1.0 PURPOSE OF NIRB REVIEW

The proposed Meadowbank project is subject to the environmental review and related licensing and permitting processes established by Part 5 of the Nunavut Land Claims Agreement (INAC and TFN, 1993). Cumberland has written this Final Environmental Impact Statement (FEIS) based on guidelines issued by the Nunavut Impact Review Board (NIRB). This report and many others describe the proposed Meadowbank project, the land, the wildlife, and the people. These reports also identify potential effects of the project and the steps Cumberland will take to make sure that the water stays clean, the fish and wildlife stay healthy, and that local people benefit from the project. The information contained in the FEIS and supporting documents will be used by NIRB and other regulators to review the project and make a decision regarding environmental permitting.

2.0 PROJECT DEFINITION

The Meadowbank Gold project represents construction, operation, maintenance, reclamation, closure, and monitoring of an open pit gold mine in the Kivalliq Region of Nunavut. The project is located on Inuit-owned land approximately 70 km north of Baker Lake (see Figures 2.1 and 2.2). As of February 2005, the Meadowbank Gold project hosts estimated combined proven and probable open pit mining reserves containing 2,768,000 oz of gold. This gold will be extracted during the roughly 8- to 10-year operational lifespan of the mine. The project is designed as a “fly-in/fly-out” operation with an airstrip at Meadowbank and access road providing the access to the site (see Figure 2.3). All construction and operating supplies for the project will be transported on ocean freight systems to facilities constructed at the Hamlet of Baker Lake, which will include barge unloading facilities, laydown area, and fuel tank area (see Figure 2.4). An all-weather haulage route from Baker Lake to the project will provide access and re-supply, while on-site mine access roads will connect the open pit areas to site infrastructure (Figure 2.5). On-site facilities include a mill, power plant, maintenance facilities, tank farm for fuel storage, water treatment plant, sewage treatment plant, airstrip, and accommodations for 250 people. A site layout is provided in Figure 2.6.

Open pit mining will occur in three separate areas and water retention dikes will be constructed from mined rock to allow for the mining of ore beneath shallow lakes. A low permeability vertical slurry wall will be constructed in the center of the dikes to minimize seepage from surrounding lakes into the work area. Construction of the dikes will use floating silt curtains to minimize the release of suspended solids into surrounding lake waters.

Mined rock will be placed in tailings impoundments and waste rock storage piles. A classification system will be used to identify both potentially acid-generating (PAG) and metal leaching rock; PAG mine rock will be stored in designated areas designed for long-term stability. Acidic runoff will be appropriately handled. Ore processing will involve cyanide leaching, cyanide destruction, and refining to produce doré bars. The combined leach residue slurry will be treated with metabisulphite to detoxify the free cyanide in the tailings stream. The freshwater supply for the mine and camp will be pumped from the Third Portage Lake. Mine process water will be primarily reclaimed from the tailings pond, and treated sewage will be discharged to the tailings pond.

Environmental baseline studies have been conducted in the project area, the results of which have been integrated into the current project design. Valued ecosystem components (VECs) and valued social and economic components (VSECs) have been identified in consultation with regulatory authorities and members of the local community. VECs include: air quality, noise, water quality, surface water quantity, permafrost, fish populations, fish habitat, vegetation cover (wildlife habitat), ungulates, predatory mammals, small mammals, raptors, waterbirds, and other breeding birds. VSECs include: employment, training and business opportunities; traditional ways of life; individual and community wellness; infrastructure and social services; and sites of heritage significance.

Cumberland will implement an Environmental Management System (EMS) consisting of three key elements: an integrated environmental management plan, a formal environmental awareness program, and ongoing environmental monitoring plans. Upon conclusion of activities, Cumberland will fully decommission the mine by removing the mill and ancillary buildings, access roads—including the all-weather access road between Baker Lake and Meadowbank, and by recontouring disturbed areas and reclaiming vegetation.

3.0 EIS OVERVIEW

To prepare the final Environmental Impact Statement (EIS) for the Meadowbank Gold project, Cumberland:

1. Determined the VECs and VSECs based on discussions with stakeholders, public meetings, traditional knowledge, and the experience of other mines in the north (see Columns 1 and 2 in Figure 3.1).

2. Conducted baseline studies for each VEC and VSEC and compared / contrasted the results with the results of traditional knowledge studies (see Column 3 in Figure 3.1 for a list of baseline studies).

3. Used the baseline and traditional knowledge studies to determine the key potential project interactions and impacts for each VEC and VSEC (see Columns 4 and 5 in Figure 3.1 for a list of Environmental Impact Assessment (EIA) reports. The impacts are also summarized in the impact matrices provided in Appendix B of this document).

4. Developed mitigation strategies for key potential interactions and propose contingency plans to mitigate unforeseen impacts by applying the precautionary principle (see Columns 4 and 5 in Figure 3.1 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. The 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 Columns 4 and 5).

6. Summarized above reports into a 150 page EIS report.

Reports generated for each step are listed in Figure 3.1. To ensure the accuracy of the submitted reports, Cumberland implemented a vigorous quality assurance/quality control (QA/QC) process. Experts were hired to collect data over several years and prepare the appropriate reports. All reports were then reviewed by third-party specialists. Members of the local community were hired to assist in all aspects of data collection and review (see Section 4.5 and Table 4.3 for a list of participants.) These reports, along with the summary Environmental Impact Statement (EIS), form the basis of Cumberland's Final Environmental Impact Statement.

As per Sections 3.1 to 3.5 of the Terms of Reference, Cumberland has observed the full intent of the NIRB guidelines issued February 2004. This document is double-spaced and conforms to the 150 page text limit (Note: Charts, diagrams, and photographs have been included as necessary to assist the reader and clarify material presented in the text.)

To facilitate the review of this document by regulatory authorities and other stakeholders, this FEIS report responds directly to the outline of the Terms of Reference provided by NIRB (February 2004) by maintaining the headings and numbering system of the Terms of Reference. Although this approach has some organizational constraints, it allows the conformity and deficiency reviews to be conducted in an efficient and effective manner, and minimizes confusion regarding the location in the document of critical project components.

As per Sections 3.6 and 3.7 of the Terms of Reference, an Executive Summary and Popular Summary have been prepared. The Executive Summary describes the key project elements and key findings of the EIS and provides a clear rationale for Cumberland's assessment of the predicted impacts. The Popular Summary has been written in non-technical language, includes a glossary, and has been translated. Both summaries are available as separate documents.

4.0 SUBSTANTIVE DIRECTIVES

4.1 The Proponent

Cumberland Resources Ltd. (Cumberland) is a public Canadian exploration and development company, and the owner of the Meadowbank project. Cumberland is the sole proponent for the environmental review process.

4.1.1 Cumberland & Regulatory Compliance

Cumberland has complied with all governmental policies and regulations pertaining to environmental and socioeconomic issues in developing the Meadowbank project and has an exemplary local employment and safety record over nine years of exploration in Canada's Arctic.

Cumberland has been forthcoming with all government authorities during all aspects of project development, and has a good rapport with the local Inuit people based on mutual respect and communication. Cumberland intends to build a mine with integrity—one that is safe, environmentally responsible, and beneficial to all parties involved. To this end, Cumberland intends to balance good stewardship in the protection of human health and the natural environment with the need for economic growth.

4.1.2 Cumberland's Environmental Policy

Cumberland is committed to achieving a high standard of environmental care in conducting its mineral exploration activities. Cumberland's Environmental Policy includes:

- Compliance with all applicable legislation including laws, regulations, and standards. Where laws do not exist, appropriate standards will be applied to minimize environmental impacts resulting from exploration activities.
- Open communication with government, the community, and employees on environmental issues.
- Development and adherence to management systems that adequately identify, monitor, and control environmental risks associated with Cumberland's exploration activities.
- Assurance that the employees are aware of their responsibilities and comply with Cumberland's Environmental Policy and field guide.

4.1.3 Contractors to the Meadowbank Gold Project

A pre-hire assessment will be made of all contractors and subcontractors based on their environmental and safety record. Preference will be given to “best-in-class” companies based on their past performance in these areas.

Major contractors to the project will be required to have their own environmental policies that meet federal and territorial legislative standards. This will be verified by Cumberland prior to final engagement of the contractor.

4.2 SUSTAINABLE DEVELOPMENT & PRECAUTIONARY PRINCIPLE

According to Environment Canada’s Sustainable Development Strategy, *sustainable development* is “not an end point, but rather an approach to decision-making. It recognizes that social, economic, and environmental issues are interconnected, and that decisions must incorporate each of these aspects if they are to be good in the long term.”

Achieving sustainable development requires continued and full consideration of the economic, environmental, and social impacts on the sustainability of both the project and the Baker Lake community. To promote the goal of sustainable development, support is needed for local people to pursue sustainable livelihoods both in the traditional and wage economy. To this end, Cumberland:

- has negotiated a benefit agreement with the KIA to accompany the exploration land lease; this agreement focuses on jobs, training, local hiring programs, contracting and community liaison
- has successfully worked with businesses in Baker Lake and elsewhere in Kivalliq Region over the exploration phase of the project; with continuing preferential contracting, local business participation in the project is expected to grow
- coordinates and supports community capacity building through local training initiatives including transportation of dangerous goods and first aid
- has made financial contributions to the local heritage center and Elders organization in Baker Lake
- has, over a nine-year term, directed approximately 25% of its exploration expenditures and maintained a 25% local employment rate through local communities in Nunavut.

Other strategies that encourage sustainable and responsible mining developments include community participation and information disclosure. Cumberland has maintained an average 25% local workforce during its exploration programs and has demonstrated its commitment to community consultation by establishing a community liaison office, hiring a local liaison officer, and holding community forums and public meetings on a regular basis. Furthermore, it has informed the communities of production designs and plans for future mining and has voluntarily distributed the results of traditional knowledge studies.

Cumberland's efforts to gather and document traditional knowledge are a testament to its commitment to undertake the full consideration of economic viability, social implications, and cultural and environmental values in decision-making and policy and program development. Cumberland respects the traditional values of the Inuit and recognizes that decision-making based on the best available scientific, traditional, and local knowledge is not only essential on a pragmatic level, but is the foundation for the promotion of a healthy community interaction.

The safe use of minerals and metals, life-cycle assessments, product stewardship, mitigation of environmental impacts of development, mine decommissioning, and site reclamation are among other commitments Cumberland has made to sustainable resource development.

In order to achieve sustainable development, policies must be based on the *precautionary principle*. Environmental measures must anticipate, prevent, and mitigate the causes of environmental degradation. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. The Meadowbank environmental impact, socioeconomic effects, and heritage resources impact assessments have addressed all known potential effects of the project on the environment, economy, culture, and heritage of the region. Comprehensive management and monitoring programs are planned to mitigate impacts and allow early detection of unpredicted changes.

4.3 BASELINE DATA COLLECTION & METHODOLOGY

This EIS applies an ecosystem-based approach by describing the ecological function of each ecosystem component, indicating the ecological pathways of the impacts that are predicted, and designing mitigation and monitoring plans to deal with those impacts (see Figures 4.1 and 4.2). Baseline data collection commenced in 1996 and continued through to 2005. These data are summarized in a series of baseline reports that are included as supporting documents in this Environmental Assessment documentation series (Figure 3.1). The content of these reports is summarized in the subsections below.

Traditional knowledge enhanced Cumberland's understanding of the environment through public interaction and interviews conducted by a local Inuit heritage consultant (Hattie Mannik). Workshops were held with the community and with the Hunter's and Trapper's Organization (HTO) to help support and clarify the baseline data collected, specifically with regard to caribou migration patterns and fish. In addition, well-known and respected Inuit were hired as surveyors and in other capacities to help in the collection of scientific and traditional baseline data.

4.3.1 Physical Environment

Baseline physical environmental data were collected for hydrology, hydrogeology, permafrost, geochemistry, sediment, and water quality. Methods for the collection of data for these studies are described below.

Hydrology – Hydrometric data were recorded from the on-site meteorological weather station (operational since 1997), as well as through monitoring of lake levels, lake outlet discharges and snow surveys. Climate data from Baker Lake, from 1947 to present, were also used to put the site in context with the regional environment.

Permafrost – Thermistor cables were initially installed at the site in 1996 as part of geotechnical drilling investigations for pit slope design purposes. Additional thermistors were installed in 1997, 1998, 2000, and 2003. A total of twenty-two thermistors have been installed at all of the deposit areas, proposed dike abutments, proposed plant site, and for background permafrost monitoring. An electromagnetic

(EM) survey was completed over the proposed plant site, airstrip, and fuel tank farm areas to investigate ground ice.

Groundwater – Hydraulic conductivity testing was carried out in thirty-five boreholes. Groundwater baseline data was collected in 2003 and 2004 from four monitoring wells located within the three main rock types in the area of the Goose Island and Portage deposits and from the talik underlying the proposed tailings disposal area at Second Portage Lake. Wells were not installed in Vault as it lies within permafrost.

Water Quality – The methods used to collect water between 1996 and 2003 were consistent among years, either by pumping water from depth using weighted C-flex tubing and a diaphragm pump, or from the surface by hand. Ultraclean techniques were employed to minimize contamination and water samples were always collected before other environmental media to limit contamination of the water column. Before samples were taken, total depth (m) and a Global Positioning System (GPS) position were recorded. Vertical temperature and oxygen profiles were then recorded to determine the depth of sampling.

Sediment - Sediment was collected at all water sampling locations using a petite grab sampler. Water sample and sediment collection were accomplished using available, proven sample collection and handling methods and QA/QC procedures to ensure unbiased comparisons. Sediment cores were also collected from discrete locations in 2005 to understand vertical distribution of metals.

Geochemistry – A mine site materials geochemical program was developed to characterize geologic materials at the mine site and define the nature and magnitude of impacts that may result from the interaction between these materials and the environment during all phases of project development, including post-closure. This program involved characterizing:

- geochemistry of bedrock in the area of the proposed open pits and planned mine infrastructure away from the ore deposits through static testing
- tailings material and overburden through static testing
- long-term weathering behaviour of selected pit rock and tailings samples with respect to acid rock drainage (ARD) potential and constituent leaching rates through kinetic testing

- aqueous chemistry of tailings decant, overland flow and surface water ponded in mineralized exploration trenches.

Guidelines proposed by INAC (1992) for Northern Mine sites were applied in the classification of ARD potential, with the neutralization potential ratio (NPR) as a principal indicator considered. The rock that will be disturbed by mining are grouped into three main lithological units: iron formation rock (IF), intermediate volcanic (IV), and mafic volcanic and ultramafic rock (UM) rocks (see Table 4.1).
A quartzite unit (QTZ) also occurs in localized areas of the southern deposits, but will generate a significantly lower quantity of waste rock (~1%). This unit was included in the static testing program but not in the kinetic testing program.

Processed ore samples from each of the three proposed pits were represented in the chemical characterization program (see Table 4.2).

Table 4.1: Pit Rock Lithology & Sample Distribution

Rock Type	**Estimated Quantity of Pit Rock Generated (10^6 tonnes)**			**Lithological Distribution of Pit Rock (%)**	**Number of Samples Analyzed (Static Tests)**	**Sample Distribution (%)**
	Goose/Portage	**Vault**	**Total**			
IV	26	68	94	54	107	50
IF	34	-	34	20	46	22
UM	42	-	42	24	54	25
QTZ	3	-	3	2	7	3
Total	**105**	**68**	**173**	**100**	**214**	**100**

Table 4.2: Proportion of Tailings from Each Deposit & Sample Distribution

Deposit	**Estimated Quantity of Ore Mined (10^6 tonnes)**	**Proportion of Tailings in Impoundment at Closure (%)**	**Number of Tailings Samples Analyzed (Static Testing)**
Goose Island	2.2	10	6
Portages	11.2	51	6
Vault	8.5	39	6
Whole Ore Composite	-	-	1
Total	**21.9**	**100**	**19**

4.3.1.1 Static Testing

Static testing was conducted between 1996 and 2005 on 53 samples from potential quarry rock along the mine access road, 15 rock samples from mine site infrastructure (at the plant site, airstrip, tank farm areas), 214 drill core samples of pit rock (including low grade ore, weathered samples), 20 tailing solids and 23 tailing decant waters of ores from each deposit and from two processing circuits, 12 lake sediment samples, 11 overburden soils, 21 overland drainage water samples, and 12 trench water samples.

Pit rock samples were obtained from exploration drill core specifically for ARD and metal leaching testing to determine the spatial and compositional variability of each rock unit to be disturbed, including targeted testing of starter pit rock that will be used for construction of mine site roads and dikes. Analysis of weathered drill core that had been exposed to climatic conditions on site for 11 to 12 years was conducted to document the effects of weathering on the chemical characteristics of pit rock.

Tailing solids and decant water samples were obtained from the metallurgical program, which focused on the processing characteristics of representative ore samples from each deposit.

4.3.1.2 Kinetic Testing

Kinetic testing was completed on representative samples of each of the three principal lithologies that will be disturbed during mining and on all flotation-circuit tailings generated from each deposit. Testing of pit rock was conducted at varying scales: on 1 kg samples, 100 kg composites, and on 250 kg composites (field site barrel tests) to assist in extrapolation of laboratory data to site conditions.

The pit rock sample selection focused on representing the average and higher concentration ranges of constituents having environmental interest. Lithological representation was addressed by considering the volume of waste to be generated from each lithology, the variance of constituents of interest for each lithology, and the potential impact from these constituents on water quality.

4.3.1.3 Metal Leaching Potential

Metal concentrations in leachate generated by static and kinetic tests were compared to the Canadian Council of Ministers of the Environment's (CCME) Canadian Environmental Quality Guidelines (CEQGs) (updated 2002) for the protection of freshwater aquatic life, and to the Canadian Metal Mining Effluent Regulations (MMER, 2002).

4.3.1.4 Water Quality Predictions

Water quality was calculated for each mine component by combining predicted water flow volumes with field-derived and laboratory-derived chemical loading rates (from kinetic tests) to bracket predicted water qualities between expected values and possible poor-end water quality.

4.3.2 Biological Environment

4.3.2.1 Vegetation

Between August 1999 and 2002, 156 vegetation plots, 5 x 5 m in size, were evaluated within the mine site local study area (LSA) (see Figure 4.3 for the location of plots). Species and the percent cover by species were recorded at each plot. Additionally, an aerial reconnaissance survey was done in 1999 to look for community types not represented within the ground survey area. In 2005, an additional 26 vegetation plots were completed in the mine site LSA, and 114 vegetation plots, 20 x 20 m in size, were completed within the access road LSA (Figure 4.3).

In 2002, six phenology plots were established in the following communities: Sedge, Heath Tundra, Birch Seep, Lichen Rock, Snowbank, and Avens. Data recorded since 2002 include snow-free date, first greening of sedges/cottongrasses, first leaf activity in dicots, floral activity, fruit formation, and seed release and dispersal.

Ecological Land Classification (ELC) units were mapped within the Regional Study Area (RSA) by conducting a supervised classification of satellite imagery (Tehek and Baker Lake scenes). Field data (157 inspections) were collected by Nunavut Department of the Environment biologists in 2001 for the Tehek Lake portion of the RSA and for the entire Baker Lake scene outside of the access road LSA

(254 inspections) in 2005. These data were used to complete ecological land classification mapping. The specific methods of the supervised classification are provided in the Terrestrial Ecosystem Baseline Report.

4.3.2.2 Wildlife

Baseline wildlife surveys were initiated in 1999 with the intent to document the seasonal numbers and distribution patterns of wildlife in the Meadowbank area. Between 1999 and 2004, eight aerial wildlife surveys in the RSA were conducted by helicopter or fixed-wing aircraft along 11,000 km of predetermined transects (see Figure 4.4) designed to maximize coverage of the RSA. In 2005, the size of the RSA was reduced resulting to a total length of 489 km of transects, and three surveys were conducted. The GPS locations of all wildlife sightings or observations of clearly identifiable wildlife signs (e.g., dens, nests, craters) were recorded. At a minimum, the number of individuals was determined and, if possible, information on sex and age class was noted. Aerial surveys were also conducted within the mine site LSA, with a total of 10 surveys between 2002 and 2005.

Transect ground surveys, connecting high elevation vantage points (i.e., observation stations), were conducted between 1999 and early 2003. Wildlife and wildlife sign were recorded within a 5 m radius circular plot at each observation station. A transect was then walked (or driven by snowmobile) to the next observation station and all wildlife and sign within a 2 m wide belt centered on this transect was recorded. Between mid-2003 and 2005, the ground transects and most observations stations were abandoned in favour of 12 stations, which could be surveyed by Inuit staff based in Baker Lake. These stations were surveyed 21 times between 2003 and 2005. At least 10 minutes was spent at each station while the surrounding area was scanned with binoculars and wildlife sign was noted within 10 m of each station.

Breeding bird surveys were conducted according to PRISM (Program for Regional and International Shorebird Monitoring) survey protocols established by the Canadian Wildlife Service (CWS) (Bart et al, 2003). The general methodology involved a “rapid survey” of 400 x 400 m plots (16 ha) with two observers, spaced at 25 m intervals, walking back and forth across each plot and recording all birds and nests observed. Orientation on the plot was accomplished with handheld GPS units. Twenty-six plots were surveyed within the mine site LSA in 2003, 23 in 2004, and 19 in 2005 (randomly selected from the previous 49 plots) (see Figure 4.5). An additional 20 plots were surveyed at a reference site in 2005. A checklist bird survey protocol has been developed by CWS. The survey simply involves a day's end estimation of the total number of individuals and species recorded within a 10 x 10 km area. A checklist survey form was completed for every day that wildlife (e.g., breeding birds) surveys were conducted within the Meadowbank LSA. All forms were submitted to the CWS.

Twenty-two winter ground surveys were conducted along the winter road in 2003 and 2004, and 16 ground surveys were conducted along the proposed all-weather access road in 2005. Incidental wildlife observations were recorded by Meadowbank camp staff on a wildlife log data sheet (1996 to 1999, and 2002 to 2005). Wildlife was discussed during the Traditional Knowledge Study and in some detail during the HTO and impact workshops.

4.3.2.3 Fish & Aquatic Environment

The Meadowbank project area contains a large number of lakes of various sizes. Early baseline studies were limited in spatial extent and sampling intensity. Later studies focused on core areas of the potential mine and covered a broader range of parameters to includ all lakes potentially vulnerable to the effects of the proposed development, as well as several reference lakes.

Key aquatic features of study area and reference lakes examined during most years between 1996 and 2005 included limnology, hydrology, water and sediment chemistry, and all levels of the aquatic food web, including phytoplankton, periphyton, zooplankton, benthic invertebrates, fish, and fish habitat. Central to this foundation was a characterization of seasonal and inter-annual physical, chemical, and ecological features, spatial variability within and among project lakes, and comparisons with key ecological features from internal and external reference areas. Regional lakes were also evaluated to provide a context against which future data can be compared to baseline.

Empirical sampling of environmental media was conducted using accepted, consistent, quantitative methods to ensure that unbiased comparisons in abundance, species composition, and density of organisms could be made within and among lakes and over time. Care was taken to ensure ongoing consistency with regard to sampling equipment, depth, and other parameters. Quality assurance and control measures were implemented at all stages of sampling and analysis. Fish was discussed during the interviews for the Baseline Traditional Knowledge Report, and in some detail during the HTO and impact workshops.

4.3.3 Socioeconomic Environment

Community and regional level quantitative data were obtained from Statistics Canada and the Government of Nunavut. Literature was also reviewed. For Baker Lake, key informant interviews in the community, including with Elders, provided both quantitative and qualitative data. The socioeconomic baseline was also informed by public consultations and the traditional knowledge and archaeology investigations, as well as by observation and experience in the region on the part of socioeconomic consultants. Other Arctic mining projects were also examined, such as Snap Lake, Doris North, Jericho, Diavik, Lupin, Ekati, Arctic Bay, Nanisivik, Eastmain, and Polaris.

At the territorial level, the secondary data sources are more consistent over time, making it possible to analyze socioeconomic trends over the recent past and plan strategic future directions for Nunavut.

4.4 TRADITIONAL KNOWLEDGE & ARCHAEOLOGY

4.4.1 Traditional Knowledge

Traditional knowledge is a complex and sophisticated system of knowledge drawing on centuries of wisdom and experience. It is an experience-based relationship with family, animals, places, spirits, and land that includes a set of empirical observations about the local environment and a system of self-management that governs resource use. To learn about traditional knowledge, Cumberland:

- conducted three sets of interviews (Phase 1, Phase 2, and Phase 3)
- held numerous public gatherings over a period of six years with local residents
- reviewed other Arctic studies
- examined other Arctic mining projects, such as Snap Lake, Doris North, Jericho, Diavik, Lupin, Ekati, Arctic Bay, Nanisivik, Eastmain, and Polaris

- studied many government regulations in several countries relating to traditional knowledge
- held an impact workshop with the community.

The interview methodology is described briefly below. Cumberland's record of public consultation is described in Section 4.5. For more information on these or any other sources listed above, see Cumberland's Baseline Traditional Knowledge Report.

Cumberland conducted three sets of interviews with the help of Hattie Mannik, a Heritage Consultant and author of *Inuit Nunavummiut*. Hattie selected the interviewees. Phase 1 of the interviews focused on gathering information about traditional lifestyle and land use within and around the project area (see Figure 4.6). Phase 2 focused more on project development (see Figure 4.7). Women were included in the interview process during both phases. Phase 3 focused on the proposed all-weather access road (Figure 4.7).

Cumberland used the information from these interviews in all aspects of project design, as appropriate. Traditional knowledge helped Cumberland understand fish populations and caribou migration patterns in the area, and contributed to project decision-making. For example, traditional knowledge was used in deciding where to build the Vault open pit access road and whether or not to fence any roads in and around the mine site. There were no conflicts between traditional knowledge and scientific data. In fact, the relationship was complimentary. For more information on how traditional knowledge shaped project design, see Cumberland's Baseline Traditional Knowledge Report and Project Alternatives Report.

4.4.2 Archaeology

Archaeological surveys were conducted at the proposed Meadowbank mine development property (including winter road route) in 1999 and 2003, and along the proposed all-weather access road in 2005. The surveys focused on areas of proposed project development such as the mine site and vicinity (Area A), the haulage route (Area B), and selected sites outside the development area (Area C). The project marshalling area east of the Hamlet of Baker Lake was also surveyed.

The sites were visited or observed by helicopter, foot, vehicle, and boat. At each site, features were identified, photographed, recorded on VHS video, and recorded in field notes. Typical information included dimensions, associated artifacts or faunal remains, site condition, impacts, and vulnerability. A hand-held GPS unit was used to record geographic coordinates, which were plotted on maps. The results of the 1999 and 2003 work were presented to the Baker Lake Hamlet Council, board members of the Inuit Heritage Centre, and the Qilautimiut (Elders) Society.

4.5 PUBLIC CONSULTATION

In conjunction with the study of traditional knowledge, public consultation with the local Inuit has enabled current and historical patterns of land and resource use, VECs, and VSECs to be identified. Cumberland has made a considerable and sustained effort to involve local residents, community organizations and leaders, government regulators, and local experts in all phases of the project since 1995 when project exploration began. This has included site visits, public meetings, impact workshops, technical meetings, school lectures, science fairs, written correspondence, on-site liaison officers, telephone conversations, and local hiring (see Table 4.3). Question and answer sessions afforded participants the opportunity to raise issues based on their knowledge of the area or to offer their opinion on various matters. Maps, slides, posters, handouts, and computer-assisted presentations were used to help explain, in layperson's terms, the proposed development and any technical issues. Cumberland has established a liaison office in Baker Lake and will continue to hold public meetings throughout all phases of project development and operation.

Based on Cumberland's interaction with the public to date, there is much community support for the project on the understanding that it will provide badly needed employment and training and that environmental impacts will be managed to protect traditional resources. Most of the concerns expressed by the public were of a socioeconomic nature. For example:

- employment and training opportunities, particularly for youth
- how the procurement of goods and services in Baker Lake could bring more services to the community at large and generate additional employment

Table 4.3: Community Meetings & Involvement

Year	Description
2005	Following submission of the Draft Environmental Impact Statement (DEIS) in January, Cumberland and its specialists held meetings in the following areas to introduce the document: in Baker Lake to the CLARC, Hamlet, and HTO members; in Arviat to the Mayor, SAO, members of the Hamlet, Gov of Nunavut and HTO; in Rankin to the HTO, KIA, and Hamlet; in Iqaluit to various federal interveners and the Government of Nunavut; in Cambridge to NIRB staff; in Yellowknife to Environment Canada and Fisheries and Oceans Canada (DFO); in Ottawa to staff from NRCan, *Canadian Environmental Assessment Act* (CEAA), and Health Canada; and in Edmonton to the NWB staff. NIRB technical session was held in Baker; PHCs were held in Baker, Chesterfield, and Rankin. Interviews were conducted with Elders of the community to gather traditional knowledge on the proposed all-weather road corridor. A workshop was held in Chesterfield in July to discuss marine shipping, employment, and other issues. In attendance where representatives of the HTO, Hamlet, Elders, business and general public. A workshop was held in Baker in July to discuss the proposed all-weather road, the fish-out and other issues. In attendance where representatives of the HTO, Hamlet, Search and Rescue, Elders, business and general public. A well-attended public meeting was held at the Recreation Center in March. A translator provided by Cumberland ensured that everything was translated into Inuktitut. After a presentation on the updated mine plan by Cumberland, a general discussion followed which covered numerous topics such as job opportunities and environmental impacts. The number of local employees varied throughout the season, but generally 8 to 15 Inuk were working in the camp at any given time in 2005. Duties ranged from cook’s helpers to geological and survey technicians, to environmental technicians, heavy equipment operators, and construction labourers and tradesmen.
2004	A community Liaison Office was opened in Baker Lake in early 2004. Michael Haqpi, a Baker Lake resident, was hired as Community Liaison Officer. Mr. Haqpi’s role is to disseminate information on the Meadowbank project to the local community and respond to any questions or concerns Baker Lake residents may have about the project. The office also contains a Resource Centre, which provides information on mineral exploration, mining, and mining-related activities. A quarterly newsletter provides updates on activities at the Meadowbank site and general information on exploration, mining, and mine processes. The Baker Lake office also provides information on possible employment opportunities at site, both present and future, and collects résumés from individuals who may be interested in obtaining employment. On March 25th, a presentation was given to the Hamlet Council by Gordon Davidson (Project Manager, Exploration). At that time the council was updated on exploration plans for the 2004 field season and was informed of the delay for the completion of the feasibility study. The feasibility study was delayed due to the escalating costs for raw materials (steel, fuel, etc.) required for development. The delay in completion of the study will allow development alternatives to be examined that might reduce the capital costs required to bring the project to production. The feasibility study is now scheduled for completion in fourth quarter of 2004. A tour of the Meadowbank site was completed on June 7th with several representatives from Baker Lake. The tour group consisted of: David Simailak (MLA), Robert Seeteetnak (Hamlet Council), Samson Arnawyok (Hamlet Council), and Rod Rudia (RCMP). On September 16th, a representative of Cumberland (Jeff Kellner, Manager of Camp Operations) attended the Kivalliq Science Camp in Baker Lake and engaged students in a discussion about mineral exploration and mining activities. Information on possible employment opportunities was also provided. To date, between 3 to 10 Inuk have been working at camp during 2004, and a total of 15 local employees were hired by Cumberland in 2004. Duties ranged from cook’s helper to geological, survey, and environmental technicians to heavy equipment operators and construction labourers. Tercon’s Senior Equipment Operator/Trainer, Ms Noella Champagne, conducted training sessions at the Training Center in Baker Lake that were open to all persons interested in possible employment at the mine. Training focused on job safety and familiarization with a mine operating environment and the equipment. Emphasis was on the equipment that was being transported at that time, namely: 50 tonne trucks, mobile crushing plant, excavator, 966 loader, and service equipment. Several meetings with Arctic College personnel to further establish the scope and objective of planned training programs for local residents. A year-end summary report was submitted to the Hamlet of Baker Lake; CLARC (Baker Lake); HTO (Baker Lake); KIA (Rankin Inlet); KIA (Baker Lake); NWB (Gjoa Haven); NIRB (Cambridge Bay); and NTI (Cambridge Bay).

Table 4.3 – Continued

Year	Description
2003	An impact workshop was held with community organizations at the Nunammiut Hotel from March 24th to 26th. A dozen coloured plans and drawings showing mine layout and environmental study areas were displayed on the walls. Students, Elders, and members of the HTO and KIA were amongst the attendees who expressed concerns, voiced opinions and asked questions regarding potential impacts of the development project on air and water quality, fish and wildlife, local youth (in terms of the possible presence of drugs and/or alcohol at the camp), and on employment and job training. Hand-outs in both English and Inuktitut were distributed. In the course of a community visit to Baker Lake between September 30 and October 2, 2003. Nineteen community members were interviewed, including the mayor and deputy mayor, mental health nurse, RCMP constable, high school principal, social worker, the economic development officer, a representative from Arctic College, and one from Baker Lake Housing Authority, in addition to several concerned citizens. Issues centered on training, employment, and concerns regarding the possible negative effects of additional money flowing into the community as a result of the mine. Support for the Meadowbank project was overwhelming (95%), providing it delivers jobs for the community. Some concern regarding lack of information, particularly employment opportunities, was expressed. A series of meetings were held on Apr 24th and 25thin Baker Lake. On April 25th a well-attended public meeting was held at the Recreation Center with over 150 people in attendance. A translator provided by Cumberland ensured that everything was translated into Inuktitut. Two separate meetings were held the following day with the elders of the community as well as students at the High School respectively. In June 2003, representatives from HTO, CLARC and various regulators from territorial and federal governments were flown into camp and were given tours of the site. The number of local employees varied throughout the season, but generally 8 to 15 Inuk were working in the camp at any given time. There were a total of 36 local employees that were hired by Cumberland in 2003. Duties ranged from cook's helpers to geological and survey technicians to environmental technicians to heavy equipment operators and construction labourers and tradesmen. Travis Mannik and Roy Avaala of Baker Lake assisted in the 2003 fieldwork. Lucy Evo of the Inuit Heritage Center and Hattie Mannik translated summaries of the original 1999 and 2003 field reports into Inuktitut. Peter's Expediting Ltd. provided logistic support for the archaeological investigations undertaken by Webster Heritage Consulting at the Meadowbank property and surrounding area in 1999 and 2003. A year-end summary report was submitted to the Hamlet of Baker Lake; CLARC; HTO (Baker Lake); KIA (Rankin Inlet); KIA (Baker Lake); NWB (Gjoa Haven); NIRB (Cambridge Bay) and NTI (Cambridge Bay). The results of the 2003 work were presented to the Baker Lake Hamlet Council, board members of the Inuit Heritage Centre, and the Qilautimiut (Elders) Society on 6 and 7 November 2003. Several meetings with Arctic College personnel establishing scope and objective of planned training programs to prepare northerners for potential mine construction and operations work. Meetings identified basic skill sets that would enhance job applicants' opportunities with the mine. The basic skills included progress in the public education system, industrial safety awareness, an appreciation of work schedules, and introduction to specialized trades training as well as equipment operating.
2002	Favourable economic conditions made 2002 a busy year: an active program of exploration, drilling, and environmental baseline monitoring was pursued, and several site visits and meetings were held. On May 2nd, a meeting was held with 23 Elders of Baker Lake at the Elders Centre, during which Cumberland presented a translated slide show of its 2001 activities and 2002 plans, and reviewed the past five years of environmental studies and plans for the 2002 Environmental Program. The following day, Cumberland made two similar presentations at the Nunammiut Lodge, attended by representatives from the HTO, CLARC, KIA (Baker Lake), and the general public including prospectors. The presentation included a detailed description of the proposed new camp, the primary airstrip construction, and locations. There was a 30- to 45-minute question period following both meetings. Site visits to camp by David Aksawnee (HTO Chairman), Phillip Putumiraqtuq (HTO Secretary/Treasurer), Josiah Nuilalik (Elder), Norman Attungala (Elder), Joe Niego (Wildlife Officer/Mayor) and Jacob Ikinilik (Elder) were organized. A meeting was held with the Baker Lake HTO on September 19th to discuss findings of the wildlife and fisheries studies, and to collect local knowledge from the HTO members. The meeting was well attended by both HTO members and Cumberland officials. The hunters and trappers expressed concern regarding the impact of noise on wildlife, notably caribou. The number of local employees varied throughout the season, but generally 5 to 10 Inuk were working in camp at any given time. There were a total of 30 local employees that were hired by Cumberland in 2002. Duties ranged from cook's helpers to geological and survey technicians to environmental technicians to heavy equipment operators and construction labourers and tradesmen. A year-end summary report was submitted to the Hamlet of Baker Lake; CLARC; HTO (Baker Lake); KIA (Rankin Inlet); KIA (Baker Lake); NWB (Gjoa Haven); NIRB (Cambridge Bay); and NTI (Cambridge Bay).

Table 4.3 – Continued

Year	Description
2001	A public meeting was held on April 20th for members of the general public and HTO, the Elders, Hamlet Councillors, Mayor, and Glen McLean, MLA for Baker Lake. The number of local employees varied throughout the season, but generally 2 to 5 Inuk were working in camp at any given time. There were a total of 8 local employees that were hired by Cumberland in 2001. Duties ranged from cook's helpers to geological and survey technicians to environmental technicians to heavy equipment operators and construction labourers. A year-end summary report was submitted to the Hamlet of Baker Lake; CLARC (Baker Lake); HTO (Baker Lake); KIA (Rankin Inlet); KIA (Baker Lake); NWB (Gjoa Haven); NIRB (Cambridge Bay); and NTI (Cambridge Bay).
2000	After the prefeasibility study report showed that more resources or a better gold price were required to economically develop the mine, only a minimal amount of exploration work was conducted in 2000. The number of local employees varied throughout the season, but generally 2 to 5 Inuk were working in camp at any given time. There were a total of 8 local employees that were hired by Cumberland in 2000. Duties ranged from cook's helpers to geological and survey technicians to environmental technicians to heavy equipment operators and labourers. A year-end summary report was submitted to the Hamlet of Baker Lake; CLARC (Baker Lake); HTO (Baker Lake); KIA (Rankin Inlet); KIA (Baker Lake); NWB (Gjoa Haven); NIRB (Cambridge Bay); and NTI (Cambridge Bay).
1999	Two meetings were held in Baker Lake. The first was convened in the Hamlet Chamber on April 12th. Participants included the mayor, William Noah; various council members; HTO representatives; the director of the KIA, Edwin Evo; and members of the general public. Affairs focused on overview activities for 1998 and 1999, a review of local expenditures, as well as projected construction, transportation, processing, and employment issues related to the mine. The second was held in the Igloo Hotel and included Nunavut's MLAs. A field trip to the mine site followed and was attended by Premier Paul Okalik and Ministers Jack Anawak, Peter Kilabuk, and Kelvin Ng. The objectives of the meetings were to present the current status of the mine site and encourage public interaction. Discussions centered on concern for local employment and the protection of caribou and fish. There was general agreement among the local Inuit to proceed with mine development providing there are environmental and social protection measures in place and providing there will be significant economic gain by the community. The number of local employees varied throughout the season, but generally 2 to 5 Inuk were working in camp at any given time. There were a total of 8 local employees that were hired by Cumberland in 2001. Duties ranged from cook's helpers to geological and survey technicians to environmental technicians to heavy equipment operators and construction labourers. A year-end summary report was submitted to the following: Hamlet of Baker Lake; CLARC (Baker Lake); HTO (Baker Lake); KIA (Rankin Inlet); KIA (Baker Lake); NWB (Gjoa Haven); NIRB (Cambridge Bay); and NTI (Cambridge Bay). Travis Mannik of Baker Lake and Jeff Tabvahtah of Nunavut Environmental Ltd. in Arviat provided field assistance in 1999, and Jose Attutuvaa volunteered his time in the evenings. Prior to starting the 1999 fieldwork, discussions about the project were held with Counsellor David Webster on behalf of the Baker Lake Hamlet Council; Mr. Webster is also the manager/curator of the local museum. An archaeological permit was not issued for the work in 1999, but a letter of authorization was received from Leah Oak, the Director of Culture, Language, Elders and Youth of the Government of Nunavut, dated 14 July 1999. The survey program was conducted from 21 July to 1 August 1999. Hattie Mannik, a traditional knowledge specialist, assisted Deborah Kigjugalik Webster (of Webster Heritage Consulting) with the interview of Elder Silas Kalluk of Baker Lake at the time of the 1999 survey. Lucy Evo of the Inuit Heritage Center and Hattie Mannik translated summaries of the original 1999 and 2003 field reports into Inuktitut. Peter's Expediting Ltd. provided logistic support for the archaeological investigations undertaken by Webster Heritage Consulting at the Meadowbank property and surrounding area in 1999 and 2003.

Table 4.3 – Continued

Year	Description
1998	Two meetings were held at both the HTO/KIA office and at Hamlet Chambers on May 1st to provide project development and environmental studies updates and to identify the primary concerns of the Inuit residing near the Meadowbank property. Mine development, wildlife protection, employment and job training, and the financial needs of the local community were the primary topics of discussion. A mock-up of the proposed airstrip was presented. All of these meetings were well attended. Attendees included: Cumberland officials; Nunavut Environmental Ltd.; Mayor, David Tagoona; KIA director Edwin Evo; and the HTO representative, Harold Etegoyuk. A year-end summary report was submitted to the following: Hamlet of Baker Lake; CLARC (Baker Lake); HTO (Baker Lake); KIA (Rankin Inlet); KIA (Baker Lake) NWB (Gjoa Haven); NIRB (Cambridge Bay); and NTI (Cambridge Bay). A traditional study consisting of interviews with eight local Inuit Elders (men and women) was undertaken in October to determine traditional use and traditional ecological areas within and around the Meadowbank project development boundary. The number of local employees varied throughout the season, but generally 3 to 6 Inuk were working in camp at any given time. There were a total of 15 local employees that were hired by Cumberland in 1998. Duties ranged from cook's helpers to geological and survey technicians to environmental technicians and labourers.
1997	On March 24th, the Igloo Hotel in Baker Lake was the site of a public meeting with 22 members of the community. Information on the current and projected activities of Cumberland in the Meadowbank project was presented through a slide show and posters displayed in a hallway. Questions by local residents concerned dates of operation of the mine and employment opportunities for the Baker Lake community. From 19 April 1997 to 25 March 1998, approximately 40 Nunavummiut signed the guest book at Meadowbank Camp. On August 11th and 12th, Jacob Ikinilik, Elder and member of the HTO, toured the project site. Having lived in the area with his family before leaving in 1962, Mr. Ikinilik was able to provide information regarding traditional use and potential archaeological sites. He identified two grave sites and stated, at the landing strip, that his people rarely hunted in the area. He indicated he was pleased regarding the number of local people employed at the exploration camp. The number of local employees varied throughout the season, but generally 4 to 6 Inuk were working in camp at any given time. There were a total of 7 local employees that were hired by Cumberland in 1997. Duties ranged from cook's helpers to geological and survey technicians to environmental technicians and labourers.
1996	Cumberland met with 14 members of the Baker Lake Prospectors Association (BLPA) on April 1st. During discussions concerning employment, the members of the BLPA inquired whether jobs would be available at the drill sites or in equipment supply. Cumberland's representative replied that employment opportunities did exist at the sites and that two Baker Lake residents were currently working on site. He added that he would encourage contractors to hire locally. Furthermore, he offered support for the BLPA's activities in the form of hand lenses, geology maps, hammers and picks, as well as assistance with the identification of samples resulting from exploration by the prospectors. The meeting closed after discussions regarding individual prospectors' properties and the cost of a preliminary drill program. On April 2nd, Cumberland held two meetings with the community. The first was with 19 students at Arctic College to discuss employment opportunities in mining and geology and training opportunities in environmental science. Information was also presented concerning a proposed environmental program and Cumberland's activities at the Meadowbank project. The second meeting was held at the community center in Baker Lake with 20 adult members of the community and 30 children from the local public school. A slide presentation on the activities of Cumberland in Meadowbank was followed by a discussion of the phases of mining exploration, the risks involved, the likelihood of finding deposits, and the roles and characteristics of junior and major mining companies. Community members asked questions regarding prospecting, mineral exploration, and costs related to permitting, licensing, and drilling. A total of 4 local employees were hired by Cumberland in 1996. Duties ranged from cook's helpers to geological and survey technicians and labourers.
1995	Cumberland first made contact to obtain licenses and permits for exploration work. A total of 3 local employees were hired as geological technicians and labourers by Cumberland in 1995.

- whether there will be an increase in gambling and use of drugs and alcohol as a result of an increase in income
- whether the rotation of employees will put stress on families and social services
- whether out-of-area workers will use local health services, which are ill equipped to deal with any increased demand
- how formal wage employment will affect traditional skills, values and language
- how any newly discovered sites of archaeological or cultural significance will be handled
- what infrastructure will be left to Baker Lake at the time of closure (e.g., the airstrip and buildings could be used to develop more tourism in the region).

These concerns have been addressed in management plans and monitoring programs that have been completed as part of this EIS (Figure 3.1).

4.6 REGIONAL CONTEXT

The issues of concern considered in this EIS within a regional context were obtained from concerns and values described by the Nunavut Planning Commission (NPC) in the Keewatin Regional Land Use Plan approved by INAC and the Department of Sustainable Development (DSD) in 2000 (now Department of Environment; DOE); those expressed to Cumberland during community consultation sessions; and from similar studies completed for other mining ventures located in the central mainland tundra over the past 10 years (e.g., Ekati, Diavik, Snap Lake, Hope Bay, Doris North, Arctic Bay, Nanisivik, Eastmain, Polaris, and Jericho). The issues include, but are not limited to, the following:

- sustainable development
- support for regional economic development
- encouragement of multiple land uses
- keeping communities informed about, and involved in, land use activities
- climate change
- cumulative effects on permafrost and ground thermal regime
- global air quality and its interaction with regional development and regional environmental quality
- water quality degradation from transboundary contaminant sources and its cumulative impact on fish, and birds
- regional water quality monitoring for early detection of potential degradation

- domestic and hazardous waste management
- minimization of negative effect of development activities on wildlife
- protection of wildlife habitat
- inclusion of mine closure and restoration plans in proposals for mining development
- providing benefits to local residents as well as Canada as a whole from non-renewable resource development
- utilization of traditional knowledge
- protection and management of heritage resources
- protection and promotion of the Inuit people and Inuit-owned land during life of project.

4.7 REGULATORY REGIME

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 (“NLCA”) (INAC and TFN, 1993). In addition to a mining lease and land leases required for Inuit-owned lands from the Kivalliq Inuit Association (KIA), the mine will require several other permits and licenses. A complete list is shown on Table 4.4.

4.8 LAND TENURE

The Meadowbank project covers an area of 30,521 ha: ten grandfathered crown mining leases encompassing 7,395 ha, and three exploration concessions administered by NTI encompassing 23,126 ha. The crown leases cover the southern portion of the property near Third Portage Lake and contain the Portage and Goose Island deposits; the Vault deposit is contained by the southernmost NTI exploration concession (BL14-99-01). Tables 4.5 and 4.6 provide detailed information on the land tenure at Meadowbank. A map showing the land tenure is provided in Figure 4.8.

Table 4.4: Required Approvals, Permits & Licenses

Legislation		**Authorization**
Federal Legislation (Canada)		
Canadian Environmental Protection Act, 1999 (CEPA)		Registration
Explosives Act		Licence for Magazine
		Explosives Transportation Permit
Federal Real Property & Federal Immovables Act		Licence of Occupation
Fisheries Act	(s. 35)	Authorization
	(s. 32)	Authorization
	(s. 30)	Approval
	Fishery (General) Regulations	Licence
Migratory Birds Convention Act: Migratory Bird Regulations		Permit
Navigable Waters Protection Act		Approval for Constructing Works in a Navigable Water
Nunavut Act: Nunavut Territorial Archaeological Sites Regulations		Archaeologist Permit
Nunavut Land & Claims Agreement (NLCA)		See below
Nunavut Waters & Nunavut Surface Rights Act (NWNSRA)		Water Licence
Territorial Lands Act	Canada Mining Regulations	Mining Lease
		Drilling Authority
	Territorial Land Regulations	Surface Lease
	Territorial Land Use Regulations	Land Use Permit
	Territorial Quarrying Regulations	Quarry Lease
		Quarry Permit
Territorial Legislation (Nunavut)		
Transportation of Dangerous Goods Act		Approval – Emergency Response Assistance Plan
Environment Protection Act: Spill Contingency Planning & Reporting Regulations		Spill Contingency Plan
Explosives Use Act		Permit
Pesticide Act		Permit
Mine Health & Safety Act (Note 1)		Permit
Scientist Act		Scientific Research Licence
Wildlife Act		Wildlife Research Permit
Inuit Owned Lands		
Nunavut Land Claim Agreement Nunavut Tunngavik Incorporated (NTI) Rules & Procedures for the Administration of Inuit Owned Lands under the NLCA		Exploration Licence
		Surface Land Lease
		Land Use Licence Right-of-Way Agreement
		Water Compensation Agreement
		Consent to Access
		Inuit Impact Benefit Agreement

Notes: 1. This Act, is administered by the Workers' Compensation Board (WCB), has a number of regulations that govern working environment and construction and operational activities on mine site, for which permits are required in relation to industrial hygiene, fire protection, and explosives.

Table 4.5: Grandfathered Crown Leases

Claim Name	Lease #	Effective Date	Expiry Date	Acreage	Hectares
Dick	3669	Dec.13/1995	Dec. 13/2016	1,800.00	728.44
Carey	3670	Dec.13/1995	Dec. 13/2016	2,545.00	1,029.93
OY 2	3782	Apr.27/1998	Apr. 27/2019	2,547.00	1,030.74
OY 3	3783	Apr.27/1998	Apr. 27/2019	2,582.00	1044.90
OY 4	3784	Apr.27/1998	Apr. 27/2019	1,954.00	790.76
YO 1	3777	Apr.27/1998	Apr. 27/2019	1,460.00	590.84
YO 2	3778	Apr.27/1998	Apr. 27/2019	2,020.00	817.47
YO 3	3779	Apr.27/1998	Apr. 27/2019	1,652.00	668.54
YO 4	3780	Apr.27/1998	Apr. 27/2019	1,105.00	447.18
YO 5	3781	Apr.27/1998	Apr. 27/2019	607.76	245.95
			Total Area:	**18,272.76**	**7,394.75**

Table 4.6: NTI Exploration Concessions

Claim Name	Effective Date	Expiry Date	Hectares
BL14-99-01	31 December 1999	31 December 2019	9,234
BL14-99-02	31 December 1999	31 December 2019	8,502
BL14-99-03	31 December 1999	31 December 2019	5,390
		Total Hectares:	**23,126**

4.9 PROJECT JUSTIFICATION

4.9.1 Project Purpose & Rationale

The purpose of this project is to mine and extract gold from several ore deposits in the Meadowbank area to provide an additional gold source for international buyers and dealers. This purpose is consistent with Canada's overall strategy of encouraging private corporations to generate national export commodities and tax revenues from natural resource development. The national objective is to encourage sustainable resource development for the benefits of increased employment, contracting opportunities, and expanded services at the local, regional, and national levels without causing significant adverse effects on the environment.

There is a sustained worldwide demand for gold that will not be materially affected by the proposed production rate at the Meadowbank Gold project. Gold is a commodity, with a price set by global supply and demand forces; the project will be able to sell all of its production into the world market at prevailing prices.

4.9.2 Project Need

Cumberland believes in the economic viability and potential of the Meadowbank project, and that project development will bring much needed training and employment opportunities, as well as business opportunities to the people of Baker Lake, the Kivalliq region, and Nunavut as a whole. The Feasibility Study (AMEC, 2005) identified a significant portion of the Meadowbank resources to have suitable confidence and economic constraints to satisfy the conditions for a mineral reserve. Additions to project reserves as a result of subsequent drilling initiatives were included in the Feasibility Study completed in early 2005.

According to Statistics Canada, the unemployment rate in the Kivalliq Region in 2001 was 18.6%, a percentage that reflects the limited employment opportunities in the region. Nunavut also has the highest birth rate in the country, with an average of 26.1 per 1,000 persons between 1998 and 2003 compared with the average Canadian rate of 10.9 per 1,000 persons (Statistics Canada, 2003b).

To estimate the economic impacts of the project on Nunavut and Canada as a whole, Cumberland funded an input-output simulation, which was run by Statistics Canada. The results indicate that during the construction phase, the project would contribute $120.3 M to the GDP of Nunavut and generate labour income of $76.7 M. During the operations phase, the annual contribution to GDP would be $35.5 M and the annual labour income $27.0 M (see Table 4.22,”Input-Output Interprovincial Model” in Section 4.21.4.8). Such project expenditures would be a significant boost to the local, regional, and territorial economies.

4.10 PROJECT DESCRIPTION

4.10.1 Project Components & Activities

Three significant gold deposits—Portage, Goose Island, and the Vault—have been identified on the property. These deposits have been defined by 111,57 m of drilling in 801 diamond drill holes. As of February 2005, the project hosts estimated proven and probable open pit mining reserves of 21.9 Mt grading 3.93 g/t of gold or 2,768,000 oz. A brief description of project components is provided in the sections below. A project development sequence is provided in Figures 4.9 to 4.14.

4.10.1.1 Geology/Mineralogy of the Ore Deposit & Mining Methods

Geology/Mineralogy

The project is located within rocks of the Archean-aged Woodburn Lake Group of the Western Churchill Province. The Woodburn Lake Group comprises a deformed sequence of Archean supracrustal rocks unconformably overlain by rocks of the Paleoproterozoic Baker Lake Basin.

The project area is underlain by a sequence of metavolcanic (ultramafic, mafic, and intermediate volcanic flows) and metasedimentary rocks. Geological units include volcaniclastic sediments, felsic to intermediate flows and tuffs, sediments (greywackes), and oxide facies iron formations. The North Portage, Third Portage, and Goose Island deposits are hosted within iron formation rocks. The Vault deposit is hosted within variably altered intermediate volcanic rock (see Figure 4.15).

Deposit mineralogy consists of pyrite and phyrrotite. Materials that are characteristically absent include arsenopyrite, sphalerite, and chalcopyrite.

Mining

Production will be by surface or open pit mining, as grades do not currently support economical underground mining. Approximately 22 Mt of ore will be mined and processed over an 8- to 10-year mine life. The mine operation will generate approximately 21.9 Mt of tailings, 173 Mt of mine waste rock, and 9.8 Mt of overburden soil, with very limited organic materials.

Mining will occur in three separate areas. The Portage open pit is expected to be the largest, measuring 2,000 m in length, 200 to 400 m in width, and 160 m deep. The Goose Island open pit is less than 500 m in diameter and is 175 m deep. The Vault open pit, located 5 km north of Portage and Goose Island, is designed to be approximately 500 m long, 300 m wide, and 185 m deep.

Due to the presence of permafrost and the long winters, the ground will remain frozen for a large portion of the year. For explosives, Cumberland expects to use 50/50 emulsion/ammonium nitrate and fuel oil (ANFO); however, this could range from 70/30 to 30/70, depending on what water resistance is required.

4.10.1.2 Ore Recovery Plant, Extraction & Concentration

Metallurgical studies were undertaken to develop the process flowsheet for the Meadowbank project. The preferred option (see Figure 4.16) leaches a mill throughput of over 7,500 t/d and includes standard crushing and grinding, gravity concentration, and carbon-in-pulp (CIP) cyanide leach technology, with cyanide destruction and refining to doré bars. A layout drawing of the main plant site, showing the location of the ore stockpile, is given in Figure 2.6.

Ore is delivered to a crusher or blending and surge pad at the crusher. Run-of-mine ore is crushed using a gyratory crusher and conveyed to an open coarse ore storage pile. The ore is reclaimed and ground in two stages through semi-autogenous grinding (SAG) and ball mill grinding. The SAG and ball mills discharge the ground product to cyclones for size classification. The ore is ground to approximately 80% passing 62 µm. Gravity separation of liberated gold particles is applied within the grinding circuit. A high-grade gravity concentrate suitable for treatment by intensive cyanidation in an Acacia reactor is produced.

The milled ore is pre-aerated prior to treatment in a CIP cyanidation circuit. The CIP circuit concurrently dissolves the gold and adsorbs it onto activated granular carbon.

The tailings from the CIP circuit are treated with a sodium metabisulphite process to detoxify the free cyanide in the tailings stream. To minimize the potential for ARD, the treated tailings are disposed of using a permanent freezing concept in the Second Portage Lake impoundment area.

The loaded carbon from the CIP circuit is stripped in a pressure Zadra-type elution circuit and returned to the CIP circuit. The loaded carbon from the CIP circuit is transferred to stripping, where the gold is dissolved from the carbon into a strip solution. Gold is recovered from the strip solution and from the pregnant liquor generated in the Acacia reactor by electrowinning. The gold-laden cathodes are treated in an on-site refinery to produce gold doré bars.

4.10.1.3 Processed Ore Containment & Tailings Ponds

Tailings Containment Area

As described in Section 4.10.1.4 and shown in Figure 4.17, disposal of the tailings slurry in Second Portage arm is the preferred disposal option. The tailings are predicted to freeze, resulting in reduced potential for ARD and metal leaching from the tails. The method of operation has precedence in the Arctic climate. The mining and processing operations will produce approximately 21.9 Mt of tailings over the project life. The tailings will be deposited in an impoundment created within the northwest arm of Second Portage Lake through the construction of a retaining dike across the lake. Excess supernatant and any water seepage from the storage facility will be collected and managed within the tailings facility during operations. To minimize water treatment requirements, separate water storage ponds, including reclaim and attenuation ponds, will be used to efficiently manage captured process water, dike seepage, and surface runoff during mine operations. At the end of mining, any remaining reclaim water will be treated prior to discharge to Third Portage Lake.

Expected conditions at the tailings dike and storage facility on completion of mining operations are summarized below.

Tailings dike – Basic engineering for the tailings dike is shown in Figure 4.18. The tailings dike will be constructed on the west side of the Portage pit from overburden till material and rockfill obtained from pre-stripping and open pit mining. During operations, the tailings dike will control seepage from the tailings storage facility. The dike will have a low-permeability till seepage control element, and granular filter zones. The seepage control element will be either a compacted till core, or compacted till upstream blanket. The upstream and downstream slopes will be two horizontal to one vertical (2H:1V). The crest will be a minimum 30 m wide. The tailings dike is designed to be stable under unfrozen, partially frozen, and frozen conditions.

Tailings storage facility – Tailings will be transported by pipeline from the process plant to the tailings storage facility and spigotted from the tailings dike to progressively fill the impoundment in a westerly direction. The tailings will be initially deposited in a subaqueous environment, but thereafter the majority will be deposited subaerially. The final surface of the tailings will be approximately 8 m above the current lake level. A series of perimeter dikes will be constructed to manage the tailings. The tailings storage facility, including the impoundment, the reclaim pond, and the attenuation storage pond, is designed to fill the Second Portage Arm. The facility will be closed progressively during mine operations as the height of the tailings deposit increases. Tailings placement operations will be managed to promote a naturally graded, sloping beach surface to direct runoff away from the area before freezing. The final tailings surface is expected to become irregular due to settlement and seasonal melting of surface ice. The facility will be monitored and corrective measures implemented if necessary to limit ponding of surface water within the tailings impoundment during the later years of mine operations.

A cover of acid-buffering ultramafic rock will be placed over the tailings surface to maintain frozen tailings and minimize erosion from surface water runoff and wind-blown dust. The cover will be at least as thick as the seasonal thaw penetration. Based on thermal monitoring conducted to date at the project site, the cover layer should be at least 2 m thick. During operations, thermal monitoring of the tailings will be undertaken as part of an adaptive management plan to determine the actual thickness of cover material required. Over time, the tailings impoundment and existing talik beneath Second Portage Arm are expected to freeze encapsulating the tailings in permafrost.

During closure, portions of the pit dewatering dikes will be breached. This will result in the lake coming into contact with the tailings dike, and potentially applying a source of heat to the dike face. Consequently, a key aspect to the success of the frozen tailings concept will be the ability to maintain the core and upstream (tailings) side of the dike in a frozen state, similar in concept to a natural shoreline. Both steady-state and transient thermal modelling for post-closure indicate that the dike will remain frozen with the lake against its outside face.

To investigate the potential effect of climate change, consistent with the application of the *precautionary principle*, an increasing surface temperature was considered. As discussed in the Mine Waste Management and Project Alternatives reports, climate change predictions of increases as much as 5.5°C in the next century have been assessed. The impact is to extend the time for freezing, but not prevent it.

4.10.1.4 Overburden & Waste Rock Disposal

A classification system will be used to identify the appropriate use and storage for all mine rock. Specifically, this system will identify PAG or non-PAG rock types, as well as those with the potential to leach metals. PAG mine rock will be stored in designated areas designed for long-term stability with minimal environmental and aesthetic impact. The relative potentials of the rock types to generate ARD or leach metals under neutral drainage conditions and the implications for potential use as construction rock are presented in Table 4.7.

Table 4.7: Rock Types & Potential for ARD

Open Pit	Material Type	Potential for ARD	Potential for ML	Restrictions for Storage or use in Construction
All Pits	Overburden	None	Low	None
	Tailings	High	High	Requires measures to control ARD
	Lake Sediment	Variable (none to high)	High	May require collection and treatment of drainage
Portage & Goose	Ultramafic & Mafic Volcanic	None	Low	May require collection and treatment of drainage
	Intermediate Volcanics	Variable (none to moderate)	Moderate	Requires measures to control ARD
	Iron Formation	High	High under ARD conditions Low under neutral conditions	Requires measures to control ARD
	Quartzite	High	Low	Co-disposal with ultramafic/mafic volcanic or cap/water cover
Vault	Intermediate Volcanics	Low	Variable (low to moderate)	May require collection and treatment of drainage

The majority of waste rock from the North Portage, Third Portage, and Goose Island open pits will be stored on the surface in the Portage waste rock storage facility; waste from the first year starter pit will be used for construction of dikes and roads and a portion of the waste will be stored within the pits (see Figure 4.14). The surface storage area will be constructed to minimize the disturbed area, and will be capped with a layer of acid-buffering ultramafic rock to constrain the active layer within non-acid generating rock. The waste rock below the capping layer will freeze, minimizing ARD generation in the long term. All of the waste rock from the Vault pit will be stored in a rock storage area northwest of the pit. Geochemical predictions indicate it will not be necessary to place capping over the Vault waste rock storage area.

4.10.1.5 Water Supply & Management

A detailed Mine Waste and Water Management Plan has been developed for the Meadowbank project (see Figure 3.1 and Figure 4.19). The plan is designed to minimize project impacts on the aquatic ecosystem of the lakes affected by the pits, including Third Portage, Second Portage, Turn, and Wally lakes. As part of the water management plan, infrastructure such as diversion ditches, sumps, and water attenuation facilities will collect and store surface water and groundwater (contact water) that may have been physically or geochemically affected by mining activities for treatment (if required) prior to discharge to the environment. Water that can be intercepted and directed away from developed areas without contact with project facilities will be controlled by means of natural or constructed diversion channels draining to the neighbouring lakes.

To examine alternatives and predict water quality in the various streams on site, a water balance simulation model was created for the property. This balance is summarized in Tables 4.8 and 4.9. The water management facilities planned to be in place at the end-of-mine operations are described below. Site water flows and containment structures are shown on Figures 4.9 to 4.14.

Fresh Water Supply & Distribution

Fresh water will be pumped from Third Portage Lake to the plant site through heat-traced, insulated lines. The pumps will discharge to an insulated main storage tank located at the plant site, providing both fire and fresh water storage.

Potable water will be drawn from the main storage tank and treated in a skid-mounted chlorination system located in a pre-fabricated structure adjacent to the accommodation camp. The treated potable water will be stored in an insulated water tank. A water distribution pump, also skid-mounted, will distribute potable water to the site.

Table 4.8: Water Balance Model Summary – Portage Mining & Milling Area

	Year 1		**Year 3**		**Year 5**		**Year 7**		**Year 8**	
	Inflow m^3/year	**Outflow m^3/year**	**Inflow m^3/year**	**Outflow m^3/year**	**Inflow m^3/year**	**Outflow m^3/year**	**Inflow m^3/year**	**Outflow m^3/year**	**Inflow m^3/year**	**Outflow m^3/year**
Reclaim Pond (Year 1 to 5)										
Tails Storage Runoff	205,100		198,600		81,700					
Tailings Transport Water	1,989,800		2,653,100		2,653,100					
Direct Precipitation	34,000		44,400		4,200					
Direct Evaporation		42,000		54,200		3,300				
In-Situ Pore Water		821,800		1,095,800		1,095,800				
Decant to Attenuation Storage						917,900				
Reclaim Water		1,556,100		1,749,900		1,068,000				
Subtotal	2,228,900	2,419,900	2,896,100	2,899,900	2,739,000	3,085,000				
Change in Storage	**(191,000)**		**(3,800)**		**(346,000)**					
Stormwater Attenuation Pond (Reclaim Pond Year 5 to 8.3)										
Goose Island Pit Runoff & Seepage			495,200		268,600					
Portage Runoff & Seepage	372,100		468,500		326,800					
Rock Storage Runoff	5,400		22,800		77,200		77,200		77,200	
Other Areas Runoff	313,100		312,400		204,400		155,000		139,400	
Decant from Reclaim Pond					917,900					
Make-Up Water to Mill		370,100		818,500		391,500				
Tails Storage Runoff							144,100		159,700	
Tailings Transport Water							2,653,100		2,653,100	
Direct Precipitation	41,100		39,600		57,100		39,000		39,000	
Direct Evaporation		49,300		49,600		75,700		47,300		47,300
Dust Control		12,000		12,000						
In-Situ Pore Water								1,095,800		1,095,800
Reclaim Water						691,600		2,074,800		2,074,800
Decant to Third Portage Lake		300,200		458,400						
Subtotal	731,700	731,600	1,338,500	1,338,500	1,852,000	1,158,800	3,068,400	3,217,900	3,068,400	3,217,900
Change in Storage	**100**				**693,200**		**(149,500)**		**(149,500)**	

Table 4.8 – Continued

	Year 1		Year 3		Year 5		Year 7		Year 8	
	Inflow m^3/year	Outflow m^3/year	Inflow m^3/year	Outflow m^3/year	Inflow m^3/year	Outflow m^3/year	Inflow m^3/year	Outflow m^3/year	Inflow m^3/year	Outflow m^3/year
Mill Water Balance										
Tailings Transport Water		1,989,800		2,653,100		2,653,100		2,653,100		2,653,100
Ore Water	63,500		84,700		84,700		84,700		84,700	
Reclaim Water	1,556,100		1,749,900		1,759,600		2,074,800		2,074,800	
Freshwater					417,300		493,500		493,500	
Make-up	370,100		818,500		391,500		0		0	
Subtotal	1,989,700	1,989,800	2,653,100	2,653,100	2,653,100	2,653,100	2,653,000	2,653,100	2,653,000	2,653,100
Balance	**(100)**						**(100)**		**(100)**	
Goose Island Pit										
Direct Precipitation					16,100		97,500		102,100	
Other Area Runoff					76,400		31,500		32,200	
Portage Runoff and Seepage					323,900					
Goose Island Pit Runoff & Seepage			495,300		491,200		435,500		408,100	
Pumped from Third Portage					1,356,000		1,356,000		1,356,000	
Pumped to Attenuation				495,200		268,600				
Evaporation						28,500		119,100		124,600
Subtotal			495,300	495,200	2,263,600	297,100	1,920,500	119,100	1,898,400	124,600
Change in Storage			**100**		**1,966,500**		**1,801,400**		**1,773,800**	
Portage Pit										
Direct Precipitation							88,900		110,200	
Other Area Runoff	32,000		52,500		85,900		62,100		57,900	
Portage Runoff and Seepage	340,100		416,000		564,800		612,900		572,700	
Pumping from Third Portage							3,224,000		3,224,000	
Pumped to Attenuation		372,100		468,500		326,800				
Pumped to Goose						323,900				
Evaporation								109,300		135,100
Subtotal	372,100	372,100	468,500	468,500	650,700	650,700	3,987,900	109,300	3,964,800	135,100
Change in Storage							**3,878,600**		**3,829,700**	

Table 4.9: Water Balance Model Summary – Vault Mining Area

	Year 1		Year 3[b]		Year 5		Year 7		Year 8	
	Inflow m^3/year	**Outflow m^3/year**	**Inflow m^3/year**	**Outflow m^3/year**	**Inflow m^3/year**	**Outflow m^3/year**	**Inflow m^3/year**	**Outflow m^3/year**	**Inflow m^3/year**	**Outflow m^3/year**
Vault Water Attenuation Pond										
Vault Pit Runoff & Seepage					55,600		55,600		55,600	
Rock Storage Runoff					42,400		75,100		75,100	
Other Areas Runoff			625,200		407,900		295,200		295,200	
Direct Runoff			175,700		3,600		2,900		2,900	
Direct Evaporation				185,700		8,500		6,800		6,800
Dust Control						4,000		4,000		4,000
Decant to Wally Lake				2,681,300		494,900		418,000		418,000
Subtotal			800,900	2,867,000	509,500	507,400	428,800	428,800	428,800	428,800
Change in Storage			**(2,066,100)[b]**		**2,100**					

Notes: a. Based on average climate conditions and hydraulic year – October 1 to September 30. **b.** Vault Lake dewatered in Year 3.

Reclaim Water

Reclaim water will be pumped through heat-traced insulated lines from the tailings impoundment area located northwest of the plant site. The pumps are sized to supply process water in the event fresh water is not available. The pumps will discharge to an insulated main storage tank located at the plant site. The reclaim water distribution pumps will be located inside the process building, adjacent to the process water tank.

4.10.1.6 Mine Dewatering & Pit Dikes

Dike construction and dewatering will be required to enable open pit mine operations beneath the lakes. The following dewatering dikes are proposed:

- Portage pit – East dike with causeway, and Bay Zone dike
- Goose Island pit – Goose Island dike and South Camp dike
- Vault pit – Vault dike.

The dikes are essentially designed to permit the area of the proposed open pits to be dewatered below existing lake levels and to minimize seepage flow through the dike structures. To simplify construction and operation activities, the dikes are aligned through shallow water areas.

A typical dike section will include two rockfill embankments with a till core, a filter zone, and a soil bentonite cutoff wall excavated to the underlying bedrock (see Figure 4.20). The dike crests will be at least 2 m above the lake level and will be surfaced with material suitable as a running course for haul trucks. The till core will be constructed of fine-grained soil recovered from overburden pre-stripping in the open pit areas. The soil-bentonite cutoff will be prepared from a mixture of till and imported bentonite.

Rockfill materials for dike construction will include iron formation for the upstream shell, intermediate volcanic for the downstream shell, and ultramafic as surface capping from the crest down to water level. Residual seepage through the dikes will be collected in a series of collection ditches and sumps and treated if necessary.

Dike construction will utilize floating sediment curtains to minimize the release of suspended solids into surrounding lake waters. During mining, water collected from the base of open pits will be directed to attenuation ponds and treated as required prior to discharge. At the end of mining operations, the pits will be flooded to minimize the potential for acid generation.

Fish salvage programs are discussed in Section 4.26.1.2, “Monitoring.”

4.10.1.7 All-Weather Roads

All-Weather Roads

Two types of roads will be constructed at the site: haul roads and service roads. Haul roads will be used to haul ore to the process plant and waste rock to various containment and construction sites; service roads will be used to provide service/maintenance vehicle access to all areas of the proposed facilities. Where possible, roads will be constructed by placing non-acid-generating mine waste rock as fill, together with crushed surfacing material to provide an adequate running surface. For safety and security, no public access will be permitted on the site road systems. Except for the crossing of the Turn Lake outlet by the Vault pit haul road, only minor drainages will be crossed by site roads. Relatively small culverts will be installed at such crossings. Regular watering will control dust on the roads during the dry periods. Calcium chloride may also be used if necessary.

Site reclamation activities are described in Section 4.28 and the Reclamation and Closure Plan. Detailed procedures for accident and incident response and reporting are provided in Cumberland’s Emergency Response Plan.

Mine Access Road

The site will be accessible by land by an all-weather road. The haulage route will begin at the storage compound in Baker Lake and enter the site north of the mine facilities.

4.10.1.8 Airport Facilities

Construction of an airstrip has begun under the exploration program immediately northwest of the mill site using suitable local borrow materials. Mine rockfill from open pit pre-stripping operations will be used for the airstrip extension. The airstrip will be 1,650 m long x 30.5 m wide to accommodate large aircraft. It will be elevated to reduce problems with snow drifting, and oriented to minimize the effect of prevailing winds on landing aircraft. No permanent facilities are planned at the strip for accommodating passengers or freight.

For information on accident and incident response and reporting, see the Emergency Response Plan.

4.10.1.9 Fuel & Explosives Storage Sites

Fuel Storage at Baker Lake

Barges will transport diesel fuel to a lined and bermed tank farm at Baker Lake. Onboard transfer pumps will pump the fuel from the barges to one of two 16 ML or one 5.6 ML capacity tanks within the containment area. P_{50} diesel (Arctic diesel) will be the primary fuel used at site. A fuel pump module installed adjacent to the storage tanks will dispense fuel to highway vehicles and tanker trucks en route to site. The module will be housed in an Arctic container installed on a lined compacted gravel pad. A spill collection sump and pumpout facilities will be provided. From this tank farm, fuel will be trucked via haulage route from Baker Lake to a 5.6 ML containment facility on site.

Fuel Storage at Site

During the first year of site preparation, approximately 5 ML of diesel fuel will be stored in a steel tank located within a lined berm. The berm will have spill collection sumps and will meet all applicable fire codes, API standards, and insurance underwriter requirements. A fuel unloading and distribution pump module will be enclosed in an Arctic grade container installed on a concrete pad with spill collection and pumpout facilities. The distribution pumps will feed a network system throughout the plant area, supplying fuel to the exterior day tanks at the power plant and boilerhouse. The light vehicle fuel dispensing station and heavy vehicle fuel dispensing station will be located adjacent to the storage facility.

Gasoline

Gasoline will be required in relatively small quantities for small vehicles such as snowmobiles and ATVs. The gasoline dispensing station will have a self-contained, 25,000 L enviro tank with an on-board pump and hoses. The station will be in a bermed area adjacent to the diesel storage tank.

Aviation Fuel

The most commonly used fuel for turbine engine aircraft, Jet-B, will be stored in a 5,000 L self-contained enviro tank mounted on an elevated pad at the air terminal shelter. This reserve will be only for emergency use by aircraft. The tanker truck with on-board pump and hoses will refill the Jet-B storage tank after use in an emergency. Jet-B fuel will also be available, on an emergency basis, for helicopters.

Explosives

The ammonium nitrate will be stored at the mine site and loaded into the ANFO mixing truck as required. The emulsion, detonators, and accessories will be stored on site in magazines that conform to all regulations applicable to the supply and storage of explosives. The explosives contractor will mix the ANFO and transport the explosives to the work site. Mine personnel will be responsible for loading, priming, and detonating the explosives.

For information on emergency response procedures, see Cumberland's Hazardous Materials Management Plan, Spill Contingency Plan, and Emergency Response Plan, all included in this EIA .

4.10.1.10 Borrow Pits & Quarry Sites

No sources of aggregate or sand have been found in the vicinity of the site. It is currently planned that aggregate and sand will be produced by crushing and screening of intermediate volcanic and quartzite rock.

4.10.1.11 Waste (Domestic & Hazardous) Management

The Meadowbank project will require the transport to site, temporary storage, and use of hazardous materials as part of everyday activities during the pre-development, operation, and closure stages of the project. All hazardous materials used on site will be handled according to safe use and environmentally acceptable disposal practices according to the *Mine Act* regulations. Detailed procedures for accident and incident response and reporting will be established prior to initiation of site activities. In addition, spill response training will be mandated for site construction and operations personnel who handle these materials.

Hazardous materials include industrial chemicals for process and water treatment, and hydrocarbon products, including but not limited to diesel fuel, gasoline, aviation fuel, and lubricants. Hydrocarbon products will be stored on site and used for electrical power generation and the operation of site equipment.

Spilled Materials

In the event of a spill, design measures to limit the infiltration and loss of released products will include geomembrane liners, containment berms, fuel aprons, and collection sumps at fuel handling locations. Containment ditches, skirted oil booms, and oil-absorbent pads will be used to limit the release of product into open waterbodies.

Written reports of all product spills associated with mine construction, operation and closure activities will be required, and investigations will be undertaken to assess the nature and extent of the area affected by the spill. Remediation of the spilled material will be subject to the results of the investigations.

Spilled Tailings

Tailings spills may occur within the process area, along the pipeline route to the tailings impoundment, or as seepage from the impoundment itself. The overall site and the tailings line route will be graded such that all site runoff and any tailings spills will drain toward the impoundment or collection sumps.

The sumps will be drained by pump and pipeline to the impoundment. Regular monitoring of the tailings pipeline, collection sumps, and impoundment facility will be required during mine operations.

Written reports of all tailings spills associated with mine operation and closure activities will be required to document the release and the investigations undertaken to assess the nature and extent of the area affected by the spill. Remediation of the spilled material will be subject to the results of the investigations.

Non-Hazardous Waste Materials

Inorganic solid wastes from the mine operation will be segregated into material categories including but not limited to concrete, metal, rubber, and plastic. Those materials deemed suitable for on-site deposition will be placed in a designated landfill area within the Portage waste rock storage facility. All other materials considered unsuitable for landfill deposition will be packaged for shipment and disposal off site.

The sewage treatment facilities will be housed in a prefabricated structure adjacent to the accommodations camp. Grease traps will be provided to handle the flow from the kitchen and shop sewers. A rotating biological contactor or sequencing batch reactor treatment system will be installed. During construction, the treated effluent will be discharged to Third Portage Lake. During operations, the effluent will be pumped to the tailings pumpbox, then to the tailings impoundment area.

Solid waste from the accommodation camp, kitchen, shops, and offices will be transported in air-tight containers by pickup truck to a pre-fabricated, diesel-fired waste incinerator located downwind of the facilities. A back-up incinerator will also be provided.

4.10.1.12 Power

Power at site will be supplied by a diesel-fuelled generation facility. The power output is rated to meet the process plant, ancillary support loads, and camp requirements. Spare units will be installed to accommodate repairs and planned maintenance. The anticipated peak power requirement of 15.5 MW will be met with an adequate number of on-site gensets. In the interests of economics and sustainability, all waste heat from the gensets will be recovered and utilized on site.

Power to the site loads will be distributed from the powerhouse using cable-in-tray and overhead distribution lines as appropriate. The main electrical loads are the main process plant; crushing, reclaim, and pebble crusher; camp and service complex; ancillary loads including water distribution/handling and treatment. The main distribution switchgear will be located in the power station, the electrical distribution hub for the site.

4.10.1.13 Camp Facilities

The camp will consist of modular, trailer-type units supported on shallow foundations. Facilities will include dormitory rooms and common areas for food preparation, food storage, dining, and recreation.

4.10.1.14 Baker Lake Site

A marshalling facility located about 2 km east of Baker Lake will receive construction and operations supplies during the shipping season from late July until early October. The facilities will consist of: a barge unloading ramp and adjacent storage and marshalling area; four upper storage benches, including a fuel storage facility; a storage compound for explosives; and interconnecting roads. A total storage area of approximately 220,000 m^2 will be provided. The entire facility will be fenced.

4.10.2 Project Design

Feasibility studies emphasized both the cold northern climate and remote location as the principal engineering considerations for successful design, construction, and operation of the project.

The Meadowbank mine is designed to minimize the areas of surface disturbance, stabilize disturbed land surfaces against erosion, and return the land to a post-mining use for traditional pursuits and wildlife habitat.

4.10.3 Pace, Scale & Timing of Project

Project milestones are shown in Figures 4.21 and 4.22. The major schedule components are briefly described below.

Pre-mining activities – Immediately following permit approval, the tendering and award of long-lead process and electrical equipment will be carried out to obtain the vendor information required to continue with detailed engineering. The engineering design philosophy will be to maximize the use of modular designs to reduce on-site labour requirements as well as capital costs and scheduling. This will allow engineering to advance and critical contracts to be tendered in a timely fashion.

Construction activities – Construction will be started as early as possible to complete the major portion of the civil work and advance the major buildings prior to the onset of winter. Process equipment can continue to be installed indoors during the winter months, leading to substantial completion 18 to 24 months later. Pre-stripping activities to remove overburden, exposing primary ore and associated waste, will be conducted during the same period.

Mining & processing – The Portage open pit will provide the primary ore supply for the process plant throughout the life of mine, with lesser amounts being supplied by the Goose Island and Vault pits. The process plant will be commissioned after 18 to 24 months of construction.

Post-mining activities – The Meadowbank project will minimize the area of surface disturbance, stabilize disturbed land surfaces against erosion, and return the land to a post-mining use for traditional pursuits and wildlife habitat.

4.10.4 Future Development

Exploration will continue at the Meadowbank project during mine development and production, focusing on expanding the resource base and extending the mine life beyond its currently proposed 8.3 years. Opportunities for future development include: expanding the existing deposits where they remain open along strike and at depth; systematically exploring numerous grassroots targets to determine their economic viability; and discovering new deposits in the Meadowbank Trend.

Development of a mining and milling complex at the Meadowbank site should have a very positive impact on future exploration in the area by lowering the grade and/or tonnage thresholds required to define economically viable gold deposits due to the reductions in capital costs required to bring these deposits to production.

4.10.5 Technology

The most current concepts have been selected for project design and to determine project impacts in each area where technology is employed (i.e., mining, processing, tailings disposal, and effluent treatment). Although the technologies are considered state-of-the-art, none is so new as to be unproven and all have a demonstrated pedigree of successful operation at other mining locations. The Meadowbank project has no difficult design issues that require new, risky technical solutions; the mining and processing techniques proposed for this project are familiar, proven approaches seen at many mining operations in production today.

4.11 PROJECT ALTERNATIVES

Project alternatives were considered during all stages of project design (i.e., prefeasibility, feasibility, impact assessment). Decisions were made based on traditional knowledge, the *precautionary principle*, common sense, best engineering practices, and financial concerns. Some examples of alternate options are briefly discussed below. For more information, see the Project Alternatives Report, included as part of this EIA submission.

4.11.1 Site & Footprint

4.11.1.1 Plant Site Options

Six plant site locations were assessed; the current location was finally selected based on the following factors: proximity to the main deposits of Third Portage and Goose Island; proximity to the tailings disposal site; relatively large area of flat but elevated terrain, giving room for the anticipated facilities; competent rock at or close to surface for good foundation conditions; remote from culturally sensitive areas. The selected site, shown in Figure 2.6, also offers the best opportunity for water management and spill containment, and reduces overall land disturbance.

4.11.1.2 Portage Rock Storage Facility Options

Four potential rock storage areas on the north side of Second Portage Lake were considered for waste rock produced from the Portage deposits, as shown on Figure 4.23 and summarized in Table 4.10.

Table 4.10: Summary of Portage Rock Storage Facility Options

Option	Description
A	North from Second Portage Lake – small footprint
B	Northwest from Second Portage Lake – large footprint
C	East from Vault haul road – small footprint
D	East from Vault haul road – large footprint

The options were evaluated using a decision matrix. The key categories that were used to evaluate the options were based on environmental, operational, and cost considerations. Within each category, the individual sub-indicators were assigned ‘weight’ values based on subjective estimates of relative importance, so that the sum of the weights would contribute to the overall option weightings. The results of the decision matrix showed Option A to be the preferred option.

There are few suitable locations for a waste rock storage facility near the Vault pit. A site on a broad area of land immediately to the west of the open pit was selected.

4.11.1.3 Tailings Storage Options

Geochemical testing has shown the tailings to have acid-generating and metal-leaching potential. Consequently, the most suitable methods for storing tailings in an Arctic environment are either subaqueously or subaerially to encourage freezing (or a combination of the two). Several potential site and method combinations were considered for tailings storage, as listed in Table 4.11 and shown in Figure 4.24.

Again, a decision matrix evaluation was performed, similar to that used for mill site selection, and Option C (slurry disposal in Second Portage Arm) was selected as the preferred option because of the following main advantages: reduced potential for ARD and metal leaching, ease of closure, ease of operation in the harsh Arctic climate, lowest relative capital cost.

Table 4.11: Summary of Tailings Storage Facility Options

Option	Location	Disposal Type
A	Second Portage Arm & North Portage pit	Subaqueous slurry
B	Second Portage Arm	Subaerial paste or drystack
C	Second Portage Arm	Subaerial slurry
D	Third Portage Lake	Subaqueous slurry
E	East from Vault haul road	Subaerial slurry
F	North of Second Portage Arm	Subaerial slurry
G	North of Second Portage Arm	Subaerial paste or drystack

4.11.1.4 Airstrip Options

Two options have been considered for siting the airstrip. The northern option, aligned along the isthmus between the northwest arm of Second and Third Portage Lakes, was selected over the southern option located on the southwest side of Third Portage Lake. Although the southern option requires less cut and fill, a roadway would need to be constructed over a narrow section in Third Portage Lake. The alignment of the northern option is slightly better and more coincident with the prevailing wind direction from the northwest. It results in a more compact site with less overall disturbance, although it will require placement of a limited amount of fill in Third Portage Lake to to achieve its full length of 1,650 m.

4.11.1.5 Vault Road Alignment

The Vault pit is connected to the main site by a 7 km long haul road that crosses the outlet of Turn Lake by bridge or culvert. The selected alignment avoids lakes as much as possible, minimizes impacts on external drainages, and avoids burial sites. The route crosses the outlet approximately 5 km from the plant site, where the water course is shallow. Other than at Turn Lake, the route requires only minor culvert crossings.

4.11.2 Mining Methods

Open pit mining methods will be used to extract the ore. The size of the mining fleet takes into account the variability of the deposits and the need for flexibility to achieve a steady supply of 2.5 to 2.7 Mt/a of ore from the various sources. Diesel power was selected over electric since the latter is not well suited to the flexibility required.

4.11.3 Pit Dewatering Dikes

Perimeter dikes will need to be constructed to allow mining. Various seepage control measures were evaluated and included use of glacial till soil, geosynthetic clay liner, sheet-piles, and slurry cutoff walls. Various embankment geometries suited to the depth of water and combination of materials were also evaluated.

It was concluded that the combination of a till core with a soil-bentonite cutoff wall will be both effective and economical in preference to a crushed rock core with slurry cutoff wall. The preferred option makes use of available stripped material and eliminates the need for crushing and quarrying. The recommended configuration is two parallel rockfill embankments with a core of glacial till. A soil bentonite cutoff wall will be excavated through the till core and foundation materials to bedrock.

4.11.4 Gold Recovery

Comparative scoping level capital cost estimates were developed for three flowsheet options based on a plant throughput of 7,500 t/d: Base Case (whole ore leaching); Option 1 (flotation concentrate leach); and Option 2 (flotation concentrate and tailings leach). A trade-off study indicated the Meadowbank deposits are more economically amenable to whole ore cyanidation than a more complex bulk sulphide flotation + concentrate cyanidation flowsheet. Subsequently, whole ore cyanidation was selected, producing a gold recovery percentage of 93.5%.

4.11.5 Tailings Processing Technology

Three alternatives were considered for tailings processing:

1. Filtration of process tailings solids and stacking of filter cake into tailings piles.
2. Thickening/filtration of tailings slurry to a very high density and placement of tailings slurry without solution recovery (filtrate solutions would be recycled).
3. Direct placement of tailings slurry either subaerially or subaqueously within a facility to allow settling of solids and decanting of process solutions for reuse.

The direct placement process (Alternative 3) was selected because it operates at a solids concentration of 45% to 55% solids (by weight) which corresponds to the product stream of the gold recovery plant. The recycle of the solutions will allow water quality to be managed within the process and minimize the impact of the process on the surrounding surface and groundwater.

4.11.6 Materials Transportation

Of the four transportation options considered, direct shipping to Baker Lake using adapted tug and barge equipment has been selected based on the pricing and equipment availability inquiries conducted for the 2005 Feasibility Study. The feasibility evaluation of the project considered the following alternative access options to the project:

- an ice road
- a seasonal land road
- an all-weather road.

An all-weather road using tractor-trailer units was selected as the best alternative.

4.11.7 Energy Sources

Remote northern mining projects typically use on-site diesel generation unless they are within 100 km of a power grid supply. This is usually based on considerations of proven technology, reliability, cost, and practicality. In the case of the Meadowbank project, the nearest grid is far to the south, and Baker Lake is itself supplied with power by diesel gensets.

Wind, solar, hydroelectric, and hydrogen fuel cell technologies were researched but found to be lacking, even as supplemental sources to reduce diesel consumption and attendant air emissions. In the interests of economics and sustainability, a heat recovery diesel generation system was chosen.

4.11.8 No-Go Alternative

From a strictly economic view, the no-go alternative would result in a significant lost opportunity since tax and royalty revenues to government and employment, and business contracting opportunities to individuals and companies would be lost. Project expenditures that could exceed $300 M over the 18-

to 24-month construction phase and $92 M per year during operations (see Table 4.22) would not occur. In addition, the attraction for others to invest in resource development in Nunavut may be compromised and no further exploration would take place at Meadowbank.

From an environmental perspective, the no-go alternative would mean no impacts from mining. Existing site facilities would be decommissioned and the area disturbed by exploration would be restored.

4.12 DESCRIPTION OF PHYSICAL ENVIRONMENT

4.12.1 Bedrock Lithology, Morphology & Structures

The Meadowbank project is located in the Canadian Shield, the largest physiographic region of Canada (see Figure 4.15). Two main faults have been encountered in geotechnical drilling completed to date; the Second Portage Lake fault, and the Bay Zone fault. The Second Portage Lake fault trends in a northwest-southeast direction along Second Portage Lake while the Bay Zone Fault trends in a north-south direction. Stratigraphic contacts are also pervasive structures. No sites of palaeontological or palaeobotonical significance were found.

The rock types comprising the Portage, Goose Island, and Vault deposits and their relative proportions within the footprint of the deposits are discussed in Section 4.3.1 and are summarized in Table 4.1. The results of kinetic testing relating the measured potential of rock to generate ARD and to leach metals are summarized in Table 4.12. The sulphide content of pit rock from each lithology is generally low, with median total sulphur contents of less than 1%. The bulk of the IF and quartzite rock is PAG. The ARD potential was realized under accelerated laboratory weathering tests but not under field conditions, after over two years of exposure. UM rock is non-PAG and has the highest median buffering capacity of all rock types. The bulk of the IV rock type is non-PAG.

Table 4.12: Summary of Kinetic Testwork

Area Lithology	Portage			Vault IV
	UM	IF	IV	
Proportion of Pit Rock Waste	36%	37%[1]	28%	100%
ARD Potential[2]	2% PAG 2%Uncertain 96%Non-PAG	67% PAG 13%Uncertain 20%Non-PAG	20% PAG 14%Uncertain 66% Non-PAG	14% PAG; 11% uncertain; 75% Non-PAG
Laboratory Test Leachate MMER Exceedances	As	pH, Zn	n.e.[3]	n.e.[3]
Field Barrel Test Leachate MMER Exceedances	n.e.	n.e.	n.e.	n.e.

Notes: 1. IF rock proportions includes 2% of quartzite rock. **2.** Based on static testing database (Golder 2005a). **3.** Result from the 100-kg composite sample. n.e.: no exceedances.

4.12.2 Geomorphology & Soils

4.12.2.1 Geomorphology

Landforms are dominated by hummocky bouldery glacial till plains and scattered boulder till moraines with frequent bedrock outcropping in isolated exposures, elevated plateaus, and elongated ridges. Localized north- to northwest-trending glacial drumlins preserve evidence of regional ice flow. Rare glaciofluvial kames and sinuous eskers form isolated topographic features.

The periglacial processes observed in the area are typical of areas underlain by permafrost, although the relatively thin cover of overburden and dry conditions on site subdue their expression. Terrain features and geomorphic processes associated with excess ground ice and generally wet conditions exist locally and are commonly associated with low-lying bogs. Some of the processes observed include: frost wedging and frost shattering, resulting in blocky colluvial slopes; cryoturbation; solifluction; and thaw subsidence and nivation.

4.12.2.2 Soils

Block fields of weathered parent material interspersed with thin veneers of till or organics are common; however, the predominant surficial material is locally derived glacial till. Till thickness at site, as determined from core and reverse circulation overburden drill holes, ranges up to 12.5 m with an average of less than 3 m. In general, till is unsorted, medium brown, silty, sandy and stony, with between 20% and 40% locally derived volcanic, sedimentary, and lesser granitic clasts. Clast sizes range from granule to boulder with a high proportion in the granule to pebble range. In most of the channels between the lakes and ponds, coarse-grained soils are common. In some, the finer organic material and sediments have been removed by flow between lakes, leaving a stony pavement. In others, solifluction has brought coarse-grained material into the low-lying areas from adjacent slopes.

Small deposits of deltaic sand and fine gravel flank some streams along Third Portage Lake. Glaciofluvial deposits are volumetrically insignificant. The site was above the last glacial marine transgression; consequently, no glaciomarine deposits are known in the area.

The terrain along the proposed access road has low relief, and is generally gently- to moderately-sloping with short, steep slopes occurring locally on some bedrock surfaces. The terrain is dominated by undulating and irregular bedrock surfaces, veneers and blankets of till and/or weathered (frost-shattered) bedrock (felsenmeer), and discontinuous organic veneers. Occasional marine (beach) deposits and very small glaciofluvial deposits are present locally. Shallow, hand-dug soil pits excavated in late July 2005 indicate thaw to depths of 1 m or less on imperfectly- to poorly-drained upland till surfaces at this time of year.

All samples of overburden (till) other than Third Portage trench spoil piles have no potential to generate ARD. The ARD potential of trench spoil piles is due to the higher sulphide content of soil directly above the ore deposit. Rock samples collected along the proposed access route are indicated to be non-acid-generating.

4.12.3 Permafrost

The project is located within the zone of continuous permafrost (see Figure 4.25). Permafrost depths are estimated to be between 450 and 550 m, depending on proximity to lakes, slope, aspect, and other site-specific conditions.The measured active layer depth in the project area currently ranges from about 1.3 m in areas of shallow overburden and away from the influence of lakes, up to 4.0 m adjacent to lakes, and up to 6.5 m beneath the streams connecting Third Portage and Second Portage lakes.

Lake ice thickness is estimated to be around 1.5 to 2.0 m thick during mid- to late-spring, depending on site-specific conditions of water depth and exposure. Where water depth is greater than about 2 to 2.5 m, taliks are expected. Round lakes that do not freeze to the bottom in winter and have a diameter in the order of 570 m or greater, or elongated lakes that do not freeze to the bottom and have a width in the order of 320 m or greater, will have a talik that extends through permafrost. The taliks beneath Second and Third Portage lakes likely extend through permafrost. The talik beneath Vault Lake likely does not penetrate through permafrost.

The ground ice content of permafrost soil and rock in the Meadowbank area is expected to be between 0% and 10% (dry permafrost) based on regional scale compilation data.

4.12.4 Potential for Instability

The main deposits at the Meadowbank project are situated adjacent to lakes or trend off-shore and beneath lakes. Consequently, a significant component of the project involves lowering the water level in Second Portage and Vault lakes to allow mining to proceed. The initial drawdown of the lakes will expose lake bottom sediments and till in the lake basin side slopes and lake bottoms, which could result in slumping of sediments on steeper lake basin slopes. Lowlands adjacent to lakes as well as lowlands along inflowing streams feeding Second Portage and Vault lakes will also be affected. The original active layer in these lowlands can be expected to deepen because lowering the water table allows more summer heat into the ground. Where the advancing thaw front at the bottom of the active layer encounters excess ground ice, thaw subsidence can be expected. Where the ground ice is in fine-grained mineral and/or organic soils, subsidence may be accompanied by local slumping and release of high suspended sediment loadings in runoff waters entering the water management areas of Second Portage and Vault lakes. The lowering of lake levels will promote aggradation of the permafrost into the former unfrozen lake bottoms. This will be accompanied by frost penetration, moisture redistribution, and ground ice growth, resulting in freezing-induced displacements of the soils and underlying rock. Overall, there are no physical features or processes observed in the area that would prohibit the development of the proposed mine.

4.12.5 Hydrology / Hydrogeology

The Meadowbank project is located close to the surface water divide between the Back River basin, which flows north to northeast towards the Arctic Ocean, and the Quoich River basin, which flows east to southeast into Chesterfield Inlet.

Short, small to medium streams with boulder channels connect all lakes in the project area. Turn Lake drains southeast into Drilltrail Lake, which drains into Second Portage Lake. Third Portage Lake drains north into Second Portage Lake across a narrow strip of land dividing the two lakes via three distinct outflow channels: a western channel, a center channel, and an eastern channel (see Figure 4.26 for a depiction of historic sampling stations and water flow direction). Water level and discharge monitoring were carried out using automated hydrometric monitoring equipment that was selected, procured, and installed by the Water Survey of Canada, Yellowknife. Snowmelt runoff in the region begins in the period between the end of May and the middle of June, and the snowmelt peak is often the largest runoff for the year. Secondary peaks due to rainfall events can occur throughout the summer. Streamflow typically declines through late summer and fall, with freeze-up occuring at the end of September for the smallest streams, and in October in all lakes. All channels freeze to the bottom with zero flows over the winter period.

In areas of continuous permafrost, there are two groundwater flow regimes: a deep regime beneath the permafrost and a shallow regime in the active layer near the ground surface (see Figure 4.27). The deep groundwater regime is connected to taliks located beneath large lakes. The water level elevations in lakes that have these deep taliks provide the driving force, or hydraulic head, for the deep groundwater flow. The presence of the thick and low permeability permafrost beneath land located between large lakes results in negligible recharge to the deep groundwater flow. Smaller lakes, which have taliks that probably do not extend down to the deep groundwater regime, do not influence the groundwater flow in the deep regime. Consequently, recharge to the deep groundwater flow regime is predominantly limited to areas of talik beneath large surface water bodies.

From late spring to late summer when temperatures are above 0°C, the active layer becomes thawed. Within the active layer, the water table is expected to be a subdued replica of the topographic surface.

Groundwater gradients, or the slope of the groundwater level, are assumed to be similar to topographic gradients. Locally, groundwater in the active layer would flow to local depressions and ponds that drain to Second Portage and Third Portage lakes or would flow directly to Second Portage and Third Portage lakes.

There does not appear to be a detectable difference in the hydraulic conductivity of the various rock types. Ultramafic rocks, at a given depth, have similar hydraulic conductivity to those of the intermediate volcanics at the same depth. The hydraulic conductivity of the shallow exfoliated and weathered bedrock and faults, regardless of rock type, is generally higher than the deeper, less fractured rock.

4.12.6 Current & Projected Groundwater Use

Groundwater sources from both the active layer and from the deep groundwater regime below the permafrost are not presently utilized for drinking water. It is unlikely that the groundwater in the shallow active layer would be utilized in the future because of its seasonal nature. Deep groundwater may be utilized in the future, but the likelihood of this is considered low because the groundwater quality is poor and supply wells would need to be installed through deep permafrost and because there are abundant sources of good quality surface water.

4.12.7 Sediment

Sediment can be an important source or sink for contaminants such as metals. Contaminants entering aquatic systems (via tributary streams or directly from local sources) are usually associated with suspended particulate material in the water column that eventually settle in depositional areas as sediment, especially in deeper areas of lakes. Sediment provides a long-term, temporal record of deposition, integrating concentrations over time.

Lakebed substrate in the project area is a key habitat attribute that dictates the species composition and abundance of benthic invertebrates and its importance as feeding habitat by fish. Water depth is the strongest determinant of physical features of lake substrate, especially grain size. Between the surface and about 4 m depth, substrate consists of a heterogeneous mixture of boulder, rock, and cobble that is ice scoured (< 2 m) and subject to erosion by wave-driven currents. Below 4 m depth, sediment grain size diminishes with sand, silt, and clay, becoming more abundant. At depths of 6 to 8 m and greater, bottom sediment consists of a uniform silt/clay mixture that dominates aerial substrate distribution in Second Portage Lake (70%) and Third Portage Lake (81%).

Sediment samples at depths of 8 m or greater collected from numerous locations throughout the project and reference lakes revealed a great similarity in grain size, organic carbon (2.5% to 5%) and metals concentration. Total metals concentration in sediment was similar among project and reference lakes and over years, suggesting that the erosional and geochemical processes within lakes in the Meadowbank region are similar. The majority of lake sediments are potentially acid generating, with relatively low sulphur but almost no buffering capacity.

At Meadowbank, all sediment metals concentrations observed can be regarded as background because of the near absence of anthropogenic activities. Metals concentrations are generally similar across the area, including reference lakes, and reflect the natural, mineralized nature of the sediments and low rate of deposition. Adverse impacts to the benthic community were not observed and fish tissue metals concentrations are low and similar to concentrations in fish found in other pristine lakes.

4.12.8 Water Quality

4.12.8.1 Surface Water

The Meadowbank project area lakes (Second Portage, Third Portage, and Wally 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, and oxygen and nutrient distributions with only minor, temporary stratification. Water clarity is extremely high with Secchi depths of 10 m or more, with very low dissolved and suspended solids concentrations. Given the absence of tributary streams, there are no external sources of nutrients or sediment that might contribute to nutrient enrichment. Due to the site’s northern latitude and climate, lakes in the area naturally experience long periods of cold temperatures and low light levels during the winter months. Ice covers the lakes for extended periods of time each year and low water temperatures exist 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. Oxygen concentration remains high under the ice; however, because of the low rates of biological activity and decomposition of organic material.

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

Average baseline water qualities in Third Portage, Second Portage, and Wally lakes are presented in Table 4.13. Total and dissolved metals concentrations in surface waters from project lakes are remarkably similar within and between lakes between 1997 and 2002. Total antimony, arsenic, chromium, copper, mercury, and nickel concentrations from project lakes are all below laboratory detection limits and well below CCME (2001) water quality guidelines for the protection of aquatic life. Besides common salts (sodium, magnesium), the only metals to exceed detection limits are aluminum (0.006 to 0.014 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 comprise 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.

Table 4.13: Average Baseline Water Quality in Third Portage, Second Portage & Wally Lakes

Parameter	Units	Third Portage Lake (N=18)	Second Portage Lake (N=14)	Wally Lake (N=3)
Conventional parameters				
Hardness	mg/L	5.3	8.9	17.2
pH	pH units	6.8	7.5	7.3
Dissolved anions				
Total alkalinity	mg/L	4	7	13
Chloride	mg/L	0.5	0.6	0.7
Fluoride	mg/L	0.07	0.07	0.05
Sulphate	mg/L	1.3	2.8	5.3
Nutrients				
Ammonia nitrogen	mg/L	0.01	0.02	0.02
Total kjeldahl nitrogen	mg/L	0.09	0.08	0.11
Nitrate nitrogen	mg/L	0.004	0.007	0.024
Nitrite nitrogen	mg/L	0.001	0.001	0.001
Total phosphate	mg/L	0.002	0.003	0.003
Total phosphorus	mg/L	0.002	0.003	0.003
Organic parameters				
Dissolved organic carbon	mg/L	1.4	1.7	2.2
Cyanides				
Total cyanide	mg/L	<0.005	<0.005	<0.005
Total metals				
Aluminum	mg/L	0.006	0.007	0.008
Antimony	mg/L	<0.0005	<0.0005	<0.0005
Arsenic	mg/L	<0.0005	<0.0005	<0.0005
Barium	mg/L	<0.02	<0.02	<0.02
Beryllium	mg/L	<0.001	<0.001	<0.001
Boron	mg/L	0.1		0.1
Cadmium	mg/L	<0.00005	<0.00005	<0.00005
Calcium	mg/L	1.2	2.3	4.6
Chromium	mg/L	<0.001	<0.001	<0.001
Cobalt	mg/L	<0.0003	<0.0003	<0.0003
Copper	mg/L	0.001	0.001	0.002
Iron	mg/L	<0.03	<0.03	<0.03
Lead	mg/L	0.0006	0.0009	0.0007
Lithium	mg/L	<0.005	<0.005	<0.005
Magnesium	mg/L	0.5	0.8	1.3
Manganese	mg/L	0.001	0.0016	0.0013
Mercury	mg/L	<0.00005	<0.00005	<0.00005
Molybdenum	mg/L	<0.001	<0.001	<0.001
Nickel	mg/L	<0.001	<0.001	<0.001
Potassium	mg/L	2	2	2
Selenium	mg/L	<0.001	<0.001	<0.001
Silver	mg/L	<0.00002	<0.00002	<0.00002
Sodium	mg/L	2	2	2
Thallium	mg/L	<0.0002	<0.0002	<0.0002
Tin	mg/L	<0.0006	<0.0005	<0.0005
Titanium	mg/L	<0.01	<0.01	<0.01
Uranium	mg/L	<0.0002	<0.0002	<0.0002
Vanadium	mg/L	<0.03	<0.03	<0.03
Zinc	mg/L	0.005	0.005	0.013

Note: N = number of samples used to calculate average values.

Overland drainage occurs principally during freshet period. This water is moderately acidic and has very low sulphate, dissolved metals, and total dissolved solids. The quality of water infers limited interaction of surface drainage water with the underlying bedrock.

4.12.8.2 Groundwater

Groundwater baseline data were collected from four monitoring wells located within the three main rock types in the area of the Goose Island and Portage deposits (see Figure 4.27) and from the talik underlying the proposed tailings disposal area at Second Portage arm. Wells were not installed in the Vault deposit as it lies within continuous permafrost.

No samples reported MMER exceedances, although some samples reported exceedances of Canadian Water Quality Guidelines (CWQG). Concentrations of total metals generally exceeded those of dissolved metals for all wells. The chemical signature of groundwater (from major ion chemistry) is distinct between each lithology and differs from that of lake water. Groundwater quality is generally consistent with rock leachate characteristics, with the majority of constituents present in rock leachate also present in the groundwater of the corresponding lithology.

The groundwater is brackish to saline with high total dissolved solids (TDS) and chloride concentrations. Based on data from other sites in the Canadian Shield, it is expected that the salinity of the groundwater will increase with depth. Water samples collected from monitoring wells installed in the talik beneath Second and Third Portage lakes to depths of 175 m have chloride concentrations of up to 626 mg/L and TDS values up to 800 mg/L. This represents a salinity of 1.1, where salinity is equal to approximately 1.8 times the chloride concentration (in parts per thousand). Water samples collected from a number of large lakes in the area have chloride concentrations of less than 1 mg/L. By comparison, sea water has chloride concentrations of approximately 19,000 mg/L.

4.12.9 Air Quality & Noise Levels

Air quality values reported by the Environment Protection Service of the Government of Northwest Territories (2004) were adopted for this project. The reported PM_{10} concentrations were less than 10 $\mu g/m^3$ for the undisturbed areas of the NWT. Concentration of other pollutants considered, such as

SO_2, NO_x, and CO, are expected to be very low in the Meadowbank area, which is in keeping with the undisturbed quality of air in pristine areas.

Baseline noise conditions for the project area are expected to show a L_{eq} of 42.7 dBA for daytime and 35.4 dBA for nighttime based on a 24-hour background sound survey completed in an area that is topographically similar to Meadowbank and absent of any anthropogenic noise sources (Fort McKay area, Northern Alberta.)

4.12.10 Climate & Climate Change

The Meadowbank region is within a low Arctic ecoclimate described as one of the coldest and driest regions of Canada. Arctic winter conditions occur from October through May, with temperatures ranging from +5°C to -40°C. Summer temperatures range from -5°C to +25°C with isolated rainfall increasing through September (see Table 4.14).

Table 4.14: Estimated Average Monthly Temperature & Precipitation – Meadowbank Site

Month	Mean Temperature[1] (°C)	Average Precipitation (mm)			Lake Evaporation (mm)
		Rainfall[1]	Snowfall	Total	
January	-32.4	0	11.2	11.2	0
February	-31.7	0	10.5	10.5	0
March	-26.3	0.1	14.6	14.6	0
April	-17.7	2.3	16.7	19.0	0
May	-6.3	9.8	11.3	21.1	0
June	3.7	14.5	3.9	18.4	8.8
July	12.1	36.7	0.0	36.7	99.2
August	9.7	45.5	0.9	46.4	100.4
September	3.4	30.1	8.8	38.9	39.5
October	-7.4	3.5	30.3	33.8	0.1
November	-17.9	0	23.6	23.6	0
December	-25.8	0	15.0	15.0	0

Note: Rounding of monthly averages has occurred. Temperatures and precipitation were estimated based on site data (1997 to 2004). Snowfall is based on adjusted Baker Lake data (1946 to 2004). Adjusted small lake evaporation was estimated from pan evaporation data *2002 to 2004). **Source:** AMEC 2004a[1]; Other sources AMEC 2003, 2005.

The long-term mean annual air temperature for Meadowbank is estimated to be approximately -12°C. Air temperatures at the Meadowbank area are, on average, about 0.6°C cooler than Baker Lake air temperatures, and extreme temperatures tend to be larger in magnitude; this climatic difference is thought to be the effect of a moderating maritime influence at Baker Lake. Skies tend to be more overcast in the winter than the summer. The average annual wind speed is 10 km/h and winds tend to be most frequently from the west and east-southeast quadrants. Light to moderate snowfall is accompanied by variable winds up to 70 km/h, creating large, deep drifts and occasional whiteout conditions. Monthly rainfall, snowfall, and total precipitation values were adjusted for undercatch using the values reported by Environment Canada for Baker Lake to develop estimates of adjusted monthly and annual values for Meadowbank (1949 to 2003). The resulting adjusted mean annual rainfall, snowfall, and precipitation totals for Meadowbank are 144.0, 148.8, and 292.8 mm, respectively.

According to the Intergovernmental Panel on Climate Change (IPCC, 2001), the global mean surface air temperature is projected to increase by 1.4°C to 5.8°C from 1990 to 2100. For the Canadian Arctic, temperatures are expected to increase by 3°C to 4°C by 2050 (NRC, 2004), rising 5°C to 7°C across the mainland by 2100. By the middle of the 21st century, the effect of temperature change is predicted to reduce near-surface permafrost by 12% to 15% once equilibrium conditions become established under the new temperatures. The predicted increase in active layer thickness of 15% to 30% will reach equilibrium relatively much faster.

Studies indicate that the boundaries of discontinuous and continuous permafrost are expected to move northward due to global warming (Woo et al, 1992). Predictions suggest the Meadowbank property would remain within the zone of continuous permafrost.

4.13 DESCRIPTION OF BIOLOGICAL ENVIRONMENT

4.13.1 Vegetation & Wildlife Habitat

No rare or regionally unique vascular plants or plant communities have been found within the mine site or access road LSAs.

To facilitate discussion of wildlife habitat utilization, development of wildlife habitat suitability ratings, and discussion of potential project-related impacts, the 33 ELC units mapped in Figure 4.28 were clumped into 10 simplified units that were still considered to be ecologically relevant (see Terrestrial Ecosystem Baseline Report).

Area summaries of the ‘Wildlife’ ELC units found in the three study areas are presented in Table 4.15.

Table 4.15: Area Summary of 'Wildlife' ELC Units in the Mine Site LSA, Access Road LSA & RSA

Wildlife ELC	Mine Site LSA		Access Road LSA		RSA	
	Area (ha)	**% of LSA**	**Area (ha)**	**% of LSA**	**Area (ha)**	**% of RSA**
Water	5,990	31	3,054	11	98,890	19
Sedge	3,936	20	2,029	7	43,935	9
Birch & Riparian Shrub	1,690	9	3,726	14	64,128	13
Heath Tundra	1,441	7	8,126	29	115,086	23
Lichen	1,460	8	4,406	16	73,425	14
Lichen-Rock	1,940	10	1,268	5	29,243	6
Ridge Crest/ Esker / Avens	26	<1	793	3	10,719	2
Rock & Boulder	2,841	15	2,275	8	45,939	9
Disturbed	15	<1	274	1	3,844	1
Residual	56	<1	1,617	6	25,526	5
Total	**19,395**	**100**	**27,568**	**100**	**510,735**	**101**

Water, which covers about 31% of the land surface, is the most common ELC unit within the mine site LSA. The most common vegetated unit is Sedge, covering approximately 20% of the mine site LSA. Other common units are Rock & Boulder and Lichen-Rock. Within the access road LSA, the Heath Tundra is by far the most common ELC unit, covering approximately 29%. Other common ELC units are Lichen and Birch & Riparian Shrub. In the RSA, Heath Tundra is the most common (23%), followed by Water (19%), Lichen (14%), and Birch & Riparian Shrub (13%).

4.13.2 Wildlife

4.13.2.1 Ungulates

Caribou

The barren-ground caribou population occurring in the Meadowbank area is listed as secure by the Government of Nunavut (GN, 2001), and is not listed federally (Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2004). The only listed population is the Dolphin and Union herd (Special Concern) which occurs north of Meadowbank along the Arctic Ocean. Individuals from this herd are unlikely to winter in the Meadowbank area. According to both baseline data and traditional knowledge, no caribou calving grounds are found within the RSA. The Beverly calving grounds are west of the RSA, the Qamanirjuaq calving grounds are to the south (BQCMB, 1999), and the Wager Bay and Lorillard calving grounds are to the east and northeast. Caribou are present in the Meadowbank RSA in all seasons, but based on aerial surveys, are most abundant in the winter. In February 2004, an estimated 21,000 caribou were recorded. Caribou results for the 11 aerial surveys are shown in Figures 4.29 and 4.30.

Radio-collaring data from the governments of Nunavut and the Northwest Territories suggest that individuals wintering in the Meadowbank area may originate from any one of several identified herds in mainland Nunavut, including the Beverly, Qamanirjuaq, Lorillard, Wager Bay, Boothia Peninsula, and Ahiak herds. Based on the patterns of seasonal abundance observed to date, the Meadowbank area does not appear to represent critical caribou habitat during spring migration, calving, or summer post-calving (see Figure 4.31).

Muskox

The muskox is now listed as secure in Nunavut (GN, 2001), and is not listed federally (COSEWIC, 2004). Nunavut is home to most of Canada’s muskox, with a population of about 60,000 animals (JWEL, 2001). The species was once hunted to near-extinction and has only recently begun to re-establish populations in parts of Nunavut.

Based on seasonal sampling and as confirmed by traditional knowledge, a small but relatively stable—and possibly increasing—population of muskox resides in the vicinity of the project site. Herd sizes range from single individuals to up to 80 animals. An estimated number of muskox for the RSA is difficult to determine because of their clumped distribution; however, a population of between 500 to 1,000 animals is likely. These numbers are supported by surveys undertaken in the central Kivalliq Region by the DOE in the summers of 1999 and 2000, which estimated a density of 0.043 muskoxen per km^2 (i.e., 430 individuals/10,000 km^2) in an area that included the western half of the RSA.

4.13.2.2 Predatory Mammals

Grizzly Bear

The grizzly bear is designated as sensitive in Nunavut (GN, 2001), and is listed as a species of Special Concern by COSEWIC (2004). It is currently not on any of the schedules under the *Species at*

Risk Act but may be added to the Schedule 1 pending a public consultation process. Grizzly bears are distributed across most of mainland Nunavut except in the northeast and the coastal fringe south of Chesterfield Inlet. Population density decreases from west to east, but traditional knowledge suggests that the grizzly's range is expanding eastward. There is no demographic data for grizzly bears in Kivalliq, but the west Kitikmeot population is thought to be stable or slightly increasing.

A sow with two cubs was seen during an aerial survey in spring 1999 within the RSA and a single bear was seen near the PDF deposit in spring 2005. Little other evidence of grizzly bear was recorded during wildlife surveys of the RSA and LSA. These data suggest that a small population of grizzly bear occurs in the Meadowbank RSA, as would be expected for a wide-ranging species typically existing at low densities (e.g., three individuals/1,000 km^2). An increased number of bears observed and killed in the Baker Lake area in the last few years has lead to concerns by local residents that the grizzly bear population is increasing rapidly and may need to be controlled.

To address these concerns, a joint project has been undertaken by Cumberland, HTO, World Wildlife Fund (WWF), and DSD to gather traditional information about the grizzly bear population.

Wolverine

The wolverine is listed as sensitive in Nunavut (GN, 2001), and the western Canadian population (which includes Nunavut) is considered to be of Special Concern (COSEWIC, 2004), although it is not listed on any schedules under the *Species at Risk Act*. Wolverine is an important furbearing species for residents of Baker Lake, and maintaining a healthy population of the species is important for local trappers. Population estimates for the NWT and Nunavut suggest there is a stable (or increasing), sparsely distributed population of more than 3,000 animals (Northwest Territories' Department of Resources Wildlife & Economic Development (NWTRWED, 2001).

Wolverine and their sign have been recorded on less than 10 occasions in the study area. Such infrequent sightings are expected given the wide-ranging habits and low densities of this species. This assumption is supported by traditional knowledge.

Wolf

The wolf is listed as sensitive in Nunavut (GN, 2001), but is not federally listed (COSEWIC, 2004). Wolf populations are stable or increasing within their range, except in northern Alberta and some parts of the NWT. According to traditional knowledge gathered, wolf harvesting in the Meadowbank area has increased in recent years; however, regional population numbers and trends remain poorly understood. Their patterns of distribution, densities, territory boundaries, and dispersal movements are influenced by interactions between packs and by prey abundance and distribution.

Wolves were observed infrequently throughout the RSA during all survey sessions, but were most common in the fall, likely related to increased caribou abundance at that time of year. Wolves apparently reproduce in the RSA as two young pups were observed with two adults during the September 2002 RSA survey and small pack of wolves accompanied by a lactating female were observed along the all-weather access road in 2005. Camp personnel also observed wolf pups within the LSA, on the east side of Turn Lake in July 2002.

4.13.2.3 Small Mammals

Arctic Hare

The Arctic hare is considered to be secure in Nunavut (GN, 2001), and is not listed federally (COSEWIC, 2002). The species is widely distributed north of the treeline in Canada. Likely predators of the Arctic hare in the Meadowbank area are raptors, Arctic foxes, wolves, and wolverines. Arctic hares were recorded in relatively small numbers in the spring, summer, and fall within the LSA, but were the second most frequently observed mammal species (after caribou) within the LSA in the fall. Hare pellet densities and direct observations during ground surveys also indicate that Arctic hares are common throughout the Meadowbank LSA. These observations are supported by traditional knowledge.

Arctic Ground Squirrel

The Arctic ground squirrel (or sik sik) is considered to be secure in Nunavut (GN, 2001), and is not listed federally (COSEWIC, 2004). Arctic ground squirrels are found throughout the northern boreal forest and Arctic tundra; however, information on the abundance and distribution of this species in the Arctic is scarce. Arctic ground squirrels were recorded in relatively small numbers in the spring, summer, and fall in the LSA. They were, however, the most frequently observed mammal species in the LSA in the summer. Arctic ground squirrels were also observed throughout the Meadowbank RSA. Burrows were concentrated in areas with sandy substrates suitable for digging, such as eskers and grassy slopes.

Collared Lemming

The status of the collared lemming in Nunavut is undetermined (GN, 2001), and the species is not listed federally (COSEWIC, 2004). Collared lemmings have a nearly circumpolar distribution and are well known for their population cycles. Lemmings were observed on only two occasions during the field surveys; however, stable moderate populations are expected given the availability of suitable habitat.

Northern Red-backed Vole

The status of the northern red-backed vole in Nunavut is undetermined (GN, 2001), and the species is not listed federally (COSEWIC, 2004). The northern red-backed vole is found throughout much of northern Canada and also exhibits marked population fluctuations. The northern red-backed vole has been recorded incidentally several times in the Meadowbank area, and is expected to be common throughout the area.

4.13.3 Birds

4.13.3.1 Raptors

Nesting habitat for breeding falcons and hawks in the Meadowbank LSA is considered to be low since preferred nesting areas such as cliffs are virtually absent. However, habitat suitability for foraging raptors is moderate to high as the area contains large areas of heath tundra combined with grassy meadows, bare rocky areas, patches of low shrub, and shallow and deep-water habitats, which support prey such as Arctic hares, rodents, passerines, ptarmigan, shorebirds, and waterfowl.

Baseline surveys indicate—and traditional knowledge confirms—the presence of five raptor species in the Meadowbank area: rough-legged hawk, gyrfalcon, snowy owl, short-eared owl, and peregrine falcon. Only peregrine falcon has been identified as a species of "Special Concern" by COSEWIC (2004) and is on Schedule 3 of the *Species at Risk Act*. During baseline surveys, most raptor sightings were made in the western half of the RSA, particularly, in the northwestern portion.

In the RSA, nesting falcons have only been confirmed along the Meadowbank River, a considerable distance from Meadowbank. No peregrine falcons have been observed within the mine site or access road LSAs. The rough-legged hawk and gyrfalcon have been seen in low numbers each year, and generally during the spring and fall migrations. Snowy Owls were the most frequently recorded raptor (10 visuals) during the fall 2002 ground survey in the LSA, and were observed in low numbers (<5 visuals per season) in the spring and fall in the RSA. Breeding rough-legged hawk, gyrfalcon, and snowy owl have not been observed within the Meadowbank RSA.

4.13.3.2 Waterfowl

During baseline surveys, 13 waterfowl species were recorded: tundra swan, greater white-fronted goose, snow goose, Ross' goose, brant goose, Canada goose, mallard, green-winged teal, northern pintail, greater scaup, long-tailed duck, common merganser, and red-breasted merganser. Of these, snow geese and Canada geese were observed in greater numbers than any other species, particularly during the migratory periods. The only species confirmed as breeding in the area are Canada goose, northern pintail and long-tiled duck, although other species such as loons and red-breasted merganser are likely to nest at low densities.

Traditional knowledge confirms that waterfowl arrive in the general area of the proposed project from mid- to late May, but fall departure dates differ considerably among species. Departure dates for snow geese may be protracted throughout August and September since birds from west Hudson Bay and the central Arctic seemingly migrate through interior southern Kivalliq. The snow goose was also the most frequently observed waterfowl species during the fall survey, whereas the Canada goose was most common during the summer survey. Both snow goose and Canada goose were regularly reported by camp personnel during the migratory periods.

During all seasons, waterfowl were associated primarily with aquatic habitats in the Meadowbank area although Heath Tundra and Lichen-Rock sites were occasionally used for foraging. Suitable foraging habitat for waterfowl is limited since the lakes in these areas are ultra-oligotrophic and the wetlands are relatively unproductive.

4.13.3.3 Other Breeding Birds

Of the 14 bird species considered to be breeding within the Meadowbank area, the Lapland longspur was by far the most common, averaging (i.e., of all 88 plots to date) approximately seven pairs per 16 ha plot or 43 pairs per 100 ha..

Other relatively common species were horned lark, averaging 1.4 pairs per plot (12 pairs per 100 ha), savannah sparrow, averaging 0.6 pairs per plot (or 3.8 pairs/100 ha), and rock ptarmigan, averaging 0.6 pairs per plot (3.5 pairs per 100 ha). Breeding evidence included females with chicks, nests with eggs, pair courtship behaviour, and other breeding-related behaviours.

Relatively few shorebirds were recorded in the Meadowbank area during baseline surveys. The most common shorebird species was the semipalmated sandpiper, which was recorded in several extensive sedge meadows, often adjacent to small lakes and ponds, during the breeding bird surveys. Average number of pairs per plot was 0.2 or 1.5 pairs per 100 ha.

Uncommon breeding birds observed during breeding bird surveys included American pipit, hoary and common redpolls, American golden-plover, and sandhill crane. A nesting pair of sandhill cranes was observed approximately 1 km south of South Camp during the June 2003 breeding bird surveys.

4.13.4 Fish & Other Aquatic Organisms

Overall, the Meadowbank project lakes support healthy communities of plankton, benthos, and fish that are typical of oligotrophic Arctic lakes free from anthropogenic impacts. For detailed information on this topic, see the Baseline Aquatic Ecosystem Report and Baseline Fish Habitat Report, both of which are included as part of this EIA submission.

4.13.4.1 Periphyton, Phytoplankton, Zooplankton & Benthic Invertebrates

There are no macrophytes along shorelines or rooted in shoals. Aquatic vegetation consists of a thin layer of algae coating rocks to a depth of 6 m (periphyton) and small plant plankton (phytoplankton) suspended in the water column. Phytoplankton are primary producers that are grazed by herbivorous zooplankton species throughout the year, especially during the open water season when primary production within lakes is greatest. Together, periphyton and phytoplankton provide an important food source for certain benthic invertebrate species and form the base of the food web.

The periphyton community of the project lakes is dominated numerically by blue-green algae, diatoms, and green algae. The dominance of blue-green algae that is capable of fixing atmospheric nitrogen suggests that the project lakes are nitrogen-limited, a contention supported by the low nutrient concentrations measured in the water.

At least 40 species of phytoplankters, representing the six major classes of algae, were identified in the Meadowbank project lakes: chrysophytes (golden-brown algae), diatoms, chlorophytes (green algae), dinoflagellates, cryptophytes, and cyanophytes (blue-green algae). Chrysophytes, by virtue of their large numbers, comprised the greatest biomass (76% to 86%) of total phytoplankton biomass in all project lakes. Diatoms (10%) and dinoflagellates (12%) were the next most abundant groups. Mean phytoplankton biomass was very consistent among project lakes and over years, ranging from 100 to 177 mg/m^3. Species composition and biomass of major taxa was also consistent between project and reference lakes and is representative of commonly occurring phytoplankton species found in other nutrient-poor, oligotrophic Arctic lakes.

All of the zooplankton taxa identified from the project lakes are common and well-known in this region of the Arctic. There were no unusual or uncommon species identified. Diversity and abundance of the zooplankton community of the project lakes was low and reflected the nutrient-poor, low productivity status of the lakes. Calanoid copepods were the most abundant group (55% of all enumerated organisms) in all lakes over all years. Cyclopoid copepods were the next most abundant group (40%), followed by Cladocera (5%).

Abundance and biomass of zooplankton typically increases over the course of the summer from 3,000 zooplankters/m^3 in June to 9,000 zooplankters/m^3 in August. Temporal factors (e.g., season), and the growth of zooplankton strongly influenced the richness and density of the species over time. There were no large differences in zooplankton community structure or biomass among lakes or over time, because of the similarity in the physical, chemical, and limnological properties of the project and nearby reference lakes.

The benthic invertebrate community of Meadowbank project and reference lakes is numerically dominated by the aquatic larval stages of insects, especially chironomids, both in terms of abundance and species diversity. This is typical of most Arctic and temperate lakes. Mean density of major taxonomic groups (oligochaetes, bivalves, chironomids, and other taxa) from project lakes were reasonably similar among years, ranging from 2,500 to 8,300 m^2.

Chironomid larvae comprised between 50% and 86% of organisms in benthic samples from all study lakes between 1997 and 2003. Numerically dominant genera included *Procladius*, *Tanytarsus*, *Rheotanytarsus*, *Paratanytarsus*, *Tanytarsini*, and *Heterotrissocladius*. Sphaeriidae bivalve clams were the second most abundant benthic group (12% to 26%), followed by oligochaetes (1% to 9%). Hydracarina (mites), cladocerans, other aquatic insect larvae, harpacticoid copepods, tadpole shrimp, amphipods, and flatworms each comprised less than 1% of total density of benthic organisms.

4.13.4.2 Lake Bottom Substrates & Fish Habitat

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 is no fine substrate, such as sand, in shallow water at depths of less than 4 m. Very coarse substrates predominate to depths of at least 4 m, at which point there is a transition to finer substrates to about 6 m. At depths greater than 6 to 8 m, substrate is predominantly silt/clay with a few partially buried individual boulders or cobble patches. Shallow, coarse material provides abundant habitat for spawning, rearing, and foraging by fish in all project lakes. Habitat at depths greater than >8 m provides foraging habitat for round whitefish and overwintering habitat for all species.

Lakebed substrate is a key habitat attribute that dictates habitat function (e.g., spawning, feeding) and the extent to which fish utilize particular habitats. In general, coarse, heterogeneous sediment mixtures have a higher habitat value because of greater diversity and structure. Coarse sediment is required for spawning, nursery, and shelter habitat by fish. Sediment comprised of an even mixture of fine substrates with little or no complexity is very common, but has lesser value than heterogeneous substrate. Fine substrate habitat is used for feeding by some species and does not provide good, direct habitat for most other life history needs for most species. See Figures 4.32 and 4.33 for more information on fish habitat values.

4.13.4.3 Fish

Lake trout and round whitefish dominate abundance in all lakes, which is consistent with the typical species composition of many Arctic lakes in this region. Other fish species present in the project lakes include land-locked Arctic char, ninespine stickleback, slimy sculpin, and burbot (see Figure 4.34). Because of permafrost, cold winter temperatures, low precipitation and low relief, drainage is slow and diffuse, preventing movement by fish between the lakes during any other time but spring. Absence of suitable habitat within connecting channels between the project lakes prohibits the presence of Arctic grayling.

Fish species composition and relative abundance (based on catch-per-unit-effort statistics) was similar among project and reference lakes. Arctic char were somewhat less abundant in Third Portage Lake than downstream lakes. Fish from project lakes are healthy and were in good condition in all years. Concentrations of metals in tissue were low and typical of what would be expected in fish from remote lakes unaffected by anthropogenic activities. The size distribution of lake trout covered a wide range, up to 1.1 m and 20 kg weight. All lakes had somewhat bimodal size 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 few large (>800 mm) individuals. Size and condition data of trout from project lakes was similar to or slightly less than trout elsewhere in remote Arctic lakes. This may be due to the highly oligotrophic, low productivity nature of the project lakes that limits growth rate and ultimately, fish size.

4.14 DESCRIPTION OF SOCIOECONOMIC ENVIRONMENT

4.14.1 Regional & Local Socioeconomy

After its formal creation on 1 April 1999, Nunavut promptly set about establishing a consultative process to determine priorities and strategies for the economic and social development of the new territory. The work took into consideration a number of unique features of the economy and population, and outlined the significant challenges in improving the well-being of the population. With a commitment to developing a more diversified economy, the government is faced with addressing a broad range of constraints, from poor health and educational status of the population to a lack of transportation and communications infrastructure.

4.14.1.1 Population

Kivalliq Region, one of three administrative regions in Nunavut, had an estimated population in 2001 of over 7,500 people spread among seven communities. Baker Lake, with an estimated population of over 1,500 in 2001, is the only inland community in the region.

Table C.1 in Appendix C provides demographic data on Baker Lake, Kivalliq Region, and Nunavut. Additional data can be found in Cumberland's Baseline Socioeconomic Study. These data indicate that populations at the community, regional, and territorial levels are characteristically young, with about 40% below the age of 15. The gender imbalance, particularly in Baker Lake with a male/female ratio of 1.13, is also substantial.

4.14.1.2 Economic Activity & Incomes

Table C.1 in Appendix C also provides data on economic activity. The economy is mixed, combining the formal wage economy with traditional ways of life. Formal employment is predominantly in the tertiary, or service sector, with government (including health and education) providing over 50% of jobs at the regional level. Over the last five years, Baker Lake has seen an increase in the participation rate. This, in combination with population growth, represents a significant increase in the number of people looking for work and consequently a large increase in the unemployment rate. The unemployment rate in Baker Lake is higher than that of the region and territory. Women tend to participate less in the formal economy and are generally less likely to be employed.

In an economy that is predominantly one of government services, there is little economic opportunity for a growing labour force with minimal formal education. Poor formal employment prospects have translated into a recent decline in family incomes, which in Baker Lake are already substantially lower than in the region and the territory. Incomes in Nunavut also compare unfavourably with the rest of Canada. A comparatively high cost of living compounds the problem. Family incomes have decreased although average full-time earnings have increased; a further indication that mounting unemployment is the driver of decreasing economic welfare.

4.14.1.3 Education

Both Kivalliq Region and Baker Lake underperform relative to Nunavut as a whole with respect to educational achievement. There is gender balance in high school completion rates between males and females in Baker Lake, although overall across Kivalliq Region, women’s educational achievement is higher. Of particular concern in Baker Lake is the apparent increase in the percentage of young people who do not complete high school, as compared to the older generations. Discussions with educational professionals suggest a number of reasons for this, including lack of employment opportunities as a disincentive. In addition, the pattern of non-Inuit teachers rotating in and out of communities creates few opportunities for sustained, culturally appropriate support for students.

The school data in Table C.2, Appendix C, indicate that although secondary schooling is now available in all communities in Kivalliq Region and the growth in school attendance is generally high, only in communities more successfully integrated into the formal economy such as Rankin Inlet and Arviat are students graduating in significant numbers. In Baker Lake, for example, only two students graduated from secondary school over a four-year period from 1999 to 2003.

For students who do graduate, both in Kivalliq Region and in Baker Lake, there is opportunity for post-secondary study. Nunavut Arctic College offers a range of courses, including some courses specific to preparation for employment in the mining sector. Because of the potential for an expanding mining sector in Nunavut, and thus the potential for employment of Nunavut residents, Cumberland and the college are working with Kivalliq Partners in Development on a more comprehensive approach to training in this industry. Cumberland's involvement includes providing a list of jobs for their training program that are relevant to the project and the mining industry as a whole. It is noteworthy that many skills learned through such training, particularly in combination with job experience in the mining sector, would be transferable to other economic sectors. The college also offers high school upgrading courses.

4.14.1.4 Traditional Activity

Participation in traditional ways of life is high, at about 50% both in Nunavut as a whole and in Baker Lake. This figure is likely higher for Inuit males between the ages of 15 and 54. Traditional ways of life provide food, clothing, and services that would otherwise have to be purchased. This activity shapes social relationships and is a source of individual identity and values, sustaining Inuit culture. It is also a source of cash income, through the sale of products such as furs and art, and increasingly through the offering of tourism services rooted in the Inuit experience of the land.

4.14.1.5 Health & Wellness

The challenges to community health and wellness are large. Although there is little data, discussions suggest that many health problems are experienced more by males. Suicide, substance abuse, smoking, teenage pregnancy, sexually transmitted disease (STD), and life expectancy statistics in Nunavut are substantially worse than in the rest of Canada. For example, the suicide rate is nine times the Canadian average, the STD rate over 15 times higher, and life expectancy almost 10 years lower. Many of these are interrelated; for example, high rates of substance abuse and smoking affect life expectancy, and suicide is considered to be strongly related to substance abuse. Many of these, although individually experienced, spill over as community effects, causing a breakdown of families, crime, and child neglect.

In response to health challenges, the government of Nunavut spends 21% of their total operating budget on health and social services, second only to education, and in 2003/2004 planned to spend

40% of their total capital budget on health facilities. Health centers are located in the larger Kivalliq Region communities, including Baker Lake. Health professionals are available to address existing problems, but also to deliver counselling and awareness intended to prevent problems from arising. Although there is some evidence across the north that large investments are bringing about improvements in health and social services, there is some distance to go towards closing the disparity that exists in health status between Inuit and other Canadians.

As indicated above, Nunavut has had some success in ensuring that education and health facilities are available in all communities. The depth of service suffers in many cases, as small populations do not create constant demand for more specialized services. Even a community the size of Baker Lake sees most types of health professionals (e.g., doctors and dentists) only on a visiting basis. These visits are supplemented with video teleconferencing, and a large percentage (20%) of the operating health budget is used to bring people to services when local services are lacking.

4.14.1.6 Crime

Crime statistics are a reflection of health (particularly substance abuse) and economic challenges. Nunavut has particularly high rates of violent crime and sexual assaults relative to the rest of Canada. The figures shown in Table C.3, Appendix C, seem to suggest that crime, particularly youth crime (almost all of which statistically is committed by males), rose significantly between 1996 and 2001. Part of this rise reflects a demographic shift to a younger population, but it is also certainly exacerbated by exigent socioeconomic conditions. Communities across the north are increasingly concerned about their youth, who have in the recent past been less likely to participate in traditional ways of life but have not had the opportunity to move into the wage economy.

4.14.1.7 Housing & Transportation

Adequate housing plays an important role in facilitating job and school performance, in family relations, and in health status. Although overcrowding appears to have eased in response to vigorous government action to address the shortage of housing, increasing demands due to high population growth will continue to place stress on families. The statistics show that the housing shortage in Baker

Lake may be less than elsewhere in the territory, although discussions in the community indicate that the figures under-represent demand, and that crowding is a serious social issue.

Providing transportation is a challenge in Nunavut, with its many small communities spread across a very large land area. All communities can be reached by air and water; however, there are no roads between population centers, water access is seasonal, and air transport is costly. Telecommunication facilities are available in all communities, but are again costly. While the government has made significant efforts to build local businesses, limited and/or expensive physical infrastructure represents a severe constraint.

4.14.2 Archaeology & Heritage Resources

Archaeological surveys covered three main areas of study: the mine site and vicinity, the all-weather haulage route corridors, and selected sites around Baker Lake. Approximately 70 sites of interest have been identified (Figure 4.35). For more information on these sites, see the Baseline Archaeology Report and Section 4.14.3.

The area between Baker Lake and the mine site is considered primarily a transit route to the Back River, a traditional winter hunting and fishing area as evidenced by the many campsites and other heritage features along the corridor. Most of the sites observed in the study area were temporary campsites less than 50 years old. Pre-Dorset and Dorset age sites were not encountered.

4.14.3 2005 All-Weather Road Archaeology Survey

A preliminary archaeological reconnaissance was completed along the proposed all-weather access route (Figure 4.35). Upwards of 55 sites of interest were located. Approximately 11 to 15 of the sites recorded this year are potentially within road alignment. No confirmed evidence of more ancient Thule or Dorset period use was found. An interesting aspect of this area is that Baker Lake residents continue to hunt here and construct stone features, particularly caches and tent rings, in the traditional manner. Consequently, there is a continuous temporal range which presents considerable difficulty in differentiating recent use from past use that would be considered archaeological (that is, more than 50 years old). More intensive archaeological investigations will take place during the detailed engineering phase. These investigations will be designed to ascertain which sites are within the final road alignment, and to determine site content and boundaries in order to recommend mitigation measures. The primary mitigation measure will be avoidance wherever possible.

4.14.4 Traditional Knowledge

Traditional information has been collected during public meetings (1996 to 2005) and site visits by Elders to the camp. Traditional studies were also undertaken to determine traditional use and traditional ecological areas within and around the Meadowbank project area (see Cumberland's Baseline Traditional Knowledge report). The studies were accomplished by way of interviews with local Inuit Elders (men and women) from the Meadowbank area in association with the staff at the Inuit Heritage Centre in Baker Lake. An archaeologist (Deborah Webster) and heritage consultant (Hattie Mannik) were also consulted.

According to the Elders of Baker Lake, the area between Baker Lake and the Meadowbank site was most commonly used as part of a transportation corridor between Baker Lake and the Back River, their traditional winter hunting and fishing area. While hunting and fishing activities were, and still are, conducted near the property, these activities seem to be of an opportunistic nature while enroute to Back River and beyond. The Inuit also stop to camp at various lake sites—including the Portage Lakes—but these sites are not annually used. More permanent camp sites utilized by both current residents and their ancestors are further north. Traditionally Tehek and the Portage Lakes were used for fishing, fox trapping, caribou hunting, and food caching, all of which are still practiced today (see Figure 4.36). This area is also reported by the Elders to be very spiritual, and grave sites exist along the shore of Second Portage Lake. There are also other grave sites located randomly throughout the area between Baker Lake and the Meadowbank study site (see Figure 4.37).

No known traditional use areas occur within the footprint of the proposed development area. All traditional use areas outside of the project will be protected by future management plans developed between Cumberland and Inuit Elders, Heritage associations, and the local government. Every effort will be made to ensure that traditional sites are not disturbed or altered.

4.15 SPATIAL BOUNDARIES

For assessment of effects on the ecosystem from project related actions and other actions, the RSA was established on a VEC-specific basis. RSA's for each VEC were grouped into the following four categories: air quality and noise; physical ecosystem (surface water quality, surface water quantity, and permafrost); terrestrial ecosystem; and fish habitat and fish population. RSA and LSA spatial boundaries are shown for each VEC in Figure 4.38.

4.15.1 Air Quality & Noise

The RSA for the cumulative air quality and noise assessment was defined in preliminary dispersion modelling with AERMOD model and resulted in the selection of a 5 km zone around the emission sources. The RSA is extended south north by 7 km resulting from the distance between the processing plant and the Vault mine.

4.15.2 Physical Ecosystem

For assessment of cumulative effects on surface water quality, surface water quantity and distribution, and permafrost, the RSA was established as the unit area where regional effects would extend beyond the directly affected zone and possibly into the main basin of Tehek Lake, and the Quoich River system.

4.15.3 Terrestrial Ecosystem

The RSA for assessment of cumulative effects on terrestrial ecosystem was established on a VEC-specific basis. At the VEC level, spatial boundaries vary depending on variables such as home range size, distribution, and densities. For example, the collared lemming has a much smaller home range than the barren-ground caribou. Other species, such as geese, are primarily migratory and may travel thousands of kilometres from the project area, while other animals such as the wolverine and grizzly bear have large home ranges that may extend well beyond the 100 x 100 km RSA (as defined for baseline survey and monitoring purposes). Accordingly, unique spatial boundaries have been established for each terrestrial VEC, as shown in Table 4.16.

Table 4.16: Spatial boundaries for Terrestrial Ecosystem VECs (in radius centered on project facilities)

VEC	RSA	Justification
Vegetation	5 km	Vegetation is sedentary and vulnerable primarily to activities in close proximity
Ungulates	Mainland Nunavut and northern Manitoba and Saskatchewan	Caribou individuals from several herds, including Ahiak, Boothia Peninsula, Beverly, Qamanirjuak, Lorillard, and Wager Bay are known to occur in winter Muskox are wide-ranging and have been thought to be moving northeast out of the Thelon River valley
Predatory Mammals	100 km	Grizzly bear, wolverine, and wolf are wide-ranging species with large annual home ranges[1]. Predatory mammals occur at very low densities within the study area
Small Mammals	5 km	Small mammals are quite resilient (i.e., easily habituated) to human activity Of small mammals, Arctic hare are the widest ranging (home range of 4 to 20 ha[2])
Raptors	50 km	Birds nesting in close proximity to mine facilities may be disturbed during the nesting season Nesting birds may forage considerable distances away from nesting areas Some species (e.g., rough-legged hawk) are migratory and undergo long-distance movements
Waterfowl	50 km	Birds nesting in close proximity to mine facilities may be disturbed during the nesting season Species may be wide-ranging during the breeding season All species are migratory, moving long-distances to wintering grounds
Other Breeding Birds	5 km	Passerines are quite resilient (i.e., easily habituated) to human activity During the breeding season, most species are restricted to home ranges <1 km^2

Notes: 1. For males in Arctic habitats – Grizzly bears: 6,000 to 7,000 km^2; Wolverines: 100 to 900 km^2; and Wolves: >60,000 km^2. **2.** Macdonald 1995.

4.15.4 Fish Habitat & Fish Population

The RSA for assessment of cumulative effects on fish habitat and fish populations has been defined similar to that for the physical ecosystem described above. Specifically, the RSA would extend beyond the northernmost bay of Tehek Lake, which receives water from both the Portage and Vault (Vault, Wally, Drilltrail) systems 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.

4.16 TEMPORAL BOUNDARIES

Temporal boundaries varied with the component of the biophysical and socioeconomic environment being considered. Where possible, temporal boundaries were defined as the four project phases associated with the proposed development (i.e., construction, operation, closure, and post-closure).

Cumberland plans to mine these deposits over an 8- to 10-year period, starting with two years of construction, eight to ten years of operations, two years for closure activities. Post-closure activities will end approximately 25 years after closure, depending on regulatory requirements and post-closure monitoring.

4.17 DATA ACQUISITION METHODOLOGY & DOCUMENTATION

See Section 4.3 for details.

4.18 DATA ANALYSIS & REPORTING

See Section 4.3 for details.

4.19 IMPACT ASSESSMENT METHODOLOGY

The impact assessment methodology applied to the Meadowbank project follows accepted, well-established protocols and procedures that are consistent with NIRB and the Canadian Environmental Assessment Act (CEAA). The ultimate purpose of the methodology is to assess the magnitude, duration, spatial extent, frequency, direction, and/or timing of adverse effects caused by the project on VECs and VSECs in as quantitative a manner as possible. Using a decision framework specific to individual VECs and VSECs (i.e., impact matrices), each project component was assessed to determine if the long-term viability of an ecological component or socioeconomic condition may be significantly adversely affected.

It is important to remember that the assessment of significance of residual effects is 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 of a spill, significant adverse impacts will not result to the water quality or fish populations of the receiving environment because the berm has considerably reduced the risk of fuel entering the aquatic environment. Thus, the impact of a spill into the receiving environment is considered, but is not assessed with the same rigor as a potential impact that is more likely to occur. As per NIRB's request, Cumberland has also determined the potential significance of unmitigated impacts to ascertain the positive effects of mitigation.

4.19.1 Summary of Key Concepts

A number of key concepts were applied during the impact assessment:

Focus on valued ecosystem components – Valued ecosystem components (VECs) are defined as those environmental attributes or components identified as a result of an ecological and social scoping exercise. These may be determined on the basis of perceived public concerns related to social, cultural, economic, and aesthetic values. They may also reflect scientific concerns of the professional community as expressed through the scoping procedures (i.e., hearings, questionnaires, interviews, workshops, media reports, etc.) and through technical studies.

Integration of traditional knowledge – Cumberland has endeavoured to include the knowledge and understanding of the local people and culture in all aspects of planning and implementation of project development.

Use of linkage matrices to identify impacts – Developing impact matrices (see Appendix B) was a critical step in identifying how a particular mine activity may cause a tangible effect which, even after mitigation has been applied, may impact VECs in a significant or unacceptable way. The impact matrices establish the relationship between all project-related activities, physical effects, mitigation, and residual ecological effects.

Focus on critical issues – One of the purposes of developing detailed impact matrices was to identify the most critical issues that could adversely affect VECs and VSECs during the various project phases. Detailed discussions have been developed around these issues, whereas less attention has been given to generic issues or effects that are not considered to be significant (i.e., acceptable) and/or are easily mitigated.

Precautionary principle – To the best of its ability, Cumberland used the *precautionary principle* to guide the development of this project by assuming that lack of scientific certainty is not a valid reason for avoiding environmental action during any phase of project design where there are threats of serious or irreversible damage. Cumberland has built a safety margin into all decision-making and has incorporated traditional knowledge as an additional guide.

Focus on residual impacts – Ultimately, the effects remaining after all mitigation effort has been applied (i.e., residual effects) are of greatest concern. Therefore, considerable attention has been given to identifying, quantifying, and describing these residual effects so that a determination of potential significant/unacceptable and/or cumulative effects is facilitated.

Linkage to environmental & social management systems – As part of this EIA submission, various management plans provide supporting documentation and a discussion on mitigation and monitoring strategies to address residual impacts.

4.19.2 Selection of Valued Ecosystem Components

Extensive consultations were held with government regulators, Baker Lake residents, and other stakeholders regarding the components of the ecosystem that were of greatest value or concern. Information from these consultations has been described and summarized in the Baseline Traditional Knowledge Report included with this EIA submission. Based on this selection process, the key VECs were determined to be: air quality, noise, permafrost, water quality, surface water quantity, fish populations, fish habitat, vegetation (wildlife habitat), ungulates, predatory mammals, small mammals, raptors, waterfowl, and other breeding birds. (Note: VSECs are listed in Section 4.21.4.1.) Baseline studies were conducted to determine the presence/absence, distribution, and abundance of the VECs identified during the consultation and literature review phases. Baseline information was used to better understand how widespread project effects on any VEC might be.

4.19.3 Describing & Classifying Impacts

4.19.3.1 Approach

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 socioeconomic 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,” the principals of the above statements and NIRB’s Terms of Reference guidelines for this project have been followed. 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 measurably impaired within a local or regional context, or whose function is measurably impaired over the long-term, is significant.

4.19.3.2 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 modelling (e.g., water quality modelling, 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. The intent of this process is to be transparent and document decision pathways so that others can review the process that was used to determine the likelihood of residual impacts, how mitigation has avoided or reduced an impact, and the significance of impacts, particularly residual impacts.

4.19.3.3 Significance

To determine significance based on the evaluation criteria, a transparent, step-wise process combining the outcome of individual criteria has been established to arrive at an overall conclusion. Significance is therefore determined depending on a particular combination of previously defined criteria.

4.19.3.4 Cumulative Effects Considerations

The reduction and elimination of cumulative effects, both temporal and spatial, is an integral goal of this EIA and the various management plans (see Figure 3.1). Despite the fact that Meadowbank would have a relatively small footprint in a large, undeveloped region, future developments in the area and certain unrelated additive effects that only become measurable when combined, cannot always be anticipated. A more detailed discussion on cumulative effects is provided in the Cumulative Effects Assessment.

4.20 INDICATORS & CRITERIA

Definitions regarding magnitude, spatial extent, frequency, duration, and timing of impacts have been assessed for project-related activities as applied specifically to individual VECs (see Appendix B for a complete set of impact matrices). These criteria are shown in Table 4.17 and defined below.

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 somewhat subjective and takes into consideration such factors as ecological relevance, degree of change from baseline conditions, certainty of occurrence, and ecological resilience. The certainty with which the magnitude of an effect can be quantified has a strong influence on whether magnitude is ranked as high, medium, or low.

Spatial extent – is a measure of the geographic boundary of effects and has been divided into LSA and RSA areas.

Frequency – is a measure of how frequently effects will be felt by the VEC using standard measures (e.g., weeks, months, years).

Duration – is the length of time in weeks, months or years that an effect is expected to persist. The endpoint is recovery or return to baseline of the ecological component and is linked to reversibility and ecological resilience (i.e., the likelihood of the potential for recovery from an effect), providing an indication of when/if the impact will diminish.

Timing – indicates whether the impact overlaps with a sensitive period of a VEC.

Table 4.17: Significance Evaluation Matrix for Project Impacts

Magnitude	Spatial Extent	Frequency	Duration	Timing	Conclusion About Significance
High	Regional	Any	Any	Any	Yes
	Local	Any	Permanent	Any	Yes
		Any	Long-term	Any	Yes
		Frequent to Continuous	Medium-term	Any	Yes
		Rare to Continuous	Short-term to Medium-term	Any	No
Medium	Regional	Any	Medium to Permanent	Any	Yes
		Frequent to Continuous	Short-term	Any	Yes
	Local	Frequent to Continuous	Long-term to Permanent	Any	Yes
		Rare to Infrequent	Long-term to Permanent	Any	No
		Continuous	Short-term to Medium-term	Any	Yes
		Rare to Frequent	Short-term to Medium-term	Any	No
Low	Regional	Frequent to Continuous	Long-term to Permanent	Any	Yes
		Rare to Infrequent	Long-term to Permanent	Any	No
		Any	Short-term to Medium-term	Any	No
	Local	Any	Any	Any	No

4.21 IMPACT ASSESSMENT

The impact matrices provided in Appendix B, which were developed for each VEC and VSEC, examined the project according to project components and activities for each phase of project development. As per the Terms of Reference, the focus of these matrices was on *significant impacts*.

4.21.1 Project Components & Activities

Sections 4.21.1.1 to 4.21.1.15 of the Terms of Reference are discussed in Sections 4.10 and 4.11 in conjunction with the physical and biological environmental components. This structure was adapted to avoid unnecessary duplication, facilitate ease of understanding, and preserve an ecosystem-based approach to the impact assessment and individual project components. For specific information on the impact of project components and activities, please refer to the impact matrices in Appendix B.

4.21.2 Physical & Biological Environmental Components

4.21.2.1 Landscape & Terrain

Impacts to the landscape and terrain include possible disturbance to the active layer, ice lenses, permafrost, and taliks. There are both non-project and project components that could affect these four features during various phases of project development. These components are described below.

Non-Project Components

Seismicity (Construction, Operation, Closure) – The project is located in an area of low seismicity (see Table 4.18 and Figure 4.39). The design of structures will take into consideration current building standards for earthquake-resistant design.

Table 4.18: Peak Horizontal Ground Accelerations for Meadowbank Site

Return Period of Seismic Event (years)	Peak Horizontal Ground Acceleration (g)
100	0.018
200	0.025
475	0.034
975	0.044

Source: Seismic Risk Calculation for Meadowbank project Site, Geological Survey of Canada, Natural Resources Canada.

Existing conditions / stability (Construction, Operation, Closure) – Rock- and soil-related terrain instability is a minor concern in the Meadowbank project area. Although permafrost will degrade in certain areas, for the most part the permafrost is “dry,” and has low ground ice content. The exception is the wetlands occupying lowlands adjacent to lakes and ponds. Here excess ground ice is present and thaw instability is foreseeable. These impacts can be managed using currently accepted permafrost engineering practices as part of dike construction, drawdown and rewatering of lakes, pit development, and waste rock facilities and tailings storage facility construction and closure.

Project Components

Project components and/or activities in the mine plan that could have an effect on the landscape and terrain, and which may require mitigation, include: (1) dewatering, (2) rock storage facilities, (3) tailings storage facilities, (4) dikes, (5) ditches, (6) heated buildings, and (7) rewatering. These are described below according to project development phase.

1. *Dewatering (Construction)* – Shoreline wetlands and some inflowing streams will be affected by lowered water tables, which will cause nearby active layer thicknesses to increase. As wetlands are associated with excess ground ice, some combination of thaw subsidence, local thaw instability and sediment production is expected. The effects are expected to be short lived, spanning construction, but quickly stabilizing during construction or early operations. If mitigation is needed, effective methods are available. Silt fences can be used to control the movement of fines into the remaining lake water or ponds. Drawdown pumping can be curtailed. Clarification ponds can be constructed in diked off portions of the lake bottoms, including the use of natural obstructions and closed depressions on the lake bottoms. Other measures involve the placement of a stabilizing rockfill, commonly in conjunction with a geotextile, thus insulating the thaw unstable area and slowing the rates of thaw and sediment production.

2. *Rock Storage Facilities (Operation)* – Construction of the rock storage facilities is expected to be straightforward except for a few isolated locations where foundations comprise wetlands. Special construction control measures are available to limit impacts. The internal temperature is expected to become superchilled and freeze, which will limit internal drainage as infiltrating runoff becomes frozen. The internal temperature will be monitored during operation so that the final topographic configuration and capping thickness can be optimized.

3. *Tailings Storage Facilities (Operation, Closure)* – Ice is expected to become entrapped during placement and freeze-back of the tailings. Up to 30% has been allowed, but actual amounts will not be known until operations commence. This would result in the final height of the tailings surface being about 3 m higher than the final tailings surface without ice entrapment.

The tailings storage facility will be progressively reclaimed during mine operation with a nominal 2 m thick cover layer of acid buffering ultramafic rock. After closure, the active layer will be confined within the capping layer. Based on modelling, the underlying tailings are predicted to freeze. The thermal regime of the tailings will be monitored during operations to confirm modelling predictions, and the proposed closure plan modified based on the actual site conditions.

Thermal modelling suggests that the tailings will freeze in the long term, and that the talik below Second Portage Arm will freeze before seepage from the tailings impoundment reaches groundwater below the permafrost or Third Portage Lake (closure). Therefore, the potential for deep groundwater contamination to occur as a result of seepage from the tailings impoundment is considered to be low. Ground temperature monitoring will be undertaken during operations and closure to evaluate the predicted freeze-back conditions.

4. *Dikes (Operation)* – The proposed tailings dike is needed to contain within the tailings facility approximately 22 Mt of tailings. Aggradation into and preservation of permafrost in the core and upstream (tailings) side of the dike is a key aspect of the design concept. Both steady-state and transient thermal modelling for the post-closure indicate that the dike will be an effective thermal barrier between the Third Portage Lake and the tailings, even with Third Portage Lake waters in contact with the downstream side and even when climate change warming is considered. Monitoring of ground temperatures and sub-permafrost pore pressures in the dike and its foundation will be undertaken during operation and post-closure to ensure that freeze-back and grouting are effectively mitigating groundwater flow between the tailings storage facility and Portage pit / Third Portage Lake.

5. *Ditches (Operation)* – Ditches will cause local degradation of permafrost. Attempts will be made to avoid crossing ice-rich areas where thaw instability is a concern. A variety of mitigation measures is available where ice-rich areas cannot be avoided.

6. *Heated Buildings (Operation)* – Heated buildings have the potential to thaw permafrost, causing instability where ground ice is present. The plant site has been located in an area where “dry” permafrost conditions are expected; however, a range of mitigation alternatives is available to limit or prevent thaw, as required by unexpected ground ice conditions.

7. *Rewatering (Closure)* – Rewatering or flooding of affected portions of Third Portage Lake as well as Vault and Phaser lakes has the potential to cause impacts. Rewatering rates will be controlled through the incorporation of engineered structures into the detailed design of the dikes. As the water levels rise, new permafrost on the previous lake bottoms will degrade. Although this loss is considered a low impact, it may result in localized mud-line instability and/or elevated sediment entrainment. This condition is expected to be both very localized and short-lived, and mitigation measures are available.

Rewatering of the Vault pit will flood areas previously underlain by permafrost and will create a through-going talik over the course of many centuries. The impact is considered low because water chemistry is expected to reach background standards relatively quickly and the through-going talik will be similar to taliks under most large nearby lakes, including that of Second Portage and Third Portage lakes where the rewatered Portage pits are located.

The shoreline of the affected portion of Second Portage Lake (i.e., between the Tailings and East dikes) will experience approximately a 1 m higher water level than the baseline elevation of 133.1 masl, as it becomes part of Third Portage Lake.

4.21.2.2 Air & Noise

Air

The following air quality issues are of primary concern: emissions resulting from combustion of diesel fuel in the power plant and vehicles including nitrogen oxides, carbon monoxide, sulphur dioxide, and particulate matter; and fugitive dust emissions from tailings, overburden and waste disposal, and process operations (including ore hauling).

<u>Diesel Fuel Emissions (Construction, Operation)</u>

A limited number of point emission sources will be present at the plant, the most significant being the exhaust stacks of the diesel power plant. Combustion of diesel fuel involves emissions of nitrogen oxides (NO_x) with most of the nitrogen oxide converting to nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), carbon dioxide (CO_2), water vapour (H_2O) and some small quantities of unburned hydrocarbons (HC), total organic compounds (TOC), particulate matter (PM), and other compounds. The project's maximum electrical demand is estimated to be 15.5 MW, which will be supplied by three diesel generators in operation with a fourth on stand-by. Table 4.19 shows the expected emission rate of contaminants from the power plant based on (U.S.) Environmental Protection Agency (EPA) (2000) emission factors.

Table 4.19: Emission Rate of Contaminants from the Power Plant

Compound	SO_2	NO_2	CO	CO_2	TOC	PM_{10}	$PM_{2.5}$
Emission Rate	0.54 g/s	63.0 g/s	14.4 g/s	3.04 kg/s	1.86 g/s	0.912 g/s	0.879 g/s

Various mining equipment and haul trucks powered by diesel engines will exhaust contaminants such as nitrogen oxides, volatile organic compounds, particulate matter (mainly small sizes, less than 10 µm (PM_{10}) and 2.5 µm ($PM_{2.5}$) of aerodynamic diameter), carbon monoxide, and carbon dioxide. The worst case scenario for emissions associated with materials transportation will involve hauling ore from the Vault pit to the processing plant approximately 7 km away. To calculate exhaust emissions, it was estimated that the project would use 11,200 m^3/a of diesel fuel with approximately 250 ppm sulphur for mobile sources (trucks). The emission factors compiled from the US EPA AP-42 (1997) were used for the estimates shown in Table 4.20. Suspended particulates (SP) and particulate matter ($PM_{2.5}$) are the sum of haul truck exhaust emissions and wheel entrainment dust emissions.

Table 4.20: Mobile Sources – Total Emissions

Compound	Emission Rate
Suspended particulates (SP) ≤30 µm	62.93 g/s
Particulate matter ≤2.5 µm ($PM_{2.5}$)	3.08 g/s
Methane (CH_4)	0.076 g/s
Nitrogen oxides (NO_x)	2.93 g/s
Sulphur dioxide (SO_2)	0.17 g/s
Volatile organic carbon (VOC)	0.03
Carbon dioxide (CO_2)	1.065 kg/s
Carbon monoxide (CO)	2.69 g/s
Nitrous oxide (N_2O)	4.69 mg/s

Other potential sources of emissions are the milling and materials handling operations, although no particulate matter is anticipated from these wet streams. Potential dry PM emission sources include the truck dump bin vent, primary crushing, ore stockpile, pebble crushing plant, and furnace. Plant design specifies installation of dust control equipment that will depress emissions of PM to the ambient air for all these sources.

Fugitive Dust (Construction, Operation)

The main sources of fugitive dust at the project site will include stockpile wind erosion, the tailings area, and the waste rock disposal facility. Fugitive dust from the coarse ore stockpile will comprise emissions from conveyor ore drop at the top of the pile and wind erosion. Estimated conveyor emission of suspended particulates (< 50 µm) will be 0.1139 g/s and the fugitive dust loss from the stockpile due to wind action for particulates <30 µm will be 0.031 g/s. Exposed surface layers of tailings containing fine grain particles of wastes discarded from the gold ore processing are subject to regular erosion by wind and water. Prediction of fugitive dust emission caused by wind erosion has been conducted for estimated areas of tailings beach that may be exposed at specific times during the operation of the proposed Second Portage Lake tailings facility. The specific time periods considered are at the end of Years 3, 5, and 7. Predicted emissions of particulates <30 µm (PM_{30}) would vary from approximately 5.6 kg/h in Year 3 to 9.3 kg/h in Year 7. Three distinct source activities within the disposal cycle can cause dust emissions from the waste rock disposal site: equipment traffic in storage area, waste aggregate unloading (handling), and wind erosion of pile surfaces and ground areas around open rubbles. Estimated fugitive emissions induced by wind erosion from the waste disposal area (approximately 0.9 km^2) will be approximately 108 kg/d during dry and windy weather. Waste disposal traffic will generate 1,347 kg of dust daily during dry weather, regardless of wind speeds. Dust emissions from road travel between the mining sites and the processing plant will cause dust entrainment by vehicle wheels and the wake created by moving vehicles. This source will be the largest contributor to all dust emissions at site. The daily dust emissions will be 5,382 kg. This includes mitigation by 29% due to days with measurable precipitation.

Dispersion Modelling (Construction, Operation)

Dust and gaseous contaminants will disperse in the atmospheric air. Their permissible concentrations are regulated by Canadian, provincial, or territorial ambient air quality objectives or guidelines (AAQO). The ground level concentrations of particulates, sulphur dioxide, nitrogen oxides, and carbon monoxide were predicted by dispersion modelling. Such modelling is a widely accepted technique for predicting the effect of air emissions on the environment.

The modelling results for the point sources and mobile sources combined, including road dust generated by haul trucks, shows compliance with AAQO for all contaminants, except particulate matter (PM_{10} and $PM_{2.5}$). Such a situation can be expected during the dry weather when continuous ore hauling on the dirt road is taking place. Commonly used mitigation techniques include road watering, use of chemical dust depressants, or road surface hardening. These measures would reduce dust concentrations to acceptable levels. Dispersion modelling of fugitive dust originating at the coarse ore stockpile, tailings area, and waste rock disposal facility showed compliance with all applicable ambient air quality objectives.

Secondary air pollutants, including sulphur compounds, nitrogen oxides, and ozone are feasible within the project air shed. When released to the atmosphere with truck exhaust or diesel plant emissions, NO_x might enter into a series of chemical reactions with air components. Nitrogen chemistry is driven by the photochemical dissociation of nitrogen dioxide (NO_2), but the products formed depend on other substances able to react with the photochemically excited NO_2 molecules, especially with atmospheric ozone (O_3).

Anthropogenic ozone creation is engendered by photochemical reactions between oxides of nitrogen and volatile organic compounds in the presence of favourable meteorology. Appreciable ozone creation tends not to occur unless atmospheric temperatures are high (> 30°C). The atmospheric conditions in Nunavut tend not to be conducive to ozone creation because high atmospheric temperatures are rare and extremely low temperatures of the atmosphere are common. In addition, absence of industrial facilities inhibits creation of anthropogenic ozone.

Greenhouse gases (GHG) such as carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) are produced during fuel combustion in diesel engines. Nearly all of the fuel carbon is converted to CO_2 during the combustion process. Formation of another greenhouse gas, carbon monoxide (CO), will also take place, but its amount is insignificant compared to the amount of CO_2 produced. Considering that the total use of the diesel by the project will be 40,000 m^3 annually, the GHG emissions were calculated to be 190,768 tonnes per year as CO_2 equivalent. The 2000 estimates of greenhouse gas emissions in Canada are 726,000,000 tonnes (Environment Canada, 2001). Therefore, the GHG emission estimates will be merely 0.026% of the total Canadian emissions based on 2000 statistics.

The impact of air disturbance on plants and wildlife will be low because of mitigation efforts. A monitoring program will be implemented to ensure the effectiveness of these techniques.

Noise (Construction, Operation, Closure)

Anticipated noise levels for the Meadowbank project were modelled using industry standards and the best available noise prediction models. The model output showed elevated, over 70 dBA, sound levels approximately 600 m from noise sources. Noise levels close to the sources would be between 70 and 80 dBA.

This estimate is based on a worst-case scenario in which all noise sources simultaneously contribute to the overall noise level. In some industrial districts the daytime noise level at 70 dBA and the nighttime level of 65 dBA are allowed. The 70 dBA noise is significant when compared to the low-level baseline noise at the project area. However, it is comparable with noise levels generated by industrial facilities.

Noise generation at site will fall into three categories: instant, intermittent, and continuous. Mining activities such as blasting and operation of the primary crusher and mills will be the main sources of noise. The ore processing and gold recovery plant will generate continuous noise associated with ore crushing, grinding, and power generation. Noise due to vehicular movement will be intermittent, but will add to the background noise levels. Air traffic noise related to fixed- and rotary-wing aircrafts will be present on an irregular basis and will be of short duration. Therefore, no consideration is given to aircraft traffic noise in this assessment.

Construction & Closure Phases

During the early site preparation and construction phases of the project, different types of construction equipment would be utilized. This equipment could include a number of machines and devices varying in physical size, horsepower rating, and mode of operation. Consequently, the noise produced can be expected to vary widely. Even for equipment of a single model, variations in sound level at a fixed distance can be expected.

Construction activities would proceed through a number of phases. Each construction phase would have both generic and phase-specific noise sources associated with it. Construction noise emissions are expected to occur during levelling and grading, vehicle/heavy equipment traffic, excavation, pile driving, concrete pouring, steel erection, mechanical installation, and commissioning and start-up. The predominant sources of construction equipment noise are associated with internal combustion engines and impact construction equipment. Expected noise levels would be from 80 to 100 dBA at 15 m.

Operation Phase

When the Meadowbank plant commences operation, the major noise sources will be located at the following three main process areas: crushing, powerhouse, and processing facility. The highest noise levels will be generated by the primary crusher, SAG mill, ball mill, and auxiliary facilities such as the conveyer and haul truck unloading bay. Other noise sources will include front-end loaders, diesel-powered generators, pneumatic valves, compressors, emergency equipment, relief valves, air coolers, small pumps, and service vehicles. The plant operations, such as leaching, refining, cyanide destruction, and electrowinning will be relatively quiet.

4.21.2.3 Water Quantity & Quality (Construction, Operation, Closure)

Water Quantity

To assess water quantity and balance, normal or typical seasonal changes were compared with project-related changes, and then the potential for these changes to cause adverse impacts to other

VECs (e.g., fish habitat) was determined. This assessment focused on the construction and operation of the dikes and pits because these components have greater potential to affect water level, flow, and circulation in the project lakes than other activities.

There are three key issues during **construction** that can potentially impact water quantity. These are described below:

1. Impacts of dike construction on water flow – Construction of the East dike and Bay Zone dike will isolate and eliminate the westernmost and primary connecting channel (i.e., 50% of current flows) between Third Portage and Second Portage lakes. Without mitigation, the natural flow outlet from Third Portage Lake would be constrained, causing higher water levels in Third Portage Lake and increased discharge through the remaining two channels, and possibly overtopping and erosion during spring freshet, and impairment of fish passage. Dewatering of the west arm of Second Portage Lake would exacerbate this problem.

Construction of the Vault dike will isolate Vault Lake from Wally Lake and eliminate discharge from Vault Lake into Wally Lake during mine operation.

To mitigate the loss of the westernmost connecting channel between Third Portage and Second Portage lakes, one of the existing channels will be modified to handle increased flows so that similar discharge relative to current conditions occurs. The new channel will also improve fish passage to Third Portage Lake, thereby increasing fisheries values.

2. Impacts of dewatering impoundments on water balance – Lake areas impounded behind dikes during construction will be dewatered prior to pit development. Second Portage Lake behind the East dike will be drawn down by 28 m to allow construction of Portage pit, and 12.2 Mm^3 of water will be pumped from Second Portage Lake to Third Portage Lake. This will approximately double the total annual average discharge from Third Portage Lake (11.6 Mm^3) and is equivalent to an increase in volume of 5.4% and lake level of about 50 cm. Potential adverse impacts are unlikely to result in significant adverse impacts to fish habitat since lake level increases fall within natural fluctuations and shorelines consist of large boulders or bedrock and are ice scoured and very resistant to wave energy. If dewatering occurred during a wet year, there may be some inundation of vulnerable shorelines. With modifications to one of the channels between Third Portage and Second Portage lakes, lake levels would decrease further and potential impacts reduced.

The projected discharge from Second Portage Lake into Tehek Lake could increase from between 18% to 27% relative to current conditions, thus adverse impacts to stream channel integrity is expected to be negligible.

Dewatering of the Bay Zone and Vault Lake involve relatively small water volumes, therefore significant adverse impacts to water quantity, fish habitat, or populations in receiving lakes are not likely to occur.

3. Impacts of Turn Lake culvert installation – 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). The size of the culverts are sufficient to pass 1:100 year flood events, increased discharge due to dewatering of Phaser Lake into Turn Lake, and will not impair water movement out of Turn Lake, nor upstream fish movement. An alternative to using culverts would be the installation of a short-span logging-style bridge. Overall impacts to water flow and Turn Lake water levels are expected to be negligible.

Four key activities during **operation**, such as construction and dewatering of Goose Island Zone, and effluent discharge and freshwater intake from Third Portage Lake, will have the potential to affect water quantity. Changes in water balance due to diversion of contact and non-contact water are also considered. These activities are described below:

1. Impacts on water balance of dewatering Goose Island zone – The estimated maximum increase in Third Portage lake elevation from dewatering the Goose Island zone is approximately 4 to 5 cm, which is well within typical annual changes in lake elevation (20 to 50 cm), thus no adverse impacts to fish habitat or fish populations are expected. The Goose Island dike will alter water circulation pattern within Third Portage Lake; however, this change is relatively small and will have negligible impact on water quality, fish habitat or fish populations.

2. Impacts on Turn Lake of Phaser Lake diversion – The estimated annual drawdown of approximately 1 m and discharge to Turn Lake is not anticipated to affect water balance in the Drilltrail and Second Portage lakes system.

3. Impacts of consumptive use of freshwater – Annual consumptive volume, assuming a continuous rate of 160 L/s is approximately 0.5 Mm^3 or 0.2% of the total volume of Third Portage Lake on an annual basis. Most of this volume will be redirected back to Third Portage Lake via the Second Portage attenuation pond up to Year 5; therefore, no significant impacts to water balance are anticipated.

4. Impacts of effluent discharge on water balance – Effluent will be discharged from the attenuation pond in Second Portage Lake to the north basin of Third Portage Lake and from the Vault attenuation pond to Wally Lake only during the open water season. Effluent volume discharges to Wally Lake (0.9% of the volume of the Wally and Drilltrail lakes), and to Third Portage Lake north basin (0.9% of total lake volume), are expected to have a negligible effect on water balance on the receiving lakes, particularly since much of this water consists of contact and non-contact water that would normally enter the lake, except that it is first directed towards the attenuation pond to reduce suspended solids.

Effluent is only discharged to Third Portage Lake until Year 5. After that time, it is directed towards Goose Island Pit for in-situ treatment if necessary.

The most significant activities during **post-closure** related to surface water is the rewatering of the Vault, Goose Island, and Portage pits and expansion of Third Portage Lake. These are discussed below.

1. Impacts of pit rewatering on lake levels & discharge patterns of contributing water bodies – During the later stages of operation and during abandonment and reclamationthe Portage and Goose Island pits will be rewatered (in the order of 45 Mm^3) over several years and eventually become part of Third Portage Lake. Since instantaneous breaching of the dikes would cause a significant drawdown of Third Portage Lake, rewatering will be achieved by a combination of seepage, precipitation, and partial re-direction of annual freshet flows from Third Portage Lake over several years. Once flooding is completed, the overall lake surface and volume of Third Portage Lake will have increased, while lake surface and volume of Second Portage Lake will have been significantly reduced. The Vault pit (21.5 Mm^3) will also be rewatered over several years primarily through redirected freshet flows from Wally Lake. Since the drawdown of Third Portage and Wally lakes will not affect lake levels and falls within annual fluctuations, there are negligible adverse impacts to water balance in contributing lakes. Discharge of water between lakes will be reduced for a period of years, however this is not expected to result in adverse impacts as opportunity for fish movement between lakes will be unaffected.

2. Impacts to water circulation of altering lake morphometry – After closure, the size of Third Portage Lake will have increased to include both the Goose Island and Portage pits and associated impoundment areas. The residual area of the deep portions of Goose Island and Portage pits will resist mixing and become a depositional area for sediment. Altered morphometry of Third Portage Lake east basin will cause different wind-driven mixing patterns in the lake, although this change is not expected to significantly alter fish habitat, turnover rates, or other limnological conditions (e.g., temperature/oxygen profiles, circulation).

Altered morphology of Second Portage will significantly increase turnover rate within the lake, although gross circulation patterns will not be changed and no adverse impacts to water quality, fish habitat, or populations are expected.

Shoreline morphometry, surface water circulation, and discharge in Vault Lake will be similar in post-closure as current conditions, although residence time will increase because of greater lake volumes associated with the Vault pit. The magnitude of morphological change to Vault Lake is small to moderate and is not expected to adversely affect water quality, fish habitat, or populations.

Water Quality

The ambient or baseline water quality in receiving environment lakes in the Meadowbank area is very high, with all conventional and metals concentrations (except lead and cadmium) below CCME guidelines for the protection of aquatic life (CCME, 2001). Maintaining good water quality is an important goal to which Cumberland will be committed throughout the life of the mine.

Mine activities with the potential to adversely affect water quality in receiving environment lakes include: sediment introduction during dike construction, leaching of metals during dike operation, and discharge of metals in effluent. All other activities (e.g., operation of roads and airstrip, mine site runoff, waste rock storage facility) are not predicted to adversely affect water quality in receiving environment lakes during operation, construction, or post-closure.

During mine **operation**, discharged will occur from two sources: from Vault Lake attenuation pond to Wally/Drilltrail lakes, and from Second Portage attenuation pond to Third Portage Lake North Basin. After initial de-watering of Vault Lake, annual discharge from the Vault attenuation pond is small (0.01 m^3/s, open water season only) and consists of non-contact runoff, pit inflow water, and seepage from the Vault rock storage facility. No treatment is required and water quality in Vault/Drilltrail lakes is not predicted to exceed CCME (2001) criteria. This discharge will be monitored as per MMER. Discharge from Second Portage attenuation will consist of contact (runoff collected by ditches and non-contact water and is not predicted to adversely affect water quality. Later in the mine life, the attenuation basin will become the reclaim pond, and attenuation storage will take place within the inactive Goose Island pit. Runoff volumes from the Portage rock storage facility are expected to be low, and can be managed in the reclaim pond if necessary. Site water will be collected at the plant site sump, and re-directed to the Goose Island pit through existing piping. The quality of attenuation pond effluent is predicted to meet MMER for conventional parameters, metals, and cyanide; it will also meet freshwater CCME for most constituents (Appendix E). After the Goose Island, Portage, and Vault pits have been mined out, they will be gradually reflooded. Goose, Portage and Vault pit lake water quality is predicted to meet MMER and freshwater CCME for the majority of constituents (Appendix E); the dikes will not be breached until pit water is of acceptable quality.

The mass loading of constituents to Third Portage Lake is predicted to increase slightly in the first four years of operation from discharge of mine contact water, however the quality of Third Portage lake water is predicted to continue to meet freshwater CCME with the possible exception of cadmium[1] (cadmium was largely undetected). After this time, mine contact water will be directed to the reclaim pond and Goose Island open pit and discharge is expected to be minimal.

Exceedances of CCME criteria do not necessarily mean that adverse effects on aquatic biota will occur. The Environmental Effects Monitoring (EEM) program is designed to detect adverse effects in effluent using toxicity testing and in the receiving environment using benthic community and fish population assessments. Thus adverse effects will be detected and alteration to water treatment will be made if necessary to eliminate adverse effects. Receiving environment water quality will at all times be safe for wildlife (geese, ducks, caribou) and humans at all stages of mine development. Tables showing the maximum predicted water quality concentrations are provided in Appendix E.

4.21.2.4 Vegetation / Terrestrial Habitat (Construction, Operation, Closure)

A comprehensive analysis of the environmental effects of the proposed mine development on vegetation cover is provided in the Terrestrial Ecosystem Impact Assessment. In the LSA, plant cover will be removed or altered due to clearing associated with infrastructure construction, development of waste rock piles, or abrasion caused by vehicle traffic and large structures being dragged over the land. Plant health can be affected by grading, salt application, and dust deposition associated with road use and maintenance. Dust deposition can also lead to early snowmelt, and thus, early flowering in some plant species. The release of grey water or other nutrients from camp operations could also potentially affect plant health and lead to a shift in plant community structure from heath tundra to grass communities. All of the above activities will have impacts on the vegetation cover that will have to be mitigated.

[1] Although cadmium was largely below detection limit in lake water, the nominal amount of cadmium assumed to be present in lake water for modelling purposes resulted in a predicted exceedance to CCME guideline.

The overall terrestrial habitat losses at the main mine site (includes Vault) are estimated to be approximately 703 ha or 4% of terrestrial habitats available in the LSA (see Table 4.21). The Sedge unit will be subject to the greatest alteration within the mine site LSA with 161 ha (i.e., 4.1% of Sedge habitat in the mine site LSA) being altered (Table 4.21). Terrestrial habitat losses along the all-weather access road are estimated to be 282 ha with Heath Tundra subject to the greatest alteration (107 ha; ~<1% of this habitat available within the Access Road LSA).

Table 4.21: Quantified Habitat Losses in the Meadowbank LSA

ELC Unit	Mine Site	Access Road	Total Area
Water	226.02	225.47	0.55
Sedge	182.26	160.84	21.42
Birch & Riparian Shrub	120.04	78.07	41.97
Heath Tundra	156.03	49.22	106.81
Lichen	124.39	67.02	57.37
Lichen-Rock	43.53	28.89	14.64
Ridge Crest / Esker / Avens	8.69	0.08	8.61
Rock & Boulder	118.43	93.72	24.71
Disturbed	2.88	0	2.88
Residual	2.88	0	2.88
Total	**985.15**	**703.31**	**281.84**

Vegetation in the immediate vicinity of construction sites will receive deposition of fugitive dust, primarily in downwind areas. As the prevailing winds in the region are northwesterly, the major impacts of dust will generally be on plant communities to the southeast of the mine facilities or other source of dust disturbance (e.g., roadways). Results from modelling, air monitoring, and snow surveys indicated that most dust particles will settle out within 100 m of the source. With or without mitigation, the residual impacts on the productivity of vegetation communities of dust generated by construction activities are not expected to be significant. Spills of gasoline, diesel, hydraulic fluid, or other deleterious substances can cause degradation to surrounding vegetation communities, generally in a very localized area. Mitigation measures will ensure that spills are avoided or contained and will not result in significant impacts to vegetation cover.

Much of the anticipated loss of ELC vegetation communities at the main site and along the all-weather access road will have already occurred before the operation phase begins. Further losses during operation will be associated development of the Vault area and the expanding waste rock dumps. Dust and emissions from the mine plant and associated facilities, as well as from road traffic, will continue to cause minor vegetation degradation and possibly increased contaminant levels during the operation phase.

Although progressive reclamation of the Portage rock storage facility and tailings storage facility will be undertaken during the operational phase of the mine, the **closure and post-closure** phase is the first significant opportunity to initiate major reclamation of areas. Removal of project facilities, reclamation of tailings and waste rock facilities, and the deactivation of roads and associated reclamation activities will result in the natural revegetation of many previously impacted areas of the project. The airstrip may be retained in a usable condition for long-term safety and future industrial activity. In the event the airstrip is decommissioned near the end of the closure phase, the disturbed area will be restored to its pre-development state and normal drainage patterns will be established to the extent practicable.

4.21.2.5 Wildlife

Appendix D contains a series of tables that summarize the high, moderate, and low suitability habitat loss during the growing season and winter in the LSA for each wildlife VEC below.

Caribou & Muskox (Construction, Operation, Closure)

A comprehensive analysis of the environmental effects of the proposed mine development on ungulates during the life of mine is provided in the impact matrices in Appendix B. At the mine site, an anticipated 239 ha (1.2% of total LSA area) or 4.2% of high suitability habitat (Sedge and Birch & Riparian Shrub) is expected to be lost due to mine development activities in the growing season. In the winter, an anticipated 145 ha (0.7% of total LSA area) or 3.0% of high suitability habitat (Heath Tundra, Lichen, Lichen-Rock, Ridge Crest / Esker / Avens) is expected to be lost. With overall losses less than 10% of the ungulate LSA, the overall magnitude of the impact is considered to be low and the unmitigated impact to be insignificant. When the ungulate-specific RSA is considered (i.e., mainland Nunavut and northern Maintoba and northern Saskatchewan), the impacts of habitat loss described above are very insignificant.

A similar analysis and conclusions regarding the impacts of habitat loss are provided for the all-weather access road in the Terrestrial Ecosystem Impact Assessment. As well, loss of habitat due to habitat effectiveness (or “zone of influence”) considerations is provided in the impact assessment report for not only Ungulates but all of the Mammal VECs. Even with “zone of influence” considerations, overall impacts to mammals remain low.

The primary potential effects of construction and operation activities on ungulates will be direct and indirect loss of habitat, avoidance of foraging habitat in and near areas of human activity (i.e., reduced habitat effectiveness), deflection from normal travel routes and energetic costs, health risk from drinking contaminated water from the tailings pond, possible injury or mortality from encounters with pits and other mine facilities, mortality due to collisions with vehicles or aircraft, contaminant loading from eating contaminated vegetation, and possible attraction of predators with increased local depredation rates.

Without mitigation, these impacts could have measurable impacts on ungulates utilizing the area. However, with mitigation (e.g., enforcing speed limits and giving caribou the right-of-way), residual impacts are anticipated to be of low significance.

Impacts to ungulates during the closure and post-closure phase will be reduced from impacts during the construction and operation phases. In general, a reduction in noise and activity and reclamation of waste rock piles, roads and other facilities will result in an improvement of habitat conditions.

Grizzly Bear, Wolves, Wolverines & Foxes (Construction, Operation, Closure)

A comprehensive analysis of the environmental effects of the proposed mine development on predatory mammals during the construction, operation and closure and post-closure phases is provided in the Terrestrial Ecosystem Impact Assessment and the matrices in Appendix B. Due to the relative rarity of bears and wolves in the area, however, hazards are deemed to be minor and the residual impacts will be of low magnitude and low significance.

In the growing season, an anticipated 161 ha (0.8% of total LSA area) or 4.0% of high suitability habitat (Sedge; Ridge Crest / Esker / Avens) is expected to be lost due to mine development activities at the main site. In the winter, an anticipated 49 ha (<0.1% of total LSA area) or 3.3% of high suitability habitat (Heath Tundra; Ridge Crest) is expected to be lost due to mine development activities. With overall losses less than 10% of the predatory mammal LSA, the overall magnitude of the impact is considered to be low and the unmitigated impact to be insignificant. When the predatory mammal-specific RSA is considered (i.e., 100 km radius or 3,140,000 ha), the impact of habitat loss described above is very insignificant.

The potential effects on predatory mammals from noise and activities related to construction will include avoidance of foraging habitat (reduced habitat effectiveness), deflection from normal travel routes, and energetic costs. Without mitigation, these impacts could have measurable impacts on predatory mammals utilizing the area. However, with mitigation (e.g., enforced speed limits, right-of-way to all predatory mammals), residual impacts are anticipated to be of low significance.

Potential effects from operation due to roads, airstrip, and traffic will include mortality due to collisions with vehicles, reduced habitat effectiveness and habitat degradation due to dust and exhaust, and potential for increased contaminant loading in food sources. With or without mitigation, these impacts are not expected to be significant.

The fuel storage and explosives facilities during operation have the potential to contaminate or degrade the surrounding environment and increase contaminant loading in prey through leaks, spills, fires and explosions. The main impact of the other facilities would be habitat loss, disturbance, and reduced habitat effectiveness. Bears and wolverines may also be attracted to certain kinds of aromatic compounds, including oil products, typically oily rags and grease tubes, as well as aerosol cans and batteries.

The domestic waste disposal facility during operations may attract predators if waste is not properly disposed. Food and other camp wastes attract scavengers including grizzly bear, Arctic fox, and wolverine, increasing risk to human safety. Mortality of animals may occur if they are deemed to be problem.

Impacts to predatory mammals during the closure and post-closure phase will be reduced from impacts during construction and operation. In general, a reduction in noise and activity and reclamation of waste rock piles, roads and other facilities will result in an improvement during closure and post-closure. The domestic sewage and waste disposal facility, and kitchen and camp facilities may still have the potential to attract predators (especially grizzly bears and wolverines), with consequent threats to human safety, prey animals, and ultimately the predators themselves. Ongoing effort will be made in restricting hunting within the vicinity of the project site during closure and post-closure.

4.21.2.6 Birds

Raptors (Construction, Operation, Closure)

Due to the relative rarity of nesting raptors in the area, hazards are deemed to be minor and the residual impacts will be of low magnitude and low significance. In both the growing and winter seasons, an anticipated 78 ha (0.4% of total LSA area) or 2.3% of high suitability foraging habitat (Heath Tundra; Lichen-Rock) is expected to be lost due to mine development activities (see Appendix D). On a raptor-specific LSA basis (i.e., 1 km radius or 314 ha), the 78 ha of high suitability habitat lost due to mine development represents an impact of high magnitude and significance to local nesting populations of raptors. On a raptor-specific RSA basis (i.e., 50 km radius or 785,000 ha), the 78 ha of lost high suitability habitat represents <0.1% of the raptor RSA, an impact considered to be of low magnitude and insignificant.

A similar analysis and conclusions regarding the impacts of habitat loss are provided for the all-weather access road in the Terrestrial Ecosystem Impact Assessment. As well, loss of habitat due to habitat effectiveness (or "zone of influence") considerations is provided in the impact assessment report for all of the Bird VECs. Even with "zone of influence" considerations, overall impacts to birds remain low.

The densities of breeding pairs of birds preyed on by raptors observed during June 2003 breeding bird surveys indicate that the loss of 703 ha of ELC terrestrial vegetation communities at the mine site may affect several species, in particular: Lapland longspurs, horned larks, American pipits, rock ptarmigan, semipalmated sandpipers, and other passerine species. Since the habitats for these prey species are widespread within the LSA and RSA, the effects on the regional raptor populations are expected to be minimal. However, the local reduction in the prey base may have some impact on nesting raptors in the vicinity. Habitat losses for birds and small mammals will be 3.6% of the LSA and 0.14% of the RSA. The overall residual impact of the decrease in prey base on raptor populations is not expected to be significant.

Based on survey information to date, no raptor nesting sites will be impacted due to construction activities. The nearest known raptor nest site (an inactive peregrine falcon nest) was 2.5 km from the field camp. Optimal nesting habitats for breeding raptors are limited in the Meadowbank area due to the almost complete absence of cliff topography.

During the nesting season, human activity and noise may cause some disturbance and displacement of nesting raptors, resulting in increased energy expenditures and stress levels, and possibly reduced reproductive success and subsequent survival of young. Susceptibility to disturbance can vary between individuals and between raptor species. When breeding, raptors tend to be quite tenacious about their chosen nest site and are reluctant to abandon it. Provided the disturbance is not too intense or prolonged, raptors will generally return to the nest once the disturbance has ceased.

Habitat degradation due to dust, exhaust, and fuel spills during project operation has the potential to increase contaminant loading in raptor prey. Aircraft traffic poses a collision hazard to raptors, particularly in the vicinity of the airstrip, and raptor mortality may occur due to vehicle/bird collisions on the roads or collision and electrocution with powerlines. However, due to the relative rarity of raptors in the area, these hazards are deemed to be minor and the residual impacts will be of low magnitude and low significance. Potential effects from roads, airstrip, and traffic will include mortality due to collisions with vehicles and potential for increased contaminant loading in food sources. With or without mitigation, these impacts are not expected to be significant.

During the closure and post-closure phase, the cessation of traffic and reclamation of roads will reduce the fragmentation of habitats, and increase the availability of habitats for small mammals and foraging and roosting habitats for other breeding birds. Passerines and ptarmigan may be attracted to reclaimed road bed areas for roosting, foraging, and possibly nesting (once vegetation has become reestablished). Raptors which prey on these species risk increased exposure to contaminant loading in birds from road materials. This risk is, however, expected to be minimal. Although aquatic habitats at Second Portage Lake (i.e., used for tailings impoundment) will be permanently lost to shorebirds and waterfowl, flooding of the Portage and Vault pits at closure will result in new aquatic habitats for these species.

Waterfowl (Construction, Operation, Closure)

An anticipated 386 ha (2.0% of total LSA area) or 3.9% of high suitability waterfowl habitat (Water; Sedge) is expected to be directly lost due to mine development activities (see Appendix D). On an ELC unit basis, loss of high suitability habitats includes 225 ha of lakes or ponds and 161 ha of Sedge. On a waterfowl-specific LSA basis (i.e., 1 km radius or 314 ha), the 386 ha of high suitability habitat lost due to mine development represents an impact of high magnitude and significance to local nesting populations of waterfowl. Despite this loss of high suitability habitat, waterfowl nesting surveys have indicated that few waterfowl nest in the Meadowbank vicinity. On a waterfowl-specific RSA basis (i.e., 50 km radius or 785,000 ha), the 386 ha of lost high suitability habitat represents approximately <1% of the waterfowl RSA, an impact considered to be of low magnitude and significance.

Most of the direct habitat losses for waterfowl caused by the mine development will occur at the mine site during the construction phase. Dewatering of portions of Second Portage and Third Portage lakes will likely have the greatest impact on waterfowl. However, the construction of the plant site (footprint), dikes, dewatering facilities, waste dump, airstrip, pits, and main roads (including all-weather access road) will cause a loss and disturbance of terrestrial and aquatic roosting, foraging, and nesting habitats. Apart from the direct loss of habitats due to alteration of terrain and vegetation, noise and activity during construction will result in the displacement and disruption of waterfowl and will reduce the effectiveness of their habitats. Disturbance of nesting birds can result in increased energy expenditures and stress levels, and possibly reduced reproductive success and subsequent survival of young. Residual impacts from disturbance are not expected to be significant.

Aircraft traffic during construction and operation poses a collision hazard to waterfowl and other bird species, particularly in the vicinity of the airstrip. However, the probability of this hazard to waterfowl is deemed to be relatively low, except perhaps during the migratory period when flocks of geese land to rest and forage. Aversion techniques will minimize potential interactions. Some waterfowl mortality may occur in summer through collisions with ground vehicles but such incidents are expected to be infrequent, involving few individual birds, and therefore of minor impact to local waterfowl populations.

Mine construction and operation can result in indirect impacts to waterfowl species. Plant health and bird forage can be affected by fugitive dust deposition associated with mining activities, road use, and maintenance. Fugitive dust deposition can also lead to early snowmelt and changes in plant phenology, resulting in early flowering in some plant species (Walker and Everett, 1987; Forbes, 1995). This may provide earlier foraging and nesting opportunities for waterfowl. The impacts of fugitive dust will mainly occur downwind of operations. As the prevailing winds in the region are northwesterly, the major impacts of dust deposition will generally be on plant communities to the southeast of the facilities or other source of dust disturbance.

By the operation phase, much of the anticipated habitat loss for waterfowl will have already occurred. There will continue to be a disruption of waterfowl and other wildlife occurring in the immediate vicinity of project facilities as a result of construction noises, blasting, operations, vehicle traffic, and machinery.

Development of the tailings facilities (Second Portage Lake) may attract waterfowl to the tailings ponds with elevated levels of contaminated water. Ingestion of contaminants from water may have adverse effects on the health and reproductive fitness of waterfowl, and in extreme cases may cause mortality of the birds. The health of waterfowl utilizing the mine site and environs will be difficult to determine directly because of their migratory and transient nature and the difficulty in obtaining samples for analysis; however a Screening Level Risk Assessment will be conducted to assess potential risks. A proactive management strategy is the best approach for avoiding these potential problems. The residual impacts of contaminant ingestion from the tailings pond will not be significant due to mitigation measures that will be implemented to minimize waterfowl exposure to contaminants.

During closure when the dikes are breached following reflooding of Portage and Goose Island pits, inundation of the adjacent terrestrial habitats will result in a minor loss and disturbance of potential roosting, nesting, and foraging habitat for waterfowl. However, flooding of the pits will result in new aquatic habitats for these species. Aquatic habitats dewatered to create the tailing storage facility at Second Portage Lake will be permanently lost to waterfowl.

Other Breeding Birds (Construction, Operation, Closure)

An anticipated 288 ha (1.5% of total LSA area) or 4.1% of high suitability habitat is expected to be lost due to mine development activities (see Appendix D). On an ELC unit basis, loss of high suitability habitats includes 78 ha of Birch & Riparian Shrub, 49 ha of Heath Tundra, and 161 ha of Sedge. On an other-breeding-bird-specific LSA basis (i.e., 500 m radius or 78.5 ha), the 288 ha of high suitability habitat lost due to mine development represents an impact of high magnitude and significance to local nesting populations of breeding birds. On an other-breeding-bird-specific RSA basis (i.e., 5 km radius or 7,850 ha), the 288 ha of lost high suitability habitat represents approximately 3.7% of the other-breeding-bird RSA, an impact considered to be of low magnitude and significance.

Most of the direct habitat losses for breeding birds caused by the mine development will occur during construction and operation of the plant site (footprint), dikes, dewatering facilities, waste dump, airstrip, pits, and main roads, causing a loss and disturbance of terrestrial and aquatic roosting, foraging, and nesting habitats. Densities of breeding bird species observed during the 2003 to 2005 breeding bird surveys indicate that the loss of a total of 478 ha of ELC vegetation communities within the mine site LSA will displace approximately 200 pairs (0.43 pair/ha) of Lapland longspurs, 60 pairs (0.12 pair/ha) of horned larks, 20 pairs (0.04 pair/ha) of savannah sparrow, 15 to 20 pairs (0.035 pair/ha) of rock ptarmigan, and minor numbers of other passerine species. Since the habitats for these species are widespread within the LSA and RSA, the effects on the total regional populations can be expected to be minimal.

Apart from the direct loss of habitats due to alteration of terrain and vegetation, noise and activity during construction will result in the displacement and disruption of other breeding birds and will reduce the effectiveness of their habitats. Disturbance of nesting birds can result in increased energy expenditures and stress levels, and possibly reduced reproductive success and subsequent survival of young. Ptarmigan, however, are often quite tolerant of human presence and several pairs have been observed in the vicinity of the Meadowbank camp. When sitting on a clutch of eggs, they can be very "broody," often allowing humans to approach extremely close to the nest (pers. obs.). Nevertheless, they may exhibit startle and flight responses to sudden noises (e.g., from blasting or low-flying aircraft). They may also avoid areas of frequent, intense, or prolonged disturbances.

Aircraft traffic poses a collision hazard to all bird species, particularly in the vicinity of the airstrip. However, this hazard is deemed to be moderate, infrequent, of short duration, and of potentially minor impact to birds. Some bird mortality may occur in summer through collisions with ground vehicles but such incidents are expected to be infrequent, involving few individual birds, and therefore of minor impact to local bird populations.

Mine construction and operation can result in indirect impacts to breeding bird species. Plant health and bird forage can be affected by fugitive dust deposition associated with mining activities, road use, and maintenance. These activities can lead to reduced plant photosynthesis and reproduction, retarded growth, and altered respiration processes. Fugitive dust deposition can also lead to early snowmelt and changes in plant phenology, resulting in early flowering in some plant species. Although this may provide earlier foraging and nesting opportunities for breeding birds, dust deposition on vegetation may have a negative effect on the birds, in that berry-producing species may be reduced. Early green-up in the vicinity of roads may attract species such as ptarmigan, increasing the likelihood of collisions with vehicles. The impacts of fugitive dust will mainly occur downwind of operations. As the prevailing winds in the region are from the northwest, the major impacts of dust deposition will generally be on plant communities to the southeast of the facilities or other source of dust disturbance. The effects of mine-generated dust on the productivity of vegetation communities, and consequently bird populations, is not expected to be significant, but will be assessed by conducting a Screening Level Risk Assessment.

Much of the anticipated habitat loss for other breeding birds will have already occurred by the operation phase. There will continue to be a disruption of birds occurring in the immediate vicinity of project facilities as a result of construction noises, blasting, operations, vehicle traffic, and machinery.

During closure and post-closure, the cessation of traffic and reclamation of roads will increase the availability of foraging and roosting habitats. Passerines and ptarmigan may be attracted to reclaimed road bed areas for roosting, foraging, and possibly nesting (once vegetation has become reestablished). In doing so, they risk increased exposure to contaminants in road materials. This risk, however, is expected to be minimal, but will be monitored. The removal and habitat reclamation of the fuel storage facilities at the plant site will reduce contaminant levels of the receiving environment in the vicinity of the discharge point.

4.21.2.7 Aquatic Organisms & Habitats

Construction & Operation

There are no rare or sensitive species within the project lakes that will be adversely affected by the proposed mine development. To protect fish populations during mine construction and operation, Cumberland is proposing a “No Fishing” policy for all non-resident workers. Based on sustainable harvest rates for the project lakes, fishing by aboriginal people will not result in a reduction in fish population status.

Potential impacts to aquatic organisms and habitats arise from changes to water quality, water quantity, and habitat loss. Project components and activities with the potential to have the greatest impact, as assessed in the impact matrices, are: (1) dikes, (2) loss of a channel connecting between the Portage lakes, (3) pit dewatering, (4) pit development, (5) noise and blasting, (6) effluent discharge, and (7) rock storage facilities. These are discussed below.

1. Dikes – Dikes considered include the East, Bay Zone, Goose Island, and Vault dikes. The cumulative direct loss of habitat as a result of dike footprints is 0.6% in Third Portage Lake, 1.9% in Second Portage Lake, and 0.1% in Wally Lake. The surface area of dike faces is very small relative to lake area and will have insignificant impact on lake productivity. Dike faces will be designed to provide high-value habitat for fish and will remain in place after mine closure as permanent features.

Compensation of dike footprint areas is considered as part of the no-net-loss (NNL) habitat compensation plan. Residual impacts from dike construction and operation are low in magnitude, local in extent, of short duration, and infrequent. Residual adverse effects are not significant.

2. Portage lakes connecting channel – One of three channels connecting Third Portage and Second Portage lakes will be eliminated by dike construction and operation, impairing fish movements. An existing channel will be enhanced to facilitate water movement and to improve fish passage between the lakes. Residual impact on fish is low in magnitude, local in extent, of short duration, and frequent. Residual adverse effects are not significant.

3. Pit dewatering – Dewatering of Second Portage pit will result in a loss of fish habitat within Second Portage Lake that is addressed as part of the NNL plan for the project. Discharge of water into Third Portage Lake north basin may cause an increase in lake elevation of about 50 cm and will increase flow from Third Portage Lake to Second Portage Lake via the remediated channel. Because water levels are being increased and not decreased, no adverse impacts on fish habitat or fish populations are anticipated. Fish will be salvaged by fishermen from Baker Lake prior to dewatering and used by the community.

Residual impacts to fish habitat and fish populations from dewatering of Portage, Bay Zone, Goose Island and Vault pits is low in magnitude, local in extent, of short duration, and infrequent. Residual adverse effects are not significant.

4. Pit Development – Operation of the Portage and Vault pits will result in the loss of productive habitat in Second Portage and Vault lakes during the life of the mine. The tailings storage area will be a permanent feature of Second Portage Lake. Although loss of habitat and fish biomass can be compensated through on-site activities (at post-closure), the temporary residual magnitude of impact to habitat and fish populations in Second Portage and Vault lakes during mine operation is high. The spatial extent of impacts on fish habitat and fish population in Second Portage Lake is local, of medium- (fish populations) to long-term (habitat) in duration, and will occur frequently. The residual effect is of local, but not regional, significance; and is short-term, because upon closure fish will be introduced into the new habitat. Spatial extent of habitat loss in Third Portage Lake is small relative to lake area and residual adverse effects are not significant. More detail about habitat loss in Third Portage Lake is considered within the NNL habitat report.

5. Noise & Blasting – Analysis of the construction and operation blast design indicated that impacts to fish from excessive peak particle velocity (13 mm/s PPV) and overpressure (100 kPa) can be controlled by appropriate blast design so that they will not occur and will meet the Fisheries and Oceans (FAO) Canada guidelines. Based on current blast designs an instantaneous overpressure of 50 kPa will not be exceeded, representing blasting during ice covered water conditions. Therefore, residual effects related to blasting will be low in magnitude, local in extent, of medium duration, and will occur frequently. Residual effects are not significant.

6. Effluent Discharge – Other than for sedimentation, no treatment is required for effluent discharged from Vault Lake attenuation pond to Wally/Drilltrail lakes since water quality is not predicted to exceed CCME (2001) criteria. Environmental Effects Monitoring under MMER will be implemented in Wally/Drilltrail lakes to ensure that adverse impacts are detected and mitigation undertaken if necessary. During operation, the quality of effluent discharged from Second Portage attenuation pond to Third Portage Lake is predicted to be within MMER concentrations for conventional parameters, metals, and cyanide, and well below CCME guidelines for most metals. An EEM program will be implemented in Third Portage Lake as part of a larger, more comprehensive program to monitor water quality, plankton, benthos, and fish populations (see Aquatic Effects Monitoring Plan (AEMP)).

7. Rock Storage Facilities – Storage of waste rock on largely upland, terrestrial habitat will not impact any fish bearing waters. All water coming in contact with the rock storage facility will be captured and directed to the reclaim pond.

Residual impacts of generic activities (for which there are proven mitigation and engineered solutions) include water intake, haulage route operation, marine barge landing and marine traffic, Turn Lake road crossing, and mine site infrastructure. These are not considered significant.

Closure & Post-Closure

Several mine components, such as dikes, pits, and tailings / rock storage facilities, without mitigation, could have adverse impacts on the aquatic environment during the closure and post-closure phase. These are described below.

<u>Dikes</u>

Dike design takes into consideration the possible locations and types of flood control structures that may be required to ensure long-term stability. 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. Oxidation of exposed 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 metals concentrations and lower pH within the pit waters. It is expected that the initial water will exceeded CCME guidelines, but will quickly improve based on empirical data from other mines. Thus, flooded dikes and pit walls will be a potential source of acid and metals to local waters at post-closure.

The Second Portage East dike will remain, preserving the 1 m difference in elevation between Third Portage and Second Portage lakes and creating habitat on the interior of the East dike. 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. Adverse effects would be expected to be limited to the initial period of pit/lake mixing, as oxidized materials will gradually be diluted, with no new oxidation because of flooded conditions. Metals toxicity will diminish rapidly, resulting in no net loss of productivity over the long term. Given the absence of food resources within the newly flooded pits, fish would initially avoid the dike/pit areas, preferring to stay in Wally or Third Portage lakes. Colonization of dike walls by periphyton and benthos may be impaired for several years following flooding. Also, because of their depth, the flooded pits will not provide productive habitat for fish over the long term, except 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.

<u>Pits</u>

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.

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 rate of flooding will be controlled by engineered structures incorporated into the detailed design of the dikes that may include spillway structures or side decant structures.

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 be removed when it is acceptable for water in Vault Lake to mix with Wally Lake.

As discussed previously, oxidation of rock walls over several years could lead to possible elevation of dissolved metals concentrations in pit waters immediately after flooding. The dikes will not be breached until the water quality meets acceptable discharge quality. 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. Monitoring will be undertaken to determine water quality in the pits prior to decommissioning.

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.

With respect to change in fish habitat in project lakes, there will be a net gain in habitat in Third Portage Lake and a net loss in Second Portage Lake, partly as a result of the exchange of lake areas between the two lakes, and because of habitat loss as a result of tailings disposal. It is the objective of the No Net Loss plan that there is no net loss of productive habitat as a result of the development, to conform with the *Fisheries Act*.

After flooding of pits and decommissioning of the southern end of Goose Island dike, most of the lake area impounded by the Goose Island dike will be returned to Third Portage Lake. Some of this habitat will be of low quality because of the great depth of the Goose Island pit. However, additional area will be gained from dike slopes, shorelines, original lake bottom, and the peninsula of land that used to separate Second Portage Lake from Third Portage Lake, which will have become part of the Portage pit. Finally, lake area between the tailings dike and the East dike, formerly part of Second Portage Lake, will become part of Third Portage Lake. 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. The additional volume (combined volume of North Portage, Portage and Goose Island pits) gained is approximately 44.6 Mm^3; minus the original dewatering volume within Goose Island (2.6 Mm^3), this represents a 18.4% increase in volume relative to the pre-mine lake volume estimate (228 Mm^3).

At post-closure, a considerable amount of habitat can be recovered within Third Portage Lake from the original lake area impounded as well as former land area between the Portage and Goose Island pits. With the exception of the pits, creating reef, shoal, and platform habitat of ideal substrate type, slope, complexity, and depth to provide spawning/nursery, rearing, and feeding habitat for fish within the entire flooded area behind the dikes will enhance this habitat.

Combined with operational habitat area, which will continue through post-closure, the total amount of residual moderate and high-value habitat created will exceed the total habitat lost from development of the Second Portage pit and tailings disposal facility, Goose Island pit and the Vault pit. The main reason for the overall gain in habitat value is that formerly low value habitat in Second Portage and Third Portage lakes and terrestrial areas (Goose Island, other small islands, peninsula separating the Portage lakes) will become high value aquatic habitat. In addition, finger dikes constructed along the outside of Goose Island dike will penetrate into deep, low value habitat in Third Portage Lake and create additional shelf and shoal habitat. This engineered habitat will be more productive and will provide spawning, rearing, and foraging habitat in an area of the lake that does not currently provide this habitat.

Although there will be an outstanding habitat deficit during operation, a net gain in habitat at post-closure will, over time, offset the net loss during mine operation. Re-flooding of Vault Lake and pit will significantly increase the area and volume of this lake. Pit walls and former shorelines will be contoured and designed to provide high value habitat for fish to several meters depth. There is currently very little deep, overwintering habitat in Vault and Wally lakes, so creation of deep water habitat may be viewed as positive.

Residual impacts on fish habitat and populations in the Portage lakes and Vault Lake are low in magnitude, local in extent, and permanent in duration. More habitat will be gained in Third Portage Lake than is lost within Second Portage Lake. Residual, long-term (i.e., post-closure) impacts are not significant and certainty of this is high.

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). Implications of this habitat loss are described in the subsection above. During the latter half of mine operation, progressive reclamation of the tailings facility will begin at the east end and will progress towards the west. A nominal 2 m thick cover of acid buffering ultramafic rock will be placed. The depth of annual thaw penetration will be confined within the 2 m thickness of cover material. The cover will be graded to promote drainage from the tailings facility. Capping is expected to be completed in Year 10.

Notwithstanding habitat loss, the potential for leaching of dissolved metals and acids into Third Portage Lake from the tailings facility is low, local in extent, of permanent duration, and occurs infrequently. Residual effects are not significant for either fish or habitat. Mitigation includes permafrost encapsulation of the tailings, and capping with acid buffering ultramafic rock. Certainty of this prediction is moderate.

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 develop in the rock storage facility and reduce infiltration and oxidation of rock. Leachate will be monitored during post-closure to ensure that water quality of surface waters of Vault and Phaser lakes are not impaired. It is anticipated that capping of the Vault rock storage facility will not be required. During operations, a monitoring program will be undertaken to evaluate the water quality predictions.

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.

4.21.3 Biological Diversity

Although the project will have localized effects on vegetation communities and associated wildlife species, the population viability of all species currently located in the LSA is not expected to be impaired. No local extirpations or local changes in biodiversity are expected because: (1) the project footprint is relatively small; (2) all species found within the LSA that may be impacted by the project are also widespread in the RSA; (3) no critical habitat for rare and endangered species or species of management concern has been documented; and (4) a comprehensive management plan will ensure that any impacts to local plant and animal species are minimized. Biodiversity and richness of local and regional flora and fauna will be maintained.

4.21.4 Social, Economic & Cultural Components

Baker Lake is the primary area of positive impacts. It is the closest community to the project site, and will receive preference for employment and business opportunities. Some benefits will also accrue to individuals and business elsewhere in Kivalliq Region and Nunavut.

4.21.4.1 Identification of Valued Socioeconomic Components (VSECs)

With the identification of key issues by the community of Baker Lake and other project stakeholders, and with understanding of socioeconomic status from baseline studies, it is possible to derive project-specific VSECs, as follows: employment, training, and business opportunities; traditional ways of life; individual and community wellness; infrastructure and social services; and sites of heritage significance. In addition, it is possible to identify two VSECs at the regional/territorial level: employment, training, and business opportunities; and fiscal benefits to the territorial government.

4.21.4.2 Socioeconomic Impact Assessment Methodology

The methodology to determine socioeconomic impacts largely drew from the wealth of traditional knowledge available to Cumberland through public meetings, workshops, discussions with Elders, site visits, interviews, and the community liaison office established in Baker Lake. While determination of socioeconomic impact significance broadly follows the methodology used for environmental impacts, there are important differences that are more fully described in the Socioeconomic Impact Assessment. These differences are summarized briefly below:

- direction (positive or negative) is an important attribute to include, as many socioeconomic impacts are in fact benefits
- reversibility does not often apply—there are few means to reverse social change that occurs as a result of a project
- socioeconomic impacts do not occur in a vacuum, but interact with an already evolving social context, thus can be unpredictable even in their direction—thus are often discussed in terms of potential rather than probability
- unpredictability often forces a more qualitative approach to assessing the significance of socioeconomic impacts
- regardless of measures that may be put in place to create conditions and opportunities for benefit, individuals and communities remain free to make choices. Poor choices can be made, people may choose not to participate, and/or other realities may intrude such that outcomes are not as foreseen.

4.21.4.3 Impacts on Employment, Training & Business

Cumberland intends to extend employment and business opportunities to the Hamlet of Baker Lake, and secondarily to other communities in Kivalliq Region, consistent with principles of cost effective, efficient, and safe operations. Cumberland will also assist the Hamlet and other communities in taking advantage of these opportunities. Finally, Cumberland will take into consideration the extent to which its suppliers and subcontractors employ and contract Kivalliq Region labour and businesses. These measures are more fully described in the Socioeconomic Impact Assessment.

Project Expenditures

Eventual employment and business impacts will depend on the success of these measures. Previous experience, through the exploration and feasibility phases of the project from 1995 to 2003, saw 23% of total expenditures spent within Nunavut. Most hiring was in Baker Lake, but business benefits were more widely spread in Kivalliq Region.

If at least 20% of expenditures were spent in the region over the lifetime of the project, there would be a total expenditure in Nunavut of over $224 M. This figure is made up of about $61 M during the 24-month construction phase, $20 M per year over a ten year operation phase, and a further $2.6 M over the closure phase. Such numbers should be interpreted with caution. For example, during the construction phase—with large capital expenditures outside the territory—a 20% target for local expenditures may not be achieved. On the other hand, over time, as a result of increasing experience of labour and business with the project, Cumberland should be able to significantly exceed a 20% target.

As project expenditures are comparatively large relative to the size of the regional and territorial economies, the impact is considered of medium magnitude, positive, long term and of moderate significance.

Employment

Over the construction period, labour force requirements will vary averaging 160 and peaking at 310. It is conditionally estimated that in the order of 25% to 30% of these jobs will require unspecialized skills (representing about 40 jobs on average). The workforce requirement for the operation phase is estimated at 370, and the demand for less skilled people will likely average 90. Semi-skilled and skilled workers would also of course be offered employment. Taking into consideration that labour force participation rates are likely to rise in the event of improved employment opportunities, Baker Lake should be able to supply the largest fraction of less skilled jobs.

The potential impacts of employment are likely to take some time to gain full momentum, and overall are considered of high magnitude, positive, long term and of high significance, specifically to those individuals and their families who are able to benefit.

Business Opportunities

The Conference Board of Canada (CBoC, 2001) and the territorial government (SEDS Group, 2003) have noted at length the challenges to businesses in Nunavut. The overall result is that there are not many businesses, they tend to be small and have high costs, and most are essentially catering to consumption needs of residents. Cumberland has worked with businesses in Baker Lake and elsewhere in Kivalliq Region over the exploration phase of the project, with some success. With continuing preferential contracting, local business participation in the project is expected to grow with time.

In addition to direct employment and business opportunities; however, indirect employment benefits and induced employment and business should also be considered. Businesses contracted to supply the project will require new employees. As well, with increasing direct and indirect local economic activity, individuals and businesses will be spending increasing incomes on local goods and services. This in turn will induce more employment, and perhaps more small businesses, as people in the community organize to provide additional goods and services demanded by others with new disposable income. There is, however, some potential for negative effects on individual businesses of labour force adjustments.

The potential impacts of business expansion and creation are likely to take some time to gain momentum, but overall are considered as of high magnitude, positive, long term and of high significance, particularly to those individuals and their families who are able to benefit. The impacts at the community level, of moderate significance, are most likely to be seen in Baker Lake and Rankin Inlet, but some stimulus to business will be felt across the region.

Education & Training

It is Cumberland's policy, as exemplified to date over the exploration and feasibility phases of the project, to provide on-the-job training to employees. Such training is intended both to improve skills towards improved job performance and promotion and towards broadening the skill base of employees such that new or strengthened skills can be applied elsewhere in the economy. Beyond on-the-job training, however, the IIBA negotiations between Cumberland and KIA will address the need for a broader based project education and training initiatives to assist those who wish to develop skills that will position them for project employment. This education and training initiatives will also include an element to address motivational issues around getting children through high school. Such measures would be intended to contribute to encouraging a commitment to education on the part of youth.

The potential impacts of education and training are considered of medium magnitude, positive, long term and of high significance, specifically to those individuals and their families who are able to benefit.

Increased Income

With the potential to employ 40 to 90 individuals directly over the construction and operation phases, the direct project wages paid to people in Kivalliq Region, primarily Baker Lake, could exceed $4 M annually. With additional induced employment creation, the expectation is that the increase in total wages paid in the community will be greater.

Increased income is broadly associated with increased individual and household wellness. There is thus potential for improved quality of life for the individuals and their families who are able to find employment with the project or with businesses that supply the project or elsewhere in the growing local economy.

The potential impacts of increased income are considered of high magnitude, positive, long term and of high significance, particularly to those individuals and their families who are able to benefit. It is expected that overall community effects, moderate in significance, are likely to be most experienced in Baker Lake, as most direct employment will occur here.

Project Closure

The closure phase of the project is projected to last over a two year period, and the post-closure phase for up to 25 years. Expenditures during closure for labour, goods, and services will be much reduced as compared to the operation phase, although reclamation activities can be more labour intensive. Further, at the end of the two-year closure phase, all expenditures, with the possible exception of very limited employment related to environmental monitoring during post-closure, will come to an end. It is also to be noted that project viability depends most importantly on the price of gold. Should this price drop significantly over the life of the project, or should other unforeseen events happen, temporary or long-term closure could occur.

Closure is the economic bust that is inherent in non-renewable resource extraction and can produce a reversal of positive economic and social benefits. This is considered a negative impact, of high magnitude particularly in Baker Lake, long term and of high significance.

4.21.4.4 Impacts on Traditional Ways of Life

The social, cultural, and economic importance of traditional ways of life to overall quality of life is fundamental and as such guides not only the content of government policy, planning, and service delivery, but also the mechanisms for developing and implementing policy.

The project has both positive and negative potential to change the patterns of traditional ways of life. The project will not significantly restrict access to or productivity of lands used for traditional activity. More indirect effects, however, are possible. There is concern that wage employment is a disincentive to traditional activity and that on-the-job cross-cultural contact may result in undervaluing of traditional ways of life. Cumberland's human resource policies, training programs, and codes of conduct for workers emphasize cross-cultural mutual respect, understanding, and trust, and provide incentive and opportunity for Inuit employees to engage in traditional ways of life. There is some evidence in the north that employment provides the resources needed to engage in traditional activity, for a positive effect.

At the community level, the mine site is located far from Baker Lake, and its out-of-area workers will be housed in workers' camps, rotated out to their own (northern and non-northern) communities on various schedules. Keeping out-of-area employees away from local communities minimizes cross-cultural contact, but there will nevertheless be an increase in contact in Baker Lake, largely associated with transportation activities.

There is potential for both negative and positive impacts, of any magnitude, on traditional ways of life, which could be of high significance. Any net impact, since it would be an impact of cultural change, would be long term and continue beyond the life of the project. The impact would be experienced primarily in Baker Lake.

4.21.4.5 Impacts on Individual & Community Wellness

Potential impacts on individual and community wellness are complex, far reaching, and given human nature, difficult to predict with certainty. Individual and community wellness is intimately associated with potential impacts on traditional ways of life as discussed above. In addition, however, individual decisions on the use of increased income, household management in relation to rotational employment, migration, public health and safety, disturbance particularly during the construction phase, and Cumberland's support for community initiatives are being negotiated in the IIBA are the other drivers that have the potential to effect individual and community wellness.

Increased Income

In addition to the expected positive benefits of increasing income, as this is related to improvements in a range of socioeconomic parameters, there are also potential downsides, experienced at the individual, household, and community levels. Essential to realizing the positive benefits of increased income is the capacity to manage that income in the interests of the household. Income that is not spent wisely does not generate the hoped for quality of life improvements.

There are concerns about the association between increased disposable income and poor choices, such as increased use of drugs and alcohol, or inappropriate sexual activity. It is possible not only to spend income unwisely such that potential benefits are not achieved, but to spend it in ways that cause actual disbenefit. Such disbenefits harm individuals and their families, and are a source of negative behaviour that harms the community as a whole.

A further concern is that steady employment and wages for some but not others in the community will contribute to income inequity, which in turn may contribute to social problems such as increases in crime and social conflict. The erosion of traditional values, such as cooperation and sharing, can also at least theoretically be linked to increasing inequity.

To better manage the effects of increased income and ensure that benefits are maximized and negative impacts minimized, Cumberland will initiate an employment support system to provide a full range of services to its employees.

The impacts of increased income at the individual, household and community levels, at any magnitude, are considered to be potentially both positive and negative, medium term and possibly of high significance.

Potential for Contamination in Traditional Food

Based on information gathered through traditional knowledge and baseline studies, the Meadowbank area is not often used for hunting and fishing. The potential for mine activities to contaminate the food chain—specifically fish and caribou—is minimal. However, because of importance of the *precautionary principle* and a commitment to protecting human health, in addition to mitigation activities, vegetation, water quality, and fish health will be monitored to ensure that fish, caribou, and other traditional foods are not affected by mining activities.

Rotational Employment

Much has been written on the potential impacts of rotational employment on the families and communities of employees. The positive impacts include reduced cross-cultural contact within communities, time and resources for traditional ways of life, and workforce discipline while on-the-job contributing to long-term capacity building. Negative impacts can include family stress, family conflict between generations and spouses, breakdown of traditional values of sharing and mutual support, undervaluing of traditional ways of life, and increased substance abuse. Baker Lake residents are also concerned that housing workers at a camp, especially female workers, can create opportunities for sexual abuse.

Many of these negative impacts are similar in nature to those generated by increased income, and depend not only on project organization but also on individual decisions and choices. They are therefore also influenced by mitigation measures described above. As well, much has been learned about best practice for workers' camps and rotational employment over the last twenty years in the north. Cumberland will apply this best practice, including protection for female workers, short rotational schedules, and transportation arrangements that return employees directly to the point of hire communities.

The impacts of rotational employment at the individual, household and community level are unpredictable, and of unknown magnitude, but potentially both positive and negative, medium term and could be of high significance, particularly at the individual level.

Migration

The mine site is remote from the community of Baker Lake, and will provide all workers at site with accommodation, meals, recreational facilities, social services, and transport in and out of their point of hire communities. The project will thus not involve the migration or movement into Baker Lake of workers themselves, with the possible exception of a very few out-of-area employees engaged at transport and storage facilities in the town.

Migration has some potential to occur as a result of members of Baker Lake resident families returning in the hope of employment at home and/or as a result of the economic pull such a project exerts as people try to move to the area to take advantage of indirect and induced economic benefits of the project. The return of family members, particularly those who are individuals who left only to find employment elsewhere, can be of great benefit to family welfare. They may, however, compete for and get jobs that would therefore be denied to present residents, place additional demands on social service delivery, and put pressure on local supplies of goods and services (particularly housing).

The potential impacts of migration are complex, and are likely to have both positive and negative components, but of low magnitude. Any effects of migration are long term but are likely to be low significance. It is not likely that migration to any other community than Baker Lake would be significant.

Health & Safety

It is of concern to the people of Baker Lake that out-of-area workers may pose a threat to public health and safety. There is an association between mining camps largely filled with men on single status and/or with increased income and such public health concerns as increased rates of sexual abuse, teenage pregnancy, single parenthood, sexually transmitted disease, substance abuse, and crime. It is this association that guides best practices in managing the behaviour of workers living in camps in proximity to small communities.

Health and safety of workers and the population at large is subject to legislation and perhaps more importantly to best practices. Health and safety training also has applications in personal life – workers often not only use new health and safety training on-the-job, but also at home in the course of daily tasks.

The potential public health and safety potential impacts of the project, of unknown magnitude, are negative, and, because there is such high impact at the individual level in the event that a risk is realized, the effects must be considered long term and of high significance.

Community Wellness

There is an expectation that, particularly since the largest part of mining project royalties are not paid to the territory directly, that a project such as this one provide benefits to most directly affected populations in addition to job creation and business opportunities. The NLCA and Terms of Reference for the Meadowbank EIS suggest expectations that project proponents work with local communities to identify contributions to community wellness. An additional factor to consider is that there are potential negative impacts on individuals and communities that can neither be clearly identified nor directly mitigated, for example: effects on traditional ways of life or effects of poor choices with respect to increased individual income, as discussed above. Support for community initiatives is therefore considered to be the means through which to enhance the net local benefit of the project.

4.21.4.6 Impacts on Infrastructure & Social Services

Negative infrastructure effects are largely related to any project demands on physical infrastructure such as roads, other transportation facilities, telecommunications, and utilities. Social services effects can result from increased demands on health, policing, education and housing services by new populations (workers and migrants) or on health and policing services particularly as a consequence of effects on individual and community wellness. Recent rapid population growth in Baker Lake has had particularly negative effects on the availability of housing, with consequent negative impacts on wellness. The concern with respect to such impacts is social service delivery to the local community will suffer in response to an increase demand that cannot be met, contributing to a vicious circle of more social problems and yet further increased demand. This in turn can imply that government will incur additional costs in increasing infrastructure and social services.

Meeting the operational needs of the project and the needs of large out-of-area workforces is part of the response to limiting pressures on the delivery of goods and services. Cumberland will ensure that its power, communications, transport and other operational needs do not depend on local facilities to the extent that this is possible, and that such local facilities that are used, for example local roads and the airport, are paid for and/or maintained as will be agreed in the IIBA. Food and accommodation, recreation facilities, physical and mental health services and other goods and services as may be identified as necessary will be provided to the mining operation independently of what is now available in Baker Lake, which is in any case too far away to be accessed regularly by the mine workforce.

However, there are also potential positive effects on infrastructure and social services. The construction of the all-weather access road between Baker Lake and the mine site will increase ease of travel to lands north of the mine site used for traditional activity. Long-term benefits may be realized to the tourist industry through project infrastructure left behind after closure. Increased employment and business opportunities will result in increased income, a measure of economic security, capacity building that will contribute to employability over the long term, and improved self-image of employees and their families. This could result in reducing dependence on government social services.

The balance between negative and positive impacts on social services delivery is difficult to predict, although the expectation is that positive impacts will gain momentum over the project life. There is potential for undoing some of this positive impact at the time of closure.

The impacts on social services and infrastructure, of low to medium magnitude, are considered largely positive in the medium term and of moderate significance. There is some potential for closure to have a negative impact on social service delivery.

4.21.4.7 Impacts on Sites of Heritage Significance

Project design was adjusted to the extent practicable to ensure that heritage resources sites are away from planned infrastructure. There are still a few recent use sites that fall within the boundaries of the project zone (see table C.4). In these cases, steps for further investigation, protecting, and/or mitigating the sites will be discussed and agreed with the community of Baker Lake, the chief archaeologist for Nunavut, and the Department of Culture, Language, Education, and Youth (CLEY).

Should additional sites be identified during construction, construction will be stopped and CLEY and the Hamlet of Baker Lake will be advised. Until such time as an evaluation of the site can be completed by a qualified archaeologist and the appropriate decisions (e.g., avoidance of the site or mitigation) discussed and implemented, restarting construction in the immediate area of the heritage resource would be postponed.

The identification and description of heritage resources sites contributes to knowledge of heritage resources in Nunavut. The impacts are considered to be of low significance.

4.21.4.8 Impacts on the Economies of Nunavut & Canada

To estimate the economic impacts of the project on Nunavut and Canada as a whole, an input-output model was run in 2004 by Statistics Canada. Summary results for Nunavut and for Canada are presented in Table 4.22. Recent project changes did not warrant re-running the model, thus some figures in what follows are slightly inconsistent with other sections of this document (see the Socioeconomic Impact Assessment for explanation).

Table 4.22: Input-Output Interprovincial Model Summary Results

Parameter	Construction $303 M/18 months		Operations $92 M/year	
	Nunavut	Canada	Nunavut	Canada
Impact on GDP (market prices, $000)	120,333	233,813	35,451	63,780
Total Labour Income ($000)	76,651	149,584	27,010	43,745
Total Employment (person years)	1,008	2,584	303	700
Indirect Taxes on Production & Products (minus subsidies, $000)	2,088	5,688	1,168	2,331
Total Output ($000)	349,377	585,208	102,745	167,635
Output Multiplier	1.15	1.93	1.12	1.82

Source: Statistics Canada.

For the construction phase, the increase to Nunavut GDP, prorated to one year from 18 months, is in the order of 7% to 8%. Total employment created in Nunavut represents approximately two jobs for every directly employed construction worker; however, it must be remembered the largest fraction of these would be out-of-area workers rather than permanent residents of Nunavut. Fiscal benefits to the Government of Nunavut are also large relative to its tax base.

Regarding job creation, 80% of the over 1,000 person-years of employment the model predicts for Nunavut during the construction phase would be in the mining and construction sectors. However, the model also predicts job creation in the following sectors in order of magnitude: (i) finance, insurance, real estate, and renting and leasing; (ii) scientific and technical services; (iii) government sector; (iv) wholesale trade; and (v) transportation and warehousing.

Operation phase economic impacts are lower on an annual basis, but would accumulate over a ten year period. The most significant difference is that whereas construction creates much indirect employment, operations does not. The total increase in employment of 303 represents only about 0.2 jobs created for each directly employed operations worker.

The economic impacts on the economy of Nunavut, of high magnitude, are positive over the medium term and of high significance, particularly during the construction phase. The economic impacts on the economy of Canada, primarily centered in Alberta, Ontario, and Quebec, are of low magnitude relative to the size of the Canadian economy, medium term and of low significance.

4.21.5 Impacts of the Environment on the Project

4.21.5.1 Seismicity

No impacts. See Section 4.21.2.1 for details.

4.21.5.2 Terrain Stability Summary

No impacts. See Section 4.21.2.1 for details.

4.21.5.3 Climate Change (Global Warming)

A report entitled, "Implications of Global Warming and the Precautionary Principle in Northern Mine Design and Closure" (BGC, 2003) suggests that globally the average temperature may increase by about 2°C by 2100 due to global warming. The increase may be double the global average for sites located at 50°N, and may be 3.5 times greater for sites located at 80°N. These estimates suggest that the average annual temperature for the Meadowbank property, located at around 65°N, may increase by approximately 5.5°C by 2100.

Studies indicate that the boundaries of discontinuous and continuous permafrost are expected to move northward due to global warming based on predictions of warming of 4°C to 5°C over the next 50 years (Woo et. al., 1992). Based on these predictions, the Meadowbank property would remain within the zone of continuous permafrost, but the active layer thickness would increase and the total thickness of permafrost may slowly reduce in time. **These changes will not compromise permafrost encapsulation strategies for the rock storage and tailings facilities.**

4.22 CUMULATIVE EFFECTS ASSESSMENT

Cumulative environmental effects are defined as: "impacts on the natural and social environments which occur so frequently in time or so densely in space that they cannot be 'assimilated' or combined with effects of other activities in a synergistic manner" (Canadian Arctic Resources Committee (CARC) in NPC, 1997). A cumulative effects assessment (CEA) was conducted to assess any cumulative environmental effects over a regional area that are likely to result from the project in combination with other projects or activities that have been or will be carried out. This assessment took into consideration the following factors: (1) valued ecosystem components (VECs); (2) significance of the cumulative environmental effects; (3) comments from the public that are received in accordance with the CEAA regulations; (4) measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project; (5) any other matter relevant to the assessment.

This CEA is limited to those residual effects (post-mitigation) on VECs resulting from past, present, or reasonably foreseeable actions that occur within the area where a linkage between the residual effects of the Meadowbank Gold project and the residual effects of other actions occurs.

Below is an explanation of the approach to, and elements of, the cumulative effects assessment.

Methodology – The methodology used during this CEA follows the guidelines provided by the Environmental Impact Screening Committee (EISC) and the Environmental Impact Review Board (EIRB) in their October 2001 guide entitled, "Cumulative Effects Assessment in the Inuvialuit Settlement Region," and CEAA's guide entitled, "Cumulative Effects Assessment Practitioners Guide" (February 1999). In addition, guidelines, comments, and recommendations from NIRB, KIA, DSD, and other federal agencies were considered.

Regional Environmental Issues of Concern – The issues central to this assessment were derived from concerns of the NPC in their Keewatin Regional Land Use Plan (approved by INAC and DSD in 2000); from public consultation sessions; and from similar studies that have been conducted for mining developments in the central mainland tundra over the past ten years

See Section 4.19.2 for a definition of VECs and explanation of how they were selected.

Temporal & Spatial Boundaries – Spatial boundaries for the cumulative effects assessment were established on a VEC-specific basis. RSAs for each VEC are discussed in Sections 4.15 and 4.16.

Mitigation of Potential Environmental Effects – Specific mitigation for each component can be found in the respective EIA sections for each VEC identified.

Mining Projects with Possible Linkages – No other mining project located within the Western Churchill Geological Province (see Figure 2.1) is currently operating or at some stage in the project permitting process. Closed mines include the Cullaton Lake / Shear Lake property and Nanisivik mine. A spatial and temporal overlap exists between the closure and decommissioning activities of the Cullaton Lake / Shear Lake property, Nanisivik mine, Baker Lake, and the Meadowbank project.

Cumulative Effects Assessment Summary – There are no measurable cumulative effects expected to occur on VECs from actions related to project development, as shown in Table 4.23.

Table 4.23: Measurable Regional Cumulative Effects Potential

VEC	Measurable Regional Cumulative Effects Potential
Air Quality	None
Noise	None
Water Quality	None
Water Quantity	None
Permafrost	None
Vegetation Cover (Habitat)	None
Wildlife	None
Aquatic Habitat	None
Fish/Aquatic Organisms	None

4.23 SUMMARY OF IMPACTS BEFORE MITIGATION

A summary of project impacts before mitigation is provided in Table 4.24 on the following page.

4.24 ENVIRONMENTAL MANAGEMENT & MITIGATION

4.24.1 Overview

A project EMS will be implemented to provide a systematic method for managing the expected and potential interactions of the project with the biophysical environment. It will consist of three key elements: an integrated environmental management plan, a formal environmental awareness program, and an ongoing environmental monitoring program.

Table 4.24: Summary of Project Impacts before Mitigation

VEC	Description of Potential Significant Impacts during Construction/Operation
Fish habitat	- Reduction of fish habitat in Second Portage, Third Portage and Vault lakes due to pit development. Permanent reduction in western portion of Second Portage Lake. - Runoff from waste rock pile at Vault Lake will introduce high pH and metal contamination to Wally Lake. - Increased TSS due to dike construction. - Introduction of sediments and porewater metals due to dewatering.
Fish population	- Reduction of fish productivity in Second Portage, Third Portage, and Vault lakes and possibly into the main basin of Tehek Lake. - Potential elevated levels of metals in lake water. - Increased pressure on fish populations from increases in fishing activity. - Dispersion of fish away from disturbed areas (e.g., dike construction area).
Air quality	- Degradation of air quality due to emissions resulting from combustion of diesel fuel in the power plant and vehicles including nitrogen oxides, carbon monoxide, sulphur dioxide, and particulate matter (PM_{10} and $PM_{2.5}$). - Fugitive dust emissions from tailings, overburden and waste disposal, process operations including ore hauling, road use, and fine sediments exposed on lake bottoms after drawdown.
Noise	- Increased noise levels from blasting, drilling, materials handling and aircraft.
Water quality	- Degradation of water quality due to effluent discharges, emission fallout, sediment releases, and dewatering resulting in increases in metals, nutrients, and/ or hydrocarbon concentrations.
Surface water quantity & distribution	- Reductions in lake area and water volume at Second Portage and Vault lakes. - Elimination of westernmost connecting channel between Third Portage and Second Portage lakes. - Increases in Third Portage Lake water levels due to dewatering of Second Portage Lake. - Change in water circulation patterns.
Permafrost	- Increase of active layer thickness, melting of ground ice, thaw subsidence and sediment loss, particularly in wetland areas. - Development of through-talik beneath Vault Lake.
Vegetation Cover	- Wind erosion of tailings resulting in contamination of vegetation in fall-out (downwind) areas.
Predatory mammals	- Attraction to mine wastes (e.g., garbage) resulting in animal mortality. - Increased hunting pressure and mortality. - Avoidance of foraging habitats and deflection from normal travel routes due to activity and noise.
Small mammals	- Loss of local habitat. - Avoidance of foraging habitats and deflection from normal travel routes due to activity and noise. - Food wastes attract small mammals leading to dependency and mortality.
Raptors	- Avoidance of foraging habitats due to activity and noise. - Disruption of nesting birds.
Waterfowl	- Loss of wetland nesting, foraging and roosting habitat. - Avoidance of nesting, foraging and roosting habitats due to activity and noise. - Attraction to contaminated wetland facilities (e.g., tailings pond) leading to contamination.
Other breeding birds	- Loss of local habitat. - Avoidance of foraging habitats and deflection from normal travel routes due to activity and noise.
Ungulates (caribou & muskoxen)	- Increased hunting pressure and mortality. - Avoidance of foraging habitats and deflection from normal travel routes due to activity and noise.

The EMS will be modified throughout the life of mine to address policy and regulation changes and to benefit from technological advances where improvements can be clearly demonstrated. The primary objective will be to maintain compliance with the regulations and requirements governing the project. ISO 14001 protocols will be used as a guide to audit project performance and demonstrate continuous improvement during the operating period.

4.24.2 Management of Impacts on Physical Environment

A large number of mitigative measures will be implemented to avoid or minimize any impact on the physical environment. To this end, Cumberland has written several draft management plans, as listed below:

- Aquatic Ecosystem Management Plan (AEMP)
- Terrestrial Ecosystem Management
- Mining Metals Effluent Regulations (MMER)
- No-Net-Loss (NNL)
- Mine Waste & Water Management
- Spill Contingency
- Socioeconomic & Archaeology
- Access & Air Traffic Management
- Air Quality & Noise Management
- Emergency Response
- Occupational Health & Safety
- Hazardous Materials Management
- Reclamation & Closure
- Human Resources

These plans set out detailed site-specific protection measures and procedures that serve to protect the VECs identified for this project during all phases of project development. A summary of management and mitigation measures for each VEC is provided in the following subsections.

4.24.2.1 Vegetation Cover

Mitigation measures for vegetation are documented in detail in the Terrestrial Ecosystem Management Plan. Mitigation to be implemented for vegetation communities during the construction and operation phases will include: (1) clearly delineating mine footprint in order to reduce habitat degradation in surrounding areas; (2) adhering to emissions and dust control protocols (see the Air Quality & Noise Management Plan) to avoid vegetation degradation; (3) constructing containment berms around fuel storage areas, and following the Hazardous Materials Management and Spill Contingency plans; (4) maximizing the use of stripped materials and suitable waste rock for road, airstrip, and dike construction; (5) facilitating progressive reclamation and natural revegetation by scarifying and/or recontouring surfaces, stabilizing slopes, and restoring natural drainage patterns (see the Reclamation and Closure Plan, and the Terrestrial Ecosystem Management Plan); and (6) assessing contaminant levels in vegetation on several plots in mine site and reference areas during the life of the mine.

4.24.2.2 Wildlife

Mitigation measures for wildlife are documented in the Terrestrial Ecosystem Management Plan. Important mitigation measures for wildlife include minimizing blast noise, engine noise, maintaining and ensuring vehicles are properly muffled, establishing speed limits, giving right-of-way on all roads, minimizing the number of take-offs and landings, dust suppression, proper containment of fuel storage areas and explosives, contingency plans (for fires, spills and explosions), complying with hazardous materials guidelines, environmental awareness programs, incineration of all garbage and foods (domestic waste), restrictions on hunting, and establishing blasting windows if possible.

Upon closure, tailings impoundments will be capped, reclaimed, and made accessible or inaccessible as necessary. Waste rock piles will be capped with non-PAG material and contoured to allow passage of wildlife such as caribou through the site.

Caribou & Muskox

In the event that ungulates venture near the tailings impoundment and risk drinking contaminated water, they will be averted from the site. If animals become embedded in tailings they will be removed safely.

Predatory Mammals

To avoid “problem” animals, all domestic waste and garbage will be incinerated, such that no residue attractive to wildlife remains. Domestic waste facilities have been designed to be tightly sealed, and to trap all odours. Care will be taken that aromatic substances such as oil (such as grease, oily rags and paint), and other products (such as aerosol cans and batteries) are stored in sealed, bear-proof containers and eventually removed offsite. A safety education program for all personnel on procedures for dealing with bear-human interactions, and avoiding interactions with wildlife in general will be implemented (see Terrestrial Ecosystem Management Plan).

Small Mammals

Small mammals may inhabit roadsides, which would make them particularly vulnerable to collisions with vehicles. Speed restrictions will be implemented, roads will be watered as necessary to reduce dust, emissions and dust control protocols will be followed, and vehicles will be maintained in good condition to minimize contaminant loading of roadside and downwind vegetation. To avoid dependence of small mammals (e.g., Arctic ground squirrel) on human foods, feeding will be prohibited, food will be properly and securely stored, and all food wastes will be incinerated. Whenever possible throughout the life of the mine, an attempt will be made to create habitat for microtine rodents on the slopes of waste rock dumps.

Birds

Specific mitigation measures for birds include minimizing noise levels around active nests, using aversive methods to discourage birds from roosting on the runway and on road edges; deterring shorebirds and waterfowl from utilizing potentially contaminated areas such as reclaim ponds by using aversive techniques including bangers, pumping potentially contaminated water ponds out of pits to a settling area, creating habitat for ptarmigan, passerines, and small mammals on slopes and possibly capped top of waste dump if substrates are not toxic, ensuring that new lake waters do not contain unacceptable levels of contaminants, and treating contaminated water inputs prior to discharge.

4.24.2.3 Fish

The NNL document presents a range of possible options to mitigate and compensate, to the extent possible, impacts to fish habitat in the project lakes with a combination of on-site and off-site measures. Greater emphasis is placed on compensation of medium and high value habitat such as spawning shoals, shelter, and feeding habitat and less on low value (e.g., deep water, low complexity) habitat. Efforts to avoid or mitigate impacts to fish include winter culvert installation; sediment control; use of properly sized intake screens; use of riprap to stabilize shorelines and anchor pipes;

modification of the external surface of containment dikes; enhancement and improvement of connecting channels between lakes to enhance fish movement; treatment of effluent discharge; and discharge only during open water, not under ice.

At closure, there is expected to be a net gain in productive habitat capacity in the project lakes. Enhancement of dike interiors, construction of finger dikes on the lakeward side of Goose Island Dike, creation of shallow reefs and other habitat features within former lake habitat areas and creation of new lake habitat as a result of flooding of former terrestrial habitat are mitigation measures.

Fish Salvage

Baker Lake community members and the HTO will harvest fish from the Portage, Bay Zone and Goose Island, and Vault impoundment areas prior to dewatering. A research initiative will be undertaken to quantify fish biomass per hectare from Arctic oligotrophic headwater lakes to gain empirical data on lake productivity and sustainable biomass to quantify actual impacts to fish populations as a result of lake impoundment and dewatering of Nunavut lakes. Collaboration with Canada Fisheries and Oceans (FAO) will be sought prior to undertaking this initiative.

Once fish have been salvaged, a portion of fish can be placed into an adjacent lake system, and/or sacrificed and provided to Baker Lake residents for domestic consumption and for dog food.

Air Quality & Noise

Cumberland's Air Quality & Noise Management Plan will be in compliance with all relevant environmental regulations during construction and operation of the project. The air quality management plan will include the following components:

- identification of the operations at the site including emission sources
- description of the air emission limits for the overall project (including plant) and for major sources and stacks (including pertinent operational parameters)
- identification of permissible sound levels
- description of air basin and baseline noise
- emission inventory and emission forecasts

- dispersion modelling
- commitment to report greenhouse gas (GHG) emissions in support of Canada's Voluntary Challenge and Registry
- development of a baseline and a monitoring system for GHG emissions to evaluate and report on progress in improving efficiency and reductions in GHG emissions
- report of particulate matter emissions to National Pollutant Release Inventory (NPRI)
- promotion of cleaner technology to improve performance
- consideration of fuel economy as an important criterion when purchasing, upgrading, or maintaining the haul truck fleet
- search for a market-based solution to ensure cost-effective emission reductions
- implementation of air quality and noise mitigation measures
- development and implementation of air quality and noise monitoring plan to verify compliance with relevant regulations
- employee training awareness
- continuous improvement program.

4.24.2.4 Permafrost

Most heavy structures (e.g., mine buildings) will be supported on concrete foundations extending to bedrock. To preserve permafrost buildings and foundations will be constructed using suitable permafrost regions construction methods. Specific options include: buildings elevated on piles or sills leaving a dead air space between the floor slab and the subgrade; slab-on-grade placed on a well-compacted structural fill with ventilation pipes in the fill (the ventilation pipes, which are operated in the winter to super chill the ground, may be forced air or non-assisted convective air flow); or slab-on-grade placed on a well-compacted structural fill with thermo siphons used to chill the fill year-round.

Thermal modelling predicts that permfrost will penetrate the tailings facility and underlying talik and will eventually encapsulate the facility. This will reduce the potential for the generation of ARD, and for pore water contaminants to migrate outside of the tailings disposal facility. Thermal modelling that incorporates climate change predictions indicates that the length of time required for the tailings to freeze will increase under climate warming trends, but the tailings will still tend to the frozen condition. The development of permafrost in the tailings dike core and tailings side of the tailings dike is a key aspect of the design concept. Both steady-state and transient thermal modelling for the post-closure indicate that the dike will become frozen during operation and remain frozen after closure under current climate conditions, and under climate warming trends. At waste rock disposal facilities, waste rock will be placed on thaw-sensitive ground during winter months to minimize ground disturbance and permafrost degradation. Potential permafrost degradation associated with the tailings discharge pipeline will be avoided by using an insulated pipe with heat tracing, and by elevating the pipeline across thaw-sensitive terrain.

For contact ditches, mitigation may involve placement of a stabilizing apron comprising granular fill, possibly in conjunction with geotextile, although such mitigation is considered unlikely given appropriate design precautions. Where thaw-related impacts affect non-contact ditches, impacts may be somewhat higher because placement of a stabilizing fill is not consistent with the “non-contact” designation. In these cases, special care will be taken to ensure aprons comprise non-acid-generating and non-metal-leaching granular materials.

4.24.2.5 Water Quality & Quantity

Water quality and quantity will be managed and protected through a comprehensive Mine Waste and Water Management Plan. This plan is described below and shown on Figures 4.9 to 4.14.

Mine Waste Rock Management Plan

The proposed mine will generate approximately 173 Mt of mine rock and 21.9 Mt of tailings. Mine rock includes iron formation, intermediate volcanic, ultramafic rocks, and overburden. Mine rock will be classified as:

- mine rock for general construction
- mine rock for dike construction
- mine rock for capping
- mine rock to waste rock storage areas
- tailings.

The overburden and ultramafic rocks are not expected to be acid generating. All other waste rock types and the tailings are potentially acid generating. Mine rock that is not used for construction will be trucked to mine waste rock storage areas. The quantities of waste rock to be excavated are summarized in Table 4.25.

Table 4.25: Quantities of Waste Rock Types

Rock Storage Facility	Rock Type	Quantity
Portage	Ultramafic and Mafic Volcanic	42 Mt
	Intermediate Volcanics	25 Mt
	Iron Formation	34 Mt
	Quartzite	4 Mt
Vault	Intermediate Volcanics	69 Mt
	Overburden	9.8 Mt

Source: AMEC, 2005.

Portage rock storage facility – Waste rock from the North Portage, Third Portage, and Goose Island open pits will be stored in an area to the north of Second Portage Arm. The storage area will be constructed to minimize the disturbed area and capped with a layer of non-acid generating rock at closure to constrain the active layer within relatively inert materials. The potentially acid generating waste rock below the capping layer will freeze, resulting in low rates ARD generation in the long term. Water from the waste pile will be collected by perimeter ditches and directed to the reclaim pond.

Vault rock storage facility – Waste rock from the Vault open pit will be stored in an area to the north and west of the Vault open pit. The rock storage facility will be graded at closure to encourage run-off and to provide a final shape consistent with the surrounding topography. The water seepage from the Vault waste rock storage area is expected to be of suitable quality to allow discharge to the environment without treatment and capping of this facility is therefore not proposed.

Tailings storage facility – Tailings will be stored in Second Portage Arm, which is currently underlain by a talik that extends through the permafrost to the underlying groundwater. Tailings will be placed as thickened slurry, initially by subaqueous deposition and later subaerially. A reclaim pond will be operated within the tailings impoundment. Tailings will be deposited in thin layers that will eventually freeze.

A dry cover of acid buffering ultramafic rockfill will be placed over the tailings at closure to confine the active layer within relatively inert materials. Thermal modelling indicates that the tailings will freeze in the long term, and that the talik that currently exists below Second Portage Arm will freeze before seepage from the tailings impoundment reaches the groundwater below the permafrost. Therefore, the potential for groundwater contamination to occur as a result of seepage from the tailings impoundment is considered to be low. This tailings deposition strategy will result in the Second Portage Arm being filled with tailings at the end of the mine life.

Water Management Plan

A water management plan has been developed to minimize the impact of the proposed project on the quantity of surface water, and on the quality of surface water and groundwater. Specific mitigation strategies include:

- reducing the intake of fresh water from the neighbouring lakes by recycling and reusing water where practicable
- implementing measures to avoid the contact of clean runoff water with areas affected by the mine or mining activities
- collecting, transporting, and treating mine water, camp sewage, and runoff water that comes into contact with project activities, as necessary
- managing potentially acid-generating or metal-leaching materials
- monitoring quality of discharges
- adjusting management practices if monitoring results indicate discharge quality does not meet discharge criteria.

The following are the minimum standards that were incorporated into water management planning activities:

- Establish compliance with all applicable federal and territorial environmental legislation (including *Canadian Environmental Protection Act*, *Fisheries Act*, Freshwater Intake End-of-pipe Fish Screen Guidelines (DFO, 1995), Canadian Environment Quality Guidelines, and Metal Mining Effluent Regulations.

- Cross reference existing guidelines relevant to water management, such as the Guidelines for the Discharge of Domestic Wastewater in Nunavut by the Nunavut Water Board.

A site water balance model (see Tables 4.8 and 4.9) was prepared to identify the water sources and their relative contribution and to evaluate proposed water management infrastructure. Surface water was grouped into two categories: contact and non-contact water. Contact water originating from affected areas will be intercepted, collected, and conveyed to central storage facilities, where it will be decanted to treatment, if needed, or directed to receiving lakes. Portions of the dewatered Vault Lake and Second Portage Arm will serve as the central water attenuation storage facilities. Second Portage Arm will have two segregated water storage facilities for the storage of process reclaim water (main basin) and the Portage area mine site runoff (northwest basin) until approximately Year 4. From Year 5 of the mine life onward, the reclaim pond will be operated at the western end of Second Portage Arm. Attenuation storage will take place in the Goose Island open pit, which will be inactgive after Year 4.

The various components of the water management system will be designed to meet the following criteria:

- Water management infrastructure along the perimeter of the developed areas must be able to intercept and convey to proper handling facilities contact water from a 1:100-year / 24-hour precipitation event.
- Water management infrastructure located within mining affected areas where water has no chance of overflow outside of developed areas, should be able to handle the runoff from a 1:10 year / 24-hour precipitation event.
- Water management infrastructure along the perimeter of the developed areas must be able to divert non-contact water from a 1:100 year / 24-hour precipitation event.
- Dewatering capacities for contact water sumps and ponds should be selected to handle the greater of: the average year freshet volume in a 30-day period; or the 1:100-year freshet volume in a 90-day period.
- Attenuation ponds should be sized to accommodate the runoff from a 1:100-year / 24-hour precipitation event in excess of their maximum operating storage volume (average year climate conditions) while maintaining a 1 m freeboard before the possibility of a spill to the receiving environment.

- All contact water will be intercepted, contained, analyzed, treated, if required, and discharged to the receiving environment when water quality meets the discharge criteria. Non-contact water is limited to runoff originating from areas unaffected by mining activity and that does not come into contact with developed areas. Non-contact water will be intercepted and directed away from developed areas by means of natural or man-made diversion channels and allowed to flow to the neighbouring lakes untreated.

4.24.3 Management of Impacts on Socioeconomic Environment

This plan describes the proposed measures that will be undertaken by Cumberland to mitigate the socioeconomic impacts of the project and enhance the benefits to the Baker Lake community and the Kivalliq region in general. These measures have the potential to increase the overall net socioeconomic benefit of the project.

4.24.3.1 Human Resources

Cumberland's Human Resources plan focuses on many issues, including the following:

- training at all levels
- Inuit training and hiring
- employment rotation
- labour relations
- housing, accommodation, and recreation
- safety, health, and hygiene
- policies and procedures that address issues such as firearms usage and discrimination, etc.
- coordination with other developments
- arbitration and amendment provisions.

4.24.3.2 Occupational Health & Safety

An Occupational Health and Safety Plan (OHSP) has been prepared to address the requirements under the *Mine Health and Safety Act and Regulations* for the Northwest Territories and Nunavut, and the Canadian Labour Code. The OHSP covers gold mining, processing, and related activities at the Meadowbank site and is guided by the following principles:

- a clear chain of command for safety and health activities
- accountability for safety and health performance
- well-defined corporate expectations regarding safety and health
- well-defined task and operational hazards/risks
- comprehensive hazard prevention and control methods
- record keeping requirements to track program progress.

For more information, see the Occupational Health and Safety Plan included in this EIA submission.

4.24.3.3 Nunavummiut Involvement

To ensure Nunavummiut involvement, Cumberland will consider hiring local Inuit to be responsible for some or all of the following:

- monitoring certain project activities
- organizing and participating in liaison committees to facilitate communications, consultation, and the resolution of environmental matters
- compiling and reviewing the use of Nunavummiut place names and other Traditional Knowledge.

4.24.3.4 Public Involvement

Since initial exploration activities began, Cumberland record of public consultation has been comprehensive and varied (see Table 4.3 in Section 4.5, "Public Consultation.") In early 2004, Cumberland opened a liaison office in Baker Lake to ensure the public has a forum in which to discuss any questions and concerns. A local Inuit man, Michael Haqpi, has been hired to communicate with local residents in their own language on Cumberland's behalf.

Cumberland is committed to furthering public knowledge and education about the Meadowbank project and mining in general through some or all of the methods listed below:

- holding communication sessions to explain the results of the EIS
- organizing information sessions on specific subjects
- establishing corporate public offices in the Region or in Nunavut
- holding open houses and workshops on project development
- meeting with government officials, interest groups, and other parties

- delivering presentations to interest groups and the public
- holding community forums
- encouraging site visits by Elders and others
- producing a company newsletter
- annual environmental reporting
- releasing project documents to the public
- establishing local monitoring committees
- providing media releases.

4.24.3.5 Impact & Benefits Agreements

An Inuit Impact Benefit Agreement (IIBA) has been successfully negotiated between Cumberland and the KIA for the land use lease. This agreement lays the foundation for establishing the terms and conditions for the project-supplied benefits to the Kivalliq Region and the Hamlet of Baker Lake, as defined by the NLCA (1993). The final IIBA will be a key factor in the mitigation of potential negative socioeconomic effects of the project.

4.24.3.6 Pollution Prevention

Pollution prevention is defined by the Federal Government in the document *Pollution Prevention: A Strategy for Action* (Environment Canada, June 1995), which links the concept of pollution prevention with sustainable development. Cumberland's focus will be on preventing pollution from occurring rather than managing it. For more information, see Sections 4.1.2 and 4.2 of this document as well as Cumberland's environmental management plans included as part of this EIA submission.

Hazardous Materials

The Hazardous Materials Management Plan (HMMP) provides a consolidated source of information on the safe and environmentally sound transportation, storage, and handling of the major hazardous products to be used at the Meadowbank Gold project. In combination with Cumberland' Emergency Response Plan, and Spill Contingency Plan, the HMMP provides instruction on the prevention, detection, containment, response, and mitigation of accidents that could result from handling hazardous materials.

The plan is based on the following principles for best practice management of hazardous materials:

- identify and prepare materials and waste inventories
- characterize potential environmental hazards posed by those materials
- allocate clear responsibility for managing hazardous materials
- describe methods for transport, storage, handling, and use
- identify means of long-term storage and disposal
- prepare contingency and emergency response plans
- ensure training for management, workers, and contractors whose responsibilities include handling hazardous materials
- maintain and review records of hazardous material consumption and incidents in order to anticipate and avoid impacts on personal health and the environment.

Cumberland recognizes that incorporating proper hazardous material management into other environmental management plans and systems leads to risk reduction, improved process control, and cost savings.

All hazardous materials to be used at the Meadowbank operation will be manufactured, delivered, stored, and handled in compliance with all applicable federal and territorial regulations, as well as ISO 14001 environmental management standards. Cumberland will institute programs for employee training, facility inspection, periodic drills to test systems, and procedural review to address deficiencies, accountability, and continuous improvement objectives.

Spill Contingency

The Spill Contingency Plan provides a practical source of information required to assess spill risks, develop an effective countermeasures program, and respond in a safe and effective manner to spill incidents. More specifically, the plan:

- complies with Cumberland's environmental policy
- identifies the organization, responsibilities, and reporting procedures of the Meadowbank emergency response team in the event of an emergency or spill
- provides readily accessible emergency information to the cleanup crews, management, and government agencies in the event of a spill

- complies with federal and territorial regulations and guidelines pertaining to the preparation of contingency plans and notification requirements
- promotes the safe and effective recovery of spilled materials
- minimizes the environmental impacts of spills to water or land
- provides site information on the facilities and contingencies in place if a spill or malfunction should occur.

4.24.3.7 Socioeconomic Management Plan

The primary vehicle for impact mitigation and benefit enhancement will be the IIBA, which is being negotiated between Cumberland and the KIA. The main objectives of the IIBA are as follows:

- mitigating the impacts and enhancing the benefits of project development
- creating opportunities for the people of Baker Lake specifically and the Kivalliq Region generally to participate in the project, thereby enhancing self-determination
- establishing Cumberland's role as an active member of the community and participant in the sustainable development of Baker Lake
- maintaining goodwill and good relations with communities and their governments.

The following principles are guiding IIBA negotiations:

- Consultation and participation will be practiced throughout the process to define priorities, needs, and preferences and to decide how mitigation and enhancement measures will be implemented.
- The development and implementation of mitigation and enhancement measures will be undertaken in partnership not only with communities but also with a range of organizations from government and civil society that are able to bring culturally appropriate experience and knowledge to maximizing net socioeconomic benefit.
- Implementation of both the terms of the IIBA and project operations will be conducted in an environment of accountability and transparency.
- Sustainability criteria will be incorporated by emphasizing the need to enable local and territorial participation in employment and business opportunities, training, and partnerships with government and community.

4.25 RESIDUAL IMPACTS

Minor residual effects of the project include: (1) change in water movement and surface area of Second Portage Lake because of the tailings deposits and Portage pit; (2) local changes in small mammal, bird, and fish populations due to temporary habitat loss); and (3) increase in fish habitat at the mine site at closure (positive effect).

4.26 MONITORING & FOLLOW-UP

4.26.1 Overview

Monitoring is a way of identifying the source of physical and chemical stressors to the environment, pathways of potential exposure, the ecological receptors at potential risk, mitigation measures, and the specific parameters to be monitored, their frequency, geographic location, and duration. Cumberland's monitoring plan takes an integrated, ecosystem-based approach that links mitigation and monitoring of physical/chemical effects on key ecological receptors. Mitigation is incorporated into mine design from the beginning, but can be improved upon based on information gathering and the results of monitoring. Monitoring is applied continuously throughout the life of the mine and will support adaptive management of effects to VECs.

4.26.1.1 Environmental Management & Monitoring Activities

An ongoing environmental monitoring program will be integrated into the EMS to demonstrate the safe performance of the mine facilities. Monitoring will identify non-compliant conditions if any, allow maintenance and planning for corrective measures to be completed in a timely manner, and enable successful completion of the abandonment and restoration plan (see Section 4.24.2 for a list of plans).

Cumberland will work with the regulatory agencies and Inuit to develop an appropriate EMP for the Meadowbank project. It is expected that the requirements for monitoring the biophysical, socioeconomic, cultural, and heritage resources throughout the life of mine will be part of the terms and conditions of the project's licenses, permits, and IIBA. It is expected the integrated EMP will include some or all of the elements shown in Table 4.26. A more detailed discussion of monitoring activities for each VEC follows the table.

Table 4.26: Potential Key Elements of the Environmental Monitoring Plan

	Function/Key Elements
Integrated EMP	A program of compliance monitoring to ensure that the project is meeting the environmental criteria established under legislation, regulation and in the license, permits and land leases that apply to the project An aquatic environmental effects monitoring program to determine impacts on the aquatic receiving environment A program of workplace air quality monitoring to measure specific contaminants within the workplace to protect employee health and prevent release of unacceptable air quality to the surrounding environment (monitoring for hydrogen cyanide in the processing plant, airborne dust levels underground and in the plant, engine emission gas monitoring in the underground mine, etc.); A quality assurance/quality control program to ensure that the environmental monitoring programs are meeting acceptable standards; A program of terrestrial effects monitoring to assess effects on wildlife and wildlife habitat generally; and A cooperative monitoring program with the Government of Nunavut that describes the nature and seasonal use of the caribou herds of the region.
Aquatic Monitoring	A monitoring program to verify compliance with water license terms and conditions and to evaluate the effectiveness of the mitigation measures Cumberland will implement an aquatic monitoring program (AEMP) prior to project construction to acquire baseline information The aquatic monitoring program will include compliance and biophysical monitoring to measure project effects on water quality and aquatic biota Subject to the development of a Surveillance Network Program (SNP) by the NWB, Cumberland proposes an SNP be established The federal MMER will be implemented as part of the more comprehensive AEMP to specifically target effluent quality and toxicity and receiving environment effects No-Net-Loss (NNL) of fish habitat program will be implemented to determine success of various habitat enhancement / replacement features in project lakes and off site
Water Quality Monitoring	A program of water quality sampling and testing will be implemented during the development, operational, and closure periods of the mine. The primary objectives of the monitoring program will be to evaluate changesin baseline surface water quality conditions, to evaluate water quality predictions of mine affected waters, to evaluate water quality predictions of pore waters within the tailings and perimeter dikes, to evaluate near- and far-field water quality predictions relating to the perimeter dikes in regard to fish habitat, and to evaluate changes in the baseline water quality predictions within the taliks beneath the lakes, and beneath the tailings storage facility
Terrestrial Monitoring	The following wildlife monitoring program components will be continued through the mine life: - Maintenance of a wildlife sighting and activity log for the project site and continued annual monitoring of raptor and waterfowl nesting patterns and numbers in relation to the proximity of mining activities - Caribou is a resource of high value to the lifestyle of Nunavut residents. Due to the large geographic range of the caribou herds, effective monitoring of caribou herd health and well being is best conducted on a scale that matches the range of these animals (e.g., Screening Level Risk Assessment and aerial and ground surveys). Cumberland would prefer to assist, where practical, caribou monitoring programs sponsored by the government of Nunavut and other governments and industry - Breeding birds will be monitored on mine site and reference / control plots
Air Quality Monitoring	A program of workplace air quality monitoring will be developed and implemented The primary objective will be to measure for specific contaminants within the workplace to protect employee health and to prevent the release of air quality harmful to the surrounding environment Monitoring will include: - Monitoring of airborne hydrogen cyanide in the process plant - Measurement of airborne dust levels and respirable quartz both underground and in the plant - Measurement of diesel engine emission gases from the underground mining equipment and - Monitoring of air quality in the underground mine

	Function/Key Elements
Permafrost Monitoring	A program of permafrost monitoring will be implemented during the development, operational, and closure period of the mine. The primary objectives of the monitoing program will be to evaluate changes to baseline permafrost conditions resulting from mining activities, to evaluate thermal modelling predictions for the rock storage facilities and tailings storage facility, and to evaluate thermal modelling predictions for the tailings dike
QA/QC Program	A quality assurance/quality control (QA/QC) program will be developed and implemented as part of each of the environmental monitoring programs described above The objective of the QA/QC program is to ensure that the environmental monitoring programs are meeting acceptable accuracy standards The QA/QC will include use of duplicate samples, field banks and analytical control standards The QA/QC program will include protocols for sampling, handling and shipping of samples and for data management and reporting

4.26.1.2 Aquatic Monitoring

Listed below are three discrete monitoring programs that have been designed and will be implemented upon initiation of the Meadowbank project that are specific to fish habitat and populations.

The *Aquatic Environment Management Plan* (AEMP) describes the rationale, framework, strategy, and scope of management plans to be implemented during all project phases in the Meadowbank area receiving environment lakes and streams. The AEMP monitoring strategy has two primary components: core monitoring and targeted studies. The core program is a general strategy to monitor water and sediment quality, periphyton, benthic invertebrates and fish that is tailored based on our understanding of mine construction, operation, and infrastructure (e.g., dikes, effluents, stream crossings, roads, etc.). Requirements under MMER are considered part of the foundation to core studies pertaining specifically to mine effluent sources.

Targeted studies are specific studies that typically have narrower temporal or spatial bounds or are designed to address specific questions related to particular components of mine development during construction or operation. These are integrated with, and complementary, to the core monitoring design.

A detailed framework document for the application of the federal Metal Mining Effluent Regulations (MMER) including EEM has been proposed. This document provides a description of required environmental monitoring for effluent and receiving environment chemistry, toxicity testing, benthic community, and fisheries surveys. Figure 4.40 shows the location of water quality monitoring stations as part of the AEMP and MMER program. Permafrost and hydrology monitoring stations are shown in Figure 4.41.

The EEM program is comprised of two parts: (1) Effluent and water quality monitoring studies intended to provide background, supporting information for the assessment and interpretation of biological monitoring. This component includes effluent characterization, sublethal toxicity testing, and water quality monitoring. (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.

As is the case for the routine MMER program, EEM program will also apply to both discharges. The MMER framework document describes how the MMER and EEM programs will be specifically applied at Meadowbank.

A No-Net-Loss (NNL) of fish habitat document describes and quantifies the area and quality of receiving environment habitat harmfully altered, disrupted, or destroyed (HADD) as a result of mine development and proposes mitigation and/or compensation to ensure no not loss. The NNL document provides a quantitative assessment of all major project activities that have the potential to cause a HADD of fish habitat and adheres to the DFO (1986) principle of no net loss. A range of possible options to mitigate and compensate, to the extent possible, impacts to fish habitat in the project lakes is proposed. Ultimately a gain in habitat will be realized after closure because of new habitat created from former submerged aquatic and former terrestrial environments. The NNL document also describes what monitoring and assessment may be required to demonstrate the performance and efficacy of the enhancement structures during and beyond mine life.

4.26.1.3 Water Quality Monitoring

Surface Water Quality Monitoring

Cumberland will continue with the current water quality monitoring program at existing sampling stations and frequencies. Additional sampling stations may be required during monitoring and maintenance to address specific areas such as adjacent to the tailings storage facility and rock storage facilities. A surface water quality monitoring program will be set up to monitor runoff quality and quantity from the Portage and Vault rock storage facilities. The results of analytical testing will be used to assess water quality predictions made at the permitting stage against actual results obtained during operations. The results of the monitoring program will be used to adapt the closure strategy for the rock storage facilities. During operations, water quality monitoring of pit sump water will be undertaken to evaluate the impact of explosive products on water quality.

Perimeter Dike Water Quality Monitoring

The quality of the water in contact with the de-watering perimeter dikes will be monitored during operations as well as during the monitoring and maintenance phase of the project. Water samples will be collected at regular intervals to be analysed and compared with predicted water quality concentrations. As part of the dike instrumentation program during operations, piezometers and monitoring wells will be installed in the dikes to monitor porewater pressures and porewater quality to verify the quality of this potential fish habitat. This information will be compared against modelling predictions and used to adapt the overall Environmental Management System.

Groundwater Quality Monitoring

Cumberland will continue with the current groundwater quality monitoring program at or close to the existing sampling stations on an annual basis during construction and operation. The existing wells will eventually be destroyed by mining operations and consequently, will be replaced by new installations proximal to their existing location. Additional monitoring wells may need to be installed: (1) around the perimeter of the tailings storage facility to monitor the quality of the groundwater within the talik zone beneath the facility; (2) into the talik zones beneath the Portage, Goose Island, and Vault pits to collect water quality data during mining activities for comparison with water quality predictions.

4.26.1.4 Terrestrial Monitoring

Wildlife monitoring is an important tool in protecting wildlife resources at the Meadowbank project. Because of uncertainties in impact prediction and the effectiveness of mitigation, monitoring will allow for verification of conclusions of the impact assessment, fine-tuning, and refinement of mitigation measures, and documentation of significant impacts on abundance and distribution of wildlife populations. Several variables that define the well-being of wildlife populations will be monitored. A summary of the general approach is provided below.

Habitat distribution – Habitat, including vegetation, rocks, rock crevices, eskers etc., is required by all wildlife species. Each wildlife species or wildlife VEC has varying needs for habitat units classified under the Ecological Land Classification. As a result, the availability (i.e., % cover within the LSA; habitat loss relative to availability in the LSA) of all ELC habitat units will be assessed on an annual basis during the life of the mine. Extent of habitat loss will be determined and mapped from ground investigations and aerial surveys. Newly disturbed areas will be delineated using GPS and GIS mapping capabilities. Where unnecessary and unplanned habitat degradation is documented, measures will be taken to reclaim these areas.

Wildlife distribution – Various monitoring programs will be in place to assess the distribution of wildlife within the LSA and RSA. Systematic aerial and ground surveys of the LSA and aerial surveys of the RSA will also provide information on the distribution of larger species, as well as small mammals such as Arctic hare. Since many species utilizing the area are migratory and/or transient, changes in distribution will not necessarily be an accurate indicator of population changes resulting from mine-related activities. Details on monitoring programs designed for particular VECs are described in separate sections below.

Wildlife abundance – Wildlife abundance is likely a better indicator than distribution of the potential effects of mine activities on wildlife utilizing the area. Both increases and decreases in populations may be observed. For example, caribou may be attracted to the mine site because of the safety from predators that the mine and its human inhabitants afford. Increased numbers of caribou in the LSA may be documented by ongoing LSA ground or aerial surveys. Aerial surveys of the RSA will also be conducted on a regular basis. Distribution of animals in proximity to the all-weather access road will provide information on the effects of the road.

Wildlife health – The health of wildlife utilizing the mine site and environs will be difficult to determine directly because of the migratory and transient nature of all larger, long-living animals and the difficulty in obtaining samples for analysis. The approach Meadowbank will take is to sample soil and vegetation such as lichens, berries and sedges, which are known to assimilate metals and other substances in their environment, and are basic foods for herbivores such as caribou, particularly in winter, and undertake a Screening Level Risk Assessment of potential risks to wildlife.

Plants and soil samples will be collected from within the mine site (e.g., on-site, near-field, far field) and be analyzed for inorganic elements, petroleum hydrocarbon constituents, and other contaminants. The results will be compared to data for soils and vegetation collected pre-development and data from control or reference areas.

Adaptive management – Within each wildlife management approach or method there is a certain level of uncertainty or unpredictability. The general purpose of monitoring is to determine if mitigation measures have been successful. For example, it may be determined that waste management practices are not effective in keeping predatory mammals away from the mine site. The residual effect would be that predatory mammals continue to return to the mine site, increasing the risk that animals will need to be destroyed. Adaptive management measures would be implemented, such as recommendations to reduce the availability of animal attractants at the landfills, protecting effluent lines with metal sheathing, and placing metal skirting around the base of buildings, to reduce potentially unacceptable impacts.

Caribou & Muskox

Caribou play a vital role in the subsistence economy in the Baker Lake area and are an important food source for carnivores. Due to the large geographic range of the caribou herds, effective monitoring of caribou herd health and well being is best conducted on a scale that matches the range of these animals. Cumberland would prefer to assist, where practical, caribou monitoring programs sponsored by the Government of Nunavut and other governments and industry. Ongoing collaboration with government researchers and review of government radio-collaring programs will provide further information on the movement patterns and herd origins of caribou found in the Meadowbank area.

Cumberland will also continue to conduct aerial surveys within the mine site LSA and RSA, and will undertake a Screening Level Risk Assessment to assess the potential risk of contaminants to ungulate health.

Other monitoring activities will include maintaining daily logs of ungulates, conducting biweekly surveys along the all-weather access road, and undertaking daily surveys within the mine site facilities. Information on ungulate locations, numbers, sex, and direction of travel will be determined, and an analysis of long-term population indicators will be conducted. Pilots will be required to report all ungulate / plane collisions and near misses as well as any caribou or muskox sighted in the area, and maintain a wildlife sighting log book. All operators of vehicles would be required to report any collisions with ungulates.

Predatory Mammals

Wildlife logs, of both sightings and interactions, will be kept on an ongoing basis to document the sightings of large predators in the vicinity of the mine facilities. These records will be one of the core elements for the site-specific monitoring plan and will provide support for actions required to prevent critical situations. Regular analyses of these data may provide solutions by way of adaptive management.

If applicable, potential or existing den sites will also be identified and monitored for use throughout the life of the mine.

Birds

Maintenance of a wildlife sighting and activity log for the project site and continued annual monitoring of raptor, waterfowl, and other breeding bird nesting patterns and numbers in relation to the proximity of mining activities will be undertaken. For waterfowl, the focus will be on wetlands and lake islands located in close proximity to mine facilities that are considered suitable for nesting. Where active nests are located, nest-specific management plans will be developed. Mitigation measures to prevent birds from flying into power lines such as tying brightly-coloured ‘banners’ onto the lines will also be monitored for their success. Breeding bird surveys will be conducted on a regular basis at both the mine site and a reference site. Data before and after mine construction, and between mine site and reference sites, will analysed to determine whether project-specific effects are occurring.

Vegetation Cover

Vegetation (e.g., lichens) will be sampled for contaminants on a regular basis within the study area (i.e., areas potentially affected by mine activities), and outside the area (i.e., control where project effects are unlikely to occur) both prior to and during the life of the mine. Pre-development sampling has been undertaken to gather information on baseline conditions on the site.

The overall habitat losses within the mine site facilities (main site and all-weather access road) will be monitored on an annual basis to ensure that unaccounted habitat losses do not occur or can be mitigated.

If progressive revegetation is attempted at the tailings impoundment and waste rock storage facilities, these sites will be monitored for success throughout the life of the mine, including closure and post-closure. Roads will be scarified and recontoured, with thought given to creating esker-like habit. Trails, however, will be prepared for regrowth and revegetated artificially. These sites will be monitored for revegetation as possible foraging habitat for herbivores, burrowing rodents, and foraging habitats for predators.

4.26.1.5 Air Quality & Noise Monitoring

The objective of air quality monitoring is to provide data to determine the environmental effect of project activities upon air quality. Air Quality monitoring will address the most prominent issues for mining projects: the concentration of suspended particle matter in the air surrounding the major areas of activity (dynamic monitoring), and the deposition rate of particles (static monitoring).

Dynamic monitoring will be based on high volume air sampling for particulate matter of diameter equal or less than 10 µm (PM_{10}) and 2.5 µm ($PM_{2.5}$), as well as total suspended particulate (TSP). The most suitable HV sampler available on the market today is Staplex Model TFIA. The instrument’s flow rate is

0 to 70 ft^3/min with the low range flow of 0 to 2 ft^3/min. It is suitable for both spot or continuous monitoring.

Alternatively, lower volume sampler might be adopted for monitoring during construction and operation of the project. There are several $PM_{2.5}$, PM_{10}, and TSP samplers available on the market that can be used either as a stand-alone module or in combination with up to three satellite units. The monitoring sampler will be deployed at the plant boundary in the direction of prevailing wind away from any taller structures or hills. Results will be extracted in a monthly basis and compared with relevant ambient air quality standards to find facility compliance status.

The monitoring sampler will be deployed at the plant boundary in the direction of prevailing wind away from any taller structures or hills. Results will be extracted in a monthly basis and compared with relevant ambient air quality standards to find facility compliance status.

Static monitoring of dust deposition will follow D1739-98 “Standard Test Method for Collection and Measurement of Dustfall” (Settleable Particulate Matter). It involves installation of a dust canister to measure the amount of dust that settles out of the atmosphere by the effect of gravity deposited on a unit area over a certain length of time. It is proposed to deploy three static samples: near the dynamic sampler and by two open pits areas on the ground level to monitor the rate of PM deposition near the mining sites. The samplers should be replaced every month and gravitational analyses performed at the plant’s laboratory. The ambient air "trigger levels" for dust fallout is a mining-standard 4 g/(m^2 month) averaged over one month.

The ambient air "trigger levels" specified in the Air Quality Management Plan are: suspended particulate, 45 µg/m^3, averaged over seven days; and deposited particulate, 4 g/m^2/month, averaged over one month.

No continuous monitoring is proposed for gaseous pollutants, except NO_x, because of relatively low concentrations in the ambient air as predicted by the AERMOD dispersion model.

The purpose of ambient air quality monitoring is not only to check degree of compliance but also to:

- commit to reporting emissions in support of Canada's Voluntary Challenge & Registry
- refine environmental management systems, reporting and stewardship
- support research and data-gathering efforts to encourage a better understanding of the issue and its integration into the public policy debate
- promote cleaner technology to improve performance
- report PM emissions to National Pollutant Release Inventory (NPRI).

The PM monitoring program will be implemented for operational phase only, as emissions during the construction phase will continuously change spatially and temporally. After the first year of monitoring during the operation phase, the results will be reviewed and, if necessary, the sampling program will be maintained, expanded, or discontinued.

The following items will be included in a dust monitoring report:

- the fallout guidelines and dust concentration standards for the facility
- the type of monitoring test conducted (that is, the concentration or fallout measurements)
- the monitoring locations
- the instrumentation used
- the weather conditions during ambient quality survey (monthly weather report)
- the time and duration of monitoring, including dates
- the results of monitoring at each monitoring location (daily for concentrations in $\mu g\ m^{-3}$, monthly for fallout in $g\ m^{-2}\ month^{-1}$)
- measurement error analysis (statistical and systematic errors)
- Partisol sampler audit report
- quality assurance/quality control (QA/QC) data
- a statement outlining the development's compliance or non-compliance with the limit
- where concentrations or dust fall exceedances are found; the reason for non-compliance should be discussed
- the strategies to be used to manage air quality exceedance
- annual report should summarized monthly report and give annual arithmetic mean as well as statistical analysis; graphs would add to transparency of the results.

A concurrent equipment maintenance program and good operating practice will further control undesirable air emissions.

The ambient noise monitoring program during both the construction and operation phase will include two 24-hour (day and night) measurements during the first year of development and every second thereafter to determine noise parameters such as the equivalent continuous noise level (L_{eq}) in decibels (dBA), the A-weighted sound pressure level that is exceeded for 50% and 90% of the time over which a given sound is measured (L_{A50} and L_{A90}) and frequency noise analysis. Measurements will be taken at noise-sensitive locations where noise levels are likely to be the highest. Noise measurements will follow a recognized guideline such as Alberta Energy and Utilities Board's (EUB) *Guide 38.*

The following items are to be included in a noise monitoring report:

- the type of monitoring test conducted (that is, the construction stage or operation)
- the noise limits (daytime and nighttime) for the facility
- description of the nearest affected receivers
- the monitoring locations
- the noise instrumentation used
- the weather conditions during noise survey
- the time and duration of monitoring, including dates
- the results of noise monitoring at each monitoring location
- a statement outlining the development's compliance or non-compliance with the limit
- where noise exceedances are found; the reason for non-compliance should be stated
- the strategies to be used to manage the noise exceedance.

The noise monitoring results will be used for noise management plan evaluation and review.

4.26.1.6 Permafrost Monitoring

Several of the Meadowbank project components benefit from, or require, freezing conditions. During construction, operation, and closure of these facilities, thermistor strings will be installed and ground temperatures monitored to ensure predicted geothermal performance is in accord with actual performance.

Thermal Monitoring of Tailings & Tailings Dike

Thermistors will be installed around the perimeter of the tailings storage facility and within the tailings dike to monitor freeze-back and compare against predictions. Vertical thermistor strings instrumented with multiple temperature monitoring points will be installed through the tailings and into the underlying foundation soils and rock. Consideration will be given to installing horizontal thermistor cables in the tailings beaches throughout a number of the active deposition stages for the facility. The thermal performance of the tailings storage facility and tailings dike will be measured against the predicted performance, allowing the closure plan to be adapted to actual operational conditions.

Thermal Monitoring of Perimeter Dikes

Although freezing of the perimeter dikes is not considered a significant contributor to the performance of the perimeter de-watering dikes, thermistor installations will be installed along the dike alignments to monitor the thermal regime within the dikes during operations and during the monitoring and maintenance phase of the project.

4.26.1.7 Socioeconomic Monitoring

The imperative of the project to deliver concrete economic benefits suggests that the measurement of those benefits is a priority for monitoring activity. Monitoring is also necessary to establish trends in community wellness so that problems that may be related to the project, or those the project can effectively address, can be identified. The primary objectives of socioeconomic monitoring are thus to:

- record the uptake of employment, business, and education and training opportunities over time and to analyze the trends in this uptake in relation to expectations and targets
- monitor the implementation of education, training, workforce management and other mitigation and benefit enhancement initiatives as described in this document and in the IIBA
- evaluate the trends in community wellness and the relationship between these and project operations.

Cumberland’s IIBA Coordinator and other management staff would informally monitor the day-to-day implementation of socioeconomic mitigation and benefit enhancement measures in the course of management and administration of their relationship with the project workforce, the population of Baker Lake and their leadership, and partner organizations.

In addition, more formal monitoring systems, and documenting of results, are also required. Cumberland will, in the course of regular operations, record information on many parameters. The IIBA will include monitoring provisions, with responsibilities shared between Cumberland and the KIA. Finally Cumberland will participate as may be agreed with levels of government from the local level up to the federal level, towards ensuring that undertakings in this document are fulfilled and to evaluate community wellness in relation to the project. In this last regard, Cumberland undertakes to negotiate a monitoring agreement.

Operations Monitoring by Cumberland

Cumberland undertakes to:

- maintain full human resource records in a form that will permit an annual roll-up of selection, employment, promotion, training, and exit statistics on the workforce by residence, ethnicity, gender, level, and field as a percentage of the total workforce
- maintain procurement records in a form that will permit an annual roll-up of the number, value, and general content of contracts for goods and services by supplier location and ownership as a percentage of total procurement
- require all contractors and subcontractors to provide annual reports documenting the same employment and business information
- maintain health and safety, accident, workforce behaviour, and other relevant records pertaining to events that occur in direct relation to Cumberland operations
- at least annually, undertake a formal review of the results of the above to determine the success and trends over time of initiatives to enhance participation of Inuit people and businesses, accommodate concerns of the local population, and to identify any specific obstacles or problem areas
- maintain records on all formal consultations, meetings, and grievance and dispute events with the public, leadership, partner organizations, the project workforce, contractors, and advisory bodies to the project, noting attendance, issues raised, and resolutions

- at least annually, undertake a formal review of the results of the above to identify any systematic successes or failures
- maintain records on all funding and other inputs (activities of the Cumberland IIBA Coordinator, the Labour Force Development Plan, information provided to the KIA such as human resource policies, etc.) provided to the KIA under terms of the IIBA.

Cumberland will communicate the results of this monitoring internally to management and to the workforce as appropriate, such that the information can be used to adjust policies, procedures, mitigation and enhancement measures, and behaviours where deemed necessary. The results will also be reported annually in an appropriate form as input into the monitoring systems provided for under the IIBA, and as may be agreed with governments. Results will also be discussed with Baker Lake, as appropriate, as part of ongoing consultation and information exchange on the project.

Monitoring Related to the IIBA

Cumberland will participate with the KIA to develop a framework for monitoring of implementation of commitments as will be set out in the IIBA. The details of this framework are presently being negotiated, but will include agreement that the IIBA implementation committee, which includes KIA, Baker Lake and Cumberland membership, will be responsible for monitoring.

The primary concern of the KIA in its joint monitoring with Cumberland is to ensure compliance with undertakings contained in the IIBA. Each of Cumberland and the KIA will be responsible for monitoring compliance of their respective obligations. On Cumberland’s part, this would entail making available to the implementation committee the results of operations monitoring described above. On KIA’s part, this would primarily entail making available to the implementation committee information on the distribution and uptake of education and community initiative funds agreed as part of the IIBA.

Collaborative Socioeconomic Monitoring

Cumberland undertakes to work with the governments of the Hamlet of Baker Lake, of Nunavut and of Canada to put in place a monitoring mechanism to ensure that undertakings in this document, whether included under the IIBA or otherwise, are fulfilled and to monitor community wellness in relation to the project. At the time of writing, discussions between Cumberland and the various levels of government have not been initiated. Cumberland would however propose a Baker Lake based socioeconomic monitoring committee, with membership of each of the three levels of government, as well as Cumberland. With government initiative to the set up this committee, the committee itself would develop the full detail of a socioeconomic monitoring program and define its overall mandate.

The monitoring of the project's eventual socioeconomic impacts on Baker Lake, including those on individual, family, and community wellness, is problematic because although there is much experience in identifying indicators of community wellness, it has proven extremely difficult to disentangle cause and effect. The project will not be the only force of change in the area. The selection of monitoring indicators and the methods of analysis of those indicators requires careful planning if the socioeconomic monitoring committee is to be enabled to establish relationships between the project and socioeconomic change in Baker Lake.

The baseline study has collected some data against which to measure trends in such areas as population, educational achievement, average household size, participation and employment rates, and average income. These data are periodically publicly reported by government based on household surveys or other sources of information, and thus are straightforward to collect over time.

Local education, health, and police services keep detailed data on their operations. Such data include rates of teenage pregnancy, attempted and actual suicides, incidents of domestic violence, mental health breakdown, and arrests for various types of crime. Social services are often able to interpret their data as well, which would facilitate the deliberations of the socioeconomic monitoring committee.

Monitoring perceptions through ongoing consultation with affected populations is also important. The extent of sharing and cooperation, the degree to which the project workplace accommodates Inuit culture, the levels of disturbance due to increased traffic, and the legal but disruptive behaviour of out-of area workforces are examples of subjective experiences.

As data from the above activities become available, they will need to be interpreted to indicate any evidence of socioeconomic trends and their relation to the project if the monitoring results are to be used effectively in adjusting mitigation. The socioeconomic monitoring committee may choose to undertake special studies as deemed valuable.

Monitoring and analysis of the impacts of resource development projects on communities across the North is ongoing by governments, special purpose agencies, academics, and resource extraction companies. Insights from such studies can inform the interpretation of data collected in Baker Lake as described above.

Cumberland would expect to work with representatives of the governments of Baker Lake, Nunavut, and Canada in order to develop the details for socioeconomic monitoring.

4.27 AUDITING & CONTINUAL IMPROVEMENT SYSTEM

Despite careful planning, it is probable that certain components of the environmental management system proposed in this document will need to be modified. It will therefore be necessary to audit or review the plan to pinpoint components that need correction, adjustment, or upgrading. Not only the operational aspects of the plan, but any paperwork that deals with the plan, will be reviewed. Cumberland's goal will be to continuously audit all aspects of the plan, in accordance with ISO 14001 protocols, for effectiveness.

Throughout the mine life, as policies and regulations change and technology advances, the EMP will be modified to address changes and to benefit from technological advances. The primary objective will be continued compliance with regulations governing the project.

Formal evaluations of the EMP will be documented, deficiencies noted in the report, and progress in addressing deficiencies tracked in writing. Responsibilities to address deficiencies and accountabilities will be assigned and deadlines for addressing required changes will be set. The Meadowbank mine site supervisor will assume overall responsibility for the process; authorization for expenditures may be required from other management personnel.

Mining is a capital-intensive industry and major facilities will not be changed during the life of the mine, considering its eight-year life span. Technological change will, however, be monitored through regular information exchanges with operating mines, especially gold mines in the Arctic. Mine personnel will also monitor relevant technical literature for process changes that may be practically implemented.

4.28 CLOSURE & RECLAMATION

Mine closure activities represent dismantling and removing 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.

Mine closure and reclamation will utilize currently accepted management practices and appropriate mine closure techniques that will comply with accepted protocols and standards. Figure 4.42 shows the closure concept for the Meadowbank mine. Closure will be based on project design and operation to minimize the area of surface disturbance, stabilize disturbed land surfaces and permafrost against erosion, and return the land to post-mining uses for traditional pursuits and as appropriate wildlife habitat.

The waste storage facilities will be progressively closed during mine operations. A dry cover of non-acid-generating ultramafic rock will be placed over potentially acid-generating waste rock piles and tailings impoundment to confine the permafrost active layer within relatively inert materials. Monitoring, inspection, and maintenance activities will be carried out during mine operations to progressively modify the abandonment and restoration plan according to the monitoring and assessment results.

All surface buildings and infrastructure will require reclamation and closure measures upon completion of mine operations. The mill complex, site services, and power plant will be dismantled and removed off site as salvage materials, or deposited in the open pits or waste storage areas. Other surface facilities (camp complex, ancillary shop, warehousing and office facilities, mine site tank farm, and a number of dry storage facilities) will be dismantled and buried on site. All infrastructure that may be required for mine operations including the airstrip, roads, plant site, storage pads, quarries, and granular borrow areas (if present) will be re-contoured and/or surface treated according to site specific conditions to minimize erosion from surface runoff and wind blown dust, and enhance the development site area for revegetation and wildlife habitat.

Should a dedicated treatment system be required at the end-of-mine life, it could consist of ferric sulphate and lime addition in a reactor clarifier or HDS-type system and flocculent followed by direct filtration in a sand filter to remove remaining particulate and possibly final pH adjustment with CO_2 or acid to meet permit limits and reduce ammonia toxicity if it is an issue. Enhanced natural attenuation may also be considered, which would require nutrient addition to achieve acceptable rates of nitrogent compound removal. A dry cover of non-acid-buffering ultramafic rock will be placed over potentially acid-generating waste rock piles and tailings impoundment to confine the permafrost active layer within relatively inert materials. Monitoring, inspection, and maintenance activities will be carried out during mine operations to progressively modify the abandonment and restoration plan according to the monitoring and assessment results.

The water management facilities (see Section 4.24.2.3), including the dewatering dikes, attenuation ponds, collection ditches, sumps and treatment plants, will be required to remain in place until mine closure activities are completed and monitoring results demonstrate that the water quality conditions are acceptable for discharge of all contact water to the environment without treatment.

Access to open pits will be secured by placement of rock berms around the pit perimeters prior to flooding to minimize hazards to human and wildlife. Where the upper portions of the pit walls will be within 8 m of the flooded pit lake surface elevation, these will be contoured to provide optimal habitat for fish.

Once the water quality from the mine development area meets discharge criteria, the water collection system will be drained and recontoured to blend with the surrounding topography and to allow uninterrupted drainage of surface runoff to the surrounding lakes.

At end-of-mine life, the reclaim pond water quality will require treatment to meet MMER criteria for arsenic, copper, nickel, zinc and possibly nitrate and ammonia. Treatment alternatives would include:

- in-pit treatment for metals in conjunction with enhanced attenuation for ammonia and nitrate

- in-pit treatment thru enhanced attenuation for ammonia and nitrate and a separate dedicated treatment for metals in a water treatment system assembled, in part, from equipment in the mill.

The dewatering dikes will be breached after pit flooding is successfully completed and water quality has improved to the point where mixing will not cause exceedances above CWQG for aquatic life. The abandonment and restoration plan will be developed in conjunction with the mine plan so that abandonment considerations can be incorporated into the mine design.

Monitoring and maintenance will be carried out during all stages of the mine life. Monitoring will be essential to demonstrate the safe performance of the mine facilities, and will assist in identifying non-compliant conditions, allow maintenance and planning for corrective measures to be completed in a timely manner, and enable successful completion of the reclamation and closure plan.

4.29 OUTSTANDING ISSUES

There are no major outstanding environmental issues associated with the construction, operation, reclamation, or closure of the Meadowbank Gold project that are not addressed in this Environmental Impact Statement.

Ongoing negotiations and a signed IIBA agreement will allow the potential socioeconomic impacts of the project discussed in this document to be more thoroughly evaluated.

5.0 CONSULTANTS & ORGANIZATIONS, ABBREVIATIONS & REFERENCES

Contributing Consultants

Company	Contact Person	Role	Address	Telephone	Fax	Email
AMEC Americas Ltd, Vancouver	Lynton Gormely	Project Description and Project Alternatives	Ste 400 - 111 Dunsmuir St., Vancouver, BC V6B 5R3	604-664-3312	604-664-3057	lynton.gormely@amec.com
AMEC Earth & Environmental, Edmonton	Neil van der Gugten; Andrew Chan	Hydrology & Climate	4810 – 93rd St., Edmonton, Alberta T6E 5M4	780-436-2152	780-435-8425	neil.vandergugten@amec.com; andrew.chan@amec.com
AMEC Earth & Environmental, Edmonton	Richard Palczynski	Air Quality & Noise	4810 – 93rd St., Edmonton, Alberta T6E 5M4	780-436-2152	780-435-8425	richard.palczynski@amec.com
AXYS Environmental Consulting Ltd.	Jeff Green Scott Grindal	Cumulative Effects Assessment; Baseline Wildlife Studies; Terrestrial Ecosystem Management Plan	Ste. 600, 555 Fourth Ave. SW, Calgary, Alberta T2P 3E7	403-703-2432	403-269-5245	jgreen@axys.net sgrindal@axys.net
AXYS Environmental Consulting Ltd.	Jason Shaw	Ecological Land Classification of the RSA	P.O. Box 2219 2045 Mills Road West Sidney, B.C. V8L 3S8	250-655-2279	250-656-4789	jshaw@axys.net
Azimuth Consulting Group Inc.	Randy Baker	Aquatic & Fisheries Components; Physical EIA	#218 0 2902 West Broadway, Vancouver, BC V6K 2G8	604-730-1220	604-739-8511	rbaker@azimuthgroup.ca
Baker Lake Project Office	Michael Haqpi			867-793-4610	867-793-4611	michael.haqpi@nv.sympatico.ca

List of Consultants – Continued

Company	Contact Person	Role	Address	Telephone	Fax	Email
Baker Lake Residents	Tom Mannik Jacob Ikinlik Victor Utatnaq Josie Attutuva Jarus Kingilik Jackie Kingilik Andrew Kalluk Hugh Haqpi Isaac Arngnaaq Larry Mannik Marvin Mannik Travis Mannik Roy Avaala Kevin Martee:	Wildlife, Vegetation, Fish and Aquatic, and Archaeological Surveys	Baker Lake	867-793-2671 (Tom Mannik contact)		tmannik@hotmail.com
Ben Hubert & Associates Ltd.	Ben Hubert	Reviewer – Wildlife and Vegetation Components	1660 Evergreen Hill, Calgary, Alberta T2Y 3B6	403-256-0017	403-256-1228	ben.hubert@telus.net
BGC Engineering Inc.	Wayne Savigny	Physical EIA	#500 – 1045 Howe Street, Vancouver, BC V6Z 2A9	604-684-5909	604-6845909	wsavigny@bgcengineering.ca
Bob Fuller		Ecological Land Classification and Vegetation Surveys (2005)	1829 Dunnett Crescent, Victoria, BC V8N 2P4	250-472-1163:		bobfuller@shaw.ca
Cumberland Resouces	Craig Goodings	Environmental Manager for Cumberland		604-608-2557	604-608-2559	cgoodings@cumberlandresources.com
Cumberland Resources	Rasool Mohammad	GIS Analyst		604-608-2557	604-608-2559	rmohammad@cumberlandresourcescom
FMA Heritage Resource Consultants Inc.	Gloria Fedirchuk	Reviewer – Archaeology Baseline Report	#200 – 1719 Tenth Ave. SW, Calgary, Alberta T3C 0K1	403-245-5661	403-244-4701	gloria.fedirchuk.fma@telusplanet.net
Gartner Lee	Alistair Kent	Reviewer – Physical EIA	#490 – 6400 Roberts St., Vancouver, BC V5G 4C9	604-299-4144	604-299-1455	akent@gartnerlee.com

List of Consultants – Continued

Company	Contact Person	Role	Address	Telephone	Fax	Email
Gebauer & Associates Ltd.	Martin Gebauer	Environmental Coordination and Wildlife Components	6387 Larch Street, Vancouver, BC V6M 4E8	604-261-2716	604-261-2716	gebauer@telus.net;
Golder Associates Ltd., Burnaby	Cameron Clayton	Hydrogeology, Permafrost, and Geomorphology Baseline Studies; Project Alternatives	#500 – 4260 Still Creek Drive, Burnaby, BC V5C 6C6	604-296-4293	604-298-5253	cameron_clayton@golder.com
Golder Associates Ltd., Ottawa	Valerie Bertrand	ARD and Baseline Geochemistry; Water Quality Predictions	32 Steacie Drive Kanata, Ontario K2K 2A9	613-592-9600	32 613-592-9601	valerie_bertrand@golder.com
Golder Associates Ltd., Calgary	Susan Ross	Socioeconomic EIA and Monitoring Plan and Baseline reviewer	10th Floor, 940 6th Ave. SW, Calgary, Alberta T2P 3T1	403-299-4663	403-299-5606	susan_ross@golder.com
Goodings Environmental Inc.	Craig Goodings	Environmental Manager for Cumberland.	18157 21A Ave., Surrey, BC V4P 3B9	604-341-7042		craigg@telus.net
Hattie Mannik/Tom Mannik	Hattie Mannik Tom Mannik	Traditional Knowledge Interviewers				hmannik@hotmail.com
Ibis Consulting Group, Inc.	Darlene Hughes	Technical Editor / Writer; Traditional Knowledge	2162 Turnberry Lane, Coquitlam, BC V3E 3N4	604-945-4247		dhughes@ibisgroupinc.com
Levelton Consulting	Bob Humphries	Reviewer - Air Quality & Noise Components	#150 – 12791 Clarke Place, Richmond, BC V6V 2H9	604-278-1411	604-278-1042	bhumphries@levelton.com
Mehling Environmental Management Inc.	Peri Mehling	Geochemistry and Water Quality EIA	3826 Balaclava St., Vancouver, BC V6L 2S8	604-731-4150	604-733-4255	pmehling@mehlingenvironmental.com
North/ South Consultants Inc.	Michael Lawrence	Reviewer – Aquatic & Fisheries Components	83 Scurfield Blvd., Winnipeg, Manitoba, R3Y 1G4	204-487-5636	204-477-4173	mlawrence@nscons.ca

List of Consultants – Continued

Company	Contact Person	Role	Address	Telephone	Fax	Email
Outcrop Communications Ltd.	Page Burt	Baseline Vegetation Studies	#800-4920 52nd Street, Yellowknife, NWT	867-766-3258		page@outcrop.com
Points West Heritage Consulting Ltd.	Gabriella Prager		Site 5, Box 15, R.R.#2, Leduc, AB. T9E 2X2	780-980-2079	780- 980-2179	gprager@interbaun.com
Robert Hornal & Associates Ltd.	Robert Hornal	Baseline Socioeconomic Study	2576 West 7th Ave., Vancouver, BC V6K 1Y9	604-731-2697	604-731-0244	rhornal@istar.ca
SRK Consulting	Steve Day	Reviewer – Waste Rock, Tailings and Overburden Characterization	#800 – 1066 West Hastings, Vancouver, B.C.	604-681-4196	604-687-5532	sday@srk.com
Stand Alone Energy Systems Ltd.	Jack van Camp	1999 Wildlife Surveys	Yellowknife, NWT			
Water Survey of Canada		Hydrology				
Webster	Deborah Webster	Archaeology Baseline Report (1999 and 2002)	138 Niven Drive, Yellowknife, NWT X1A 3W8	867-920-7879		websterdeborah@hotmail.com

5.1 LIST OF ORGANIZATIONS

MEADOWBANK GOLD MINE – DISTRIBUTION LIST

Corporation / Institution Contact Phone Fax E-mail

Cumberland Resources Craig Goodings 604-608-2557 604-608-2559 cgoodings@cumberlandresources.com

Baker Lake Project Office Michael Haqpi 867-793-4610 867-793-4611 michael.haqpi@nv.sympatico.ca

Legal Counsel for NIRB William A. Tilleman 403-246-7505 403-297-4152 tilleman@naturelaw.com

NWB Philippe Di Pizzo 867-669-1238 exec@nwb.nunavut.ca

Phyllis Beaulieu 867-360-6338 867-360-6369 licensing@nwb.nunavut.ca

NPC Brian Aglukark 867-857-2242 867-857-2243 aglukark@npc.nunavut.ca

NWMB Josee Galipeau 867-975-7300 867-975-7320 jgalipeau@nwmb.com

NTI Carson Gillis 867-983-5602 867-983-5624 cgillis@ntilands.com

George Hakongak 867-983-5612 867-983-5624 ghakongak@ntilands.com

Jeannie Ehaloak 983-5618 983-5624 jeannie_ehaloak@ntilands.com

Kivalliq IA (President) Tongola Sandy 867-645-2800 867-645-2348 tsandy@arctic.ca

KIA (Director of Lands) Luis Manzo 867-645-2800 867-645-2348 lmanzo@arctic.ca

KIA (Lands Administrator) Veronica Tattuinee 867-645-2800 867-645-2348 veronica@arctic.ca

KIA (Lands Manager) David Ningeongan 867-645-2800 867-645-2348 davidsn@arctic.ca

Counsel for KIA John Donihee 403-220-3971 403-282-6596 donihee@telusplanet.net

KIA Board Member *(Baker Lake CLARCS Director*) Philip Putumiraqtuq 867-793-4001 867-793-2126

Inuit Heritage Trust William Beveridge 867-979-0731 867-979-6700 wbeveridge@ihti.ca

Keewatin Wildlife Federation David Alagalak 867-857-2695 867-857-2990 kwflucy@saltspring.com

FEDERAL GOVERNMENT

INAC Andy Mitchell (Minister) minister@inac.gc.ca

HQ Anne Snider (A/ Director) 819-997-0046 819-953-2590 snidera@inac-ainc.gc.ca

Eric Hopkins 819-994-7110 819-953-2590 hopkinse@ainc-inac.gc.ca

Don Law-West (Minerals) 819-994-6422 819-953-9066 LawWestD@ainc-inac.gc.ca

Doug Paget (Minerals) 819-994-6435 819-953-9066 PagetD@ainc-inac.gc.ca

Nunavut Robyn Abernethy-Gillis 867-975-4552 867-975-4585 abernethygillisr@inac.gc.ca

Carl McLean (Mgr Lands) 867-975-4280 McLeanC@inac-ainc.gc.ca

Robert Eno (Water) 867-975-4548 867-975-4585 enor@inac.gc.ca

Jason Sharp (Minerals) 867-975-4290 867-975-4276 sharpj@inac-ainc.gc.ca

DFO - Iqaluit Tania Gordanier 867-979-8007 867-979-8039 gordaniert@dfo-mpo.gc.ca

Derrick Moggy 867-979-8011 867-979-8039 moggyd@dfo-mpo.gc.ca

CCG Barry Putt 519-383-1862 519-383-1989 Puttb@dfo-mpo.gc.ca

EC Colette Meloche 867-975-4639 867-975-4645 colette.meloche@ec.gc.ca

Mike Fournier 867-669-4765 867-873-6776 Mike.Fournier@ec.gc.ca

NRCan John Ramsey 613-947-1591 613-995-5719 jramsey@nrcan.gc.ca

Health Canada Carolyn Dunn 613-948-2875 613-941-8921 Carolyn_Dunn@hc-sc.gc.ca

Anjala Puvananathan 416-954-0821 416-952-0236 anjala_puvananathan@hc-sc.gc.ca

Transport Canada Doug Soloway 204-983-7705 204-983-5048 solowad@tc.gc.ca

CEAA Debra Myles 819-994-5225 819-997-4931 Debra.Myles@ceaa.gc.ca

David Robinson 613-957-0024 613-957-0941 DavidJ.Robinson@ceaa-acee.gc.ca

GOVERNMENT OF NUNAVUT

Dept. of Env. Earle Baddaloo (Director) 867-975-5910 867-975-5981 ebaddaloo@gov.nu.ca

Gladis Lemis glemus@gov.nu.ca

Michael Setterington 867-857-2828 867-857-2986 msetterington@gov.nu.ca

Alain Chouinard 867-857-2828 867-857-2986 achouinard@gov.nu.ca

Francois Berniolles 867-645-5067 867-645-2346 fberniolles@gov.nu.ca

Feliks Kappi 867-645-5067 867-645-2346 fkappi@gov.nu.ca

Mathieu Dumond 867-982-7444 867-982-3701 mdumond@gov.nu.ca

Economic Devpt & Transp Gord MacKay 867-975-5917 867-975-5980 gmackay@gov.nu.ca

Enuk Pauloosie 867-360-4638 867-360-4619 epauloosie@gov.nu.ca

Jeremy Ford 867-975-5408 867-975-5981 jford@gov.nu.ca

Comm & Govt. Services Robert Chapple 867-645-8100 867-645-8143 rchapple@gov.nu.ca

Dept. Of Culture & Heritage Doug Stenton 867-975-5500 867-975-5504 dstenton1@gov.nu.ca

Health & Social (Nunavut) Jim Talbot 867-975-5743 867-975-5705 jtalbot@gov.nu.ca

Health & Social (Kivalliq) Fred O’Brien 867-645-2171 867-645-2409 fo’brien@gov.nu.ca

OTHER

Nunavut Research Institute Mary Ellen Thomas 867-979-4108 867-979-4681 slcnri@nunanet.com

Nunavut Tourism Maureen Bungaard 867-979-6551 867-979-1261 maureen@nunavuttourism.com

Fund du Lac Indian Band Chief: Eddie Marton 306-686-2102 306-686-2040 (SK)

Hatchet Lake Indian Band Chief: Angus Joseyounen 306-633-2003 306-633-2040 (SK)

Fort Churchill Indian Band Chief: Ila Bussidor 204-684-2022 204-684-2069 (MB)

Northlands Indian Band Chief: Jo Hyslop 204-337-2270 204-337-2055 (MB)

Treaty Land Entitlement (TLE) Pascal Denechezhe: *Coordinator Northlands Indian Band*

(Beverly Qamanirjuak Caribou Mitch Campbell 867-857-2770 867-857-2986 mcampbell@gov.nu.ca

Management Board) Dan Shewchuk 867-857-2770 867-857-2986 dshewchuk@gov.nu.ca

CARC Kevin O’Reilly 867-873-4715 867-873-3654 koreilly@theedge.ca

Shelagh Montgomery 867-873-4715 867-920-2685 smontgomery@theedge.ca

NWT / Nunavut Chamber of Mines Mike Vaydik 867-873-5281 867-920-2145 mavydik@ssimicro.com

NWT / Nunavut Chamber of Commerce 867-920-9505 867-873-4174 admin@nwtchamber.com

Concerned citizen Peter Tapatai 867-793-2703 867-793-2988 ptapatai@arctic.ca

COMMUNITIES

Rankin Inlet John Hodgson (SAO) 867-645-2895 867-645-2146 munri@arctic.ca

PO Box 310, X0C-0G0 Charlotte Hickes (EDO) 867-645-2895 867-645-2146 charlotte_hickes330@hotmail.com

Aqiggiaq HTO Jerome Tattuinee (Chair) 867-645-2350 867-645-3257 rihto@arctic.ca

Baker Lake Denis Zettler (SAO) 867-793-2874 867-793-2509

PO Box 149, X0C-0A0

Town Planning Committee Karen Yip (Chair) 867-793-2873 icesisxxx@hotmail.com

HTO David Aksawnee (Chair) 867-793-2520 867-793-2034 bakerlakehto@hotmail.com

Community Liaison Officer KIA Hugh Nateela Hugh01@allstream.net

Chesterfield Inlet Roy Mullims (SAO) 867-898-9951 867-898-9108 hamletci@islandnet.com

PO Box 10, X0C-0B0

HTO Andre Tautu (Chair) 867-898-9063 867-898-9079 sylvia@arctic.ca

Arviat Richard Vanhorne (SAO) 867-857-2841 867-857-2519 hamletarv@nv.sympatico.ca

PO Box 150, X0C-0E0

HTO Paul Pemik (Chair) 867-857-2636 867-857-2488

Whale Cove Imelda Angootealuk (SAO) 867-896-9961 867-896-9109 hamwhale@arctic.ca

PO Box 120, X0C-0J0

HTO Soloman Voisey (Chair) 867-896-9944 867-896-9143

Repulse Bay Brian Mcquarrie (SAO) 867-462-9952 867-462-4411 bmcquarr@internorth.com

PO Box 10, X0C-0H0

HTO Steve Mapsalak (Chair) 867-462-4334 867-462-4335

Coral Harbour Lucy Netser (SAO) 867-925-8867 867-925-8233 hamlet@nv.sympatico.ca

PO Box 30, X0C-0C0

HTO Willie Nakoolak (Chair) 867-925-8622 867-925-8300

5.2 ACRONYMS, ABBREVIATIONS & UNITS OF MEASUREMENT

(U.S.) Environmental Protection Agency	EPA
acid rock drainage	ARD
ambient air quality objectives	AAQO
Ammonium nitrate and fuel oil	ANFO
Aquatic Effects Monitoring Plan	AMEP
Baker Lake Prospectors Association	BLPA
Canadian Council of Ministers of the Environment's	CCME
Canadian Environmental Assessment Act	CEAA
Canadian Environmental Protection Act	CEPA
Canadian Environmental Quality Guidelines	CEQGs
Canadian Water Quality Guidelines	CWQG
Canadian Wildlife Service	CWS
carbon-in-pulp	CIP
Canadian Arctic Resources Committee	CARC
Committee on the Status of Endangered Wildlife in Canada	COSEWIC
Conference Board of Canada	CBoC
Culture, Language, Education, and Youth	CLEY
Cumberland Resources Ltd.	Cumberland
cumulative effects assessment	CEA
Department of Environment	DOE
Fishiers & Oceans Canada	DFO
Department of Sustainable Development	DSD
Dissolved organic carbon	DOC
Draft Environmental Impact Statement	DEIS
Ecological Land Classification	ELC
Electromagnetic	EM
Energy and Utilities Board's	EUB
Environmental Effects Monitoring	EEM
Environmental Impact Assessment	EIA
Environmental Impact Review Board	EIRB
Environmental Impact Screening Committee	EISC
Environmental Impact Statement	EIS
Environmental Management System	EMS
Final Environmental Impact Statement	FEIS
Fisheries and Oceans	FAO
Global Positioning System	GPS
Government of Nunavut	GN
Greenhouse gases	GHG
Gross Domestic Product	GDP
Hazardous Materials Management Plan	HMMP
High density sludge	HDS
Hunter's and Trapper's Organization	HTO
Hydrocarbons	HC
Indian and Northern Affairs Canada	INAC
Intergovernmental Panel on Climate Change	IPCC
intermediate volcanic	IV
Inuit Impact Benefit Agreement	IIBA
iron formation rock	IF
Kivalliq Inuit Association	KIA

Local Study Area	LSA
Metal Mining Effluent Regulations	MMER
Meters above sea level	masl
National Pollutant Release Inventory	NPRI
National Research Council	NRC
neutralization potential ratio	NPR
No-Net-Loss	NNL
Northwest Territories	NWT
Northwest Territories' Department of Resources Wildlife & Economic Development	NWTRWED
Nunavut Impact Review Board	NIRB
Nunavut Land & Claims Agreement	NLCA
Nunavut Land Claims Agreement	INAC
Nunavut Land Claims Agreement	NLCA
Nunavut Land Claims Agreement	NLCA
Nunavut Planning Comission	NPC
Nunavut Planning Commission	NPC
Nunavut Tunngavik Incorporated	NTI
Nunavut Water Board	NWB
Nunavut Waters & Nunavut Surface Rights Act	NWNSRA
Occupational Health and Safety Plan	OHSP
Particulate matter	PM
potentially acid-generating	PAG
Program for Regional and International Shorebird Monitoring	PRISM
quality assurance/quality control	QA/QC
quartzite	QTZ
Regional Study Area	RSA
Royal Canadian Mounted Police	RCMP
Senior Arctic Official	SAO
Semi-autogenous grinding	SAG
Sexually transmitted disease	STD
Sivummut Economic Development Strategy	SEDS
Surveillance Network Program	SNP
Suspended particulates	SP
Total dissolved solids	TDS
Total organic compounds	TOC
Tungavik Federation of Nunavut	TFN
Ultramafic (rock)	UM
Valued ecosystem components	VECs
Valued social and economic components	VSECs
Volatile organic carbon	VOC
Workers' Compensation Board	WCB
World Wildlife Fund	WWF

UNITS OF MEASURE

Above mean sea level	amsl
Ampere	A
Centimetre	cm
Cubic centimetre	cm^3
Cubic feet per second	ft^3/s or cfs
Cubic foot	ft^3
Cubic inch	in^3
Cubic metre	m^3
Cubic metres per annum	m^3/a
Cubic yard	yd^3
Day	d
Decibel adjusted	dBa
Decibel	dB
Degree	°
Degrees Celsius	°C
Foot	ft
Gram	g
Grams per litre	g/L
Grams per tonne	g/t
Greater than	>
Hectare (10,000 m^2)	ha
Horsepower	hp
Hour	h
Hours per day	h/d
Hours per week	h/wk
Hours per year	h/a
Inch	"
Kilo (thousand)	k
Kilogram	kg
Kilograms per cubic metre	kg/m^3
Kilograms per hour	kg/h
Kilograms per square metre	kg/m^2
Kilojoule	kJ
Kilometre	km
Kilometres per hour	km/h
Kilopascal	kPa
Kilowatt	kW
Less than	<
Litre	L
Litres per minute	L/m
Megavolt-ampere	MVA
Megawatt	MW
Metre	m
Metres above sea level	masl
Metres per minute	m/min
Metres per second	m/s
Metric ton (tonne)	t
Micro siemen	µS

Microgrames per cubic metres	µg/m^3
Micrometre (micron)	µm
Milligram	mg
Milligrams per litre	mg/L
Millilitre	mL
Millimetre per second	mm/s
Millimetre	mm
Million tonnes	Mt
Million	M
Minute (time)	min
Month	mo
Nephelometric tubidity units	NTU
Ounce	oz
Parts per billion	ppb
Parts per million	ppm
Pascal (newtons per square metre)	Pa
Percent	%
Pound(s)	lb
Square centimetre	cm^2
Square foot	ft^2
Square inch	in^2
Square kilometre	km^2
Square metre	m^2
Tonne (1,000 kg)	t
Tonnes per day	t/d
Tonnes per hour	t/h
Tonnes per year	t/a
Total dissolved solids	TDS
Total suspended solids	TSS
Volt	V
Week	wk
Yard	yd
Year (annum)	a

CHEMICAL SYMBOLS

Aluminum	Al
Ammonia	NH_3
Antimony	Sb
Arsenic	As
Bismuth	Bi
Cadmium	Cd
Calcium	Ca
Calcium carbonate	$CaCO_3$
alcium oxide	CaO
Calcium sulphide dehydrate	$CaSO_4 \bullet 2H_2O$
Carbon	C
Carbon monoxide	CO
Chlorine	Cl
Chromium	Cr
obalt	Co
Copper	Cu
Cyanide	CN
Fluorine	F
Gold	Au
Hydrogen	H
Iron	Fe
Lead	Pb
Magnesium	Mg
Manganese	Mn
Manganese dioxide	MnO_2
Manganous hydroxide	$Mn\ (OH)_2$
Molybdenum	Mo
Nickel	Ni
Nitrite	NO_2
Nitrogen	N
Nitrogen oxide compounds	No_x
Oxygen	O_2
Palladium	Pd
Platinum	Pt
Potassium	K
Selenium	Se
Silver	Ag
Sodium	Na
Sulphur	S
Thallium	Tl
Tin	Sn
Titanium	Ti
Tungsten	W
Uranium	U
Zinc	Zn

5.3 LITERATURE CITED

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