CUMBERLAND
RESOURCES LTD.

MEADOWBANK GOLD PROJECT

AQUATIC ECOSYSTEM/ FISH HABITAT IMPACT ASSESSMENT

JANUARY 2005

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DESCRIPTION OF SUPPORTING DOCUMENTATION

Cumberland Resources Ltd. (Cumberland) is proposing to develop a mine on the Meadowbank property. The property is located in the Kivalliq region approximately 70 km north of the Hamlet of Baker Lake on Inuit-owned surface lands. Cumberland has been actively exploring the Meadowbank area since 1995. Engineering, environmental baseline studies, and community consultations have paralleled these exploration programs and have been integrated to form the basis of current project design.

The Meadowbank project is subject to the environmental review and related licensing and permitting processes established by Part 5 of the Nunavut Land Claims Agreement. To complete an environmental impact assessment (EIA) for the Meadowbank Gold project, Cumberland followed the steps listed below:

1. Determined the VECs (air quality, noise, water quality, surface water quantity and distribution, permafrost, fish populations, fish habitat, ungulates, predatory mammals, small mammals, raptors, waterbirds, and other breeding birds) and VSECs (employment, training and business opportunities; traditional ways of life; individual and community wellness; infrastructure and social services; and sites of heritage significance) based on discussions with stakeholders, public meetings, traditional knowledge, and the experience of other mines in the north.

2. Conducted baseline studies for each VEC and compared / contrasted the results with the information gained through traditional knowledge studies (see Column 1 on the following page for a list of baseline reports).

3. Used the baseline and traditional knowledge studies to determine the key potential project interactions and impacts for each VEC (see Column 2 for a list of EIA reports).

4. Developed preliminary mitigation strategies for key potential interactions and proposed contingency plans to mitigate unforeseen impacts by applying the precautionary principle (see Column 3 for a list of management plans).

5. Developed long-term monitoring programs to identify residual effects and areas in which mitigation measures are non-compliant and require further refinement. These mitigation and monitoring procedures will be integrated into all stages of project development and will assist in identifying how natural changes in the environment can be distinguished from project-related impacts (monitoring plans are also included in Column 3).

6. Produce and submit an EIS report to NIRB.

As shown on the following page, this report is part of the documentation series that has been produced during this six-stage EIA process.

EIA DOCUMENTATION ORGANIZATION CHART

ENVIRONMENTAL IMPACT STATEMENT

Project Description Report
Main Contributor: Cumberland Resources
Reviewer: All Consultants

Project Alternatives
Main Contributor: Lynton Gormley, AMEC Americas
Reviewer: Brad Thiele, Cumberland Resources; Golder Associates Ltd.

Baseline Reports

Aquatic Ecosystem
Main Contributor: Randy Baker, Azimuth Consulting
Reviewer: Mike Lawrence, North-South Consulting

Fish Habitat
Main Contributor: Randy Baker, Azimuth Consulting
Reviewer: Mike Lawrence, North-South Consulting

Terrestrial Ecosystem
Main Contributor: Martin Gebauer, Gebauer & Associates
Reviewer: Ben Hubert , Hubert & Associates

Physical Ecosystem
Main Contributor: BGC Engineering
Reviewer: Golder Associates Ltd.

Socioeconomic
Main Contributor: Robert Hornal
Reviewer: Susan Ross, Golder Associates Ltd.

Archaeology
Main Contributor: Deborah Webster
Reviewer: Gloria Fedirchuk, FMA Heritage Resource Consultants

Traditional Knowledge (TK)
Main Contributor: Darlene Hughes, IBIS Group, Inc.
Reviewer: Tom & Hattie Mannik

Impact Assessments

Aquatic Ecosystem/Fish Habitat
Main Contributor: Randy Baker, Azimuth Consulting
Reviewer: Mike Lawrence, North-South Consulting

Cumulative Effects (CEA)
Main Contributor: Ly-Shu Ramos, AMEC Americas
Reviewer: Robert Hornal, Hornal & Associates

Terrestrial Ecosystem
Main Contributor: Martin Gebauer, Gebauer & Associates
Reviewer: Ben Hubert, Hubert & Associates

Physical Ecosystem
Main Contributor: BGC Engineering Ltd.
Reviewer: Golder, Azimuth, AMEC

Socioeconomic & Archaeology
Main Contributor: Susan Ross, Golder Associates Ltd.
Reviewer: George Hegmann, AXYS Environmental Consulting

Noise
Main Contributor: Richard Palczynski, AMEC Americas
Reviewer: Bob Humphries, Levelton Engineering

Air Quality
Main Contributor: Richard Palczynski, AMEC Americas
Reviewer: Levelton Engineering

Management & Monitoring Plans

Aquatic Effects Management Program (AEMP)
Main Contributor: Randy Baker, Azimuth Consulting
Reviewer: Mike Lawrence, North-South Consulting

Metal Mining Effluent Regulations (MMER)
Main Contributor: Randy Baker, Azimuth Consulting
Reviewer: Mike Lawrence, North-South Consulting

Terrestrial Ecosystem
Main Contributor: Martin Gebauer, Gebauer & Associates
Reviewer: Ben Hubert , Hubert & Associates

No-Net-Loss of Habitat (NNL)
Main Contributor: Randy Baker, Azimuth
Reviewer: Mike Lawrence, North-South Consulting

Socioeconomic & Archaeology
Main Contributor: Susan Ross, Golder Associates Ltd.
Reviewer: Robert Hornal, Hornal & Associates

Mine Waste & Water
Main Contributor: Golder Associates Ltd..
Reviewer: BGC Engineering Ltd.

Air Quality & Noise
Main Contributor: Richard Palczynski, AMEC Americas
Reviewer: Bob Humphries, Levelton

Access & Air Traffic
Main Contributor: Raj Anand, Cumberland Resources
Reviewer: Alistair Kent, Gartner Lee

Reclamation & Closure
Main Contributor: Golder Associates Ltd..
Reviewer: BGC Engineering Ltd.

Emergency Response
Main Contributor: Darlene Hughes, IBIS Group, Inc.
Reviewer: Cumberland Resources

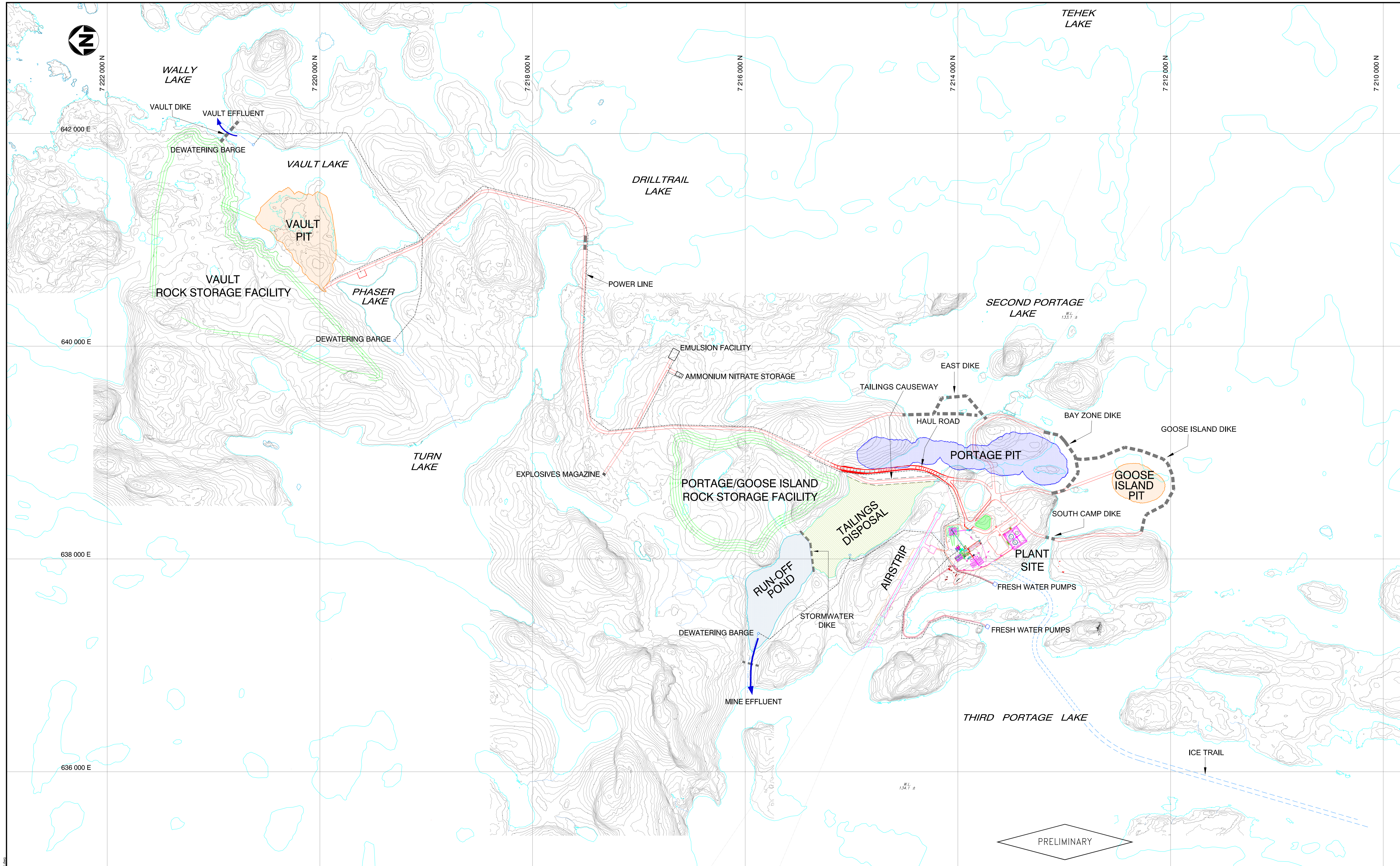
Hazardous Materials
Main Contributor: Darlene Hughes, IBIS Group, Inc.
Reviewer: Cumberland Resources

Spill Contingency
Main Contributor: Darlene Hughes, IBIS Group, Inc.
Reviewer: Cumberland Resources

Occupational Health & Safety
Main Contributor: Darlene Hughes, IBIS Group, Inc.
Reviewer: Ted Rutherglen, Cumberland Resources

Human Resources
Main Contributor: Ted Rutherglen, Cumberland Resources
Reviewer: Cumberland Resources

PROJECT LOCATION MAP



Datum: UTM NAD83 Zone 14

Proposed Mine Site Layout

CUMBERLAND RESOURCES LTD.
Meadowbank Gold Project

SECTION 1 • INTRODUCTION

Fish populations and the habitats that support fish have been identified as valued ecosystem components (VECs). These VECs recognize the traditional importance of this natural resource and the sustenance that it provides to community members of Baker Lake and to local wildlife. Local fish habitat and fish populations will sustain impacts during the life of the mine and, for some components, beyond. Impacts to fish habitat and fish populations as a result of construction and operation and closure of the Meadowbank Gold project are identified and quantified and their significance is assessed in this chapter.

The Meadowbank project will have complex and diverse effects on the aquatic environment primarily during mine construction and operation; although some minor residual impacts may persist during and after mine closure. Examples include: minor impacts associated with continuous activities (e.g., consumption of lake water); severe, short-term impacts that occur only once during mine development (e.g., dike construction and dewatering); and impacts of a routine nature such as dust generated from use of roads, or operation of a culvert over a stream. Because of the complexity of the project and the potential impacts, it is important that the process of identifying, quantifying, and determining the significance of impacts be thorough, straightforward, and understandable to practitioners of EIA science as well as local community members.

Assessment of impacts to fish populations and their habitats are combined within this section of the EIA because they are inextricably linked, and implications for habitat will necessarily affect fish. Fish habitat is defined as “spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes" (*Fisheries Act*, sec. 34(l)). For the purposes of this assessment, we consider all physical habitat (water and sediment quality, substrate size, and depth) features and food supply (aquatic plants, benthic invertebrates, and zooplankton) as habitat elements, clearly separating these from fish populations.

SECTION 2 • ENVIRONMENTAL SETTING

To understand how the Meadowbank project has the potential to affect fish habitat and fish populations, it is important to view the regional aquatic environment in context of the project. The climate and the physical and chemical characteristics of lakes in this region of the Arctic have a profound influence on the species composition, biomass, and productivity of aquatic organisms. For example, the project lakes are situated in the extreme headwaters of the watershed boundary that separates two main drainages—the Arctic and Hudson Bay drainages. Only a few hundred metres to the north of Second and Third Portage lakes, water flows north to the Arctic Ocean via the Meadowbank/Back River system. The project lakes fall within the Quoich River system that flows south through Tehek Lake into Chesterfield Inlet and eventually into Hudson Bay. Because of the headwater nature of the project lakes, the drainage area relative to surface area is very small. Thus, the lakes experience only local inflow from the immediately surrounding terrain, which limits the degree of nutrient additions and explains why there are no streams. The lakes are instead connected by small, ephemeral channels that are frozen during winter and only allow movement by fish between lakes for a brief period during spring freshet. In addition, about 50 km upstream from Chesterfield Inlet on the Quoich River is St. Clair Falls, which is impassable to fish and prevents upstream movements by anadromous Arctic char.

There is no spring spawning fish species such as longnose sucker or Arctic grayling in this system. The lack of stream habitat, cold water temperature, and short growing season are all contributors to this phenomenon. Fisheries surveys of the Keewatin District conducted in the 1970s (Lawrence et al, 1977; MacDonald and Stewart, 1980) indicated that spring spawning species did not occur in river systems north of Chesterfield Inlet, possibly due to the above reasons, as well as the impassable falls.

Available guidelines and legislation to protect aquatic biota and habitat have also been incorporated into the design of facilities or procedures (e.g., Guidelines for Use of Explosives [Wright and Hopky 1998]; Freshwater Intake End-of-Pipe Fish Screen Guideline [DFO 1995]; Fishway Design criteria [Katopodis, 1992]).

2.1 WATER QUALITY

Meadowbank project area lakes are ultra-oligotrophic, soft water, nutrient-poor and isothermal with neutral pH and high oxygen concentrations year round. Limnological conditions tend to be very stable, with uniform, vertical temperature, oxygen, and nutrient distributions with only minor, temporary stratification. Water clarity is extremely high with Secchi depths of 10 m or more, and with very low dissolved and suspended solids concentrations (BAEAR, 2005). Given the absence of tributary streams, there are no external sources of nutrients or sediment that might contribute to nutrient enrichment or productivity of the system. Other factors contributing to low productivity include low light levels during the winter months, extended periods of ice cover, and low water temperatures year round. The ice-free season is very short, with ice break-up in late June and ice-up beginning in late September. Maximum ice thickness is at least 2 m by March/April. Because the lakes are ice-covered for most of the year, gas exchange with the atmosphere is limited; however, oxygen concentration remains high under the ice because of the low rates of biological activity and decomposition of organic material.

Total and dissolved solids in surface waters were low, typically below laboratory detection (<1 mg/L and <10 mg/L, respectively) as was turbidity (<1.1 NTU). Hardness (4.4 to 9.5 mg/L), and dissolved anions (chloride, fluoride, and sulphate) were also very low (<0.05 to 0.06 mg/L) and near detection limits. Surface water had circum-neutral pH (6.6 to 7.7) and low conductivity (5 to 77 µS/cm). Nutrient concentrations (nitrogen, carbon, and phosphorus) in the project lakes did not differ appreciably within or between lakes and seasons. Values are very low and equivalent to values typical of ultra-oligotrophic lakes (Wetzel, 1983). Nitrogen nutrients (nitrate, nitrite, and ammonia) seldom exceeded 0.001 mg/L while dissolved phosphate ranged from <0.001 to 0.003 mg/L. Dissolved organic carbon (DOC) values ranged from 1.4 to 2.3 mg/L in all lakes.

Total and dissolved metals concentrations in surface waters from project lakes were remarkably similar within and between lakes between 1997 and 2002 (BAEAR, 2005). Total antimony, arsenic, chromium, copper, mercury, and nickel concentrations from project lakes were all below laboratory detection limits and well below CCME (2001) water quality guidelines for the protection of aquatic life. The only metals to exceed detection limits were aluminum (0.006 to 0.014 mg/L), cadmium (up to 0.0015 mg/L), lead (up to 0.0012 mg/L), and zinc (0.001 to 0.019 mg/L). Only lead marginally exceeded surface water quality guidelines at a few stations. Dissolved metals concentrations composed the vast majority of total metals concentrations where results exceeded detection limits, indicating that nearly all metals are dissolved and not associated with particulates, which is consistent with the low suspended solids concentrations observed.

2.2 HABITAT ELEMENTS

Lakebed substrate is a key habitat attribute that dictates the function of the habitat (e.g., spawning, feeding) and the extent to which fish utilize particular habitats. Structure and composition of substrate are major factors in determining habitat value for different species and life history stages. In general, coarse, heterogeneous sediment mixtures have higher value because of greater diversity and structure as well as providing spawning habitat for lake trout, round whitefish and Arctic char. Sediment composed of an even mixture of fine substrates with little or no complexity is relatively very abundant in the project lakes providing only feeding and overwintering habitat with lesser overall value than heterogeneous substrates.

Substrate along shorelines and shallow shoals consists of a heterogeneous mixture of large boulder and cobble, areas of sloping, fractured bedrock shelves, and occasional patches of cobble and coarse gravel. There are no fine substrates such as sand or silt in shallow water at depths of less than 4 m. Very coarse substrates predominate to depths of at least 3 m, at which point there is a transition to finer substrates. At depths greater than 6 to 8 m, substrate is predominantly silt/clay with a few partially buried individual boulders or cobble patches. This shallow, coarse material provides abundant habitat for spawning, rearing, and foraging by fish. There is also a great deal of offshore, shoal habitat that may also be suitable for spawning and rearing by fish. There are no submerged macrophytes anywhere in the project lakes.

2.3 LOWER TROPHIC LEVEL BIOTA

Lower trophic level biota comprises plant plankton (periphyton and phytoplankton), zooplankton, and benthic invertebrates. These groups provide the food base and foundation of the food source for juvenile and adult fish in all project lakes.

2.3.1 Periphyton

Periphyton are unicellular and colonial aquatic algae species attached to rocks and other hard substrates beneath the water surface. Periphyton are most abundant between the surface and several metres water depth, and their biomass reflects the growing season. Ice scouring can limit periphyton abundance in the upper metre or two. Species composition and biomass of periphyton are indirect indicators of lake productivity, reflecting nutrient concentrations in the lake, and are sometimes indicators of the presence of contaminants. Because some periphyton species are sensitive to the presence of metals, reductions in periphyton communities over time can indicate the presence of dissolved metals in the water column.

Three major taxonomic groups, blue-green algae (cyanophytes), green algae (chlorophytes), and diatoms dominate the periphyton community. Golden-brown algae (chrysophytes) sometimes compose a minor component of periphyton biomass in the project lakes. In 2002, blue-green algae dominated biomass in nearly all lakes, accounting for 68% of periphyton biomass, with diatoms (26%) and chlorophytes (6%) making up smaller portions of total biomass (BAEAR, 2005). Relative proportions of major groups can differ considerably between years and among lakes because of the large inherent natural variability in periphyton species composition and biomass. Because of this variability, periphyton data are typically only useful for monitoring gross effects to the community.

2.3.2 Phytoplankton

Phytoplankton are microscopic, unicellular, or colonial plant species that are suspended in the water column and provide the basis of the food web because they convert the sun’s energy to plant tissue. Phytoplankton are primary producers that are grazed by herbivorous zooplankton (i.e., free swimming invertebrates) throughout the year, especially during the open water season when primary production within the lake is greatest. Maximum production usually occurs within the upper 10 m of water, where there is the greatest amount of light; sufficient solar radiation is available for phytoplankton productivity to start increasing as early as April while there is still ice on the lakes. Annual production can vary widely depending on water temperature, mixing, nutrient concentration, sunlight, water clarity, and predation by zooplankton. Estimates of phytoplankton biomass are used as gross indicators of productivity from a snapshot perspective, depending on frequency of sampling, and are only useful to detect long-term trends or gross changes in lake production, such as eutrophication as a result of nutrient additions (e.g., from sewage disposal) or addition of nitrites as a result of the use of explosives.

There are six major groups of phytoplankton present in the project lakes: chlorophytes (green algae), cyanophytes (blue green algae), cryptophytes, dinoflagellates, chrysophytes (golden-brown algae), and diatoms. The diversity in types and sizes of phytoplankton is very large and their abundance is very great, typically exceeding one million individuals/litre with a total biomass of only approximately

100 mg/m^3. Biomass of each group is the most useful measure to determine the relative importance of each group as a food source for zooplankton.

At least 40 species of phytoplankters were identified from Meadowbank project lakes. Chrysophytes (golden-brown algae) are a small, usually unicellular phytoplankton group that are very numerous in lake water samples and frequently compose the greatest biomass by virtue of their large numbers. This group composed 76% to 86% of total phytoplankton biomass over all stations in 2002 from all study lakes. Major chrysophyte species were *Dinobryon sociale*, *Chrysococcus* sp., and *Uroglena volvox*. The major phytoplankton species found in project lakes are consistent with dominant and commonly occurring phytoplankton species usually found in oligotrophic lakes of circum-neutral pH with low nutrient concentrations (Wetzel, 1983).

Diatoms (10% of biomass) and dinoflagellates (12% of biomass) were the next most abundant groups. Diatoms are a diverse and important group, although the majority of species are sessile and associated with littoral substrates such as rocks and attached vegetation. Therefore, abundance of diatoms in the water column is reduced relative to other groups. Dinoflagellates are unicellular, flagellated, motile algae that are common in freshwater. Dinoflagellates are useful for biomonitoring purposes because certain species are very sensitive to changes in certain water chemistry parameters such pH, dissolved organic matter, and temperature. Mean phytoplankton biomass was very consistent among project lakes, ranging from 101 mg/m^3 to 174 mg/m^3 and from 145 mg/m^3 to 177 mg/m^3 in July and August 2002, respectively (BAEAR, 2005).

2.3.3 Zooplankton

Zooplankton are small, free-swimming animal species that feed on phytoplankton, bacteria, detritus, and other zooplankton. This group is a key food source for fish, especially young-of-the-year lake trout, round whitefish, and minnow species. Zooplankton are also the main food source for some adult species, particularly round whitefish and Arctic char. Density, diversity, and richness of zooplankton taxa from project lakes is low and typical of oligotrophic Arctic lakes. All of the zooplankton taxa identified from study lakes are common, widespread species that are well-known from this region of the Arctic (Patalas et al, 1994).

Three major groups of zooplankton dominate the plankton community in freshwater lakes: rotifers and two subclasses of the Crustacea--Cladocera and Copepoda (within which there are two major orders, calanoid and cyclopoid copepods) (Wetzel, 1983). Rotifers are a large and diverse group that are often sessile and associated with littoral substrates, although planktonic species can form a significant component of the zooplankton community. Because of their small size, their importance is frequently underrepresented in community surveys.

Calanoid copepods have dominated abundance (55% of all enumerated organisms) of crustacean zooplankton in all project lakes since 1997. Cyclopoid copepods were the next most abundant group (40%), followed by Cladocera (5%). *Leptodiaptomus ashlandi*, a calanoid copepod, was the most abundant species in most lakes, followed by *L. sicilis* and *L. priblofensis*. The other dominant calanoid species, *Heterocope septentrionalis* was present in all lakes. Mean zooplankton density in Meadowbank project lakes ranged from 3,000 to 9,000 individuals/m^3 and is similar to densities of zooplankton observed in other regional lakes.

Natural inter-annual, seasonal, and/or spatial variability in zooplankton species composition and abundance can occur as a result of differences in water temperature, nutrient availability, phytoplankton abundance, and grazing by fish. Because their distribution in the water column has a heterogeneous distribution, long-term monitoring programs seldom focus on zooplankton because their composition represents a snapshot in time. Notwithstanding this, the taxonomic composition of zooplankton in project lakes was very similar on a regional basis.

2.3.4 Benthos

Benthic invertebrates (collectively referred to as benthos) live on or in bottom sediments. Lake benthos communities include many different organisms with a wide variety of feeding mechanisms and ecological niches. Benthic invertebrates provide an important food source for most fish species, especially young-of-the-year and juvenile lake trout and round whitefish (Machniak, 1975; Scott and Crossman, 1979). As lake trout get larger, they gradually shift from a diet dominated by invertebrates, to one dominated by fish (Scott and Crossman, 1979). Abundance and species composition of benthic invertebrates is strongly affected by water depth, sediment grain size, and organic carbon content. Benthic invertebrates are typically most abundant at depths between approximately 4 and 12 m. Species composition and abundance of benthic invertebrates is a useful environmental indicator because benthos are sessile and therefore their exposure regime is predictable. Also, they are easy to monitor (depending on the substrate) and their ecology is relatively well understood.

The benthic invertebrate community of Meadowbank lakes is dominated by the aquatic larval stages of insects, especially chironomids, both in terms of abundance and species diversity, which is typical of most Arctic and temperate lakes. Mean density of major benthic invertebrate taxonomic groups (oligochaetes, bivalves, chironomids, and other taxa [e.g., mites, insects]) from Meadowbank lakes ranged from 2,500 to 8,300 individuals/m^2 and was dominated by chironomid larvae, which composed between 50% and 86% of organisms in benthic samples from all study lakes and ponds between 1997 and 2003 (BAEAR, 2005). Other groups identified in benthic samples included oligochaetes, Hydracarina (mites), cladocerans, harpacticoid copepods, eubranchiopods (tadpole shrimp; a common organism found in stomachs of round whitefish), amphipods, Turbellaria (flatworms), and stoneflies (Trichoptera). With the exception of oligochaetes, none of these other groups composed more than 1% of total density of organisms in benthic samples. The benthic communities of project lakes are healthy, diverse, and typical of pristine Arctic, oligotrophic lakes.

2.4 FISH

Fish compose the upper trophic level of aquatic organisms in lakes. At the top of the food web, fish exert a degree of control and structure over lower trophic levels. The fish community also exhibits the greatest structural stability of the various members of northern aquatic ecosystems. This stability is derived from fish being large, long-lived, and containing large stores of energy; however, fish biomass is ultimately dictated by the level or amount of primary and secondary production of the system. An important consideration is that any changes to chemical or biological features and productivity of the project lakes, either natural or mine-related, would be reflected in fish last. That is, changes would be observed in limnological parameters or abundance and biomass of lower trophic level biota long before these changes may be manifest in fish.

Lake trout and round whitefish dominate abundance of fish in all project lakes. Arctic char are the next most abundant species and their relative importance differs considerably among lakes. For example, char are relatively much more abundant in Second Portage Lake (28%) than in Third Portage Lake (8%). Prior to studies being undertaken on the project lakes in 1997, little was known about the lakes or their resources. According to a traditional knowledge study (Cumberland Resources, 2005), residents of Baker Lake did not traditionally use this area for resource harvesting in summer and they purportedly did not consume fish from project lakes, except in rare, opportunistic circumstances.

Slimy sculpin (*Cottus cognatus*) occur in the project lakes and have been recorded in the gut contents of lake trout from Turn Lake, Pipedream Lake, and the Vault lakes. There are no other minnow species known to be present at this latitude. The only other small species present is ninespine stickleback (*Pungitius pungitius*). Individual stickleback have been observed in the gut contents of lake trout from Inuggugayualik Lake, Second Portage Lake, and Tehek Lake, thus they are likely widespread in the project lakes. The importance of small species such as sculpins and stickleback in the diet of lake trout is minor because they are not abundant in the lakes and are infrequently observed in gut contents.

The project lakes contain a large biomass of fish, characterized by many, very large (>5 kg), old (>20 years) fish dominated by lake trout. Although biomass of fish appears high, productivity of Arctic lakes is very low. That is, the rate at which the biomass is replaced, or turned over, is very small because of the limited amount of nutrients available to fish, and the great competition for it. Given the short growing season, limited nutrient availability, and very cold water, growth rates of Arctic fish are exceedingly slow.

The geographic location of the Meadowbank project lakes strongly affects the species composition and relative abundance and biomass of species. Lack of stream habitat and small ephemeral channels limits movements of fish between lakes at all times except brief periods during spring freshet. Arctic char in the system are landlocked because of an impassable falls on the Quoich River, upstream of Chesterfield Inlet. This falls and the short growing season have prevented spring spawning fish such as Arctic grayling, from inhabiting the system (Lawrence et al 1977; MacDonald and Stewart, 1980).

The size distribution of trout in Third Portage, Second Portage, and Tehek lakes covered a wide range, from fingerlings up to 1.1 m in length and 20 kg in weight. There were no deficiencies in particular size classes. All lakes had somewhat bimodal distributions of fish with a relatively larger number of fish between 200 and 300 mm in length, and a second mode between 500 and 550 mm, with a small number of fish up to 850 mm or more. This bi-modal size distribution is very typical of long-lived Arctic fish populations (Johnson, 1976).

Mean length and weight of round whitefish from Third Portage Lake (233 g) was less than mean length and weight of whitefish from Second Portage (495 g), Tehek (425 g), and Turn lakes (503 g). This trend of fish being smaller in Third Portage Lake than other project lakes is similar to what has been observed for lake trout and Arctic char. Nevertheless, condition factors of lake trout, round whitefish, and char were high in all lakes.

Mean age of lake trout ranged from 12.6 years (Tehek Lake) to 16 years (Second Portage Lake) and was correlated with mean fish size. That is, larger fish tended to be older. Mean age of lake trout did not differ greatly among project lakes and age—frequency distributions illustrate that there is a wide range in age of trout from all lakes studied, with a maximum age of 26 to 38 years for those specimens aged. Note that not all specimens, particularly the largest lake trout captured were aged. Many of the large trout captured were released alive and no ageing structures were collected; therefore, it is a matter of speculation as to the actual mean and maximum age of the lake trout populations. The largest fish aged in baseline studies (38 years) weighed 3.8 kg, which is a fraction of the size of the largest fish captured (20 kg). These data confirm that project lake fish are old and slow-growing.

Flesh of lake trout, round whitefish, and Arctic char has been analysed for mercury and metals concentration. Mercury and metals concentrations were relatively low and similar to levels found in fish elsewhere in the Northwest Territories and Nunavut. As expected, mercury was positively correlated with fish size. Mean concentrations were below the recommended guideline concentration for commercial sale (0.5 mg/kg).

SECTION 3 • SUMMARY OF KEY CONCEPTS

This section summarizes key concepts that were applied during our assessment of the significance of adverse effects on fish and fish habitat as a result of construction and operation of the Meadowbank Gold project. The key concepts discussed are as follows:

- focus on critical issues
- focus on VECs
- focus on stressors of concern
- focus on residual impacts
- use of linkage matrices (Appendices A to C)
- support from environmental management system documents.

Each of these key concepts is summarized as follows.

Focus Attention on Critical Issues – Critical issues include those major construction or operation components that have the potential to cause significant adverse effects to fish and fish habitat. Examples of critical issues include dike construction, dewatering of impoundments, and discharge of effluent. These issues have been posed as key questions, such as: what is the effect of dewatering of impoundments on fish? Less attention is paid towards what we have termed generic issues. Generic issues are activities that occur at most construction projects and for which there are proven, engineered mitigation solutions to minimize impacts. Examples of these include road construction, barge offloading facilities, winter road utilization, and culvert installation.

Focus on Valued Ecosystem Components – Aquatic Valued Ecosystem Components (VECs) for this project include fish and fish habitat.

Focus on Stressors of Concern – Stressors are any physical, chemical, or biological entity that can induce an adverse effect on a VEC. There are four groups of project-related stressors of potential concern (SOPC) that have the potential to affect Meadowbank project VECs. These are:

- suspended solids and sedimentation
- contaminants (chemicals, metals, ions, nutrients, etc.)
- peak particle velocity and overpressure during blasting
- direct habitat impacts such as dike construction and dewatering.

Focus on Residual Impacts – This document focuses on the significance of residual impacts, after mitigation has been applied. Focus on residual effects provides a realistic, unambiguous approach that is consistent with the approach promulgated by the *Canadian Environmental Assessment Act* (CEAA). The impact matrices for fish habitat and fish emphasize the significance of residual effects but also describes impacts in the absence of mitigation, to provide a contrast to and to conform with the Terms of Reference (TOR) for Meadowbank, which states, “the proponent shall describe the residual effects of the project in a way that permits comparisons with the project’s potential effects in the absence of mitigation and shall express their significance in the same manner as for the said potential effects.”

Use Linkage Matrices to Identify Impacts – Linkage matrices are used to provide a tangible link between how a particular mine-related activity causes a physical effect that, even after mitigation has been applied, may have a direct impact on fish or an indirect impact, via habitat. For example, during dike construction, there is potential for adverse physical effects on the water column from sediments disturbed from the bottom. Increased suspended sediment in the water column can affect fish habitat by smothering, or affect fish directly by impairing gill function. Using silt curtains will reduce the magnitude and spatial extent of this effect. The impact matrices establish the relationship between all project-related activities, physical effects, mitigation, and residual ecological effects. Detailed summaries of the potential effects, mitigation, and residual effects and significance of all mine-related activities during construction, operation, and post-closure are provided in a series of matrices appended to this document (Appendices A to C).

Linkage to Environmental Management Systems – As part of this EIA submission, three supporting environmental management system (EMS) documents provide supporting documentation and further elaboration of key issues. These are the “Aquatic Environment Management Program” (AEMP, 2005), “No Net Loss (NNL) Report,” (2005) and Metal Mining Effects Regulations Report (MMER, 2005).

- The AEMP report is an umbrella document that delineates that relationship between a project activity, mitigation, and residual effects and provides a detailed description of the monitoring design that will be implemented during construction and operation phases. The AEMP describes what will be monitored, where, when, and how often.

- The MMER framework document addresses specific monitoring requirements for mine effluent as part of the Metal Mining Effluent Regulations including Environmental Effects Monitoring (EEM) under the *Fisheries Act*. The AEMP considers and incorporates monitoring requirements of MMER.

- The NNL report quantifies specific impacts affecting the productive capacity of fish habitat. For example, it indicates how diking and dewatering of lakes, crossing streams, and constructing a barge-landing facility will destroy or alter fish. The NNL report quantifies the amount and value of affected habitat, and specifies how habitat will be replaced to compensate for this.

These reports provide important information and documentation of mitigation and management to support conclusions drawn as a result of this impact assessment.

3.1 VALUED ECOSYSTEM COMPONENTS

Fish habitat and fish populations have been identified as the key aquatic VECs in addition to water quality which is discussed in the “Physical Ecosystem Impact Assessment.”

3.1.1 Fish Habitat

For the purposes of this assessment greater importance to certain habitat elements over others has been assigned. Spawning and rearing habitat (areas where eggs and larval fish exist) for fish are recognized as being more important than foraging, overwintering, or migratory habitats and should be afforded the greatest amount of protection. Spawning and rearing habitat is generally found in shallow water, between 2 and 6 m depth and is characterized by cobble/boulder substrate with high complexity (see NNL). This habitat constitutes a relatively small portion of the total available habitat in the project lakes and is less resilient to impacts than other habitats. By contrast, foraging and overwintering habitat is very abundant in the project lakes and the relative impact on productivity of these habitat types is much less. Because of the headwater nature of the lakes, there is very little stream habitat and movement between lakes by fish is small and infrequent (BAEAR, 2005). Because there are no spring spawning or anadromous species, no concerted migrations by fish occur within or between project lakes.

3.1.2 Fish Populations

Lake trout are the most abundant fish species in the project lakes, constituting at least 60 to 70% of all individuals enumerated. Round whitefish are an important food component of lake trout and are the next most abundant species (20%), followed by Arctic char (8 to 28%). The only other species identified were ninespine stickleback, sculpin, and burbot, which compose a very small portion of the fish biomass in the project lakes. Because of its abundance and importance to resource users, lake trout have been selected as the primary VEC fish species. Round whitefish and Arctic char have similar habitat requirements as lake trout (NNL, 2005) and will be afforded a similar level of protection. Consequently, efforts to mitigate project-related impacts will be focused on spawning and rearing habitat of lake trout and round whitefish. This approach will result in a broad range of protection goals for all important fish species.

It is important to note that productivity of fish in the project lakes in the Meadowbank region is limited by nutrient availability and not by habitat. The project lakes are headwater, ultra-oligotrophic lakes with very low water column nutrient concentrations throughout the year. Although the lakes support a large biomass of fish represented by many old, large lake trout, the rate of replacement or growth of these fish is very low. Assessment of the distribution of spawning, nursery, foraging, and overwintering habitat in the lakes indicated that all habitat types were very abundant and were not limiting in any of the lakes. Therefore, elimination of a small area of habitat does not necessarily mean that an equivalent degree of impact on the fish population will occur. The existing habitat could support many more fish than currently exist if there was the food base to support them.

3.2 INFORMATION SOURCES

A wide variety of information was used to assess the significance of impacts to fish and fish habitat within the Meadowbank project lakes. Of particular importance is the site-specific information gathered since 1996 from the project lakes including water and sediment chemistry, lower trophic level biota, fish and fish habitat characteristics. This information is summarized in the BAEAR. Traditional Knowledge (TK), which is documented in the Baseline Traditional Knowledge Report (Cumberland, 2005), enhances our understanding of ecological features of the local environment for the Hamlet of Baker Lake.

In addition to this site-specific information, published scientific and grey literature and other information contained in recent EIAs conducted elsewhere (e.g., Diavik, Snap Lake, Miramar, Tahera) were used to put the project lakes and the potential impacts they might sustain in perspective from a broader viewpoint. Professional experience and judgment was also used to assist in determining the significance of residual impacts of project-related activities on fish and fish habitat.

3.3 DIRECT VS. INDIRECT IMPACTS

It is important to distinguish between direct and indirect effects on fish and fish habitat as part of the environmental assessment process. Direct effects to fish or fish habitat are impacts that have direct consequence and are not mediated or delivered via in intermediate or indirect pathway. Examples of direct effects are loss of fish habitat due to dike installation, removal of fish during dewatering or by worker fishing, elimination of fish spawning habitat as a result of smothering by sediment, or by dewatering. Direct effects are typically more obvious and easy to measure or quantify.

Indirect effects are typically less apparent and are more difficult to quantify because they may involve several pathways, and there is greater uncertainty with regard to the magnitude or severity of the effect. Examples of indirect impacts to fish or fish habitat include changes in: hydrology, which may affect productivity of benthic habitats; nutrient enrichment, which may increase secondary productivity and possibly fish; increased suspended sediment concentration in the water column, which may reduce feeding efficiency by fish, or cause irritation of gills; and increased contaminant concentrations in benthic invertebrates, which may be transferred to fish. Many indirect effects are closely related to changes in water quality or are mediated via the diet of fish as a result of changes to productive capacity of habitat.

SECTION 4 • DETERMINING SIGNIFICANCE

4.1 APPROACH

The CEAA defines environmental effects as “any change that the project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources…” The magnitude of this effect is related to “the capacity of renewable resources that are likely to be significantly affected by the project to meet the needs of the present and those of the future.” To define a significant effect, we have incorporated the principles of the above statements stated in the *CEAA Act*, as well as following guidance in the NIRB Terms of Reference (TOR) for this project. Simply stated, any project-related residual effect (i.e., effects remaining after appropriate mitigation has been applied) that causes adverse effects to an ecological resource to such a degree that the resource is noticeably impaired within a local or regional context, or whose function is impaired over the long-term, is significant.

Bear in mind that the assessment of significance of residual effects is being made after mitigation is applied. For example, construction and maintenance of a berm around the fuel tank farm will ensure that, in the unlikely event there is a spill, the impact will not be significant because the berm has eliminated the risk that fuel can enter the aquatic environment. Thus, the impact of a spill into the aquatic environment is considered, but is not assessed with the same rigor as a potential impact that is more likely to occur. Having said this, however, Section 4.25 of the Meadowbank TOR states that “the Proponent shall describe the residual effects of the project in a way that permits comparisons with the project’s potential effects in the absence of mitigation, and shall express their significance in the same manner as for the said potential effects, using the same criteria.”

To satisfy this requirement and to illustrate and quantify the effectiveness of mitigation in reducing the magnitude, extent, duration, and frequency of impacts, we have compared the potential environmental impacts of all project components and their impact with and without mitigation. As is described in Section 5.1, this is accomplished by contrasting the significance of impacts with and without mitigation within a series of impact matrices during construction, operation, and post-closure.

4.2 ASSESSMENT CRITERIA

Criteria for evaluating the significance of residual effects have been developed for this project based on best practice, professional judgment, and experience on other impact assessments for similar projects. Where possible, quantitative and integrative methods to assess significance are used, combining information gathered from field investigations, quantitative and semi-quantitative modeling (e.g., water quality modeling, blast design), statistical analysis, and technical studies designed to address specific questions. In applying mitigation to determine residual effects, available guidelines and legislation to protect aquatic biota and habitat have also been incorporated into the design of facilities or procedures (e.g., Guidelines for Use of Explosives [Wright and Hopky, 1998]; Freshwater Intake End-of-Pipe Fish Screen Guideline [DFO, 1995]; Fishway Design criteria [Katopodis, 1992]).

The intent of this process is to be transparent and to document our decision pathway so that others can review the process that was used to determine the likelihood of predicted residual impacts, how mitigation has avoided or reduced an impact, and our assessment of the residual significance. This section presents the definition for each criterion used to determine significance. Note that definitions for magnitude, duration, and frequency are applied specifically to particular VECs, while spatial extent is applied across VECs.

To determine whether or not an impact may have a significant adverse effect on a VEC component, we have assessed, in order of importance, the magnitude, spatial extent, duration, frequency, and timing of residual effects for each project-related activity. How each of these criteria influence significance is discussed below and summarized in Table 4.1.

4.2.1 Magnitude

Magnitude is a measure of the intensity or severity of the effect of a mine-related activity relative to a change from background conditions. Magnitude is a relative term, as the specific definition is dependent on the VEC (definitions are provided in each section). Magnitude is somewhat subjective and takes into consideration such factors as: ecological relevance, degree of change from baseline conditions, certainty of occurrence, and ecological resilience (defined as the rate of ecosystem recovery to a stable state, following disturbance or stress). The certainty with which we are able to quantify the magnitude of an effect has a strong influence on whether the magnitude is ranked as high, medium or low, as follows:

- **High** magnitude impacts are obvious, easily detectable with a minimum of effort, as well as having a high certainty of occurring. If residual impacts on the VEC results in a change of 25% or more (e.g., to fish population abundance, reduction in condition, loss of fish habitat, reduction in benthic diversity), the impact magnitude is high.

- **Medium** magnitude impacts may not immediately be apparent, and some degree of effort is required to demonstrate a departure from baseline conditions, over and above natural changes. Medium magnitude effects have a moderate certainty of occurring and residual impacts to the VEC results in a 10% to 25% change relative to baseline.

- **Low** magnitude impacts can be very difficult to detect, require considerable effort to demonstrate a departure from baseline, and usually have a low probability of occurrence. Residual impacts to VEC abundance, diversity, or condition of less than 10% from baseline conditions are generally low magnitude changes.

4.2.2 Spatial Extent

Spatial Extent is a measure of the geographic boundary of residual effects, and has been divided into local and regional areas.

- **Local** effects occur over narrow spatial bounds and, for the purposes of this assessment, are restricted to the project lakes themselves, extending no further downstream than the northernmost bay of Tehek Lake, which receives water from both the Portage and Vault (Vault, Wally, Drilltrail) systems.

Table 4.1: Evaluation Criteria to Determine Residual Effects

Criteria	Levels/Ranks of Criteria	Definition of Level/Rank of Criteria	VEC-Specific
Magnitude	High	Residual effect within the project lake is >25% change from baseline conditions, are easily detectible and have a high certainty of occurring.	Yes
	Medium	Residual effect within project lake is >10% and <25% change from baseline conditions, are moderately difficult to detect and have a moderate to high certainty of occurring.	
	Low	Residual effect within project lake is <10% change from baseline conditions, are very difficult to detect and have a low to moderate certainty of occurring.	
Spatial Extent	Regional	Residual effects extend beyond the project lakes into Tehek Lake and the Quoich River.	No
	Local	Residual effects are restricted to the Portage lakes and the Vault/Wally lakes.	
Duration	Permanent	Residual effects to VECs continue into foreseeable future, well beyond mine life during operation and post-closure.	Yes
	Long-term	Residual effects to VECs occur over a time period similar to the lifespan of the VEC during operations and post-closure.	
	Medium-term	Residual effects to VECs occur over a time period shorter than the VEC lifespan (25% to 100% of lifespan).	
	Short-term	Residual effects to VECs occur over a time period <25% of lifespan of the VEC.	
Frequency & Timing	Frequent	Residual effects to VECs occur very regularly (daily or weekly) and overlaps with sensitive periods.	Yes
	Infrequent	Residual effects to VECs occur infrequently (monthly to yearly) and may/may not overlap with sensitive periods.	
	Rare	Residual effects to VECs occur rarely (yearly or less frequently) and typically do not overlap with sensitive periods.	

- **Regional** effects occur over a larger spatial scale, and, in this assessment, would extend beyond this bay into the main basin of Tehek Lake, and into the Quoich River system. This assessment is consistent across VECs such as lake trout spawning habitat or productivity of benthic habitats.

4.2.3 Duration

Duration is the length of time in weeks, months, or years that a residual effect is expected to persist. The endpoint is recovery or return to baseline of the ecological component (e.g., fish population or habitat) and is linked to reversibility and ecological resilience (i.e., likelihood of the potential for recovery from a residual effect), providing an indication of when/if the residual impact will diminish. Duration is described for each project activity, such as dewatering of impoundments (short-term) or effluent discharge and its relative influence on particular VECs. Some activities, such as dike installation during construction, may occur over limited time frames, but may cause impacts that persist for time periods equivalent to or greater than the life span of the VEC. On the other hand, the duration of impact during installation of a water withdrawal system may only persist for the amount of time it takes to install the facility.

4.2.4 Frequency & Timing

Frequency and Timing is a measure of how frequently residual effects will be felt by the VEC, using standard measures (e.g., weeks, months, years) and whether or not the impact overlaps with the sensitive period of a VEC, such as during spawning by lake trout, or during emergence of fish larvae. Frequency and timing are specific to particular VECs. For example, blasting may take place on a daily basis and, depending on setback from fish bearing waters, may occur frequently and affect fish on a year-round basis. Discharge of effluent also occurs frequently, but is scheduled to occur only during open water periods and thus has a distinct seasonal component. Given that egg incubation of all species occurs during winter, restricting the timing of effluent discharge to avoid spawning and egg incubation by fish is noteworthy. We then considered whether certain activities overlapped with particularly sensitive life history periods of fish. For example, if a particular activity is predicted to occur or extend over the spawning period for lake trout and Arctic char and has the potential to adversely affect spawning success or egg survival, this was taken into account when assessing significance.

4.3 FINAL ASSESSMENT OF SIGNIFICANCE

Measures of magnitude, spatial extent, duration, and frequency are individually evaluated and ranked (e.g., high, medium low; frequent, infrequent, rare) for each project-related activity to assess whether the residual impact is predicted to be significant or not. To determine significance, we have established a transparent, step-wise process combining the outcome of individual criteria to arrive at an overall conclusion. Significance is determined depending on the particular combination of magnitude, spatial extent, duration, and frequency and timing (Table 5.1). Following is an overall summary of the distinction between significant and non-significant impacts.

- All high magnitude impacts to VECs, regardless of spatial extent, duration, and frequency, with the exception of short-term, rare events within the local area, are considered significant.

- All medium magnitude impacts within the regional area are also considered significant, again, regardless of duration or frequency.
- Low magnitude impacts within the regional area of a long-term to permanent nature that occur frequently are significant.
- Medium magnitude impacts within the local area of medium to permanent duration that occur frequently and overlap with a sensitive period to the VEC (e.g., spawning by fish) are significant.
- Medium magnitude impacts of a short to medium-term duration that occur infrequently or less and do not overlap with sensitive periods of VECs are not significant.
- Low magnitude impacts within the local area that are not at least long-term, regardless of duration, frequency, or timing, are not significant.

SECTION 5 • APPROACH TO IMPACT ASSESSMENT

Construction, operation, and post-closure are assessed independently for each major project activity, creating a temporal phased approach to the impact assessment. The magnitude, duration, and frequency of project activities differ among temporal phases and the significance of these are determined separately (see Table 5.1).

During assessment of construction-related impacts, the duration of impacts is restricted to a medium-term assessment because the activity of installing infrastructure components is not expected to exceed the life span of the VEC species. In terms of fish habitat, the duration is approximately two years, which is the average life span of most aquatic invertebrate species. In terms of impacts to fish, the duration of construction relative to the average life span of lake trout (at least 25 to 30 years) is assessed as a short-term impact.

Table 5.1: Evaluation Matrix to Determine Significance of Residual Effects

Magnitude	Spatial Extent	Duration	Frequency & Timing	Significance
High	Regional area	Any	Any	Yes
	Local area	Permanent or Long-term	Any	Yes
		Medium-term	Frequent	Yes
		Short-term	Infrequent or Rare	No
Medium	Regional area	Any	Any	Yes
	Local area	Permanent or Long-term	Frequent	Yes
		Medium- to Long-term	Infrequent or Rare Occurs during Sensitive Period	Yes
		Medium- or Long-term	Infrequent or Rare Does not occur during Sensitive Period	No
		Short- to Medium-term	Infrequent or Rare	No
Low	Regional	Long-term to Permanent	Frequent or Infrequent	Yes
		Short- to Medium-term	Any	No
	Local	Any	Any	No

The Meadowbank project has three distinct spatial components: the Portage development; Vault development; and Baker Lake development. The Portage and Vault developments share similar activities, dominated by dike installation, dewatering of impoundments, dike operation, and effluent discharge. Developments at Baker Lake are entirely different from those of the project lakes and consist of a barge loading and unloading area, storage facilities, winter road, tank farm, and a staging facility. These are assessed independently of the Vault/Portage developments, which are considered together.

5.1 IMPACT MATRICES

The primary means by which impacts of construction, operation, and closure/post-closure on fish habitat and fish populations were assessed was through the use of impact matrices (see the appendices). Potential impacts on fish habitat and fish populations were assessed for each major development activity during construction, operation, and closure in the absence of and with mitigation (i.e., residual impacts). The purpose of comparing unmitigated and residual impacts was to satisfy the TOR and to highlight the effectiveness of planned mitigation efforts to avoid or reduce the magnitude, extent, and duration of impacts. By taking this approach, consideration is given to every possible combination of activity during the life of mine development to ensure that nothing was missed and that the assessment procedure is thorough and our decision pathway transparent.

5.2 KEY QUESTIONS DURING CONSTRUCTION & OPERATION

To reduce the complexity of addressing all of the impacts to fish and fish habitat from each of the development activities during construction and operation, similar activities have been grouped together and addressed as critical issues, and posed as key questions. For example, the kinds of impacts that dike construction in Second Portage, Third Portage, and Vault/Wally lakes can have on habitat or fish populations are similar. Dike operation is also expected to generate similar effects, regardless of dike location. Thus, similar activities occurring within different geographic areas have been addressed together, while recognizing local differences in magnitude, spatial extent, duration, and frequency/timing to assess impacts of particular facilities or activities.

Ancillary activities and facilities that are generic in nature and for which there are proven mitigation measures or engineered solutions to minimize impacts (e.g., road construction, winter road utilization) are assessed together and with less rigor or scrutiny that more important issues warrant. In general, the implications of these activities during either construction or operation are similar and are thus considered together. It is important to note that, although the main text of the environmental assessment groups similar issues, all possible combinations of mine-related impacts and their potential significance, with and without mitigation during construction, operation and closure are considered in the impact matrices.

The emphasis on text to fully elaborate whether the residual effects of generic activities are or are not significant is not explored to the same degree as the residual impacts of dike installation, for which a similar level of mitigation is not possible.

The key questions posed in this assessment during construction of the Portage pit, Goose Island pit, and Vault pit on fish habitat and fish populations are:

- What are the impacts of dike construction?
- What are the impacts of dewatering of impoundments?
- What are the impacts of freshwater intake and effluent pipe installation?
- What are the impacts of mine site infrastructure installation?
- What is the impact of construction of the rock storage facilities at Portage and Vault?
- What is the impact of installation of the Turn Lake crossing?

Key questions posed during operation of the Portage pit, Goose Island pit, and Vault pit on fish habitat and fish populations are:

- What are the impacts of dike operation?
- What are the impacts of pit development?
- What are the impacts of operation of the rock storage facilities?
- What is the impact of Turn Lake crossing operation?
- What are the impacts of effluent discharge?
- What is the impact of consumption of freshwater from the lake?

Key questions related to generic activities that have a similar magnitude and effect, occur during both construction and operation, and are therefore considered together, include the following:

- What are the impacts of mine site infrastructure facilities such as roads, airstrip, fuel storage, borrow pit, etc.?
- What are the impacts of blasting?
- What is the impact of worker fishing of fish populations?
- What are the impacts of infrastructure facilities at Baker Lake including marine barge landing facility, winter road operation, and staging facility?

5.3 CLOSURE & POST-CLOSURE

The closure/post-closure environment will be considerably different than the environment during operation. Dikes will be decommissioned and pits will be flooded, roads will be decommissioned, infrastructure facilities will be removed, and waste rock and tailings facilities will be capped. Any residual impacts of the post-closure environment may persist for time periods that exceed the life span of the VEC species by a considerable amount and, for all intents and purposes, may be considered permanent.

Residual impacts during closure and post-closure will be assessed in exactly the same fashion as residual impacts during construction and operation, although the confidence or certainty of the assessment is reduced because of the time frame involved and the potential for mine development and operation to change over time.

5.4 MINE COMPONENTS

Major project components and activities assessed in the matrices (in appendices) were divided among construction, operation, and post-closure scenarios. These are outlined along the left hand column of the matrices and include the following:

Dikes – This relates to the construction, operation and closure of the dike footprint itself and does not consider what is captured within or behind a dike. Dikes considered include the East dike (Second Portage Lake), Bay Zone dike (Third Portage Lake), Goose Island dike and Vault dike (Vault/Wally

Lake). The tailings dike is not considered until closure because it is isolated from the aquatic environment until the mine is closed and the Goose Island dike is decommissioned.

Pit Dewatering – Impacts of dewatering (i.e., the activity of pumping water into the receiving environment) the Portage pit, Goose Island pit, and Vault Lake on receiving environment habitat and fish populations are only considered during construction.

Pit Development – Impact assessment of development of the Portage, Goose Island, and Vault pits includes all habitat and fish populations affected by the pit footprint; that is, all habitat captured between the dike exterior and the shoreline. In the case of the East dike, this includes habitat lost during mine operation between the East dike and the tailings dike. Impacts of pit development behind the tailings dike include all habitat and fish population impacts within the tailings and attenuation ponds during operation, which ultimately becomes the tailings disposal facility at closure. This habitat is permanently lost and will be replaced under terms of the NNL program.

Rock Storage Facilities – Storage of waste rock (Portage – Goose Island and Vault) on largely upland, terrestrial habitat will result in the elimination of several small fishless ponds and one pond that contains fish. Impact assessment considers fish habitat loss as well as possible impacts from runoff of low pH, metals-contaminated water.

Roads & Traffic & Airstrip – Potential and residual impacts of road and airstrip construction and operation on aquatic habitats are considered.

Water Intake & Pipeline – The impact matrix evaluates potential impact of construction of the water intake and pipe facility with respect to direct habitat impacts from disturbance and total suspended solids (TSS) introductions. The matrix evaluates impacts of withdrawal of freshwater from Third Portage Lake during mine life.

Effluent Discharge & Barge – Similar to water intake, the matrix for construction of the barge and dock facility considers direct habitat impacts to shorelines and offshore habitat. During operation, the impact matrix evaluates impacts to fish habitat and fish populations from effluent discharge over mine life. Note that monitoring and effects assessment of effluent discharge into Third Portage and Wally lakes are included within the AEMP and the MMER framework study design for Meadowbank.

Access Road & Traffic – The matrix evaluates impacts associated with annual operation of the winter road between Baker Lake and the mine site. The matrix does not evaluate unexpected events such as an accident or spill.

Baker Lake Marine Barge Landing Facility – The matrix evaluates impacts of construction and operation of a barge-landing facility on the shores of Baker Lake. The matrix does not evaluate catastrophic events such as an accident or spill. These are considered under the “Spill Contingency Plan” (Cumberland, 2005).

Marine Barge Traffic – The impact matrix evaluates impacts of increased shipping traffic and routine operation of marine transport vessels in Hudson Bay between Churchill and Baker Lake and does not evaluate catastrophic events such as an accident or spill. These events are considered under the Spill Contingency Plan.

5.5 EFFECTS ASSESSMENT & SIGNIFICANCE

The structure of the remaining columns of the matrices is focused on evaluating the unmitigated and residual impacts of each major development component or activity during construction, operation, and post-closure. Major headings and their content are as follows:

Physical & Ecological Effects – This column outlines the physical activity (e.g., dike construction), the physical effect (e.g., introduction of suspended sediment) and the probable ecological consequence (e.g., elimination of fish habitat, disturbance of fish) without mitigation for each mine component.

Effects Assessment & Significance – The magnitude, spatial extent, duration, and frequency/timing (Table 4.1) of impacts to fish habitat and fish populations are assessed in the absence of mitigation to arrive at an overall significance based on the combination of assessment results (Table 5.1).

Proposed Mitigation – This column describes the mitigation proposed for each project component during construction, operation, and closure phases. Mitigation may include re-location, avoidance of sensitive periods, and/or other measures to reduce the magnitude, spatial extent, and frequency of impacts.

Residual Effect & Influence of Mitigation – This column assesses the likely residual effects after mitigation has been applied and summarizes the consequences of mitigation and its influence on reducing the magnitude, extent, duration and/or frequency/timing of the activity. In some cases, significant impacts in the absence of mitigation can be reduced to insignificant after mitigation is applied. In other cases, although mitigation may reduce the relative magnitude or spatial extent of significant impacts, mitigation may not be sufficiently effective to reduce significance to negligible levels.

Consistent with the assessment methodology described here and as promulgated by the CEAA, impact assessment is focused on residual effects, after mitigation has been applied. This is discussed in detail in Section 4.

Significance of Residual Effects – The overall ecological significance of residual impacts (i.e., after mitigation is applied) on fish habitat and fish populations (significant or insignificant) is assessed based on the combination of magnitude, extent, duration and frequency/timing (Table 5.1).

Probability – This column assesses the probability or certainty that the proposed mitigation will be successful in reducing impacts and achieving the predicted residual assessment of significance stated in the previous column.

AEMP Description – This column describes whether or not a monitoring program exists to monitor residual effects and confirm/refute our assessment of the magnitude, extent, duration, and frequency/timing of impacts. The AEMP encompasses baseline and targeted monitoring, management and mitigation of all mine components, and is consistent with the MMER for mine effluent and monitoring of habitat utilization by fish under the NNL Program.

SECTION 6 • ENVIRONMENTAL IMPACT ASSESSMENT

6.1 IMPACT OF MINE CONSTRUCTION

6.1.1 Impact of Dike Construction

6.1.1.1 Activity

Construction of dikes to impound lake areas for open pit mining in Second and Third Portage lakes and Vault Lake will alter water quality, sediment deposition, benthic communities, fish, and fish habitat within the immediate vicinity of the construction activity. This section provides a brief description of how the dikes would be constructed, potential impacts, proposed mitigation, and the residual ecological consequences and significance. Note that this question addresses the physical impacts of the dike footprint and impacts to the receiving aquatic environment during construction, but does not address impacts behind the dikes, within impounded lakes during operation. This is addressed in Section 6.2, Impact of Mine Operation.

Development of Meadowbank mine will require construction of four dikes in the following order: Vault Dike (Year 1), East dike (Year 1 or Year 2), Bay Zone (Year 1), and Goose Island dike (Year 5). The East dike will form new shoreline extending north from Third Portage Peninsula to North Portage deposit area. Between the East dike and the open pit, the West dike or tailings dike will be constructed that would form the southern boundary of the tailings storage facility. This part of the lake will no longer be available to fish. The Goose Island dike and Vault dike will temporarily (i.e., for the life of the mine) isolate the lake areas within the dikes to create open pits. These areas will be re-flooded after mine closure.

All dikes will be constructed by end-dumping of large-grain-size material from an onshore initiation point to create the dike. The materials used to build the dikes will consist of pre-strip materials, and a typical dike cross-section could comprise iron formation (IF) in the upstream rockfill, intermediate volcanic (IV) rock in the downstream rockfill, and ultramafic rock (UM as a surface capping cover because this material has relatively low metals-leaching capability.

Sideslopes of rockfill embankments would will likely fall within a range of about 1.5H:1V to 2.5H:1V, depending on water depth and foundation conditions. Total footprint width of the dikes will range between about 90 and 135 m, again, depending on water depth. The construction period would be on the order of one to two months for each dike and would occur after ice-off during the open-water season. There is a variable amount and thickness of fine (silt/clay) sediment that lies on the lake bottom beneath the dike footprint areas. The thickness and grain size of this fine material varies according to water depth. Based on habitat mapping and field investigations (BAEAR, 2005), the majority of sediment below 4 to 6 m water depth consists primarily of clay (40% to 70%) with lesser amounts of silt (25% to 40%) and sand (<5%). At water depths between 2 and 4 m, sediment grain size consists of lesser amounts of silt/clay and greater amounts of sand/gravel. Shallow water depth sediment (<2 m) consists of stones and boulders. Thus water depth has a considerable influence on the amount of fine sediment that would be disturbed and dispersed into the water column during dike construction.

Dikes will be constructed in water as shallow as possible to minimize costs and for engineering design considerations. Mean depth of the East dike, Bay Zone, and Goose Island dikes are approximately 1.5, 2.5, and 5 m, respectively. Maximum depth of East, Bay Zone, and Goose dikes are 4, 3.6, and 15.5 m, respectively. It is estimated that the thickness of fine silt/clay and overburden (sand/gravel) sediment beneath the dike footprints to bedrock in water depths greater than 4 m ranges from 1 to 3 m in the Bay Zone, 2 to 6 m in the East dike, and 2 to 5 m in the Goose Island dike. A portion of this sediment will become compacted and fill interstitial spaces between the large grain size material used to construct the dike. Some of the fine sediments will disperse into the water column during end-dumping.

6.1.1.2 Mitigation

Silt curtains will be used to minimize the extent to which sediment is suspended and dispersed into the water column within the area immediately adjacent to the construction area at the toe of the dike. Silt curtains are a well-established, effective mitigation technique and no other mitigation is necessary. The relatively short construction period (on the order of one to two months), the shallow nature of the waters, and thickness of fine sediment overlying glacial till are factors that increase viability of this technique. Prior to placement of coarse material on the lake bottom, the geotextile silt curtain will be deployed to circle the development area, suspended from the lake surface to the lake bottom, and anchored outside of the dike embayment. As sections of the dike are completed the silt curtain would be disassembled and moved to afford as much containment of sediment as can be achieved.

An on–site monitor will be monitoring the situation to ensure that the silt curtains function as designed and contain sediment within the perimeter of the curtains. In addition, water column turbidity and TSS will be monitored daily at a series of stations surrounding the perimeter of the silt curtain to ensure that sediment escaping from beneath the silt curtain does not go undetected. Further details can be found in the AEMP (2005).

Provided that the silt curtains operate as designed, very little sediment should enter the water column and be dispersed beyond the immediate dike construction area; however, it is recognized that silt curtains can fail (e.g., under high wind conditions, snag on rocks, collapse from sediment on bottom). If this occurs, sediment would be dispersed into the water column beyond the curtain perimeter and be deposited into the lake. Actual areas and volumes of deposition would be dictated by the amount of sediment lost from behind the silt curtain, sediment grain size, duration of the impact, direction and intensity of wind driven water currents, and local bathymetry. A monitoring strategy has been designed to detect failure in sediment containment so that the situation can be quickly remedied (AEMP, 2005). The proposed monitoring program is also designed to measure the magnitude and nature of any residual water quality effects, such as elevated suspended solids, metals, or nutrient concentrations in the water column outside of the silt curtains.

As a contingency, Cumberland Resources will have additional silt curtains and related equipment available as a redundancy or precautionary measure. In the event of loss of a silt curtain, new panels can be quickly installed.

6.1.1.3 Residual Effects & Significance of Sediment & Total Suspended Solids

Fish habitat will be affected directly by the dike footprint and from impairment of water column quality from TSS introductions and siltation of benthic habitats within the area encompassed by the silt curtains. Impacts on fish habitat include smothering of benthic invertebrates, siltation of spawning habitat, and a reduction in water transparency, which would reduce primary production. These effects, with exception to spawning area effects, are spatially and temporally small in magnitude.

It is important to note that the magnitude of residual impacts from increased TSS and sediment deposition will differ according to the type of habitat on which each dike is constructed. For example, the East, Bay Zone and Vault dikes are preferentially constructed in relatively shallow water depths where sediment grain size is very coarse and there is very little fine sediment available to be dispersed into the water column. The Goose Island dike is constructed across shallow and deep sections, up to 15 m depth. Details of each dike are as follows:

- The East dike in Second Portage Lake is 925 m in length and will be constructed across predominantly high (60%) and medium value (40%) habitat with a footprint area of 7.2 ha. The maximum water depth the dike will be constructed in is 3.6 m. Average water depth is 2 m. Substrate grain size at water depths of 4 m or less is predominantly boulder/cobble with some fines draped over the coarse material; therefore, the amount of sediment available to be released into the water column is small.

- The Bay Zone dike in Third Portage Lake is 720 m in length and will be constructed across high (35%) and low value (65%) habitat, with a footprint area of 3.0 ha. Maximum water depth of the dike is 4.0 m with a mean water depth of 2.6 m. Similar to the East dike, sediment grain size in this area is relatively large and very little sediment is present and available for dispersion into the water column.

- The Goose Island dike is 1,724 m in length and will be constructed predominantly (80%) across low-value habitat, with 20% high-value habitat at the southern end of Goose Island. Maximum water depth of the dike is 15.5 m, with a mean depth of approximately 7.5 m. Total footprint area is 19.6 ha. Approximately 45% of the dike will be constructed in water depths of 4 m or more where there is considerably more fine material available to be dispersed into the water column. Given the greater depth and abundance of fine material, the magnitude of sediment introduced into the water column is higher here than at the other dike locations.

- The Vault dike is constructed across a narrow (25 m) channel at the entrance to Wally Lake and is 180 m in length. The bottom consists of large boulders and there is no fine sediment beneath the dike footprint (0.5 ha). No impacts due to sediment introduction to the water column are expected.

Benthic communities are very resilient to smothering and will recover quickly from burial and recolonize. Empirical studies have shown that recovery of benthic communities from smothering occur within about one year (Wallace, 1990; Lamberti et al, 1991; Merrit and Cummins, 1996).

Residual effects on fish habitat during dike construction will be low in magnitude, local in extent, of short duration, and occur infrequently, resulting in no significant residual impacts. Certainty of this prediction is high because of the demonstrated ability of silt curtains to minimize sediment dispersion.

Fish may be directly affected by increased water column suspended sediment concentrations during dike construction, which can result in impairment of gill function, direct uptake of dissolved metals, reduced visibility, and impairment of foraging ability. Physical disturbance, noise, and diminished water quality will cause visual feeders (lake trout, round whitefish, and Arctic char) to move away and evacuate the disturbed area during dike construction because they are not constrained from doing so.

As shown in Table 6.1, residual impacts to fish will be low in magnitude, local in extent, of short duration, and occur infrequently, over one or two months during dike construction. Because construction is scheduled to occur during summer, there is no overlap with sensitive periods of spawning or rearing. Certainty of this prediction is high because of the demonstrated ability of silt curtains to minimize sediment dispersion.

Table 6.1: Residual Effects – Sediment & TSS

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Short-term	Infrequent	NO
Fish	Low	Local	Short-term	Infrequent	NO

6.1.1.4 Residual Effect & Significance of Habitat Loss

Habitat area equivalent to the footprint area of each dike will be eliminated during construction of the Vault, East, Bay Zone, and Goose Island dikes. The surface area of the footprint of each dike relative to the habitat area available in each lake is shown in Table 6.2.

Table 6.2: Surface Area of the Dike Footprints Relative to the Habitat Area Available

Dike	Footprint Area (ha)	Surface Area of Lake (ha)	Area Occupied by Dike (%)
East Dike – Second Portage	7.2	383	1.9
Bay Zone Dike – Third Portage	3.0	3,600	0.1
Goose Island Dike – Third Portage	19.6	3,600	0.5
Vault Dike – Vault/Wally Lake	0.5	697	0.1

The cumulative direct loss of habitat as a result of the dike footprint is 0.6% in Third Portage Lake, 1.9% in Second Portage Lake and 0.1% in Wally Lake. Note that the exterior of each dike will be constructed to provide high value habitat for fish (see NNL, 2005) to compensate for the loss of habitat during operation, which is addressed in Section 6.2.1. The residual impact to fish habitat from dike construction in each of the lakes is low in magnitude, local in extent, of short duration, and has infrequent occurrence (see Table 6.3). There is no residual significance. Certainty of this prediction is high. Note that impacts of dike construction are relatively short-term, persisting for no more than two or three months, which is the maximum duration of dike construction. Operational impacts of dikes last much longer and the nature of environmental impacts is different. Impacts of dike operation are addressed in Section 6.2.

Table 6.3: Summary of Residual Effects – Dike Footprint

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Short-term	Infrequent	NO

6.1.1.5 Residual Effect & Significance of Introduction of Nitrates

Nitrate enrichment of the receiving environment water may occur as a result of residue from explosives adhering to the external surface of the blasted rock being washed off. The project lakes are very nutrient poor and introduction of nitrates may cause a temporary increase in local phytoplankton production, but would not result in a detectable increase in lake productivity. Typically, the amount of nutrients adhered to rock used to construct dikes does not introduce sufficient nutrient to cause a meaningful increase in primary productivity. Furthermore, silt curtains will contain nutrient enriched water within the bounds of the curtain.

The residual effect of increased nitrogen nutrients on fish habitat in each of the lakes is low in magnitude, local in extent, of short duration, and infrequent (see Table 6.4). Residual adverse effects are not significant. Certainty of this prediction is high.

Table 6.4: Summary of Residual Effects – Nutrients

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significant
Fish Habitat	Low	Local	Short-term	Infrequent	NO

6.1.1.6 Residual Effect & Significance of Loss of Connecting Channel

Construction of the Portage South and East dike will eliminate one of the three channels connecting Second and Third Portage lakes. Fish passage via the westernmost channel is difficult or impossible during the open water season except possibly during spring freshet. Movement by fish between the lakes is impossible during winter because of blockage by ice. Construction of the dike will result in more water being directed to the two smaller channels east of the dikes. As part of the NNL (2005) plan for the project lakes, the easternmost channel will be widened and deepened to facilitate greater flow and increase the potential for movement by fish, especially Arctic char, between Second and Third Portage lakes. Thus, loss of this channel will be compensated for during mine operation.

During construction, this is a short-term impact because elimination of passage by fish will only occur during the construction period. Fish passage via the remaining two channels may be enhanced because of greater water flow in the remaining two channels. During operation, duration of impact is considered to be permanent because the channel will not be replaced (see Section 6.2.1).

The residual impact to fish from loss of a connecting channel is low in magnitude, local in extent, of short duration, and frequent (see Table 6.5). The residual adverse effect is not significant. Certainty of this prediction is high. The hydraulic connection between Second and Third Portage lakes will be enhanced, which may facilitate movements of fish between these lakes.

Table 6.5: Summary of Residual Effects – Connecting Channel

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish	Low	Local	Short-term	Infrequent	NO

6.1.2 Impact of Pit Dewatering

6.1.2.1 Activity

Lake areas behind dikes will be dewatered prior to pit development. Water will be discharged from the impoundment using pumps situated on a barge moored near the deepest portion of the impoundment. During drawdown, sediment along the margins of the impounded areas will slough downwards, releasing pore water with elevated dissolved metals concentrations and introducing suspended sediment into the water column. Depending on the stage of drawdown, water depth, and proximity of the barge to sediment sources, there is the potential for entraining water with elevated TSS concentrations and discharging it into receiving environment lakes. Pit drawdown water will be discharged to receiving environment lakes via a series of pipes suspended near the water surface. A description of the particulars of pit dewatering specific to Second Portage East dike, Third Portage South, Goose Island and Vault pits is as follows:

- *Second Portage East Dike* – The area of Second Portage Lake behind the East dike will be drawn down by 28 m resulting in a discharge of 12 Mm^3 of water. Dewatering is scheduled to occur during the summer of Year 1. Water will be discharged from the middle of Second Portage Lake Northwest Arm to the North Basin of Third Portage Lake. Complete dewatering is not required.

- *Third Portage Bay Zone Dike* – Complete dewatering of the lake area impounded by the Bay Zone dike is scheduled to occur one year after dewatering of Second Portage Northwest Arm. The water volume discharged directly to Third Portage Lake is estimated at 0.4 Mm^3.

- *Goose Island Dike* – Lake area impounded by the Goose Island will be completely dewatered in Year 4, four years after impoundment and dewatering of the Portage Bay Zone Dike. Water volume discharged directly to Third Portage Lake is 2.2 Mm^3.

- *Vault Dike* – Dewatering of the Vault pit is scheduled to occur in Year 1. Approximately 2.0 Mm^3 of water will be discharged over the dike, directly into Wally Lake. This will allow the two attenuation ponds to be joined by excavation of a connecting channel, resulting in the required storage for attenuation. Phaser Lake normally drains into Vault Lake. Phaser Lake will be drawn down by 1 to 2 m during mine operation and excess inflow will be pumped to Turn Lake.

6.1.2.2 Mitigation

Mitigation of the potential effects of discharge of water from impounded areas into the receiving waterbodies includes the following actions:

- withdraw water near the surface, away from the sediment-water interface and sediment sloughed from shorelines
- withdraw water at a rate that does not create currents that would entrain sediments
- ensure that water levels in receiving environment water bodies are maintained within historical ranges
- position the barge to maximize depth under the barge to take advantage of the settling capacity of the area being dewatered
- discharge during open water periods and not under ice
- discharge to the receiving environment near the surface, well away from shorelines and sediment-water interface, and avoid important or sensitive habitat
- targeted monitoring (AEMP, 2005) will be used to evaluate the effectiveness of these actions, triggering further mitigation if necessary.

The greatest volume discharged will be from Second Portage Lake into Third Portage Lake, which has the capacity to absorb this volume with minimal hydrological impacts. Maintaining water levels in Third Portage Lake within the typical range in water level will ensure that shorelines are not flooded and the natural stream channels are not overwhelmed.

Fish will be salvaged prior to dewatering of impoundments. Options for salvaging fish are described in the AEMP (2005). Options for compensation for loss of fish habitat within pits are described within the NNL (2005) report.

6.1.2.3 Residual Effects & Significance on Habitat & Fish Populations

The magnitude of impact of directing water from impoundments to adjacent lakes is directly dependent on the volume of water discharged relative to the water volume of the receiving environment and relative to the annual average discharge volume from the receiving environment waterbody. A summary of the basic hydrological information of the project lakes is summarized in Table 6.6. Discharge data are mean values from 2002 and 2003 data. This information is important to put dewatering volumes in context with normal discharge volumes to estimate the impacts of dewatering on fish habitat in the receiving environments.

To estimate the residual impacts of discharging pit water to receiving environment waterbodies, fish habitat impacts were evaluated in two ways: by the amount of water contributed to the receiving environment by dewatering as a percent of total volume; and as an incremental increase in the volume and percentage increase of the typical annual discharge volume from the receiving environment lake.

Table 6.6: Total Estimated Water Volume, Annual Discharge & Discharge as a Percent of Lake Volume

Waterbody	Total Volume (Mm^3)	Total Annual Discharge (Mm^3)	Discharge as a % of Volume
Third Portage Lake	228	11.58	5.1
Second Portage Lake	22	~1.45	~6.5
Wally/Drilltrail Lake	(28.1 + 15^)	15.67	35
Turn Lake	?	4.16	?
Vault Lake	2	0.2*	~10

Notes: ^ Estimated based on surface area relative to Wally Lake. ***** Estimated based on precipitation/area. ? Indicates "unknown"

Table 6.7 quantifies the volume of water discharged during pit dewatering to the receiving environment in terms of an absolute quantity (m^3); as a percent of lake volume; and as a percent of the annual discharge volume from the receiving environment to the next downstream lake. This information is used to estimate the possible impacts on receiving environment fish habitat. Increasing water levels in receiving environment lakes can increase overall habitat by expanding shorelines, but may also cause erosion along non-bedrock controlled shorelines.

Table 6.7: Total Estimated Water Volume, Annual Discharge, & Discharge as a Percent of Lake Volume

Pit	Receiving Environment	Dewatering Volume (Mm^3)	Recipient Lake Volume (Mm^3)	Percent of Lake Volume	Mean Discharge Volume (Mm^3)	Incremental Increase in Discharge (%)
Portage South	Third Portage	0.4	228	0.18	11.578	3.4
Goose Island	Third Portage	2.2	228	0.96	11.578	19.0
Second Portage	Third Portage	12	228	5.3	11.578	104
Vault	Wally	~1.5	28.1	5.3	21.99*	6.8

Note: * Discharge volume here is for Vault/Wally/Drilltrail lakes to Second Portage Lake (AMEC 2003).

A description of the details for each pit is as follows:

Bay Zone Pit – The total volume of water contained within the Bay Zone pit behind the dike is 0.4 Mm^3, which is a very small percentage (0.18%) of the volume of Third Portage Lake. The approximate timing of dewatering is in 2006 (year 1), one year prior to dewatering of Second Portage pit, so there is no cumulative impact associated with this activity.

Although the volume of water pumped from behind the Bay Zone dike is small and bottom substrate consists primarily of boulder/cobble, there is the potential for the introduction of sediment into Third Portage Lake East Basin, especially during the later stages of drawdown when natural attenuation capacity has been exhausted.

Potential impacts of dewatering of Portage South pit on fish habitat and fish include:

- introduction of suspended sediments from Bay Zone impoundment to Third Portage Lake East Basin

- deposition of sediment causing temporary impairment of benthic productivity and fish spawning habitat in Third Portage East Basin.

TSS levels during dewatering will be monitored to ensure that concentrations in the receiving environment do not exceed CCME criteria (see AEMP, 2005).

The residual impact to fish habitat and fish populations from dewatering of the Bay Zone pit is expected to be low in magnitude, local in extent, of short duration, and infrequent (see Table 6.8). Residual adverse effects are not significant. Certainty of this prediction is high.

Table 6.8: Summary of Residual Effects – Bay Zone Pit

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Short-term	Infrequent	NO
Fish	Low	Local	Short-term	Infrequent	NO

Goose Island Pit – The total volume of water contained within the Goose Island pit behind the dike is 2.2 Mm^3 (excluding the Portage South pit volume), which is less than 1% of the volume of Third Portage Lake (Table 6.7). Discharging this volume from Third Portage Lake to Second Portage Lake represents an incremental increase in discharge of approximately 19% of the mean annual discharge during 2002 and 2003. Note that discharge in 2002 was estimated to be 14.96 Mm^3, which was 45% higher than the discharge volume of 8.19 Mm^3 in 2003. Thus, depending on the year, the value of 19% appears to fall well within historic, inter-annual differences in discharge volume. A 1% increase in volume of Third Portage Lake is low in magnitude.

Dewatering of Goose Island pit is scheduled to occur four years after dewatering of Second Portage pit, so there is no cumulative impact from Goose Island pit dewatering with other dewatering events. Because the Goose Island pit is being completely dewatered, again, there is the potential for the introduction of sediment and possibly dissolved metals into Third Portage Lake East Basin during drawdown, especially during the later stages of drawdown, when natural attenuation capacity has been exhausted.

Potential impacts of dewatering of Goose Island pit on fish habitat and fish include:

- increase in water volume of Third Portage Lake by 1% will not result in a measurable increase in habitat area
- introduction of suspended sediments and dissolved metals from impoundment to Third Portage Lake East Basin
- deposition of sediment causing temporary impairment of benthic productivity and fish spawning habitat in Third Portage East Basin.

TSS levels during dewatering will be monitored to ensure that concentrations in the receiving environment do not exceed CCME criteria (see AEMP, 2005).

The residual impact to fish habitat and fish populations from dewatering of Goose Island pit is low in magnitude, local in extent, of short duration and infrequent (see Table 6.9). Residual adverse effects are not significant. Certainty of this prediction is high.

Table 6.9: Summary of Residual Effects – Goose Island Pit

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Short-term	Infrequent	NO
Fish	Low	Local	Short-term	Infrequent	NO

Second Portage Pit – The total volume of water discharged from Second Portage pit behind the East dike is 12 Mm^3, which is approximately 5.3 % of the volume of Third Portage Lake (Table 6.7). Second Portage pit is scheduled for dewatering in 2006 (Year 1), prior to dewatering of all other pits. Discharging 12 Mm^3 of water to Third Portage Lake from Second Portage pit is approximately double the annual average discharge volume of 11.58 m^3; therefore, the likelihood that water levels in Third Portage Lake will rise during the open water season is high. It is presently unknown to what extent the existing connecting channels can facilitate the increased flow between Third Portage Lake and Second Portage Lake, or what the lag time is between discharge to the North Basin and discharge from the East Basin to Second Portage. Maintaining high water levels throughout the summer and over the first winter after dewatering of Second Portage pit will have uncertain impacts on shoreline habitat. A net gain in lake area is possible. Because water levels are expected to increase, the depth of water over spawning, rearing, and feeding areas is expected to increase.

In the year following dewatering of Second Portage Lake, the lake area of Third Portage and Second Portage may rise following spring thaw, depending on the ability of the existing connecting channels between Second and Third Portage lakes to handle the increased flow. This may result in temporary flooding of shorelines and erosion by ice of non-bedrock-controlled soils.

In summary, potential impacts of dewatering of Second Portage pit include:

- increased water levels in Second and Third Portage lakes during one or two years, causing minor flooding of shoreline habitat and introduction of suspended sediment
- deposition of sediment causing temporary impairment of benthic productivity and fish spawning habitat in Third Portage North Basin
- direct introduction of suspended sediments and dissolved metals from Second Portage into Third Portage Lake
- transfer of nutrients, phytoplankton, and zooplankton from Second Portage Lake to Third Portage Lake North Basin.

Total suspended solids levels during dewatering will be monitored to ensure that concentrations in Third Portage Lake do not exceed CCME criteria (see AEMP, 2005).

The residual impact of dewatering Second Portage pit on fish habitat and fish populations in Third Portage Lake is low in magnitude, local in extent, of short duration, and infrequent (see Table 6.10). Residual adverse effects are not significant. The certainty of this prediction is low.

Table 6.10: Summary of Residual Effects – Second Portage Pit

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Short-term	Infrequent	NO
Fish	Low	Local	Short-term	Infrequent	NO

Vault Pit – The total volume of water contained within the Vault pit, behind the dike, is 2.0 Mm^3. Most of this volume (approximately 1.5 Mm^3) will be pumped to Wally Lake, leaving two small residual attenuation ponds within the former Vault Lake basin. The dewatering volume from Vault Lake relative to the volume of Wally Lake (28.8 Mm^3) is 5.3% (Table 6.6). Water from Phaser Lake that normally discharges to Vault Lake will be pumped to Turn Lake to manage water levels in Phaser during mine-life. The incremental increase in discharge from Vault pit to Wally Lake from dewatering is approximately 6.8% greater than the annual average discharge volume (AMEC, 2003). The approximate timing of dewatering is in 2010 (Year 5).

Given the relatively small volume of water discharged to Wally Lake and the minor increase in discharge to Second Portage Lake, the magnitude of impact is low. Nevertheless, there is the potential for the introduction of sediment and dissolved metals into Wally Lake during drawdown, again, especially during the later stages when natural attenuation capacity has been reduced. The residual attenuation ponds in Vault Lake will assist in reducing the potential for sediment transfer to Wally Lake during dewatering.

Potential impacts of dewatering of Vault pit on fish habitat and fish in Wally Lake include:

- introduction of suspended sediments and dissolved metals from Vault Lake to Wally Lake
- deposition of sediment causing temporary impairment of benthic productivity in Wally Lake.

During dewatering, TSS levels will be monitored to ensure that TSS concentration in Wally Lake does not exceed CCME criteria (see AEMP, 2005).

The residual impact to fish habitat and fish populations from dewatering of Vault pit is low in magnitude, local in extent, of short duration, and infrequent (see Table 6.11). Residual adverse effects are not significance. Certainty of this prediction is moderate.

Table 6.11: Summary of Residual Effects – Vault Pit

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Short-term	Infrequent	NO
Fish	Low	Local	Short-term	Infrequent	NO

6.1.3 Impact of Freshwater Intake & Effluent Pipe Installation

6.1.3.1 Activity

The north basin of Third Portage Lake will be the source of all freshwater for the project (mine process water, potable water, dust suppression, etc.). This will also be the area in which all treated effluent (along with all contact, surface, and sewage waters) is discharged from the Portage Island mining facility. Three pipelines will be constructed:

- a water intake pipe situated west of the plant site on the western shore of the small south-facing peninsula
- a water effluent pipe extending from the north end of the Second Portage Lake attenuation pond into Third Portage Lake, discharging between the mainland and the most northerly island (>year 5)
- a water effluent pipe extending from the Vault Lake attenuation pond into Wally Lake.

The freshwater intake pipe will extend from shore and run along the sediment surface along the lake bottom. The pipe will extend approximately 75 m offshore and withdraw water from a depth of 10 to 12 m. The pipe will be constructed of a heavy duty, insulated PVC and be 1 m in diameter. During installation, local disturbance of coarse, nearshore substrate may occur during seating of the pipe along the bottom. Coarse material will be placed on either side of the pipe to anchor it to the bottom. At depths deeper than 4 to 6 m there is a transition to fine silt/clay sediment. During installation there is the potential for introduction of fine sediments into the water column, which will be dispersed, depending on wind-generated currents. This might result in minor, short-term increase in TSS concentration of the water column and disturbance of benthic invertebrates beneath the pipeline footprint.

Effluent will be discharged to each of the receiving environments (Wally and Third Portage) via an 18" high density polyethylene (HDPE) pipe. The pipe will run along the bottom and the end of pipe will be situated at least 50 m offshore of the nearest coarse substrate or shoal habitat, in at least 10 m of water. The end of pipe will have a diffuser to maximize dilution of effluent into the receiving environment. Effluent will be directed away from any sensitive habitats. Negligible impacts to shorelines are expected from pipeline installation because of the very coarse boulder shorelines that are not subject to erosion or disturbance by the pipes.

All three pipes will be removed during mine closure.

6.1.3.2 Mitigation

The effects of installing intake and discharge pipes on fish populations and their habitat will be mitigated through careful selection of timing and location of installation.

The water intake pipeline will extend approximately 75 m into the lake to avoid shoreline effects at the intake/discharge point. The submerged end of the pipeline will be positioned off of the bottom to maintain sufficient clearance of the intake to minimize entrainment of sediment or benthos by currents. Care will be taken when placing the pipe onto the bottom to prevent shoreline damage. The intake will be fitted with an appropriately sized screen to minimize entrainment of small fish. The size of the intake has been calculated using DFO's (1995) guidance to minimize entrainment of fish in the intake, based on intake volume, screen size, intake velocity, and swimming ability of local fish species.

Effluent pipes will be installed offshore, above the lake bottom, and will not directly affect fish habitat. Disturbance to shorelines and bottom sediments is negligible. Once installed, the pipes will remain anchored to the bottom during mine life and will provide shelter habitat for fish in deeper water, away from coarse substrates associated with the shoreline.

6.1.3.3 Residual Effects & Significance to Fish Habitat

Installation of intake and discharge pipes into project lakes will temporarily affect fish habitat in the immediate area through direct habitat alteration as well as minor temporary inputs of TSS which may lead to local smothering of benthos/periphyton. Fish will avoid the area during construction activity, so no impacts are anticipated. Timing of activities will avoid sensitive periods as spawning and egg incubation occurs in fall/winter, not spring.

The total amount of fish habitat affected by installation of the intake pipeline is estimated to be: 75 m x 1 m = 75 m^2. This is a very insignificant amount relative to the surface area of the lakes. Furthermore, the pipeline will provide cover habitat, especially in water depths greater than 4 m, which will improve habitat quality for young-of-the-year and juvenile fish of all species and adult sculpin and stickleback. The net change in habitat quantity and quality in Third Portage Lake is negligible.

Mitigation will result in negligible ecological effects to fish and fish habitat. Residual effects are considered low in magnitude, local in extent, of short duration, and occur rarely over only several days during construction (see Table 6.12). Residual adverse effects are not significant. Certainty of this prediction is high.

Table 6.12: Summary of Residual Effects – Pipeline Installation

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Short-term	Rare	NO
Fish	Low	Local	Short-term	Rare	NO

6.1.4 Impact of Mine Site Infrastructure Facilities

6.1.4.1 Activity

Construction of the Meadowbank Gold project will require the installation of several infrastructure facilities at the mine site as listed below. The majority of these pose little or no threat to either fish or fish habitat, given that they are situated on land well away from water; thus, there is no pathway to cause effects under normal predicted operations. Only under rare circumstances will any of these facilities have the potential to cause adverse impacts to the receiving environment (see Spill Contingency Report (2005). The following facilities are not considered to be significant sources of stressors causing negative effects to fish populations or fish habitats during construction:

- borrow pit/quarry (within footprint of ultimate pits)
- mine plant and facilities (offices, storage)
- non-contact diversion facility
- fuel storage and power generating facilities
- emulsion/ammonium nitrate (AN) storage/explosives magazines
- camps (north and south)
- sewage and solid waste disposal.

The construction of roads, the airstrip, and both air- and land-based traffic have the potential to affect fish and fish habitat during both construction and operation phases of the project.

The construction of approximately 12 km of roads and associated drainage within the project footprint will involve the use of heavy vehicles and equipment to quarry and transport construction materials from the borrow pit to areas throughout the project area. This will directly disturb the underlying terrestrial terrain. Roads will run throughout the Portage mine site, as well as from Portage to Vault pit areas, and to access the ammonium nitrate and explosives storage facilities. These roads will run adjacent to, or near, lakes and connecting channels. Dust and hydrocarbon by-products from roads and vehicle emissions will enter the local watershed directly via aerial transmission, or indirectly, being deposited on land and dissolved or washed into the aquatic environment during spring melt and rain events in summer. These will be episodic in nature and restricted to construction.

Construction of adequately sized drainage ditches, berms and sumps will be required to capture particulates/runoff, which will be directed to the Second Portage attenuation pond. This mitigation will eliminate or considerably reduce the potential for introduction of sediments directly from roads or ditches to the receiving aquatic environment.

Construction of a 1,300 x 30 m airstrip will involve cutting and filling the area, with import of additional fill materials where necessary (final design to be confirmed in detailed design), thus providing another potential source of particulate and hydrocarbon source to nearby waters. Drainage ditches will encircle the facility to capture this non-contact runoff and direct it to the attenuation pond at the main site.

6.1.4.2 Mitigation

The mine infrastructure facilities will all be constructed using standard construction practices for which there are well established, proven mitigation solutions:

- On-site environmental monitors will be present to ensure that prescribed construction practices are followed and to identify potential problems as they may arise.
- Environmental monitoring of the receiving environment (see AEMP, 2005) will allow early detection of any bio-physical changes that may occur during construction.
- Refuelling of trucks and other equipment will be conducted at least 100 m away from the nearest waterbody.

- Spills and contingency plans will be implemented where necessary.
- Dust suppressants will be applied regularly on roads and the airstrip to minimize aerial dispersion of particulate borne contaminants. A series of collection ditches will be constructed to direct all mine site surface runoff (i.e., contacts water) from roads, waste piles, and the airstrip into the Second Portage attenuation pond.
- Fuel products will be stored according to best practice. The fuel tanks will be within a secondary containment facility comprising a geomembrane liner (110% criterion), overlying soil containment berms and access ramps, a storm water sump, and grease traps.

To further minimize impacts, roads and the airstrip are to be situated as far from water bodies as possible. No direct contact of vehicles in lakes or connecting channels will be permitted.

6.1.4.3 Residual Effects & Significance of Mine Site Infrastructure Construction

The mitigation measures described above will minimize any residual effects by avoiding, minimizing, or eliminating exposure pathways. The residual effects of traffic and construction related to roads, and the airstrip will be low in magnitude, local in extent, of short duration, and will occur infrequently on an irregular basis (see Table 6.13). Residual adverse effects are not significant. Certainty of this prediction is high.

Table 6.13: Summary of Residual Effects – Road/Airstrip Construction & Traffic

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Short-term	Infrequent	NO
Fish	Low	Local	Short-term	Infrequent	NO

6.1.5 Impact of Construction of Rock Storage Facilities

Two areas will be designated as Rock Storage Facilities to contain overburden and waste rock materials:

- Portage (surface area ~140 ha)
- Vault (surface area ~195 ha).

At each area, overburden will be removed, and the ground will be levelled using graders. To initiate construction of these facilities, two small lakes within the perimeter of the Portage rock storage pile (NP-1 and NP-2) will be dewatered. There are no small lakes within the perimeter of the Vault storage facility, although there are two lakes quite nearby, lying adjacent to the facility. One of the ponds, Lake NP-2 at the Portage facility, is 9.5 ha in size and contains a small population of lake trout. This lake lies within a small depression, has no direct contact with Second Portage Lake, and is isolated. Habitat value within NP-1 was, determined based on groundtruthed air photo interpretation, was assessed as having 4.8 ha, 0.9 ha and 3.6 ha of high, medium, and low value habitat. Options for replacement of this habitat will be presented as part of the NNL (2005) report.

The second pond, NF-1, is very shallow, with a maximum depth of about 3 m and does not contain fish. There is a small, ephemeral connection between this pond and Second Portage Lake that flows only in spring and has a very small surface connection. The potential habitat value of this pond was assessed as 1.1 ha high value, 0.4 ha moderate value and 1.5 ha low value habitat.

The waste rock facilities at Vault and Portage will be constructed early and then maintained during the life of the mine. Contact waters from disturbed terrain and rock piles are expected to be of low pH (acidic) and to contain elevated concentrations of metals. Drainage ditches will encircle each rock storage facility to collect and redirect all contact water runoff to the attenuation pond at each respective area. It is expected that permafrost beneath the waste rock pile will creep into the piles and freeze the core over time, reducing the likelihood of leachate flow into groundwater. Undesired mined rock and overburden of low ore content will be transported and dumped by truck, with some secondary handling by dozer to evenly distribute the waste rock over the designated area.

6.1.5.1 Mitigation

To minimize impacts to fish and fish habitat from construction and operation of the Vault and Portage rock storage facilities, the following mitigation measures will be implemented:

- Drainage ditches, berms, and sumps will be used to collect and re-direct all contact water run-off to the Second Portage attenuation pond (Portage facility) or the Vault attenuation pond (Vault facility). Ditches will be designed to contain runoff under 1:100 year flood conditions.

- Lost fish habitat in Lake NP-2 will be compensated for by the connection of Dogleg Lake (fish-bearing) to Second Portage Lake through enhancement of a connector stream. This would improve fish movement between these two lakes and increase net habitat available to fish (see NNL, 2005).

- Fish within Lake NP-2 will be salvaged prior to dewatering and will be provided to elders and residents of Baker Lake.

6.1.5.2 Residual Effect & Significance of Rock Storage Facilities

There is a small net loss of potential habitat from the elimination of one 9.5 ha pond (NP-2) containing lake trout. Another small (3.0 ha), shallow pond does not contain fish. Loss of fish and fish habitat will be compensated for by establishing a hydraulic connection between Dogleg Lake and Second Portage Lake (NNL, 2005). The relative loss of two small, isolated ponds within the local region is negligible. The above mitigation measures will ensure the protection of fish and fish habitat through the prevention of contact waters reaching aquatic receiving environments, by monitoring groundwater and directing all surface water to attenuation ponds.

Mitigation has reduced the magnitude, duration, and frequency of impacts resulting in negligible ecological effects to the fish and fish habitat. Residual effects are considered low in magnitude, local in extent, of short-medium duration, and occur rarely during operation (see Table 6.14). Residual adverse effects are not significant. Certainty of this prediction is high.

Table 6.14: Summary of Residual Effects of Constructing Rock Storage Facilities

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Medium-term	Rare	NO
Fish	Low	Local	Short-term	Rare	NO

6.1.6 Impact of Installation of the Turn Lake Crossing

6.1.6.1 Activity

The access road between the plant site and the Vault development requires that a culverted crossing be installed at Turn Lake. The crossing will be approximately 70 m wide and pass over the constriction in the lake connecting Turn and Drilltrail lakes, approximately 100 m from the discharge point to Drilltrail Lake. The crossing will require two 2.5 m diameter round culverts, each 75 m long (to allow side slope ratio of 3H:1V for protection of habitat), connecting the upstream and downstream sides. Culverts will be installed in the dry during winter and sunk 0.8 m (⅓ embedded) into the existing lake bottom to provide lateral structural stability.

6.1.6.2 Mitigation

Culverts are used regularly where roads cross water bodies and there are established mitigation measures to ensure that the crossing does not impair fish passage or pose a potential chronic source of suspended sediment. The following mitigation measures will be implemented:

- Standard construction practices will be employed during culvert installation.
- Shorelines will be riprapped to prevent exposure of permafrost and minimize soil erosion.
- Coarse substrate will be placed inside the culverts and at both ends to encourage fish movements and provide compensatory fish habitat with suitable complexity.

Construction will take place during winter, when the channel is normally frozen to the bottom, avoiding the open water period when fish passage occurs.

6.1.6.3 Residual Effect of Installation of Turn Lake Crossing

Fish habitat under the stream crossing footprint will be altered. Mitigation will allow replacement of lost habitat with new habitat along the banks of the crossing as well as at the mouths and insides the culverts themselves through the addition of coarse material.

Because installation will occur during the winter when no fish are present or moving in streams, no direct impacts to fish will be observed. Riprap will guard against bank erosion leading to TSS input. The AEMP (2005) core-monitoring program will monitor for any potential TSS in the lake in the vicinity of the stream crossing. Therefore, barring any unforeseen events such as spills or accidents, no residual adverse effects are expected (see Impact Matrices); however, should an accident occur, a targeted study would be designed and implemented to determine the extent and magnitude of the impact with a view to implementing appropriate rehabilitation measures.

The residual effects of installing the Turn Lake Crossing will be low in magnitude, local in extent, of short duration, and will occur rarely (see Table 6.15). Residual effects are not significant. Certainty of this prediction is high.

Table 6.15: Summary of Residual Effects – Turn Lake Crossing Construction

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Short-term	Rare	NO
Fish	Low	Local	Short-term	Rare	NO

6.2 IMPACT OF MINE OPERATION

Once the mine infrastructure is in place, the dikes have been constructed, pits dewatered, and the mine has become operational, there are several key areas where potential impacts may arise:

1. release of metals from dikes and their effect on water quality, habitat, and fish
2. functionality of the dikes as productive fish habitat and a medium for growth of lower trophic level biota (periphyton and benthos)
3. effects of effluent discharge (TSS, nutrients, and metals) on the receiving environment habitat and fish
4. impacts of the loss of habitat within the pit developments
5. impacts of physical mine site operations, especially the rock storage facilities at Goose/Portage and Vault Lake
6. impairment of fish movement between Drilltrail and Turn lakes because of the crossing structure.

Each of these areas is the basis for the key questions where the residual impacts and significance during the life of the mine are addressed.

6.2.1 Impact of Dike Operation

6.2.1.1 Activity

The impacts of dike construction on fish habitat and fish are summarized in Section 6.1.1. Once the dikes are operational, they will provide habitat for periphyton and benthic communities, as well spawning and rearing habitat for fish. The dike exteriors adjacent to project lakes will be designed to provide optimal habitat for fish during the life of the mine, as well as beyond mine life, because the vast majority of dike habitat will become a permanent feature of the lakes. This section addresses how dike exteriors will function as productive fish habitat during mine life. The relative impacts of loss of habitat and fish as a result of pit development are assessed in Section 6.2.2. Furthermore, a detailed accounting of the relative abundance and quality of habitat affected by mine development and habitat replacement is provided in the NNL (2005) report.

Four dikes will be constructed at Meadowbank in the following order: East dike (Year 1 or Year 2), Bay Zone (Year 1), Vault dike (Year 4), and Goose Island dike (Year 5). The East dike will form the new shoreline habitat of the east shore of Second Portage Lake. The West dike or tailings dike will not be productive habitat until after mine closure, when the Goose Island dike is decommissioned and the West Dike becomes part of Third Portage Lake (see Reclamation and Closure Plan). The Goose Island dike will provide productive habitat for fish in Third Portage Lake during mine operations and beyond. The Vault dike is in very shallow water and will provide foraging and shelter habitat for fish during the open water months.

Side slopes of dike exteriors will depend on water depth and gradation of rockfill. In shallow lake areas less than about 5 m depth, side slopes will range between 1.4H:1V to 1.8H:1V. The slope of dike exteriors is sufficiently steep to ensure that wave action prevents fine sediments from accumulating, thus preventing potential impacts to incubating fish eggs. In lake areas greater than 5 m depth, side slopes will be slightly shallower, between 1.8H:1V and 2.5H:1V.

Capping material will consist of a mixture of boulder/cobble ranging from 0.2 to 0.8 m diameter rock. Slightly larger material will be used between 0 and 2 m depth to provide for make the dike sufficient durable to resist erosion from wave action and ice scouring. The size of material used to cap the dikes is similar in size to substrates found elsewhere in the project lakes and is of an optimal size for spawning by lake trout, round whitefish and Arctic char.

A typical dike will be constructed from iron formation (IF), ultramafic (UM), and intermediate volcanic (IV) rock. Ultramafic (UM) rock will be used as a surface capping cover because this material has relatively lower metals leaching potential than either IV or UM rock.

Spawning by lake trout, round whitefish, and char in the project lakes occurs in relatively shallow water, between 2 and 6 m depth. This is the depth range below the ice scour depth and above the depth where there is a transition to very fine grain sediment (BAEAR, 2005). This is consistent with the generalized spawning habitat preferences for lake trout as Scott and Crossman (1979) stated that, “spawning occurs over large boulder or rubble bottom in inland lakes at depths of less than 40 ft [12 m].” Note that the spawning habitat requirements of the other VEC species, round whitefish and Arctic char, are similar to those for lake trout. Arctic char spawn over gravel and rocky shoals at depths to 4.5 m, while round whitefish seek “gravelly shallows of lakes,” or a “gravel and rock bottom,” in reasonably shallow depths (Scott and Crossman, 1979).

Other authors who have documented spawning habitat features for lake trout in the Great Lakes (Thibodeau and Kelso, 1990), northeastern USA and Ontario (Sly and Evans, 1996), and in Northwest Territories and Nunavut lakes (Richardson et al, 2001) and at other mine sites found similar preferences. In Lac de Gras for example, lake trout selected spawning characterized by either open water shoals or shorelines bordered by deep water with large substrates (boulders >256 mm in diameter), with many interstitial spaces, shallow water (2.5 to 7 m), steep slope, and wind exposed areas to prevent accumulation of fine materials (Diavik EIA, 1999). Similarly, preferred spawning habitat by lake trout in Snap Lake occurred over exposed, rocky shoals of 2 to 6 m depth with a boulder/bedrock substrate (Snap Lake EIA, 2002).

Thus, the dike design will incorporate the optimal features to provide for spawning, egg incubation, and nursery habitat for lake trout, round whitefish, and Arctic char. This will offset, to some degree, habitat lost as a result of mine development (NNL, 2005). Recent research has shown that replacing lost habitat with artificially created spawning habitat that was successful for lake trout in most of the

Great Lakes (Fitzsimons, 1996). Also, when lake trout have been deprived of traditional spawning sites, trout responded by seeking out alternative spawning locations within the lake, or utilizing other traditional spawning sites to a greater degree than before (McAughey and Gunn, 1995). The authors observed that there was no change in the timing of spawning, and that trout adapted very quickly to the altered conditions and appeared to readily and quickly use alternate sites. McAughey and Gunn (1995) stated that theirs was the first study to quantitatively demonstrate this behaviour in lake trout.

Although design specifications can meet life history requirements for fish, other factors must also be satisfied if the dike exteriors are to function as productive habitat for plants, invertebrates, and fish. Predicted post-construction porewater quality concentrations are below water quality guidelines for all parameters and all rock types, with the exception of fluoride in IF rock and aluminium in IV rock.

The results of the water quality assessment indicate that during construction, concentrations of some metals could exceed water quality guidelines in the dike porewater and within less than 1 m of the dikes. Post-construction dike porewater concentrations will be below water quality guidelines. In the long-term, the quality of water within and near the dikes is not expected to have an adverse effect on fish or fish habitat.

Several factors may reduce the probability that pore water metals exceed CCME criteria including: cold water temperatures, use of low metal leaching rock and dike permeability. Dike permeability is especially important to consider. Because the dike is somewhat permeable to water inflow because of the large hydraulic pressure exerted by the lake against the dike and the pit, there is predicted be a net inflow of lake water through the dike and into the pits. Also, dike permeability may diminish over time as permafrost is expected to creep into the dike over time and create a freeze-barrier. During summer, wind and wave action will also act to rapidly exchange water within pore spaces, further reducing metal concentrations.

6.2.1.2 Mitigation

The exterior dike faces of the East dike, Bay Zone, Goose Island and Vault dikes will be designed and constructed so that they are stable, resist erosion, and provide suitable features for habitat elements and fish directly. Following are the mitigation measures that will be implemented during dike operation:

- Dike slopes will range between 1.4H:1V to 1.8H:1V at water depths of 6 m or less. The slope of dike exteriors is sufficient to ensure that wave action prevents fine sediments from accumulating, thus preventing potential impacts to benthic communities and incubating fish eggs.
- Dikes will be capped with IF rock material with a lower metal leaching potential than IV or UM rock.
- Size of capping material will consist of a mixture of cobble and boulder that is suitable for spawning by VEC fish species.
- Slope, depth, rock size, and complexity of dike surfaces have been designed to mimic high value habitat as determined from habitat mapping of the project lakes to optimize habitat compensation for lost habitat due to impoundment (NNL, 2005).

- During the first several years of dike operation, permeability of the dike will cause a net inward movement of water and dissolved metals (i.e., towards the pit), reducing the amount of metals released to receiving environment lakes. This is especially important during the first year or two of dike operation.

As part of the AEMP (2005), two targeted monitoring studies would be conducted. Given the potential for leaching of dissolved metals from the dikes, the interstitial spaces within East Dike and Goose Island Dike would be sampled for dissolved metals concentrations four times in the first year of operation (AEMP, 2005). Also, species composition, abundance, and biomass of periphyton communities will be measured at discrete locations on the East Dike and Goose Island Dike and compared with periphyton data from reference areas. This will indicate whether the dikes are functioning as productive fish habitat by determining whether algal growth is impaired to any degree by measured metals leached from the rock material used to construct the dikes. A targeted study has also been proposed to determine the extent to which dikes are used for spawning by lake trout. The NNL (2005) report quantifies the amount and quality of habitat lost and provides the framework for a habitat compensation plan.

6.2.1.3 Residual Effects & Significance of Portage East Dike

The Portage East dike will be approximately 1 km in length with an average depth of only 1.5 m. Maximum water depth along the East Dike is 4 m. The dike will have a surface area of 3,800 m^2 (0.38 ha) below the water surface and is considered medium to high value habitat (NNL, 2005). Because of the relatively shallow water depth west of the dike, this habitat will provide limited if any spawning habitat for fish, but will provide a medium for growth of periphyton and benthos as well as providing shelter habitat for juvenile VEC fish.

Residual effects of the East dike on fish habitat and fish populations will be low in magnitude, local in extent, of permanent duration, and occur frequently (see Table 6.16). The surface area of the dike face is very small relative to the remainder of the lake and is not expected to significantly alter lake productivity either in a positive or negative sense. The East dike will remain in place after mine closure, as a permanent feature. Residual adverse effects related to dike operation are not significant. Certainty of this prediction is moderate to low because of the uncertainty regarding the magnitude of metals leaching and porewater contamination.

Table 6.16: Summary of Residual Effects – East Dike

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Permanent	Frequent	NO
Fish	Low	Local	Permanent	Frequent	NO

6.2.1.4 Residual Effects & Significance of Bay Zone Dike

The Bay Zone dike will be a temporary dike that will be replaced by the Goose Island dike in Year 5. The Bay Zone dike is short (650 m) and will be constructed in very shallow water with an average depth of 1.5 m and maximum depth of 3 m. Surface area of the dike below 0 m is only 280 m^2, but is considered high value habitat for periphyton and benthos. This habitat will not function as spawning habitat for fish because water depth is too shallow; however, the habitat will be functional as rearing and shelter habitat for VEC fish.

Residual effects of the Bay Zone dike on fish habitat and fish populations will be low in magnitude, local in extent, of short-term duration, and occur frequently (see Table 6.17). The surface area of the dike face is very small relative to the remainder of the lake and is not expected to significantly alter lake productivity, either positively or negatively. The Bay Zone dike will be replaced by the Goose Island dike, although a small part of the dike along the northeast side will form part of the Goose Island dike, which will remain in place after mine closure, and is a permanent feature. Residual adverse effects associated with dike operation are not significant. Certainty of this prediction is moderate because of the uncertainty regarding the magnitude of metals leaching and pore water contamination; however, given the very small area of dike surface under the water, the worst-case magnitude impact would still be very small and would diminish over time.

Table 6.17: Summary of Residual Effects – Bay Zone Dike

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Medium Term	Frequent	NO
Fish	Low	Local	Short Term	Frequent	NO

6.2.1.5 Residual Effects & Significance of Goose Island Dike

The Goose Island dike will be approximately 2 km in length and is projected to have an average depth of 5 m. To put this in perspective, the approximate length of shoreline eliminated during mine life by the Goose Island dike is 2.6 km. Maximum water depth along the Goose Island dike is 15.5 m with a surface area of 27,200 m^2 (2.7 ha) below the water surface. Approximately 14,900 m^2 of the Goose Island dike lies between 0 m and 5 m depth and is considered high value habitat (NNL, 2005). The remaining surface area (12,200 m^2) is deeper than 5 m and is considered moderate value habitat. Habitat created along the dike is expected to provide an excellent medium for growth of periphyton and benthos, as well as providing optimal habitat for spawning and nursery areas for VEC fish species. This is especially true along the entire eastern section of the dike that borders deep water, which is preferred for spawning by fish. During the life of the mine, the entire face of the dike is expected to provide spawning habitat; however, it is assumed that dike habitat greater than 5 m depth will gradually accumulate fine sediments, which may reduce habitat suitability over time, which is why this habitat is ranked as moderate value (NNL, 2005).

Residual effects of the Goose Island dike on fish habitat and fish populations will be low in magnitude, local in extent, of permanent duration and occur frequently (see Table 6.18). The surface area of the dike face is small relative to the remainder of Third Portage Lake.

Table 6.18: Summary of Residual Effects – Goose Island Dike

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Permanent	Frequent	NO
Fish	Low	Local	Permanent	Frequent	NO

The high value habitat created along the entire length of the dike face will compensate for the majority of the difference in lost shoreline habitat (NNL, 2005). The majority of the Goose Island dike will remain in place after mine closure as a permanent feature. During closure, the southern boundary of the dike will be decommissioned and removed, joining the Goose Island and Portage pits with the greater part of Third Portage Lake.

6.2.1.6 Residual Effects & Significance of Vault Dike

The Vault Dike separates Vault Lake from Wally Lake and is constructed across the narrow (10 m) 20 m long connecting channel. The existing channel is very shallow (0.5 m) and is comprised of large boulders. The channel completely freezes during winter. The Vault Dike will be approximately 250 m in length and will extend into Wally Lake, slightly increasing the existing shoreline length. The surface area of the dike below water will be small (230 m^2) and quite shallow, between 1 and 2 m. The dike surface will provide only a small amount of high value habitat (NNL, 2005) and is expected to provide a good medium for growth of periphyton and benthos during summer. Because of the shallow depth of water along the dike face, this will freeze during winter and will not provide suitable spawning habitat for fish.

Given the very small surface area of the dike below the water level, the magnitude of metals leaching from the dike exterior will be small. The Vault dike will be installed at Year 5 and will be removed at the end of mine life (Year 11), so the duration that the dike will be in place is relatively short.

Residual effects of the Vault dike on fish habitat and fish populations will be low in magnitude, local in extent, of short to medium duration, and will occur frequently (see Table 6.19). Given the small surface area of the dike face relative to Wally Lake, there is no significant adverse residual effect.

Table 6.19: Summary of Residual Effects – Vault Dike

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Medium-Term	Frequent	NO
Fish	Low	Local	Short-Term	Frequent	NO

6.2.2 Impact of Pit Development

6.2.2.1 Activity

Development of Meadowbank mine will require construction of four dikes that will impound four discrete areas of the project lakes, which will be developed as pits. Pit size and depth will increase over the life of the mine as ore is extracted, either for processing and disposal in the tailings pond, or as waste rock. The net impact to the project lakes is directly related to the loss of habitat area and relative quality of habitat lost within the pit areas, relative to the remaining habitat area and quality in the affected lakes. The pits themselves have no direct impact on the aquatic receiving environment over the life of the mine, once they have been dewatered. The pits and their dimensions are as follows:

- In Year -1, the East dike will impound 135 ha of Second Portage Lake, which represents 35% of the total surface area and 65% of the volume of Second Portage Lake (AMEC, 2003). Of this total, 94 ha, or 24% of the pit development is situated behind the West Dike (or tailings dike), which isolates the Northwest Arm of Second Portage Lake and contains the tailings pond and attenuation pond. Total lake volume eliminated within the Portage pit (Second Portage) and tailings/attenuation facilities are 2.6 Mm^3 (9.3% of lake volume) and 10.2 Mm^3 (46% of lake volume), respectively. The area behind the West dike (tailings dike) containing these ponds will be filled with tailings by the end of mine life and represent a permanent loss of fish habitat. The lake area east of the West dike, occupied by the Portage pit (41.5 ha), will be re-flooded upon mine closure and will be reoccupied by fish, as part of Third Portage Lake.

- In Year 1 the Bay Zone dike will be constructed, which will impound approximately 19.9 ha of Third Portage Lake, which is 0.5% of the total surface area of Third Portage Lake. In Year 5, the Goose Island dike will expand the affected area to allow development of the Goose Island pit. The Goose Island pit occupies approximately 73 ha of Third Portage Lake. Combined with the Bay Zone pit area (93 ha), this is 2.6% of the total surface area of Third Portage Lake.

- The combined lake surface area of the pits in Second Portage (135 ha) and Third Portage Lake (93 ha), relative to total surface area of both lakes (3983 ha) is 228 ha, or 5.7% of total lake area. The combined pit de-watering volume of Second Portage (12 Mm^3) and Third Portage Lake (2.6 Mm^3) relative to the total volume of both lakes (250 Mm^3) is 14.6 Mm^3, or 5.8% of total water volume.

- In Year 5 the Vault dike will be constructed which will result in the isolation of Vault and Phaser lakes from Wally Lake during mine life. Phaser Lake is 26 ha in size and is a shallow lake connected to Vault via a small rocky channel that is not passable by fish. The area and value of Phaser Lake has been quantified and the loss of this habitat will be accounted and compensated for in the compensation plan described in the NNL (2005) report. The impounded area of Vault (98 ha) and Phaser lakes (26 ha) is 124 ha, which is 18% of the combined area of Vault and Wally lakes. At mine closure, the Vault dike will be dismantled and the Vault pit will be flooded.

This section quantifies the lake area and habitat quality affected by the pit developments, and determines the overall significance of this habitat loss to the project lakes. Other impacts associated with pit development include the impacts of blasting and pit inflow water. Impacts to fish and fish habitat, from blasting to develop each pit during mine-life, are dealt with independently from this section and are described in detail in Section 6.3.3.

Pit inflow water (i.e., water that seeps into the pits though the dikes, from groundwater inflow or during precipitation events) will be pumped to the Second Portage attenuation pond, where it will be discharged to Third Portage Lake either untreated (prior to Year 5) or treated (after Year 5), after installation of a water treatment plant. Thus, there is no direct impact to Second Portage Lake from pit inflow water. Pit inflow water in Vault pit will be directed to the Vault attenuation pond, prior to being released to Wally Lake. Impacts of effluent quality are described in Section 6.2.5, Impact of Effluent Discharge.

Operation of the Portage pit will result in the permanent loss of one of the westernmost of the three channels connecting Second and Third Portage Lake. Impacts of loss of migratory habitat are also briefly described in Section 6.1.1, Impact of Dike Construction. Fish passage via the all of the connecting channels, including the westernmost channel is difficult or impossible during the open water season except possibly during spring freshet. The connecting channels are frozen during winter.

6.2.2.2 Mitigation

Mitigation of the loss of habitat area within the Portage, Goose Island, and Vault pits is described in detail in the NNL (2005) report. Mitigation efforts include a combination of the following activities:

- Water entering the Second Portage and Goose Island pits (dike seepage, groundwater infiltration, precipitation, and runoff) will be pumped to the Second Portage attenuation pond and treated prior to discharge.
- The exteriors of the East, Goose Island, and Vault dikes will be engineered to provide optimal habitat requirements to support periphyton and benthic communities, and spawning habitat for fish where other habitat parameters are also favourable (e.g., sufficient depth, grain size, exposure).
- At closure, the dike interiors of the West Dike (tailings dike), East dike and Goose Island dike will be engineered to provide optimal habitat for fish habitat elements and spawning by fish. Information gathered regarding habitat suitability during mine operations will be incorporated into the dike interior design.
- The connecting channel(s) between Second and Third Portage Lake will be enhanced to accommodate the consolidated discharge as well as to improve fish movement between the lakes, especially by Arctic char.
- Access by fish from Second Portage Lake to Dogleg Lake will be created. Dogleg Lake is 23 ha in size and has a small resident fish population. Currently, movement by fish between Dogleg Lake and Second Portage Lake is not possible. Creating a new channel will allow mixing of the two populations, increase genetic diversity and will optimize available habitat to fish from both lakes.
- Similar to the above, there are two small, unnamed lakes near Vault Lake that are connected to Wally Lake by inaccessible connecting channels. Consideration is being given to allowing reciprocal access by fish between these unnamed lakes and Wally Lake to compensate for loss of habitat area in Vault and Phaser lakes.
- Residual loss of habitat in the project lakes cannot be fully compensated for on-site (NNL, 2005). Consideration is being given to off-site habitat improvement of lakes or streams near the community of Baker Lake. This will provide greater long-term benefits to community residents than habitat improvements in an area that traditionally, has seldom been used as a fishing area (Traditional Knowledge Report, Cumberland 2005).

6.2.2.3 Residual Effect of Loss of Connecting Channel

Operation of the Portage and Goose pits will require that all water discharged from Third Portage to Second Portage Lake be directed through the remaining two smaller channels east of the East and Goose Island dikes. To accommodate the increased flow, the easternmost channel will be widened and deepened. This activity is also intended to facilitate or increase the potential for movement by fish, especially Arctic char, between the lakes. The implications of this are described in greater detail below and in the NNL (2005) report.

The residual impact to fish from loss of a single connecting channel is low in magnitude, local in extent, of medium duration, and frequent (see Table 6.20). The residual adverse effect is not significant. Certainty of this prediction is high. The hydraulic connection between Second and Third Portage lakes will be enhanced, which may facilitate movements of fish, especially Arctic char, between these lakes.

Table 6.20: Summary of Residual Effects – Connecting Channel

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish	Low	Local	Medium-term	Frequent	NO

6.2.2.4 Residual Effects & Significance of Portage Pit

Operation of the Portage pit will result in the effective loss of 41.5 ha, or 11% of the productive habitat area of Second Portage Lake during the life of the mine. Together with the lake habitat impounded behind the West Dike (tailings dike), this is in excess of 35% of the total lake area (and 65% of lake volume) of Second Portage Lake. Although the loss of habitat and fish biomass can be compensated for to some degree from on-site and off-site habitat compensation efforts, the residual magnitude of impact to habitat and fish populations in Second Portage Lake during mine operation is high. The spatial extent of the impact is local, of medium (fish populations) to long-term (habitat) in duration, and will occur frequently during operation; therefore, the residual effect is significant (see Table 6.21). Certainty of this prediction is high.

Table 6.21: Summary of Residual Effects – Portage Pit

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	High	Local	Long-term	Frequent	YES
Fish	High	Local	Medium-term	Frequent	YES

6.2.2.5 Residual Effects & Significance of Bay Zone/Goose Island Pit

Operation of the Bay Zone and Goose Island pits will result in the effective loss of 93 ha or 2.6% of the productive habitat area of Third Portage Lake during the life of the mine. Enhancement of dike exteriors along the 2 km long dike will compensate for part of the lost habitat area along the shorelines eliminated by the pit. The residual magnitude of impact to habitat and fish populations during mine operation is considered low because of the small area of habitat affected by the pit relative to available habitat area in Third Portage Lake. No important or critical habitat is eliminated within the Goose Island pit that does not exist in abundance elsewhere in Third Portage Lake (NNL, 2005). The spatial extent of the impact is local, of medium (fish populations) to long-term (habitat) in duration and will occur frequently during operation (see Table 6.22). The residual impact is not significant. Certainty of this prediction is high.

Table 6.22: Summary of Residual Effects – Goose Island Pit

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Long-term	Frequent	NO
Fish	Low	Local	Medium-term	Frequent	NO

6.2.2.6 Residual Effects & Significance of Tailings Pit

The West Dike (tailings dike) will impound 93 ha (25% of total lake area) and 46% of the water volume of Second Portage Lake to create the Tailings pit. During the course of mine development, this area will function as an attenuation pond and as a tailings disposal facility prior to Year 5. Between Year 5 and mine closure, the entire lake area behind the West dike will be filled with tailings and will be permanently lost as fish habitat. Improvements made to increase available habitat, such as Dogleg Lake, to increase the potential for fish movement between Second and Third Portage lakes via the enhancement of an existing connecting channel, or to provide off-site habitat compensation may not fully compensate for the loss of habitat occupied by the tailings disposal area or pit during operations.

At mine closure, habitat along the exterior of the tailings dike will be enhanced as compensation for lost habitat area and for the re-flooded pit, which is considered low value habitat (NNL, 2005). The loss of 135 ha of habitat in Second Portage Lake is significant relative to fish production in Second Portage Lake. However, most of the affected habitat (98 ha) is low value habitat because of the very deep depth in most of the Northwest Arm. Only 27% of this area (37 ha) rated was high or moderate value habitat, which is less than 10% of total lake area. Furthermore, given (1) that more combined habitat will be created at closure than lost, and (2) the improved hydraulic connection between Second and Third Portage lakes, it could be argued that habitat loss/gain within both lakes should be combined and evaluated together. Thus, the combined habitat area affected by pit development in Second Portage (135 ha) and Third Portage Lake (93 ha), relative to total surface area of both lakes (3983 ha) is 228 ha or 5.7% of total lake area. This would render the impact magnitude as low (even without a net gain in habitat at closure) which would result in residual adverse effects as not significant: therefore, the magnitude of the residual impact of permanent elimination of habitat behind the West Dike (tailings dike) is high. The spatial extent of residual impacts is local, of permanent duration, and will occur frequently The residual impact is significant to Second Lake but not to the system taken as a whole. Certainty of this prediction is high. (see Table 6.23).

Table 6.23: Summary of Residual Effects – Tailings Pit

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	High	Local	Permanent	Frequent	YES/No
Fish	High	Local	Permanent	Frequent	YES/No

6.2.2.7 Residual Effects & Significance of Vault Pit

The Vault dike will impound Vault Lake (98 ha) and Phaser Lake (26 ha), which is 18% of the total area of Wally and Vault lakes (797 ha). The majority of the habitat affected by the pit development in Vault Lake was rated as high (59 ha; 60%) because of the complex boulder shoal habitat of moderate depth (<4 m). After Year 5, when the pit is dewatered, part of the former lake will function as an attenuation pond and will not be available to fish. To replace lost habitat, the dike exterior will be enhanced, although the surface area of the dike exterior is small (240 m^2) and will not compensate for the loss. Consideration is being given to excavating a channel to connect two small lakes adjacent to Vault Lake to Wally Lake to increase habitat accessible by Wally Lake fish. Nevertheless, these efforts will not completely compensate for the lost habitat during pit operation.

At mine closure, the dike will be decommissioned and removed, allowing the lake to refill; however, given the great depth of the pit, the productivity of the habitat regained will be inferior to the existing habitat and there will be a net loss of habitat quality in Vault and Wally lakes. Given the amount and quality of the habitat lost during mine operation (up to 18%) and post-closure, the magnitude of residual impact of habitat loss within the Vault pit is medium, of local spatial extent, medium (fish) to long (habitat) duration, and will occur frequently (see Table 6.24). Residual adverse effects are not significant. Certainty of this prediction is high.

Table 6.24: Summary of Residual Effects – Vault Pit

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Medium	Local	Long-term	Frequent	No
Fish	Medium	Local	Medium-term	Frequent	No

6.2.3 Impact of Rock Storage Facilities

6.2.3.1 Activity

The Vault and Portage rock storage facilities will receive waste rock from their respective pits. This will occur year-round; however, as described in Section 6.1, drainage ditches encircling each storage facility will collect and redirect all contact water runoff to attenuation ponds at each mine site. There will, therefore, be no contact between low pH, acid-contaminated water and aquatic receiving environments. In addition, permafrost is expected to migrate upwards, gradually freezing the core of the Vault and Portage rock storage facilities. At closure, this will further reduce the likelihood that metals will leach out of the rock storage facilities and migrate to surface or groundwater. Note that the Portage waste rock pile will also be capped with low-metal-leaching ultramafic rock during post-closure. The Vault waste rock pile will consist of non-metal leaching rock and will not require capping.

6.2.3.2 Mitigation

To minimize or eliminate impacts to fish and fish habitat due to operation of the Portage and Vault storage facilities, the following mitigation will be implemented:

- All rainfall, snowmelt, and leachate from the waste rock piles will be directed to either the Vault or Second Portage attenuation pond via perimeter ditches designed to contain runoff under 1:100 year flood conditions.

- Post-closure capping of Portage waste rock pile with low metal-leaching and low acid-generating-potential rock.

6.2.3.3 Residual Effect & Significance of Runoff from Rock Storage Areas

The mitigation strategy will ensure that fish habitat and fish populations are protected from low pH or water with elevated metals concentrations by eliminating the potential pathway between contact water and aquatic receiving environments. Mitigation has reduced the magnitude, duration, and frequency of impacts, resulting in negligible ecological effects to the fish and fish habitat. Residual effects are considered low in magnitude, local in extent, of short-medium duration, and occur rarely during operation (see Table 6.25). Residual effects are not significant. Certainty of this prediction is high.

Table 6.25: Summary of Residual Effects – Rock Storage Facility

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Medium-term	Rare	NO
Fish	Low	Local	Short-term	Rare	NO

6.2.4 Impact of the Turn Lake Crossing

6.2.4.1 Activity

Turn Lake Crossing will allow the access road to pass over the constriction in the lake connecting Turn and Drilltrail lakes. It will have two 2.5 m diameter culverts to allow water movement underneath the access road, with coarse substrate deposited along the bottom to provide new habitat and encourage culvert use. The culverts at Turn Lake Crossing will be engineered to pass a 1:100 year flood event. Also, maximum water velocity through the culverts during spring freshet will not exceed 0.6 m/s. This velocity is slow enough to permit movements by subcarangiform fish (lake trout, whitefish, and char) within the culvert at all times.

The crossing will create shading along nearby fish habitat (and within culvert habitat), thereby reducing primary productivity. Erosion of stream banks along the crossing will be avoided through the installation of riprap.

6.2.4.2 Mitigation

The use of properly sized and installed culverts will negate residual effects to fish movements or fish habitat. Culverts will be large enough in width to contain waters under normal, freshet, and flood conditions and will ensure that discharge velocity within the culvert will not prevent upstream movement by fish. There are no spring spawning fish within the Quoich River watershed and there are no defined migrations by fish. Lake trout, round whitefish, and Arctic char may move between Turn Lake and Drilltrail Lake; however, their movements are occasional and are not timed with season or any particular life history requirement such as spawning or overwintering (BAEAR, 2005).

Riprap will be used to ensure the protection of shoreline banks from erosion and to provide complexity to habitat. In addition, a layer of coarse gravel and stone will be placed inside the entire length of the culverts to a depth of 0.5 m. This will provide sufficient cover habitat within the bottom of the culverts to reduce avoidance by fish passing through the culverts. A layer of very coarse material will also be placed at the approaches to the culverts to provide habitat similar to that inside the culverts to facilitate fish movement. These coarse materials also will provide suitable habitat for periphyton and benthic colonizers.

Fish movement during summer will be monitored both upstream and downstream of the culverts using hoop nets. Fish captured in a hoop net will be tagged with a small Floy tag. Observations of tagged fish at both ends over time will reveal whether or not fish travel through the culverts. Impairment of fish movement through the culverts is not anticipated. Note that the culverts and crossing will be removed once the mine is closed.

6.2.4.3 Residual Effect & Significance of Turn Lake Crossing During Operation

The use of riprap and proper construction procedures will mitigate the effects of bank erosion to a low level. Mitigation will also ensure that fish movements are not impeded and that lost habitat is compensated for through the careful design of new habitat along the outsides of the Turn Lake Crossing and within the culvert itself. Targeted monitoring of fish passage through the culverts (see AEMP, 2005) will ensure that fish were not adversely affected by the crossing.

Residual effects related to the Turn Lake Road Crossing during mine operation will be low in magnitude, local in extent, of medium-long duration, and will occur infrequently or rarely (see Table 6.26). Residual effects are not significant in both cases and certainty of this prediction is high.

Table 6.26: Summary of Residual Effects – Turn Lake Road Crossing During Operation

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Long-term	Infrequently	NO
Fish	Low	Local	Medium-term	Rarely	NO

6.2.5 Impact of Effluent Discharge on Receiving Environment Water Quality & Fish

6.2.5.1 Activity

Two effluent sources will be discharged from attenuation ponds to Meadowbank project area aquatic receiving environments. From the Northwest Arm of Second Portage Lake to the North Basin of Third Portage Lake and from the Vault attenuation pond to Wally Lake. Monitoring of effluent from both sources is subject to the MMER. A detailed description of the study design for effluent monitoring at Meadowbank is provided in the MMER (2005) framework report, which describes routine testing for chemistry, toxicity testing, and receiving environment Environmental Effects Monitoring (EEM) studies (benthos and fish survey).

Effluent will be discharged to each of the receiving environments via an 18” HDPE pipe. The pipe will be anchored along the bottom and the end of pipe will be situated at least 50 m away from coarse shoreline substrate or shoal habitat in at least 10 m of water. The end of pipe will have a diffuser to maximize dilution of effluent into the receiving environment. Effluent will be directed away from any sensitive habitats.

Effluent discharged to Wally Lake and North Basin Third Portage Lake consists of a mixture of contact water originating from mine infrastructure-related sources (waste rock seepage and runoff, pit inflow water, runoff from waste rock piles, and drainage water collected from road and airstrip ditches) and local non-contact drainage resulting from precipitation. In addition, the Second Portage attenuation pond will receive all grey water, sewage, and water discharged to the tailings impoundment area. The tailings impoundment area is situated between the attenuation pond and the tailings dike.

The tailings impoundment area has sufficient capacity to absorb all tailings discharge up to Year 5 of operation, after which time the attenuation and tailings pond will be combined, and the effluent discharged to North Basin Third Portage Lake will consist of a mixture of the two. Prior to Year 5, therefore, mine effluent is not expected to contain contaminants or other constituents that exceed MMER water quality guideline concentrations, and no water treatment plant is planned until Year 5. Because no tailings are being discharged to the Vault attenuation pond, no exceedances of MMER guidelines are anticipated and no water treatment plant will be required. Routine monitoring will be conducted to ensure compliance (MMER, 2005).

It is important to note that effluent will be discharged to the receiving environment only during open water season, between early July and mid- to late-October; effluent will not be discharged under ice.

Mine construction and operation activities may introduce a wide range of potentially deleterious substances into aquatic receiving environments. Effluent discharge is potentially the single greatest source of contaminants from mines. This is recognized by the MMER, which regulates the deposition of a select group of metals, notably arsenic, copper, cyanide, lead, nickel, and zinc, as well as total suspended solids (TSS) and radium 226.

The routine MMER program requires that the mine undertake the following studies:

- weekly chemical analysis of effluent for pH and the suite of deleterious substances

- monthly testing of acute lethality of effluent to rainbow trout (*Oncorhynchus mykiss*) and the water flea (*Daphnia magna*)
- weekly or continuous measurement of effluent flow rates to derive an estimate of loading
- calculation of mass loadings of deleterious substances to receiving environments.

In addition, the Environmental Effects Monitoring (EEM) program under MMER requires that regular monitoring of possible impacts to receiving environment waters be carried out. Specifically, the EEM program comprises two parts:

- Part 1 – Effluent and water quality monitoring studies intended to provide background supporting information for the assessment and interpretation of biological monitoring (see below). This component includes effluent characterization, sublethal toxicity testing, and water quality monitoring.

- Part 2 – Biological monitoring studies, including a site characterization, a fish survey (using indicators of fish population health and fish tissue analysis), and a benthic invertebrate community survey.

A detailed framework study design has been compiled for the Meadowbank project and has been included as a separate document (MMER, 2005). This document describes how the MMER will be implemented at Meadowbank to ensure compliance with the regulations.

The primary contaminants discharged to Third Portage North Basin from the Second Portage Lake attenuation pond (especially after Year 5) consist of metals, TSS, and nutrients. Concentrations of total and dissolved metals in the project lakes are very low and are consistently below detection limits and almost never exceed CCME guideline concentrations (CCME, 2001). Dissolved metal concentrations compose the vast majority of total metals concentrations in project lakes where results exceed detection limits, indicating that nearly all metals are dissolved and not associated with particulates (BAEAR, 2005).

Sediment is an important sink for most contaminants, including metals. Contaminants entering aquatic systems via tributary streams or directly from local sources (e.g., effluents, dikes, non-contact water) are often associated with suspended particulate matter in the water column. Particulates eventually settle in depositional areas as sediment, especially in deeper areas of lakes. Also, sediments can scavenge metals from their dissolved phase; the degree to which sediments function this way depends on the contaminant and physical condition of the environment (temperature, redox, pH, grain size, etc.).

Measuring water for the presence of contaminants, such as metals, is not necessarily as indicative as measuring sediments, because sediments provide a long-term, temporal record of deposition, integrating concentrations over time. Low concentrations of water-borne contaminants that may meet relevant water quality criteria may ultimately be associated with elevated concentrations in sediments that exceed sediment quality guidelines. Given sediments can become a sink as well as potential source and exposure pathway to aquatic biota, they are an important aspect of water quality.

For the project lakes' baseline, when sediment metals concentrations were compared against CCME (2001) guidelines for arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc, several guideline concentrations were exceeded (BAEAR, 2005), despite the pristine nature of the lakes. Arsenic, chromium and nickel in project lakes exceeded “probable effects concentrations” (CCME (2001) in nearly all lakes over all years that sediment was collected in baseline studies, while cadmium, copper and zinc concentrations exceeded “interim sediment quality guidelines” at the majority of lakes in most years. Note that exceedances of these guideline values does not imply that adverse effects have occurred or are expect to occur, such would need to be evaluated through site-specific studies. Natural mineralization can result in elevated metals concentrations in sediment. Also, the chemical form that many metals exist in sediment makes them unavailable for uptake or accumulation by biota.

The total annual and monthly volume of effluent discharged to Wally Lake, with the exception of dewatering, is consistent over mine life and averages 0.08 m^3/s. Total average annual discharge is approximately 391,500 m^3, which is equivalent to 1.4% of the volume of the receiving environment, Wally Lake.

Instantaneous annual discharge to Third Portage Lake North Basin is predicted to be 0.13 m^3/s in Year 1, 0.15 m^3/s in Year 3, 0.18 m^3/s in Year 5 and 0.22 m^3/s in Year 11 of mine life. Maximum annual average discharge in Year 11 is 2.13 Mm^3, which is 2.5% of the volume of the North Basin of Third Portage Lake or 1.6% of the combined volume of the North and East basins. Water from the North Basin will be further diluted by water moving from the South Basin before entering the East Basin, and eventually Second Portage Lake.

It is difficult to determine or predict how effluent discharged into the North Basin of Third Portage Lake will affect water quality in the basin, and, ultimately fish and their habitats in the wider area over time. Modeling of water quality in the receiving environment water bodies has been used to make predictions of whole lake changes in water quality in Third and Second Portage lakes over mine life using conservative assumptions. This work considers metals inputs from dikes and the treated effluent discharge; however, the effluent discharge is by far the greatest contributor of metals.

Key conclusions of water quality modelling can be found in the Physical Ecosystem Impact Assessment included as part of this documentation series. Assessment of potential impacts to fish habitat and populations from changes to receiving environment water quality as a result of effluent discharge is based on information provided there. Receiving environment water quality will change over time as some metals (e.g., cadmium, chromium and copper) may exceed CCME guideline concentrations. However, the vast majority of other metals are not expected to exceed guidelines because of the very low ambient concentration of metals in the lakes and the tremendous dilution potential. Predicted changes in water quality in Wally Lake are generally less than in Third Portage and Second Portage Lakes, because no tailings water will be released to Wally Lake.

It is well known that exceedances of CCME guidelines do not necessarily mean that adverse effects will be observed. CCME guidelines, by definition, are guideline concentrations. Metals concentrations below guideline values typically do not result in adverse effects while exceedances of guideline values may or may not result in effects and depend on many factors including pH, hardness, water temperature, synergistic effects, and acclimatization by biota. There are several targeted studies described within the AEMP (2005) directed at determining whether changes to water quality is having adverse impacts on biomass and productivity of lower trophic level biota and fish. In addition, MMER and environmental effects monitoring studies will be implemented over the course of mine life to determine if adverse effects can be detected and to undertake changes to water treatment if necessary.

6.2.5.2 Mitigation

Following are the major mitigative measures being implemented at Meadowbank to minimize impacts to water quality in the receiving environments of Third Portage and Wally lakes:

- Isolation of a portion of Vault Lake and the Northwest Arm of Second Portage Lake to function as attenuation ponds (Year 0 to 5) will reduce suspended solids, nutrient, and metals concentrations in effluent prior to discharge to Wally Lake and Third Portage Lake, respectively. Monitoring of the effectiveness of the attenuation ponds will be undertaken as part of the AEMP (2005).
- All water discharged from the mine/mill site, sewage treatment facility, and the Second Portage attenuation pond will be directed through a water treatment facility after Year 5 before being discharged to Third Portage Lake North Basin. Water quality parameters will meet or exceed MMER criteria for metals and suspended solids. Vault effluent will be treated, if required, based on MMER monitoring.
- Effluent will only be discharged during the open water season and not under ice.
- A diffuser will be installed to maximize effluent dilution.
- Effluent will be directed offshore of Wally Lake and Third Portage Lake, in deep water away from any sensitive habitat.

6.2.5.3 Residual Effect & Significance of Effluent Discharge on Receiving Environment Water Quality & Fish

Vault Lake – The volume of effluent discharged from the Vault attenuation pond to Wally Lake is small (0.08 m^3/s) and constitutes a small portion of the receiving environment volume of Wally Lake (1.4% annually). Furthermore, effluent is uncontaminated by mine-related facilities, with the exception of the Vault waste rock facility, and is predicted to have only minor exceedances of CCME guidelines for arsenic. Given the small volume and minor exceedances of guidelines, residual impacts to fish habitat and fish populations from metals, TSS, and nutrients in Wally Lake are low in magnitude, local in spatial extent, long-term in duration, and occur frequently. As shown in Table 6.27, residual impacts are not significant. Certainty of this prediction is moderate.

Table 6.27: Summary of Residual Effects – Vault Effluent

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Medium	Local	Long-term	Frequent	NO
Fish	Medium	Local	Medium-term	Frequent	NO

Third Portage Lake – Prior to Year 5, effluent will consist of contact water from roads, ditches, pit water, mill site water, and runoff from the Portage waste rock pile. Given the small annual volume relative to receiving environment volume (maximum 1.6% prior to Year 5) and the relatively uncontaminated nature of the effluent, impacts to fish habitat and fish populations in Third Portage

Lake are expected to be low in magnitude, local in spatial extent, medium to long-term in duration, and occur frequently. Residual impacts are not significant. Certainty of prediction is moderate.

After Year 5, water from all sources, including water used to transport tailings, will be discharged to Third Portage Lake North Basin. This will require installation of a water treatment plant to reduce metals, cyanide, and nutrient concentrations below MMER criteria. The lower the contaminant loading, the lower the likelihood that adverse effects will occur.

Worst-case modeling of water quality Third Portage Lake North Basin did not show significant increases for the vast majority of metals; therefore, impacts to fish and fish habitat from impaired water quality are expected to be moderate in magnitude, local in extent, medium to long-term in duration, and occur frequently (see Table 6.28). Although no discharge occurs under the ice, impaired water quality will persist and may interact with sensitive periods for fish (e.g., spawning and egg incubation). Thus, assuming a precautionary principle, residual adverse effects may be significant. Certainty of this prediction is low.

Table 6.28: Summary of Residual Effects –Effluent Discharge on Receiving Environment Water Quality & Fish

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat < Year 5	Low	Local	Long-term	Frequent	NO
Fish < Year 5	Low	Local	Medium-term	Frequent	NO
Fish Habitat > Year 5	Medium	Local	Long-term	Frequent/Sensitive	YES
Fish > Year 5	Medium	Local	Medium-term	Frequent/Sensitive	YES

6.2.6 Impact of Freshwater Consumption

6.2.6.1 Activity

All freshwater for the Meadowbank project (e.g., potable water, mine process water, dust suppression) will be collected via a submerged intake pipe with intake screen situated 75 m offshore in 10 m water depth from the north basin of Third Portage Lake. The opening to the pipe will be at least 0.5 m off of the bottom. Freshwater will be drawn from the lake at a continual rate of approximately 21 L/s. Maximum potential water withdrawal rate is 130 L/s.

6.2.6.2 Mitigation

The following mitigation measures will be implemented to minimize impacts to fish and fish habitat:

- The intake pipe will be situated at least 25 m from the nearest rocky shoal or shoreline. Small or juvenile fish are not usually found away from the protection or rocky shoals or shorelines because of vulnerability to predation by lake trout. Siting the intake in deep water away from cover habitat will minimize the risk of entrainment.

- The intake will operate at a water depth of at least 8 m and sit 0.5 m off of the bottom above silt/clay sediment away from shorelines or shoals.

- The intake will incorporate Department of Fisheries and Oceans (1995) design features to minimize entrainment of fish by reducing intake velocity and incorporating a 1.5 mm screen at the intake. DFO (1995) fish screen guidelines stipulate that given the predicted maximum intake volume of approximately 0.13 m^3/s; based on instantaneous flow calculated from an average monthly intake volume of 55,600 m^3), the minimum surface area at the intake must be 1.16 m^2, not including additional area to account for the type of mesh screen used at the intake. Assuming that a 1.5 mm wire screen is used, this would increase the minimum intake opening to 1.78 m^2. This is sufficient to reduce intake velocity to prevent entrainment and impingement of fish on the screen.

6.2.6.3 Residual Effect & Significance

Entrainment and impingement of fish and aquatic life over mine operation will be minimized through appropriate siting and design of the intake structure. Impact of entrainment of fish is negligible. The residual effects of water withdrawal from Third Portage Lake are low in magnitude, local in extent, of medium-long duration (depending on life span of the VEC), and occur frequently during operations (see Table 6.29). Residual adverse effects are not significant. The certainty of this prediction is high.

Table 6.29: Summary of Residual Effects – Operation of Freshwater Intake

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Long-term	Frequent	NO
Fish	Low	Local	Medium-term	Frequent	NO

6.3 IMPACT OF GENERIC ACTIVITIES

6.3.1 Impact of Mine Site Infrastructure Operation

6.3.1.1 Activity

As discussed in Section 6.1, the majority of mine site infrastructure facilities (borrow pit/ quarry, mine plant and facilities (offices, storage), non-contact diversion facility, fuel storage and power-generating facilities, emulsion/ ammonium nitrate (AN) storage/explosives magazines, camps (north and south), and sewage and solid waste disposal) will have no residual adverse effects on fish or fish habitat. Facilities will be situated far from receiving environment water bodies and will not produce related stressors that could be transmitted into aquatic systems under normal operations. The rare situation involving a spill has been considered separately (see Spill Contingency Plan).

The only possible exceptions are use of roads and the airstrip. Heavy trucks will be used to transport mined ore-bearing rocks to the Portage mill facility throughout the year. The dispersion of dust and hydrocarbon by-products from vehicle emissions and roads will occur on a regular basis along the road network, entering the local lake system directly via aerial transmission, or indirectly, during spring melt and rain events as surface runoff from land into water bodies.

Air traffic is the sole transport connection between Baker Lake and the Meadowbank project area during summer. Incoming and departing flights will occur regularly throughout the year, during all seasons. Dust generated during takeoff and landing of aircraft is a potential source of particulates and hydrocarbons to aquatic habitats through aerial deposition.

6.3.1.2 Mitigation

Mitigation of mine site infrastructure facilities whose effects were deemed to be negligible (see Section 6.1) will also apply to these same facilities in the operations phase.

To reduce potential adverse effects associated with roads and airstrip traffic during operation, the following mitigation measures will be implemented:

- Drainage ditches will capture surface runoff from the airstrip, mill site, and from roads, eliminating the pathway between terrestrial and aquatic environments.
- A system of collection ditches will redirect all contact water into the Second Portage attenuation pond where it will be treated (after Year 5) prior to discharge to Third Portage Lake.
- Regular application of water for dust control on roads and the airstrip during summer will considerably reduce dispersion of airborne particulates.
- Refuelling of trucks and other equipment will be conducted at least 100 m away from the nearest waterbody.
- Double-walled tanks will be used to store fuel products. Containers will be surrounded by berms of sufficient capacity to hold the container volume.
- An on-site environmental monitor will routinely inspect collection systems and ditches to ensure that the collection and diversion systems are functioning as designed.
- Routine environmental monitoring (see AEMP, 2005) will allow early detection of changes during operation.
- Spills and contingency plans will be implemented if necessary.

6.3.1.3 What is the Residual Impact of Mine Site Infrastructure during Operation?

Minor, seasonal inputs of air-borne dust to receiving water bodies are possible despite mitigation efforts. The residual effects operation of roads and airstrip operation will be low in magnitude, local in extent, of short duration, and will occur infrequently or rarely (see Table 6.30). Residual effects are not significant in both cases. Certainty with respect to mitigation and residual effects is high.

Table 6.30: Summary of Residual Effects – Mine Site Infrastructure Operation

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Short-term	Infrequently	NO
Fish	Low	Local	Short-term	Rare	NO

6.3.2 Impact of the Turn Lake Crossing

6.3.2.1 Activity

Turn Lake Crossing will allow the access road to pass over the constriction in the lake connecting Turn and Drilltrail lakes. It will have two 2.5 m diameter culverts to allow water movement underneath the access road, with coarse substrate deposited along the bottom to provide new habitat and encourage culvert use. The culverts at Turn Lake Crossing will be engineered to pass a 1:100 year flood event. Also, maximum water velocity through the culverts during spring freshet will not exceed 0.6 m/s. This velocity is slow enough to permit movements by subcarangiform fish (lake trout, whitefish, char) within the culvert at all times; however, because of their length and dark environment, culverts may be avoided by fish, particularly visual feeders such as lake trout, which are the dominant fish of these lakes.

The crossing will create shading along nearby fish habitat (and within culvert habitat), thereby reducing primary productivity. Erosion of stream banks along the crossing will be avoided through the installation of riprap.

6.3.2.2 Mitigation

The use of properly sized and installed culverts will negate residual effects to fish movements or fish habitat. Culverts will be large enough in width to contain waters under normal, freshet, and flood conditions and will ensure that discharge velocity within the culvert will not prevent upstream movement by fish. There are no spring spawning fish within the Quoich River watershed and there are no defined migrations by fish. Lake trout, round whitefish, and Arctic char may move between Turn Lake and Drilltrail Lake; however, their movements are occasional and are not timed with season or any particular life history requirement such as spawning or overwintering (BAEAR, 2005). Construction methods are described in Section 6.1.6.

Riprap will be used to ensure the protection of shoreline banks from erosion and to provide complexity to habitat. In addition, a layer of coarse gravel and stone will be placed inside the entire length of the culverts to a depth of 0.5 m. This will provide sufficient cover habitat within the bottom of the culverts to ensure that fish are not deterred from passing through the culverts. A layer of very coarse material will also be placed at the approaches to the culverts to provide similar habitat as inside the culverts to facilitate fish movement. These coarse materials also will provide suitable habitat for periphyton and benthic colonizers.

Fish movement during summer will be monitored both upstream and downstream of the culverts using hoop nets. Fish captured in a hoop net will be tagged with a small Floy tag. Observations of tagged fish at both ends over time will reveal whether or not fish travel through the culverts. Impairment of fish movement through the culverts is not anticipated. Note that the culverts and crossing will be removed once the mine is closed.

6.3.2.3 Residual Effect & Significance of Turn Lake Crossing during Operation

The use of riprap and proper construction procedures will mitigate the effects of bank erosion to a low level. Mitigation will also ensure that fish movements are not impeded and that lost habitat is compensated for through the careful design of new habitat along the outsides of the Turn Lake

Crossing and within the culvert itself. Routine monitoring of fish passage through the culverts (see AEMP, 2005) will ensure that fish were not adversely affected by the crossing.

Residual effects related to the Turn Lake Road Crossing during mine operation will be low in magnitude, local in extent, of medium-long duration, and will occur infrequently or rarely (see Table 6.31). Residual adverse effects are not significant in both cases and certainty of this prediction is high.

Table 6.31: Summary of Residual Effects – Turn Lake Road Crossing

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Long-term	Infrequently	NO
Fish	Low	Local	Medium-term	Rarely	NO

6.3.3 Impact of Blasting

6.3.3.1 Activity

The federal *Fisheries Act* includes provisions for the protection of fish and their habitats from the detonation of explosives within or adjacent to waters frequented by fish. The detonation of explosives in the vicinity of fish-bearing waters has been demonstrated to cause disturbance, injury and/or death to fish, and/or the harmful alternation, disruption, or destruction of their habitats, sometimes at a considerable distance from the point of detonation.

Construction and operation of the several mine site facilities will require intermittent blasting for a number of purposes, including: acquisition of material for construction of dikes, road construction, site preparation, overburden removal, development of the pits, and pit mining itself. While most of the blast activities will occur under conditions that will not result in direct mortality on fish, the construction of de-watering dikes and blasting for pit excavation both occur in proximity to fish habitat and fish populations and hence have the greatest potential for impacts.

The detonation of explosives in or near water produces post-detonation compressive shock waves that can be harmful to fish and fish eggs. The shock waves are characterized by a rapid rise to a peak pressure, followed by a rapid rebound to below ambient hydrostatic pressure (Wright and Hopky, 1998). The rapid fall in pressure causes most impacts to fish. Vibrations from the detonation of explosives may cause damage to incubating eggs.

Wright and Hopky (1998) reviewed the mechanisms of blasting effects, their regulatory context, and provide specific guidance on interpretation and application of the guidelines. These guidelines represent the standard as applied by Canada’s Department of Fisheries and Oceans (DFO). Briefly, the primary site of damage to fish is the swimbladder (the gas-filled organ that permits most pelagic fish to maintain neutral buoyancy). The kidney, liver, spleen, and sinus venous may also rupture and haemorrhage. Fish eggs and larvae may also be killed or damaged.

Wright and Hopky (1998) stated that, “no explosive is to be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change greater than 100 kPa in the swimbladder of a fish, and no explosive may be used that produces or is likely to produce, a peak particle velocity greater than 13 mm/s in a spawning bed during egg incubation." Peak particle velocity (PPV) is measured in units of mm/s and overpressure is measured in units of kPa. The degree of damage to fish is related to the type of explosive, size and pattern of charges, method of detonation, rock density through which the force travels, distance from the point of detonation (setback), water depth, fish species, and size and life history stage.

To determine potential impacts to fish and fish habitat, theoretical PPVs generated at Meadowbank were modeled at points along the proposed de-watering dikes using a US Bureau of Mines' estimate method. The preliminary estimates are based on the current understanding of the proposed mine and its development, and estimate some variables based on published values. Preliminary PPV estimates vary at different locations (e.g., various dikes, and locations relative to pit centre, dike crest, and shoreline) and with the charge weight per delay. Analysis of the blast design predicts that estimates of instantaneous pressure change (kPa) should not exceed DFO (Wright and Hopky, 1998) guidelines during mine development. Note that direct in-water blasting is not anticipated and physical alteration of fish habitat due to blasting is not expected.

6.3.3.2 Mitigation

Mitigation strategies will include various combinations of the following measures:

- reduction in charge weight (kg) to reduce the force of the detonation
- lower bench heights on the face nearest aquatic habitats will result in lighter charge weights which will reduce the required setback distance to achieve guideline thresholds
- modify the blasthole patterns or blasthole size and hence charge weight in critical areas
- modify the millisecond delays. Increasing the time between detonations of consecutive blast holes minimizes the additive effect generated by synchronous detonation of adjacent or sequential holes
- increased upstream (lakeside) dike width in areas where the DFO overpressure or vibrations guidance cannot be met, thereby increasing the setback distance from the blasting. In particular, this might be needed in the pit-face blasting area, near the aquatic environment (proposed set-back is 80 m).

In some cases it may be impossible from an engineering perspective to construct the proposed de-watering dikes at the minimum setback distances to protect fish. During detailed engineering design, the final alignment of the proposed de-watering dikes will be assessed further to consider, among other items, the minimum setback required to minimize the impact of detonation on the potential fish habitat along the lakeside dike faces.

6.3.3.3 Residual Impact & Significance of Blasting

Preliminary analysis of the blast design during construction phase indicated that impacts to fish from excessive PPV along the dike exteriors of the Portage and Goose pits can be managed and minimized, but not necessarily eliminated. Estimated minimum setback distances, below which the 100 kPa overpressure guideline will not be exceeded to ensure that, to a great extent, the DFO guidelines (Wright and Hopky, 1998) can be met in Second and Third Portage lakes. PPV values will not exceed the guideline of 13 mm/s on the lakeside of the dikes.

The distance between blasting activities associated with development of the Vault pit and fish-bearing waters of Wally Lake is greater than the Portage lakes; therefore, it is not expected that overpressure or velocity guidelines will be exceeded in Wally Lake.

It is expected that experience from the construction phase will direct mitigation requirements during the operations phase to reduce the likelihood of impacts to fish in the Portage lakes. A benefit of the adaptive approach used to monitor and adjust blasting during the construction phase will establish, if merited, a defensible targeted monitoring framework for the operational phase of the mine (see AEMP, 2005). The implications of various blasting scenarios will enhance our understanding of the relationship between blast designs and PPV and overpressure, so it is likely that appropriate mitigation will have been identified and already used as standard procedure.

Given the reasonably good understanding of the blast design and implementation of mitigation measures to eliminate or reduce impacts of overpressure and velocity in Second and Third Portage lakes, the residual impacts are expected to be small.

Residual effects related to blasting during mine construction and operation will be low in magnitude, local in extent, of medium-long duration, and will occur frequently (see Table 6.32). Residual effects are not significant. The level of certainty of this prediction is high.

Table 6.32: Summary of Residual Effects – Blasting

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Long-term	Frequent	NO
Fish	Low	Local	Medium-term	Frequent	NO

6.3.4 Impact of Worker Fishing

6.3.4.1 Activity

Cumberland Resources is proposing a no-fishing policy, in accordance with a recommendation made in the Terms of Reference for the project; however, it is recognized that local aboriginal people may periodically exercise their rights to fish within the study lakes during the life of the project.

6.3.4.2 Mitigation

To minimize the number of fish captured and retained by sport-fishers and Inuit workers, the following measures will be implemented:

- Cumberland Resources will adopt and enforce a no-fishing policy for its employees while working on the job site.
- All staff will be informed about the no-fishing policy and provided with an educational presentation targeting conservation issues.

- Periodic creel surveys will be carried out to assess harvest rates of fish captured by local Inuit, if they choose to fish. Data gathered from carcasses will be used as part of the core monitoring program. Fish will be autopsied and tissue samples collected for analysis of tissue metals concentrations.
- An on-site environmental monitor will monitor fishing activities, if any.

6.3.4.3 Residual Effect & Significance of Worker Fishing

Implementing the mitigation measures listed above will minimize or prevent fish harvesting, resulting in negligible impacts to fish populations. Therefore, we have assumed that the residual effects would be low in magnitude, local in extent, of medium duration, and would occur infrequently during open-water season (see Table 6.33). Potential residual effects are deemed not significant. Effects will also be reversible at mine closure. The level of certainty with respect to mitigation is moderate.

Table 6.33: Summary of Residual Effects – Worker Fishing

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish	Low	Local	Medium-term	Infrequent	NO

6.3.5 Impact of Ancillary Infrastructure Facilities at Baker Lake

6.3.5.1 Activity

Several facilities will be constructed and operated at or near Baker Lake in order to facilitate the construction and operation phases of the Meadowbank project to the north. These include:

- marine barge landing facility
- marine transport
- Baker Lake access roads
- Baker Lake staging facility
- explosives magazine and tank farm.

The facility is approximately 2 km east of the community of Baker Lake, Nunavut. To provide access by barges to the facility, a ramp will be constructed, extending from about 1 m depth below water and 10 m offshore towards the shoreline to connect with a road. The approximate area of the barge landing facility is 200 m^2. The geotextile material and ramp will alter a small amount of the shoreline that is normally ice-scoured or frozen in winter. A very small area of benthic and foraging habitat (100 m^2) may be temporarily altered.

Project materials and bulk fuel will be received by barge at this facility, off-loaded, sorted and temporarily stored until such time that their transport is made possible by winter road access to the mine site. Dry freight materials will be off-loaded at the push tug barge landing ramp and received in the marshalling area located to the south of the facility, which is situated just above high water mark. A series of dry freight storage pads will be developed on graded benches. The total area for the facility will be about 135,000 m^2. Ammonium nitrate will be stored within a fenced area and a separate secure area will be provided for explosive storage.

Fuel for the project will be pumped from bulk container barges into two above-ground storage tanks located at the east end of the facility. The fuel tanks will be contained within the bermed tank farm facility. An all-weather access road will be constructed from the community of Baker Lake to the proposed facility. Site roads will provide access between the landing and storage areas. The facility will be used annually from about July to the following May. The facility will receive dry freight and bulk fuel during open water conditions on Baker Lake from September and January for delivery to the mind site by winter road from May to July. Based on the above schedule, the majority of facility operations will occur during frozen ground conditions with the exception of thawed ground conditions between about June and September.

No significant adverse effects are foreseen during construction or operation of this facility. All activities will take place above the waterline. The Baker Lake staging facility will be built on land far from water bodies, and poses no threat to fish or fish habitat.

The explosives magazine and tank farm will likewise not be located proximate to any water bodies, thus there is no pathway between a potential contaminant source and an aquatic receiving environment. Standard safety protocols regarding the separate storage and handling of explosive materials and fuels will be followed, including the use of double-hulled tanks to protect against leaks, safety containment units, and berms surrounding each tank to contain leaks in the event of a spill.

6.3.5.2 Mitigation

Each of the infrastructure components listed above will require various forms of mitigation as follows:

- Barges will transport materials from the Port of Churchill to Baker Lake during open water season and will follow all standard safety procedures to minimize the risk of a spill into marine waters.
- The barge landing facility will be constructed during open water and will avoid sensitive habitats and spawning/nursery periods by fall-spawning fish.
- Sediment control measures will be implemented to ensure that sediment is not introduced into Baker Lake.
- Marine barge operators will be required to follow hazardous material handling guidelines, the spill contingency plan, and standard operating procedures.
- Annual monitoring and maintenance of the barge offloading facility will be conducted to maintain structural integrity and ensure that no erosion occurs.
- Standard construction procedures and hazardous material handling guidelines will be followed in constructing and operating the access road.
- Explosives and fuel will be stored well away from aquatic environments at the staging facility.

6.3.5.3 Residual Effect & Significance of Baker Lake Infrastructure Facilities

Construction and operation of the barge landing facility will alter a very small area (perhaps 100 m^2) of habitat along the foreshore of Baker Lake. Avoiding high quality habitat, constructing during non-sensitive periods, and ensuring the integrity of the landing facility to minimize erosion, will minimize adverse effects. Implementation of the Spill Contingency Plan will ensure that any spills are contained and remediated prior to entering receiving environments. Road construction and operation, operation of the staging facility, and storage of hazardous materials are not expected to result in significant effects to aquatic environments because of mitigative procedures. This prediction is high certainty.

Residual ecological effects of constructing and operating the marine barge landing facility, access roads, staging facility and tank farm will be low in magnitude, local in extent, of short duration, and will occur infrequently (see Table 6.34). Residual effects are not significant. The certainty of this prediction is high.

Table 6.34: Summary of Residual Effects – Baker Lake Infrastructure Facilities

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Short-term	Infrequent	NO
Fish	Low	Local	Short-term	Infrequent	NO

6.4 POST-CLOSURE IMPACT ON AQUATIC RESOURCES

6.4.1 Setting

The Meadowbank mine is expected to operate over 8 to 10 years, followed by two years of general closure activities and an additional minimum three years of final closure activities that will include pit flooding, water management, and monitoring. At post-closure period the dikes will be partially decommissioned once the water quality in pits meets MMER guidelines.

The greatest residual impacts to the landscape, after mine closure and flooding of pits, are elimination of a significant portion of Second Portage Lake due to tailings disposal east of the Tailings or West Dike (tailings dike) and the expanded surface area and volume of Third Portage Lake. After post-closure, Third Portage Lake will be returned to its original configuration (notwithstanding the presence of the decommissioned Goose Island dike), plus additional lake area gained from the Goose Island, Portage, and North Portage pits within the former Second Portage Lake. The East dike will separate Third Portage from Second Portage Lake and will maintain the 1 m elevation difference between the two lakes, consistent with the current elevation difference. Consideration will be given to raising and expanding the East dike at closure to ensure integrity of the dike over the long-term. Thus, the area and volume of Third Portage Lake will be expanded, partly at the expense of Second Portage Lake.

The act of mine closure is complex and involves the deconstruction and demobilization of all buildings (offices, mills, rock processing areas, and storage facilities), fuel, explosives, supplies, crushers, treatment plant, sewage treatment plant, camps, equipment (pipelines, extraction machines, and rock processing and ore smelting machinery), decommissioning of roadways and the airstrip, as well as drainage ditches. The Turn Lake road crossing will be removed during winter to avoid impacts to fish, and the area will be rebuilt to return to previous conditions. Materials will be salvaged and hauled out wherever feasible, or deposited in pits prior to re-flooding. Ancillary infrastructure around Baker Lake will be removed and associated areas restored to pre-mine condition, including the marine barge-landing facility, Baker Lake staging facility, explosives magazine, fuel tank farm, and access road. By ensuring proper worker training and implementation of all appropriate safety protocols for the handling and transport of hazardous materials, none of these components are expected to result in impacts to fish or habitat.

There are, however, several mine components that could pose adverse effects to the aquatic environment during post-closure phase. These include:

- dikes
- pits
- Second Portage tailings facility
- Vault and Portage waste rock storage facilities.

6.4.2 Dikes

Dikes will be designed to ensure that they are stable over the very long-term, considering the possible locations and types of flood control structures that may be required. Dewatering dikes will remain intact during the controlled flooding of both Portage and Vault pit areas, in order to isolate flooded pit waters from surrounding lakes. Pits will be filled gradually over the course of three to five years using water captured from freshet runoff, precipitation, redirected runoff, seepage and possibly water from adjacent lakes, depending on lake elevation and water balance. Once the water levels have stabilized within the flooded pits and water quality meets MMER guidelines, parts of dikes will be decommissioned during closure activities to allow circulation of pit water and lake water. Approximately 200 m of the Goose Island dike will be taken down by 6 m to allow Third Portage and the flooded pits to mix. Similarly, the Vault dike will be dismantled, to allow water from Wally Lake and Vault Lake and Vault pit to mix.

Exposure of dike (pit) walls over a period of several years during gradual filling will allow oxidized rock to come in contact with pit waters and cause an increase in dissolved metal concentrations and lower pH within pit waters that may exceed CCME guideline concentrations. Mixing of pit water and lake water will not occur until conditions have equilibrated.

As noted above, the Second Portage East dike will remain, preserving the 1 m difference in elevation between Third Portage and Second Portage lakes. Habitat will be created on interior of East dike, prior to filling of Portage pit. Similarly, the Portage Tailings dike will remain to contain the stored mine tailings, and will be enhanced to provide fish habitat along its outer slope. The remaining portions of Bay Zone and Goose Island dikes will provide fish habitat along both interior and exterior walls.

The new habitat created along dike walls will be of greater surface area and equal or greater quality (coarse substrate providing shelter, and varying depth available along wall from pit ledges) relative to current pre-mine conditions. In the short-term, this may be offset by elevated metals concentrations. Any adverse effects would be limited to the period of mixing as oxidized materials will be rapidly diluted and flushed, with no additional oxidization because of submergence. Given the absence of food resources within the newly created aquatic habitat during the first few years, this area will not be utilized extensively by fish, but will rapidly improve over time. Flooded pits are very deep and will be used by fish for overwintering.

Residual effects related to dikes during post-closure are of low magnitude, are local in extent, of permanent duration, and occur frequently. Residual effects are not significant in either case and certainty of this prediction is high. The net change in habitat quantity and quality relative to pre-mining conditions in Third Portage Lake is negligible. The net increase in surface area and volume of the lake and habitat conditions created along the dike walls is partly offset by the deep, unproductive habitat of the flooded pits.

Summary of Residual Post-Closure Effects – Dikes

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Permanent	Frequent	NO
Fish	Low	Local	Permanent	Frequent	NO

6.4.3 Pits

There are two issues considered in the post-closure environment: impacts to fish habitat and fish populations as a result of flooding and mixing of pit waters with waters in adjacent lakes; and changes to fish habitat in Second and Third Portage lakes and Vault Lake relative to pre-mine conditions.

During the closure period, the Goose Island and Portage open pits will be flooded over a period of about five years. The pit lake water levels will eventually equilibrate with the adjacent lake elevations. Instantaneous breaching of the dike would cause significant drawdown of Third Portage Lake, which would have an unacceptable effect on fish habitat. Therefore, flooding will be accomplished through a combination of seepage, precipitation and some re-direction of spring freshet flows from Third Portage Lake. The control of the rate of flooding will be through incorporation of engineered structures into the detailed design of the dikes, which could potentially involve spillway structures, side decant structures, or other engineered designs.

The Vault pit will be flooded during the closure period over a period of about six years, and will become part of Vault Lake. The dike between Vault Lake and Wally Lake will be removed. In the same manner as for the Portage open pits, the dike will only completely be removed when it is acceptable for water in Vault Lake to mix with Wally Lake. The rate of flooding will be determined by the rate of groundwater seepage, the surface runoff that can be directed into the pit, and by the amount of water that can be directed from Wally Lake during the spring freshet.

Configuration of the residual pit footprints in Third Portage and Vault lakes is as follows:

- Within Third Portage Lake, there are three four pits: North Portage, Portage, Connector Zone and Third Portage, parts of which formerly occupied Second Portage Lake. The combined dimensions of the pits are significant. The Portage pits are long (2 km), rectangular (150 to 250 m), deep (100 to 120 m) pits connected by a 50 m deep sill. Flooded surface area is 57 ha with a projected volume of 29.8 Mm^3. These pits are adjoined to the Goose Island pit, which is 500 m in length, 350 m wide, and 130 m deep with a surface area of 11 ha and volume of 6.1 Mm^3. Combined, the pit surface area is 68 ha with a volume of 35.9 Mm^3. Relative to the original area (3600 ha) and volume of Third Portage Lake, this is greater than 10% of the area and 16% of pre-mine volume, most of which is additional volume (e.g., dewatered volume of the Goose Island pit is 2.6 Mm^3).

Vault pit will cover a triangular area of 42 ha, and is projected to be 900 m long, 600 m wide, and have a maximum depth of 160 m. When flooded, the pit volume is projected to be 19.6 Mm^3, which is several times the volume of Vault Lake (2.0 Mm^3) and more than half the volume of Wally Lake. Monitoring will be undertaken to determine water quality in the pits prior to release.

Clearly, re-flooding of the original lake areas and pit volumes will require several years to avoid compromising lake levels in Wally, Second and Third Portage lakes. On the order of five summer seasons will be required.

As discussed previously, oxidation of rock walls over several years could lead to possible acidification and elevated dissolved metals concentrations in pit waters immediately after flooding. These conditions would most likely result in only a one-time insult to surrounding receiving waters upon decommissioning of dike walls. Given that there are no fish present and periphyton and benthos have not recolonized the flooded pits, no impacts to fish or fish habitat within the pits will occur. Depending on water quality and mixing of pit water with water in Third Portage Lake after dike decommissioning, a minor reduction in water quality in Third Portage East Basin might occur, which could affect fish habitat and fish populations. Monitoring will be undertaken to determine water quality in the pits prior to release.

The residual impacts to fish and habitat in the Portage and Vault pits in the post-closure environment are of low magnitude, local extent, of short (fish) to medium (habitat) duration, and may occur frequently. Pit water quality is expected to improve relatively quickly, given the low oxidation potential post-flooding, and should not pose significant risks in the medium-term. Algae, periphyton, benthos, zooplankton, and communities of fish will recolonize pit areas over time. Residual effects are not significant and certainty of this prediction is medium.

Summary of Residual Effects – Portage/Vault Pits

	Magnitude	Spatial Extent	Duration	Frequency/Timing	Significance
Fish Habitat	Low	Local	Short-term	Frequent	NO
Fish	Low	Local	Short-term	Frequent	NO

6.4.4 Recovered Lake Area

Portage Lakes – Excluding pit areas, large areas of former lake and terrestrial habitat will be gained after flooding at post-closure, resulting in a net gain in fish habitat in project lakes (NNL, 2005). The loss of habitat in Second Portage Lake due to the tailings facility will be more than offset by gains made in Third Portage Lake, partly as a result of the exchange of lake areas between the two lakes. Given the geographic proximity, improved hydraulic connection and the swapping of habitat between the lakes, residual effects on Second and Third Portage lakes are considered together at post-closure.

After flooding of pits and decommissioning of the southern end of Goose Island dike, 92 ha, or 2.5% of lake area impounded by the Goose Island dike will be returned to Third Portage Lake. With the exception of shorelines and dike surface area, much of this habitat will be of low quality because of the great depth of the Goose pit. Additional high quality habitat will be gained from the peninsula of land that used to separate Second from Third Portage Lake, which will have become part of the Portage pit. Finally, 41.5 ha of lake area between the tailings dike and the East dike, formerly part of Second Portage Lake, will become part of Third Portage Lake, plus an additional 10 to 15 ha north of the original lake boundary that is part of the North Portage pit. The incremental gain in surface area of Third Portage Lake, relative to pre-mine conditions is approximately 120 ha, which is more than 3% of the original lake area. Given the deep depth of the pits, the gain in area is partly offset by the relatively poor-quality habitat of the lake bottom and lack of littoral zone habitat.

The additional volume (combined volume of North Portage, Portage and Goose pits) gained is approximately 35.9 Mm^3; minus the original dewatering volume within Goose Island (2.6 Mm^3). This represents a 14.6% increase in Third Portage Lake volume relative to the pre-mine lake volume estimate (228 Mm^3).

A significant portion of the lake area and volume of Second Portage Lake will become, in the post-closure environment, part of Third Portage Lake. The net reduction in surface area (135 ha) and volume of Second Portage Lake impounded west of the East dike (12.8 Mm^3) are 35% and 58%, respectively, relative to pre-mine conditions. There is a permanent loss of 93 ha (24%) of habitat within the tailings impoundment area that is offset by habitat gain in Third Portage Lake, which was formerly part of Second Portage (NNL, 2005).

Lake area and volume of Third Portage Lake is projected to increase relative to pre-mine conditions at post-closure, which is offset by habitat loss in Second Portage Lake, due primarily to the tailings disposal facility. The net difference in habitat value or fish biomass in Third Portage and Second Portage lakes is predicted to be negligible. Given these circumstances, the magnitude of impact on Third Portage and Second Portage lakes is low, local, of permanent duration, and will occur frequently. Residual impacts will not be significant. Certainty of this prediction is moderate.

Summary of Residual Effects – Third Portage and Second Portage Lake					
	Magnitude	**Spatial Extent**	**Duration**	**Frequency/Timing**	**Significance**
Fish Habitat	Low	Local	Permanent	Frequent	NO
Fish	Low	Local	Permanent	Frequent	NO

Vault Lake – Vault Lake will largely be unaltered during mining, except for a small portion of the lake affected by the Vault pit. Re-flooding will return most of Vault Lake and Phaser Lake to their pre-mine areas and volumes; however, given the large size and great depth of the Vault pit, there will be a significant increase (about 50%) in water volume of the Vault/Wally Lake area. The relative value of this habitat is low, however, because of the lack of a littoral zone. Pit walls will be contoured and riprapped to provide high quality habitat for fish to several metres depth. There is currently very little deep water, overwintering habitat for within Vault and Wally lakes, so creation of this deep-water habitat may be viewed as positive from that aspect.

Residual impacts on habitat and fish populations in Vault Lake are low in magnitude, local in extent, permanent in duration, and will occur frequently. Residual impact is not significant and has high certainty.

Summary of Residual Effects – Vault Lake					
	Magnitude	**Spatial Extent**	**Duration**	**Frequency/Timing**	**Significance**
Fish Habitat	Low	Local	Permanent	Frequent	NO
Fish	Low	Local	Permanent	Frequent	NO

6.4.5 Second Portage Tailings Facility

All mine tailings will be stored at this facility permanently, representing a loss of fish habitat equivalent to the area of the tailings pond (93 ha), or 24% of the area and 46% of the volume of Second Portage Lake. Implications of this habitat loss are described within the pit section above. During the latter half of mine operation, closing of the tailings storage pond starting at the east end will be done using waste rock materials covered by a minimum of 2 m (thermal active layer of permafrost) of ultramafic rock, which generates only small amounts of acid and has low potential for metal leaching. Capping is expected to be completed by 2017. This action is necessary to ensure that all tailings materials eventually become frozen as part of the permafrost layer and are isolated from ground water and from surface waters, to eliminate a chronic contamination source to Third Portage Lake.

Notwithstanding habitat loss, the potential for leaching of dissolved metals and acids into Third Portage Lake from the Tailings Facility is low in magnitude, local in extent, of permanent duration, and occurs infrequently. Residual effects are not significant for either fish or habitat. Capping using non-metal leaching ultramafic rock and freezing by permafrost should result in complete mitigation. Certainty of this prediction is moderate.

Summary of Residual Effects – Leaching from Second Portage Tailings Facility					
	Magnitude	**Spatial Extent**	**Duration**	**Frequency/Timing**	**Significance**
Fish Habitat	Low	Local	Permanent	Infrequent	NO
Fish	Low	Local	Permanent	Infrequent	NO

6.4.6 Vault & Portage Rock Storage Facilities

By post-closure, Vault rock storage facility will cover an area of 191 ha, and will be composed of 28 Mm^3 of non-PAG intermediate volcanic rock. It is expected that permafrost will gradually creep into the rock storage facility and reduce infiltration and oxidation of rock. Leachate will be monitored during post-phase to ensure that water quality of surface waters of Vault and Phaser lakes are not impaired. The Vault rock storage facility will not require capping with non-PAG ultramafic rock.

Residual effects on fish and habitat related to leaching of contaminants from Vault rock storage facility are of low magnitude, local in extent, of permanent duration, and occur infrequently. Residual effects are not significant in either case and certainty of this prediction is moderate.

Summary of Residual Effects – Vault Rock Storage Facility					
	Magnitude	**Spatial Extent**	**Duration**	**Frequency/Timing**	**Significance**
Fish Habitat	Low	Local	Permanent	Infrequent	NO
Fish	Low	Local	Permanent	Infrequent	NO

SECTION 7 • REFERENCES

Aquatic Environment Management Report (AEMP), 2005. Framework for the application of aquatic environment management and monitoring of Meadowbank project area lakes. A report prepared for Cumberland Resources, Vancouver by Azimuth Consulting Group, Vancouver. March 2005.

Baseline Aquatic Environment Assessment Report (BAEAR), 2005. Baseline aquatic environmental assessment report, Meadowbank study area lakes, Nunavut. A report prepared for Cumberland Resources, Vancouver by Azimuth Consulting Group, Vancouver. October 2003.

Canadian Council of Ministers of the Environment (CCME), 2001. Water quality guidelines for the protection of aquatic life. Environment Canada. Ottawa Ontario. Revised 2001.

Christie, G.C. and H.A. Regier, 1988. Measures of optimal thermal habitat and their relationship to yields for four commercial fish species. Can J. Fish. Aquat. Sci. 45: 301-314.

Cumberland Resources Ltd., 2005. Baseline Traditional Knowledge Report.

Cumberland Resources Ltd., 2005. Spill Contingency Report.

Department of Fisheries and Oceans (DFO), 1992. Introduction to fishway design. C. Katopodis, Freshwater Institute, Department of Fisheries and Oceans, Winnipeg MB.

Department of Fisheries and Oceans (DFO), 1995. Freshwater intake end-of-pipe fish screen guideline. Department of Fisheries and Oceans, Ottawa Report No. 5080. 27 p.

Diavik, 1999. Diavik Diamond Mine Environmental Impact Assessment document.

Environment Canada, 2002. Metal Mining Effluent Regulations (MMER).

Evans, D.O., J.M. Casselman, and C.C. Wilcox, 1991. Effects of exploitation, loss of nursery habitat and stocking on the dynamics and productivity of lake trout populations in Ontario lakes. Lake Trout Synthesis. Ontario Ministry of Natural Resources, Toronto Ontario.

Fitzsimmons, J.D., 1996. The significance of man-made structures for lake trout spawning in the Great Lakes: are they a viable alternative to natural reefs? Can. J. Fish. Aquat. Sci. 53: 142 151.

Hanson, J.M. and W.C. Leggett, 1982. Empirical production of fish biomass and yield. Can. J. Fish. Aquat. Sci. 39: 257-263.

Johnson, L.L., 1976. Ecology of Arctic populations of lake trout, *Salvelinus namaycush*, lake whitefish, *Coregonus clupeaformis*, Arctic char, *S. alpinus* and associated species in unexploited lakes of the Northwest Territories. J. Fish. Aquat. Sci. Can. 33: 2459-2488.

Jones, J.R. and M.V. Hoyer, 1982. Sportfish harvest predicted by summer chlorophyll-*a* concentration in midwestern lakes and reservoirs. Trans. Am. Fish. Soc. 111: 176-179.

Katopodis, C., 1992. Fishway design. Department of Fisheries and Oceans, Freshwater Institute, Winnipeg MB. Unpublished report.

Lamberti, G.A., S.V. Gregor, L.R. Ashkenas, R.C. Wildman and K.M.S. Moore, 1991. Stream ecosystem recovery following a catastrophic debris flow. Can. J. Fish. Aquat. Sci. 48: 196-208.

Lawrence, M.J., S. Davies, G. Collins, F. Hnytka, K. Kroeker and R. Sie, 1977. Aquatic resources survey – Keewatin District preliminary report 1977. ESCOM No. A1-07. 50 p.

MacDonald, G. and D.B. Steward, 1980. Arctic land use research program 1980: a survey of the aquatic resources of the central Keewatin District region of the Northwest Territories. Northern Affairs Program Environmental Studies Vol. 17. March, 1980. Ottawa Ontario. 111 p.

Machniak, K., 1975. The effects of hydroelectric development on the biology of northern fishes (reproduction and population dynamics) IV. Lake trout *Salvelinus namaycush* (Walabum). A literature review and bibliography. Fisheries and Marine Services Div. Tech. Rep. No. 530. 52 p.

Marshall, T.R., 1996. A hierarchical approach to assessing habitat suitability and potential yield of lake trout. J. Fish. Aquat. Sci. 53: 332-341.

Matuszek, J.E., 1978. Empirical predictions of fish yields of large North American lakes. Trans. Am. Fish. Soc. 119: 718-729.

McAughey, S.C. and J.M. Gunn, 1995. The behavioural response of lake trout to a loss of traditional spawning sites. J. Great Lakes Res. 21: 375-383.

Merritt, R.W. and K.W. Cummins, 1996. An introduction to the invertebrates of North America. Kendall/Hunt Publishing, Dubuque, Iowa. 862 p.

Metal Mining Effluent Report (MMER), 2005. Framework for the application of metal mining effluent regulations (MMER) at Meadowbank. A report prepared for Cumberland Resources, Vancouver by Azimuth Consulting Group, Vancouver. March 2005.

No Net Loss Framework (NNL) Report, 2005. A framework for no net loss of fish habitat, Meadowbank Gold project. Prepared for Cumberland Resources, Vancouver by Azimuth Consulting Group, Vancouver. April, 2005.

Patalas, K., J. Patalas and A. Salki, 1994. Planktonic crustaceans in lakes of Canada (Distribution of species, bibliography). Can. Tech. Rep. Fish. Aquat. Sci. No. 1954. v + 218 p.

Payne, N.R., R.M. Dorver, D.S. MacLennan, S.J. Nepszy, B.J. Shuter, T.J. Stewart and E.R. Thomas, 1990. The harvest potential and dynamics of lake trout populations in Ontario. Lake Trout Synthesis. Ontario Ministry of Natural Resources, Toronto Ontario.

Ricker, W.E., 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fish. Res. Bd. Canada. 191. 382 p.

Ryder, R.A., 1965. A method for estimating the potential fish production of north-temperate lakes. Trans. Am. Fish. Soc. 94: 214-218.

Scott, W.B. and E.J. Crossman, 1979. Freshwater fishes of Canada. Fish. Res. Bd. Canada. Bull. 184.

Snap Lake EIA, 2002. Snap Lake Environmental Impact Assessment. Prepared for DeBeers by Golder Associates, Calgary, AB.

Sly, P.U. and D.O. Evans, 1996. Suitability of spawning habitat for lake trout. J. Aquat. Eco. Health 5: 153-175.

Thibodeau, M.L. and J.R.M. Kelso, 1990. An evaluation of putative lake trout (*Salvelinus namaycush*) spawning sites in the Great Lakes. Can. Tech. Rep. Fish. Aquat. Sci. 1739. 20 p.

Wallace, J.B., 1990. Recovery of lotic macroinvertebrate communities from disturbance. Environm. Manage. 14: 605-620.

Wetzel, R.G., 1983. Limnology. W.B. Saunders Co. Toronto ON. 743 p.

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

APPENDIX A

Surface Water Impact Matrices

Table A.1: Surface Water Quantity Impact Matrix – Construction

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Mine Waste and Water Management Plan
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
MAIN FACILITIES												
Construction Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	
Dikes												
East Dike	Isolation of northwest arm of Second Portage Lake (~135 ha); impoundment of 35% surface area and 58% volume of Second Portage Lake (see dewatering section); dike itself displaces very little water volume	Low	Local	Continuous	Permanent	All Year	No	None	Construction of East Dike will have very small impact on water volume within the project lake because of the very small footprint and volume of dikes relative to the lake	No	Certain	No mitigation required because of small area displaced by dikes
	Change in lake circulation patterns in residual areas of Second Portage Lake; residence time of water in Second Portage Lake is expected to decrease	Low	Local	Continuous	Permanent	All Year	No	None recommended.	NA	No	NA	Ongoing hydrological monitoring will be conducted at the Second Portage Lake outlet channel
West Dike	No impact since West dike on Second Portage Lake is constructed within the dewatered Second Portage Lake arm after the construction of East dike	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Frequency	Temporal Boundaries: Duration	Temporal Boundaries: Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Mine Waste and Water Management Plan
Bay Zone Dike	Isolation of a small portion of Third Portage Lake (~20 ha); impoundment of 0.5% surface area and ~0.2% volume of Third Portage Lake (see dewatering section); dike itself displaces very little water volume	Low	Local	Continuous	Permanent	All Year	No	None	Small footprint and volume of dikes relative to the lake	No	Certain	No mitigation required because of small area displaced by dikes
	Construction of Bay Zone Dike will eliminate the westernmost connecting channel (the main outlet of three channels, holding ~50% of the flow) between Third Portage and Second Portage lakes; increased flow to other outlet channel(s) with potential for channel overtopping and erosion; rise in Third Portage Lake water levels leading to shoreline erosion	High	Regional	Continuous	Permanent	All Year	Yes	One of the existing channels between Third Portage and Second Portage lakes will be modified to accept larger flows. Bottom elevation of the new channel will be engineered to ensure that discharge will not be constrained and that the existing 1 m elevation difference between Third Portage and Second Portage lakes is maintained	The new channel will ensure that discharge capacity is not diminished below current conditions; concerns related to Third Portage Lake water levels and erosion of existing channels due to high flows will not reduced	No	High	Ongoing hydrological monitoring will be conducted at the Third Portage Lake outlet channel
	Change in lake circulation patterns; increased mixing between basins within Third Portage Lake is expected with the removal of the Bay Zone area	Low	Local	Continuous	Medium-term	All Year	No	None recommended.	NA	No	High	Ongoing hydrological monitoring will be conducted at the Third Portage outlet channel.
Goose Island and Third Portage Arm Dikes	Constructed during the operation phase.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Mine Waste and Water Management Plan
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Dewatering												
Second Portage Arm & Pumping Facilities	Approximately 12 million cubic meters of water will be pumped from Second Portage Arm (i.e., area impounded by East Dike) to Third Portage Lake resulting in increased volume (5%) and water levels (20-30 cm) in Third Portage Lake; because of constraints at outlet channels, in the absence of mitigation, the increased water volume will be released back to residual areas of Second Portage Lake over several years; although water level increases fall within natural lake level fluctuations, some shoreline erosion due to ice and wave scour is possible; increased discharge volumes may also cause erosion of outlet channels, particularly since the main channel is eliminated by the Bay Zone Dike	High	Regional	Continuous	Short-term	Summer	Yes	One of the existing channels between Third Portage and Second Portage lakes will be modified to accept greater flows.	The new channel will ensure that discharge capacity is not diminished below current conditions.	No	High	Ongoing hydrological monitoring will be conducted at the Third Portage Lake outlet channel
	Anticipated increase in discharge from Second Portage Lake to Tehek Lake fall within natural fluctuation and is not expected to impact outlet channel integrity between Second Portage and Tehek lakes or lake levels in Tehek Lake	Low	Regional	Continuous	Short-term	Summer	No	No mitigation is required since flows fall well within seasonal norms.	NA	No	Certain	Ongoing hydrological monitoring will be conducted on the outlet channel from Second Portage Lake to Tehek Lake
	Decrease in Second Portage Lake volume	High	Local	Continuous	Permanent	All Year	Yes	No mitigation is possible since dewatered area will be used as permanent disposal area for mine tailings	NA	Yes	Certain	NA

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Mine Waste and Water Management Plan
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Bay Zone	Dewatering will not occur until the operation phase	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pits												
Portage Pits	Portage pit will be excavated within area impounded by East and West dikes, so no additional impacts on water quantity anticipated; some potential for seepage from Second and Third Portage lakes into the pit and then pump-back from the sumps to the attenuation pond	Low	Local	Continuous	Medium	All Year	No	Seepage water pumped into attenuation pond.	NA	No	High	Pit limits defined by reserves and geotechnical parameters; set back of 80m between pit and dike might be reduced through further study or after initial experience gained.
Goose Island Pit	Constructed when the mine is in operation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Waste Dump (Portage & Goose)	Gradual loss of natural surface drainage equal to the area of the waste dump; loss of storage capacity in small ponds and wetlands	Low	Local	Continuous	Permanent	All Year	No	Collect seepage and runoff from waste dumps in the attenuation pond and discharge to Third Portage Lake.	Overall small changes in inputs to Third Portage Lake	No	Certain	Minimize footprint and separate clean from contaminated runoff as far as possible through appropriate layout; discharge clean run-off to Third Portage Lake
Borrow Pit(s)	No borrow pits required. All construction materials to be produced from on-site crushing & screening of pre-stripping material.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tailings Disposal (Facilities & Ponds)	Reduction of lake area and water volume in Second Portage Lake. Impacts resulted from construction of East Dike and dewatering of Second Portage Lake arm (see above)	High	Local	Continuous	Permanent	All Year	Yes	No mitigation is possible since dewatered area will be used as permanent disposal area for mine tailings	NA	Yes	Certain	NA
Main Site Roads & Traffic	Disruption of surface drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain roads & culverts in good condition and maintain adequate drainage patterns.	NA	No	Certain	Use sedimentation traps, selection of more durable materials for road surfacing.

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Mine Waste and Water Management Plan
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Airstrip & Air Traffic	Disruption of surface drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain adequate drainage patterns	NA	No	Certain	Strip straddles a ridge and drainage disruption minor. Ensure drainage patterns are not disrupted.
	Reclamation of portion of Third Portage Lake for northwest end of runway; small amount of volume displaced	Low	Local	Continuous	Permanent	All Year	No	Minimize length of runway	NA	No	Certain	None recommended.
	Alteration of circulation patterns in Third Portage Lake is expected to be negligible	Low	Local	Continuous	Permanent	All Year	No	Minimize length of runway	NA	No	Certain	None recommended.
Plant Site (Footprint & Ground Activity)	Interference with surface drainage patterns; runoff directed to the attenuation pond	Low	Local	Infrequent	Medium	Summer	No	Grade site to control and collect runoff.	NA	No	Certain	Clean runoff will be directed to attenuation pond and eventually discharged to Third Portage Lake; monitor integrity of surface drainage structures
Process Plant Activity	Processing commences after the construction is completed and the mine is in operation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Freshwater Intake & Pipeline	Intake structure and pipeline constructed in construction phase. Fresh water demand for the process commences in operations; negligible reduction in Third Portage Lake volume for water consumption during construction. Minor interference with surface drainage patterns.	Low	Local	Infrequent	Medium	Summer	No	Minimize freshwater requirements	NA	No	High	Monitor freshwater intake volumes.

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Mine Waste and Water Management Plan
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Discharge Facilities & Pipeline	Extra volume (`2.1 million cubic metres/ year; 0.9% of total lake volume) discharged to Third Portage Lake during operations phase; discharge during construction phase is expected to be minimal; Interference with surface drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Discharging water to the receiving environment lake that would normally receive this runoff; discharging only during the open water season	NA	No	Certain	Monitor discharge volumes.
Non-Contact Diversion Facilities	Drainage patterns changed. Runoff diverted from Second Portage Lake catchment to Third Portage Lake catchment resulting in increased runoff volumes to Third Portage Lake.	Low	Local	Infrequent	Permanent	Summer	No	Diverted to Third Portage Lake.	NA	No	Certain	Monitor discharge volumes of non-contact water.
Fuel Storage (at Plant Site)	Minor loss of runoff volume to Third Portage Lake due to fuel containment berm. Site runoff directed to attenuation pond	Low	Local	Infrequent	Medium	Summer	No	None	NA	No	Certain	None recommended,
AN / Explosives Storage & Emulsion Plant	Minor loss of runoff volume to Third Portage Lake due to containment berm. Interference with drainage patterns	Low	Local	Infrequent	Medium	Summer	No	None	NA	No	Certain	None recommended.
Site Accommodations	Interference with local drainage patterns (see Plant Site above)	Low	Local	Infrequent	Medium	Summer	No	Grade site to control runoff.	NA	No	Certain	None recommended.
Sewage & Waste Disposal	No effects on surface water quantity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
VAULT FACILITIES												
Construction Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vault Dike	Complete isolation of Vault Lake from Wally and Drilltrail lakes with natural discharge eliminated; small volume of water displaced by dike	Low	Local	Continuous	Permanent	All Year	No	None	Small footprint and volume of dikes relative to the lake	No	Certain	No mitigation required because of small are displaced by dikes

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Frequency	Temporal Boundaries: Duration	Temporal Boundaries: Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Mine Waste and Water Management Plan
Dewatering												
Vault Lake Dewatering & Drainage Facilities	Approximately 1.5 million cubic meters of water will be pumped from Vault Lake to Wally/Drilltrail lakes resulting in a small increase in volume of receiving lakes (~3.4%); discharge volumes are expected to be well within inter-annual variation and the existing discharge channel can easily pass this additional flow	Low	Regional	Continuous	Medium	Summer	No	None required	NA	No	High	Ongoing hydrological monitoring will be conducted on the outlet channel between Second Portage Lake (i.e., receiving water for Wally and Drilltrail lakes) and Tehek Lake
	Decrease in Vault Lake volume	High	Local	Continuous	Medium	All Year	Yes	No mitigation is possible since dewatered area will be used as temporary attenuation pond	NA	Yes	Certain	NA
Vault Pit	Pit developed within dewatered area, so no further impacts to water quantity anticipated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Discharge Volumes & Facilities	Extra volume (`0.4 million cubic metres/ year; 0.9% of total lake volume) discharged to Wally and Drilltrail lakes; Interference with surface drainage patterns	Low	Local	Continuous	Medium	Summer	No	Discharging water to the receiving environment lake that would normally receive this runoff; discharging only during the open water season	NA	No	High	Monitor discharge volumes.
Vault Waste Dump	Gradual loss of natural surface drainage equal to the area of the waste dump; loss of storage capacity in small ponds and wetlands	Low	Local	Continuous	Permanent	All Year	No	Collect seepage and runoff from waste dumps in the attenuation pond and discharge to Wally/ Drilltrail lakes	Overall small changes in inputs to Wally/ Drilltrail lakes	No	Certain	Minimize footprint and separate clean from contaminated runoff as far as possible through appropriate layout
Vault Access Road & Traffic	Disruption of surface drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain roads & culverts in good condition and maintain adequate drainage patterns.	NA	No	Certain	Use sedimentation traps, selection of more durable materials for road surfacing.

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Mine Waste and Water Management Plan
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Access Road Culverts (Turn Lake)	Culverts will reduce ability of Turn Lake to discharge spring freshet and Phaser Lake diversions resulting in increases in water levels	Medium	Local	Continuous	Medium-term	Summer	Yes	Culverts will be sized (i.e., 2.5 m diameter) to handle 1:100 year flood events and increased discharge due to annual Phaser Lake dewatering; culverts will be installed in winter when the outlet from Turn Lake to Drilltrail Lake is frozen to the bottom, ensuring no disruption of flow	With no constraints on water discharge, the potential magnitude of the impact would be low	No	High	Ongoing hydrological monitoring will be conducted at the Turn Lake outlet to Drilltrail Lake
Mine Shop / Office	Interference with surface drainage patterns; runoff directed to the attenuation pond	Low	Local	Infrequent	Medium	Summer	No	Grade site to control and collect runoff.	NA	No	Certain	Clean runoff will be directed to attenuation pond and eventually discharged to Third Portage Lake; monitor integrity of surface drainage structures
OTHER FACILITIES												
Winter Road & Traffic	No impact on surface water anticipated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Existing route used traditionally
Baker Lake Access Road & Traffic	Interference with local surface drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain roads in good condition and maintain adequate drainage pattern.	NA	No	Certain	Use sedimentation traps, selection of more durable materials for road surfacing.
Barge Landing Facility	Small changes or interference with local drainage patterns and lake circulation	Low	Local	Infrequent	Medium	Summer	No	Minimize footprint.	NA	No	Certain	None recommended
Barge Traffic	No measurable impacts on surface water anticipated	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA
Staging Facility (approx. 1.5 km east of town)	Interference with local drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Minimize footprint; construct in area with minimal impacts to drainage patterns, install culverts as required	NA	No	Certain	Runoff directed to Baker Lake.

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Mine Waste and Water Management Plan
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Explosives Magazine	Interference with local drainage patterns	Low	Local	Infrequent	Medium	Summer	No	None recommended	NA	No	Certain	None recommended
Tank Farm	Small loss of surface drainage area and interference with drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain adequate drainage patterns.	NA	No	Certain	Monitor integrity of drainage facilities.

Table A.2: Surface Water Quantity Impact Matrix – Operation

Project Components	Potential Effects	Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects	Proposed Mitigation	Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Mine Waste and Water Management Plan
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
MAIN FACILITIES												
Construction Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dikes												
East Dike	Impact occurred during construction phase	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
West Dike	No impact - dike is constructed after East dike within already dewatered arm of Second Portage Lake	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bay Zone Dike	Impact occurred during construction phase	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Goose Island and Third Portage Arm Dikes	Isolation of a small portion of Third Portage Lake (~73 ha), small reduction in Third Portage Lake surface area and volume	Low	Local	Continuous	Medium	All Year	No	None	NA	No	Certain	None recommended.
	Change in lake circulation patterns. Water entering the East basin of Third Portage Lake from the North and South basins will be forced further east, possibly resulting in increased mixing. This change in potential circulation pattern is considered to be relatively small.	Low	Local	Continuous	Medium	All Year	No	Dewatering will be timed such that there is no cumulative impact on water balance in Third Portage Lake as a result of dewatering of Second Portage Lake	NA	No	Certain	Ongoing hydrological monitoring will be conducted at the Third Portage Lake outlet.
Dewatering												
Second Portage Lake	No further dewatering anticipated during operations	NA	NA	NA	NA	NA	NA	None	None	NA	Certain	

Table A.2 Continued

Project Components	Potential Effects	Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects	Proposed Mitigation	Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Mine Waste and Water Management Plan
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Bay Zone	Approximately 0.4 million cubic meters of water will be pumped to residual areas of Third Portage Lake resulting in a negligible increase in volume (0.2%) and water levels. Given that dewatering takes place at least two years after dewatering of Second Portage Lake, negligible cumulative effects in water volume and levels in Third Portage Lake are anticipated.	Low	Local	Continuous	Medium	All Year	No	Enhancement of one of Third Portage Lake outlet channels will ensure that increased discharge is easily handled	NA	No	Certain	Ongoing hydrological monitoring will be conducted at the Third Portage Lake outlet.
Goose Island (Third Portage Lake)	Approximately 2.2 million cubic meters of water will be pumped to residual areas of Third Portage Lake in Year 4 or 5 resulting in an increase in volume (<1%) and water levels (maximum of 4 -5 cm), well within annual variations. Given that dewatering takes place at least four years after dewatering of Second Portage Lake, negligible cumulative effects in water volume and levels in Third Portage Lake are anticipated.	Low	Local	Continuous	Medium	Summer	No	Controlled rate of dewatering to minimize flow fluctuations	NA	No	Certain	Ongoing hydrological monitoring at Third Portage Lake outlet to Second Portage Lake

Table A.2 Continued

Project Components	Potential Effects	Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects	Proposed Mitigation	Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Mine Waste and Water Management Plan
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Pits												
Portage Pit	Some potential for high seepage rates from Second Portage and Third Portage lakes into pit, but minor effect lake water levels	Low	Local	Continuous	Medium	All Year	No	Dikes designed with suitable cutoffs to minimize seepage rates. Treatment plant and Attenuation Pond designed to handle projected seepage rates.	NA	No	Moderate	Monitoring of pit seepage rates.
Goose Island Pit	Some potential for high seepage rates from Third Portage lakes into pit, but minor effect lake water levels	Low	Local	Continuous	Medium	All Year	No	Dikes designed with suitable cutoffs to minimize seepage rates. Treatment plant and Attenuation Pond designed to handle projected seepage rates.	NA	No	Moderate	Monitoring of pit seepage rates.
Waste Dump (Portage & Goose)	Loss of natural surface drainage equal to the area of the waste dump. Loss of natural storage capacity in small ponds and wetlands. Changed local drainage patterns.	Low	Local	Infrequent	Medium	Summer	No	Collect and treat any runoff and/or seepage from waste dump. Divert non-contact water away from waste dump.	NA	No	Certain	Minimize footprint and separate clean from contaminated runoff as far as possible through appropriate layout; discharge clean run-off to Third Portage Lake
Borrow Pit(s)	No borrow pits required. All construction materials to be produced from on-site crushing & screening of pre-stripping material.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.2 Continued

Project Components	Potential Effects	Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects	Proposed Mitigation	Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Mine Waste and Water Management Plan
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Tailings Disposal Facilities	Impacts previously resulted from construction of East Dike (see dewatering during Construction phase)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Pumping of tailings water to treatment plant for discharge to Third Portage Lake after year 6. Minor increase in flows to Third Portage Lake, no measurable water level changes expected	Low	Local	Continuous	Medium	All Year	No	Pace treatment plant releases to receiving water flows; discharge water only during open water season.	NA	No	Certain	Monitor discharge volumes and timing.
Main Site Roads & Traffic	Disruption of surface drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain roads & culverts in good condition and maintain adequate drainage patterns.	NA	No	Certain	Use sedimentation traps, selection of more durable materials for road surfacing.
Airstrip & Air Traffic	Disruption of surface drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain adequate drainage patterns	NA	No	Certain	Strip straddles a ridge and drainage disruption minor. Ensure drainage patterns are not disrupted.
Plant Site Footprint & Ground Activity	Interference with surface drainage patterns; runoff directed to the attenuation pond	Low	Local	Infrequent	Medium	Summer	No	Grade site to control and collect runoff.	NA	No	Certain	Clean runoff will be directed to attenuation pond and eventually discharged to Third Portage Lake; monitor integrity of surface drainage structures
Process Plant Activity including Freshwater Intake and Pipeline	Lower seasonal water levels in Third Portage Lake from freshwater consumption; annual consumption is estimated at 4.1 million cubic metres or 1.8% of the total volume of Third Portage Lake on an annual basis	Low	Local	Continuous	Medium	All Year	No	Minimize intake of fresh water; treat tailings and reclaim water and discharge back to Third Portage Lake; ensure reclaim system operates all year.	Decrease net process-related flows to/from Third Portage Lake	No	Certain	Monitor fresh water pumped, monitor reclaim system.

Table A.2 Continued

Project Components	Potential Effects	Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects	Proposed Mitigation	Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Mine Waste and Water Management Plan
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Discharge Facilities & Pipeline	Possible minor increase in water levels in Third Portage Lake during discharge periods.	Low	Local	Continuous	Medium	Summer	No	Pace treatment plant releases to receiving water flows.	Minimize or eliminate possible effects	No	Certain	Monitor treated water flow at discharge point.
Non-Contact Diversion Facilities	Drainage patterns changed. Runoff diverted from Second Portage Lake catchment to Third Portage Lake catchment resulting in increased runoff volumes to Third Portage Lake.	Low	Local	Infrequent	Permanent	Summer	No	Diverted to Third Portage Lake.	NA	No	Certain	Monitor discharge volumes of non-contact water.
Fuel Storage (at Plant Site)	Minor loss of runoff volume to Third Portage Lake due to fuel containment berm. Site runoff directed to attenuation pond	Low	Local	Infrequent	Medium	Summer	No	None	NA	No	Certain	None recommended,
AN / Explosives Storage & Emulsion Plant	Minor loss of runoff volume to Third Portage Lake due to containment berm. Interference with drainage patterns	Low	Local	Infrequent	Medium	Summer	No	None	NA	No	Certain	None recommended.
Site Accommodations	Interference with local drainage patterns (see Plant Site above)	Low	Local	Infrequent	Medium	Summer	No	Grade site to control runoff.	NA	No	Certain	None recommended.
Sewage & Waste Disposal	Very small effects on surface water quantity. Treated water is discharged to tailings pond, treated again before being discharged to Third Portage Lake	Low	Local	Infrequent	Medium	All Year	No	Discharge treated water back to Third Portage Lake.	NA	No	Certain	None recommended.
VAULT FACILITIES												
Construction Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.2 Continued

Project Components	Potential Effects	Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects	Proposed Mitigation	Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Mine Waste and Water Management Plan
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Vault Dike	Impact on water circulation patterns in Wally Lake	Low	Local	Continuous	Medium	All Year	No	None	NA	No	Certain	None recommended.
Dewatering												
Vault Lake Dewatering & Drainage Facilities	Dewatering occurred during Construction phase	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Ongoing discharge into Wally Lake from attenuation pond, not expected to be greatly different from pre-development	Low	Local	Infrequent	Medium	Summer	No	Control discharge rates to minimize/eliminate impacts on Wally Lake levels	NA	No	Certain	Monitor attenuation pond discharge rates.
Phaser Lake dewatering	Decrease in water volumes and levels in Phaser Lake	Low	Local	Infrequent	Medium-term	Summer	No	Control pumping rates to minimize the rate of summer drawdown in Phaser Lake	NA	No	Certain	Minimize fluctuations in water levels.
	Increased runoff volume into Turn Lake due to Phaser Lake diversion (i.e., approximately 1m); additional volume during summer from lowering of Phaser Lake	Low	Local	Infrequent	Medium-term	Summer	No	Control pumping rates to minimize or eliminate impacts on Turn Lake levels	NA	No	Certain	Ongoing hydrological monitoring will be conducted at the Turn Lake outlet
Vault Pit	Pit water collected and pumped to attenuation Pond.	Low	Local	Infrequent	Medium	Summer	No	Attenuation Pond designed with adequate storage, controlled release or treat/release to Wally Lake	NA	No	Certain	Monitor attenuation pond levels.
Vault Waste Dump	Loss of natural surface drainage equal to the area of the waste dump. Loss of natural storage capacity in small ponds and wetlands. Changed local drainage patterns.	Low	Local	Infrequent	Medium	Summer	No	Collect and treat any runoff and/or seepage from waste dump. Divert non-contact water away from waste dump.	NA	No	Certain	Minimize footprint and separate clean from contaminated runoff as far as possible through appropriate layout; discharge clean run-off to Wally Lake

Table A.2 Continued

Project Components	Potential Effects	Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects	Proposed Mitigation	Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Mine Waste and Water Management Plan
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Vault Access Road	Disruption of surface drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain roads & culverts in good condition and maintain adequate drainage patterns.	NA	No	Certain	Use sedimentation traps, selection of more durable materials for road surfacing.
Access Road Culverts (Turn Lake)	Culverts will reduce ability of Turn Lake to discharge spring freshet and Phaser Lake diversions resulting in increases in water levels	Medium	Local	Continuous	Medium-term	Summer	Yes	Culverts will be sized (i.e., 2.5 m diameter) to handle 1:100 year flood events and increased discharge due to annual Phaser Lake dewatering; culverts will be installed in winter when the outlet from Turn Lake to Drilltrail Lake is frozen to the bottom, ensuring no disruption of flow	With no constraints on water discharge, the potential magnitude of the impact would be low	No	High	Ongoing hydrological monitoring will be conducted at the Turn Lake outlet to Drilltrail Lake; check culverts on regular basis for blockages and ensure free-flowing
Mine Shop / Office	Interference with surface drainage patterns; runoff directed to the attenuation pond	Low	Local	Infrequent	Medium	Summer	No	Grade site to control and collect runoff.	NA	No	Certain	Clean runoff will be directed to attenuation pond and eventually discharged to Third Portage Lake; monitor integrity of surface drainage structures
OTHER FACILITIES												
Winter Road	No impact on surface water anticipated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Existing route used traditionally
Baker Lake Access Road	Interference with local surface drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain roads in good condition and maintain adequate drainage pattern.	NA	No	Certain	Use sedimentation traps, selection of more durable materials for road surfacing.
Barge Landing Facility	Small changes or interference with local drainage patterns and lake circulation	Low	Local	Infrequent	Medium	Summer	No	Minimize footprint.	NA	No	Certain	None recommended
Barge Traffic	No measurable impacts on surface water anticipated	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA

Table A.2 Continued

Project Components	Potential Effects	Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects	Proposed Mitigation	Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Mine Waste and Water Management Plan
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Staging Facility (approx. 1.5 km east of Baker Lake)	Interference with local drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Minimize footprint; construct in area with minimal impacts to drainage patterns, install culverts as required	NA	No	Certain	Runoff directed to Baker Lake.
Explosives Magazine	Interference with local drainage patterns	Low	Local	Infrequent	Medium	Summer	No	None recommended	NA	No	Certain	None recommended
Tank Farm	Small loss of surface drainage area and interference with drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain adequate drainage patterns.	NA	No	Certain	Monitor integrity of drainage facilities.

Table A.3: Surface Water Quantity Impact Matrix – Closure & Post-Closure

		Assessment of Unmitigated Effects							Assessment of Residual Effects			
		Spatial Boundaries		Temporal Boundaries								
Project Components	**Potential Effects**	**Magnitude**	**Spatial Extent**	**Frequency**	**Duration**	**Timing**	**Significance of Unmitigated Effects**	**Proposed Mitigation**	**Residual Effects/ Influence of Mitigation**	**Significance of Residual Impacts**	**Probability**	**Mine Waste and Water Management Plan**
MAIN SITE												
Construction Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dikes											**High**	
East Dike	Impact occurred during construction phase; remains permanently; will provide shoreline for arm of Third Portage Lake after reflooding	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
West Dike	Impact occurred during construction phase; remains permanently; will provide shoreline for arm of Third Portage Lake after reflooding	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bay Zone Dike	Breached on closure to allow controlled flooding of Portage pit; area of Third Portage Lake increased; some continued alteration of lake circulation patterns	Low	Local	Continuous	Permanent	All Year	No	Construct permanent breach openings to minimize water level differentials	NA	No	Certain	None recommended.
Goose Island and Third Portage Arm Dikes	Breached on closure to allow controlled flooding of Goose Island pit, portion of Third Portage Lake "recovered"; some continued alteration of lake circulation patterns	Low	Local	Continuous	Permanent	All Year	No	Construct permanent breach openings to minimize water level differentials	NA	No	Certain	None recommended.

Table A.3 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects					Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects			Mine Waste and Water Management Plan
		Spatial Boundaries			Temporal Boundaries							
		Magnitude	Spatial Extent	Frequency	Duration	Timing			Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
Rewatering												
Portage and Goose Island Pit	Instantaneous rewatering of the Portage and Goose Island Pit (100 million cubic metres) has the potential for significant drawdowns of Third Portage Lake	High	Regional	Infrequent	Short	All Year	Yes	Rather than instantaneous rewatering, pit flooding will be achieved by a combination of seepage, precipitation and some re-direction of annual freshet flows from Third Portage Lake	Impact of rewatering will be of low magnitude	No	High	Rewatering volumes will be carefully monitored.
	Third Portage Lake surface area and volume will increase after rewatering - POSITIVE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Lake circulation patterns will be altered with increased mixing expected due to the presence of a new arm of Third Portage Lake (formerly Portage pit); because of the depth of pits, they will become a depositional area for sediment	Low	Local	Continuous	Permanent	All Year	No	None recommended	NA	No	High	None recommended
Dewatering	Construction phase	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.3 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects					Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects			Mine Waste and Water Management Plan
		Spatial Boundaries			Temporal Boundaries				Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Pits												
Portage Pit	Instantaneous rewatering of the Portage and Goose Island pit (100 million cubic metres) has the potential for significant drawdowns of Third Portage Lake	High	Regional	Infrequent	Short	All Year	Yes	Rather than instantaneous rewatering, pit flooding will be achieved by a combination of seepage, precipitation and some re-direction of annual freshet flows from Third Portage Lake; complete breaching of dikes will not occur until water levels have stabilized	Impact of rewatering will be of low magnitude	No	High	Rewatering volumes will be carefully monitored.
Goose Island Pit	Instantaneous rewatering of the Portage and Goose Island pit (100 million cubic metres) has the potential for significant drawdowns of Third Portage Lake	High	Regional	Infrequent	Short	All Year	Yes	Rather than instantaneous rewatering, pit flooding will be achieved by a combination of seepage, precipitation and some re-direction of annual freshet flows from Third Portage Lake; complete breaching of dikes will not occur until water levels have stabilized	Impact of rewatering will be of low magnitude	No	High	Rewatering volumes will be carefully monitored.
Waste Dump (Portage & Goose)	Recontoured surface drainage equal to the area of the waste dump gained on closure; loss of storage capacity in small local ponds and wetlands	Low	Local	Continuous	Permanent	All Year	No	Design stable drainage channels	NA	No	Certain	Monitor drainage volumes.

Table A.3 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects					Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects			Mine Waste and Water Management Plan
		Spatial Boundaries			Temporal Boundaries							
		Magnitude	Spatial Extent	Frequency	Duration	Timing			Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
Borrow Pit(s)	No borrow pits identified in the project. All construction material locally generated.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tailings Disposal (Facilities & Ponds)	Permanent reduction of lake area and water volume in 2nd Portage Lake	High	Local	Continuous	Permanent	All Year	Yes	None recommended.	NA	Yes	Certain	None recommended.
	Larger catchment area diverted to Third Portage Lake	Low	Local	Continuous	Permanent	All Year	No	Design stable channels and outlets to Third Portage Lake	NA	No	High	Monitor diversion channel discharge volumes.
Main Site Roads & Traffic	Site roads to be decommissioned and reclaimed to restore drainage patterns - POSITIVE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Airstrip & Air Traffic	Upon completing closure activities the airstrip to be decommissioned and surface recontoured to restore drainage patterns; some ongoing disruption of circulation patterns in Third Portage Lake anticipated	Low	Local	Continuous	Permanent	All Year	No	Recontour and restore natural drainage patterns.	NA	No	High	Maintain drainage structures.
Plant Site Footprint	Upon completing closure activities the plant site to be decommissioned and surface recontoured to restore drainage patterns	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Process Plant Activity	No impacts during closure	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.3 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects					Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects			Mine Waste and Water Management Plan
		Spatial Boundaries			Temporal Boundaries							
		Magnitude	Spatial Extent	Frequency	Duration	Timing			Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
Freshwater Intake & Pipeline	Intake structure and pipeline removed; temporary very minor disturbance in lake during removal activities.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Discharge Facilities & Pipeline	Discharge facilities and pipeline removed; temporary very minor disturbance in lake during removal activities.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Non-Contact Diversion Facilities	On closure all surfaces to be reclaimed and recontoured to provide adequate drainage to the natural environment	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fuel Storage (at Plant Site)	Upon completing closure activities the fuel storage site will be decommissioned and surface recontoured to restore drainage patterns	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
AN / Explosives Storage & Emulsion Plant	Upon completing closure activities the fuel storage will be decommissioned and surface recontoured to restore drainage patterns	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Accommodations Complex	See Plantsite Footprint	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sewage & Waste Disposal	No impacts during closure; facilities removed.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
VAULT FACILITIES												

Table A.3 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects – Spatial Boundaries – Magnitude	Spatial Extent	Frequency	Temporal Boundaries – Duration	Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects – Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Mine Waste and Water Management Plan
Construction Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA
Vault Dike and Pit	Instantaneous rewatering of the Vault pit has the potential for significant drawdowns of Third Portage Lake	High	Regional	Infrequent	Short	All Year	Yes	Rather than instantaneous rewatering, pit flooding will be achieved by a combination of seepage, precipitation and some re-direction of annual freshet flows from Wally Lake; complete breaching of dikes will not occur until water levels have stabilized	Impact of rewatering will be of low magnitude	No	High	Rewatering volumes will be carefully monitored.
Vault Waste Dump	Recontoured surface drainage equal to the area of the waste dump gained on closure; loss of storage capacity in small local ponds and wetlands	Low	Local	Continuous	Permanent	All Year	No	Design stable drainage channels	NA	No	Certain	Monitor drainage volumes.
Vault Access Road & Traffic	Site roads to be decommissioned and reclaimed to restore drainage patterns - POSITIVE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Access Road Culverts (Turn Lake)	Culverts removed to restore natural drainage patterns - POSITIVE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mine Shop / Office	Upon completing closure activities the mine shop and office to be decommissioned and surface recontoured to restore drainage patterns	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OTHER FACILITIES												

Table A.3 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Extent	Frequency	Temporal Boundaries: Duration	Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Mine Waste and Water Management Plan
Winter Road & Traffic	No impact.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Baker Lake Access Road & Traffic	Interference with local surface drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain roads in good condition and maintain adequate drainage pattern.	NA	No	Certain	Use sedimentation traps, selection of more durable materials for road surfacing.
Barge Landing Facility	Activities cease on closure.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barge Traffic	Activities cease on closure.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Staging Facility (approx. 1.5 km east of town)	Interference with local drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain drainage patterns.	NA	No	Certain	Runoff directed to Baker Lake.
Explosives Magazine	Interference with local drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain drainage patterns.	NA	No	Certain	Runoff directed to Baker Lake.
Tank Farm	Interference with local drainage patterns	Low	Local	Infrequent	Medium	Summer	No	Maintain drainage patterns.	NA	No	Certain	Runoff directed to Baker Lake.

APPENDIX B

Water Quality Impact Matrices

Table B.1: Water Quality Impact Matrix – Construction

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
MAIN FACILITIES												
Construction Noise & Activity (General)	Sedimentation may degrade nearby water quality.	medium	footprint to local	Continuous	Short-term	Summer	low	Best management practices for sediment control (silt fences, settling ponds, silt curtains, sediment traps). See Mine Waste and Water Management Plan	high	low	medium	Maintain and monitor conditions. See Mine Waste and Water Management Plan and Aquatic Environmental Management Plan.
	Dust and emission from construction activities may degrade nearby water quality	low	footprint to local	Continuous	Short-term	Summer	low	Use of dust suppressants, watering, road preparation and/or other dust control procedures. See Air Quality and Noise Management Plan.	high	low	high	See Air Quality and Noise Management Plan and Aquatic Environment Management Plan
	Potential for blasting residues (nitrogen species) to be released to lakes in runoff or melting of lake ice	medium	footprint to local	Frequent	Short-term	Summer	low	Appropriate selection of explosive type, and charge load. Best Management Practices to minimize spills and excess explosives loss. See Aquatic Environment Management Plan and Mine Waste and Water Management Plan)	medium	low	medium	See Aquatic Environment Management Plan
	Spills of fuel and/or loads on ice and in close proximity to water bodies may result in water quality degradation.	medium	footprint to local	Rare	Short-term	All Year	low to medium	Implement Spill Contingency Plan and other emergency responses, when required.	medium	low	medium	Spill Contingency Plan, Emergency Response Plan, and Accidents and Malfunctions Plan

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Dikes												
All Dikes	Dust and emission from construction activities may degrade water quality in 2PL and 3PL	low	local	Continuous	Short-term	Summer	low	Use of dust suppressants, watering, road preparation and/or other dust control procedures. See Air Quality and Noise Management Plan.	high	low	high	See Air Quality and Noise Management Plan and Aquatic Environment Management Plan
East Dike	Disturbance of lake sediment during rock placement releasing TSS to 2PL	very high to high	footprint to local	Continuous	Short-term	Summer	high	Utilize silt curtains, and other sediment control practices and monitoring (BMP). See Aquatic Environment Management Plan.	High: Spatial extent reduced to vicinity of dikes inside silt curtains	medium to low	medium	See Aquatic Environment Management Plan and other relevant monitoring documents
	Release of soluble rock and/or till constituents to dike porewaters and 2PL as material is placed into water (blasting residues, metals, TSS).	high to medium	footprint	Continuous	Short-term	Summer	medium	Appropriate selection of explosive type (use emulsion explosives rather than dry ANFO), and charge load. Selection of appropriate rock type for use to minimize metals loading (rocks with low leaching potential) and potential acid generation. See Aquatic Environment Management Plan.	Medium: Magnitude reduced	medium to low	medium to low	Monitor water quality. See Aquatic Environment Management Plan
	Seepage through dike to pit area during and after drawdown	high	footprint	Continuous	Short-term	Summer	low	Collect seepage water and direct to the settling pond.	high	low	high	Mine Waste and Water Management Plan

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
West (Tailings) Dike	Runoff from construction materials will enter the de-watered area of the northwest arm of Second Portage Lake, and will likely be contained within shallow remnant ponds.	very high to high	footprint	Continuous	Short-term	Summer	low	Best management practices for sediment control (silt fences, settling ponds, sediment traps). Construct diversion facilities to capture and direct water to settling ponds.	medium	low	medium	Maintain and monitor conditions. See Mine Waste and Water Management Plan and Aquatic Environmental Management Plan.
Portage South (Bay Zone) Dike	Disturbance of lake sediment during rock placement, releasing TSS to 3PL	very high to high	footprint to local	Continuous	Short-term	Summer	high	Utilize silt curtains, and other sediment control practices and monitoring (BMP). See Aquatic Environment Management Plan.	High: Spatial extent reduced to vicinity of dikes inside silt curtains	medium to low	medium	See Aquatic Environment Management Plan and other relevant monitoring documents
	Release of soluble rock and/or till constituents to 3PL as material is placed into water (blasting residues, metals, TSS)	high to medium	footprint	Continuous	Short-term	Summer	medium	Appropriate selection of explosive type (use emulsion explosives rather than dry ANFO), and charge load. Selection of appropriate rock type for use to minimize metals loading (rocks with low leaching potential) and potential acid generation. See Aquatic Environment Management Plan.	Medium: Magnitude reduced	medium to low	medium to low	Monitor water quality. See Aquatic Environment Management Plan
	Seepage through dike during and after drawdown	high	footprint	Continuous	Short-term	Summer	low	Collect seepage water and direct to the settling pond.	high	low	high	Mined Waste and Water Management Plan
Goose Island & 3rd Portage Arm (South Camp Island) Dikes	Constructed during operations (see comments in Operations Matrix)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Dewatering												
2nd Portage Lake	Release of TSS to 3PL in dewatering discharge	very high to high	footprint to local	Frequent	Short-term	Summer	high	Only relatively clean water to be discharged directly to 3PL; non-compliant water to be directed to tailings storage facility or attenuation storage pond. Monitor location of suction pipe to minimize sediment disturbance. Monitor outlet pipe location and use silt curtains.	high	low	medium	Monitor conditions. See Mine Waste and Water Management Plan and Aquatic Environmental Management Plan.
Portage Pit (3rd Portage Lake)	Release of TSS to 3PL in dewatering discharge	very high to high	footprint to local	Frequent	Short-term	Summer	high	Only relatively clean water to be discharged directly to 3PL; non-compliant water to be directed to tailings storage facility or attenuation storage pond. Monitor location of suction pipe to minimize sediment disturbance. Monitor outlet pipe location and use silt curtains.	high	low	medium	Monitor conditions. See Mine Waste and Water Management Plan and Aquatic Environmental Management Plan.
Goose Island (3rd Portage Lake)	Dewatered during operations (see comments in Operations Matrix)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Pits												
Portage Pit	Release of sediments, metals and contaminants to local sumps, and possibly local lakes and groundwater, from surface water runoff during overburden and lake sediment prestripping and initial mining.	very high to high	footprint to local	Continuous	Short to medium term	Summer	low to high	Direct sump water to tailings storage facility, use sediment control structures and BMP. Contain water and treat, if required before discharge. Impacts to groundwater are likely limited to surface active layer within mine footprint, as groundwater flows into, not out of, dewatered pit. See Mine Waste and Water Management Plan.	high	low	medium	Monitor conditions. See Mine Waste and Water Management Plan and Aquatic Environmental Management Plan.
	Generation of dust from blasting, overburden stripping, excavation and other construction activities depositing in 2PL and 3PL.	medium	footprint	Frequent	Short-term	All Year	low	Use of dust suppressants, watering, road preparation and/or other dust control procedures (see Air Quality and Noise Management Plan). Select appropriate explosives and charge weight. Maintain and operate equipment in an efficient manner.	medium	low	medium	See Air Quality and Noise Management Plan and Aquatic Environment Management Plan
Goose Island Pit	Constructed during operations (see comments in Operation Matrix)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Portage Rock Storage Facility	TSS, metals and acidity from waste rock seepage and runoff released to tundra, surface water and ground water	very high to high	footprint	Continuous	Short to medium term	Summer	medium	Material to be placed in containment facility. Seepage and runoff to be collected by collection facilities and sumps, and directed to Attenuation Storage Pond for discharge and treatment if required. Release to groundwater will be limited by collection facilities. Rock will eventually freeze (below the active zone) reducing potential generation of metals and acidic drainage. See Mine Waste and Water Management Plan.	high	low	high	Monitor conditions. See Mine Waste and Water Management Plan, and Aquatic Environmental Management Plan.
	Dust and emissions generated from stripping of organic soils and deposition of waste rock, reaching 2PL through direct deposition or in runoff.	medium	footprint	Frequent	Short-term	All Year	low	Use of dust suppressants, watering, road preparation and/or other dust control procedures (see Air Quality and Noise Management Plan). Select appropriate explosives and charge weight. Maintain and operate equipment in an efficient manner.	medium	low	medium	See Air Quality and Noise Management Plan and Aquatic Environment Management Plan

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Borrow Pit(s)	N/A (All borrow from within pit footprint)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tailings Disposal Facilities	N/A (See comments on Tailings Dike construction)											
Main Site Roads & Traffic	Sedimentation, dusting, fuel and load spills from traffic affects quality in water bodies along transit route.	medium	footprint and local	Continuous/ Rare	Short-term	Summer/ All Year	medium to low	Use of dust suppressants, watering, road preparation and/or other dust control procedures (see Air Quality and noise Management Plan). Use BMP for sediment control in ditches and control of runoff. Implement Spill Contingency Plan and other emergency responses, when required.	high	low	medium	Monitor conditions. See Mine Waste and Water Management Plan, Aquatic Environmental Management Plan, Air Quality and Noise Management Plan.
Airstrip & Air Traffic	Sedimentation and dusting from construction affects water quality in 3PL.	medium	local	Continuous	Short-term	Summer	medium	Use of dust suppressants, watering, road preparation and/or other dust control procedures (see Air Quality and Noise Management Plan). Use BMP for sediment control in ditches and control of runoff. Implement Spill Contingency Plan and other emergency responses, when required. Minimize disturbed area.	high	low	medium	Monitor conditions. See Mine Waste and Water Management Plan, Aquatic Environmental Management Plan, Air Quality and Noise Management Plan.

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Mine Plant and Associated Facilities	Sedimentation and dusting from construction, fuel and load spills from traffic effects localized water quality that drains to tailings impoundment.	medium	footprint	Continuous/ Rare	Short-term	Summer/ All Year	low	Use of dust suppressants, watering, road preparation and/or other dust control procedures (see Air Quality and Noise Management Plan). Use BMP for sediment control in ditches and control of runoff. Implement Spill Contingency Plan and other emergency responses, when required. Minimize disturbed area.	high	low	medium	Monitor conditions. See Mine Waste and Water Management Plan, Aquatic Environmental Management Plan, Air Quality and Noise Management Plan.
Freshwater Intake & Pipeline	Disruption of 3PL foreshore from construction of wet well or barge causes release of sediment to 3Pl. Blasting for wet well releases blast residues and emissions to 3PL. Construction of pipeline will release sediment to 3PL along route	low	footprint	Rare	Short-term	Summer	low	Use BMP for construction and control of sediment and dust. Minimize disturbed area. Pipeline constructed above ground surface on raised footings.	high	low	high	Monitor conditions.
Discharge Facilities & Pipeline	Disruption of 3PL foreshore from construction of diffuser station and pipeline causes release of sediment to 3Pl.	low	footprint	Rare	Short-term	Summer	low	Use BMP for construction and control of sediment and dust. Minimize disturbed area. Pipeline constructed above ground surface on raised footings.	high	low	high	Monitor conditions.

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Effluent Discharge	Effluent from construction disturbance released to 3PL	medium	local	Continuous	Short-term	Summer	medium	Surface waters in mine footprint collected in natural depressions in dewatered Northwest Arm of 2PL. Best Management Practices applied to reduce total suspended solids. No effluent discharge planned during construction period. See Mine Waste and Water Management Plan	high	low	high	Monitor contained water quality and filling of depressions (Mine Waste and Water Management Plan)
Non-Contact Diversion Facilities	Sedimentation from construction of ditches and sumps released to 2PL and/or 3PL; sediment losses due to degradation of permafrost associated with ditches and sumps, particularly through bogs.	medium	footprint	Frequent	Short-term	Summer	low	Use BMP for construction and control of sediment and dust.	medium	low	medium	Monitor conditions. See Mine Waste and Water Management Plan, Aquatic Environmental Management Plan.

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Storage (at Plant Site)	Construction of laydown areas releases sediment and blast residues which drain to tailings impoundment or 3PL.	medium	footprint	Continuous	Short-term	Summer	low	Runoff directed to tailings impoundment, or directed to sedimentation ponds and pumped to tailings impoundment.	high	low	high	Monitor conditions.
	Fuel storage area construction of area and potential leaks.	medium	footprint	Continuous/ Rare	Short-term	Summer/ All Year	medium to low	Contain runoff and trap sediments from construction area using BMP and direct water to sedimentation ponds. In the event of a spill containment should be achieved by protective liner and bermed area.	high	low	high	Mine Waste and Water Management Plan
AN/Explosives Storage & Emulsion Plant	Sedimentation and blast residues during facility construction released to local water bodies	medium	footprint	Continuous	Short-term	Summer	low	Runoff directed to tailings impoundment, or directed to sedimentation ponds and pumped to tailings impoundment.	high	low	high	Monitor conditions.
	Spills of explosives during manufacture and transport	medium	footprint	Rare	Short-term	All Year	low/medium	Implement Spill Contingency Plan and other emergency responses, when required.	medium	low	medium	Spill Contingency Plan, Emergency Response Plan, and Accidents and Malfunctions Plan

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Site Accommodations	Construction of site accommodations releases sediment to local water bodies and sediment ponds.	medium	footprint	Continuous	Short-term	Summer	low	Use BMP for construction and control of sediment and dust. Minimize disturbed area.	high	low	high	Monitor conditions. See Mine Waste and Water Management Plan, Aquatic Environmental Management Plan.
	Incinerated waste emissions settle in water bodies, degrading water quality	low	local	Continuous	Short-term	All Year	low	Use BMP for operation of facility and insure appropriate environmental controls for stack emissions are in place.	medium	low	high	Air Quality and Noise Management Plan
	Leachate from incineration ashes enter water bodies, degrading water quality	medium	footprint	Continuous	Short-term	Summer	medium to low	Incinerator residue will be disposed of in the tailings facility. Monitor and maintain tailings facility and ensure dust control so incinerator ash does not become airborne.	high	low	medium	Mine Waste and Water Management Plan
Sewage & Waste Disposal	Waste water and sewage discharge increases BOD and nutrient load to water bodies	medium	footprint	Continuous	Short-term	All Year	low	Sewage treatment plant to reduce effluent concentrations to legislated levels. Sewage sludge will be incinerated. Effluent from sewage treatment plant will be disposed of in the tailings facility.	high	low	medium	Mine Waste and Water Management Plan
VAULT FACILITIES												
Construction Noise & Activity	Constructed during operations (see comments in Operations Matrix)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vault Dike	Constructed during operations (see comments in Operations Matrix)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Vault Lake Dewatering & Drainage Facilities	Constructed during operations (see comments in Operations Matrix)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vault Pit	Constructed during operations (see comments in Operations Matrix)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vault Rock Storage Facility	Constructed during operations (see comments in Operations Matrix)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vault Area Effluent Discharge	N/A during construction	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vault Access Road & Traffic	Constructed during operations (see comments in Operations Matrix)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Access Road Culverts (Tern Lake)	Constructed during operations (see comments in Operations Matrix)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mine Shop/Office	Constructed during operations (see comments in Operations Matrix)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OTHER FACILITIES												
Winter Road & Traffic	Spills of fuel and/or loads on ice and in close proximity to water bodies may result in water quality degradation.	medium	footprint	Rare	Short-term	All Year	low to medium	Implement Spill Contingency Plan and other emergency responses, when required.	medium	low	medium	Spill Contingency Plan, Emergency Response Plan, and Accidents and Malfunctions Plan

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Baker Lake Access Road & Traffic	Sedimentation, dusting, fuel and load spills from traffic affects quality in water bodies along transit route.	low to medium	footprint	Continuous/ Rare	Short-term	All Year	low to medium	Implement Spill Contingency Plan and other emergency responses, when required. Follow BMP for storm water management and sediment control, and use dust control measures, as necessary.	medium	low	medium	Spill Contingency Plan, Emergency Response Plan, and Accidents and Malfunctions Plan
Barge Landing Facility	Localized degradation of water quality along Baker Lake foreshore due to sediment loading during construction of facility. Loss of diesel during transfer.	low to medium	footprint	Continuous/ Rare	Short-term	Summer	low to medium	Implement Spill Contingency Plan and other emergency responses, when required. Follow BMP for storm water management and sediment control, and use dust control measures, as necessary.	medium	low	medium	Spill Contingency Plan, Emergency Response Plan, and Accidents and Malfunctions Plan
Barge Traffic	Dust and emissions from off-loading equipment traffic settles in Baker Lake affecting water quality	low	footprint	Continuous	Short-term	Summer	low	Use dust control, as required. Ensure proper equipment maintenance.	medium	low	medium	Air Quality and Noise Management Plan
	Fuel and load spills from traffic affect runoff quality and possibly water bodies along transit route.	low to medium	footprint	Continuous/ Rare	Short-term	All Year	low to medium	Implement Spill Contingency Plan and other emergency responses, when required. Follow BMP for storm water management and sediment control, and use dust control measures, as necessary.	medium	low	medium	Spill Contingency Plan, Emergency Response Plan, and Accidents and Malfunctions Plan

Table B.1 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
In-town Staging Facility												
Explosives Magazine	Disturbance of area with sediment entering surface water runoff during construction. Once in use if an accident, then leaks, fires or explosions from this facility could negatively impact water quality.	low to high	footprint	Continuous/ Rare	Short-term	Summer/ All Year	low to high	Construct plant on concrete foundation surrounded by a berm and drainage control structures. See Hazardous Materials Management Plan	high	low	medium	See Construction Documents and Hazardous Materials Storage Plan
Tank Farm	Diesel spills to Baker Lake	low to medium	footprint	Rare	Short-term	All Year	low to medium	Lined, bermed facility	high	low	high	Spill Contingency Plan, Emergency Response Plan, and Accidents and Malfunctions Plan

Table B.2: Water Quality Impact Matrix – Operation

Project Component	Potential Effect	Assessment of Unmitigated Effects: Spatial Boundaries – Magnitude	Spatial Boundaries – Spatial Extent	Temporal Boundaries – Frequency	Temporal Boundaries – Duration	Temporal Boundaries – Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	Management and Monitoring
MAIN FACILITIES												
Construction Noise & Activity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dikes												
East Dike	Leaching of metals and acidity from dike rock to 2PL Leached metals and acidity initially reach pit as seepage through dike. Metals and acidity in runoff from downstream (pit side) rock embankment report to pit (see Pit discussions)	Low	footprint to local	Continuous	Long-term	Year Round	low	Use of UM rock for capping. Use of IF for submerged rock in upstream shell.	medium	low	medium to high	Monitor water quality adjacent to dikes. See Aquatic Environment Management Plan.
West (Tailings) Dike	Metals and acidity in seepage and runoff from downstream (pit side) of rock embankment report to pit	High	Footprint	Frequent	Medium-term	Summer	Low	Use of IV and UM as construction rock. Directing all seepage and runoff to pit, and pump to attenuation pond for potential treatment. Permafrost aggradation into dike will reduce seepage.	Medium: magnitude reduced	Low	medium	Monitor internal dike temperature using thermistors (potential seepage control).
	Metals and acidity in runoff from downstream portion of tailings dam report to tailings impoundment (See Tailings Storage Facility Discussion)	High	Footprint	Frequent	Medium-term	Summer	Low	Use of IV and UM as construction rock. Directing all seepage and runoff to tailings storage facility and eventually attenuation pond for treatment.	Medium: magnitude reduced	Low	medium	
Portage South (Bay Zone) Dike	Leaching of metals and acidity from dike rock to 3PL during open season Leached metals and acidity initially reach pit as seepage through dike. Metals and acidity in runoff from downstream (pit side) rock embankment report to pit (see Pit discussions)	Low	footprint to local	Continuous	Long-term	Year Round	low	Use of UM rock for capping. Use of IF for submerged rock in upstream shell.	medium	low	medium to high	Monitor water quality adjacent to dikes. See Aquatic Environment Management Plan.

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Goose Island & 3rd Portage Arm (South Camp Island) Dikes	Disturbance of lake sediment during rock placement, releasing TSS to 3PL	very high to high	footprint to local	Continuous	Short-term	Summer	high	Utilize silt curtains, and other sediment control practices and monitoring (BMP). See Aquatic Environment Management Plan.	high	medium to low	medium	See Aquatic Environment Management Plan.
	Release of soluble rock and/or till constituents to 2PL as material is placed into water (blasting residues, metals, TSS)	high to medium	footprint	Continuous	Short-term	Summer	medium to low	Appropriate selection of explosive type (use emulsion explosives rather than dry ANFO), and charge load. Selection of appropriate rock type for use to minimize metals loading (rocks with low leaching potential) and potential acid generation. See Aquatic Environment Management Plan.	medium	medium to low	medium to low	Monitor water quality. See Aquatic Environment Management Plan
	Seepage through dike to pit during and after drawdown (See Pit Discussion)											
	Leaching of metals and acidity from dike rock to 3PL during open season Leached metals and acidity initially reach pit as seepage through dike. Metals and acidity in runoff from downstream shell of dam report to pit (see Pit discussions)	Low	footprint to local	Continuous	Long-term	Year Round	low	Use of UM rock for capping. Use of IF for submerged rock in upstream shell.	medium	low	medium to high	Monitor water quality adjacent to dikes. See Aquatic Environment Management Plan.
Dewatering												
2nd Portage Lake	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Portage Pit (3rd Portage Lake)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Goose Island (3rd Portage Lake)	Release of TSS to 3PL in dewatering discharge	very high to high	footprint to local	Frequent	Short-term	Summer	high	Only relatively clean water to be discharged directly to 3PL; non-compliant water to be directed to tailings storage facility or attenuation storage pond. Monitor location of suction pipe to minimize sediment disturbance. Monitor outlet pipe location and use silt curtains.	high	low	medium	Monitor conditions. See Mine Waste and Water Management Plan and Aquatic Environmental Management Plan.
	Dust and emission from construction activities may degrade water quality in 2PL and 3PL	low	footprint	Continuous	Short-term	Summer	low	Use of dust suppressants, watering, road preparation and/or other dust control procedures. See Air Quality and Noise Management Plan.	high	low	high	See Air Quality and Noise Management Plan and Aquatic Environment Management Plan
Pits												
Portage Pit	Metals, acidity and explosives residues are released in runoff from pit walls and in seepage and runoff from dikes.	Very High	Footprint	Continuous	Medium-term	Year Round	Low	Use of appropriate rock in dike construction. Remove water rapidly from pit. Encourage permafrost aggradation into dike to reduce seepage. Collect pit water and pump to attenuation pond for potential treatment.	Medium	Low	medium	Monitor conditions. See Mine Waste and Water Management Plan.

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Goose Island Pit	Metals, acidity and explosives residues are released in runoff from pit wall and seepage and runoff from dikes	Very High	Footprint	Continuous	Medium-term	Year Round	Low	Use of appropriate rock in dike construction, removal of water rapidly from pit, pit water collected and directed to attenuation pond.	Medium	Low	medium	Monitor conditions. See Mine Waste and Water Management Plan.
	Dust and emissions from haul truck traffic	Low	Footprint	Continuous	Medium-term	Year Round	Low	Use of water trucks for dust suppression	Medium	Low	High	
	Potential for blasting residues (nitrogen species) to be released to lakes in runoff or melting of lake ice	medium	footprint to local	Frequent	Short-term	Summer	low	Appropriate selection of explosive type, and charge load. Best Management Practices to minimize spills and excess explosives loss. See AEMP	medium	Low	medium	See Aquatic Environment Management Plan
Portage Rock Storage Facility	Metals, acidity and nitrogen species are released in seepage and runoff to tundra, active layer groundwater and project lakes	High	Local	Frequent	Medium-Term	Summer	High	Seepage and runoff contained by collection facilities, and directed to sumps and the attenuation pond. Release to active layer groundwater limited by collection facilities.	High: Spatial extent reduced	Low	High	
Borrow Pit(s)	Within waste rock storage facility and/or ultimate pit footprints.											

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Tailings Disposal Facilities	Decant from tailings process water and runoff from exposed tailings beaches confined to tailings storage facility from Year 1 to 5. Tailings Pond and Portage Attenuation Pond are combined after Year 5 (See comments on Portage Attenuation Pond)	Very high	Footprint	Continuous	Medium-term	All Year	Low	Cyanide destruction treatment in mill. Progressive capping with UM rock to promote freezing and improve runoff quality. Recycle to mill to reduce volumes. Contained within tailings pond with in Years 1 to 5. No contribution to effluent discharge to 3PL.	High: Spatial extent confined to footprint; No contribution to effluent.	Low	High	Monitor cyanide destruction plant and reclaim to validate predictions. Monitor of internal temperatures in tailings with thermistors.
	Release of concentrated pore water when forced to surface during tailings freeze back	Very High	Footprint	Infrequent	Medium to Long term	Winter	Low	Containment in tailings disposal facility and/or attenuation pond, with treatment before discharge to environment. Progressive capping with UM rock to encourage freezing of tailings	High	Low	Medium	Monitor tailings beach and recycle
	Dust from desiccated exposed tailings transports metals and nitrogen species to local water bodies.	Medium	Footprint to Local	Infrequent	Medium-term	Year Round	Medium	Progressive placement of UM cover material to reduce erosion and wind blow dust (Abandonment & Restoration Plan)	Medium: magnitude reduced; Spatial extent reduced.	Low	Medium	Air Quality and Noise Monitoring Plan
	Tailings process water moves into the groundwater system via the talik under the former Northwest Arm of Second Portage Lake	Very high	footprint to local	Continuous	Medium-term	Year Round	High	Promote permafrost aggradation in the tailings facility to encourage permafrost to act as a cutoff to groundwater flow.	High: Reduce magnitude, reduce spatial extent	Low	Medium	Monitor permafrost development in the underlying talik

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Main Site Roads & Traffic	Diesel spills to local water bodies	Medium	Footprint to Local	Rare	Medium to Long term	Year Round	Medium to Low	Best Management Practices and Spill Contingency Plans	Medium	Low	High	
	Dust from traffic releases metals and nitrogen species to local water bodies	Low	Footprint/Local	Frequent	Medium-term	Year round	Low	Dust control water will be drawn from the Portage Attenuation Pond (Abandonment & Restoration Plan) within Portage catchment. Dust control water for haul roads outside the Portage catchment areas will be drawn from Phase Lake in an effort to keep contact water within the mining areas. (Abandonment & Restoration Plan)	Medium	Low	High	Air Quality and Noise Monitoring Plan
	Metals, acidity and nitrogen species in runoff and seepage from road bed are released to local water bodies	Low	Footprint to Local	Frequent	Medium to Long term	Summer	Low	Majority of roadways servicing the Portage mining and milling areas are located such that their drainage will be directed at proposed contact water management infrastructure (Abandonment & Restoration Plan)	Medium	Low	medium	Mine site monitoring, and settling pond cleanout

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Timing	Assessment of Unmitigated Effects: Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Influence of Mitigation on Effects Assessment	Assessment of Residual Effects: Significance of Residual Impacts	Assessment of Residual Effects: Probability	Management and Monitoring
Airstrip & Air Traffic	Fuel spills to local water bodies	Medium	Footprint to Local	Rare	Medium to Long term	Year Round	Medium to Low	Best Management Practices and Spill Contingency Plans	Medium	Low	High	
	Dust from air traffic/ loading and unloading transports metals and nitrogen species to local water bodies	Low	Footprint/Local	Frequent	Medium-term	Year round	Low	Dust control water will be drawn from the Portage Attenuation Pond (Abandonment & Restoration Plan) within Portage catchment. Dust control water for haul roads outside the Portage catchment areas will be drawn from Phase Lake in an effort to keep contact water within the mining areas. (Abandonment & Restoration Plan)	Medium	Low	High	Air Quality and Noise Monitoring Plan
	Metals, acidity and nitrogen species in runoff and seepage from road bed are released to local water bodies	Low	Footprint to Local	Frequent	Medium to Long term	Summer	Low	Runoff collected in ditches and directed to attenuation pond	Medium	Low	Medium	Mine site monitoring, and settling pond cleanout
Mine Plant and Associated Facilities	Runoff from mine plant site contains TSS, metals, acidity and potential reagent spills.	Medium	Footprint	Infrequent	Medium-term	Summer	Medium	Plant site runoff directed to a local sump, and pumped to attenuation pond.	High	Low	High	Mine site monitoring, and settling pond cleanout
	Dust from traffic and ore handling releases metals and nitrogen species to local water bodies.	Low	Footprint/Local	Frequent	Medium-term	Year round	Low	Dust control water will be drawn from the Portage Attenuation Pond (Abandonment & Restoration Plan)	Medium	Low	High	Air Quality and Noise Monitoring Plan
	Inadvertent spill of tailings.	High	Footprint	Rare	Medium-term	Year round	Low	Tailings contained within ditch, containment sumps located in depressions, Pipeline pressure monitored	High	Low	High	Regular inspections of tailings pipeline; Monitoring of tailings line pressure.
Freshwater Intake & Pipeline	N/A											

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Portage Attenuation Pond (Discharge Facilities & Pipeline)	From Year 1 to 5, effluent from attenuation pond releases TSS, metals, acidity, explosives residues to 3PL. Effluent sources are runoff and seepage from Portage Area pits, Portage Rock Storage Facility and Plant Site Runoff.	Medium	Local	Continuous	Medium-term	Summer	Medium	All effluents directed to Portage Attenuation Pond for settling and monitoring prior to discharge; See comments on effluent sources for additional mitigation. Effluent discharged through diffusers, only during summer months	medium	Low	Low	
	After Year 5, effluent includes tailings supernatant, releasing TSS, metals, acidity, explosives residue and cyanide species to 3PL.	High	Local	Continuous	Medium-term	Summer	High	All effluents directed to Portage Attenuation Pond for settling and treatment prior to discharge. See comments on effluent sources for additional mitigation. Effluent discharged through diffusers, only during summer months. Potable water intake located away from effluent discharge location.	medium	Medium	Low	
Non-Contact Diversion Facilities	Sediment loss to receiving waters due to degradation of permafrost associated with ditch and sump construction, particularly through bogs..	medium	Local	Infrequent	Medium to Long term	Summer	Low	Construction of diversion facility to address local permafrost conditions, and placement of erosion protection.	Medium	Low	Medium	See Aquatic Environmental Management Plan
Storage (at Plant Site)	Runoff from storage facility contains contaminants from pad, stored materials or spilled diesel and reagents.	High	Footprint	Infrequent	Medium - term	Summer	Low	Plant site runoff directed to a local sump, and pumped to attenuation pond. Spill Contingency Plan	High	Low	Medium	

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Influence of Mitigation on Effects Assessment	Assessment of Residual Effects: Significance of Residual Impacts	Assessment of Residual Effects: Probability	Management and Monitoring
AN/Explosives Storage & Emulsion Plant	Spills of explosives during manufacture and transport	Medium	Footprint	Rare	Medium to Long term	Summer	Low	Best Management Practices; Runoff collected and directed to settling pond.	Medium	Low	Medium	
	Site runoff releases nitrogen species to local water bodies	Medium	Footprint	Infrequent	Medium to Long term	Summer	Low	Placed on a local topographic high; runoff collected and directed to settling pond	Medium	Low	Medium	See Aquatic Environmental Management Plan
Site Accommodation s	Incinerated waste emissions settle in water bodies, degrading water quality	Low	Local	Frequent	Medium-term	Year Round	Low	Best Management Practices in operation of incinerator.	High	Low	Medium	Air Quality and Noise Monitoring Plan
	Leachate from incineration ashes enter water bodies, degrading water quality							Ash from incinerated organic materials (including but not limited to paper, wood, food waste and sewage treatment sludge will be placed within the tailings impoundment (Abandonment & Restoration Plan)				
Sewage & Waste Disposal	Waste water and sewage discharge increases BOD and nutrient load to water bodies	Medium	Footprint	Continuous	Medium to Long term	Year Round	Medium	Effluent will be treated to a Level 3 standard for discharge into the pipeline tailings stream (Abandonment & Restoration Plan)	High	Low	High	
	Leachate from landfill released to water bodies	medium	Local	Frequent	Long-term	Year Round	High	All materials considered unsuitable for landfill depositions will be packaged for shipment and disposed off site (Abandonment & Restoration Plan)	High	Low	Medium	
VAULT FACILITIES												
Construction Noise & Activity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Vault Dike	Construction in Year 1: Disturbance of lake sediment during rock placement, releasing TSS to Wally Lake and Attenuation Storage Pond	very high to high	footprint to local	Continuous	Short-term	Summer	high	Utilize silt curtains, and other sediment control practices and monitoring (BMP). See Aquatic Environment Management Plan.	high	medium to low	medium	See Aquatic Environment Management Plan and other relevant monitoring documents
	Release of soluble rock and/or till constituents as material is placed underwater (blasting residues, metals, TSS) to Wally Lake and Attenuation Storage Pond	high to medium	footprint	Continuous	Short-term	Summer	medium to low	Appropriate selection of explosive type (use emulsion explosives rather than dry ANFO), and charge load. Selection of appropriate rock type for use to minimize metals loading (rocks with low leaching potential) and potential acid generation. See Aquatic Environment Management Plan.	medium	medium to low	medium to low	Monitor water quality. See Aquatic Environment Management Plan
	Metals, acidity and nitrogen species released in seepage through dike and runoff from downstream dike shell to Attenuation Pond during and after drawdown	high	footprint	Continuous	Short-term	Summer	low	Collect seepage water and direct to the settling pond.	high	low	high	Mine Waste and Water Management Plan
	Leaching of metals and acidity from dike rock to Wally Lake during open season	Low	footprint to local	Continuous	Long-term	Year Round	low	Use of UM rock for capping. Use of IF for submerged rock in upstream shell.	medium	low	medium to high	Monitor water quality adjacent to dikes. See Aquatic Environment Management Plan.

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Vault Lake Dewatering & Drainage Facilities	Release of TSS and metals to Turn Lake in dewatering discharge of relatively clean water from Phaser Lake	very high to high	footprint to local	Frequent	Short-term	Summer	high	Only relatively clean water to be discharged directly to Turn Lake; non-compliant water to be directed to the attenuation storage pond. Monitor location of suction pipe to minimize sediment disturbance. Monitor outlet pipe location.	high	low	medium	Monitor conditions. See Mine Waste and Water Management Plan and Aquatic Environmental Management Plan.
	Release of TSS and metals to Wally Lake in dewatering discharge of relatively clean water from Vault Lake (V1)	very high to high	footprint to local	Frequent	Short-term	Summer	high	Turbid water left in attenuation storage pond; treated for TSS removal if required. Monitor location of suction pipe to minimize sediment disturbance. Monitor outlet pipe location and water quality.	high	low	medium	Monitor conditions. See Mine Waste and Water Management Plan and Aquatic Environmental Management Plan.
	Sediment loading in attenuation pond is increased as Vault Lake bottom sediments are disturbed during drawdown, and runoff from local area increases TSS.	very high to high	footprint to local	Continuous	Short-term	Summer	high	Turbid water left in attenuation storage pond; treated for TSS removal if required	high	low	medium	Monitor conditions. See Mine Waste and Water Management Plan and Aquatic Environmental Management Plan.
	Runoff from the local area releases TSS to the Attenuation Pond.	medium	local	Continuous	Short-term	Summer	medium	A small berm will be constructed between Phaser and Vault Lake to ensure no flow is directed to Vault Lake. Non-contact water is directed away from the Attenuation Pond				

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Vault Pit	Metals, acidity and explosives residues are released in runoff from pit walls.	Medium	Footprint	Continuous	Medium-Term	Year Round	Low	Pump to Attenuation Pond	High	Low	medium	
	Dust and emissions from haul truck traffic	Low	Footprint	Continuous	Medium-term	Year Round	Low	Use of water trucks for dust suppression	Medium	Low	High	
	Potential for blasting residues (nitrogen species) to be released to lakes in runoff or melting of lake ice	medium	footprint to local	Frequent	Short-term	Summer	low	Appropriate selection of explosive type, and charge load. Best Management Practices to minimize spills and excess explosives loss. See Aquatic Environment Management Plan.	medium	low	medium	See Aquatic Environment Management Plan
Vault Rock Storage Facility	Metals, acidity and nitrogen species are released in seepage, runoff, and active layer groundwater.	High	Footprint	Frequent	Medium-term	Summer	High	Seepage and runoff contained by collection facilities, and directed to sumps, then to Vault attenuation pond. Release to active layer groundwater limited by collection facilities.	Medium	Low	High	
Vault Area Effluent Discharge	Collected water from pits, waste rock piles are directed to the Attenuation Pond and discharge to Wally Lake	High	Local	Continuous	Medium-term	Summer	High	All effluents to be directed to the Vault Attenuation Pond for settling and monitoring prior to discharge. Effluent to be discharged through diffuser, only during summer months. Treatment of effluent prior to discharge if required (Abandonment & Restoration Plan)	medium	medium	medium	

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Influence of Mitigation on Effects Assessment	Assessment of Residual Effects: Significance of Residual Impacts	Assessment of Residual Effects: Probability	Management and Monitoring
Vault Access Road & Traffic	Diesel spills to local water bodies	Medium	Footprint to Local	Rare	Medium to Long term	Year Round	Medium to Low	Best Management Practices and Spill Contingency Plans	Medium	Low	High	Spill Contingency Plan, Emergency Response Plan, and Accidents and Malfunctions Plan
	Dust from traffic releases metals and nitrogen species to local water bodies	Low	Footprint/Local	Frequent	Medium-term	Year round	Low	Dust control water for haul roads will be drawn from Phaser Lake (Abandonment & Restoration Plan)	Medium	Low	High	Air Quality and Noise Monitoring Plan
	Metals, acidity and nitrogen species in runoff and seepage from road bed are released to local water bodies	Low	Footprint to Local	Frequent	Medium to Long term	Summer	Low	Where possible, haul road drainage will be directed to areas serviced by contact water management infrastructure.	Medium	Low	medium	Mine site monitoring, and settling pond cleanout
Access Road Culverts (Turn Lake)	Metals, acidity and nitrogen species in runoff and seepage from road bed are released to Turn Lake	Medium	Footprint to Local	Rare	Medium to Long term	Year Round	Medium to Low	Select rock with low ARD and metal leaching potential will be used for construction. Best Management Practices for sediment and erosion control	Medium	Low	High	Mine site monitoring, and settling pond cleanout
Mine Shop/Office	Runoff from mine plant site contains TSS, metals, acidity and potential reagent spills.	Medium	Footprint	Continuous	Medium-term	Summer	Low	Runoff collected in ditches and directed to attenuation pond	medium	Low	High	Mine Site monitoring.
OTHER FACILITIES												
Winter Road & Traffic	Diesel spills released to local water bodies	Medium	Local	Rare	Medium to Long term	Winter	Medium	Best Practices; Spill Contingency Plan	Medium	Low	medium	See Aquatic Environment Management Plan.
Baker Lake Access Road & Traffic	Diesel spills released to local water bodies	Medium	Local	Rare	Medium to Long term	Year Round	Medium	Best Practices; Spill Contingency Plan	Medium	Low	medium	See Aquatic Environment Management Plan.
Barge Landing Facility	Spills from transferred materials	Medium	Local	Rare	Medium to Long term	Summer	Medium	Best Practices; Spill Contingency Plan	Medium	Low	medium	See Aquatic Environment Management Plan.
Barge Traffic	Diesel spills	Medium	Local	Rare	Medium to Long term	Summer	Medium	Best Practices (Abandonment & restoration Plan)	Medium	Low	medium	See Aquatic Environment Management Plan.
Staging Facility (approx. 1.5 km east of town)	Runoff contains reagent spills	Medium	Footprint	Infrequent	Medium to Long term	Year Round	Low	Best Practices; Spill Contingency Plan	Medium	Low	medium	See Aquatic Environment Management Plan.

Table B.2 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Explosives Magazine	Runoff contains nitrogen species	Medium	Footprint	Rare	Medium to Long term	Year Round	Low	Best Practices; Spill Contingency Plan	Medium	Low	medium	See Aquatic Environment Management Plan.
Tank Farm	Diesel spills during transfer.	High	Footprint	Infrequent	Medium to Long term	Year Round	Low	Best Practices - The tank farm will be contained within a secondary containment facility approximately 15,200 m2 comprising a geomembrane liner overlying soil containment berms and access ramps, a storm water sump and grease trap. (Abandonment & Restoration Plan).	Medium	Low	medium	See Aquatic Environment Management Plan.

Table B.3: Water Quality Impact Matrix – Closure & Post Closure

Project Component	Potential Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Frequency	Temporal Boundaries: Duration	Temporal Boundaries: Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	Management and Monitoring
MAIN FACILITIES												
Construction Noise & Activity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dikes												
East Dike	Flooding will release soluble components from downstream (pit side) rock fill embankment to Pit Lake (See Comments on Pit Lake)											
	Leaching of metals and acidity from dike rock to 2PL	Low	Footprint to local	Continuous	Long-term	Year Round	Low	Use of UM rock for exposed surface rock. Use of IF for submerged rock in upstream shell.	medium	low	medium	Monitor water quality adjacent to dikes. See Aquatic Environment Management Plan.
West (Tailings) Dike	Flooding will release soluble components from downstream (pit side) rock fill embankment to Pit Lake (See Comments on Pit Lake)											
Portage South (Bay Zone) Dike	Flooding will release soluble components from downstream (pit side) rock fill embankment to Pit Lake (See Comments on Pit Lake)											
	Leaching of metals and acidity from dike rock to 2PL	Low	Footprint to local	Continuous	Long-term	Year Round	Low	Use of UM rock for exposed surface rock. Use of IF for submerged rock in upstream shell.	medium	low	medium	Monitor water quality adjacent to dikes. See Aquatic Environment Management Plan.
Goose Island & 3rd Portage Arm (South Camp Island) Dikes	Flooding will release soluble components from downstream (pit side) rock fill embankment to Pit Lake (See Comments on Pit Lake)											
	Leaching of metals and acidity from dike rock to 2PL	Low	Footprint to local	Continuous	Long-term	Year Round	Low	Use of UM rock for exposed surface rock. Use of IF for submerged rock in upstream shell.	medium	low	medium	Monitor water quality adjacent to dikes. See Aquatic Environment Management Plan.
Dewatering												
2nd Portage Lake	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table B.3 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects					Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries					Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Portage Pit (3rd Portage Lake)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Goose Island (3rd Portage Lake)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pits												
Portage Pit	Flooding releases soluble metals from pit walls and dikes to Pit Lake	Medium	Footprint	Continuous	Short to medium term	Summer	Low	Flood slowly over five summer seasons to minimize TSS release. Pit Lake water not to be released to project lakes until of acceptable quality	Low	Low	low	Water quality will be monitored and managed until pit water is acceptable to be mixed with surrounding lake water.
Goose Island Pit	Flooding creates a single Pit Lake from North Portage, Third Portage and Goose Pits (see Pit Lake comments)											

Table B.3 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects					Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries					Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Pit Lake	Pit Lake water released to 3PL	Medium	Local to regional	Continuous	Medium-term to Long term	All year	High	Effluent will be managed, such that water quality will not be released until it reached acceptable levels (Abandonment & Restoration Plan). Removal of portions of the Goose Island Dike will not occur until the pit lake elevation achieves static conditions and the water quality monitoring results are considered acceptable for discharge without treatment to the environment. (Abandonment & Restoration Plan)	Medium: Magnitude reduced	Low	Low	Water quality will be monitored and managed until pit water is acceptable to be mixed with surrounding lake water.
	Pit Lake water moves into underlying talik to impact underlying deep regional groundwater.	Medium	Footprint	Continuous	Long-term	All year	Low	Low differential head between Pit Lake and surrounding lakes limits driving head, such that downward contaminant transport limited to diffusion.	Low: reduction of spatial extent below pit floor.	Low	moderate	Water quality monitored in pit lake and minimal driving head confirmed.
	Pit Lake itself becomes permanent part of receiving environment	Medium	Local	Continuous	Long-term	All Year	High	Pit Lake will not become part of 3PL until water quality reaches acceptable levels.	Medium	Medium	Low	Water quality will be monitored and managed until pit water is acceptable to be mixed with surrounding lake water.

Table B.3 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects					Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries					Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Portage Rock Storage Facility	Release of metals and acidity from active layer to tundra and local lakes	Very high	Footprint	Frequent	Long-term	Summer	High	Regrading to promote runoff and use of UM rock in active layer to minimize release of acidity and metals (Abandonment & Restoration Plan). Seepage to be directed to Portage Attenuation Pond until quality and volumes are shown suitable for uncontrolled discharge.	High	Medium	Low	Monitoring to validate predictions (see Aquatic Environment Management Plan)
Borrow Pit(s)	N/A											
Tailings Disposal Facilities	Combined with Portage Attenuation Pond (see comments below)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Main Site Roads & Traffic	Continued leaching of metals and acidity from active layer rock	Medium	Footprint	Frequent	Long-term	Summer	Medium	Selection of appropriate construction rock. (see Water and Waste Management Plan). Contingency (where monitoring indicates unanticipated metal leaching or acidic drainage) capping with nominal 2 m layer of UM rock.	High	Low	moderate	

Table B.3 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Airstrip & Air Traffic	Continued leaching of metals and acidity from active layer rock	Medium	Footprint	Frequent	Long-term	Summer	Medium	Selection of appropriate construction rock. (see Water and Waste Management Plan). Contingency (where monitoring indicates unanticipated metal leaching or acidic drainage) capping with nominal 2 m layer of UM rock.	High	Low	moderate	
Mine Plant and Associated Facilities	Continued leaching of metals and acidity from active layer rock	Medium	Footprint	Frequent	Long-term	Summer	Medium	Selection of appropriate construction rock. (see Water and Waste Management Plan). Contingency (where monitoring indicates unanticipated metal leaching or acidic drainage) capping with nominal 2 m layer of UM rock.	High	Low	moderate	
Freshwater Intake & Pipeline	N/A (removed)											

Table B.3 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects					Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries					Influence of Mitigation on Effects Assessment	Significanc e of Residual Impacts	Probabilit y	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Portage Attenuation Pond	Drainage/runoff from rock storage facility continues to discharge to attenuation pond.	High	Footprint	Frequent	Long-term	Summer	High	See comments on Portage Rock Storage Facilities for mitigation. Portage Attenuation Pond provides additional settling and aging of runoff.	High	Medium	Moderate	
	Release of concentrated pore water when forced to surface during tailings freeze back; Release of metals and acidity from active layer of frozen tailings to attenuation pond	Very high	Footprint	Infrequent	Long-term	Summer	High	Placement of UM cover material to allow pore water to move into rock voids and minimize release of acidity and metals from tailings by promoting freezing in the tailings (Abandonment & Restoration Plan). Tailings placement to be managed to promote a naturally graded, sloping beach surface prior to freezing to promote runoff. Tailings runoff permanently directed to Portage Attenuation Pond for settling and aging.	High	Medium	Moderate	
	Dust from desiccated exposed tailings releases metals and nitrogen species deposited in local water bodies.	Medium	Footprint to local	Frequent	Long-term	Year Round	High	Placement of UM cover material to reduce erosion and wind blow dust (Abandonment & Restoration Plan)	High: reduces magnitude and spatial extent	Low	High	See Air Quality and Noise Monitoring Plan

Table B.3 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Discharge Facilities & Pipeline	Portage Attenuation Pond connected to 3PL	Medium	Local	Continuous	Long-term	Summer	High	Treatment plant continues in operation until all mime operations and closure activities are completed in the Portage mining and milling areas, the attenuation pond is drained and covered, and the monitoring results can demonstrate that the water quality from this watershed is acceptable for discharge without treatment to the environment (Abandonment & Restoration Plan)	Medium	Low	Low	See Aquatic Environment Management Plan
Non-Contact Diversion Facilities	Remain as per operations.											
Storage (at Plant Site)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AN/Explosives Storage & Emulsion Plant	N/A after removal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Site Accommodations	N/A after removal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sewage & Waste Disposal	N/A after removal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
VAULT FACILITIES												
Construction Noise & Activity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table B.3 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects					Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries					Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Vault Dike	Flooding will release soluble components from dike downstream shell materials to Attenuation Pond. (see comments on Vault pit)							Selection of appropriate construction rock to minimize buildup of metals and acidity prior to flooding. Dike can be removed entirely if required.				
	Leaching of metals and acidity from dike rock to Wally Lake during open season	Low	Footprint to local	Continuous	Long-term	Year Round	Low	Use of UM rock for exposed surface rock. Use of IF for submerged rock in upstream shell. Dike can be removed entirely if required.	medium	low	medium	Monitor water quality adjacent to dikes. See Aquatic Environment Management Plan.
Vault Lake Dewatering & Drainage Facilities	Increased TSS as non-contact diversion above Phase Lake returned to natural path and flow to pit	Medium	Footprint	Frequent	Short to medium term	Summer	Low	Use of erosion protection and best management practices for sediment control until flows are reestablished	Medium	Low	High	On-site monitoring at closure

Table B.3 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Vault Pit Lake/Attenuation Pond	Flooding releases soluble metals from previously exposed pit walls and suspended sediments from former lake bed to Attenuation Pond	Medium	Footprint	Continuous	Short to medium term	Summer	Medium	Flooding conducted over five summer seasons to minimize impacts to lake elevations.	low	Medium	Low	Water quality will be monitored and managed until pit water is acceptable to be mixed with surrounding lake water.
	At steady state, both exposed and submerged pit walls and dike materials continue to leach to Vault pit/Attenuation Pond. Dike removed to connect Vault Attenuation Pond with Wally Lake.	Low	Local	Continuous	Long-term	Year Round	Low	Effluent will be managed, such that water quality will not be released until it reached acceptable levels (Abandonment & Restoration Plan). Removal of Vault Dike will not occur until the pit lake water levels achieve static conditions and the water quality monitoring results from pit lake are considered acceptable for discharge without treatment to the environment. (Abandonment & Restoration Plan)	Medium	Low	Low	Water quality will be monitored and managed until pit water is acceptable to be mixed with surrounding lake water.
	Pit Lake water moves into talik that develops under Attenuation Pond and flooded pit, and may be released to underlying deep regional groundwater system.	Medium	Footprint	Continuous	Long-term	All year	Low	Analyse suggests that the talik will not develop a connection to the underlying regional groundwater system. In addition, low differential head between Pit Lake and surrounding lakes limits driving head, such that downward contaminant transport would primarily be limited to diffusion.	Low	Low	moderate	Water quality monitored in pit lake, and minimal driving head confirmed.

Table B.3 Continued

Project Component	Potential Effect	Assessment of Unmitigated Effects					Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries					Influence of Mitigation on Effects Assessment	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Vault Rock Storage Facility	Continued release of metals and acidity from active layer to local water bodies and Attenuation Pond	Medium to High	Footprint	Frequent	Long-term	Summer	Medium	Regrading to promote runoff. Use of appropriate construction rock.	Medium	Medium	Low	
Vault Access Road & Traffic	Continued release of metals and acidity from active layer to local water bodies and Attenuation Pond	Low	Local to footprint	Frequent	Long-term	Summer	Low	Regrading to promote runoff. Contingency (where monitoring indicates unanticipated metal leaching or acidic drainage) capping with nominal 2 m layer of UM rock.	Medium	Low	High	
Access Road Culverts (Tern Lake)	N/A after removal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mine Shop/Office	N/A after removal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OTHER FACILITIES												
Winter Road & Traffic	N/A after final closure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Baker Lake Access Road & Traffic	N/A after final closure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Barge Landing Facility	N/A after final closure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Barge Traffic	N/A after final closure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
In-town Staging Facility	N/A after final closure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Explosives Magazine	N/A after final closure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tank Farm	N/A after final closure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

APPENDIX C

Table C.1: Fish Impact Matrix – Construction

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency & Timing						
MAIN FACILITIES											
Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dike Construction											
Second Portage Lake East Dike	Disturbance of fine sediments beneath dike footprint causing increase in TSS. Compression of sediments releasing dissolved metals in pore water. Dispersion of fish away from the disturbed area (avoidance of TSS).	M	L	S	F	YES	Use silt curtains to contain sediments during dike construction and prevent fish from entering disturbed area, minimizing potential for exposure to higher dissolved metals in water. Eliminate overlap with sensitive time period with fish.	Possible escape of sediment beneath or around silt curtain causing local increase in TSS and impaired feeding efficiency. Evacuation of fish from disturbed area. Mitigation will eliminate overlap with sensitive timing, and decrease the magnitude and spatial extent of effects.	NO	High	AEMP will monitor water quality in dike near-field. Targeted study to address productivity of fish habitat on dike exterior. See NNL Habitat Report (2005) for details of compensation for habitat loss and implications for fish.
	Elimination of the westernmost connecting channel between Third and Second Portage lakes. Impaired fish movement between the lakes.	L	L	M*	I	NO	Improve fish passage at the remaining two connecting channels between Third and Second Portage lakes. See No Net Loss Report (2005) for full details.	Improved fish passage between Second and Third Portage lakes.	NO	High	Creation of an improved connection channel between the lakes is a key component of the No Net Loss of Fish Habitat program. A targeted study (AEMP) will monitor movement of fish between Second and Third Portage lakes via the new channel
Second Portage Lake Tailings Dike	NA (See Post-Closure phase).	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects – Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects – Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects – Temporal Boundaries: Duration	Assessment of Unmitigated Effects – Temporal Boundaries: Frequency & Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Assessment of Residual Effects: Significance of Residual Effects	Assessment of Residual Effects: Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Dike Construction – Third Portage Lake Portage Dike	Disturbance of fine sediments beneath dike footprint causing increase in TSS. Compression of sediments releasing dissolved metals in pore water. Dispersion of fish away from the disturbed area due to disturbance (avoidance of TSS).	L	L	S	F	NO	Use silt curtains to contain sediment during dike construction.	Possible escape of sediment beneath or around silt curtain causing local increase in TSS and impaired feeding efficiency. Evacuation of fish from disturbed area. Mitigation will eliminate overlap with sensitive timing, and decrease the magnitude and spatial extent of effects.	NO	High	AEMP will monitor water quality in dike near-field and assess impacts of TSS and metals in Third Portage Lake See NNL Habitat Report (2005) for habitat compensation assessment.
	Elimination of the westernmost connecting channel between Third and Second Portage lakes. Impaired fish movement between the lakes.	L	L	M*	I	NO	Improve fish passage at the remaining two connecting channels between Third and Second Portage lakes. See No Net Loss Report (2005) for full details.	Improved fish passage between Second and Third Portage lakes.	NO	High	Creation of an improved connection channel between the lakes is a key component of the No Net Loss of Fish Habitat program. A targeted study (see AEMP) will monitor movement of fish between Second and Third Portage lakes via the new channel

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Duration	Temporal Boundaries: Frequency & Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Dike Construction – Third Portage Lake Goose Island	Disturbance of fine sediments beneath dike footprint causing increase in TSS. Compression of sediments releasing dissolved metals in pore water. Dispersion of fish away from the disturbed area due to disturbance, TSS.	L	L	S	F	NO	Use silt curtains to contain sediment during dike construction.	Possible escape of sediment beneath or around silt curtain causing local increase in TSS and impaired feeding efficiency. Evacuation of fish from disturbed area. Mitigation will eliminate overlap with sensitive timing, and decrease the magnitude and spatial extent of effects.	NO	High	AEMP will monitor water quality in dike near-field and assess impacts of TSS and metals in Third Portage Lake. See NNL Habitat Report (2005) for habitat compensation assessment.
	Introduction of nitrates from blasted rock used to construct dike. Increase in phytoplankton and zooplankton abundance may benefit fish.?	L	L	M*	F	NO	No mitigation possible to avoid nutrient input to during construction.	Small increase in fish productivity from nutrients.	NO	Mod	A targeted study has been proposed to monitor near-field water quality and assess changes in productivity (see AEMP).
Blasting											
Dike Construction and Pit Development	Blasting of rock to remove overburden and material, during pit development may cause mortality of fish and fish eggs on or near dikes habitat. Degree of impact depends upon setback from dike and stage of pit development which dictates distance between blast and fish bearing water.	L	L	M*	F	NO	Use smaller charges and blast holes, stagger detonations. Increase set back distance (see Blast Design Report).	Possible residual mortality of fish depending on blast frequency and peak particle velocity. Mitigation reduces magnitude, extent and frequency of effect.	NO	Mod	Monitoring of blasting effects on fish has been identified as a Targeted Study (see AEMP).

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Duration	Temporal Boundaries: Frequency & Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Pit Dewatering											
Dewatering of Second Portage North Arm	Discharge of 12 M m^3 of water behind the East Dike into Third Portage (north basin). During drawdown, entrained sediment and porewater metals may be discharged into the lake. Fish avoidance of these waters (TSS).	M	R	S	I	YES	Locate dewatering barge and pumps in an area of Second Portage Lake such that withdrawal of suspended sediments from water column is minimized.	Temporary increase in dissolved metals; increase in water column TSS, sedimentation and reduced light penetration resulting in impaired feeding by fish; temporary evacuation of fish from disturbed area. Mitigation will reduce magnitude and spatial extent of effects.	NO	Mod	Monitoring of water column TSS during dewatering of impoundment has been identified as a targeted study within the AEMP.
	Discharge of water drawn from Second Portage to Second and Third Portage (north basin) lakes will increase water levels and discharge to Third Portage Lake, increasing flow and velocity in connecting channel. Altered fish movements between lakes.	L	R	S	I	NO	Excavate connecting channel to Second Portage Lake to accommodate increased flow from Third Portage Lake.	Increase in flow rate through connecting channel. Given that passage by fish between is currently impaired, additional flow may assist fish movement.	NO	High	Routine monitoring of fish passage between Second and Third Portage lakes and between Second Portage and Tehek lakes has been incorporated as part of the AEMP.
Dewatering of Portage Pit into Third Portage Lake	Entrainment of sediment during draw down and pumping of impounded water within Portage pit into Third Portage Lake. Dispersal and reduction in feeding efficiency by fish.	L	L	S	I	NO	Locate dewatering barge and pumps in Third Portage Lake such that withdrawal of suspended sediments from water column is minimized.	Temporary increase in dissolved metals; increase in water column TSS, sedimentation and reduced light penetration resulting in impaired feeding by fish; temporary evacuation of fish from disturbed area.	NO	High	Monitoring of water column TSS during dewatering of Portage impoundment has been identified as a targeted study within the AEMP.

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Duration	Temporal Boundaries: Frequency & Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Dewatering of Bay Zone Pit into Third Portage Lake	Entrainment of sediment during draw down and pumping of impounded water within Bay Zone pit into Third Portage Lake. Dispersal and reduction in feeding efficiency by fish.	L	L	S	I	NO	Locate dewatering barge and pumps in Third Portage Lake such that withdrawal of suspended sediments from water column is minimized.	Temporary increase in dissolved metals; increase in water column TSS, sedimentation and reduced light penetration resulting in impaired feeding by fish; temporary evacuation of fish from disturbed area. Mitigation will reduce magnitude and spatial extent of effects.	NO	High	Monitoring of water column TSS during dewatering of Bay Zone impoundment has been identified as a targeted study within the AEMP.
Dewatering of Goose Island Pit into Third Portage Lake	Entrainment of sediment during draw down and pumping of impounded water within Goose Island pit into Third Portage Lake. Dispersal and reduction in feeding efficiency by fish.	L	L	S	I	NO	Locate dewatering barge and pumps in Third Portage Lake to minimize entrainment of suspended sediment.	Temporary increase in dissolved metals; increase in water column TSS, sedimentation and reduced light penetration resulting in impaired feeding by fish; temporary evacuation of fish from disturbed area. Mitigation will reduce magnitude and spatial extent of effects.	NO	High	Monitoring of water column TSS during dewatering of Goose Island impoundment has been identified as a targeted study within the AEMP.

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries – Magnitude	Spatial Boundaries – Spatial Extent	Temporal Boundaries – Duration	Temporal Boundaries – Frequency & Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Pit Development											
Second Portage Pit	Pit development will result in medium-term loss of fish in pit footprint at Second Portage Lake.	M	L	M*	F	YES	Loss of fish in Second Portage Lake from pit footprint will be compensated for by improving access by fish to Third Portage Lake. Fishway to Dogleg Lake to be connected to system, and further offsite habitat compensation at Baker Lake. See No Net Loss Report (2005) for details.	Mitigation will reduce the net loss of fish biomass. Net loss is partially offset by habitat area and value created along dike exterior (operation) and from additional habitat at Baker L., Dogleg L. and connecting channel.	YES	High	The NNL Habitat Report (2005) addresses net impacts to fish over mine life during operation and post-closure.

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency & Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Assessment of Residual Effects: Significance of Residual Effects	Assessment of Residual Effects: Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Bay Zone Pit	Pit development will result in loss of fish beneath pit footprint in Third Portage Lake. (Bay Zone pit will be incorporated into Goose Island pit after Year 5.)	L	L	M*	F	NO	Loss of fish in Third Portage Lake from pit footprint will be compensated for by improving access by fish to Third Portage Lake. Fishway to Dogleg Lake to be connected to system, and further offsite habitat compensation will be at Baker Lake.	Loss within pit footprint is offset by habitat area and value created along dike exterior (operation) and interior (post-closure) in Third Portage Lake.	NO	High	The NNL Habitat Report (2005) addresses net impacts to fish over mine life during operation and post-closure.
Goose Island Pit	Pit development will result in loss of fish beneath pit footprint in Third Portage Lake.	L	L	M*	F	NO	Loss of fish in Third Portage Lake from pit footprint will be compensated for by improving access by fish to Third Portage Lake. Fishway to Dogleg Lake to be connected to system, and further offsite habitat compensation will be at Baker Lake.	Loss within pit footprint is offset by habitat area and value created along dike exterior (operation) and interior (post-closure) in Third Portage Lake.	NO	High	The NNL Habitat Report (2005) addresses net impacts to fish over mine life during operation and post-closure.

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency & Timing	Assessment of Unmitigated Effects: Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Assessment of Residual Effects: Significance of Residual Effects	Assessment of Residual Effects: Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Tailings Facility											
Second Portage Tailings Facility	Permanent loss of fish in north arm of Second Portage Lake.	H	L	P	F	YES	Permanent loss of fish biomass in pit footprint will be compensated for by creating enhanced dike habitat and a connection to Dogleg Lake. See No Net Loss Report (2005) for full details.	Reduce aerial proportion of fish habitat loss by connecting Dogleg Lake by a connecting channel and habitat at Baker L.; mitigation reduces magnitude of habitat loss.	YES	High	The NNL Habitat Report (2005) addresses net impacts to fish habitat and implications on fish from elimination of isolated lakes due to waste rock storage facility.
Rock Storage											
Portage – Goose Island Rock Storage Facility	Waste rock disposal will result in permanent loss of fish within Lake NP-2. However, because NP-2 is isolated from Second Portage, there is negligible loss of fish to system. Contact water runoff from disturbed terrain and the waste rock pile could introduce low pH water with elevated metals concentrations into Third Portage Lake, leading to localized fish mortality.	L	L	M*	F	YES	Loss of fish in NP-2 will be compensated for by creating access by fish to Dogleg Lake. See No Net Loss Report (2005) for full details. All contact water with Rock Storage facility will be directed to the Second Portage Lake attenuation pond to eliminate impacts to habitat from introduction of low pH, high metals surface water drainage.	Loss of fish will partially be offset by increased access by fish from Second Portage Lake to habitat in Dogleg Lake, which was previously unavailable. Reduced magnitude, extent, and frequency of effects.	NO	High	The NNL Habitat Report (2005) addresses net impacts to fish habitat and implications on fish from elimination of isolated lakes due to waste rock storage facility.

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Duration	Temporal Boundaries: Frequency & Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Mine Site Infrastructure											
Borrow Pit/Quarry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Roads and Traffic	Terrain disturbance, introduction of particulates to lakes during rain events, aerial dispersion of particulates, local habitat disturbance, road dust. Smothering of fish eggs, impaired feeding efficiency by fish; toxicity due to metals introduction.	L	L	S	F	NO	Construction activities in and around waterways will be avoided. No direct contact of vehicles in lakes. Dust suppressants applied to roads. Other dust control measures for aerial emissions. Perimeter ditches will direct all contact water to tailings pond.	Negligible ecological effects on fish. Because all contact water is captured and routed to the attenuation pond, there is no direct runoff to the receiving environment and no routine monitoring is required. Mitigation will reduce magnitude, extent, and frequency of effects.	NO	High	Targeted monitoring during road construction will be implemented if necessary. See AEMP.
Airstrip and Air Traffic	Terrain disturbance, introduction of particulates to lakes during rain events, aerial dispersion of particulates, local habitat disturbance, introduction of dust from runoff from airstrip. Smothering of fish eggs, impaired feeding efficiency by fish; toxicity due to metals introduction.	L	L	S	F	NO	Dust suppressants applied to airstrip. Perimeter ditches to direct contact runoff with roads, waste piles, airstrip, etc. to attenuation pond.	Collection of contact water and diversion by ditches to attenuation pond to eliminate exposure pathway. Mitigation will reduce magnitude, extent and duration of effects. Negligible residual ecological effects.	NO	High	Water quality monitoring in Portage lakes near to air strip will be conducted routinely. See AEMP.
Mine Plant and Associated Facilities	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency & Timing						
Freshwater Intake and Pipeline	Construction of water intake pipe in Third Portage Lake resulting in fish disturbance and avoidance of immediate area; loss of fish eggs directly under pipe.	L	L	S	R	NO	Minimize disturbance of bottom, timing installation during open water (not fall or winter).	Negligible impacts on fish.	NO	High	No monitoring required.
Discharge Facility and Pipeline	Installation of a pipeline, barge and dock in Third Portage Lake, resulting in fish disturbance and avoidance of immediate area; loss of fish eggs in directly affected area.	L	L	S	R	NO	Minimize disturbance of bottom, timing installation during open water (not fall or winter).	Negligible impacts on fish.	NO	High	No monitoring required.
Non-Contact Diversion Facility	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fuel Storage at Site	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Emulsion/AN Storage / Explosives Magazines	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Camps (North and South)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sewage and Solid Waste Disposal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
VAULT FACILITIES											
Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dike Construction											

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency & Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Assessment of Residual Effects: Significance of Residual Effects	Assessment of Residual Effects: Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Dike Construction – Vault Lake	Minor disturbance to nearshore area of Wally Lake/Vault Lake beneath dike footprint with potential for minor increase in TSS. Dispersion of fish away from the disturbed area.	L	L	S	I	NO	Use silt curtains to contain sediments during dike construction.	Low potential for escape of sediment beneath or around silt curtain because of boulder substrate, Low possibility of increase in TSS and impaired feeding efficiency by fish. Nearshore area impacted is very small and potential for residual effects in Wally Lake is negligible.	NO	High	AEMP will monitor water quality in dike near-field. See No NNL Habitat Report (2005) for details of compensation for habitat loss and implications for fish.
	Elimination of the connecting channel between Vault and Wally lakes. Elimination of connection between Phaser Lake and Vault Lake, resulting in loss of fish during mine-life.	L	L	M*	I	NO	Improve access channel between Wally Lake and two small, isolated ponds to increase habitat available by fish from Wally Lake.	Loss of access by fish to Vault and Phaser lakes offset by access to lakes formerly unavailable to fish.	NO	High	Monitor access by fish between Wally Lake and small ponds. See NNL Habitat Report (2005).

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Duration	Temporal Boundaries: Frequency & Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Vault Lake Dewatering	Entrainment of sediments during draw down and pumping into Wally Lake causing increase in TSS. Ecological effects may be reduced feeding efficiency, impairment of benthic, spawning habitat from sedimentation.	L	L	S	F	NO	Locate dewatering barge and pumps in deep areas of Vault Lake to minimize entrainment of suspended sediment.	Temporary increase in dissolved metals; increase in water column TSS, sedimentation and reduced light penetration resulting in impaired feeding by fish; temporary evacuation of fish from disturbed area. Mitigation will reduce magnitude and spatial extent of effects.	NO	Mod	Monitoring of water column TSS during dewatering of Vault Lake has been identified as a targeted study within the AEMP.
Pit Development	Pit development will result in loss of fish productivity within Vault Lake.	M	L	M*	F	YES	Loss of fish habitat from pit footprint will be compensated for by creating habitat along Vault dike exterior. See NNL Report (2005).	Temporary loss of fish habitat beneath pit footprint during operation. Net loss is only partially offset by the new habitat area and value created along Vault dike exterior.	YES	High	The NNL Habitat Report (2005) addresses net impacts to fish habitat and implications on fish over mine life during operation.

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency & Timing						
Vault Rock Storage Facility	Runoff from disturbed terrain and the waste rock pile (i.e., contact water) could introduce low pH water with elevated metals concentrations into Wally Lake, adversely affecting fish.	M	L	M*	F	YES	All contact water with Rock Storage facility will be directed to the Vault Lake attenuation pond to eliminate impacts to habitat from introduction of low pH, high metals surface water drainage. Discharge only during open water season.	Small increase in TSS, metals from discharge of attenuation pond water into Wally Lake during open water. Mitigation will reduce magnitude and extent of impact to fish from collection of contact water and redirection to attenuation ponds.	NO	High	Water quality monitoring adjacent to dikes and outfall. Targeted monitoring during construction will be implemented when necessary. See AEMP.
Roads and Traffic	Terrain disturbance, introduction of particulates to lakes during rain events, aerial dispersion of particulates, local habitat disturbance, road dust.	L	L	M*	F	NO	Construction activities in and around waterways will be avoided. No direct contact of vehicles in lakes. Dust suppressants applied to roads. Other dust control measures for aerial emissions. Perimeter ditches to direct runoff to attenuation pond.	Mitigation will eliminate exposure pathways and result in negligible ecological effects.	NO	High	Water quality monitoring adjacent to mine site will be conducted routinely at a variety of locations. Targeted monitoring during construction will be implemented when necessary. See AEMP.
Non-Contact Diversion Facility	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mine Shop / Office	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency & Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Assessment of Residual Effects: Significance of Residual Effects	Assessment of Residual Effects: Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Turn Lake Road Crossing	Culverts installation will disturb fish movement between Turn and Drilltrail lakes.	L	L	S	R	NO	Construct during winter. Place coarse grain substrate in bottom of culverts to replace habitat loss. Culverts will be designed with maximum discharge velocity of 0.6 m/s to ensure fish passage. See Aquatic Environmental Management Plan and No Net Loss Report (2005).	Culverts will mitigate crossing impact. Crossing will be constructed in winter when there are no fish movements therefore resulting in negligible ecological effects.	NO	High	Hoop nets will be set at the upstream and downstream end of the culverts to capture fish for purposes of a mark-recapture study. Routine monitoring to confirm that movements of fish between Turn Lake and Drilltrail Lake are not impaired. (see AEMP).
OTHER FACILITIES											
Worker Fishing	Increase in direct mortality of fish in all project lakes due to influx of workers during construction phase.	M	L	M*	F	YES	A strict no-fishing policy will be implemented for all workers on-site.	First Nations may exercise their traditional right to fish for sport, domestic consumption or to provide fish to dogs, resulting in an unknown degree of impact.	NO	Mod	Despite a no fishing policy, impacts by worker fishing are potentially significant. The number and type of fish captured within each project lake will be monitored where possible and biological data collected opportunistically (see AMEP).

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency & Timing	Assessment of Unmitigated Effects: Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Assessment of Residual Effects: Significance of Residual Effects	Assessment of Residual Effects: Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Winter Road and Traffic	Potential temporary stream blockage in spring due to freeze-down and snow pack at stream crossing locations.	L	R	S	I	NO	Use existing winter road route; use lake areas as much as possible; Use of large tundra tires and enter/exit lakes and streams where there is snow cover protecting soils.	Negligible residual effect. Mitigation will further reduce magnitude and extent of impacts to fish movements.	NO	High	Routine, annual monitoring of the winter road will be conducted to determine if any adverse effects can be observed and corrected, if necessary (see AEMP).
Baker Lake Access Road and Traffic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Baker Lake Marine Barge Landing Facility	Localized degradation of fish habitat along Baker Lake foreshore resulting in decreased fish biomass.	L	L	S	I	NO	Construct landing facility to minimize impacts to near-shore and shoreline of Baker Lake; avoid high quality habitat; use geotextile material during unloading to minimize erosion; see AEMP and No Net Loss Report (2005).	Negligible residual effect.	NO	High	Implement emergency spills response in event of an accidental spill (see AEMP). Routine, annual monitoring of the Barge Landing Facility will be conducted to determine if any adverse effects can be observed and corrected, if necessary (see AEMP).

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency & Timing						
Marine Barge Traffic	Increase in marine barge traffic. Will cause small incremental rise of noise and hydrocarbon emissions along the transport route.	L	R	S	I	NO	Follow hazardous material handling guidelines; follow spill contingency guidelines; protocols and standards for barge operators	Negligible residual effect. Mitigation will reduce the magnitude and frequency of effects.	NO	High	No routine monitoring required.
Baker Lake Staging Facility	Construction of the staging facility will take place well away from fish-bearing waters and no adverse physical effects are anticipated	L	L	S	R	NO	Ensure compliance with policies for vehicle re-fuelling, safe storage of explosives, fuels, etc.	Negligible residual effect.	NO	High	No monitoring required.
Explosives Magazine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.1 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Duration	Temporal Boundaries: Frequency & Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Accidental Spills: Fuel Storage Site (Portage), Tank Farm, Roads, Marine Transport.	Potential spills can impact fish and their eggs through introduction of contaminants (toxicity), or physical effect (blockages of streams reducing movements).	L	L	M	R	NO	Tank farm built within berms for containment. Follow hazardous material handling guidelines; follow spill contingency guidelines; protocols and standards for barge operators. Follow standard marine shipping procedures during Hudson Bay open water season. Implement strategies contained in the Spill Contingency Report.	Mitigation will reduce the magnitude, duration and spatial extent of any spills that may occur and cause impacts.	NO	High	Implement emergency spills response in event of an accidental spill (AEMP).

Table C.2: Fish Impact Matrix – Operation

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects – Spatial Boundaries: Magnitude	Spatial Extent	Temporal Boundaries: Duration	Frequency and Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
MAIN FACILITIES											
Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dikes											
Second Portage - East Dike	Leaching of dissolved metals from dike materials into surrounding water columns. Cause potential toxicity to fish eggs, reducing survival and development.	L	L	P	F	NO	A 2 m thick layer of IF rock material (lowest metal leaching potential) will be placed on external dike surface to provide optimal habitat for spawning by lake trout and round whitefish. Excavate Dogleg Lake stream channel to connect to Second Portage Lake, providing hydrologic connection and access by fish between these lakes, thereby increasing available habitat and fish biomass in Second Portage Lake.	Net reduction in fish biomass in Second Portage Lake that is partly offset by habitat and biomass gain from connection with Dogleg Lake; Incorporate optimal habitat for fish spawning and egg survival on dike exteriors to partly offset loss of habitat along shorelines. Dissolved metals may reduce fish egg survival and larval development during overwinter incubation. Use of low metal-leaching rock will reduce magnitude and frequency of habitat impairment.	NO	Mod	Monitoring of changes in fish biomass in Second Portage Lake will be assessed as described in the NNL Habitat Report. A targeted study has been proposed to monitor pore water and very near-field water quality along the dike to confirm/refute predicted water quality modeling results of metal leaching (see AEMP).

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency and Timing						
Second Portage Lake Tailings Dike	See Pit Development	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Third Portage – Bay Zone Dike	Potential for local impairment of Third Portage Lake dike pore water quality due to metals leaching into waters from dike material. Possible impairment of fish eggs laid on dikes. Short term as this will be eliminated after 5 years when Goose Island pit is developed.	L	L	S	F	NO	Fish habitat will be replaced along dike exteriors during operations phase and will be effective until Goose Island installation in Year 5. Use IF material with lowest metal leaching potential to construct outer face of Bay Zone Dike. See No Net Loss Report (2005). Substrate, depth and slope of dike exterior designed to optimize spawning and rearing habitat for lake trout and round whitefish.	Reduced fish biomass in Third Portage Lake, offset by habitat compensation. Possible impairment of spawning and nursery habitat on dike exteriors. Use of low metal-leaching rock will reduce magnitude and frequency of habitat impairment.	NO	High	The net difference in productive capacity of fish habitat is assessed within the NNL Report. There will be a net loss of habitat in the project area and off-site habitat compensation is being considered.

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency and Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Assessment of Residual Effects: Significance of Residual Effects	Assessment of Residual Effects: Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Third Portage – Goose Island Dike	Potential for local impairment of Third Portage Lake dike pore water quality due to metals leaching from dike material Possible reduction of habitat suitability for fish egg survival.	L	L	L	F	NO	Fish habitat will be replaced along dike exteriors during operations phase and post-closure to enhance fish biomass. Use IF material with lowest metal leaching potential to construct outer face of Goose Island Dike. See No Net Loss Report (2005). Substrate, depth and slope of dike exterior designed to optimize spawning and rearing habitat for lake trout and round whitefish.	Reduced fish biomass in Third Portage Lake, offset by habitat compensatio n. Possible impairment of fish egg survival. Use of low metal-leaching rock will reduce magnitude and frequency of habitat impairment.	NO	High	The net difference in productive capacity of fish biomass is assessed within the NNL Report. A targeted study has been proposed to monitor pore water and very near-field water quality along the dike to confirm/refute predicted water quality modeling results of metal leaching (see AEMP).
Blasting											
Pit Development	Blasting of rock during pit development may cause mortality of fish and fish eggs on or near dike habitat. Degree of impact depends upon setback from dike and stage of pit development which dictates distance between blast and fish-bearing water.	L	L	L	F	NO	Use smaller charges and blast holes, stagger detonations. Implement Blast Design Plan	Possible residual mortality of fish depending on blast frequency and peak particle velocity. Mitigation proposed, Blast Design Report will reduce magnitude and spatial extent of effects.	NO	High	Monitoring of blasting effects on fish has been identified as a Targeted Study (see AEMP).
Pit Dewatering	NA – occurs during Construction, not Operation phase	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency and Timing						
Pit Operation - Portage Pit and Goose Island	Pit operation will result in loss of fish biomass within pit area in Second Portage Lake. Net loss of fish biomass proportional to pit surface area.	M	L	M	F	YES	Loss of fish biomass in Second Portage Lake from pit footprint will be compensated for by creating habitat along dike during operations phase and during post-closure. Fishway to Dogleg Lake to be connected to system, and further offsite habitat compensation will be required (to be resolved with DFO) at Baker Lake. See NNL Report (2005) for full details.	Loss of fish biomass proportional to pit footprint. Net loss is partially offset (reduced magnitude) by habitat area and value created along dike exterior (operation) and interior (post-closure), as well as Dogleg L. and offsite at Baker L., but not enough to become insignificant.	YES	Mod	The NNL Habitat Report addresses net impacts to fish habitat and implications on fish over mine life during operation and post-closure.
Pit Operation – Goose Island/ Bay Zone pits	Pit operation will result in loss of fish biomass within pit area in Third Portage Lake. Net loss of fish biomass proportional to pit surface area.	L	L	M	F	NO	Loss of fish biomass in Second Portage Lake from pit footprint will be compensated for by creating habitat along dike during operations phase and during post-closure. Fishway to Dogleg Lake to be connected to system, and further offsite habitat compensation will be required (to be resolved with DFO) at Baker Lake. See NNL Report (2005) for full details.	Loss of fish biomass proportional to pit footprint. Net loss is partially offset (reduced magnitude) by habitat area and value created along dike exterior (operation) and interior (post-closure).	NO	Mod	The NNL Habitat Report addresses net impacts to fish habitat and implications on fish over mine life during operation and post-closure.

Table C.2 Continued

		Assessment of Unmitigated Effects						Assessment of Residual Effects			
		Spatial Boundaries		Temporal Boundaries							
Project Component	**Potential Physical and Ecological Effect**	**Magnitude**	**Spatial Extent**	**Duration**	**Frequency and Timing**	**Significance of Unmitigated Effects**	**Proposed Mitigation**	**Residual Effect / Influence of Mitigation**	**Significance of Residual Effects**	**Certainty of Prediction**	**Aquatic Environment Management Program (AEMP) Description**
Second Portage Tailings Facility	Permanent loss of fish biomass due to development of tailings disposal and attenuation ponds.	H	L	P	F	YES	Loss of fish biomass in Second Portage Lake due to tailings pond and attenuation pond footprint will be partially compensated for by creating habitat along dike exteriors during post-closure; added habitat at Dogleg Lake, connecting channel, and offsite habitat at Baker Lake. See NNL Report (2005) for full details.	Permanent loss of fish biomass proportional to tailings and attenuation pond footprint. Net loss in fish biomass is partially offset (reduced magnitude) by habitat area and value created along dike exterior (operation) and interior (post-closure), as well as Dogleg L. and at Baker L., but not enough to become insignificant.	YES	High	The NNL Habitat Report addresses net impacts to fish habitat and implications on fish over mine life during operation and post-closure.

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency and Timing						
Portage – Goose Rock Storage Facility	The Portage – Goose Rock storage facility lies directly over Lake NP-2 (fish bearing) and adjacent to one small non-fish bearing pond. Lake NP-2 does not have a hydraulic connection to Second Portage Lake and is isolated. Runoff from the waste rock pile (i.e., contact water) during operation could introduce low pH water with elevated metals concentrations into Second Portage Lake and Third Portage lakes, resulting in toxicity to fish and eggs.	L	L	P	F	NO	Construct a reliable hydraulic connection between Second Portage Lake and Dogleg Lake (NP-1). Dogleg contains fish but, like NP-2 does not have a hydraulic connection. Excavating a stream channel will allow fish to move back and forth between the lakes and will increase available fish habitat within the Second Portage Lake drainage system. All contact water with Rock Storage facility will be directed to the Second Portage Lake attenuation pond to eliminate impacts to habitat from introduction of low pH, high metals surface water drainage.	Access by fish to Dogleg Lake will result in a net increase in fish biomass in Second Portage Lake despite elimination of NP-2 pond. Use of collection ditches and attenuation ponds will eliminate pathway to receiving environment, reducing magnitude, duration and frequency of impacts.	NO	High	Access to Dogleg Lake by fish from Second Portage Lake will increase available habitat and increase productive capacity. See NNL Habitat Report (2005).
Borrow Pit/Quarry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Duration	Temporal Boundaries: Frequency and Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Roads and Traffic	Terrain disturbance, introduction of particulates to lakes during rain events, aerial dispersion of particulates, local habitat disturbance, introduction of dust from runoff from roads. Potential adverse physiological effects to fish (leading to stress) and potential for increased egg mortality.	L	L	M	F	NO	Avoid operating heavy equipment in and around waterways. No direct contact of vehicles in lakes. Dust suppressants applied to roads. Other dust control measures for aerial emissions. Perimeter ditches to direct contact runoff with roads, waste piles, airstrip, etc. to tailings facility (see Golder 2005).	Negligible ecological effects on fish. Mitigation will eliminate pathways of contamination, reducing magnitude, extent and duration of impacts.	NO	High	Water quality monitoring adjacent to mine site will be conducted routinely at a variety of locations. See AEMP.
Airstrip and Air Traffic	Terrain disturbance, introduction of particulates to lakes during rain events, aerial dispersion of particulates, local habitat disturbance, introduction of dust from runoff from airstrip. Potential increase in sedimentation and impairment of benthic habitat.	L	L	M	F	NO	Dust suppressants applied to airstrip. Perimeter ditches to direct contact runoff with roads, waste piles, airstrip, etc. to tailings facility (see Golder 2005).	Negligible ecological effects on fish. Mitigation will eliminate pathways of contamination, reducing magnitude, extent and duration of impacts.	NO	High	Water quality monitoring of Portage lakes will be conducted routinely. See AEMP.
Mine Plant and Facilities	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency and Timing						
Freshwater Intake and Pipeline	Operation of a water intake pipe in Third Portage Lake. Average intake volume is estimated to be 0.021 m^3/s. Entrainment of fish larvae during open water is possible.	L	L	L	F	NO	Install intake at deep depth near bottom to minimize entrainment of fish larvae. Intake facility will be sized to reduce intake flow velocity below minimum speed to minimize entrainment of trout and whitefish.	Mitigation will reduce the magnitude of any residual effects. Minimal entrainment of fish.	NO	High	No monitoring required.
Effluent Discharge and Pipeline – Third Portage Lake	Effluent discharge to Third Portage Lake North Basin during construction and years 1 – 5 of operation will consist of water discharged from the Second Portage attenuation pond. In years 1 – 5 this pond will receive direct precipitation, contact and non-contact water, and treated sewage. Potential for particulates and dissolved metals to result in sublethal toxicity to fish.	(Year 1-5) L	L	M	F	NO	Install a diffuser at the outfall to increase dilution potential. Effluent will only be discharged during the open-water season and will not be discharged under ice to avoid sensitive periods for fish spawning and egg incubation.	Years 1-5 does not involve discharge of tailings effluents. Discharge below MMER standards and only during open water. Effect will be to reduce magnitude and extent of impact.	NO	Mod	Metal Mining Effluent Regulations are very specific with regards to monitoring requirements of effluents. A draft monitoring program (EEM 2005) has been designed for this project to address all EEM requirements.

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency and Timing						
	After year 5, metals contaminated water from the tailings pond will be combined with the attenuation pond and discharged to Third Portage Lake. Given the low dilution potential and turnover in Third Portage Lake, there is potential for dissolved metals to exceed CCME criteria for the protection of aquatic life. Inputs of particulate bound contaminants may affect fish (metal toxicity leading to stress, avoidance, behavioural changes).	(> 5 Yr) M	R	M	F	YES	Delay discharge to Third Portage for as long as possible and contain wastes within Second Portage attenuation pond. A water treatment plant will be installed in Year 5 to reduce metals and TSS loading. Install a diffuser at the outfall to increase dilution potential. Effluent will only be discharged during the open-water season and will not be discharged under ice to avoid sensitive periods for fish spawning and egg incubation.	Despite water treatment and given the low buffering capacity of the project lakes, there is the potential for dissolved metals to exceed CCME criteria for the protection of aquatic life. Uncertain effects to phytoplankto n and zooplankton. Magnitude will depend on spatial and temporal extent of exceedances, pending results of more detailed Water Quality Monitoring. This is the worst case scenario. Mitigation (adaptive water treatment) will reduce magnitude and extent of impacts to local and regional lakes.	YES	Mod	Metal Mining Effluent Regulations are very specific with regards to monitoring requirements of effluents. A draft monitoring program (MMER 2005) has been designed for this project to address all MMER requirements. A plume delineation study will be conducted in accordance with guidance. In addition, the AEMP will monitor impacts of the effluent from a wider spatial scale and place impacts in context with non-effluent impacts. Targeted studies will be implemented if necessary in accordance with adaptive management principals to assess habitat impacts.

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency and Timing						
	Increase in nutrient levels in Third Portage Lake as a result of discharge of treated sewage. Possible increase in fish biomass due to higher rates of primary and secondary productivity.	L	L	M	F	NO	Primary treatment is proposed to reduce nutrient inputs. Wastes will be discharged only during the open water season after holding in attenuation pond. Install a diffuser at the outfall to increase dilution potential.	Increase in nutrient concentrations may cause an increase in primary productivity (i.e., phytoplankton) that may be reflected as an increase in secondary productivity and ultimately, fish.	NO	Mod	Routine monitoring of near-field and far-field stations as part of the AEMP for water column nutrient concentration chlorophyll a and phytoplankton biomass to quantify change. Depending on perspective, this may be viewed as a positive impact.
	Input of suspended sediment may result in fish avoidance, reduced feeding and gill functions, and increased egg mortality.	L	L	M	F	NO	Installation of a water treatment facility to control TSS introductions. Discharge only during the open water season to increase dispersion of suspended solids. Conform to MMER standards.	Possible degradation of fish habitats, smothering of fish eggs, and negative effects to fish. Mitigation will reduce the magnitude and extent and minimize adverse ecological effects.	NO	High	Implement MMER program. See AEMP for routine monitoring of TSS.
Non-Contact Diversion Facility	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fuel Storage	NA – No pathway to aquatic ecosystem (see Spills).	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Emulsion/AN Storage / Explosives Magazine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Camp (North and South)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sewage and Solid Waste Disposal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency and Timing						
VAULT FACILITIES											
Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vault Dike	Potential for local impairment of water quality along Vault dike due to leaching of dissolved metals.	L	L	M	F	NO	Two m thick layer of IF rock material will be placed on external surface of Vault Dike to provide optimal nursery and shelter habitat for lake trout and round whitefish. See NNL Report (2005) for details of habitat compensation.	Connections to two small lakes to provide new habitat will offset losses to fish biomass. Low metal-leaching rock will reduce magnitude and extent of dissolved metals.	NO	High	A targeted study has been proposed to monitor pore water and very near-field water quality along the Vault dike to confirm/refute Golder (2005) predicted water quality modeling (see AEMP).
Vault L. Dewatering	NA – refer to Construction phase	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pit Operation	Pit operation will result in loss of habitat of Vault Lake. Net loss of fish productivity equivalent to lake area.	M	L	M	F	YES	Loss of fish habitat will be compensated for by creating habitat along dike exteriors during operations phase, as well as new habitat (two small lakes) connected to Wally Lake. See NNL Report (2005) for full details.	Loss of fish habitat (Vault Lake) during operation, to be regained post-closure (re-flooding lakes area over several years; lowered quality). Net loss is only partially reduced by habitat area and value created along dike exterior (operation).	YES	Mod	The NNL Habitat Report addresses net impacts to fish habitat and implications on fish over mine life during operation and post-closure.

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency and Timing						
Vault Rock Storage Facility	Runoff from disturbed terrain and the waste rock pile (i.e., contact water) could introduce low pH water with elevated metals concentrations into Wally Lake, adversely affecting fish.	M	L	P	F	YES	All contact water with Rock Storage facility will be directed to the Vault Lake attenuation pond to eliminate impacts to fish from introduction of low pH, high metals surface water. Discharge only during open water season.	Small increase in TSS, metals from discharge of attenuation pond water into Wally Lake during open water. Mitigation will reduce magnitude and extent of adverse effects.	NO	High	Water quality monitoring adjacent to dikes and outfall. Targeted monitoring during construction will be implemented when necessary. See the AEMP.
Roads and Traffic	Terrain disturbance, introduction of particulates to lakes during rain events, aerial dispersion of particulates, local habitat disturbance, road dust. Possible impacts to fish from sedimentation and dissolved metals.	L	L	M	F	NO	Operation of heavy equipment in and around waterways will be avoided. No direct contact of vehicles in lakes. Dust suppressants applied to roads. Other dust control measures for aerial emissions. Perimeter ditches to direct runoff to Vault attenuation pond.	Negligible ecological effects on fish habitat. Use of collection channels will eliminate pathway and reduce magnitude and extent of adverse effects.	NO	High	Water quality monitoring in Wally Lake will be conducted routinely at a variety of locations. See AEMP.

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency and Timing						
Effluent Discharge – Wally Lake	Effluent discharge to Wally Lake is scheduled to in Year 5 of operation. No input of mine water or other contaminants will be directed to the attenuation ponds and water treatment plant will be required. Effluent will be discharged during open water and will consist of pit inflow water, precipitation and non-contact water (Golder 2005). Possible adverse effects to fish and eggs from exposure to metals and TSS.	L	L	M	F	NO	Install a diffuser at the outfall to increase dilution potential. Effluent will only be discharged during the open-water season and will not be discharged under ice to avoid sensitive periods for fish spawning and egg incubation. Effluent will be monitored, and will be treated if necessary (MMER).	Minor potential for direct impacts to fish from dissolved metals and TSS. Reduced feeding efficiency by trout. Possible settling of particulates on fish spawning habitat. Mitigation will reduce the magnitude and extent of residual effects.	NO	Mod	Effluent from the Vault attenuation ponds will be monitored under MMER in the same fashion as mine water discharge. See the MMER Report. A plume delineation study will be conducted to determine the spatial extent of the plume and determine whether a fish survey is required.
Non-Contact Diversion Facility	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mine Shop / Office	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Turn Lake Road Crossing	Potential for impaired fish passage because of high water velocity during spring freshet; visual barrier to fish movement because of long culvert length.	L	L	M	I	NO	Install rip rap along shorelines and approaches to road crossing and within dike to encourage movement by fish. Install culvert to maintain discharge velocity <0.6 m/s to ensure fish passage.	Possible reduced movement by fish into or out of Turn Lake. Adequate culvert sizing will ensure that fish passage is not compromised.	NO	High	Hoop nets will be set at the upstream and downstream end of the culverts to capture fish for purposes of a mark-recapture study to determine movement of fish through the culvert into Turn Lake. See AEMP Targeted study.

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries – Magnitude	Spatial Boundaries – Spatial Extent	Temporal Boundaries – Duration	Temporal Boundaries – Frequency and Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
OTHER FACILITIES											
Worker Fishing – Project Lakes	Increase in direct mortality of fish in all project lakes due to presence of mine workers during life of mine.	M	L	M	F	YES	Implement a strict no-fishing policy at all project lakes.	First Nations may exercise their traditional right to fish for sport, domestic consumption or to provide fish to dogs, resulting in an unknown degree of impact. Implementation of the policy will reduce the frequency of fishing and magnitude of fish harvest.	NO	Mod	The AEMP describes a program to gather biological data (e.g., tissue samples for metals) for fish captured by workers, where possible.
Winter Road Operation and Traffic	Compaction of stream beds; erosion of entry/exit points of lakes causing erosion, permafrost exposure. Potential impacts to fish movements if streams are blocked.	L	R	M	I	NO	Use existing winter road route; use lake areas as much as possible; Use of large tundra tires, and enter/exit lakes and streams where there is snow cover protecting soils. Select alternate route if a problem is identified during routine monitoring (see AEMP). Follow hazardous material handling guidelines; follow spill contingency guidelines.	Mitigation will reduce magnitude and frequency of impacts. Negligible residual impact on fish and their movements within streams and channels.	NO	High	Routine, annual monitoring of the winter road to determine if any adverse effects can be observed and corrected (see AEMP). Implement emergency spills response in event of an accidental spill.

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency and Timing						
Baker Lake Marine Barge Landing Facility	Localized disturbance to fish along Baker Lake foreshore due noise, barge activity, and introduction of TSS.	L	L	M	I	NO	Construct landing facility away from sensitive areas to fish avoid high quality habitat; use geotextile material during unloading to minimize erosion and habitat disturbance; see AEMP and No Net Loss Report (2005).	Negligible residual impact to fish. Mitigation will reduce the magnitude of impacts to shoreline habitat.	NO	High	Routine, annual monitoring of the barge landing facility will be conducted to determine if any adverse effects can be observed and corrected, if necessary (see AEMP).
Marine Barge Traffic	Increase in marine barge traffic. Will cause small incremental rise of noise and hydrocarbon emissions along the transport route.	L	R	S	I	NO	Follow standard marine shipping procedures during Hudson Bay open water season.	Negligible residual impact to fish. Mitigation will reduce the magnitude of impacts to shoreline habitat.	NO	High	No monitoring required.
Baker Lake Staging Facility	Construction of the staging facility will take place well away from fish-bearing waters and no adverse physical effects are anticipated.	L	L	S	R	NO	Ensure compliance with policies for vehicle re-fuelling, safe storage of explosives, fuels, etc.	Negligible residual impact to fish. Mitigation will reduce the magnitude of impacts to shoreline habitat.	NO	High	No monitoring required.
Explosives Magazine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.2 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects					Proposed Mitigation	Assessment of Residual Effects			Aquatic Environment Management Program (AEMP) Description
		Spatial Boundaries		Temporal Boundaries		Significance of Unmitigated Effects		Residual Effect / Influence of Mitigation	Significance of Residual Effects	Certainty of Prediction	
		Magnitude	Spatial Extent	Duration	Frequency and Timing						
Accidental Spills: Fuel Storage Site (Portage), Tank Farm, Roads, Marine Transport.	Potential spills can impact fish and their eggs through introduction of contaminants (toxicity), or physical effect (blockages of streams reducing movements).	L	L	M	R	NO	Tank farm built within berms for containment. Follow hazardous material handling guidelines; follow spill contingency guidelines; protocols and standards for barge operators. Follow standard marine shipping procedures during Hudson Bay open water season. Implement strategies contained in the Spill Contingency Report.	Mitigation will reduce the magnitude, duration and spatial extent of any spills that may occur and cause impacts.	NO	High	Implement emergency spills response in event of an accidental spill.

Table C.3: Fish Impact Matrix – Closure & Post-Closure

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Assessment of Residual Effects		
		Spatial Boundaries		Temporal Boundaries				
		Magnitude	Spatial Extent	Duration	Frequency and Timing	Influence of Activity/ Residual Effect	Significance of Residual Effects	Certainty of Prediction
MAIN FACILITIES								
Dikes								
Second Portage - East Dike	Create habitat on dike interior in Third Portage Lake. Leaching of dissolved metals from dike materials into surrounding water column. Loss of habitat suitable for fish egg development. Cause potential toxicity to fish eggs, reducing survival and development. Fish avoidance of local area. Effect diminishes over time.	L	L	S	F	New dike habitat represents an increase in structural complexity and area of fish habitat compared to pre-mining condition; benefit is partially offset by localized leaching of dissolved metals through capped dike wall into water. Net effect is neutral or positive to fish productivity. Significant increase in habitat for fish spawning. Dissolved metals may reduce fish egg survival and larval development during overwinter incubation. Effect decreases over time.	NO	High
Second Portage Lake Tailings Dike	Create habitat on tailings dike exterior (now part of Third Portage Lake). Leaching of metals from dike porewaters into immediate water columns, affecting fish egg survival on dikes facing old pit area. Cause potential toxicity, resulting in reduced egg survival, fish avoidance of area, thereby reducing fish habitat of Third Portage Lake. Effect diminishes over time.	L	L	S	F	New dike habitat represents an increase in structural complexity and area of fish habitat compared to pre-mining condition; benefit is partially offset by localized leaching of dissolved metals through capped dike wall into water. Net effect is neutral to fish productivity. Moderate increase in habitat for fish spawning. Dissolved metals may reduce fish egg survival and larval development during overwinter incubation. Effect decreases over time.	NO	High

Table C.3 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Duration	Temporal Boundaries: Frequency and Timing	Assessment of Residual Effects: Influence of Activity/ Residual Effect	Significance of Residual Effects	Certainty of Prediction
Third Portage – Goose Island Dike	Create habitat on breached dike exterior and interior (Third Portage Lake). Leaching of metals from dike materials into surrounding water column. Loss of suitable habitat for fish egg development. Cause potential toxicity, resulting in reduced egg survival, fish avoidance of area, thereby reducing fish habitat of Third Portage Lake. Effect diminishes over time.	L	L	S	F	New dike habitat represents an increase in structural complexity and area of fish habitat compared to pre-mining condition; benefit is partially offset by localized leaching of dissolved metals through capped dike wall into water. Net effect is neutral or positive to fish productivity. Significant increase in habitat for fish spawning. Dissolved metals may reduce fish egg survival and larval development during overwinter incubation. Effect decreases over time.	NO	High
Pits								
Pit Operation - Portage Pit and Goose Island	Adjoining Third Portage Lake to new habitat (part of which was previously Second Portage Lake) within Portage/ Goose Island pit areas. Deep pit footprint (Portage) will remain following closure, representing new habitat of lower quality to fish (altered conditions at bottom, less food available).	M	L	P	F	Habitat area in Second Portage Lake now part of Third Portage Lake; habitat of lowered quality (very deep), proportional to flooded pit area. Reduced fish productivity. Insignificant increase in fish productivity in Third Portage Lake.	YES (SPL) NO (TPL)	High
	Connection of Portage and Goose Island pit areas to Third Portage Lake. Residual metals from pit walls will move into water column. Potential toxicity to fish and fish eggs in local area (along dikes encircling pits). Fish avoidance and reduced fish biomass in pit area relative to pre-mine condition.	L	L	S	F	New habitat within pit area may cause toxicity to fish and eggs. Net loss in productivity may be offset by increase in habitat area. See NNL 2005.	NO	High
Second Portage Tailings Facility	Permanent capping and storage of tailings at Second Portage Tailings Facility. North arm of Second Portage Lake is lost fish habitat. Reduced fish productivity in this lake.	H	L	P	F	Permanent loss of fish habitat resulting in reduced fish productivity (See NNL 2005).	YES	High
	Capping tailings material. Leaching of dissolved metals from tailings materials into surface waters.	L	L	P	I	Metals leaching will be minimal due to capping and gradual permafrost formation. Toxicity reducing fish productivity limited to open water season, diminished over time as tailings freeze.	NO	Mod

Table C.3 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Assessment of Residual Effects		
		Spatial Boundaries		Temporal Boundaries		Influence of Activity/ Residual Effect	Significance of Residual Effects	Certainty of Prediction
		Magnitude	Spatial Extent	Duration	Frequency and Timing			
Portage – Goose Rock Storage Facility	Permanent storage of waste rock material. Runoff from the waste rock pile (i.e., contact water) could introduce low pH water with elevated metals concentrations into Second Portage Lake and Third Portage lakes, resulting in localized toxicity to fish and eggs.	L	L	P	I	During open-water season, some runoff from surface waters/ leachate from capped rock storage materials may lead to decreased fish productivity. Permafrost formation over several years will reduce exposure to fish.	NO	Mod
Borrow Pit/Quarry	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Roads and Traffic	Roads will be decommissioned; land will be restored.	NA	NA	NA	NA	NA	NA	NA
Airstrip and Air Traffic	Airstrip will be decommissioned; land will be restored.	NA	NA	NA	NA	NA	NA	NA
Mine Plant and Facilities	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Freshwater Intake and Pipeline	Pipeline will be removed during closure. No residual effect.	NA	NA	NA	NA	NA	NA	NA
Effluent Discharge and Pipeline – Third Portage Lake	No effluent discharge will occur following mine closure. Removal of discharge pipeline during closure. No residual effects.	NA	NA	NA	NA	NA	NA	NA
Non-Contact Diversion Facility	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Fuel Storage	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Emulsion/AN Storage / Explosives Magazine	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Camp (North and South)	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Sewage and Solid Waste Disposal	Decommissioned.	NA	NA	NA	NA	NA	NA	NA

Table C.3 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Assessment of Residual Effects		
		Spatial Boundaries		Temporal Boundaries		Influence of Activity/ Residual Effect	Significance of Residual Effects	Certainty of Prediction
		Magnitude	Spatial Extent	Duration	Frequency and Timing			
VAULT FACILITIES								
Vault Pit	Connecting re-flooded Vault pit with Wally Lake (Vault dike removed at closure). Vault Lake has reduced quality of fish habitat (deep pit). Pit area will show a loss of fish productivity from original Vault Lake.	L	L	P	F	Fish habitat in Vault Lake will be of lowered quality, proportional to pit area. Fish productivity will be reduced post-closure.	YES	High
	Connection of Vault pit area to Wally Lake. Residual metals from pit walls will move into water column. Potential toxicity to fish and fish eggs in local area (lake littoral habitat encircling pits). Fish avoidance and reduced fish biomass in Vault Lake. Effects decrease over time.	L	L	S	F	Restored Vault Lake will contain residual metals from pit walls. Potential toxic effects to fish and eggs. Possible fish avoidance of these lakes. Effects decrease over time.	NO	High
Vault Rock Storage Facility	Permanent storage of waste rock materials. Runoff from the waste rock pile (i.e., contact water) could introduce low pH water with elevated metals concentrations into Wally and Vault lakes, causing localized impacts on fish productivity.	M	L	P	I	During open-water season, some runoff from surface waters/ leachate from capped rock storage materials may lead to decreased fish productivity. Permafrost formation over several years will reduce metals leaching and diminish exposure to fish.	NO	Mod
Roads and Traffic	Roads will be decommissioned; land will be restored.	NA	NA	NA	NA	NA	NA	NA
Effluent Discharge – Wally Lake	No effluent discharge will occur following mine closure. Removal of discharge pipeline during closure. No residual effects.	NA	NA	NA	NA	NA	NA	NA
Non-Contact Diversion Facility	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Mine Shop / Office	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Turn Lake Road Crossing	Removal in winter when natural stream channel is frozen. Minor disturbance to localized fish during closure; no residual effects following restoration.	NA	NA	NA	NA	NA	NA	NA
OTHER FACILITIES								
Worker Fishing – Project Lakes	Fish harvest reduced to historic, traditional use, depending on community of Baker Lake.	NA	NA	NA	NA	NA	NA	NA
Winter Road Operation and Traffic	No further use of road.	NA	NA	NA	NA	NA	NA	NA

Table C.3 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Assessment of Residual Effects		
		Spatial Boundaries		Temporal Boundaries				
		Magnitude	Spatial Extent	Duration	Frequency and Timing	Influence of Activity/ Residual Effect	Significance of Residual Effects	Certainty of Prediction
Baker Lake Marine Barge Landing Facility	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Marine Barge Traffic	NA (no traffic in this phase).	NA	NA	NA	NA	NA	NA	NA
Baker Lake Staging Facility	Removal of the staging facility is not expected to cause any adverse effects during operation; no residual effects post-closure.	NA	NA	NA	NA	NA	NA	NA
Explosives Magazine	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Accidental Spills	Facilities (fuel storage (Portage), tank farm, roads, marine transport) will be removed at mine closure; no residual effects post-closure.	NA	NA	NA	NA	NA	NA	NA

Table C.4: Fish Habitat Impact Matrix – Construction

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Program (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
MAIN FACILITIES											
Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dike Construction											
Second Portage Lake East Dike	Disturbance of fine sediments beneath dike footprint causing increase in TSS. Compression of sediments releasing dissolved metals in pore water. Elimination of fish habitat beneath dike footprint.	M	L	S	F	NO	Use silt curtains to contain sediments during dike construction.	Possible escape of sediment beneath or around silt curtain causing local increase in TSS and smothering of fish habitat. Decreased magnitude of ecological effect.	NO	High	AEMP will monitor water quality in dike near-field. Targeted study to address productivity of fish habitat on dike exterior. See NNL Habitat Report for habitat compensation assessment.
	Dike placement will eliminate one connecting channel between Second and Third Portage Lake.	M	L	M*	I	NO	Enhance (widen, deepen) one stream channel, improving opportunity for fish movement in the two remaining channels.	Decreased magnitude of ecological effect, improving passage, and extending period for fish movement into Third Portage Lake.	NO	High	Monitor stream channel integrity.
	Local impairment of Second Portage Lake from introduction of nitrates from blasted rock used to construct dike. Increase in phytoplankton and zooplankton abundance.	L	L	M	I	NO	Use silt curtains to minimize sediment dispersion.	Leaching of nitrates from blasted rock. Small increase in lake productivity in near-field from nutrients.	NO	Mod	A targeted study has been proposed to monitor near-field water quality and assess changes in productivity (see AEMP).
Second Portage Lake Tailings Dike	NA (See Post-Closure phase)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.4 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Program (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Third Portage Lake Portage Dike	Disturbance of fine sediments beneath dike footprint causing increase in TSS. Compression of sediments releasing dissolved metals in pore water. Elimination of fish habitat beneath dike footprint.	L	L	S	F	NO	Use silt curtains to contain sediment during dike construction.	Possible escape of sediment beneath or around silt curtain causing local increase in TSS and smothering of fish habitat. Evacuation of fish from disturbed area	NO	High	AEMP will monitor water quality in dike near-field and assess impacts of TSS and metals in Third Portage Lake See NNL Habitat Report for habitat compensation assessment.
	Local impairment of Third Portage Lake from introduction of nitrates from blasted rock used to construct dike. Increase in phytoplankton and zooplankton abundance.	L	L	M	I	NO	No mitigation possible to protect fish habitat during construction.	Leaching of nitrates from blasted rock. Small increase in lake productivity in near-field from nutrients.	NO	Mod	A targeted study has been proposed to monitor near-field water quality and assess changes in productivity (see AEMP).

Table C.4 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Magnitude	Spatial Extent	Duration	Frequency and Timing	Significance of Unmitigated Effects	Assessment of Residual Effects: Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
Third Portage Lake Goose Island	Disturbance of fine sediments beneath dike footprint causing increase in TSS. Compression of sediments releasing dissolved metals in pore water. Elimination of fish habitat beneath dike footprint.	L	L	S	F	NO	Use silt curtains to contain sediment during dike construction.	Possible escape of sediment beneath or around silt curtain causing local increase in TSS and smothering of fish habitat. Leaching of nitrates from newly placed dike material. Evacuation of fish from disturbed area	NO	High	AEMP will monitor water quality in dike near-field and assess impacts of TSS and metals in Third Portage Lake See NNL Habitat Report for habitat compensation assessment.
	Local impairment of Third Portage Lake from introduction of nitrates from blasted rock used to construct dike. Increase in phytoplankton and zooplankton abundance.	L	L	M	I	NO	No mitigation possible to protect fish habitat during construction.	Leaching of nitrates from blasted rock. Small increase in lake productivity in near-field from nutrients.	NO	Mod	A targeted study has been proposed to monitor near-field water quality and assess changes in productivity (see AEMP).
Pit Dewatering											
Dewatering of Second Portage North Arm into Third Portage Lake	Second Portage Lake behind the East Dike will be drawn down by 28 m. Water will be discharged to Third Portage Lake North Basin. During drawdown, there is the potential for entrainment of sediment and pore water metals discharged to Third Portage Lake. Potential for smothering and toxicity to aquatic invertebrates.	M	L	S	F	NO	Locate dewatering barge and pumps in an area of Second Portage Lake such that withdrawal of suspended sediments from water column is minimized.	Temporary increase in TSS causing reduced light penetration and productivity, smothering of fish habitat in depositional areas of North Basin Third Portage Lake. Mitigation will reduce magnitude and duration of effects.	NO	Mod	Monitoring of water column TSS during dewatering of impoundment has been identified as a targeted study within the AEMP.

Table C.4 Continued

		Assessment of Unmitigated Effects					Assessment of Residual Effects				
Project Component	**Potential Physical and Ecological Effect**	**Magnitude**	**Spatial Extent**	**Duration**	**Frequency and Timing**	**Significance of Unmitigated Effects**	**Proposed Mitigation**	**Residual Effect / Influence of Mitigation**	**Significance of Residual Effect**	**Certainty of Prediction**	**Aquatic Environment Management Program (AEMP) Description**
Dewatering of Portage Pit into Third Portage Lake	Entrainment of sediments during draw down and pumping into Third Portage Lake. Decreased water quality, sedimentation of benthic habitats.	L	L	S	F	NO	Locate dewatering barge and pumps within deepest portion of impounded area such that withdrawal of suspended sediments is minimized as much as possible.	Increase in TSS causing reduced light penetration and productivity, smothering of fish habitat in depositional areas of Third Portage Lake. Mitigation reduces magnitude and duration of effects.	NO	Mod	Monitoring of water column TSS and effects on fish during dewatering of Portage pit impoundment has been identified as a targeted study within the AEMP.
Dewatering of Bay Zone Pit into Third Portage Lake	Entrainment of sediments during draw down and pumping into Third Portage Lake. Decreased water quality, sedimentation of benthic habitats.	L	L	S	F	NO	Locate dewatering barge and pumps within deepest portion of impounded area such that withdrawal of suspended sediments is minimized as much as possible.	Increase in TSS causing reduced light penetration and productivity, smothering of fish habitat in depositional areas of Third Portage Lake. Mitigation reduces magnitude and duration of effects.	NO	Mod	Monitoring of water column TSS and effects on fish during dewatering of Portage pit impoundment has been identified as a targeted study within the AEMP.
Dewatering of Goose Island Pit into Third Portage Lake	Entrainment of sediments during draw down and pumping into Third Portage Lake. Decreased water quality, sedimentation of benthic habitats.	L	L	S	F	NO	Locate dewatering barge and pumps within deepest portion of impounded area such that withdrawal of suspended sediments is minimized as much as possible.	Increase in TSS causing reduced light penetration and productivity, smothering of fish habitat in depositional areas of Third Portage Lake. Mitigation reduces magnitude and duration of effects.	NO	Mod	Monitoring of water column TSS during dewatering of impoundment has been identified as a targeted study within the AEMP.

Table C.4 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Program (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Pit Development											
Portage Pit	Pit development will result in medium-term loss of habitat behind dike in Second Portage Lake. Net loss of habitat and productivity in Second Portage Lake equivalent to pit surface area.	M	L	M*	F	YES	Loss of fish habitat in Second Portage Lake from pit footprint will be compensated for by creating habitat along dike exteriors during operations phase and during post-closure. Further offsite habitat compensation will be required (to be resolved with DFO) at Baker Lake. See No Net Loss Report (2005) for full details.	Loss of fish habitat during mine life; alteration of habitat at post-closure. Net loss is offset by habitat area and value created along dike exterior (operation) and interior (post-closure), as well as additional habitat at Baker Lake.	YES	High	The NNL Habitat Report (2005) addresses net impacts to fish habitat and implications on fish over mine life during operation and post-closure.
Bay Zone Pit	During Year 0-5, pit development will result in medium-term loss of habitat behind dike in Second Portage Lake. Net loss of habitat and productivity in Second Portage Lake equivalent to pit surface area. This pit will be incorporated within Goose Island pit after Year 5.	L	L	M*	F	NO	Loss of fish habitat in Third Portage Lake from pit footprint will be compensated for by creating habitat along dike exteriors during operations phase and during post-closure. Further offsite habitat compensation will be required at Baker Lake.	Loss of fish habitat within pit footprint. Net loss is offset by value created along dike exterior (operation) and interior (post-closure).	NO	High	The NNL Habitat Report (2005) addresses net impacts to fish habitat and implications on fish over mine life during operation and post-closure.

Table C.4 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Program (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Goose Island Pit	Pit development will result in medium-term loss of habitat behind dike in Third Portage Lake. Net loss of habitat and productivity in Third Portage Lake equivalent to pit surface area.	L	L	M*	F	NO	Loss of fish habitat in Third Portage Lake from pit footprint will be compensated for by creating habitat along dike exteriors during operations phase and during post-closure. Further offsite habitat compensation will be required at Baker Lake.	Loss of fish habitat within pit footprint. Net loss is offset by value created along dike exterior (operation) and interior (post-closure).	NO	High	The NNL Habitat Report (2005) addresses net impacts to fish habitat and implications on fish over mine life during operation and post-closure.
Second Portage Tailings Facility	Permanent loss of fish habitat due to tailings disposal.	H	L	M	F	YES	Replace habitat by connecting a channel to Dogleg Lake. Offsite compensation at Baker Lake.	Reduce aerial proportion of fish habitat loss by connecting Dogleg Lake by a connecting channel and habitat at Baker L.; mitigation reduces magnitude of habitat loss.	YES	High	Habitat lost as a result of installation of a tailings disposal facility will be partially compensated for by a combination of on-site and off-site activities. See NNL Program for details.

Table C.4 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Program (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Portage – Goose Island Rock Storage Facility	The Portage – Goose Rock storage facility lies directly over Lake NP-2 (fish bearing) and adjacent to one small non-fish bearing pond. Lake NP-2 does not have a hydraulic connection to Second Portage Lake and is isolated. The rock storage facility will eliminate all fish habitat in Lake NP-2. Contact water runoff from disturbed terrain and the waste rock pile could introduce low pH water with elevated metals concentrations into Third Portage Lake.	L	L	M*	F	NO	Construct a reliable hydraulic connection between Second Portage Lake and Dogleg Lake (NP-1). All contact water with Rock Storage facility will be directed to the Second Portage Lake attenuation pond to eliminate impacts to habitat from introduction of low pH, high metals surface water drainage.	Access by fish to Dogleg Lake will result in a net increase in available habitat despite elimination of NP-2 pond. Directing all contact water to attenuation pond will reduce magnitude and frequency of effects.	NO	High	Access to Dogleg Lake by fish from Second Portage Lake will increase available habitat and increase productive capacity. The NNL Habitat Report (2005) describes effectiveness of habitat compensation.
Borrow Pit/Quarry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Roads and Traffic	Terrain disturbance, introduction of particulates to lakes during rain events, aerial dispersion of particulates, local habitat disturbance, road dust. Smothering of benthos and fish spawning habitat, impaired feeding efficiency by fish; toxicity due to metals introductions.	L	L	S	F	NO	Construction activities in and around waterways will be avoided. No direct contact of vehicles in lakes. Dust suppressants applied to roads. Other dust control measures for aerial emissions. Perimeter ditches for all contact water directed to runoff to tailings facility in Second Portage Lake.	Collection of contact water and diversion by ditches to attenuation pond to eliminate exposure pathway. Mitigation will reduce magnitude, extent and duration of effects. Negligible residual ecological effects.	NO	High	Targeted monitoring during road construction will be implemented if necessary. See AEMP (2005). Because all contact water is captured and routed to the attenuation pond, there is no direct runoff to the receiving environment and no routine monitoring is required.

Table C.4 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Program (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Airstrip and Air Traffic	Terrain disturbance, introduction of particulates to lakes during rain events, aerial dispersion of particulates, local habitat disturbance, dust during aircraft take-off and landing. Smothering of benthos and fish spawning habitat, impaired feeding efficiency by fish; toxicity due to metals introductions.	L	L	S	F	NO	Dust suppressants applied to airstrip. Other dust control measures for aerial emissions. Perimeter ditches for all contact water to direct runoff to attenuation pond.	Collection of contact water and diversion by ditches to attenuation pond to eliminate exposure pathway. Mitigation will reduce magnitude, extent and duration of effects. Negligible residual ecological effects.	NO	High	Targeted monitoring during airstrip construction will be implemented if necessary. See AEMP (2005).
Mine Plant and Associated Facilities	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Freshwater Intake and Pipeline	Construction of water intake pipe in Third Portage Lake altering the directly underlying fish habitat.	L	L	S	R	NO	Minimize disturbance of bottom, time installation during open water.	Negligible ecological effect.	NO	High	No monitoring required.
Discharge Facility and Pipeline	Installation of a pipeline and floating barge in Third Portage Lake, altering the directly underlying fish habitat.	L	L	S	R	NO	Minimize disturbance of bottom, time installation during open water.	Negligible ecological effect.	NO	High	No monitoring required.
Non-Contact Diversion Facility	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fuel Storage at Site	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Emulsion/AN Storage / Explosives Magazines	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Camps (North and South)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sewage and Solid Waste Disposal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.4 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Magnitude	Spatial Extent	Duration	Frequency and Timing	Significance of Unmitigated Effects	Assessment of Residual Effects: Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	Aquatic Environment Management Program (AEMP) Description
VAULT FACILITIES											
Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dike Construction – Vault Lake	Minor disturbance to nearshore area of Wally Lake/Vault Lake beneath dike footprint with potential for minor increase in TSS. Elimination of fish habitat beneath dike footprint.	L	L	S	I	NO	Use silt curtains to contain sediments during dike construction.	Low potential for escape of sediment beneath or around silt curtain because of boulder substrate. Low possibility of increase in TSS and smothering of fish habitat. Nearshore area impacted is very small and potential for residual effects in Wally Lake is negligible.	NO	High	AEMP will monitor water quality in dike near-field during construction and assess impacts on fish habitat in Wally Lake. See NNL Habitat Report for habitat compensation assessment.
	Introduction of nitrates from blasted rock used to construct dike. Increase in primary and secondary productivity.	L	L	S	I	NO	Use silt curtains to contain disturbance during dike construction.	Small increase in lake productivity in near-field from nutrients.	NO	High	A targeted study has been proposed to monitor near-field water quality and assess changes in productivity (see AEMP).

Table C.4 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Program (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Vault Lake Dewatering	Entrainment of sediments during draw down and pumping into Wally Lake causing increase in TSS and local impairment of benthic habitat.	M	L	S	F	NO	Locate dewatering barge and pumps in profundal area of Vault Lake to minimize entrainment of suspended sediments.	Increase in TSS causing reduced light penetration and productivity, smothering of fish habitat in depositional areas of Wally Lake. Mitigation will reduce magnitude and extent of effects.	NO	Mod	Monitoring of water column TSS during dewatering of impoundment has been identified as a targeted study within the AEMP.
Pit Development	Pit development will result in loss of habitat within Vault Lake. Net loss of habitat and productivity equivalent to lake surface area.	M	L	M*	F	YES	Loss of fish habitat from pit footprint will be compensated for by creating habitat along dike exterior. See NNL Report (2005).	Temporary loss of fish habitat beneath dike footprint during operation. Net loss is offset by habitat area and value created along dike exterior.	YES	High	The NNL Habitat Report addresses net impacts to fish habitat and implications on fish over mine life during operation.

Table C.4 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Program (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Vault Rock Storage Facility	Runoff from disturbed terrain and the waste rock pile (i.e., contact water) could introduce low pH water with elevated metals concentrations into Wally Lake, adversely affecting fish habitat.	M	L	M*	F	YES	All contact water with Rock Storage facility will be directed to the Vault Lake attenuation pond to eliminate impacts to habitat from introduction of low pH, high metals surface water drainage. Discharge only during open water season.	Small increase in TSS, metals from discharge of attenuation pond water into Wally Lake during open water. Mitigation will reduce magnitude and frequency of effects by directing all contact water to Vault attenuation pond.	NO	High	Water quality monitoring adjacent to dikes and outfall. Targeted monitoring during construction will be implemented when necessary. See the AEMP.
Roads and Traffic	Terrain disturbance, introduction of particulates to lakes during rain events, aerial dispersion of particulates, local habitat disturbance, road dust. Localized reductions in habitat productivity due to reduced water clarity and smothering of benthos.	L	L	M*	F	NO	Construction activities in and around waterways will be avoided. No direct contact of vehicles in lakes. Dust suppressants applied to roads. Other dust control measures for aerial emissions. Perimeter ditches to direct runoff to attenuation ponds.	Negligible residual effect. Mitigation will reduce the frequency and duration of effects and eliminate the exposure pathway and ecological effects.	NO	High	Water quality monitoring adjacent to mine site will be conducted routinely at a variety of locations. Targeted monitoring during construction will be implemented when necessary. See AEMP.
Non-Contact Diversion Facility	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mine Shop / Office	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.4 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Program (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Turn Lake Road Crossing	Culverts will be installed in the dry season during winter when natural stream channel is frozen. Elimination of fish habitat beneath culvert footprint	L	L	S	R	NO	Construct during winter. Place coarse grain substrate in bottom of culverts to replace habitat loss. see Aquatic Environmental Management Plan and No Net Loss Report (2005).	Negligible residual effect.	NO	High	Annual monitoring to confirm that rep rap habitat at entry and exit points to culvert is stable and functioning as designed (see AEMP).
OTHER FACILITIES											
Winter Road and Traffic	Potential damage to lake and stream habitat quality at winter road crossings via compaction and erosion (i.e., destabilization of entry/ exit points). Potential temporary stream blockage in spring due to freeze-down and snow pack at stream crossing points of lakes causing erosion, permafrost exposure.	L	R	M	I	NO	Avoid use of winter road at the beginning and end of the season; install protective devices or maintain winter road to minimize potential effects; cross at established entry points; use appropriate vehicles and tires; Select alternate route if a problem is identified during routine monitoring (see AEMP).	Negligible residual effect. Mitigation will reduce magnitude, duration and frequency of effects.	NO	High	Routine, annual monitoring of the winter road will be conducted to determine if any adverse effects to fish habitat at key crossing areas can be detected and corrected, if necessary (see AEMP).
Baker Lake Access Road and Traffic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.4 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Program (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Baker Lake Marine Barge Landing Facility	Localized alteration of fish habitat along Baker Lake foreshore.	L	L	M*	I	NO	Construct landing facility to minimize impacts to near-shore and shoreline of Baker Lake; avoid high quality habitat; use geotextile material during unloading to minimize erosion and habitat disturbance; see AEMP and No Net Loss Report .	No residual effects anticipated. Mitigation will reduce magnitude, duration and frequency of effects.	NO	High	Implement emergency spills response in event of an accidental spill (see AEMP). Routine, annual monitoring of the Barge Landing Facility will be conducted to determine if any adverse effects to fish habitat can be detected and corrected, if necessary (see AEMP).
Marine Barge Traffic during Construction	Increase in marine barge traffic. Will cause small incremental rise of noise and hydrocarbon emissions along the transport route.	L	R	S	I	NO	Follow hazardous material handling guidelines; follow spill contingency guidelines; protocols and standards for barge operators	Mitigation will reduce the magnitude and frequency of effects (negligible residual effect).	NO	High	No monitoring required.
Baker Lake Staging Facility	Construction of the staging facility will take place well away from fish-bearing waters and no adverse physical effects are anticipated	L	L	S	R	NO	Ensure compliance with policies for vehicle re-fuelling, safe storage of explosives, fuels, etc.	Negligible residual effect.	NO	High	No monitoring required.
Explosives Magazine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.4 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Program (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect / Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Accidental Spills: Fuel Storage Site (Portage), Tank Farm, Roads, Marine Transport.	Potential spills can impact fish habitat through introduction of contaminants (toxicity), or physical effect (smothering, compaction, erosion).	L	L	M	R	NO	Tank farm built within berms for containment. Follow hazardous material handling guidelines; follow spill contingency guidelines; protocols and standards for barge operators. Follow standard marine shipping procedures during Hudson Bay open water season. Implement strategies contained in the Spill Contingency Report.	Mitigation will reduce the magnitude, duration and spatial extent of any spills that may occur and cause impacts.	NO	High	Implement emergency spills response in event of an accidental spill (see AEMP).

Table C.5: Fish Habitat Impact Matrix – Operation

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Plan (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
MAIN FACILITIES											
Noise and Traffic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dikes											
Second Portage - East Dike	Leaching of metals from dike materials into water columns, affecting constructed fish habitat quality on dikes. Loss of habitat under dike footprint. Cause potential toxicity, limiting periphyton growth, and colonization by benthos, thereby reducing fish habitat.	L	L	P	F	NO	Fish habitat will be replaced along dike exteriors during operations phase and during post-closure. Use IF material with lowest metal leaching potential to construct outer face of East Dike. Substrate, depth and slope of dike exterior designed to optimize spawning and rearing habitat for fish and colonization by periphyton and benthos.	Reduced productive capacity of fish habitat in Second Portage Lake. Mitigation will further reduce magnitude and provide productive habitat. Possible impairment of periphyton growth and benthic colonization. Use of low metal leaching rock will reduce magnitude and frequency of habitat impairment.	NO	Mod	The net difference in productive capacity of fish habitat is assessed within the NNL Report (2005). There will be a net loss of habitat in the project area and off-site habitat compensation is being considered.
	Potential for local impairment of Second Portage Lake water quality due to metals leaching from dike material pore waters. Reduction in periphyton and benthic communities (fish habitat) away from dike.	L	L	L	F	NO	Use IF material with lowest metal leaching potential to construct outer face of East Dike.	Possible toxicity to phytoplankton and benthos. Effect will be reduced over time. Use of low metal leaching rock will reduce magnitude and frequency of habitat impairment.	NO	Mod	A targeted study has been proposed to monitor pore water and very near-field water quality along the dike to confirm/refute Golder (2005) predicted water quality modeling results of metal leaching (see AEMP). Implications on productivity of fish habitat will be assessed.

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Plan (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Second Portage – Tailings Dike	See Pit Development	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Third Portage Lake – Bay Zone Dike	Elimination of fish habitat within Portage South Dike footprint will reduce productive capacity of fish habitat in Third Portage Lake (Years 0-5).	L	L	S	F	NO	Replace fish habitat along dike exteriors during operations and post-closure. Use IF material with lowest metal leaching potential to construct outer face of East Dike; See No Net Loss Report (2005). Substrate, depth and slope of dike exterior designed to optimize spawning and rearing habitat for lake trout and round whitefish.	Reduced productive capacity of fish habitat in Third Portage Lake. Habitat loss offset by enhancement of habitat on dikes.	NO	Mod	The net difference in productive capacity of fish habitat is assessed within the NNL Report (2005). There will be a net loss of habitat in the project area and off-site habitat compensation is being proposed.
	Potential for local impairment of Third Portage Lake dike pore water quality due to metals leaching from dike material. Possible impairment of periphyton growth and benthos on dike exterior.	L	L	L	F	NO	Use IF material with low metal leaching potential to construct outer face of Portage South Dike.	Possible impairment of growth by periphyton and colonization by benthic invertebrates. Use of low metal leaching rock will reduce magnitude and frequency of habitat impairment.	NO	Mod	A targeted study has been proposed to monitor pore water and very near-field water quality along the dike to confirm/refute Golder (2005) predicted water quality modeling results of metal leaching (see AEMP).

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Plan (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Third Portage Lake Goose Island	Elimination of 3% of lake area will reduce productive capacity of fish habitat in Third Portage Lake behind Goose Island dike.	L	L	P	F	NO	Fish habitat will be replaced along dike exteriors during operations phase and during post-closure. Use IF material with lowest metal leaching potential to construct outer face of East Dike. Substrate, depth and slope of dike exterior designed to optimize spawning and rearing habitat for lake trout and round whitefish.	Reduced productive capacity of fish habitat in Third Portage Lake within Goose Island dike.	NO	Mod	Enhancement of dike exterior is expected to offset habitat loss in Third Portage Lake and is addressed in the NNL Habitat Report (2005).
	Local impairment of Third Portage Lake water quality from leaching of metals from outside of dikes. Possible impairment of periphyton growth and benthos on dike exterior.	L	L	L	F	NO	Use IF material with lowest metal leaching potential to construct outer face of Goose Island Dike.	Possible impairment of growth by periphyton and colonization by benthic invertebrates. Use of low metal leaching rock will reduce magnitude and frequency of habitat impairment.	NO	Mod	A targeted study has been proposed to monitor pore water and very near-field water quality along the dike to confirm/refute Golder (2005) predicted water quality modeling results of metal leaching (see AEMP) to assess productivity of fish habitat compensation.
Pit Dewatering	NA – see Construction	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Plan (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Pit Operation											
Pit Operation – Portage Pit and Goose Island Pit	Pit operation will result in loss of habitat beneath pit footprints in Second Portage Lake. Net loss of habitat and productivity equivalent to pit surface area.	M	L	L	F	YES	Loss of fish habitat in Second Portage Lake from pit footprint will be compensated for by creating habitat along dike during operations phase and during post-closure. Offsite habitat compensation will be required (to be resolved with DFO) at Baker Lake. See NNL Report (2005) for full details.	Loss of fish habitat beneath pit footprint. Net loss is partially offset (reduced magnitude) by habitat area and value created along dike exterior (operation) and interior (post-closure), and offsite at Baker L., but not enough to become insignificant.	YES	Mod	The NNL Habitat Report (2005) addresses net impacts to fish habitat and implications on fish over mine life during operation and post-closure.
Pit Operation – Bay Zone/ Goose Island pits	Pit operation will result in loss of habitat beneath pit footprints in Third Portage Lake. Net loss of habitat and productivity equivalent to pit surface area.	L	L	L	F	NO	Loss of fish habitat in Second Portage Lake from pit footprint will be compensated for by creating habitat along dike during operations phase and during post-closure. Offsite habitat compensation will be required (to be resolved with DFO) at Baker Lake. See NNL Report (2005) for full details.	Loss of fish habitat beneath pit footprint. Net loss is partially offset (reduced magnitude) by habitat area and value created along dike exterior (operation) and interior (post-closure).	NO	Mod	The NNL Habitat Report (2005) addresses net impacts to fish habitat and implications on fish over mine life during operation and post-closure.

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Plan (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Second Portage Tailings Facility	Permanent loss of habitat due to tailings disposal.	H	L	P	F	YES	Permanent loss of fish habitat in Second Portage Lake from pit footprint will be partially compensated for by creating habitat along dike exteriors during operations phase and during post-closure. See NNL Report (2005) for full details.	Permanent loss of fish habitat beneath post-closure pit footprint. Net loss is partially offset (reduced magnitude) by habitat area and value created along dike exterior (operation) and interior (post-closure), but not enough to become insignificant.	YES	High	The NNL Habitat Report (2005) addresses net impacts to fish habitat and implications on fish over mine life during operation and post-closure.

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Plan (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Portage – Goose Rock Storage Facility	The Portage – Goose Rock storage facility lies directly over Lake NP-2 (fish bearing) and adjacent to one small non-fish bearing pond. Lake NP-2 does not have a hydraulic connection to Second Portage Lake and is isolated. Runoff from the waste rock pile (i.e., contact water) during operation could introduce low pH water with elevated metals concentrations into Second Portage Lake and Third Portage lakes, reducing primary and secondary productivity.	L	L	P	F	NO	Construct a reliable hydraulic connection between Second Portage Lake and Dogleg Lake (NP-1). Dogleg contains fish but, like NP-2 does not have a hydraulic connection. Excavating a stream channel will allow fish to move back and forth between the lakes and will increase available fish habitat within the Second Portage Lake drainage system. All contact water with Rock Storage facility will be directed to the Second Portage Lake attenuation pond to eliminate impacts to habitat from introduction of low pH, high metals surface water drainage.	Access by fish to Dogleg Lake will result in a net increase in available habitat in Second Portage Lake despite elimination of NP-2 pond. Use of collection ditches and attenuation ponds will eliminate pathway to receiving environment, reducing magnitude, duration and frequency of impacts.	NO	High	Access to Dogleg Lake by fish from Second Portage Lake will increase available habitat and increase productive capacity. The NNL Habitat Report (2005) describes effectiveness of habitat compensation.
Borrow Pit/Quarry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Plan (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Roads and Traffic	Terrain disturbance, introduction of particulates to lakes during rain events, aerial dispersion of particulates, local habitat disturbance, road dust. Potential for reduction in primary and especially secondary productivity.	L	L	L	F	NO	Operation activities in and around waterways will be avoided. No direct contact of vehicles in lakes. Dust suppressants applied to roads. Other dust control measures for aerial emissions. Perimeter ditches will capture and direct all contact water to tailings facility.	Negligible ecological effects on fish. Mitigation will eliminate pathways of contamination, reducing magnitude, extent and duration of impacts.	NO	High	Water quality monitoring adjacent to mine site will be conducted routinely at a variety of locations. Targeted monitoring during construction will be implemented when necessary. See AEMP.
Airstrip and Air Traffic	Terrain disturbance, introduction of particulates to lakes during rain events, aerial dispersion of particulates, local habitat disturbance, road dust. Potential increase in sedimentation and impairment of benthic habitat.	L	L	L	F	NO	Operation activities in and around waterways will be avoided. No direct contact of vehicles in lakes. Dust suppressants applied to roads. Other dust control measures for aerial emissions. Perimeter ditches to direct runoff to tailings facility.	Negligible ecological effects on fish. Mitigation will eliminate pathways of contamination, reducing magnitude, extent and duration of impacts.	NO	High	Water quality monitoring adjacent to mine site will be conducted routinely at a variety of locations. Targeted monitoring during construction will be implemented when necessary. See AEMP.
Mine Plant and Associated Facilities	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Freshwater Intake and Pipeline	Operation of a water intake pipe in Third Portage Lake. Average intake rate is estimated to be 0.021 m^3/s. Entrainment of plankton from the lake during open water.	L	L	L	F	NO	Install intake at deep depth near bottom to minimize entrainment of plankton.	Minimal entrainment of plankton, with negligible ecological effects.	NO	High	No monitoring required.

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Plan (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Effluent Discharge and Pipeline – Third Portage Lake	Effluent discharge to Third Portage Lake North Basin during construction and years 1 – 5 of operation will consist of water discharged from the Second Portage attenuation pond. In years 1 – 5 this pond will receive direct precipitation, contact and non-contact water, and treated sewage. Potential for metals exposure to result in sublethal toxicity to aquatic life, and possible effects to fish habitat by deposition of particulates.	(Year 1-5) L	L	L	F	NO	Install a diffuser at the outfall to increase dilution potential. Effluent will only be discharged during the open-water season and will not be discharged under ice to avoid sensitive periods for fish spawning and egg incubation.	Years 1-5 does not involve discharge of tailings effluents. Discharge below MMER standards and only during open water. Effect will be to reduce magnitude and extent of impact.	NO	Mod	Metal Mining Effluent Regulations are very specific with regards to monitoring requirements of effluents. A draft monitoring program (EEM 2005) has been designed for this project to address all EEM requirements.

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Magnitude	Spatial Extent	Duration	Frequency and Timing	Significance of Unmitigated Effects	Assessment of Residual Effects: Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	Aquatic Environment Management Plan (AEMP) Description
	After year 5, metals contaminated water from the tailings pond will be combined with the attenuation pond and discharged to Third Portage Lake. Given the low dilution potential and turnover in Third Portage Lake, there is potential for dissolved metals to exceed CCME criteria for the protection of aquatic life. Inputs of particulate bound contaminants will settle in depositional areas and may affect fish habitat.	(> 5 Yr) M	R	L	F	YES	Delay discharge to Third Portage for as long as possible and contain wastes within Second Portage attenuation pond. A water treatment plant will be installed in Year 5 to reduce metals and TSS loading. Install a diffuser at the outfall to increase dilution potential. Effluent will only be discharged during the open-water season and will not be discharged under ice to avoid sensitive periods for fish spawning and egg incubation.	Despite water treatment and given the low buffering capacity of the project lakes, there is the potential for dissolved metals to exceed CCME criteria for the protection of aquatic life. Uncertain effects on phytoplankton and zooplankton. Magnitude will depend on spatial and temporal extent of exceedances, pending results of more detailed Water Quality Monitoring. This is the worst case scenario. Mitigation (adaptive water treatment) will reduce the magnitude and extent of negative water quality impacts to local and regional lakes.	YES	Mod	Metal Mining Effluent Regulations are very specific with regards to monitoring requirements of effluents. A draft monitoring program (MMER 2005) has been designed for this project to address all MMER requirements. A plume delineation study will be conducted in accordance with guidance. In addition, the AEMP will monitor impacts of the effluent from a wider spatial scale and place impacts in context with non-effluent impacts. Targeted studies will be implemented (e.g., impacts of sediment on benthos) if necessary in accordance with adaptive management principals to assess habitat impacts.

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Magnitude	Spatial Extent	Duration	Frequency and Timing	Significance of Unmitigated Effects	Assessment of Residual Effects: Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	Aquatic Environment Management Plan (AEMP) Description
	Increase in nutrient levels in Third Portage Lake as a result of discharge of treated sewage. Possible increase in primary and secondary productivity.	L	L	L	F	NO	Primary treatment is proposed to reduce nutrient inputs. Wastes will be discharged only during the open water season after holding in attenuation pond. Install a diffuser at the outfall to increase dilution potential.	Increase in nutrient concentrations may cause an increase in primary productivity (i.e., phytoplankton) that may be reflected as an increase in secondary productivity and ultimately, fish.	NO	Mod	Routine monitoring of near-field and far-field stations as part of the AEMP for water column nutrient concentration chlorophyll a and phytoplankton biomass to quantify change. Depending on perspective, this may be viewed as a positive impact.
	Input of suspended sediment that may settle in depositional areas and degrade aquatic habitat.	L	L	L	F	NO	Installation of a water treatment facility to control TSS introductions. Discharge only during the open water season to increase dispersion of suspended solids.	Possible degradation of benthic habitats by TSS causing smothering or decreased feeding). Mitigation will reduce the magnitude of these potential effects.	NO	High	Implement MMER program. See AEMP for routine monitoring of TSS.
Non-Contact Diversion Facility	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fuel Storage	NA – No pathway to aquatic ecosystem (see Spills).	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Emulsion/AN Storage / Explosives Facility	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
North and South Camp	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sewage and Solid Waste Disposal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
VAULT FACILITIES											
Noise and Activity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects: Magnitude	Spatial Extent	Duration	Frequency and Timing	Significance of Unmitigated Effects	Assessment of Residual Effects: Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	Aquatic Environment Management Plan (AEMP) Description
Vault Dike	Metals leaching from dike face may impair colonization by periphyton and benthos.	L	L	L	F	NO	Two m thick layer of IF rock material will be placed on external surface of Vault Dike to provide optimal habitat for spawning by lake trout and round whitefish. See No Net Habitat Loss Report (2005) for details of habitat compensation.	Possible impairment of growth by periphyton and colonization by benthic invertebrates. Low metal-leaching rock will reduce magnitude and extent of dissolved metals.	NO	High	A targeted study has been proposed to monitor pore water and very near-field water quality along the Vault dike to confirm/refute Golder (2005) predicted water quality modeling (see AEMP).
Vault L. Dewatering	NA – see Construction phase	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pit Operation	Pit operation will result in loss of habitat within Vault Lake. Net loss of habitat and productivity equivalent to lake surface area.	M	L	L	F	YES	Loss of fish habitat within Vault Lake will be compensated for by creating habitat along dike exteriors during operations phase and during post-closure. See NNL Report (2005). Establish a reliable hydraulic connection between the two small ponds north of the Vault Rock Storage facility and Wally Lake to permit access to fish habitat by fish.	Loss of fish habitat beneath post-closure pit footprint. Net loss is offset by habitat area and value created along dike exterior (operation) and interior (post-closure). Magnitude of habitat lost is only partially reduced at post-closure.	YES	Mod	The NNL Habitat Report (2005) addresses net impacts to fish habitat and implications on fish habitat over mine life during operation and post-closure.

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Plan (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Vault Rock Storage Facility	Runoff from the waste rock pile (i.e., contact water) could introduce low pH water with elevated metals concentrations into Wally Lake, adversely affecting fish habitat.	M	L	P	F	YES	All contact water with Rock Storage facility will be directed to the Vault Lake attenuation pond to eliminate impacts to habitat from introduction of low pH, high metals surface water drainage.	TSS and metals discharged from attenuation pond to Wally Lake during open water only. Collection and attenuation will reduce magnitude and extent of impacts.	NO	High	Water quality monitoring adjacent to dikes and outfall. EEM Program for mine effluent will be implemented for discharges from Vault attenuation pond to Wally Lake. See AEMP.
Roads and Traffic	Terrain disturbance, introduction of particulates to lakes during rain events, aerial dispersion of particulates, local habitat disturbance, road dust. Possible impairment of aquatic habitats from sedimentation and dissolved metals.	L	L	L	F	NO	Operation of heavy equipment in and around waterways will be avoided. No direct contact of vehicles in lakes. Dust suppressants applied to roads. Other dust control measures for aerial emissions. Perimeter ditches to direct runoff to Vault attenuation pond.	Negligible ecological effects on fish habitat. Use of collection channels will eliminate pathway and mitigate adverse effects to fish habitat by reducing magnitude and extent.	NO	High	Water quality monitoring in Wally Lake will be conducted routinely at a variety of locations. See AEMP.
Effluent Discharge – Wally Lake	Effluent discharge to Wally Lake is scheduled to begin during Year 5 of operation. No input of mine water or other contaminants will be directed to the attenuation ponds, and a water treatment plant is not expected to be required. Effluent will be discharged during open water and effluent will consist of pit inflow water, precipitation and non-contact water. Possible adverse effects to fish habitat leading to decreased productivity from exposure to metals and TSS.	L	L	L	F	NO	Install a diffuser at the outfall to increase dilution potential. Effluent will only be discharged during the open-water season and will not be discharged under ice to avoid impacts to sessile biota. Treatment of effluent if necessary.	Settling of TSS and altered sediment chemistry may impact benthos. Mitigation will reduce the magnitude and extent of effects.	NO	Mod	Effluent from the Vault attenuation ponds will be monitored under MMER in the same fashion as mine water discharge. See EEM Report. A plume delineation study will be conducted to determine the spatial extent of the plume and determine whether fish and benthic invertebrate surveys are required.

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Plan (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Non-Contact Diversion Facility	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mine Shop / Office	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Turn Lake Road Crossing	Reduced productivity because of shading by road crossing. Loss of benthic habitat.	L	L	L	F	NO	Install rip rap along shorelines and approaches to road crossing to replace low value, soft sediment habitat with higher value habitat.	Negligible residual impact. Mitigation will protect habitat and lessen effects.	NO	High	Annual monitoring of shoreline stability at Turn Lake crossing (see AEMP).
OTHER FACILITIES											
Winter Road and Traffic	Potential damage to lake and stream habitat quality at winter road crossings via compaction and erosion (i.e., destabilization of entry/ exit points). Potential temporary stream blockage in spring due to freeze-down and snow pack at stream crossing points of lakes causing erosion, permafrost exposure.	L	R	L	I	YES	Avoid use of winter road at the beginning and end of the season; maintain winter road to minimize potential effects; cross at established entry points; use appropriate vehicles and tires; Select alternate route if a problem is identified during routine monitoring (see AEMP). Follow hazardous material handling guidelines; follow spill contingency guidelines.	Negligible residual impact. Mitigation will significantly reduce magnitude and extent of effects to fish habitat.	NO	High	Routine, annual monitoring of the winter road will be conducted to determine if any adverse effects can be observed and corrected, if necessary (see AEMP). Implement emergency spills response in event of an accidental spill (AEMP).
Baker Lake Access Road and Traffic	NA	NA	NA	NA	NA	NA	NA	MA	NA	NA	NA

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Plan (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Baker Lake Marine Barge Landing Facility	Localized degradation of fish habitat along Baker Lake foreshore due to compaction, disturbance, bank destabilization and introduction of TSS.	L	L	L	I	NO	Landing facility designed to minimize impacts to near-shore and shoreline fish habitats in Baker Lake; avoid high quality habitat; use geotextile material during unloading to minimize erosion and habitat disturbance;	Negligible residual impact. Mitigation will reduce the magnitude of impacts to shoreline habitat.	NO	High	Annual monitoring of shoreline stability and integrity will be conducted to avoid habitat impacts. See AEMP and NNL Habitat Report (2005).
Marine Barge Traffic	Increase in marine barge traffic will cause small incremental rise of noise and hydrocarbon emissions along the transport route.	L	R	S	I	NO	Follow standard marine shipping procedures during Hudson Bay open water season.	Negligible residual impact. Mitigation will reduce magnitude and spatial extent of ecological effects.	NO	High	No monitoring required.
Baker Lake Staging Facility	Construction of the staging facility will take place well away from fish-bearing waters and no adverse physical effects are anticipated.	L	L	S	R	NO	Ensure compliance with policies for vehicle re-fuelling, safe storage of explosives, fuels, etc.	Negligible residual impact. Mitigation includes proper guidelines for reducing risk of impacts to fish habitat.	NO	High	No monitoring required.
Explosives Magazine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C.5 Continued

Project Component	Potential Physical and Ecological Effect	Assessment of Unmitigated Effects				Significance of Unmitigated Effects	Assessment of Residual Effects				Aquatic Environment Management Plan (AEMP) Description
		Magnitude	Spatial Extent	Duration	Frequency and Timing		Proposed Mitigation	Residual Effect /Influence of Mitigation	Significance of Residual Effect	Certainty of Prediction	
Accidental Spills: Fuel Storage Site (Portage), Tank Farm, Roads, Marine Transport.	Potential spills can impact fish habitat through introduction of contaminants (toxicity).	L	L	M	R	NO	Tank farm built within berms for containment. Follow hazardous material handling guidelines; follow spill contingency guidelines; protocols and standards for barge operators. Follow standard marine shipping procedures during Hudson Bay open water season. Implement strategies contained in the Spill Contingency Report.	Mitigation will reduce the magnitude, duration and spatial extent of any spills that may occur and cause impacts.	NO	High	Implement emergency spills response in event of an accidental spill (see AEMP).

Table C.6: Fish Habitat Impact Matrix – Closure & Post-Closure

Project Component	Activity/ Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency and Timing	Assessment of Residual Effects: Influence of Activity/ Residual Effect	Assessment of Residual Effects: Significance of Residual Effects	Assessment of Residual Effects: Certainty of Prediction
MAIN FACILITIES								
Dikes								
Second Portage - East Dike	Create habitat on dike interior in Third Portage Lake. Leaching of dissolved metals from dike materials into surrounding water column. Cause potential toxicity to benthos and periphyton, reducing fish habitat productivity. Effects diminish over time.	L	L	M	F	New dike habitat represents an increase in structural complexity and area of fish habitat compared to pre-mining condition; benefit is partially offset by localized leaching of dissolved metals through capped dike wall into water. Increase in habitat area for benthos and periphyton. Dissolved metals may reduce primary and secondary productivity. Net effect is neutral or positive to benthic productivity.	NO	High
Second Portage Lake Tailings Dike	Create habitat on tailings dike exterior (now part of Third Portage Lake). Leaching of metals from dike porewaters into immediate water columns, affecting fish habitat on dikes facing old pit area. Cause potential toxicity to benthos and periphyton, reducing fish habitat productivity. Effects diminish over time.	L	L	M	F	New dike habitat represents an increase in structural complexity and area of fish habitat compared to pre-mining condition; benefit is partially offset by localized leaching of dissolved metals through capped dike wall into water. Moderate increase in fish habitat area. Dissolved metals may reduce primary and secondary productivity. Net effect is neutral to benthic productivity.	NO	High
Third Portage – Goose Island Dike	Create habitat on breached dike exterior and interior (Third Portage Lake). Leaching of metals from dike materials into surrounding water column. Loss of suitable habitat for benthos and periphyton. Cause potential toxicity to benthos and periphyton, reducing fish habitat productivity in Third Portage Lake. Diminished effects over time.	L	L	M	F	New dike habitat represents an increase in structural complexity and area of fish habitat compared to pre-mining condition; benefit is partially offset by localized leaching of dissolved metals through capped dike wall into water. Significant increase in habitat for benthos and periphyton. Dissolved metals may reduce primary and secondary productivity. Net effect is neutral or positive to benthic productivity.	NO	High

Table C.6 Continued

Project Component	Activity/ Ecological Effect	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Extent	Temporal Boundaries: Duration	Frequency and Timing	Assessment of Residual Effects: Influence of Activity/ Residual Effect	Significance of Residual Effects	Certainty of Prediction
Pits								
Pit Operation - Portage Pit and Goose Island	Adjoining Third Portage Lake to new habitat (part of which was previously Second Portage Lake) within Portage/ Goose Island pit areas. Deep pit footprint (Portage) will remain following closure, representing new habitat of lower quality to benthos.	M	L	P	F	Habitat area in Second Portage Lake now part of Third Portage Lake; habitat of lowered quality (very deep), proportional to flooded pit area. Reduced primary and secondary productivity in former Second Portage Lake. Insignificant increase in fish habitat in Third Portage Lake.	YES (SPL) NO (TPL)	High
	Connection of Portage and Goose Island pit areas to Third Portage Lake. Residual metals from pit walls will move into water column. Potential toxicity to benthos in local area (along dikes encircling pits). Reduction in primary and secondary productivity in pit habitat relative to pre-mine conditions.	L	L	M	F	New habitat within pit area may cause toxicity to benthos and periphyton. Effect decreases over time. Net loss in productivity within Third Portage Lake from metals toxicity may be offset by increase in habitat area. See NNL 2005.	NO	High
Second Portage Tailings Facility	Permanent capping and storage of tailings at Second Portage Tailings Facility resulting in net loss of fish habitat equivalent to 572,900 m^2.	H	L	P	F	Permanent loss of fish habitat resulting in reduced primary and secondary productivity (See NNL 2005).	YES	High
	Capping tailings material. Leaching of dissolved metals from tailings materials into surface waters of Third Portage Lake.	L	L	P	I	Leaching will be minimal due to capping and gradual permafrost formation. Toxicity reducing benthic productivity limited to open water season, diminished as tailings freeze; negligible residual effect.	NO	Mod
Portage – Goose Rock Storage Facility	Permanent storage of waste rock material. Runoff from the waste rock pile (i.e., contact water) could introduce low pH water with elevated metals concentrations into Second Portage Lake and Third Portage lakes, resulting in localized toxicity to periphyton and benthos.	L	L	P	I	During open-water season, some runoff from surface waters/ leachate from capped rock storage materials may lead to decreased habitat productivity. Permafrost formation over several years will reduce metals leaching and diminish exposure to benthos and periphyton; negligible residual effect.	NO	Mod
Borrow Pit/Quarry	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Roads and Traffic	Roads will be decommissioned; land will be restored.	NA	NA	NA	NA	NA	NA	NA
Airstrip and Air Traffic	Airstrip will be decommissioned; land will be restored.	NA	NA	NA	NA	NA	NA	NA

Table C.6 Continued

Project Component	Activity/ Ecological Effect	Assessment of Unmitigated Effects				Assessment of Residual Effects		
		Spatial Boundaries		Temporal Boundaries				
		Magnitude	Spatial Extent	Duration	Frequency and Timing	Influence of Activity/ Residual Effect	Significance of Residual Effects	Certainty of Prediction
Mine Plant and Facilities	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Freshwater Intake and Pipeline	Pipeline will be removed during closure. No residual effect.	NA	NA	NA	NA	NA	NA	NA
Effluent Discharge and Pipeline – Third Portage Lake	No effluent discharge will occur following mine closure. Removal of discharge pipeline during closure. No residual effects.	NA	NA	NA	NA	NA	NA	NA
Non-Contact Diversion Facility	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Fuel Storage	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Emulsion/AN Storage / Explosives Magazine	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Camp (North and South)	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Sewage and Solid Waste Disposal	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
VAULT FACILITIES								
Vault Pit	Connecting re-flooded Vault pit with Wally Lake (Vault dike removed at closure). Vault Lake has reduced quality of fish habitat (deep pit). Pit area will show a loss of benthic productivity from original levels in Vault Lake.	L	L	P	F	Fish habitat in Vault Lake will be of lowered quality, proportional to pit area. Habitat productivity will be reduced post-closure.	YES	High
	Connection of Vault pit area to Wally Lake. Residual metals from pit walls will move into water column. Potential toxicity to primary and secondary producers in local area (littoral habitat encircling pits). Reduced habitat productivity in Vault Lake. Effect diminishes over time.	L	L	M	F	Restored Vault Lake will contain residual metals from pit walls. Potential toxic effects to benthos and periphyton; negligible reduction in productivity. Effect will decrease over time.	NO	High
Vault Rock Storage Facility	Permanent storage of waste rock materials. Runoff from the waste rock pile (i.e., contact water) could introduce low pH water with elevated metals concentrations into Wally and Vault lakes, causing localized impacts on primary and secondary productivity.	M	L	P	I	During open-water season, some runoff from surface waters/ leachate from capped rock storage materials may lead to decreased habitat productivity. Permafrost formation over several years will reduce metals leaching and diminish exposure to primary and secondary producers.	NO	Mod

Table C.6 Continued

Project Component	Activity/ Ecological Effect	Assessment of Unmitigated Effects				Assessment of Residual Effects		
		Spatial Boundaries		Temporal Boundaries				
		Magnitude	Spatial Extent	Duration	Frequency and Timing	Influence of Activity/ Residual Effect	Significance of Residual Effects	Certainty of Prediction
Roads and Traffic	Roads will be decommissioned; land will be restored.	NA	NA	NA	NA	NA	NA	NA
Effluent Discharge – Wally Lake	No effluent discharge will occur following mine closure. Removal of discharge pipeline during closure. No residual effects.	NA	NA	NA	NA	NA	NA	NA
Non-Contact Diversion Facility	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Mine Shop / Office	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Turn Lake Road Crossing	Removal in winter when natural stream channel is frozen. Minor disturbance to localized benthos and periphyton during closure; no residual effects following restoration.	NA	NA	NA	NA	NA	NA	NA
OTHER FACILITIES								
Winter Road Operation and Traffic	No further use of road.	NA	NA	NA	NA	NA	NA	NA
Baker Lake Marine Barge Landing Facility	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Marine Barge Traffic	NA (no traffic in this phase).	NA	NA	NA	NA	NA	NA	NA
Baker Lake Staging Facility	Removal of the staging facility is not expected to cause any adverse effects during operation; no residual effects post-closure.	NA	NA	NA	NA	NA	NA	NA
Explosives Magazine	Decommissioned.	NA	NA	NA	NA	NA	NA	NA
Accidental Spills	Facilities (fuel storage (Portage), tank farm, roads, marine transport) will be removed at mine closure; no residual effects post-closure.	NA	NA	NA	NA	NA	NA	NA