	2	5	0.10	0.04	0.10	0.26	0.13	0.27
			10	0.14	0.07	0.15	0.27	0.18	0.29
			20	0.19	0.12	0.19	0.32	0.25	0.34
	3	3	5	0.15	0.07	0.16	0.32	0.21	0.33
			10	0.20	0.09	0.21	0.31	0.27	0.34
			20	0.19	0.11	0.20	0.36	0.29	0.38
	4	1	5	0.12	0.06	0.13	0.27	0.17	0.28
			10	0.15	0.10	0.16	0.29	0.22	0.31
			20	0.21	0.13	0.21	0.35	0.30	0.36
	4	2	5	0.18	0.11	0.20	0.34	0.25	0.35
			10	0.19	0.12	0.19	0.33	0.27	0.34
			20	0.24	0.17	0.25	0.37	0.31	0.38
	4	3	5	0.17	0.11	0.18	0.32	0.24	0.33
			10	0.21	0.14	0.22	0.36	0.28	0.37
			20	0.25	0.20	0.26	0.40	0.37	0.42
50%	3	1	5	0.32	0.10	0.33	0.58	0.37	0.60
			10	0.46	0.20	0.48	0.69	0.54	0.70
			20	0.55	0.37	0.57	0.75	0.63	0.76
	3	2	5	0.53	0.36	0.57	0.74	0.65	0.76
			10	0.61	0.50	0.63	0.78	0.71	0.80
			20	0.67	0.59	0.70	0.82	0.78	0.83
	3	3	5	0.67	0.57	0.69	0.82	0.78	0.84
			10	0.74	0.68	0.76	0.88	0.85	0.90
			20	0.76	0.71	0.79	0.88	0.87	0.90
	4	1	5	0.41	0.27	0.44	0.61	0.51	0.62
			10	0.54	0.41	0.55	0.72	0.65	0.73
			20	0.58	0.50	0.60	0.74	0.70	0.75
	4	2	5	0.64	0.53	0.66	0.81	0.74	0.82
			10	0.71	0.63	0.73	0.84	0.80	0.85
			20	0.76	0.71	0.78	0.88	0.86	0.88
	4	3	5	0.75	0.69	0.78	0.88	0.85	0.89
			10	0.77	0.74	0.79	0.90	0.89	0.91
			20	0.81	0.79	0.83	0.91	0.90	0.92

Table 6. Two controls; Wet biomass: Statistical power for BACI tests (one tailed) by station (SP, TPE, TPN) as a function of years sampled in the before/after periods and the number of replicate samples (Reps) per year. Power is shown for two effect sizes (ES = 20% and 50% reductions) and alpha levels (0.05 and 0.10). Light shading denotes power ≥ 0.8; dark shading denotes power ≥ 0.9.

Effect	Years sampled			Power (α = 0.05)			Power (α = 0.10)		
Size	Before	After	Reps	SP	TPE	TPN	SP	TPE	TPN
20%	3	1	5	0.00	0.01	0.00	0.05	0.06	0.06
			10	0.01	0.02	0.01	0.05	0.08	0.07
			20	0.00	0.01	0.01	0.06	0.08	0.08
	3	2	5	0.01	0.01	0.01	0.07	0.08	0.08
			10	0.02	0.02	0.02	0.07	0.09	0.09
			20	0.02	0.02	0.02	0.06	0.09	0.08
	3	3	5	0.02	0.03	0.03	0.11	0.13	0.12
			10	0.03	0.04	0.04	0.11	0.13	0.13
			20	0.03	0.05	0.05	0.11	0.13	0.13
	4	1	5	0.02	0.03	0.03	0.07	0.08	0.08
			10	0.02	0.03	0.02	0.06	0.08	0.08
			20	0.01	0.02	0.02	0.08	0.09	0.09
	4	2	5	0.04	0.06	0.06	0.14	0.17	0.16
			10	0.05	0.06	0.06	0.13	0.16	0.15
			20	0.05	0.06	0.06	0.14	0.18	0.17
	4	3	5	0.04	0.05	0.05	0.14	0.16	0.16
			10	0.05	0.06	0.06	0.14	0.16	0.15
			20	0.06	0.06	0.06	0.13	0.16	0.16
50%	3	1	5	0.05	0.08	0.08	0.16	0.21	0.20
			10	0.05	0.08	0.08	0.18	0.24	0.22
			20	0.06	0.09	0.09	0.18	0.24	0.24
	3	2	5	0.14	0.17	0.17	0.34	0.39	0.38
			10	0.14	0.21	0.20	0.36	0.42	0.42
			20	0.15	0.19	0.19	0.37	0.42	0.41
	3	3	5	0.27	0.29	0.29	0.49	0.52	0.52
			10	0.28	0.31	0.31	0.49	0.53	0.52
			20	0.29	0.33	0.33	0.52	0.56	0.56
	4	1	5	0.09	0.12	0.12	0.27	0.31	0.31
			10	0.08	0.13	0.12	0.26	0.30	0.29
			20	0.10	0.15	0.14	0.28	0.32	0.32
	4	2	5	0.23	0.26	0.26	0.41	0.45	0.45
			10	0.25	0.32	0.32	0.45	0.48	0.47
			20	0.28	0.32	0.31	0.45	0.49	0.48
	4	3	5	0.32	0.34	0.34	0.53	0.54	0.54
			10	0.36	0.39	0.39	0.54	0.57	0.56
			20	0.37	0.41	0.40	0.58	0.61	0.60

Table 7. Two controls; Dry biomass: Statistical power for BACI tests (one tailed) by station (SP, TPE, TPN) as a function of years sampled in the before/after periods and the number of replicate samples (Reps) per year. Power is shown for two effect sizes (ES = 20% and 50% reductions) and alpha levels (0.05 and 0.10). Light shading denotes power ≥ 0.8; dark shading denotes power ≥ 0.9.

Effect	Years sampled			Power (α = 0.05)			Power (α = 0.10)		
Size	Before	After	Reps	SP	TPE	TPN	SP	TPE	TPN
20%	3	1	5	0.05	0.07	0.06	0.16	0.20	0.18
			10	0.11	0.15	0.14	0.23	0.27	0.27
			20	0.18	0.25	0.25	0.34	0.43	0.42
	3	2	5	0.11	0.15	0.13	0.27	0.32	0.29
			10	0.17	0.22	0.19	0.37	0.44	0.41
			20	0.24	0.30	0.30	0.45	0.50	0.50
	3	3	5	0.17	0.20	0.19	0.35	0.41	0.38
			10	0.25	0.29	0.28	0.43	0.47	0.46
			20	0.36	0.41	0.40	0.58	0.61	0.62
	4	1	5	0.12	0.14	0.11	0.22	0.27	0.23
			10	0.13	0.17	0.16	0.31	0.37	0.35
			20	0.22	0.29	0.28	0.42	0.48	0.48
	4	2	5	0.17	0.21	0.18	0.32	0.36	0.35
			10	0.23	0.30	0.29	0.43	0.48	0.47
			20	0.36	0.40	0.39	0.52	0.56	0.57
	4	3	5	0.19	0.23	0.20	0.37	0.42	0.39
			10	0.32	0.36	0.36	0.51	0.55	0.53
			20	0.46	0.52	0.50	0.62	0.65	0.65
50%	3	1	5	0.58	0.65	0.60	0.81	0.84	0.83
			10	0.75	0.80	0.80	0.92	0.94	0.94
			20	0.91	0.94	0.95	0.98	0.99	0.99
	3	2	5	0.88	0.91	0.91	0.98	0.98	0.98
			10	0.96	0.98	0.98	1.00	1.00	1.00
			20	1.00	1.00	1.00	1.00	1.00	1.00
	3	3	5	0.96	0.97	0.97	0.98	0.99	0.99
			10	0.99	0.99	0.99	1.00	1.00	1.00
			20	1.00	1.00	1.00	1.00	1.00	1.00
	4	1	5	0.70	0.75	0.73	0.87	0.90	0.87
			10	0.88	0.90	0.89	0.95	0.97	0.97
			20	0.97	0.98	0.98	0.99	0.99	0.99
	4	2	5	0.92	0.93	0.93	0.97	0.97	0.97
			10	0.97	0.98	0.97	1.00	1.00	1.00
			20	1.00	1.00	1.00	1.00	1.00	1.00
	4	3	5	0.98	0.99	0.99	1.00	1.00	1.00
			10	0.99	0.99	0.99	1.00	1.00	1.00
			20	1.00	1.00	1.00	1.00	1.00	1.00

Table 8. Two controls; Abundance: Statistical power for BACI tests (one tailed) by station (SP, TPE, TPN) as a function of years sampled in the before/after periods and the number of replicate samples (Reps) per year. Power is shown for two effect sizes (ES = 20% and 50% reductions) and alpha levels (0.05 and 0.10). Light shading denotes power ≥ 0.8; dark shading denotes power ≥ 0.9.

Effect	Years sampled			Power (α = 0.05)			Power (α = 0.10)		
Size	Before	After	Reps	SP	TPE	TPN	SP	TPE	TPN
20%	3	1	5	0.03	0.06	0.06	0.09	0.16	0.14
			10	0.04	0.09	0.09	0.13	0.23	0.19
			20	0.06	0.15	0.14	0.17	0.26	0.22
	3	2	5	0.05	0.10	0.09	0.17	0.22	0.21
			10	0.08	0.13	0.12	0.21	0.26	0.26
			20	0.10	0.17	0.16	0.23	0.29	0.28
	3	3	5	0.10	0.14	0.14	0.23	0.27	0.27
			10	0.14	0.17	0.18	0.28	0.30	0.31
			20	0.15	0.18	0.19	0.32	0.35	0.36
	4	1	5	0.07	0.10	0.10	0.16	0.20	0.21
			10	0.06	0.12	0.10	0.18	0.24	0.23
			20	0.10	0.17	0.16	0.22	0.29	0.28
	4	2	5	0.11	0.15	0.14	0.24	0.28	0.27
			10	0.12	0.18	0.17	0.29	0.34	0.33
			20	0.20	0.23	0.23	0.32	0.35	0.35
	4	3	5	0.13	0.15	0.15	0.25	0.30	0.29
			10	0.17	0.20	0.20	0.32	0.35	0.36
			20	0.20	0.22	0.23	0.39	0.42	0.42
50%	3	1	5	0.23	0.36	0.33	0.49	0.60	0.58
			10	0.32	0.47	0.44	0.57	0.68	0.67
			20	0.41	0.60	0.55	0.65	0.77	0.76
	3	2	5	0.53	0.63	0.62	0.74	0.79	0.78
			10	0.67	0.77	0.74	0.83	0.87	0.86
			20	0.75	0.81	0.80	0.88	0.91	0.90
	3	3	5	0.74	0.78	0.77	0.88	0.91	0.91
			10	0.80	0.84	0.83	0.92	0.94	0.94
			20	0.86	0.88	0.87	0.94	0.95	0.96
	4	1	5	0.38	0.47	0.45	0.60	0.67	0.66
			10	0.48	0.59	0.57	0.72	0.78	0.77
			20	0.60	0.70	0.68	0.78	0.84	0.82
	4	2	5	0.62	0.70	0.69	0.80	0.84	0.84
			10	0.74	0.78	0.78	0.86	0.88	0.88
			20	0.81	0.85	0.84	0.92	0.93	0.93
	4	3	5	0.72	0.76	0.75	0.86	0.89	0.88
			10	0.82	0.85	0.85	0.93	0.94	0.94
			20	0.89	0.91	0.90	0.95	0.95	0.95

Figure 1. Box-plots of zooplankton variables by station collected in August 2010 (5 samples per station) and August 2011 (10 samples per station).

Note: Dashed lines denote means across all samples

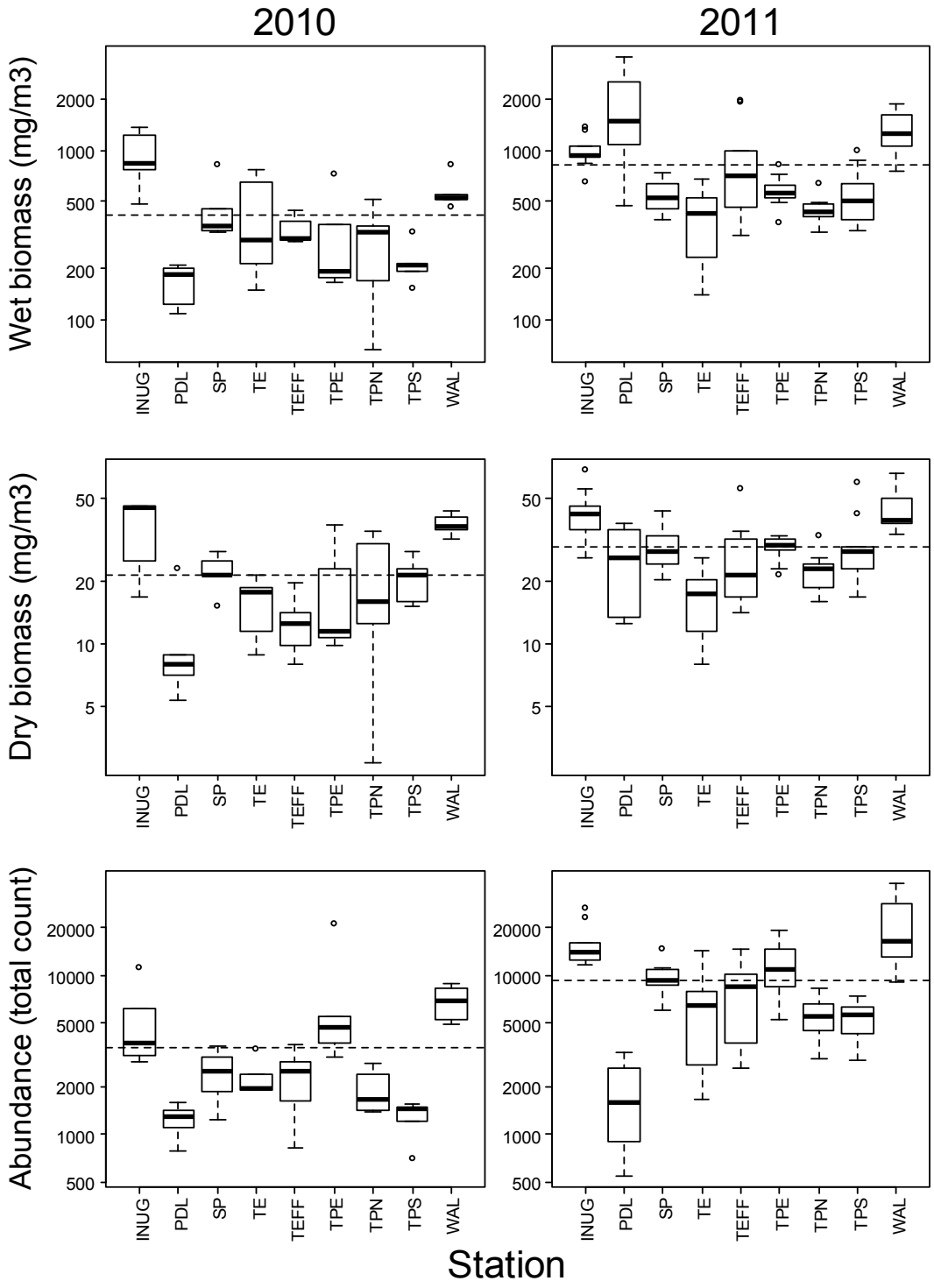


Figure 2. Wet biomass, ES = 20%: Power for BACI tests (one tailed with alpha = 0.05) by station (columns) as a function of the years of sampling (before-period in rows, after-period along x-axis).

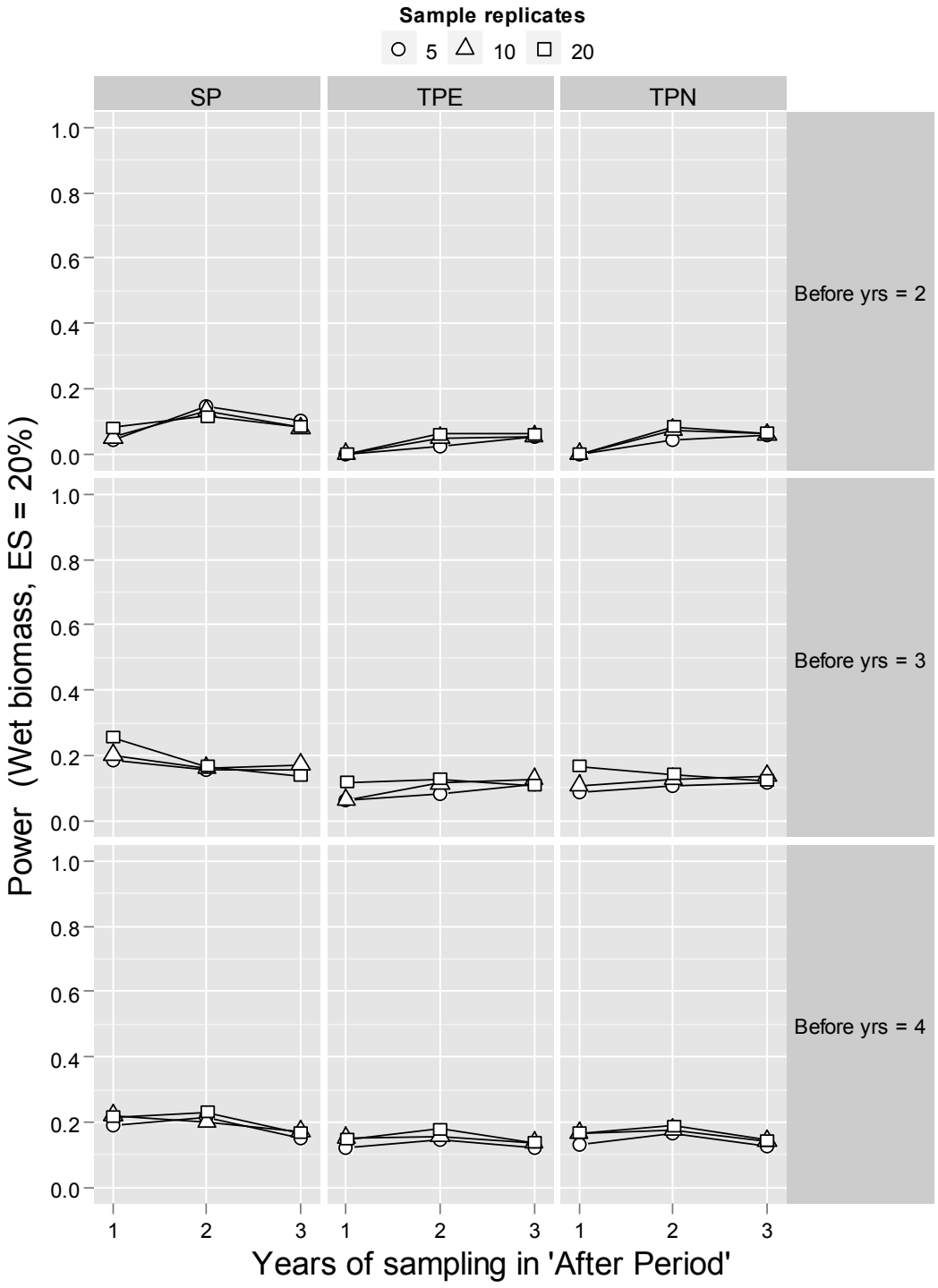


Figure 3. Wet biomass, ES = 50%: Power for BACI tests (one tailed with alpha = 0.05) by station (columns) as a function of the years of sampling (before-period in rows, after-period along x-axis).

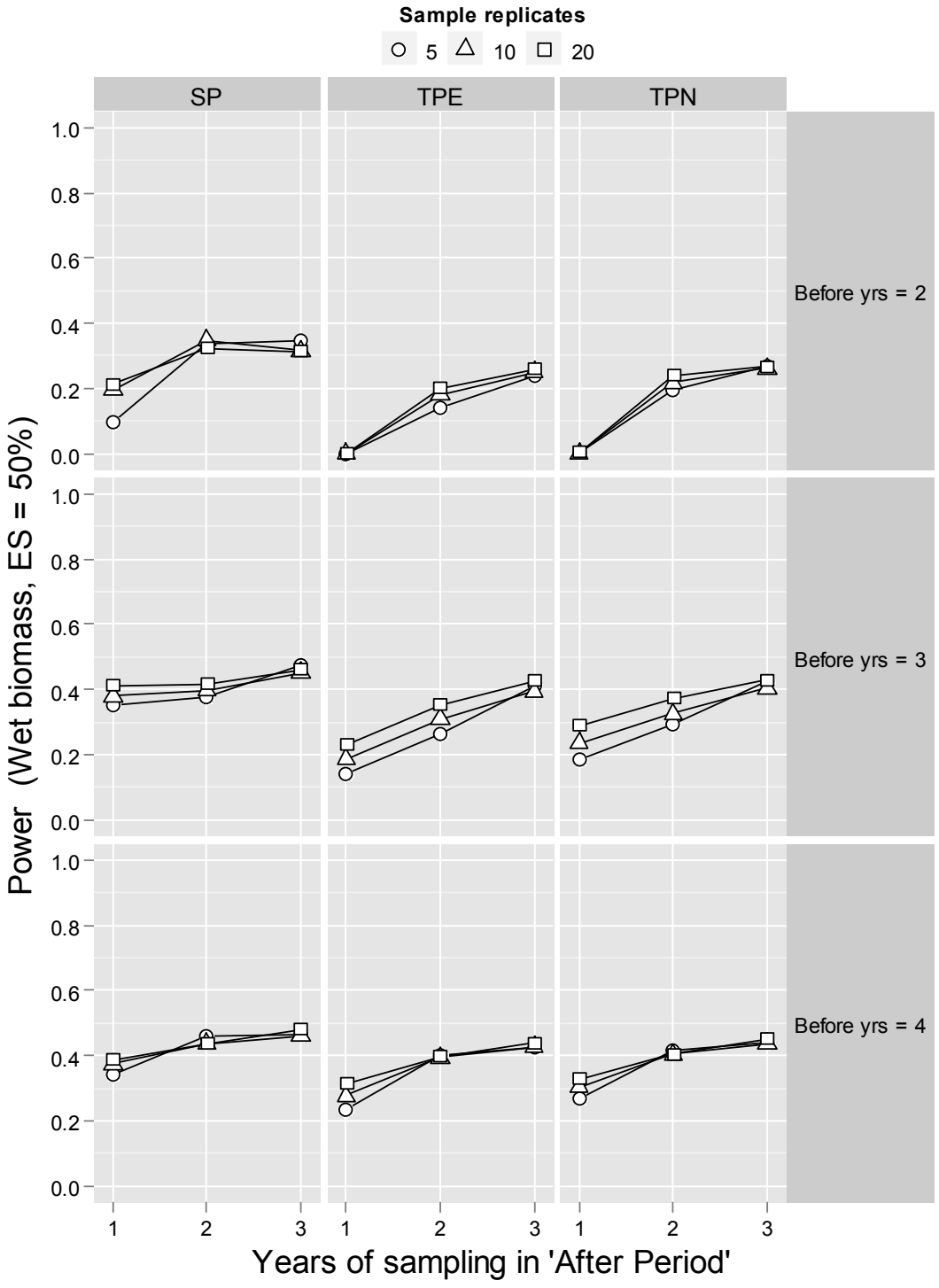


Figure 4. Dry biomass, ES = 20%: Power for BACI tests (one tailed with alpha = 0.05) by station (columns) as a function of the years of sampling (before-period in rows, after-period along x-axis).

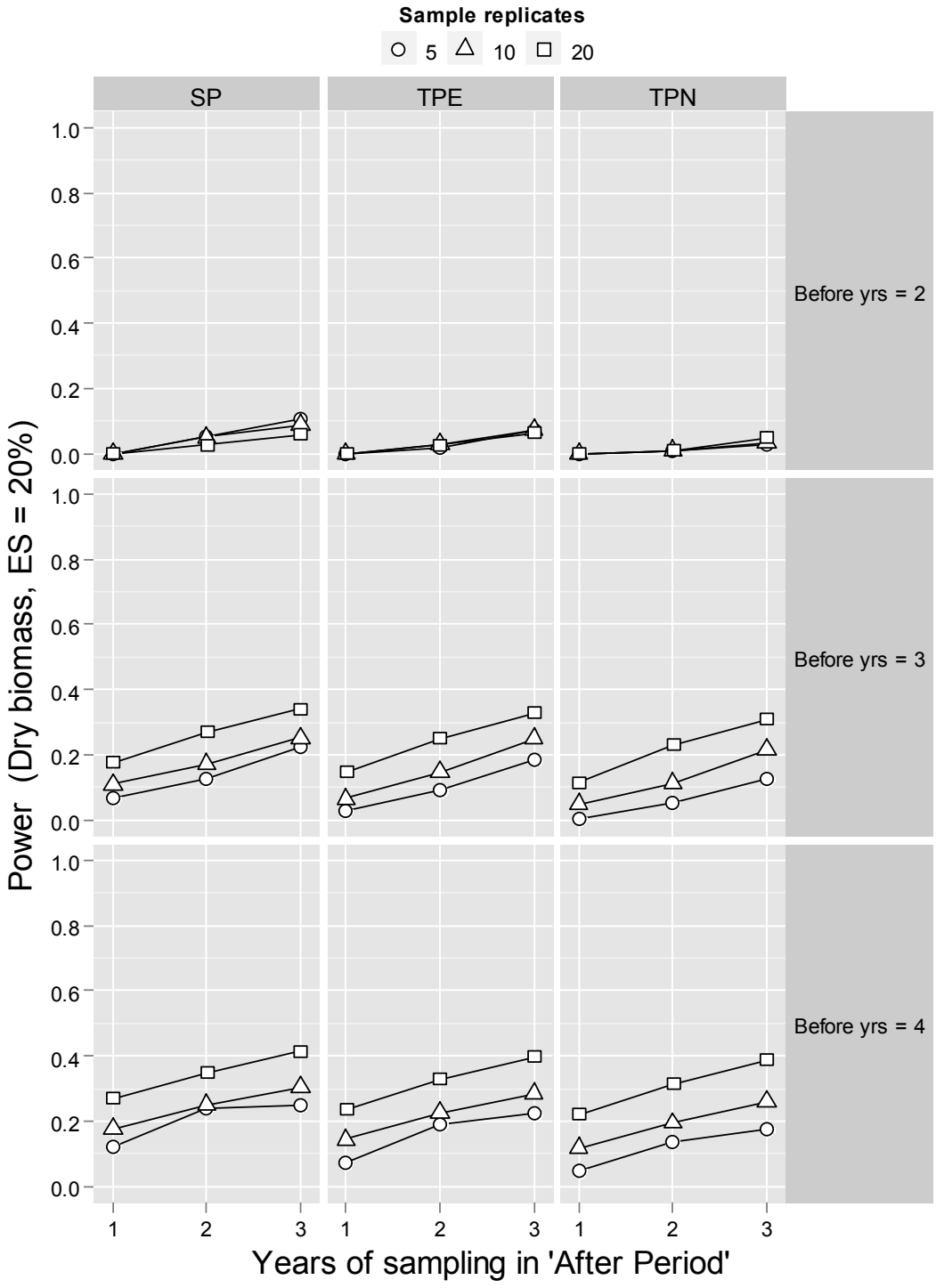


Figure 5. Dry biomass, ES = 50%: Power for BACI tests (one tailed with alpha = 0.05) by station (columns) as a function of the years of sampling (before-period in rows, after-period along x-axis).

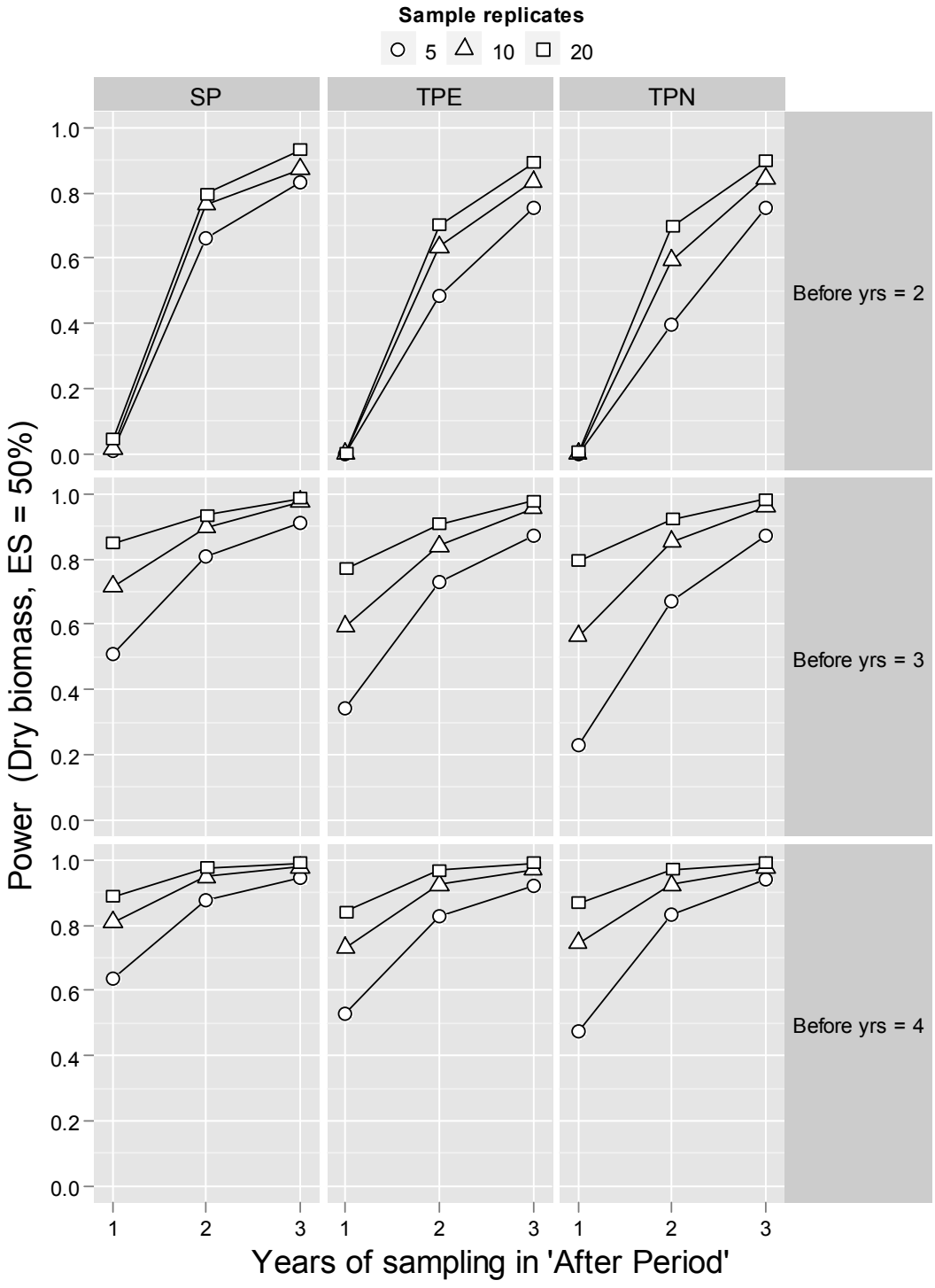


Figure 6. Abundance, ES = 20%: Power for BACI tests (one tailed with alpha = 0.05) by station (columns) as a function of the years of sampling (before-period in rows, after-period along x-axis).

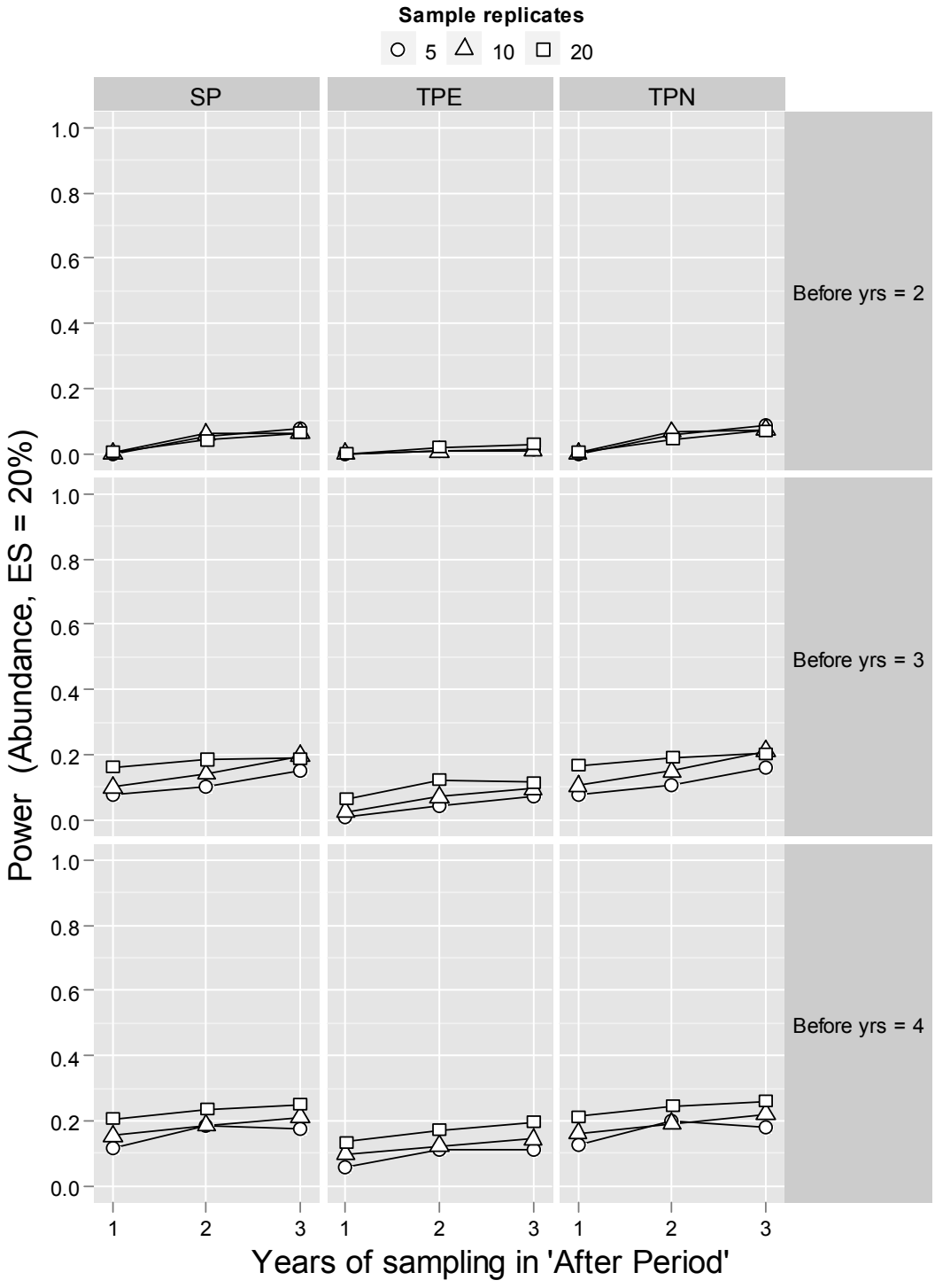


Figure 7. Abundance, ES = 50%: Power for BACI tests (one tailed with alpha = 0.05) by station (columns) as a function of the years of sampling (before-period in rows, after-period along x-axis).

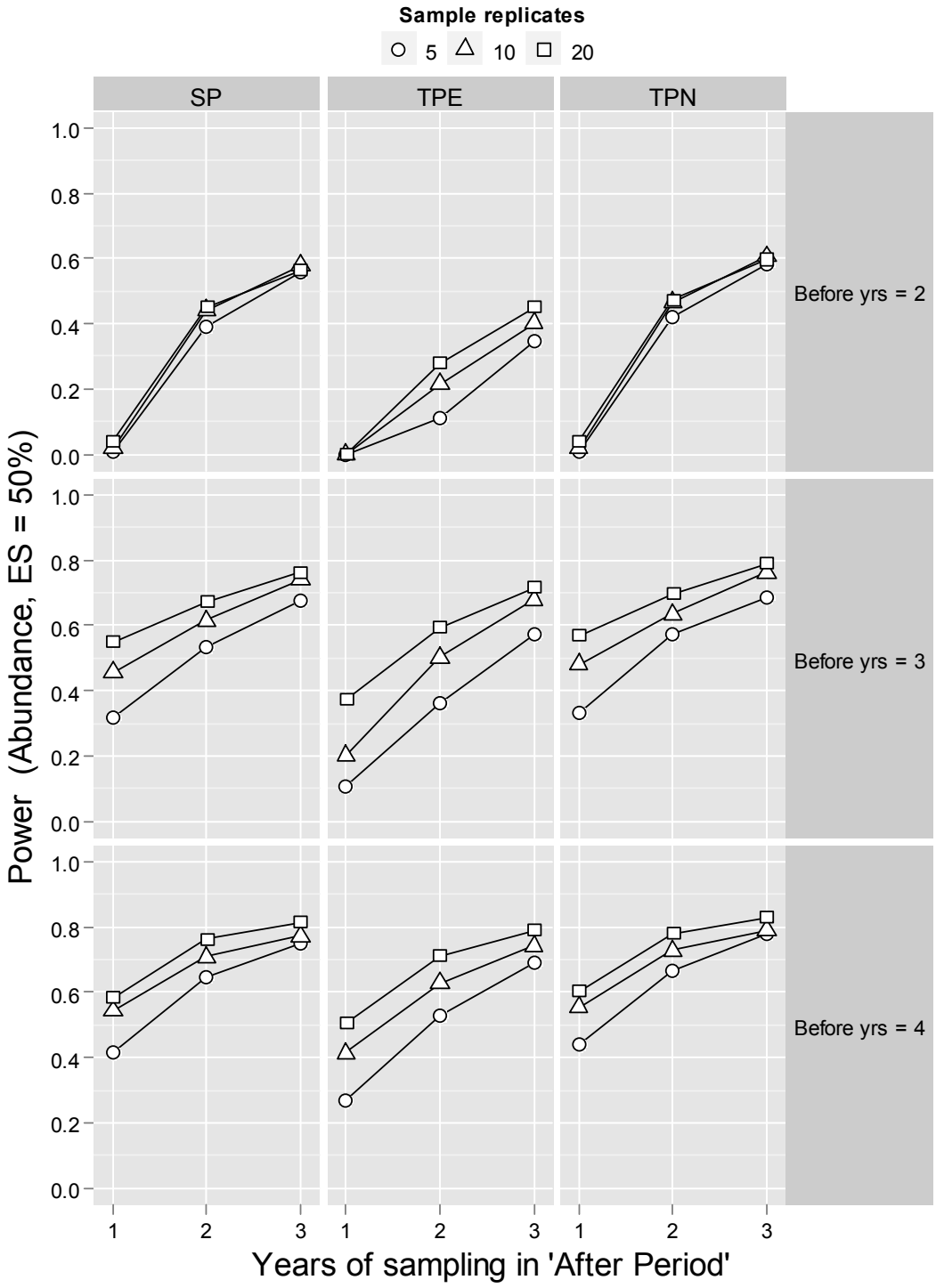


Figure 8. Two controls; Wet biomass, ES = 20%: Power for BACI tests (one tailed with alpha = 0.05) by station (columns) as a function of sampling years (before-period in rows, after-period along x-axis).

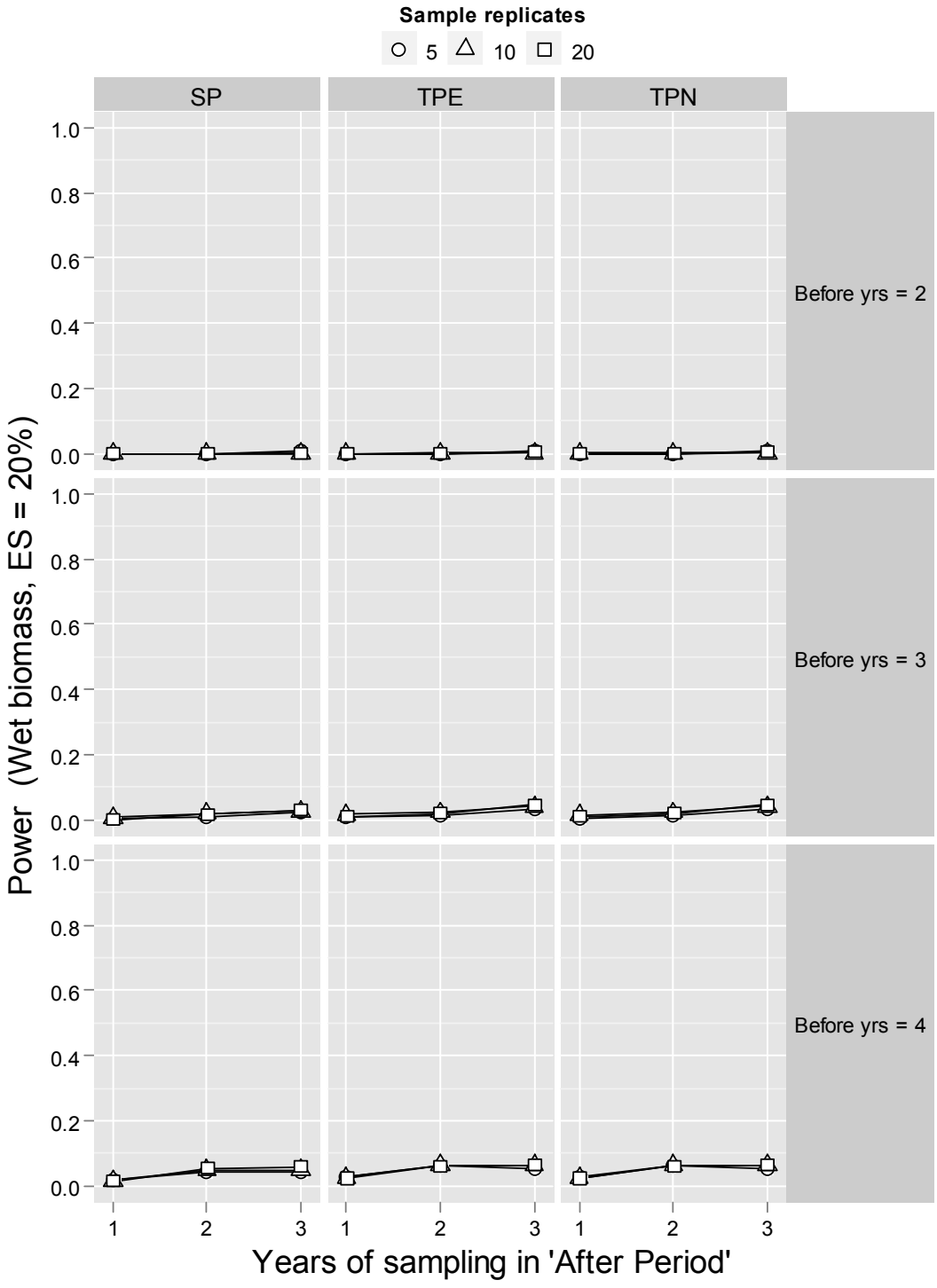


Figure 9. Two controls; Wet biomass, ES = 50%: Power for BACI tests (one tailed with alpha = 0.05) by station (columns) as a function of sampling years (before-period in rows, after-period along x-axis).

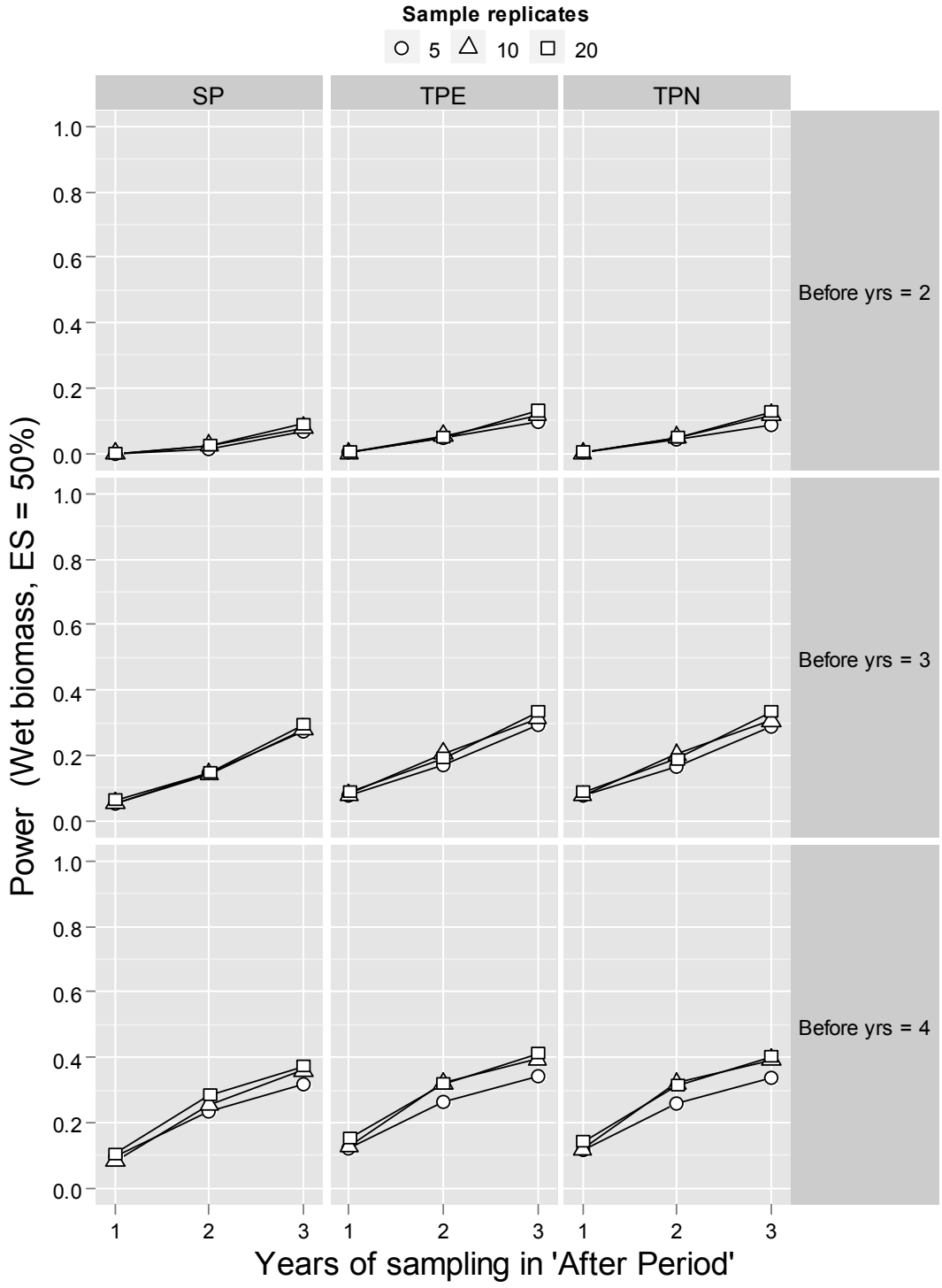


Figure 10. Two controls; Dry biomass, ES = 20%: Power for BACI tests (one tailed with alpha = 0.05) by station (columns) as a function of sampling years (before-period in rows, after-period along x-axis).

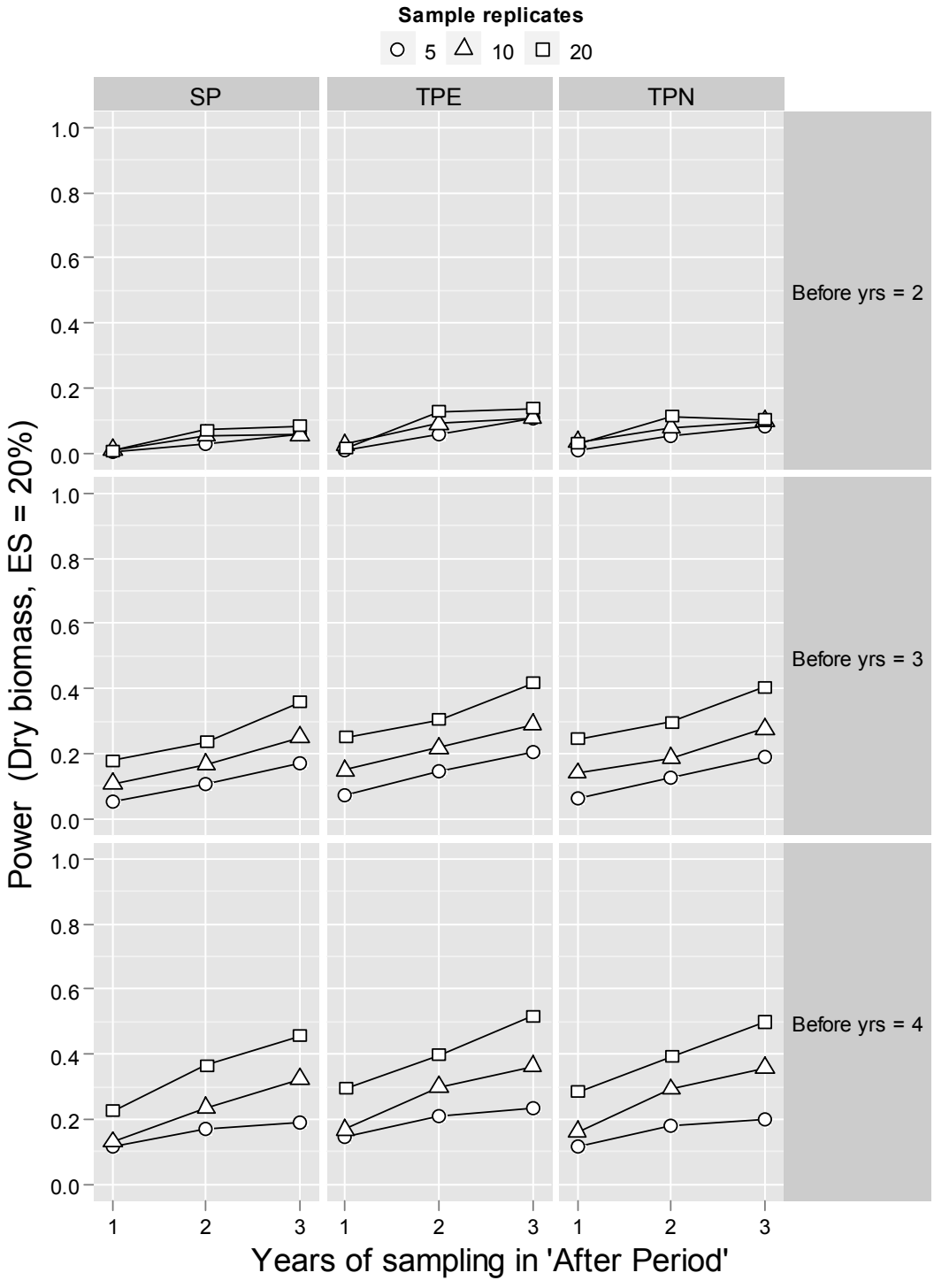


Figure 11. Two controls; Dry biomass, ES = 50%: Power for BACI tests (one tailed with alpha = 0.05) by station (columns) as a function of sampling years (before-period in rows, after-period along x-axis).

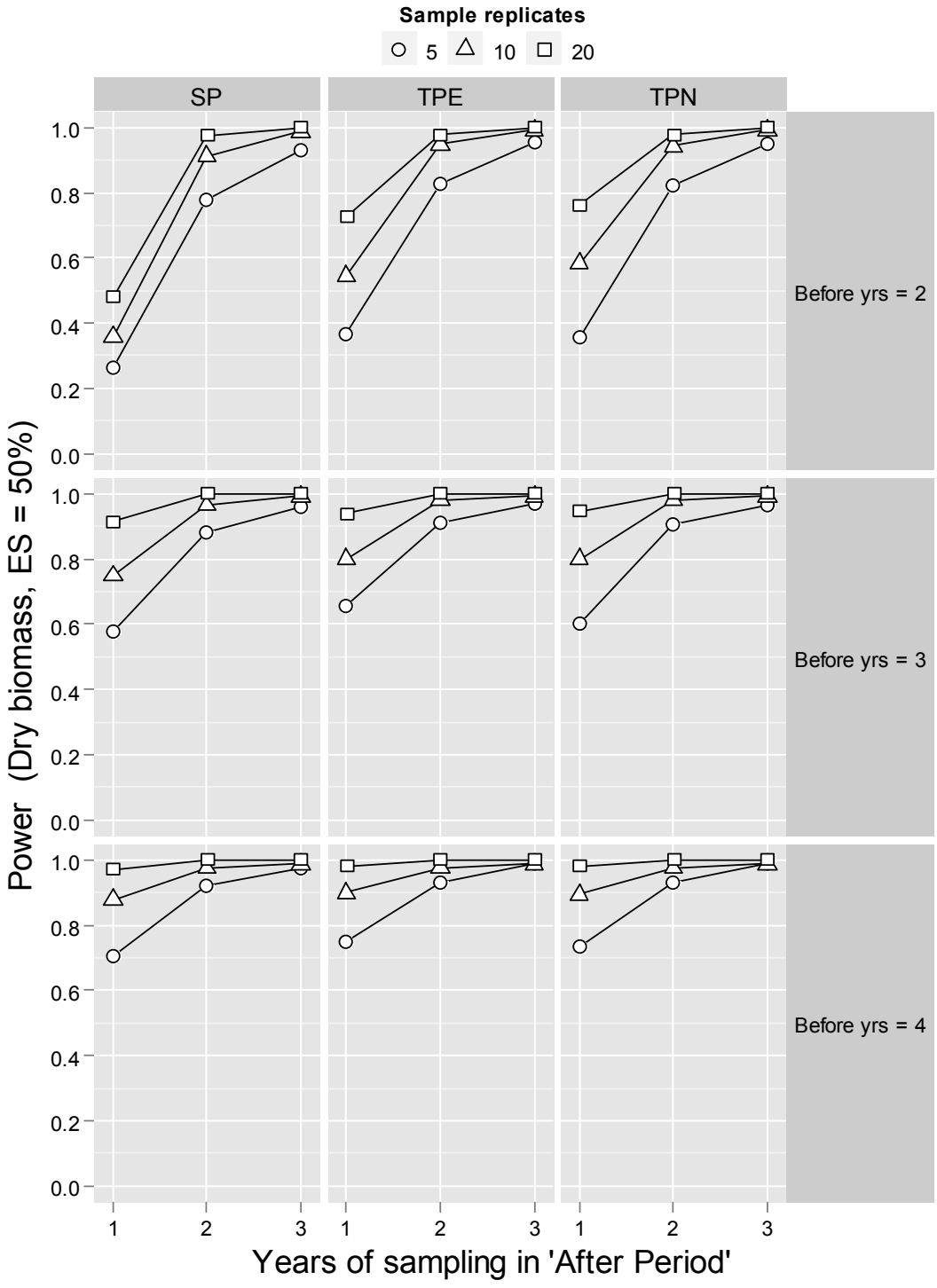


Figure 12. Two controls; Abundance, ES = 20%: Power for BACI tests (one tailed with alpha = 0.05) by station (columns) as a function of sampling years (before-period in rows, after-period along x-axis).

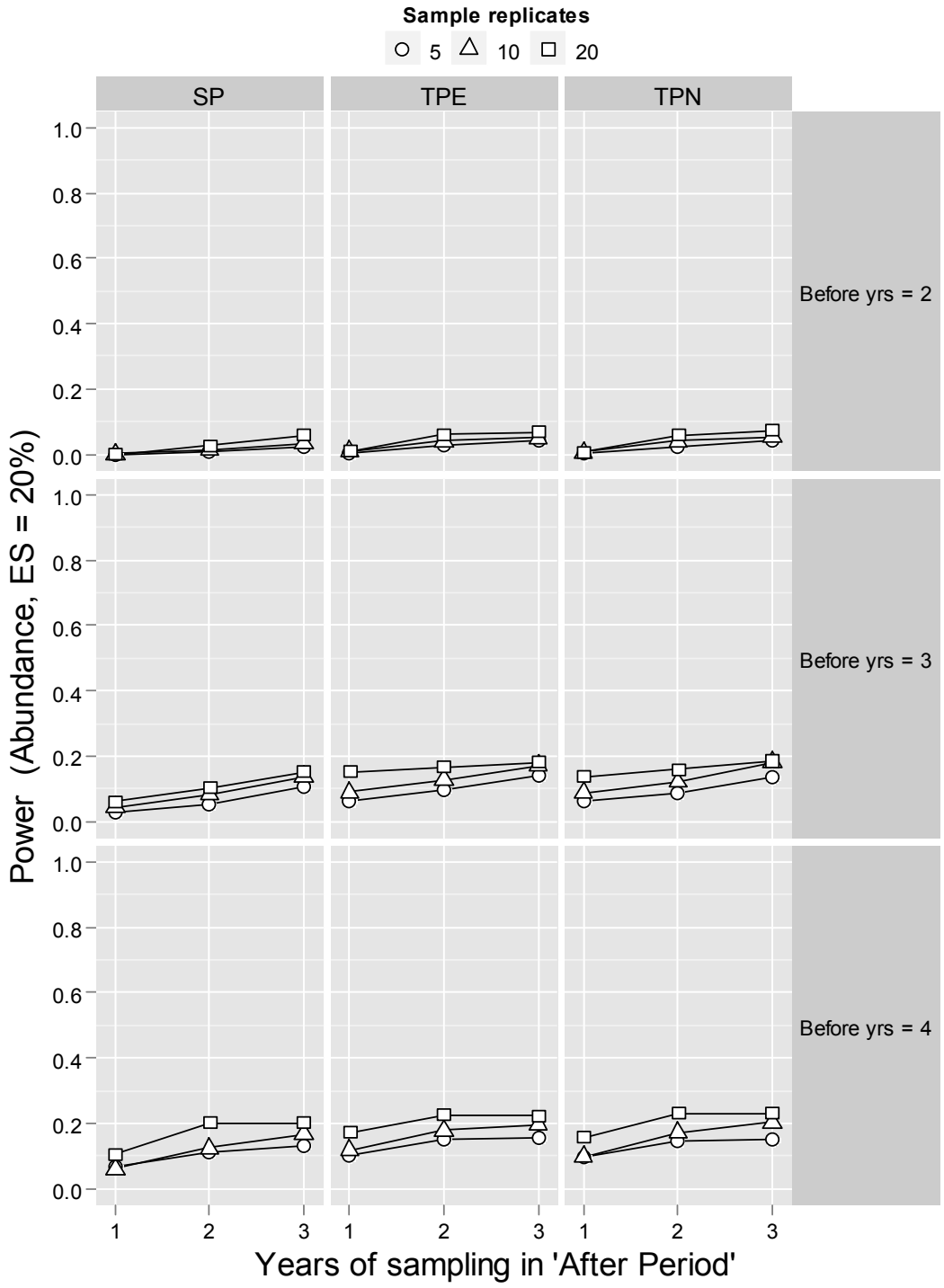
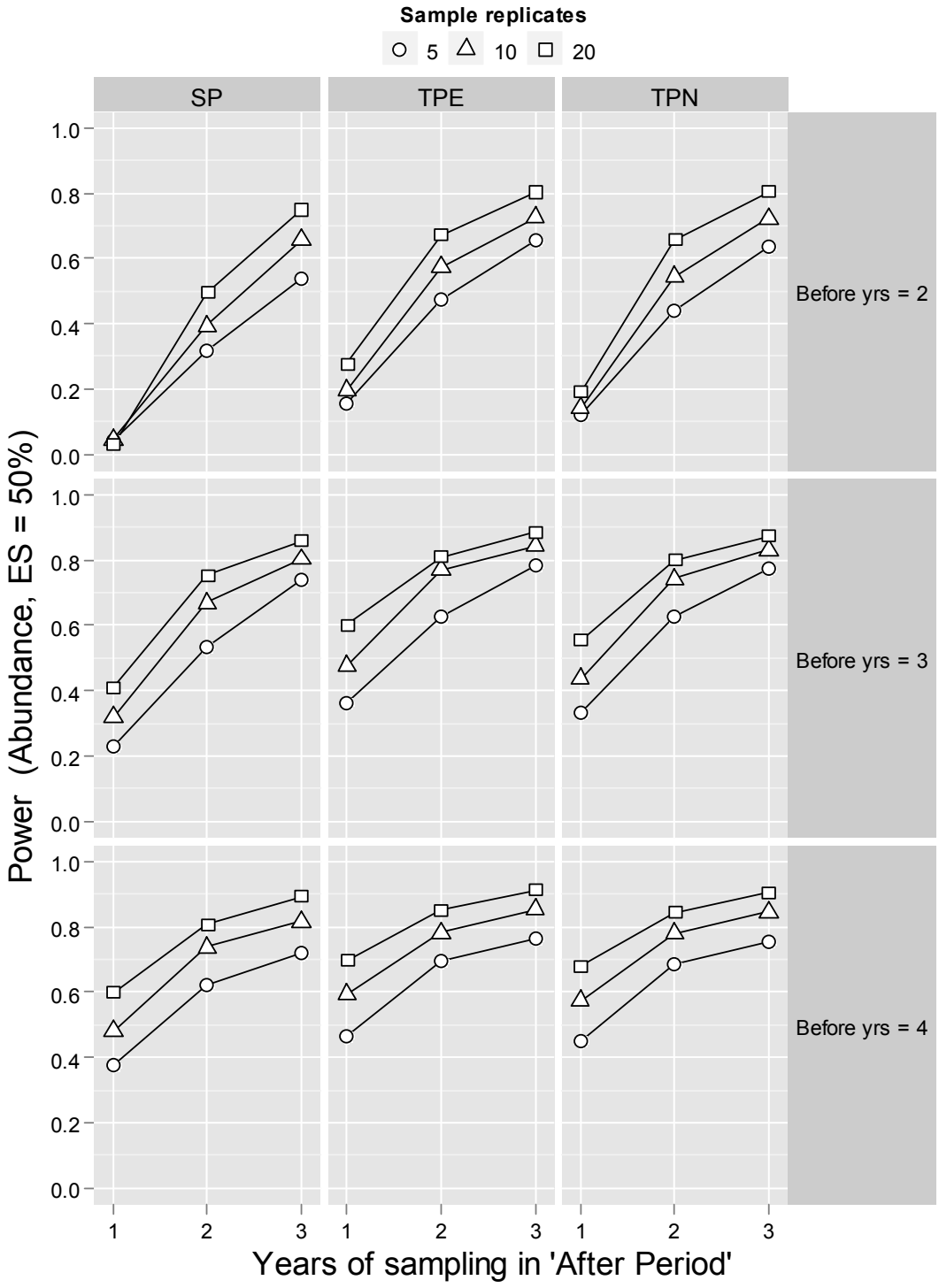


Figure 13. Two controls; Abundance, ES = 50%: Power for BACI tests (one tailed with alpha = 0.05) by station (columns) as a function of sampling years (before-period in rows, after-period along x-axis).



APPENDIX F – STATISTICAL ANALYSES FOR PERIPHYTON

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1. INTRODUCTION

This appendix contains the following analyses:

- Summary of CREMP periphyton data
- Analysis and implications for sampling design

The material in this appendix assumes understanding of basic statistical methods (Venables and Ripley 2002), mixed-effects models (Pinheiro and Bates 2000), before-after-control-impact (BACI) experimental design (Stewart-Oaten et al. 1986; Underwood 1994; Smith 2002), and use of simulation in statistical analysis (Gelman and Hill 2006).

2. SUMMARY AND EVALUATION OF CREMP PERIPHYTON DATA

Periphyton samples were collected as part of the CREMP from 2007 onwards in August of each year (**Table 1**). Most of the samples were collected in 2007 and 2008 (5 spatial replicates at each of 7 Meadowbank stations, for a total of 35 samples each year). For 2009 to 2011 there were 5 spatial replicates collected in SP and also at reference (SP-DT). We examined biomass variables (ug/cm^2), which are summarized in **Table 2** across all samples. Across samples, total biomass was dominated by Cyanobacteria, followed by Diatoms and Chlorophyte. Data appear highly variable across samples, with CV (coefficient of variation) = 0.57 for total biomass and > 0.7 for all other variables. **Table 3** shows Spearman correlations among variables. Across samples, variation in total biomass reflected variation in Cyanobacteria (r = 0.68) and Diatoms (r = 0.61). However, Cyanobacteria and Diatoms were not correlated (r = 0.0), suggesting these two components have distinct patterns across stations (or at some spatial/temporal scale).

The remaining analysis focused on three biomass variables: Cyanobacteria, Diatom, and total biomass. **Figure 1** shows box-plots for each variable by station (all years combined). Diatoms show considerably greater variation among stations than Cyanobacteria. From a sampling-design perspective, we are most interested in potential year-to-year differences. **Figures 2-4** show box-plots of sample measurements by station and year for each variable. In general, although there is some indication of variability among years (e.g., Cyanobacteria biomass and total biomass at SP), such patterns may be simply a result of limited sample sizes and high variability among spatial replicates.

An important consideration in the experimental design (discussed in next section) is the extent to which variation in a given periphyton measure is due to differences among stations, years, and replicates. To estimate these components of variation, we fit a mixed-effects model to each variable of the form:

$$X_{jks} = \beta_j + \tau_k + (\tau\beta)_{kj} + \varepsilon_{jks}$$

where all Station (β) and Year (τ) terms (including the interaction term $\tau\beta$) were treated as random effects, X is the measured value of subsample s at Station j in Year k, and ε is the residual error for subsamples.

There were notable differences among variables in the results (**Table 4**). For Cyanobacteria, most of the variation (76%) was accounted for by sampling variation (Error; the residual variation among replicate samples). In contrast, larger Station effects (i.e., differences among stations that were consistent across years) were estimated for Diatoms (52% of variation) and total biomass (31%). For all three variables, a similar proportion of variation (~10%) was accounted for by Station x Year (differences specific to each station-year combination). For the experimental design explored in the next section, we would expect relatively low power to detect change for Diatoms due to higher Station x Year variation (SD = 0.32), and the highest power to detect change for total biomass due to lower Station x Year variation (SD = 0.20) and sampling error (0.47).

3. ANALYSIS OF SAMPLING DESIGN

Impact hypotheses and statistical design – Two general classes of impacts are hypothesized for the Meadowbank mine for the case of periphyton:

1. Pulse events for which potential impacts would be high for a short time but may then dissipate. Pulse events could be associated with any phase of the mine, but are more likely to be associated with particular activities such as dike construction.
2. Long-term cumulative impacts that may be associated with ongoing activities. Long-term cumulative impacts are more likely to be associated with ongoing activities of mine operations.

As operations have just begun in 2010, the focus of CREMP monitoring to date has been on detecting pulse events associated with construction. The appropriate framework for analysis is a before-after-control-impact (BACI) that is aimed at detecting a potential impact in a particular lake or basin in a particular time period. The BACI framework can also be used to evaluate long-term impacts, but other tools such as time series regression analysis may also be appropriate for evaluating long-term trends. For this design document, we focus on the use of the BACI framework, recognizing that other tools such

as time series regressions may be useful at a future date once sufficient time series data are available[1].

The classic BACI (paired) design has before/after periods α_i (i = B, A; I = 2), control/impact sites β_j (j = C, I; J = 2), and a total of K paired sampling times τ_k that are nested within period. A statistical model for this design is given by (Smith 2002, equation 2):

$$(1) \qquad X_{ijk} = \mu + \alpha_i + \tau_{k(i)} + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \ .$$

The key term is the interaction ($\alpha\beta$), which can be tested using an F test with F = MS[($\alpha\beta$)]/MS[Resid] and degrees of freedom = 1, K – 2. As discussed by Smith (2002), this is equivalent to simply taking the differences between the control and impact values across times and using a two-sample (before-after) t test (Stewart-Oaten et al. 1986).

Model (1) can be extended to include additional control sites (e.g., "asymmetric" designs; Underwood 1994) and/or additional impact sites. To be valid, the additional sites must be replicates rather than subsamples (i.e., as controls, they should be spatially independent of each other but representative of the impact sites, while replicates for impacts need to be spatially independent and (ideally) affected by independent disturbances). So whereas j = (C, I) in the classic BACIP, j may compose any combination of J total sites, for example J = 4 where j = (C_1, C_2, C_3, I). The general test of ($\alpha\beta$) still applies, but with degrees of freedom = (J – 1), (K – 2)(J – 1) (e.g., see Table 1 of Underwood (1994) and Table 9 of Smith (2002)).

In addition, there may be n replicate subsamples s at each site/time combination (jk), as assumed in Table 1 of Underwood (1994). In this case, we modify equation (1) as:

$$(2) \qquad X_{ijks} = \mu + \alpha_i + \tau_{k(i)} + \beta_j + (\alpha\beta)_{ij} + (\tau\beta)_{k(i)j} + \varepsilon_{ijks} \ ,$$

where subsamples now permit estimation of times-by-site interactions ($\tau\beta$). The appropriate F ratio for ($\alpha\beta$) is now F = MS[($\alpha\beta$)]/MS[($\tau\beta$)] with df = (J – 1), (K – 2)(J – 1). As Underwood demonstrates, specific comparisons (interaction terms, such as the impact site versus either "period" or a specific "time" unit) can be examined by partitioning variation accordingly (e.g., Underwood Table 2[2]).

Methods – The analysis assessed the expected precision and power of BACI estimates for different after-period (impact) durations and different numbers of sub-samples (random spatial replicates collected at the same station during the sampling event each August).

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[1] In theory, a BACI analysis that is appropriately framed should be capable of detecting changes associated with long-term trends.

[2] We note that there are mistakes in the tables presented by Underwood (1994).

Separate analyses were conducted for the three primary impact stations SP, TPE, and TPN. In each case, INUG was used as the control station. Separate analyses were conducted for the three biomass variables. For each variable, the effect size or ES (fixed across months) was set at either a 20% reduction from baseline or a 50% reduction in baseline.

For purposes of the BACI analyses, the two years (2007-2008) of available control-impact paired data were used to represent the "before period" dataset. This assumes that these data, regardless of station or year, are reasonably representative of "natural" conditions. We also examined scenarios in which one or two additional "before" years of data were simulated prior to impacts, providing three scenarios (before years = 2, 3, and 4). The additional before-period data were simulated with variances equal to those estimated for observed data across all stations (**Table 4**), using the model specified in **Section 2** above[3]. After-period data were simulated using after-period means (β _control, β _impact + **ES**) for three durations (1, 2, and 3 years) and three sub-sample scenarios (5, 10, and 20 replicates per station per year), again using variances derived from the observed data (**Table 4**). For each scenario, 500 simulations were used. Power was computed for one-tailed tests (based on the a priori assumption that impacts will reduce periphyton biomass) using two alpha levels (0.05 and 0.10).

Results – Estimates of statistical power are shown in **Tables 5-7** and displayed in **Figures 5-10**. The tables report power for both alpha levels (0.05 and 0.10) but omit results for "Before" years = 2 (very low power). The figures only show power for alpha = 0.05 but include "Before" years = 2 Results were quite consistent across impact stations (SP, TPE, and TPN) for all variables and sampling designs. Power was low (< 0.8) for Cyanobacteria across all scenarios (**Table 5**; **Figures 5-6**) except for the most extensive sampling design (4 years of "Before" data, three years of "After" data, and 20 sample replicates for all additional sampling years) with ES = 50% and alpha = 0.10. Power was also low for Diatom biomass across all scenarios (**Table 6**; **Figures 7-8**). For total biomass with ES = 50%, high power was achieved for several scenarios (**Table 7**; **Figures 9-10**). Power was only high for alpha = 0.05 for the longest duration design (4 "Before" years and three "After" years) with 10 or 20 sample replicates, while for alpha = 0.10, high power was often achieved when the combination before/after years totaled 5 or more years.

Conclusion – Overall, periphyton variables are not realistically capable of detecting effects in a given year, and generally will not achieve high power even with high

[3] Data were insufficient to justify estimation of variances specific to each impact station paired to control (as was done for water chemistry), therefore variances were derived based on pooled data for all stations.

replication and several years of data. The only potentially useful variable, total biomass, does not achieve high (0.8) power until several years of data are available.

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Table 1. Summary of August periphyton samples by station.

Note: Shading denotes "Impact" periods.

Year	INUG	SP	SP-DT	TE	TPE	TPN	TPS	WAL	Total
2007	5	5		5	5	5	5	5	35
2008	5	5		5	5	5	5	5	35
2009		5	5						10
2010		5	5						10
2011		5	5		5				15
Total	10	25	15	10	15	10	10	10	105

Table 2. Summary statistics for periphyton biomass (ug/cm^2) variables across all samples.

Note: CV = Coefficient of variation (SD/Mean).

Variable	N	N=0	Mean	Median	SD	CV
Cyanobacteria	105	0	231	180	171	0.74
Chlorophyte	105	14	62	34	84	1.36
Chrysophyte	105	98	0.1	0.0	0.4	5.64
Diatom	105	0	129	103	111	0.86
Dinoflagellate	105	98	0.9	0.0	4.7	5.26
Total biomass	105	0	423	353	240	0.57

Table 3. Spearman correlations among periphyton biomass variables (N = 105 samples).

	Cyanobacteria	Chlorophyte	Chrysophyte	Diatom	Dinoflagellate
Cyanobacteria					
Chlorophyte	0.08				
Chrysophyte	-0.04	-0.06			
Diatom	0.00	0.30	-0.28		
Dinoflagellate	-0.12	0.06	0.09	-0.04	
Total biomass	0.68	0.43	-0.13	0.61	-0.02

Table 4. Estimates of standard deviation (SD) and percent of variation explained for each term in the mixed-effects models fit to (log) periphyton biomass variables.

	SD Estimate (log data)			Percent of variation		
Term	Cyanobact.	Diatom	Total biomass	Cyanobact.	Diatom	Total biomass
Station	0.19	0.73	0.34	6%	52%	31%
Year	0.20	0.17	0.00	7%	3%	0%
Station x Year	0.24	0.32	0.20	10%	10%	11%
Error (reps)	0.66	0.60	0.47	76%	35%	58%
Sum				100%	100%	100%

Table 5. Cyanobacteria biomass: Statistical power for BACI tests (one tailed) by station (SP, TPE, TPN) as a function of years sampled in the before/after periods and the number of replicate samples (Reps) per year.

Note: Power is shown for two effect sizes (ES = 20% and 50% reductions) and alpha levels (0.05 and 0.10). Light shading denotes power ≥ 0.8.

Effect	Years sampled			Power (α = 0.05)			Power (α = 0.10)		
Size	Before	After	Reps	SP	TPE	TPN	SP	TPE	TPN
20%	3	1	5	0.04	0.04	0.01	0.18	0.19	0.13
			10	0.08	0.08	0.05	0.24	0.25	0.19
			20	0.14	0.15	0.09	0.32	0.32	0.27
	3	2	5	0.08	0.08	0.06	0.19	0.20	0.15
			10	0.10	0.11	0.09	0.25	0.25	0.21
			20	0.17	0.17	0.15	0.33	0.33	0.29
	3	3	5	0.10	0.11	0.08	0.25	0.26	0.21
			10	0.14	0.15	0.11	0.29	0.29	0.27
			20	0.18	0.19	0.16	0.32	0.32	0.30
	4	1	5	0.09	0.10	0.07	0.24	0.25	0.19
			10	0.14	0.14	0.11	0.28	0.28	0.24
			20	0.18	0.19	0.17	0.36	0.36	0.32
	4	2	5	0.15	0.16	0.13	0.29	0.30	0.25
			10	0.14	0.15	0.12	0.28	0.29	0.26
			20	0.21	0.22	0.19	0.33	0.33	0.31
	4	3	5	0.13	0.13	0.11	0.27	0.28	0.25
			10	0.19	0.19	0.17	0.31	0.31	0.29
			20	0.22	0.22	0.20	0.38	0.38	0.36
50%	3	1	5	0.16	0.18	0.11	0.41	0.44	0.34
			10	0.28	0.29	0.21	0.58	0.59	0.51
			20	0.46	0.46	0.38	0.68	0.68	0.62
	3	2	5	0.35	0.37	0.28	0.57	0.58	0.53
			10	0.44	0.45	0.38	0.66	0.66	0.62
			20	0.55	0.55	0.52	0.74	0.74	0.70
	3	3	5	0.50	0.50	0.45	0.69	0.70	0.65
			10	0.55	0.55	0.51	0.75	0.75	0.73
			20	0.61	0.61	0.59	0.78	0.79	0.77
	4	1	5	0.28	0.30	0.21	0.49	0.50	0.45
			10	0.42	0.43	0.37	0.61	0.61	0.57
			20	0.50	0.50	0.48	0.66	0.66	0.63
	4	2	5	0.46	0.47	0.42	0.66	0.66	0.60
			10	0.55	0.56	0.51	0.74	0.74	0.71
			20	0.62	0.62	0.60	0.79	0.79	0.77
	4	3	5	0.57	0.57	0.53	0.74	0.74	0.71
			10	0.64	0.64	0.61	0.79	0.79	0.77
			20	0.71	0.71	0.68	0.81	0.81	0.81

Table 6. Diatom biomass: Statistical power for BACI tests (one tailed) by station (SP, TPE, TPN) as a function of years sampled in the before/after periods and the number of replicate samples (Reps) per year.

Note: Power is shown for two effect sizes (ES = 20% and 50% reductions) and alpha levels (0.05 and 0.10). Light shading denotes power ≥ 0.8.

Effect	Years sampled			Power (α = 0.05)			Power (α = 0.10)		
Size	Before	After	Reps	SP	TPE	TPN	SP	TPE	TPN
20%	3	1	5	0.02	0.04	0.04	0.14	0.17	0.18
			10	0.06	0.09	0.09	0.22	0.25	0.25
			20	0.13	0.16	0.16	0.33	0.34	0.35
	3	2	5	0.06	0.08	0.08	0.16	0.19	0.20
			10	0.11	0.11	0.12	0.22	0.24	0.24
			20	0.16	0.17	0.17	0.31	0.30	0.30
	3	3	5	0.08	0.10	0.10	0.21	0.25	0.26
			10	0.13	0.15	0.14	0.28	0.28	0.29
			20	0.16	0.17	0.16	0.30	0.29	0.29
	4	1	5	0.08	0.10	0.10	0.21	0.23	0.24
			10	0.14	0.15	0.15	0.27	0.29	0.29
			20	0.18	0.19	0.19	0.33	0.34	0.35
	4	2	5	0.13	0.15	0.15	0.26	0.29	0.29
			10	0.15	0.17	0.17	0.30	0.31	0.32
			20	0.21	0.22	0.22	0.33	0.33	0.34
	4	3	5	0.13	0.14	0.13	0.24	0.26	0.26
			10	0.18	0.19	0.19	0.29	0.30	0.30
			20	0.20	0.20	0.21	0.34	0.35	0.35
50%	3	1	5	0.10	0.15	0.15	0.32	0.38	0.39
			10	0.22	0.26	0.27	0.49	0.53	0.53
			20	0.38	0.39	0.39	0.58	0.59	0.60
	3	2	5	0.27	0.30	0.32	0.50	0.53	0.55
			10	0.38	0.40	0.39	0.59	0.60	0.60
			20	0.47	0.47	0.47	0.64	0.64	0.64
	3	3	5	0.43	0.47	0.48	0.63	0.66	0.66
			10	0.47	0.49	0.49	0.68	0.68	0.68
			20	0.53	0.54	0.54	0.69	0.69	0.69
	4	1	5	0.22	0.26	0.26	0.43	0.46	0.47
			10	0.36	0.37	0.38	0.54	0.55	0.55
			20	0.44	0.45	0.45	0.60	0.59	0.60
	4	2	5	0.42	0.45	0.45	0.60	0.61	0.62
			10	0.48	0.49	0.49	0.65	0.66	0.67
			20	0.52	0.52	0.52	0.71	0.71	0.71
	4	3	5	0.49	0.51	0.52	0.70	0.70	0.71
			10	0.56	0.57	0.58	0.71	0.72	0.72
			20	0.59	0.60	0.60	0.75	0.75	0.75

Table 7. Total biomass: Statistical power for BACI tests (one tailed) by station (SP, TPE, TPN) as a function of years sampled in the before/after periods and the number of replicate samples (Reps) per year.

Note: Power is shown for two effect sizes (ES = 20% and 50% reductions) and alpha levels (0.05 and 0.10). Light shading denotes power ≥ 0.8.

Effect	Years sampled			Power (α = 0.05)			Power (α = 0.10)		
Size	Before	After	Reps	SP	TPE	TPN	SP	TPE	TPN
20%	3	1	5	0.07	0.07	0.04	0.21	0.22	0.18
			10	0.10	0.10	0.09	0.27	0.27	0.24
			20	0.20	0.19	0.17	0.40	0.40	0.38
	3	2	5	0.11	0.11	0.09	0.25	0.25	0.23
			10	0.15	0.15	0.14	0.26	0.27	0.25
			20	0.23	0.22	0.21	0.36	0.35	0.35
	3	3	5	0.13	0.14	0.11	0.30	0.30	0.29
			10	0.16	0.17	0.15	0.35	0.34	0.33
			20	0.21	0.21	0.20	0.36	0.35	0.34
	4	1	5	0.12	0.13	0.10	0.27	0.28	0.24
			10	0.19	0.19	0.16	0.36	0.36	0.34
			20	0.23	0.23	0.21	0.37	0.37	0.36
	4	2	5	0.17	0.17	0.15	0.33	0.34	0.31
			10	0.20	0.19	0.18	0.35	0.35	0.33
			20	0.27	0.27	0.25	0.42	0.42	0.41
	4	3	5	0.20	0.21	0.18	0.34	0.35	0.34
			10	0.23	0.22	0.22	0.38	0.38	0.37
			20	0.31	0.31	0.30	0.44	0.44	0.43
50%	3	1	5	0.29	0.30	0.24	0.55	0.56	0.52
			10	0.48	0.47	0.43	0.70	0.71	0.68
			20	0.60	0.60	0.57	0.77	0.76	0.75
	3	2	5	0.57	0.57	0.54	0.76	0.77	0.74
			10	0.67	0.67	0.65	0.85	0.84	0.83
			20	0.72	0.71	0.70	0.85	0.85	0.85
	3	3	5	0.71	0.71	0.67	0.86	0.86	0.85
			10	0.77	0.77	0.76	0.92	0.92	0.91
			20	0.79	0.79	0.78	0.90	0.90	0.90
	4	1	5	0.43	0.44	0.39	0.62	0.63	0.60
			10	0.58	0.57	0.54	0.75	0.75	0.74
			20	0.67	0.67	0.65	0.79	0.79	0.78
	4	2	5	0.66	0.66	0.63	0.82	0.83	0.80
			10	0.76	0.76	0.73	0.89	0.89	0.88
			20	0.80	0.80	0.79	0.90	0.90	0.90
	4	3	5	0.78	0.78	0.77	0.90	0.89	0.89
			10	0.84	0.84	0.83	0.93	0.93	0.93
			20	0.89	0.89	0.88	0.94	0.94	0.94

Figure 1. Box-plots of periphyton variables by station (all available years combined).

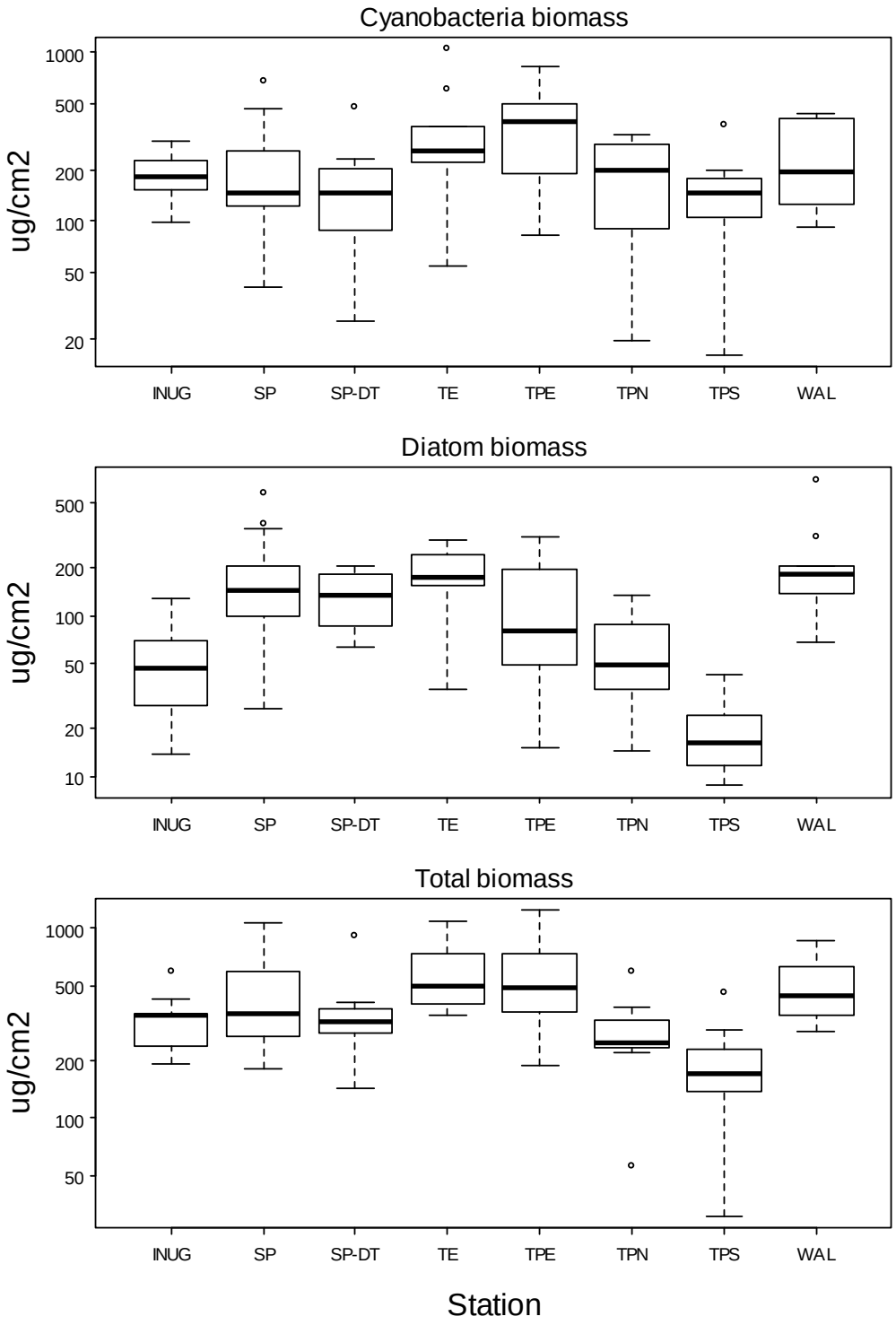
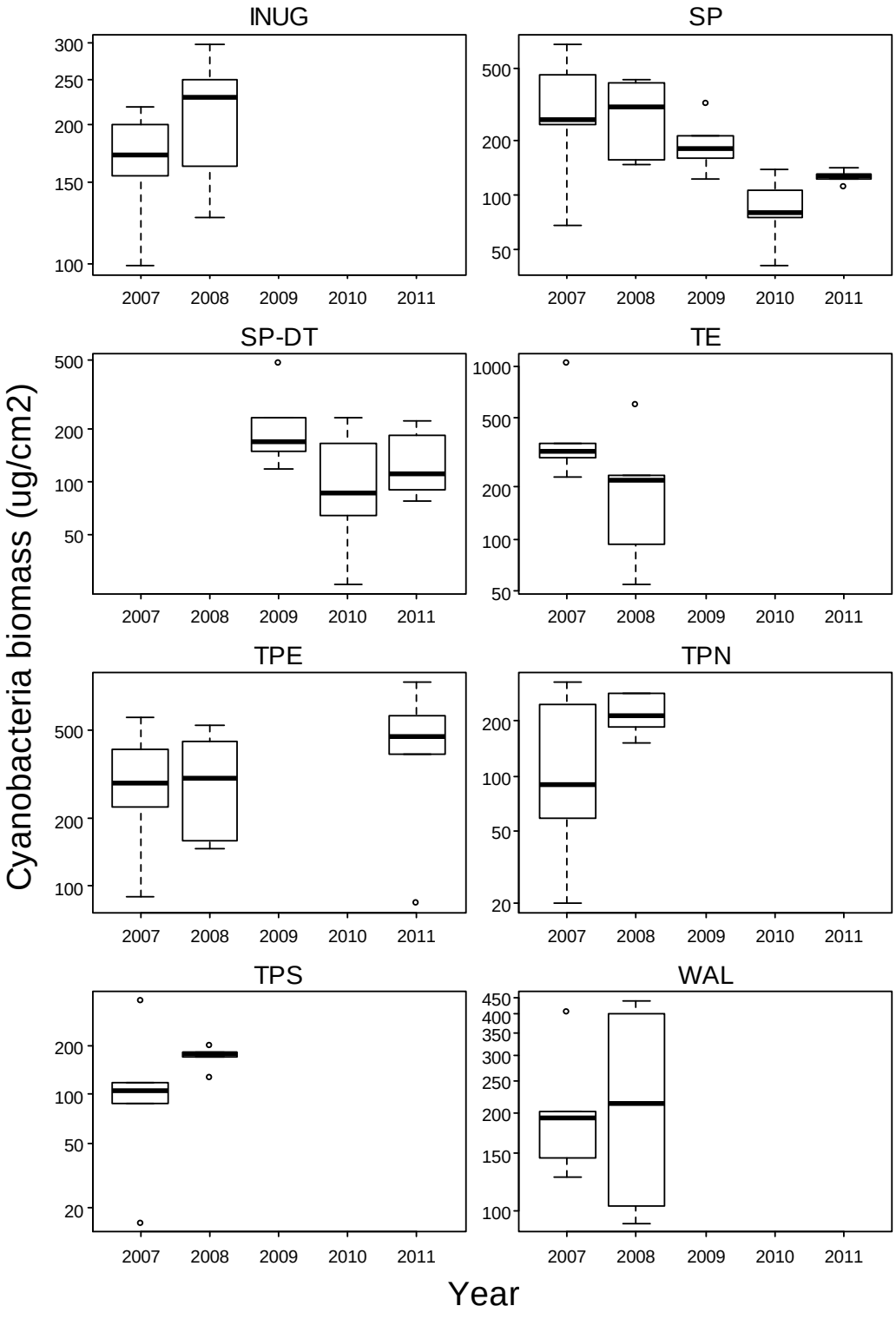


Figure 2. Box-plots of Cyanobacteria biomass by station and year (5 samples per station/year).



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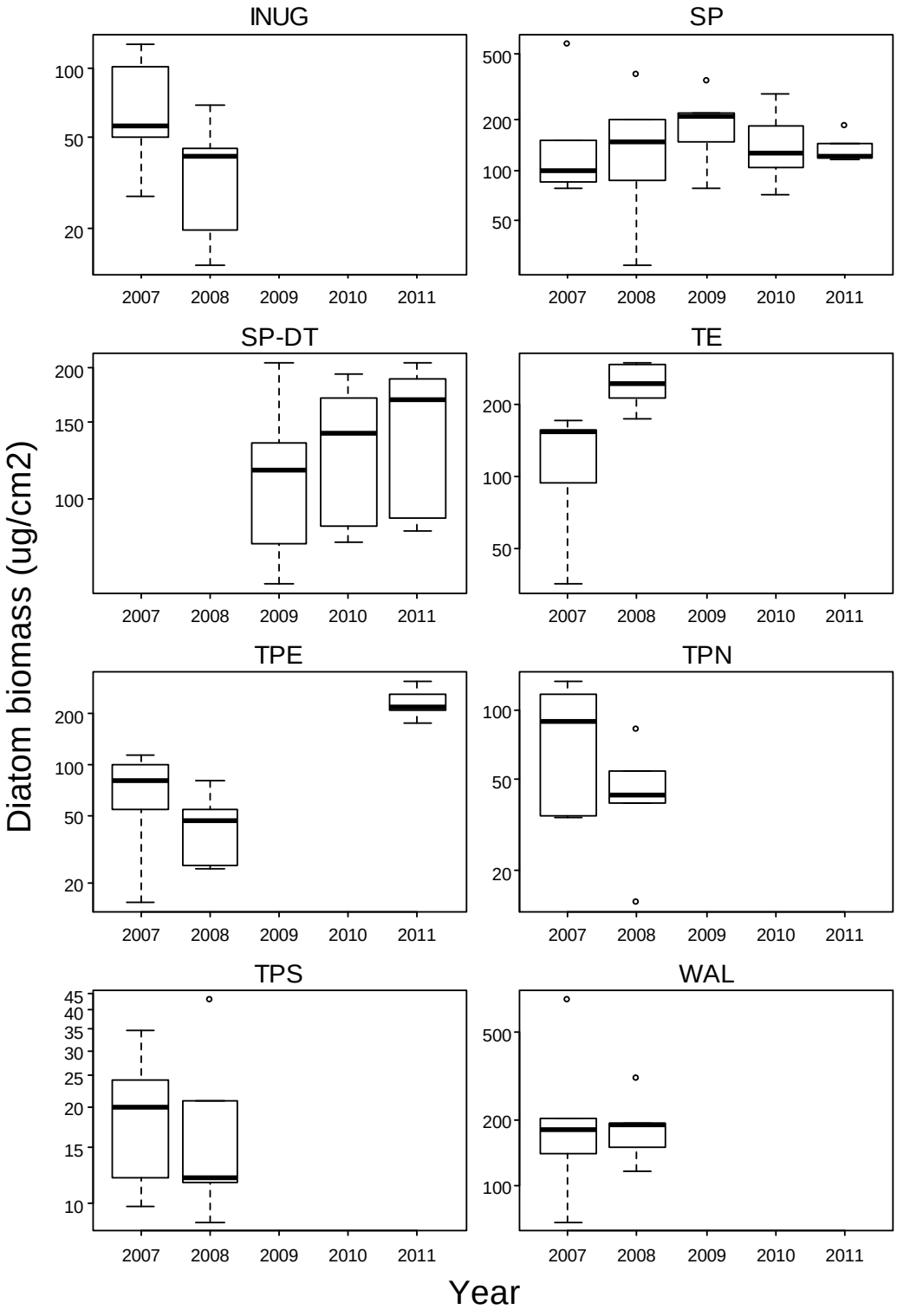

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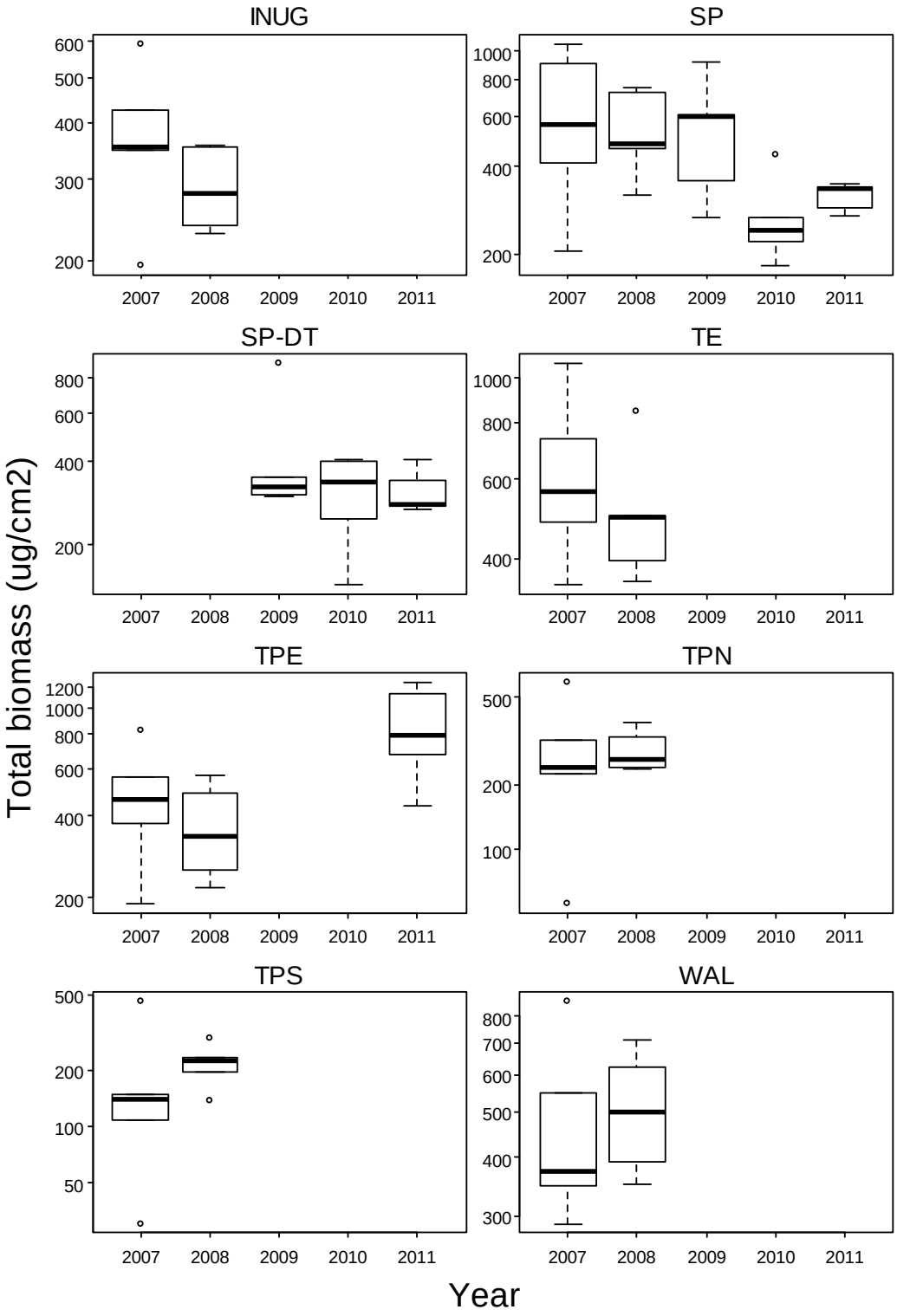

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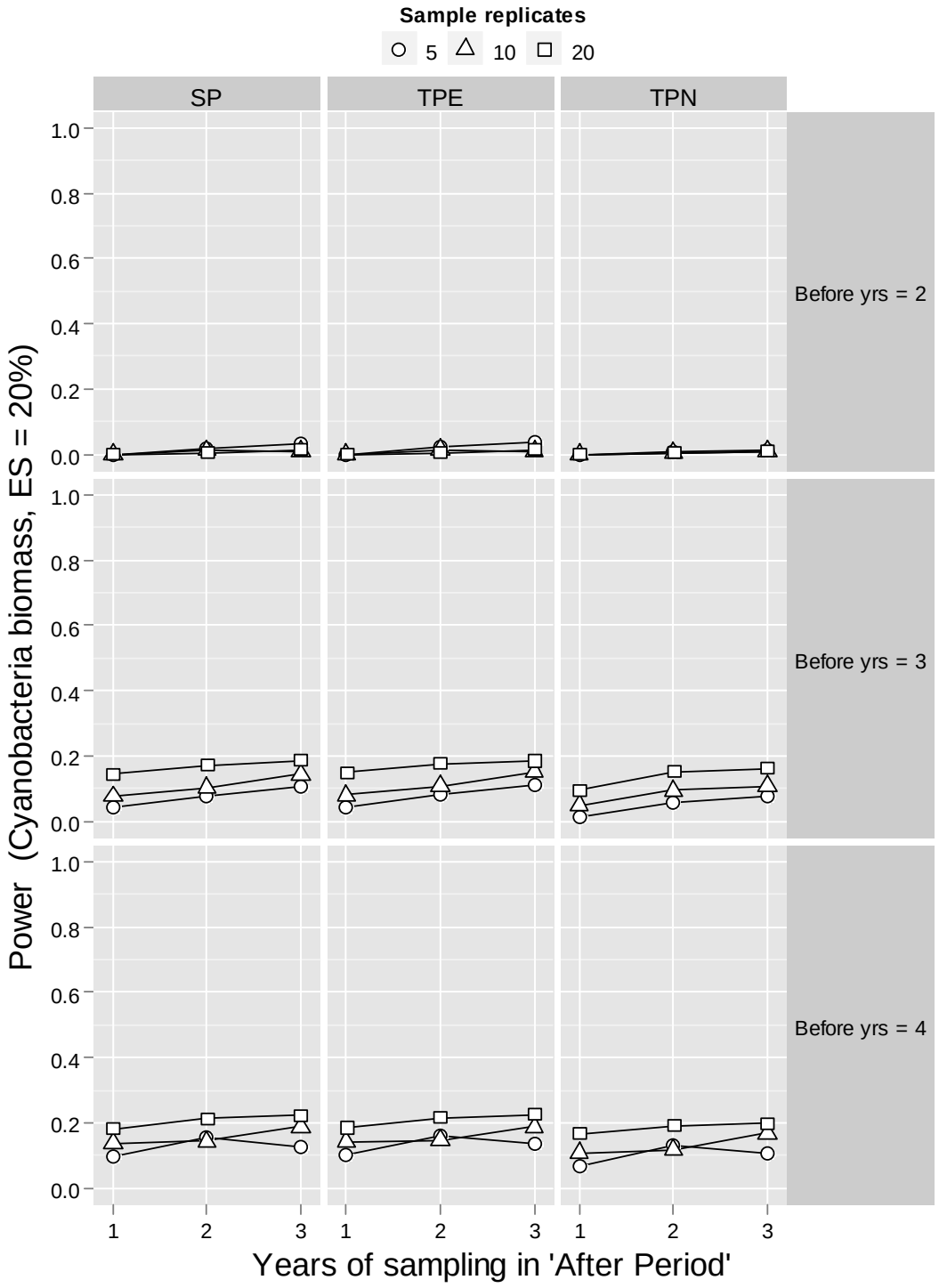

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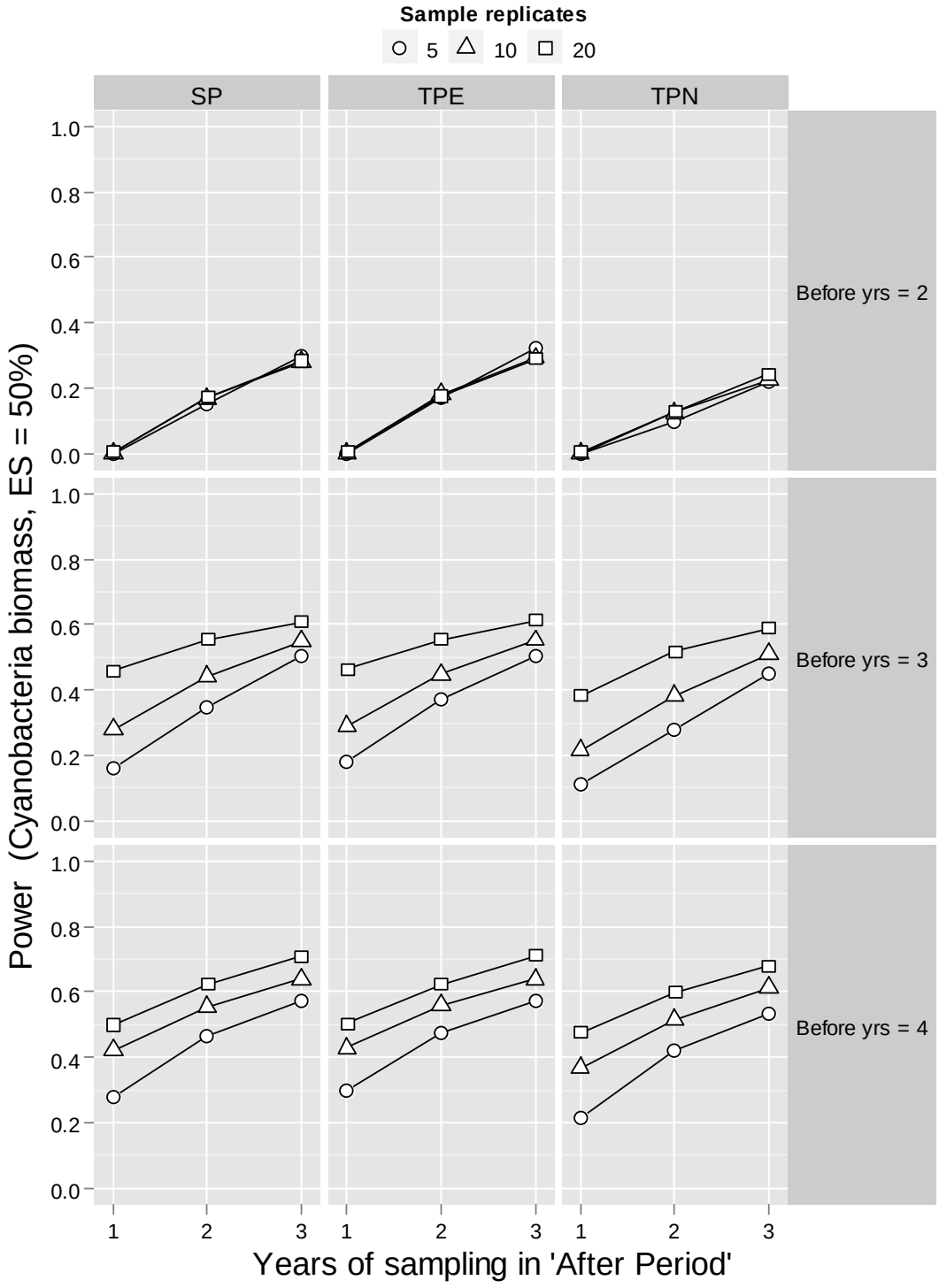

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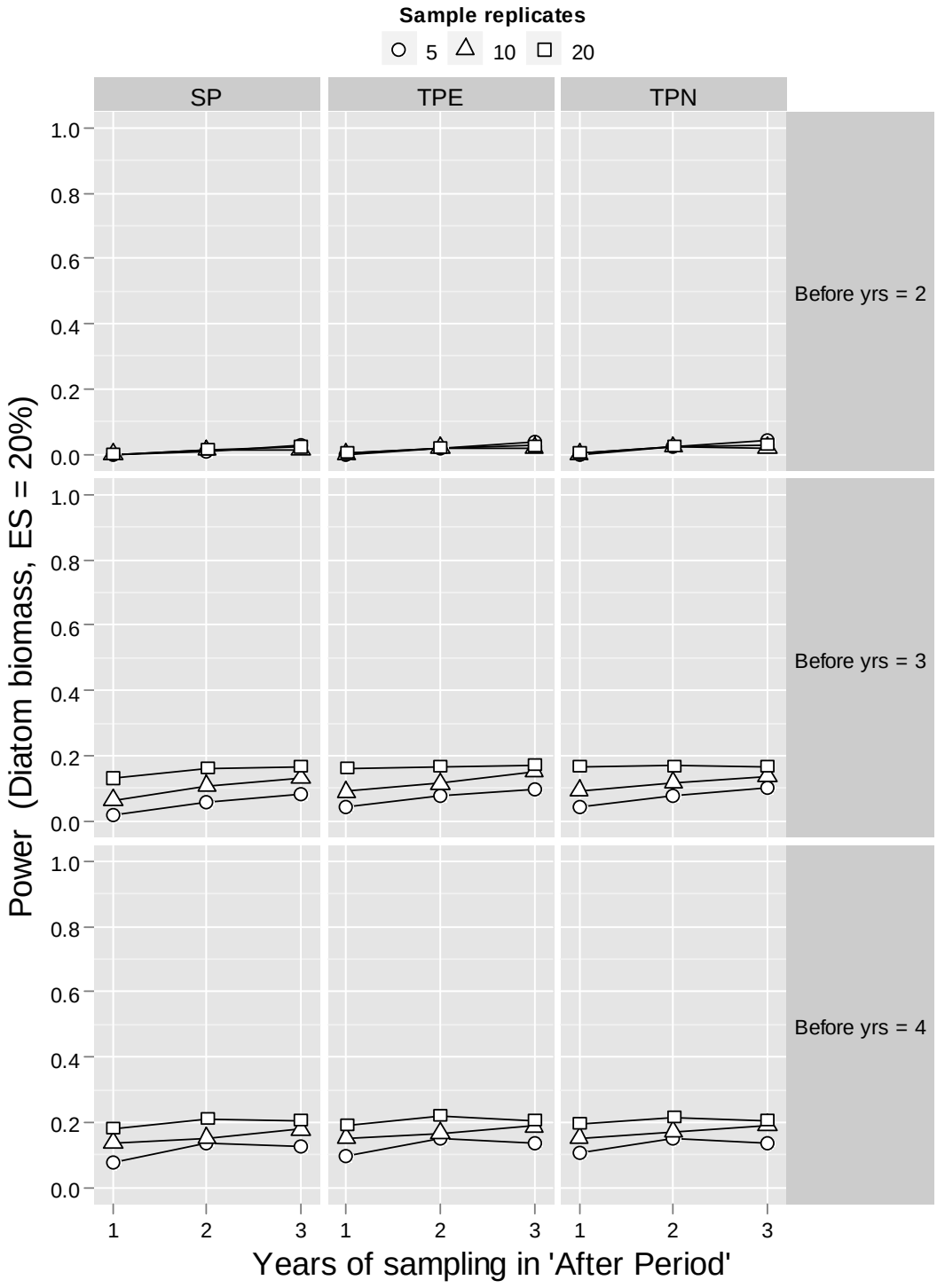

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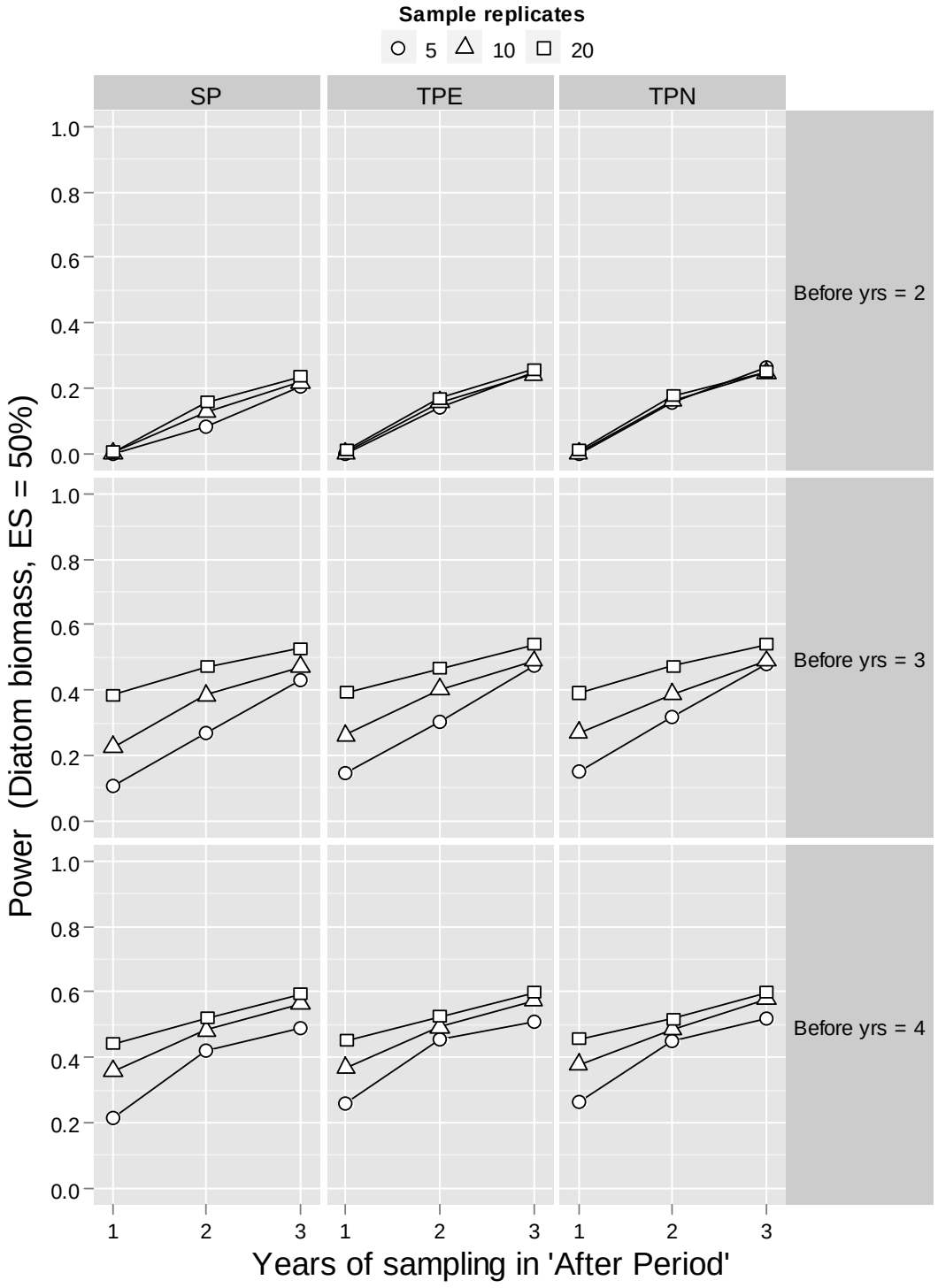

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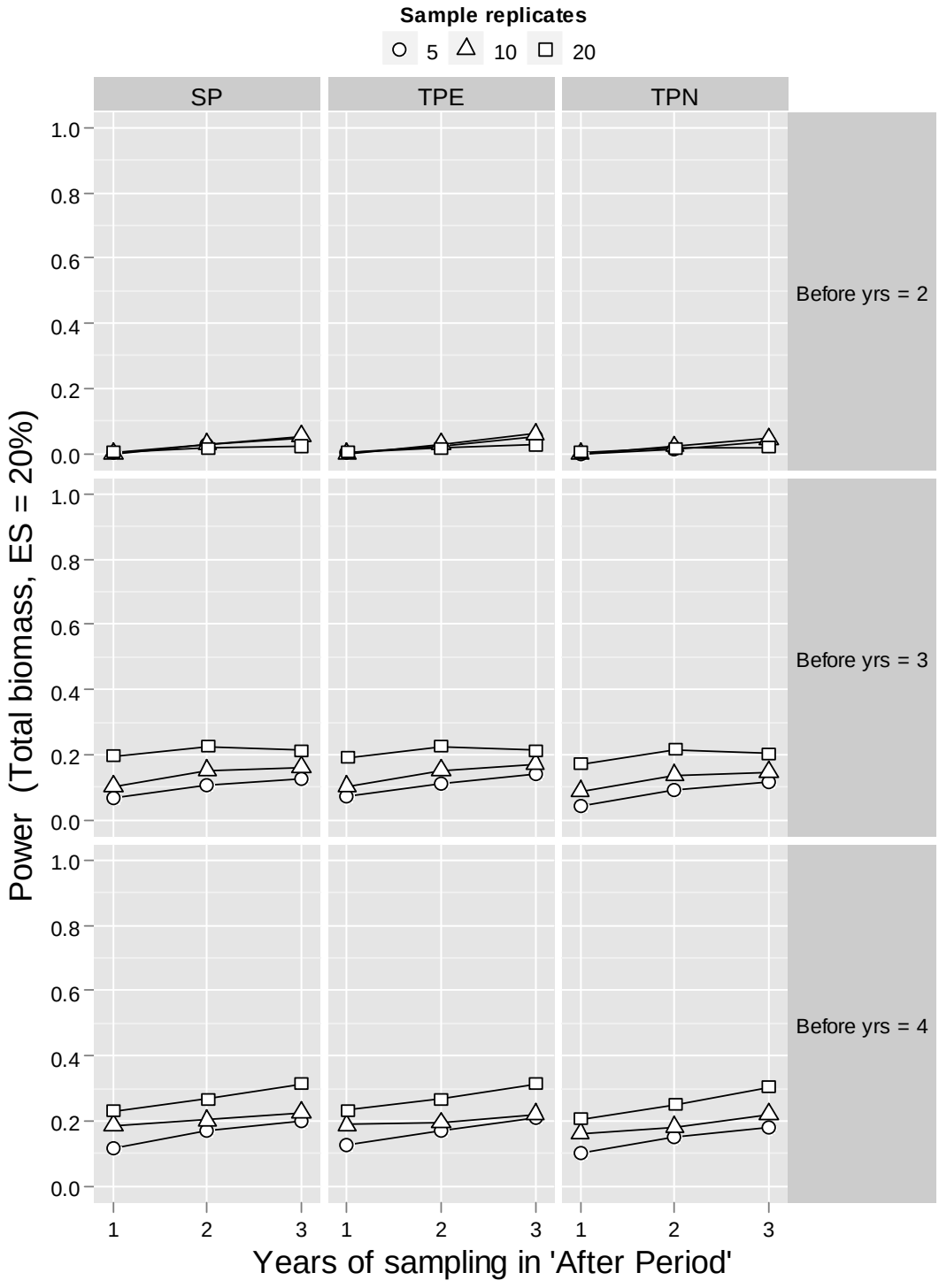

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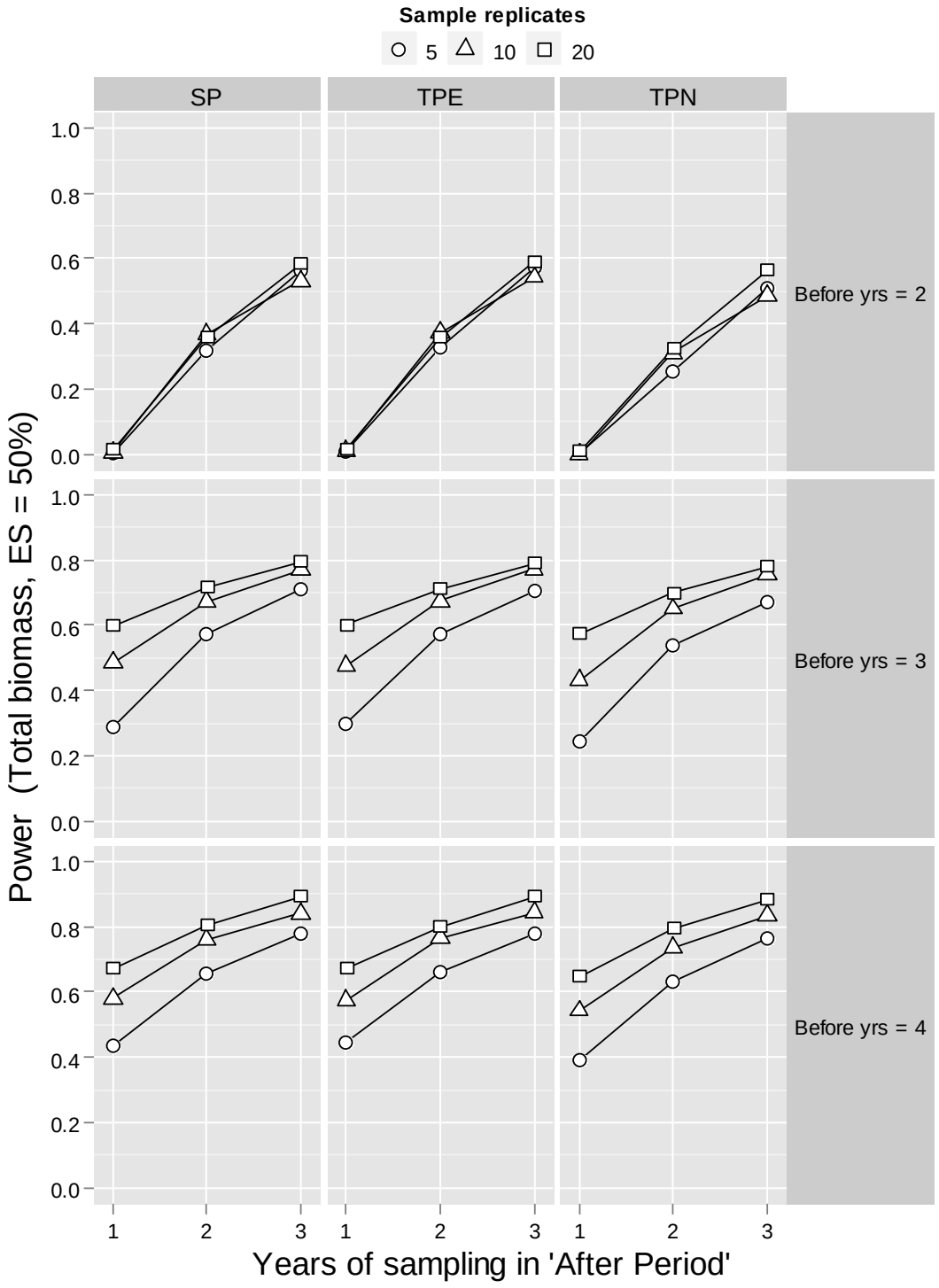

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Project No. AE-10-01
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Aquatic Effects Management Program (AEMP)
Meadowbank Mine

Prepared for:

Agnico-Eagle Mines Ltd.
Meadowbank Division

P.O. Box 540
Baker Lake,
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Prepared by:

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1	2010-05	All	All	Aquatic Effects Management Program (AEMP) Meadowbank Gold Project
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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.

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[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.

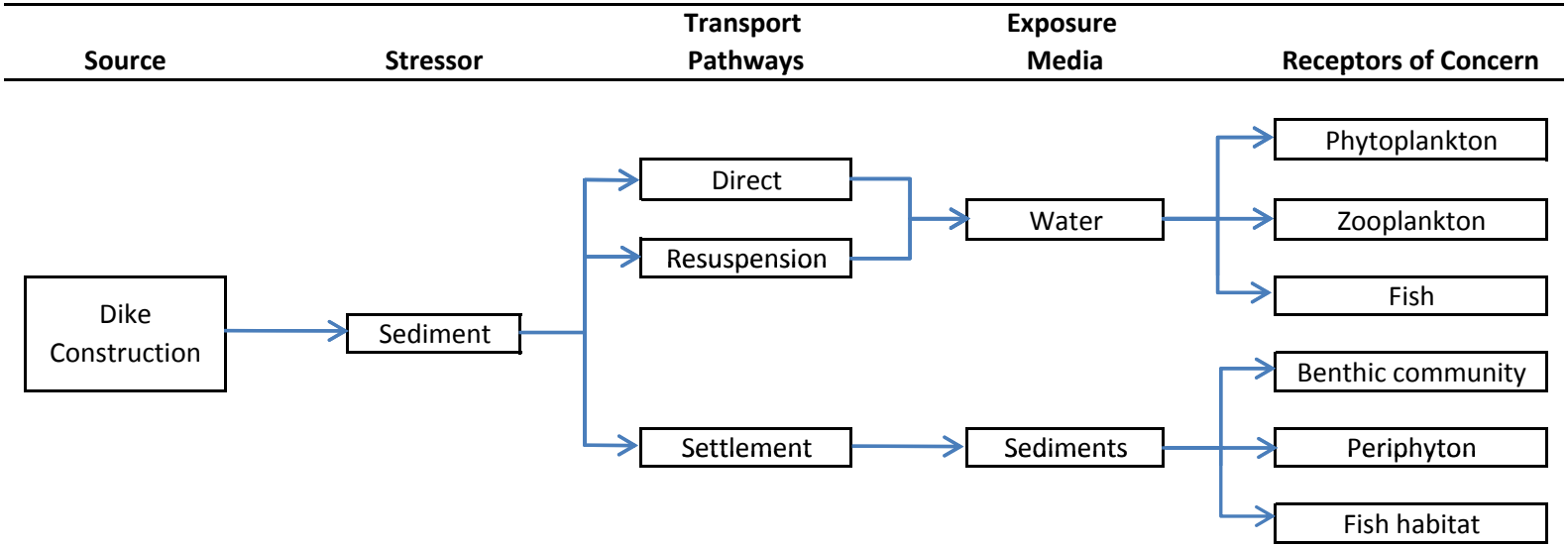


Figure 3-2. Primary transport pathways, exposure media, and receptors of concern for the Meadowbank Gold Project's Aquatic Effects Management Program.

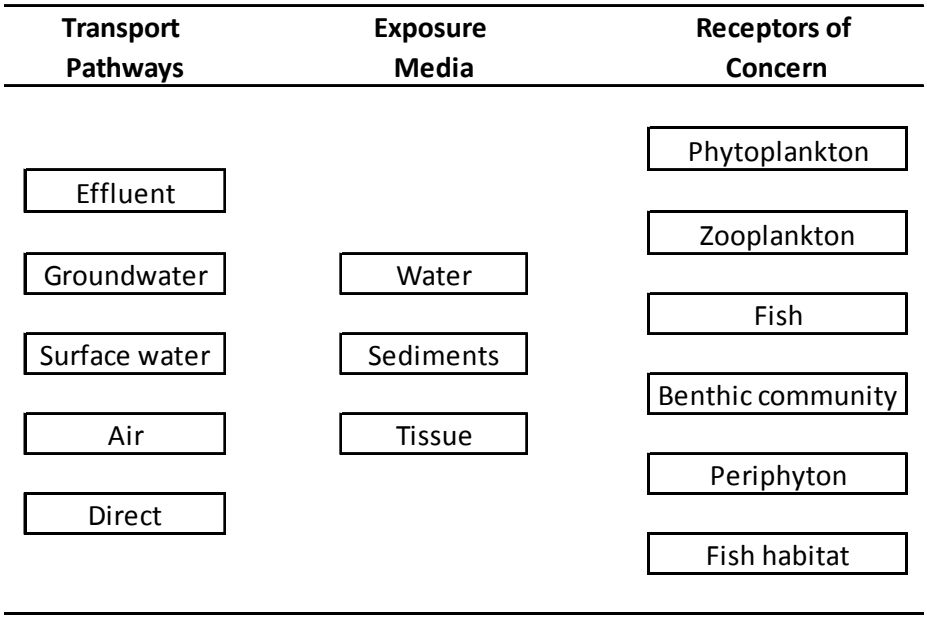
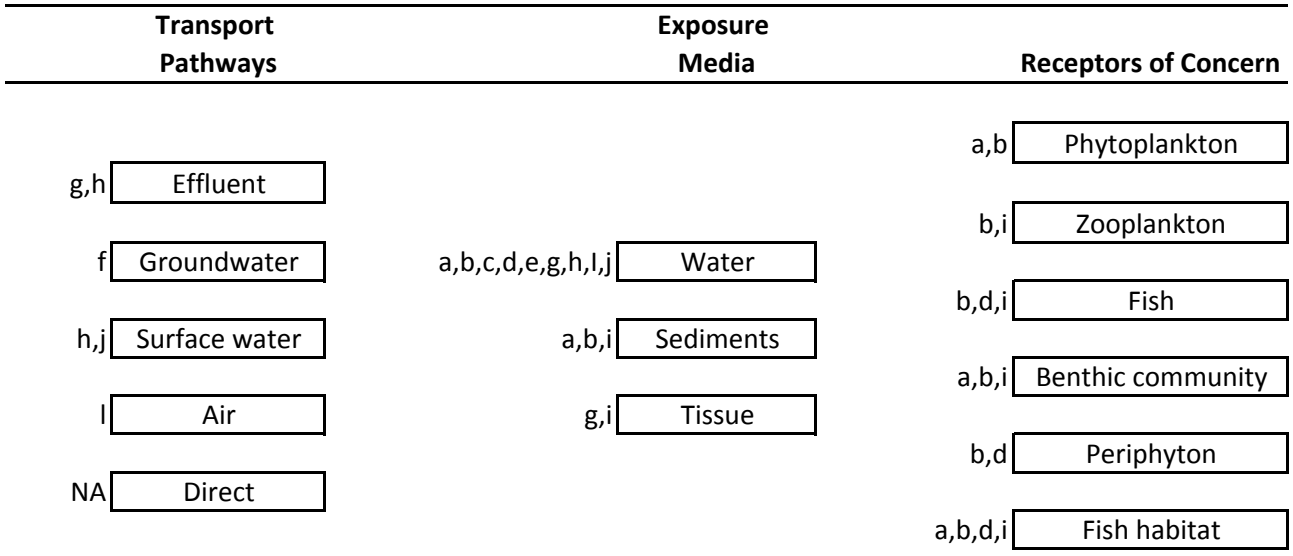


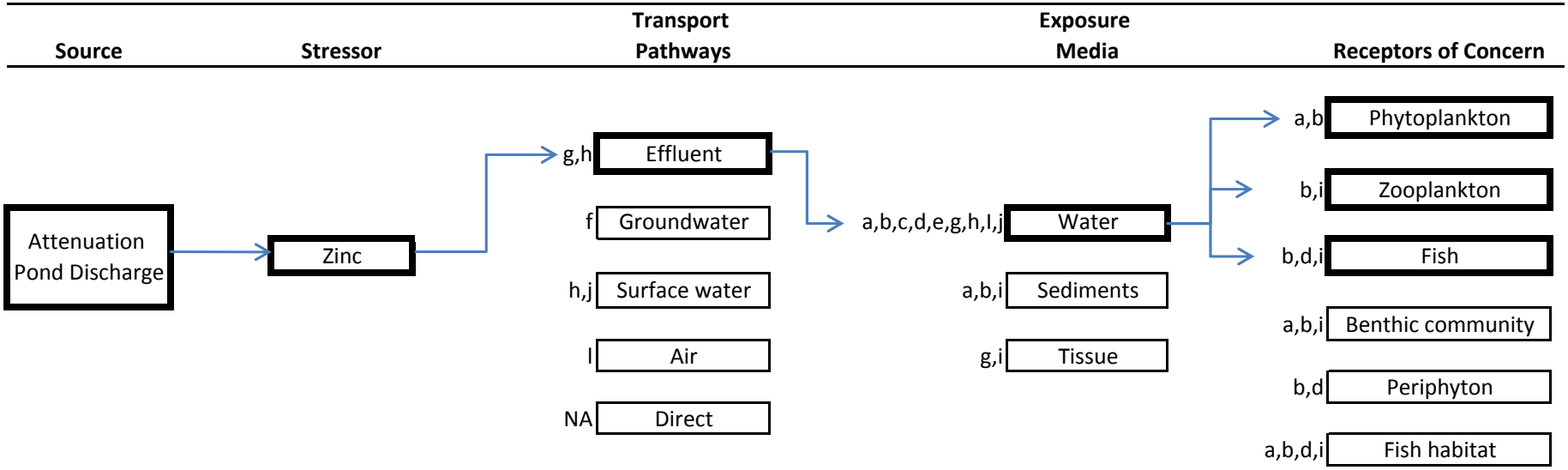
Figure 3-3. Primary transport pathways, exposure media, and receptors of concern for the Meadowbank Gold Project's Aquatic Effects Management Program.



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.
- *Reversibility* – 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, reversibility 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, reversibility 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 reversibility 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, reversibility 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	Medium	Magnitude[1]	Spatial Scale[2]	Causation[3]	Reversibility[4]	Uncertainty[5]	Comments
Lead	Sediment	○	n/a	n/a	Moderate	??	
Zinc	Sediment	◍	Small	Moderate	Moderate	?	
…							

[1] **Magnitude Ratings:**

○ - no exceedances of early warning triggers or thresholds

◍ - early warning trigger exceeded.

● - threshold exceeded.

[2] **Spatial Scale Ratings:**

n/a – not applicable, because no exceedances of triggers or thresholds

Small – Isolated occurrence or very small area

Moderate – Moderately sized area affected, such as a portion of a basin

Large – An entire lake basin (or lake) is likely to be affected

[3] **Causation Ratings:**

n/a There is no magnitude of effect, therefore causation is not evaluated.

Low – There is no evidence for a mine-related source.

Moderate – There is some likelihood of a mine-related source.

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

[4] **Reversibility Ratings:** bad = largely irreversible for at least several decades; moderate = reversible over long time periods (e.g., decades); good = most reversible in less than 10 years.

[5] **Uncertainty Ratings:** ? = low uncertainty; ?? = moderate uncertainty; ??? = high uncertainty.

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 exceedance of early warning triggers or thresholds

◎ Early warning trigger exceeded

● Threshold exceeded

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]**	**Reversibility[2]**	**Uncertainty[2]**	**Comments**
EAS and CREMP	●	Large	High	Good	?	
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.

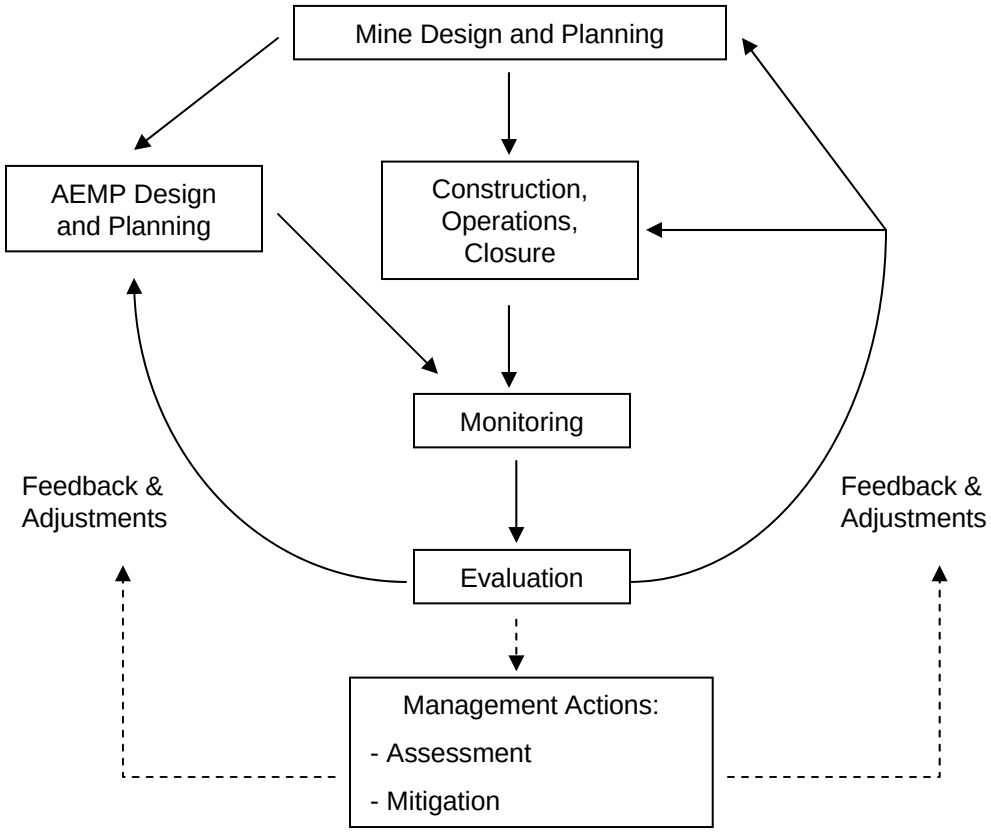


Figure 4-2. Management Response Plan for the Meadowbank Mine AEMP

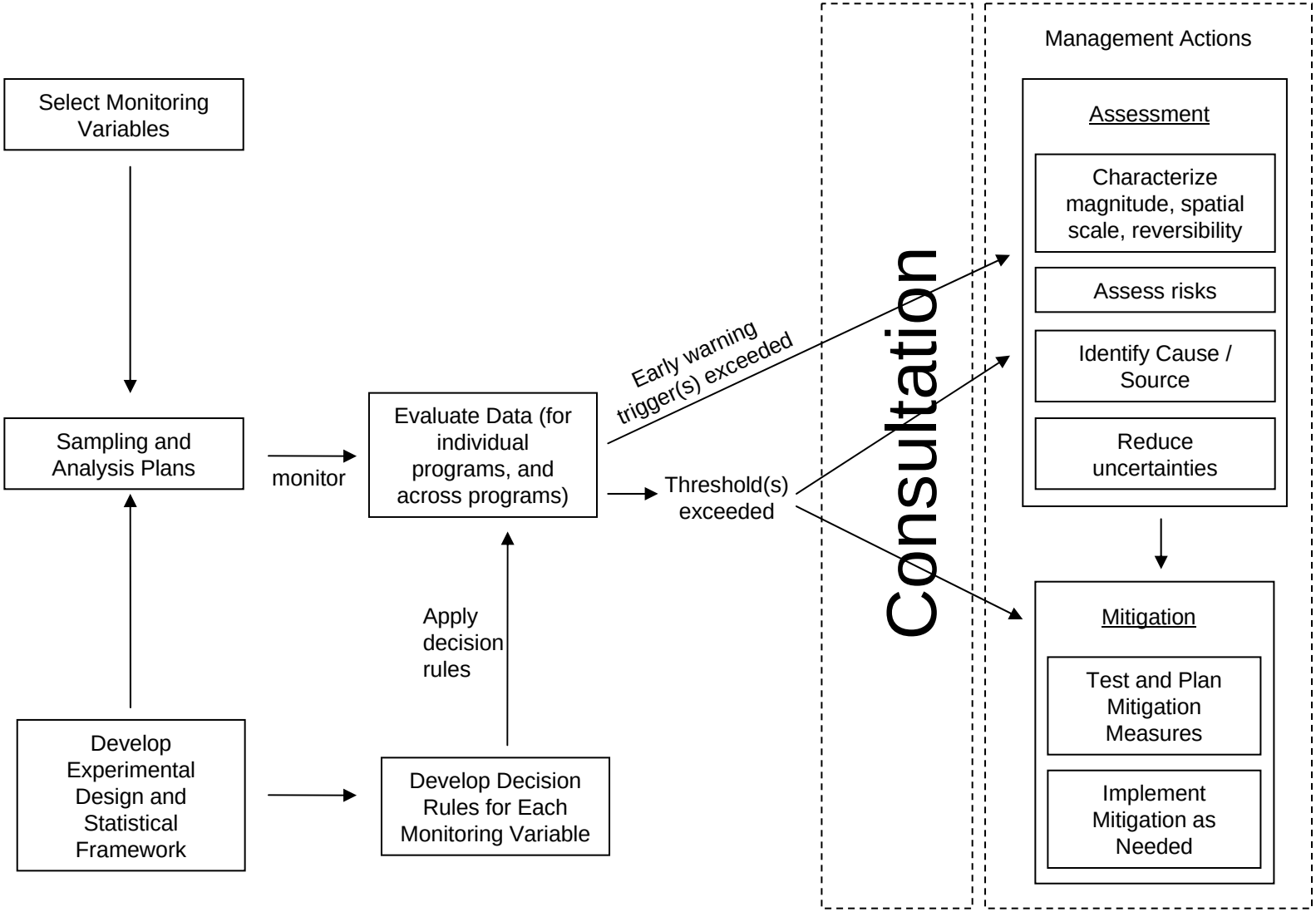
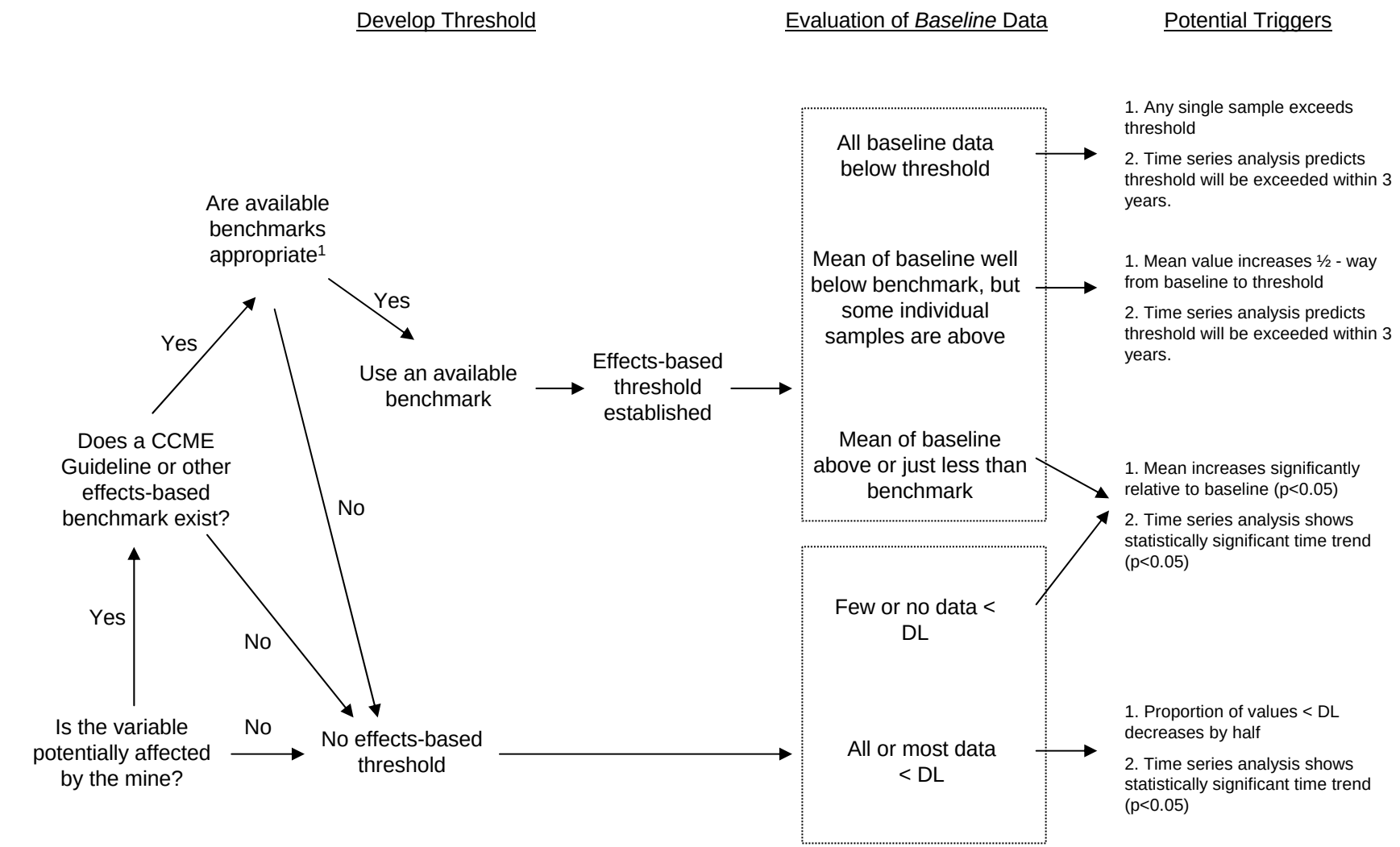
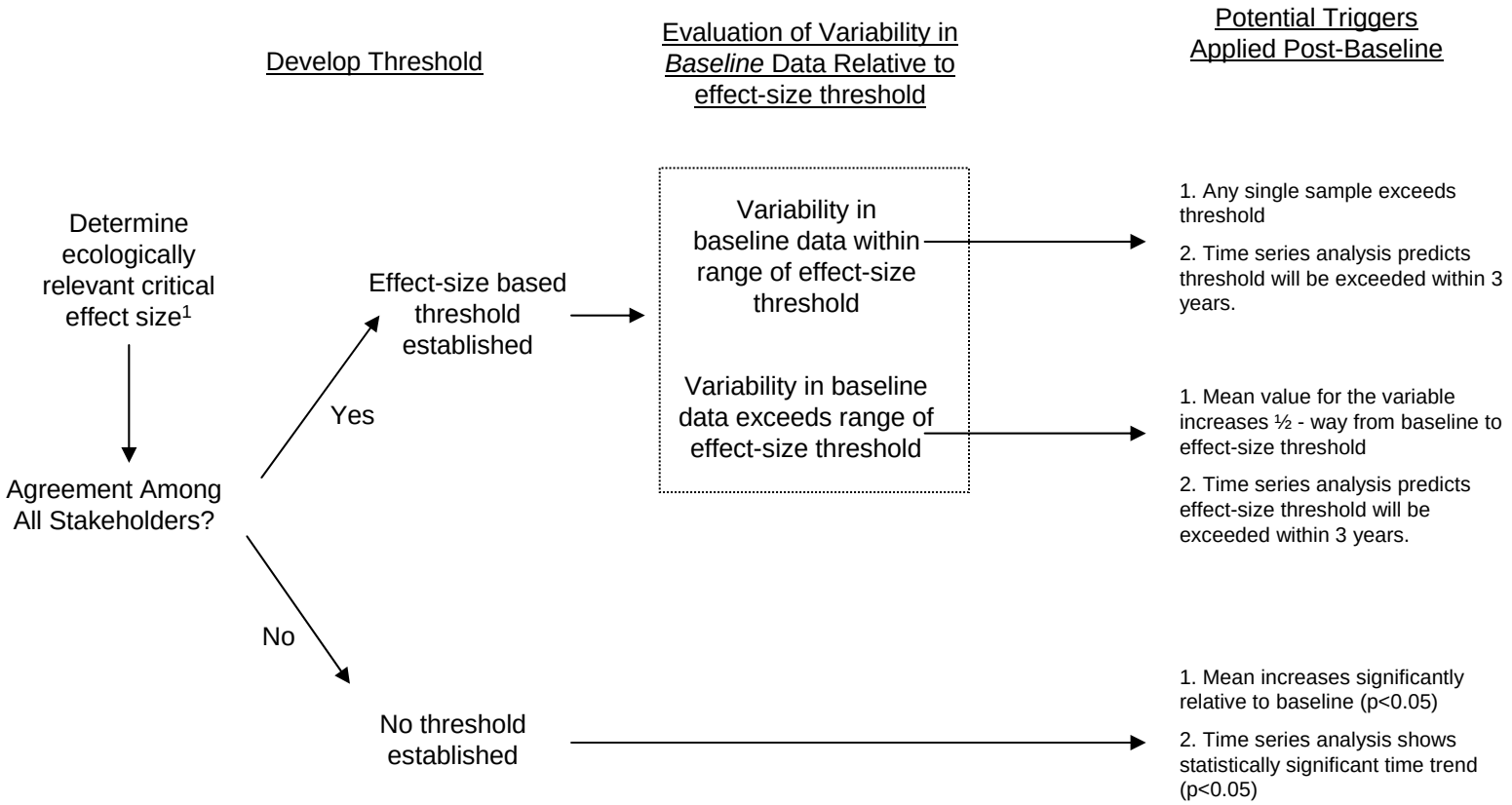


Figure 4-3. Derivation of Thresholds and Potential Triggers for Exposure Variables



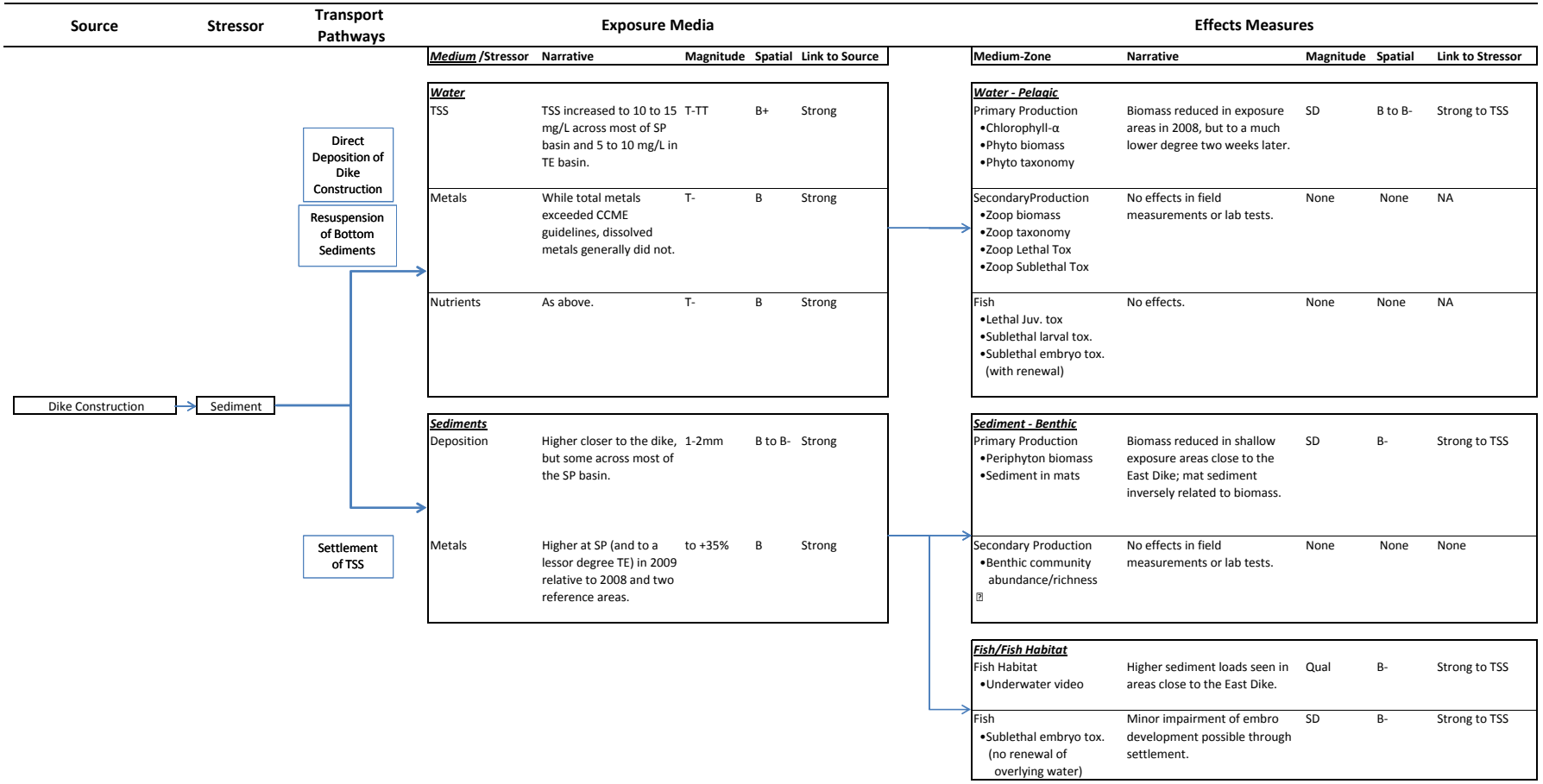
[1] Considering acceptable effect sizes and site-specific information on receptors and exposure pathways.

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

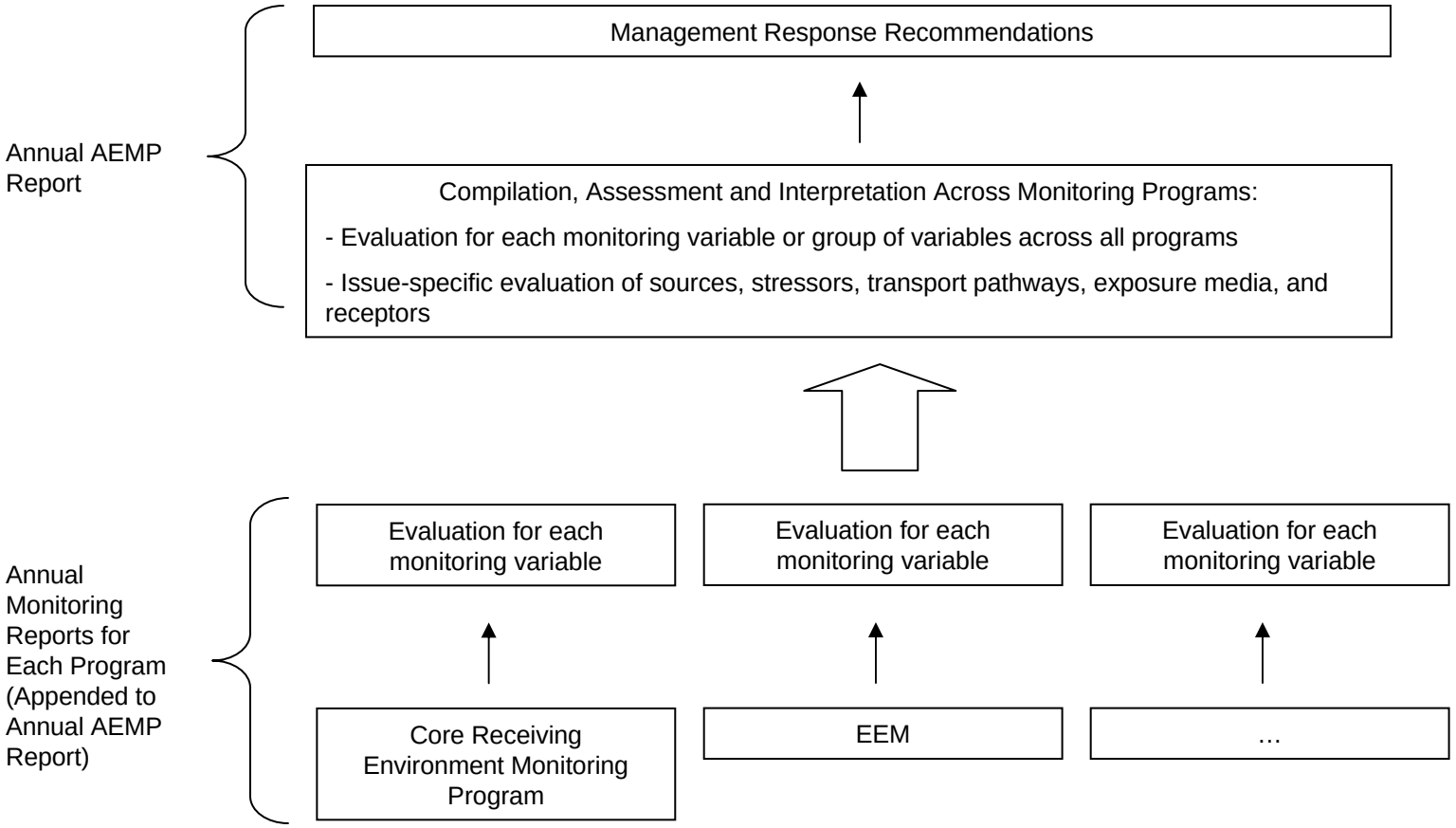
5. STRUCTURE AND CONTENT OF ANNUAL AEMP REPORTS

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.



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