AREVA Resources Canada Inc.

The Kiggavik Project

Project Proposal

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AREVA
PURE ENERGY

EXECUTIVE SUMMARY

The Kiggavik Project is a proposed uranium ore mining and milling operation located in the Kivalliq region of Nunavut approximately 80 km west of the community of Baker Lake. Uranium in the Kiggavik area was identified during the 1970s and 1980s. In 1993, AREVA Resources Canada Inc. (AREVA) became the operator of the Kiggavik Project, and further exploration was carried out between 1993 and 1997. The Project was put in care and maintenance mode in 1998. As the uranium market improved during the first half of 2005, AREVA re-established a number of community and territory contacts in Baker Lake and Nunavut. Field activities, engineering studies and environmental assessment studies resumed in 2007.

AREVA Resources Canada Inc. is a Canadian company headquartered in Saskatoon, Saskatchewan. The company is part of the AREVA Group of companies, headquartered in France, and a world leader in nuclear energy, and electricity transmission and distribution. Sustainable development is at the core of the Group's business strategy. AREVA, and its predecessor companies, have been involved in uranium exploration and in project development and operation in Saskatchewan's Athabasca Basin for the past 40 years. The social partnerships and high level of safety and environmental protection achieved by these operations have enabled economic development to occur in northern Saskatchewan without compromising the future of the land or the people. AREVA is committed to developing a similar outcome for the Kiggavik Project.

The Kiggavik Project has substantial potential to contribute to economic development in Nunavut, particularly in the Kivalliq region. Capital and operating expenditures over the Project lifetime will amount to several billion dollars. AREVA is committed to maximizing the economic benefits to the region. Local employment will be facilitated by preferential hiring for people in the Kivalliq region, combined with employee pick-up points at each community. AREVA also provides extensive on-the-job training and recognizes the need for a broad based education and training strategy to prepare people for employment. AREVA will facilitate local business development; there will be opportunities for existing businesses to expand, and for new businesses to form, in response to Project needs for goods and services.

The objective of this Project Proposal is to introduce the Kiggavik Project to the public and regulatory agencies and to initiate the formal Project review process. This Project Proposal presents AREVA's proposed plans to develop, operate and decommission the Kiggavik Project. It also provides a broad description of the existing biophysical and socioeconomic conditions with the objective of identifying potential interactions with Project components. Preliminary environmental impact studies were used to design key components of the Project. These studies are included in this Project Proposal.

Project Description

There are three main geographical areas incorporated in the Kiggavik Project; these are the Kiggavik site, the Sissons site and the Baker Lake dock site. The main base of operations will be the Kiggavik site, which will include open pit mining, power generation, ore processing, warehousing, administration and personnel accommodation. The proposed activities at Sissons include open pit mining, underground mining, and the ancillary activities required to support these mining operations. The dock site at Baker Lake will serve as a transfer and storage facility for materials and supplies en route to Kiggavik.

The Project includes the development of three open pit mines (East Zone, Center Zone, and Main Zone) at Kiggavik and both an open pit mine (Andrew Lake) and an underground mine (End Grid) at Sissons. The ore would be mined using excavating equipment and then trucked to an ore stockpile. The ore would then be directed to the mill to produce between 2,000 and 4,000 tonnes of uranium (U) as a concentrate, commonly referred to as yellowcake, per year. Clean waste rock from the mines would be used as construction material or placed on the land in designated areas. Subeconomic mineralized waste rock (termed special waste) would be temporarily placed on surface in managed stockpiles during operation and then backfilled in the mined-out open pits after mining is complete. Tailings resulting from the extraction of uranium from the ore would be treated and deposited below ground in two mined-out open pits converted for use as tailings management facilities. A small mined-out open pit (East Zone) would also be used as a water management facility to maximize water storage and recycling. Any water discharged would be treated to meet regulatory discharge requirements for protection of the environment.

Reagents, fuel and supplies would be barged to a storage facility near Baker Lake and then transported to Kiggavik via truck on a 90 – 100 km access road. Several options for this access road will be further considered during the Project review process. An airstrip would be constructed on site for the transport of both employees and materials. The airstrip would also be used to transport drums of uranium concentrate by air to southern Canada. A limited number of concentrate drums may be shipped by barge during the open water season.

The Project would also include construction of an accommodation complex for employees, warehouse and maintenance facilities, fuel tanks, explosives storage, water treatment plants, administration buildings, and haul roads.

Currently the Kiggavik Project is estimated to contain geological resources representing approximately 52,000 tonnes U with a grade of approximately 0.23% U. Mining reserves in the order of 44,000 tonnes U were considered to design the Project. Based on these reserves and production schedule, mining and milling is complete after 17 years of operation.

On completion of mining and milling activities, all Project sites would be returned as close as practical to their natural states. The decommissioning plans include demolition and removal of site facilities and remediation of all site areas that may have become contaminated. Closure of the two tailings management facilities will include the placement of a cover layer and an erosion barrier of waste rock over the tailings. The surface of the final cover will be graded to blend into the existing topography. Closure of the waste rock piles will include the placement of a layer of compacted waste rock, which will be then covered with clean overburden material to encourage revegetation prior to final monitoring. The final surface of the waste rock piles will be regraded to blend into the existing topography and to enhance conditions for wildlife access.

The Kiggavik Project is summarized as follows:

Location Kivalliq Region of Nunavut, approximately 80 km west of Baker Lake.

Property The Project includes two properties: Kiggavik and Sissons (collectively called the Kiggavik Project). The Kiggavik site, located at approximately 64^{o}26'N and 97^{o}37'W is composed of 17 mineral leases, covering 9,808 acres. The Sissons site, located approximately 17 km south-west of Kiggavik at 64º20'N and 97º52'W, is composed of 22 mineral leases, covering 36,371.5 acres.

Resources & Reserves The total quantity of geological resources is currently estimated at 52,000 tonnes U (134 million lbs U_3O_8) at an average grade of 0.23% U. The total quantity of recoverable reserves is currently estimated at approximately 44,000 tonnes U (114 million lbs U_3O_8). Approximately 35% of these reserves are associated with the Kiggavik deposits, while the remainder are associated with the Sissons deposits.

Mining There are five individual mines proposed for the Project: East Zone, Center Zone and Main Zone at Kiggavik; End Grid and Andrew Lake at Sissons. The three Kiggavik deposits and Andrew Lake deposit would be mined via truck-shovel open pit, while End Grid would be an underground mine using underhand drift-and-fill.

Waste Rock Mine waste rock would be segregated into clean and subeconomic mineralized material and managed in surface stockpiles. Clean waste would be used for construction material when possible. Upon completion of mining, subeconomic mineralized waste rock would be backfilled into mined-out pits.

Process The ore would be processed in an on-site mill at Kiggavik to produce approximately 3,000 tonnes U (7.8 million lbs U_3O_8) per year as uranium concentrate, commonly referred to as yellowcake.

Tailings The mill tailings would be managed via in-pit tailings management facilities constructed using the mined-out Center Zone and Main Zone open pits at Kiggavik.

Water Management Site drainage, recycled tailings water, and fresh water from nearby lakes would be used in the mill process. All effluent would be treated prior to discharge.

Life of Mine	Approximately 17 years of operation, based on studies to date. It is currently anticipated that pre-operational construction would require 3 years while post-operational decommissioning would require 5 years.
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Access	Access to the site would be provided by either an all-season road or a winter road between Baker Lake and Kiggavik. Supplies would be shipped to a Baker Lake dock facility during the summer barge season and trucked to Kiggavik via the road. An airstrip would be constructed and operated at site for transportation of personnel and yellowcake. During construction, a winter road would be required for interim site access.
Personnel	The Project is expected to employ 400-600 people during operations. The operation would be fly-in/fly-out on a 7 to 14 day schedule with on-site employees housed in a permanent accommodations complex.

Public Consultation

Public participation is an essential component of AREVA's sustainable development model for mining projects and is one of the 5 guiding principles used by the Nunavut Impact Review Board. AREVA began public participation initiatives for the Kiggavik Project in 2005, two years prior to the resumption of work on the site.

AREVA places a high emphasis on maintaining a consistent presence in Baker Lake. To that end, a Community Liaison Officer was hired in May 2006 and an information office was opened in Baker Lake in August 2006. Ongoing dialogue between AREVA and the community ensures that the community is aware of, and has input into, Project activities. AREVA and the Baker Lake Hamlet Council have therefore cooperated to establish a community liaison committee to facilitate this dialogue. In addition, as the Project has the potential to impact the Kivalliq region, both economically and environmentally, a regional liaison committee that includes members from all seven Kivalliq communities has been in place since 2007.

To supplement the dialogue established through the liaison committees, the Project team frequently participates in meetings within Kivalliq communities to provide Project updates and obtain stakeholder feedback. Over the past three years, meetings have been held with: local residents at community meetings, Hamlet councils, Hunter and Trapper Organizations, Community Land and Resources Committees, wildlife organizations, educational institutions, Inuit organizations, Institutions of Public Government, and regulators. AREVA has also hosted tours of both the Kiggavik site and northern Saskatchewan uranium operations for several of these groups.

Consultation activities for the Kiggavik Project are modified to meet the requirements of each Project phase. The next phase for consultation is the environmental assessment phase. While consultation during this phase will be guided by NIRB, AREVA will continue the consultation activities that have been developed thus far to support further Project design.

Traditional Knowledge

Traditional knowledge, or Inuit Qaujimajatuqangit (IQ), includes Inuit knowledge and insights and incorporates values (including consensus building, collaboration and environmental stewardship) that guide Inuit relationships with the land and its resources, as well as social and cultural life. IQ is invaluable to environmental and social impact assessment, because it includes a wealth of information both on biophysical resources over time and on factors that have affected, and will continue to affect, community health and well being.

The integration of IQ into the Kiggavik Project development work, including the environmental assessment work, is therefore a priority of AREVA. The importance of integration of IQ into Project development on the part of communities has been clear during numerous meetings with people, governments at all levels and local organizations. To date, Inuit traditional knowledge has been sought to advance Project decision making and to inform baseline data collection.

In order to capture the knowledge and experience of community members about the environment, work planning for the Environmental Assessment includes an IQ component. AREVA has obtained a socioeconomic and traditional knowledge research licence from the Nunavut Research Institute to research IQ. IQ results, as well as socioeconomic results as may be relevant, are important to obtain early, as these results will be used as input into Project development, including environmental baseline programs, identification of valuable environmental and socioeconomic components, impact assessments, framing of mitigation and benefit enhancement measures and design decisions as the Project advances.

Existing Biophysical and Socioeconomic Environments

Baseline studies on the biophysical environment for the Kiggavik Project have been scoped to include all Project components and associated sites, including the Kiggavik and Sissons mine facilities, the access road, the Baker Lake port facility and the marine transportation route. In terms of socioeconomics, the closest settlement to the Kiggavik Project site is Baker Lake, approximately 80 km to the east; while Chesterfield Inlet is a further 190 km east, and is located on the Project's marine transportation route. There is potential for both environmental and socioeconomic effects and benefits in these two settlements. The other five settlements in the Kivalliq Region – Rankin Inlet, Whale Cove, Arviat, Coral Harbour and Repulse Bay – are also expected to be affected by the Project, primarily through the potential for employment, training and business opportunities. All seven Kivalliq communities would therefore be included in the socioeconomic study area for the Project.

Based on the above scope, informal community consultation and previous Part 5 reviews in Nunavut, AREVA has developed a list of potential valued ecosystem (VECs) and socioeconomic (VSECs) components for the Project. The potential VECs and VSECs are summarized as follows:

- Biophysical Environment:
  - Air quality and noise
  - Freshwater environment, including surface water and sediments
  - Freshwater fish and fish habitat
  - Permafrost
  - Groundwater
  - Soils and landforms
  - Terrestrial wildlife, including caribou, muskoxen, grizzly bear, and wolverine
  - Birds, including raptors and upland breeding birds
  - Vegetation and associated biodiversity
  - Marine environment, including water, sediments, fish, marine mammals and habitats

- Human and Socioeconomic Environment:
  - Employment
  - Education and training
  - Business opportunities
  - Community health and well being
  - Traditional culture
  - Social and physical services and infrastructure
  - Economic and fiscal benefits
  - Heritage sites

It is anticipated that the identified ecosystem and socioeconomic valued components will be further refined through the regulatory scoping process and through continued public consultation.

For most components, recent baseline data from 2007 and historical baseline data gathered during the 1980s and early 1990s is currently available and has been summarized in this Project Proposal. It is expected that, through on-going studies during 2008 and 2009, an additional one to two years of baseline data, including associated traditional knowledge, will be incorporated in the draft Environmental Impact Statement (DEIS).

Potential Environmental Effects and Proposed Mitigation

The Kiggavik Project has the potential to impact the biophysical and human environments through components associated with all phases of the Project life, including construction, operation, decommissioning, and post-decommissioning periods. Preliminary assessments of effects have considered the full scope of the Project, including the mine sites and associated infrastructure, the access road, and the marine transportation route.

The components of the biophysical environment that could potentially be affected by the Project are as follows:

- Air quality
- Noise

- Ground stability and permafrost
- Groundwater quality
- Surface water drainage
- Freshwater and marine sediment and water quality
- Freshwater and marine aquatic organisms, fish and fish habitat
- Terrestrial and marine wildlife
- Soils, landforms and vegetation

The potential human and socioeconomic components that may be affected by the Project are as follows:

- Human health
- Heritage sites
- Employment opportunities and incomes
- Education and training opportunities
- Business opportunities
- Traditional lifestyles and community well-being
- Infrastructure and social services

Mitigation measures for many of the above potential effects have been developed and incorporated in the Project design and/or the proposed management and operating strategies. These measures are described in this Proposal and will be further developed during the environmental assessment phase.

The three Project operational sites (Kiggavik site, Sissons site, and Baker Lake dock and storage site), the access road connecting them, and the marine transportation route through Baker Lake and Chesterfield Inlet, are all within the territory of Nunavut. The majority of the potential effects of the Project will be at, or in close proximity to, these operational areas. However, several species, including caribou, migratory birds, and grizzly bears, found in the Kiggavik area may travel outside the territory of Nunavut. Similarly, marine wildlife, including seals, beluga and narwhal, may migrate throughout Hudson Bay and beyond. Mitigation measures are expected to minimize impacts to these species in the vicinity of the Project sites.

Some Project residual effects may overlap spatially and temporally with other existing or possible future projects in the region, creating the potential for cumulative effects. These effects could include:

- reduction in air quality
- increase in noise
- degradation of unique landforms
- degradation of heritage sites
- impacts on surface water and groundwater quality
- habitat loss or alteration,
- increased human interaction with terrestrial wildlife, birds, marine mammals and marine and freshwater fish, potentially causing disturbance or disruption of movement patterns, indirect or direct mortality, or acoustic disturbance.

AREVA continues to improve Project design and to evaluate the potential effects of the Project on the people, environment and wildlife of the Kivalliq. AREVA is committed to regulatory compliance and public consultation to ensure that the Project is carried out safely, potential environmental effects are mitigated, and that the Project benefits the people of the region.

Organizational Management and Key Programs

AREVA has identified seven key areas that will be integral to the successful operation of the Kiggavik site. These are:

- Quality
- Health and Safety
- Radiation Protection
- Environmental Protection
- Human Resources and Training
- Economic Viability
- Social Aspects

The Project will draw extensively on the organizational and operating experience of the Saskatchewan sites currently operated by AREVA; however the Kiggavik programs will be adapted to reflect the unique characteristics of the Kivalliq region through public consultations, regulatory processes and benchmarking with existing Arctic operations.

Management plans have been developed to administer the Environment, Health and Safety Program at the active Kiggavik exploration site; including the:

- Radiation Protection Plan
- Waste Management Plan
- Emergency Response Plan
- Wildlife Mitigation and Monitoring Plan
- Spill Contingency Plan
- Abandonment and Restoration Plan
- Noise Abatement Plan

These plans will continue to be implemented and improved at Kiggavik. As these plans represent AREVA's growing experience in Nunavut, they will be used, in concert with existing operational programs and plans, as a reference point for the creation of plans specific to Project development, operation and closure.

Summary

This Project Proposal presents AREVA's proposed plans to develop, operate and decommission the Kiggavik Project. It also provides a broad description of the existing biophysical and socioeconomic baseline conditions. Preliminary environmental impact studies, as well as a range of measures to mitigate potential adverse effects from the Project and to enhance potential positive effects, have been used to design key aspects. Based on the work completed to date, and many years of successful experience in northern Saskatchewan, AREVA believes that the Kiggavik Project can be carried out safely, that all potential environmental effects can be mitigated, and that benefits to the people of the Kivalliq region can be realized. AREVA is committed to achieving this outcome through further optimization and assessment of the Project, which will result through the consultation processes and regulatory reviews associated with the environmental assessment process.

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KIGGAVIK PROJECT

Project Proposal

<u>MAIN DOCUMENT</u>

TABLE OF CONTENTS

SECTION **PAGE**

1 INTRODUCTION 1-1

1.1 General 1-1

1.2 Project Location and Purpose 1-1

1.2.1 Project Location..1-1

1.2.2 Project Fact Sheet 1-2

1.2.3 Purpose of the Project and Need for the Project 1-4

1.2.4 Alternatives to the Project...1-4

1.3 Project Background 1-4

1.4 Policy Framework for Uranium Development.....................................1-6

1.5 Required Permits, Approvals and Licences 1-9

1.5.1 DFO Operational Statement of Conformity.....................................1-12

1.6 Project Proponent 1-13

1.7 Document Scope and Organization...1-15

1.8 Supporting Documents..1-16

2 PROJECT DESCRIPTION.. 2-1

2.1 Introduction 2-1

2.1.1 Basic Configuration 2-1

2.1.2 Project Schedule 2-2

2.2 Geology and Resources 2-2

2.2.1 Kiggavik Site Geology 2-2

2.2.2 Sissons Site Geology 2-4

2.2.3 Project Resources and Reserves 2-5

2.3 Mining..2-6

2.3.1 General...2-6

2.3.2 Production Schedule 2-6
2.3.3 Kiggavik Mines 2-6
2.3.3.1 East Zone 2-8
2.3.3.2 Center Zone 2-8
2.3.3.3 Main Zone 2-9
2.3.3.4 Dewatering at Kiggavik 2-9
2.3.4 Sissons Mines 2-9
2.3.4.1 Andrew Lake Open Pit 2-10
2.3.4.2 End Grid Underground Mine 2-11
2.3.4.3 Dewatering at Sissons 2-13
2.3.5 Alternatives 2-14

2.4 Waste Rock Management 2-15
2.4.1 Introduction 2-15
2.4.2 Waste Rock Characterization 2-15
2.4.3 Special Waste Characterization 2-17
2.4.4 Quantities 2-17
2.4.5 Management Plan 2-18

2.5 Process Description 2-20
2.5.1 Milling Design Considerations and Selection 2-20
2.5.2 Process Description 2-21
2.5.2.1 Ore Handling 2-21
2.5.2.2 Grinding 2-21
2.5.2.3 Leaching 2-21
2.5.2.4 Resin-in-Pulp 2-22
2.5.2.5 Solvent Extraction (SX) 2-22
2.5.2.6 Impurity Precipitation 2-23
2.5.2.7 Uranium Precipitation 2-23
2.5.2.8 Yellowcake Packaging 2-23
2.5.2.9 Tailings Neutralization 2-23
2.5.2.10 Reagent Preparation 2-24
2.5.3 Alternatives 2-26
2.5.3.1 Reagent Options 2-26
2.5.3.2 Solid-Liquid Separation Options 2-26
2.5.3.3 Product Purity 2-26
2.5.3.4 By-Product Processing 2-27

2.6 Tailings Management 2-27
2.6.1 Concept 2-27
2.6.2 Tailings Properties 2-28
2.6.3 Production Schedule 2-28
2.6.4 Tailings Preparation 2-29
2.6.5 Tailings Placement 2-29

2.6.6 Decommissioning 2-30

2.7 Water and Waste Management 2-30
2.7.1 Fresh Water Use 2-31
2.7.1.1 Site Requirements 2-31
2.7.1.2 Sources of Fresh Water 2-31
2.7.2 Water Treatment 2-34
2.7.2.1 Kiggavik Water Treatment 2-34
2.7.2.2 Sissons Water Treatment 2-34
2.7.2.3 Domestic Water Treatment 2-34
2.7.3 Treated Effluent Discharge 2-34
2.7.4 Wastewater and Sewage 2-35
2.7.5 Dewatering of Andrew Lake 2-36
2.7.6 Solid Waste Management 2-36
2.7.6.1 Domestic Waste 2-36
2.7.6.2 Industrial Waste 2-36
2.7.6.3 Contaminated Waste 2-36
2.7.6.4 Hazardous Waste 2-36

2.8 Site Infrastructure 2-37
2.8.1 Power Supply and Facilities 2-37
2.8.1.1 Power House 2-38
2.8.1.2 Site Power Distribution 2-39
2.8.1.3 Fuel Storage and Distribution 2-40
2.8.1.4 Site Power Alternatives 2-40
2.8.2 Communications Systems 2-40
2.8.3 Airstrip 2-41
2.8.3.1 Airstrip Design and Construction 2-41
2.8.3.2 Airstrip Location 2-42
2.8.4 Site Haul Road 2-42
2.8.5 Explosives 2-43
2.8.6 Hazardous Materials 2-43
2.8.7 Site Accommodations 2-44

2.9 Logistics and Transportation 2-45
2.9.1 General 2-45
2.9.2 Project Shipping Quantities 2-46
2.9.3 Marine Transportation 2-48
2.9.3.1 Ocean-going vessels 2-48
2.9.3.2 Tug-Barge Fleet 2-48
2.9.4 Baker Lake Facilities 2-49
2.9.4.1 Facility Location 2-49
2.9.4.2 Wharf 2-49
2.9.4.3 Tank Farm and Fuel Loading 2-50

2.9.4.4 Storage Facilities 2-50
2.9.5 Road Transportation 2-51
2.9.5.1 All-Weather Road Options 2-52
2.9.5.2 Winter Road Option 2-54
2.9.6 Yellowcake Transportation 2-55
2.9.6.1 Air Shipment of Yellowcake 2-55
2.9.6.2 Marine Shipment of Yellowcake 2-55
2.9.7 Personnel Transportation 2-56
2.9.8 Summary of Transportation Alternatives 2-56

2.10 Decommissioning and Reclamation 2-57
2.10.1 Kiggavik 2-57
2.10.2 Sissons 2-60
2.10.3 Baker Lake Area 2-61
2.10.4 Monitoring 2-61

2.11 Summary of Project Alternatives 2-62

3 PUBLIC CONSULTATION 3-1

3.1 Introduction 3-1

3.2 Information Office 3-1

3.3 Liaison Committees 3-1
3.3.1 Community Liaison Committee 3-1
3.3.2 Regional Liaison Committee 3-2

3.4 Meetings with Organizations 3-3
3.4.1 Project Initiatives 3-3
3.4.2 Inuit Organizations and Institutions of Public Government 3-5
3.4.3 Other Organizations 3-6
3.4.4 Kiggavik Site Tours 3-6
3.4.5 Saskatchewan Minesite Tours 3-6
3.4.6 Participation in Inuit Organizations and IPG Initiatives 3-7

3.5 Summary of Comments 3-8

3.6 Future Consultations 3-9

4 TRADITIONAL KNOWLEDGE 4-1

4.1 Introduction 4-1

4.2 Methods 4-2

5 DESCRIPTION OF THE EXISTING BIOPHYSICAL ENVIRONMENT 5-1

5.1 Potential Valued Ecosystem Components 5-1

5.2 Regional Setting 5-2

5.3 Topography....................5-2

5.4 Geology....................5-2

5.4.1 Regional Geology....................5-2

5.4.2 Surface Geology....................5-3

5.5 Climate....................5-4

5.5.1 Regional Climate....................5-4

5.5.2 Local Climate....................5-5

5.5.3 Evaporation and Evapotranspiration....................5-6

5.6 Air Quality....................5-6

5.7 Noise Levels....................5-6

5.8 Surface Hydrology....................5-6

5.8.1 Regional Data....................5-6

5.8.2 Local Drainage Patterns....................5-7

5.8.3 Lake Level Monitoring Stations....................5-8

5.9 Permafrost and Hydrogeology....................5-9

5.9.1 Permafrost....................5-9

5.9.2 Groundwater Flow Regime....................5-10

5.9.3 Groundwater Quality....................5-12

5.10 Freshwater Environment....................5-12

5.10.1 Surface Water Quality....................5-13

5.10.2 Sediment Quality....................5-14

5.10.3 Fish....................5-14

5.10.4 Fish Habitat....................5-15

5.10.5 Benthic Invertebrate Community....................5-15

5.10.6 Phytoplankton....................5-16

5.10.7 Zooplankton....................5-16

5.11 Marine Environment....................5-17

5.11.1 Marine Water....................5-17

5.11.1.1 Water and Sediment Quality....................5-17

5.11.1.2 Physical Processes....................5-17

5.11.2 Marine Aquatic Life....................5-18

5.11.2.1 Marine Phytoplankton....................5-18

5.11.2.2 Marine Zooplankton....................5-18

5.11.2.3 Marine Benthic Invertebrates....................5-18

5.11.2.4 Marine Fish....................5-19

5.11.3 Marine Wildlife....................5-19

5.11.4 Marine Species of Concern....................5-23

5.12 Terrestrial Environment....................5-23

5.12.1 Soils....................5-24

5.12.1.1 Soil Surveys 5-24
5.12.1.2 Soil Chemistry 5-24
5.12.2 Vegetation 5-25
5.12.2.1 Vegetation Chemistry 5-27
5.12.3 Wildlife and Wildlife Habitat 5-28
5.12.3.1 Baseline Study Areas 5-28
5.12.3.2 Barren-ground Caribou 5-29
5.12.3.3 Muskoxen 5-31
5.12.3.4 Grizzly Bears 5-31
5.12.3.5 Wolverine 5-31
5.12.3.6 Other Predators 5-31
5.12.3.7 Small Mammals 5-32
5.12.3.8 Birds 5-32
5.12.3.9 Species of Concern 5-34

6 DESCRIPTION OF THE EXISTING SOCIOECONOMIC CONDITIONS 6-1

6.1 Introduction 6-1

6.2 Potential Valued Socioeconomic Components 6-1

6.3 Archaeology and Culturally-Significant Sites 6-2

6.4 Palaeontological Component of Surface and Bedrock Geology 6-3

6.5 Regional Population 6-3

6.6 Community Profiles 6-5

6.7 Land and Resource Use 6-9
6.7.1 Land Management 6-9
6.7.2 Traditional Land Use and Harvest Activities 6-9
6.7.3 Non Traditional Economy 6-11

6.8 Health 6-14

6.9 Socioeconomic Baseline Work 6-15

7 POTENTIAL ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION 7-1

7.1 Identification of Potential Environmental Effects 7-1

7.2 Potential Effects on the Biophysical Environment 7-2
7.2.1 Effects on Air Quality 7-2
7.2.2 Effects on Noise Levels 7-4
7.2.3 Effects on Ground Stability and Permafrost 7-5
7.2.4 Effects on Groundwater 7-5
7.2.5 Effects on the Freshwater Environment 7-6
7.2.5.1 Effects on Water and Sediment Quality 7-6
7.2.5.2 Effects on Aquatic Organisms, Fish and Fish Habitat 7-9

7.2.6 Effects on the Marine Environment 7-11
7.2.6.1 Effects on Marine Water and Sediment Quality 7-11
7.2.6.2 Effects on Marine Organisms, Fish and Fish Habitat 7-12
7.2.6.3 Effects on Marine Wildlife 7-12
7.2.7 Effects on the Terrestrial Environment 7-14
7.2.7.1 Effects on Soil 7-14
7.2.7.2 Effects on Vegetation 7-14
7.2.7.3 Effects on Terrestrial Wildlife 7-15
7.2.7.4 Effects on Birds 7-16

7.3 Ecological and Human Health Risk Assessments 7-17
7.3.1 Ecological Assessment 7-18
7.3.2 Human Health Assessment 7-19

7.4 Potential Effects on Heritage Resources 7-19

7.5 Potential Socioeconomic Effects 7-20
7.5.1 Employment 7-22
7.5.2 Education and Training 7-22
7.5.3 Business 7-23
7.5.4 Increased Incomes 7-23
7.5.5 Maintenance of Traditional Ways of Life 7-23
7.5.6 Individual and Community Well Being 7-24
7.5.7 Public Health and Safety 7-25
7.5.8 Infrastructure and Social Services 7-26
7.5.9 Community Investment 7-26
7.5.10 Territorial Economic and Fiscal Benefits 7-26
7.5.11 Socioeconomic Mitigation and Benefit Enhancement 7-27

7.6 Potential for Transboundary Effects 7-33

8 POTENTIAL CUMULATIVE EFFECTS 8-1

8.1 Biophysical Cumulative Effects 8-1
8.1.1 Air Quality 8-2
8.1.2 Noise 8-2
8.1.3 Unique Landforms 8-2
8.1.4 Heritage Sites 8-2
8.1.5 Surface Water and Groundwater 8-2
8.1.6 Terrestrial Wildlife 8-3
8.1.7 Birds 8-4
8.1.8 Marine Mammals 8-5
8.1.9 Marine and Freshwater Fish 8-5

8.2 Social, Cultural, and Economic Cumulative Effects 8-5

9 POTENTIAL EFFECTS OF THE ENVIRONMENT ON THE PROJECT 9-1

9.1 Seismic Events **9-1**

9.2 Meteorological Effects **9-1**

9.3 Climate Change **9-1**

10 ORGANIZATIONAL MANAGEMENT AND KEY PROGRAMS **10-1**

10.1 Organizational Management and Operational Approach **10-1**

10.1.1 Organization Management 10-1
10.1.2 Operating Policies 10-2
10.1.3 Kiggavik Project Integrated Quality Management System........ 10-2

10.2 Key Programs and Management Plans **10-3**

10.2.1 Environmental Protection 10-3
10.2.1.1 AREVA's Integrated Environmental Protection Approach 10-3
10.2.1.2 Environmental Management System........ 10-4
10.2.1.3 Environmental Protection Program........ 10-5
10.2.2 Radiation Protection 10-5
10.2.3 Occupational Health and Safety 10-6
10.2.4 Emergency Preparedness 10-7
10.2.5 Training........ 10-8
10.2.6 Security........ 10-8

LIST OF APPENDICES

Appendix I	Non-Technical Project Summary (English and Inuktitut)
Appendix II	Nunavut Impact Review Board Forms
Appendix III	Kivalliq Inuit Association and Community Resolutions
Appendix IV	Department of Fisheries and Oceans Statement of Conformity
Appendix V	Selected Environmental Data
Appendix VI	Selected Socioeconomic Data
Appendix VII	Past, Present, and Future Projects and Cumulative Effects
Appendix VIII	AREVA Resources Canada Inc. Policy Statements

LIST OF TABLES

Table 1.1 Major Permits and Licences Required for the Kiggavik Project 1-11
Table 1.2 Legislation and Responsible Authorities for Potential Permits, Licences, and Authorizations for the Kiggavik Project..1-12

Table 2.1 Resources and Reserves…………………………………………………………… …..2-5
Table 2.2 Mine Design Parameters for Kiggavik Deposits……………………………………….2-8
Table 2.3 Andrew Lake Surface Mine Design Parameters……………………………..……….2-11
Table 2.4 Estimated Quantities of Waste Rock and Overburden Materials……..……………….2-18
Table 2.5 Summary of Unit Processes for Mill Options…………………………………………2-21
Table 2.6 Tailings Properties and Operational Data…………………………………………….2-26
Table 2.7 Project Processing Water Requirements……………………………………..…… 2-31
Table 2.8 Monthly Water Storage in East Storage Reservoir...2-33
Table 2.9 Proposed Water Sources and Water Withdrawal Rates 2-33
Table 2.10 Summary of Logistics Strategies...2-45
Table 2.11 Estimated Annual Supplies…………………………………………………………… .2-47
Table 2.12 Baker Lake Facility Fuel Tanks……………………………………………………… .2-50
Table 2.13 Baker Lake Facility Dry Storage Requirements…………………………………….....2-51
Table 2.14 Summary of Access Road Options………………………………………………… .2-52
Table 2.15 Summary of Transportation Options………………………………………………....2-56
Table 2.16 Summary of Project Alternatives……………………………………………………… .2-63

Table 5.1 Extreme Rainfall (mm) Statistics for Baker Lake Climate Station................................5-5
Table 5.2 Stream Discharge Measurements in 2007 5-9
Table 5.3 Status of Marine Mammals Present in Hudson Bay and Chesterfield Inlet................5-23
Table 5.4 Area and Proportion of Ecological Landscape Classification Units within the RSA ...5-27
Table 5.5 Mammal Species Observed within the Project Area 5-28
Table 5.6 Bird Species Recorded in the Kiggavik RSA..5-33
Table 5.7 Species at Risk Observed or Expected in the Kiggavik RSA 5-34

Table 6.1 Labour Force Characteristics, 2001 and 2006……………………………………… …6-4
Table 6.2 Registered Hunters by Community and Year……………………………………..…..6-11

LIST OF FIGURES

Figure 1.1 Location of Proposed Kiggavik Project in Nunavut
Figure 1.2 Location of Proposed Kiggavik Project Sites
Figure 1.3 Location of Kiggavik and Sissons Leases
Figure 1.4 Existing Kiggavik Exploration Camp
Figure 1.5 AREVA Core Business Divisions

Figure 2.1 Proposed Layout of Kiggavik Project
Figure 2.2 Proposed Layout Kiggavik
Figure 2.3 Proposed Layout Sissons
Figure 2.4 Conceptual Kiggavik Layout
Figure 2.5 Conceptual Sissons Layout
Figure 2.6 Overall Project Schedule
Figure 2.7 Key Kiggavik Area Geological Features
Figure 2.8 Key Sissons Area Geological Features
Figure 2.9 Proposed Production Schedule
Figure 2.10 Proposed Center Pit Design
Figure 2.11 Proposed Main Pit Design
Figure 2.12 Proposed Andrew Lake Pit Design
Figure 2.13 Proposed End Grid Underground Design
Figure 2.14 Flowsheet of Resin-in-Pulp Process Options
Figure 2.15 Flowsheet of Alternative Process
Figure 2.16 Projected Tailings Production Schedule
Figure 2.17 Proposed Water Management System
Figure 2.18 Potential Fresh Water Sources
Figure 2.19 Potential Treated Effluent Discharge Receptors
Figure 2.20 Location of Andrew Lake Pit Relative to Andrew Lake
Figure 2.21 Proposed Airstrip Conceptual Design
Figure 2.22 Airstrip Options
Figure 2.23 Proposed Haul Road
Figure 2.24 Proposed Transportation Routes
Figure 2.25 Access Road Route Options
Figure 2.26 Typical All-Weather Access Road Cross-Section
Figure 2.27 Potential Borrow Locations
Figure 2.28 Proposed Thelon Bridge – Conceptual Design

Figure 3.1 The AREVA Baker Lake Information Office
Figure 3.2 Aberdeen Lake Visit; July 27, 2006
Figure 3.3 Shultz Lake Visit; August 17, 2007
Figure 3.4 The Baker Lake CLC Inspecting Core at Kiggavik, August 2007

Figure 3.5 Premier and Delegation Examining Core at the Kiggavik site, June 12, 2008
Figure 3.6 Nunavut Group tour at McClean Lake, October 2005
Figure 3.7 KIA Uranium Information Session at Repulse Bay, April 13, 2007

Figure 5.1 Proximity of Project to Designated Environmental Areas
Figure 5.2 Regional Geology
Figure 5.3 Fault Structures
Figure 5.4 Temperature and Precipitation For Baker Lake
Figure 5.5 Local Drainage Boundaries and Monitoring Locations
Figure 5.6 Predicted Groundwater Flow Patterns
Figure 5.7 Composite Soil Sampling Transect
Figure 5.8 Permanent Sample Plot Locations - 2007
Figure 5.9 Regional Study Area - 2008
Figure 5.10 Local Study Area - 2008
Figure 5.11 Beverly Herd Traditional Calving Grounds

Figure 6.1 The Kivalliq Region of Nunavut
Figure 6.2 Population of Kivalliq Communities 1996 – 2006

Figure 9.1 Seismic Hazard Map - 2005

KIGGAVIK PROJECT

Project Proposal

SECTION 1

TABLE OF CONTENTS

SECTION **PAGE**

1 INTRODUCTION.....1-1

1.1 General.....1-1

1.2 Project Location and Purpose.....1-1

1.2.1 Project Location.....1-1

1.2.2 Project Fact Sheet.....1-2

1.2.3 Purpose of the Project and Need for the Project.....1-4

1.2.4 Alternatives to the Project.....1-4

1.3 Project Background.....1-4

1.4 Policy Framework for Uranium Development.....1-6

1.5 Required Permits, Approvals and Licences.....1-9

1.5.1 DFO Operational Statement of Conformity.....1-12

1.6 Project Proponent.....1-13

1.7 Document Scope and Organization.....1-15

1.8 Supporting Documents.....1-16

LIST OF TABLES

Table 1.1 Major Permits and Licences Required for the Kiggavik Project.....1-11

Table 1.2 Legislation and Responsible Authorities for Potential Permits, Licences, and Authorizations for the Kiggavik Project.....1-12

1 INTRODUCTION

1.1 General

The Kiggavik Project is a proposed uranium ore mining and milling operation located in the Kivalliq region of Nunavut approximately 80 km west of the community of Baker Lake. Uranium in the Kiggavik area was identified during the 1970s and 1980s. In 1993, AREVA Resources Canada Inc. (AREVA) became the operator of the Kiggavik Project, and further exploration was carried out between 1993 and 1997. A pre-feasibility study was completed in 1997, and concluded that the deposits were not economic given the market conditions at that time. The Project was put in care and maintenance mode in 1998. As the uranium market improved during the first half of 2005, AREVA re-established a number of community and territory contacts in Baker Lake and Nunavut. Field activities, engineering studies and environmental assessment studies resumed in 2007.

The objective of this Project Proposal is to introduce the Kiggavik Project to the public and regulatory agencies and to initiate the formal Project review process. This Project Proposal presents AREVA's proposed plans to develop, operate and decommission the Kiggavik Project. It also provides a broad description of the existing environmental and socioeconomic conditions with the objective of identifying potential interactions with Project components.

Preliminary identification of potential effects, development of mitigation measures, and ecological risk assessments have been used to evaluate key components of the Project. These assessments are summarized in this Project Proposal, while the complete reports are available to reviewers upon request (refer to Section 1.8). A non-technical summary of the Project, in both English and Inuktitut, is included as Appendix I, while the associated Nunavut Impact Review Board (NIRB) Part 1 and Part 2 forms are included in Appendix II.

1.2 Project Location and Purpose

1.2.1 Project Location

The Kiggavik Project sites are located in the Kivalliq Region of Nunavut approximately 80 km west of the community of Baker Lake, which is west of Hudson Bay (Figures 1.1 and 1.2), and roughly 800 km northwest of AREVA's McClean Lake Operation in northern Saskatchewan. The Kiggavik Project includes two properties (Figure 1.3):

- The Kiggavik site is located at approximately 64°26'N and 97°37'W. The property consists of 17 mineral leases totalling 3,972 ha (officially 9,808 acres). All leases are currently on Crown Land (i.e. surface and subsurface rights are administered by Indian & Northern Affairs Canada, (INAC)).
- The Sissons site is situated approximately 17 km south-west of Kiggavik at approximately 64°20'N and 97°52'W. The Sissons property consists of 22 mineral leases totalling 14,730 ha (officially 36,371.50 acres). Five of the mineral leases, including those containing the Andrew Lake and End

Grid deposits, are located on Inuit Owned Land subsurface parcels (surface rights are administered by the Kivalliq Inuit Association; subsurface rights are “grandfathered” so are still administered by INAC). The remaining 17 Sissons leases are currently on Crown Land (i.e. surface and subsurface rights are administered by INAC).

An exploration camp currently exists at the Kiggavik site (Figure 1.4). The camp was first established in 1977 and it was occupied for exploration programs until 1997. This camp was renovated and expanded as part of the 2007 and 2008 field programs to accommodate approximately 50 persons.

There are currently no permanent road connections between any Nunavut communities. All passengers travel by air, while goods are shipped by annual sealift, as air cargo, or along winter trails. The Kivalliq air hub is Rankin Inlet, which is the only paved and jet-capable runway in the region. Other communities, including Baker Lake, are served by turboprop aircraft with daily flight service. Baker Lake is accessible from major southern transportation routes by barge via Churchill, Manitoba, during the summer shipping season only. Access to the Kiggavik Project sites is currently restricted to the following modes of transport:

- Helicopter,
- Fixed wing aircraft with tundra tires (landing on eskers),
- Float plane,
- Overland winter travel via winter trail

1.2.2 Project Fact Sheet

The following information is intended to provide a brief overview of the proposed Project.

Project	Kiggavik Project
Location	Kivalliq Region of Nunavut, approximately 80 km west of Baker Lake
Property	The Project includes two properties: Kiggavik and Sissons (collectively called the Kiggavik Project). The Kiggavik site, located at approximately 64°26’N and 97°37’W is composed of 17 mineral leases, covering 9,808 acres. The Sissons site, located approximately 17 km south-west of Kiggavik at 64º20’N and 97º52’W, is composed of 22 mineral leases, covering 36,371.5 acres.
Resources & Reserves	The total quantity of geological resources is currently estimated at 52,000 tonnes U (134 million lbs U_3O_8) at an average grade of 0.23% U. The total quantity of recoverable reserves is currently estimated at approximately 44,000 tonnes U (114 million lbs U_3O_8). Approximately 35% of these reserves are associated with the Kiggavik deposits, while the remainder are associated with the Sissons deposits.

Mining There are five individual mines proposed for the Project: East Zone, Center Zone and Main Zone at Kiggavik; End Grid and Andrew Lake at Sissons. The three Kiggavik deposits and the Andrew Lake deposit would be mined via truck-shovel open pit, while End Grid would be an underground mine.

Waste Rock Mine waste rock would be segregated into clean and subeconomic mineralized material and managed in surface stockpiles during operation. Clean waste would be used for construction material when possible. Upon completion of mining, subeconomic mineralized waste rock would be backfilled into mined-out pits.

Process The ore would be processed in an on-site mill at Kiggavik to produce approximately 3,000 tonnes U (7.8 million lbs U_3O_8) per year as uranium concentrate, commonly referred to as yellowcake.

Tailings The mill tailings would be managed via in-pit tailings management facilities constructed using the mined-out Center Zone and Main Zone open pits at Kiggavik.

Water Management Site drainage, recycled tailings water, and fresh water from nearby lakes would be used in the mill process. All effluent would be treated prior to discharge.

Life of Mine Approximately 17 years of operation, based on studies to date. It is currently anticipated that pre-operational construction would require 3 years while post-operational decommissioning would require 5 years.

Access Access to the site would be provided by either an all-season road or a winter road between Baker Lake and Kiggavik. Supplies would be shipped to a dock facility at Baker Lake during the summer barge season and trucked to Kiggavik via the road. An airstrip would be constructed and operated at site for transportation of personnel and yellowcake.

Personnel The Project is expected to employ 400-600 people during operations. The operation would be fly-in/fly-out on a 7 to 14 day schedule with on-site employees housed in a permanent accommodations complex.

1.2.3 Purpose of the Project and Need for the Project

The purpose of the Project is to mine the Kiggavik and Sissons deposits and to produce uranium concentrate, within the framework of sustainable development principles applied by AREVA to all of its activities.

The Kiggavik Project is needed to add to the ore reserves available for processing in Canada at the present time and thereby add to the positive economic, employment and business opportunities related to uranium developments in Nunavut.

From a broader perspective, world uranium production currently falls short of projected future annual requirements for generation of clean electricity using nuclear power (as an alternative to electricity generated by fossil fuel consumption). Uranium from the Kiggavik area will help to meet the future needs for nuclear power, which will help reduce, on a global scale, greenhouse gas emissions. The advantages of nuclear power are that it is clean and affordable, has predictable costs and security of supply, and facilitates grid stability. Uranium is also the raw material used for production of a wide range of radioisotopes in nuclear reactors. These radioisotopes are used in research, medicine and industry.

1.2.4 Alternatives to the Project

Alternative Project designs have been identified and are discussed in the Project description (Section 2). The design alternatives and the no-go option will be evaluated in detail in the draft Environmental Impact Statement (DEIS).

1.3 Project Background

1974 - 1989 Discovery and Initial Feasibility Study

Uranium in the Kiggavik area was identified during systematic coverage with an airborne radiometric survey carried out by Metallgesellschaft Canada Ltd. in 1974. In 1975, Metallgesellschaft was succeeded by Urangesellschaft Canada Ltd. (UG). Drilling at Kiggavik commenced in 1977 and led to the discovery of potentially economic mineralization.

In 1986/1987 a pre-feasibility engineering and environmental study was conducted by Strathcona Mineral Services. This study was positive and justified a more detailed feasibility study. Between May 1988 and December 1989 a feasibility study was undertaken for UG by Wright Engineers. In May 1990, UG commissioned Bechtel Canada Inc. to conduct a review and optimization of the feasibility study prepared by Wright Engineers.

1989 - 1990 The Urangesellschaft Proposal

In 1989, UG proposed a mine and mill development for the Kiggavik site deposits. Subsequently the Federal Environmental Assessment and Review Office (FEARO) set up an Environmental Assessment Review Panel to review the project proposal. UG presented its Environmental Assessment Report (EAR) in late 1989.

The technical review of the EAR identified deficiencies that would need to be addressed before the proposal could proceed to public hearings.

There was strong public opposition to the project, and a plebiscite in Baker Lake in 1990 showed that about 90% of the local population opposed the Urangesellschaft proposal. In early July 1990, UG asked FEARO to delay the public hearings indefinitely.

1986 - 2004 Further Exploration and Feasibility Work

The Sissons area was prospected in 1986 using airborne geophysics. Resistivity lows at End Grid and Andrew Lake were followed up by ground gravity surveys and the resulting anomalies were investigated by drilling. Uranium mineralization at End Grid and Andrew Lake was discovered in 1987 and 1988 respectively. Delineation of these two deposits was the focus of drilling up to 1993.

In 1993, AREVA (formerly COGEMA Resources Inc.) became the operator of the Kiggavik and Sissons Project, and further exploration was carried out between 1993 and 1997. A pre-feasibility study was completed in 1997, and concluded that the deposits were not economic given the market conditions at that time. The Project was put in care and maintenance mode in 1998. In 2003 and 2004, clean-up work was done on the properties to put them into a low maintenance condition for the indefinite future.

2005 – 2006 The Uranium Market Improves

As the uranium market improved during the first half of 2005, AREVA re-established a number of community and territory contacts in Baker Lake and Nunavut, with the objective of better understanding the issues related to potential future uranium developments in Nunavut.

Public consultation work continued in 2006 and a new office was opened in Baker Lake. A preliminary assessment of the viability of the Kiggavik Project was conducted during the second half of 2006 and several technical, regulatory and environmental issues were identified. Subsequently, a pre-feasibility study was initiated in October 2006.

2007 – 2008 Resumption of Field Work and Feasibility Studies

In 2007, AREVA resumed exploration and field work at the Kiggavik and Sissons properties, with the objective of collecting engineering and environmental data to support the pre-feasibility study. Following completion of the study in November 2007, AREVA and the Project joint venture partners elected to initiate a feasibility study in 2008.

1.4 Policy Framework for Uranium Development

Since the Nunavut Lands Claim Agreement, a number of policy developments have provided clarity and direction for the development of uranium in Nunavut. The Nunavut Territory has given special consideration and planning to uranium development as evidenced in the consideration of uranium development in the Keewatin Regional Land Use Plan by the Nunavut Planning Commission, the broad principles, objectives and conditions for uranium exploration and mining outlined in the NTI Uranium Policy and the six guiding principles developed by the Government of Nunavut.

Government of Nunavut

The Mineral Exploration and Mining Strategy was developed by the Government of Nunavut (GN) Department of Economic Development and Transportation to guide development and create participation opportunities for Nunavummiut in the sustainable development of Nunavut mineral resources. The goal of the strategy is "To create the conditions for a strong and sustainable minerals industry that contributes to a high and sustainable quality of life for all Nunavummiut." Eighteen policy statements are given under the four pillars of jurisdictional framework, community benefit, infrastructure development and environmental stewardship.

On June 4, 2007 the GN released Six Guiding Principles for Uranium Development. It was read at the Legislature by the Minister of Finance / Economic Development and Transportation; under its principles the GN:

- Regards mining, including uranium mining, as an important potential source of revenues to meet the needs of Nunavut's growing population and also as a potential source of employment and associated skills development for Nunavummiut.
- Recognizes that uranium development places special responsibilities on government because of the nature of uranium and its by-products, the history of its use for both peaceful and non-peaceful purposes, and its potential risks to human health and the environment.
- Understands that uranium development must have the support of Nunavummiut, especially in communities close to uranium development.
- Will support uranium development in Nunavut provided that the following conditions are satisfied:
    - Health and safety standards that are at least at Canada's national standard must be assured for workers involved in uranium development in Nunavut;
    - Environmental standards must be assured, especially for the land, water and wildlife;

    - o Nunavummiut must be the major beneficiaries of uranium development activities.
- o Believes that nuclear power generation will be an important part of global strategies for ensuring energy supplies while reducing reliance on greenhouse gas-emitting fossil fuels.
- o Believes that Canadian law and international agreements provide a reasonable level of assurance that uranium mined in Nunavut will be used for peaceful purposes.

Nunavut Tunngavik Inc. Uranium Policy

In 1997, Nunavut Tunngavik Incorporated (NTI) released its Mining Policy. The policy did not specifically address uranium mining, but remained applicable to uranium exploration and mining as the policy addressed the general subject of the development of mineral resources in Nunavut. NTI presented general support of mining through the policy's guiding principle that "*NTI will support and promote the development of mineral resources in Nunavut if there are significant long-term social and economic benefits for the Inuit of Nunavut, and is consistent with protecting the eco-systemic integrity of the Nunavut Settlement Area*".

On September 18, 2007, NTI provided a clear and consistent position on uranium mining by approving a policy concerning uranium mining in Nunavut. The NTI 1st Vice President said "*After several months of careful consultation with communities and various Inuit organizations and regulatory agencies, the NTI Board of Directors reviewed a policy concerning uranium mining and made the decision to approve it*".

The guiding principle of the policy is that "uranium exploration and mining must be carried out in an environmentally and socially responsible way and the uranium that results from the mining shall be used only for peaceful and environmentally friendly purposes". NTI further established five objectives supported by 16 policy statements. The five objectives are as follows:

1. Support Responsible and Peaceful Uses of Nuclear Energy
2. Require Benefits from Uranium Exploration and Mining
3. Ensure Protection of Human Health
4. Limit Impacts of Uranium Exploration and Mining
5. Promote Participation of Inuit

Keewatin Regional Land Use Plan

In 1993 the Nunavut Land Claim Agreement (NLCA) Act was passed. Inuit obtained surface and subsurface rights over significant land areas. As a result of the NLCA, the Nunavut Planning Commission (NPC) was established in 1993. The NPC is responsible for Land Use Planning in Nunavut. The Nunavut Planning Commission (NPC) prepared the *Keewatin Regional Land Use Plan* in accordance with the procedure for public consultation and government review set out in Part 5, Article 11 of the *Nunavut Land Claims Agreement.* The plan was approved in June, 2000. Uranium mining is the subject of two specific conditions, Terms 3.5 and 3.6.

Term 3.5 of the Keewatin Regional Land Use Plan states: *"Uranium development shall not take place until the Nunavut Planning Commission (NPC), the Nunavut Impact Review Board (NIRB), the Nunavut Water Board (NWB) and the Nunavut Wildlife Management Board (NWMB) have reviewed all of the issues relevant to uranium exploration and mining. Any review of uranium exploration and mining shall pay particular attention to questions concerning health and environmental protection".*

The Nunavut Planning Commission organized a uranium workshop, for the benefit of NPC and the Boards and included participation by a range of stakeholders and experts. This workshop was held in Baker Lake on June 4-7, 2007. On June 27, 2007 the Nunavut Planning Commission unanimously passed a resolution indicating that NPC "*believes it has thereby complied with its obligations pursuant to Term 3.5 Keewatin Regional Land Use Plan*".

Term 3.6 of the Keewatin Land Use Plan states: *"Any future proposal to mine uranium must be approved by the people of the region".*

Uranium development proposals must be accompanied by approvals from the people of the region in order to conform to the Keewatin Regional Land Use Plan. The Nunavut Planning Commission has indicated that this requirement may be satisfied by the following:

- The Kivalliq Inuit Association (KIA), as the representative of Inuit in the region, passes a motion in favour of uranium development, and
- Baker Lake plus three or more other communities representing 50% of the remaining population in the remaining Hamlets also pass Hamlet Council Motions in favour of uranium development and mining.

Progress on meeting these requirements is as follows (documentation is included in Appendix III):

- KIA passed a motion of support on January 9, 2007
- The Hamlet of Baker Lake passed a resolution of support on December 7, 2006
- The Hamlet of Repulse Bay passed a resolution of support on February 28, 2007
- The Hamlet of Rankin Inlet passed a resolution of support on March 26, 2007
- The Hamlet of Arviat passed a motion of support on May 9, 2007
- The Hamlet of Whale Cove passed a motion of support on August 27, 2007
- The Hamlet of Chesterfield Inlet passed a motion of support on April 17, 2008
- The Hamlet of Coral Harbor passed a motion of support on May 8, 2008

The Kiggavik Project in Nunavut

AREVA has engaged in a series of initiatives to involve the community in the Kiggavik Project. These initiatives are described in Section 3.

1.5 Required Permits, Approvals and Licences

Uranium project developments, such as the Kiggavik Project, must receive proper licences and approvals, after undergoing an environmental review to assess the potential for impacts, prior to commencing any site activities related to development.

AREVA is initiating the Nunavut impact review process with the submission of various licence and permit applications and this Project Proposal. AREVA anticipates that the submission of applications to the Nunavut Water Board (NWB) for a Type 'A' water license, to Indian Northern Affairs Canada (INAC) for a Class 'A' Land Use Permit, to the Kivalliq Inuit Association (KIA) for a production license, and to the Canadian Nuclear Safety Commission (CNSC) for a License to Prepare and Construct a Uranium Mine and Mill will require a NPC conformity decision and NIRB screening. Authorizing agencies will forward applications to the NPC (in accordance with NLCA 11.5.10) for a conformity determination against the Keewatin Regional Land Use Plan. Following a positive conformity decision (NLCA 11.5.10 and 12.3.1) or a Ministerial exemption (NLCA 11.5.11 and 12.3.4), the NPC will forward the proposal to the NIRB for screening.

Further, AREVA anticipates that the results of this screening will be a determination that the Kiggavik Project has significant impact potential and therefore the NIRB will recommend to the Minister that a Review under Part 5 or 6 in accordance with Article 12 of the Nunavut Land Claim Agreement be conducted. Aiming for efficiency the Kiggavik Project Proposal and licensing applications will be submitted simultaneously to the NPC, NIRB, NWB, CNSC, INAC and the Kivalliq Inuit Association (KIA).

Authorizing Agency approvals are conditional on a NIRB Project Certificate and both the NIRB Project Certificate and CNSC License require the completion and positive outcome of an environmental review.

All new uranium mines and mills require a licence to be issued by the CNSC; depending on the stage of development the CNSC issues one of the following licences:

- Licence to prepare a site and construct
- Licence to operate
- Licence to decommission
- Licence to abandon (ie. release from CNSC licence)

Recent legislative amendments to the Nunavut Lands Claim Agreement (NLCA) included two new provisions (12.12.7 and 12.12.8) and the replacement of Section 12.4.7(a) to remove all Acts regarding Environmental Assessment (i.e. Canadian Environmental Assessment Act), other than the NLCA itself from applying in the geographic area of which the NLCA applies. Therefore, the environmental assessment review process will be subject either to a Part 5 (Review of Project Proposals by NIRB) or Part 6 (Review by a Federal Environmental Assessment Panel) review, as determined by the Minister of INAC. The process will be led by NIRB with other regulatory agencies participating as technical reviewers to meet their environmental mandates.

The Project will also require a Type ‘A’ Water Licence issued by NWB, which cannot be issued until after NIRB issues a Project Certificate. The water licence process typically only commences upon completion of the review process.

The Project will require a Land Use Permit issued by INAC for access and development on Crown Land and a Production Licence and eventually a Commercial Lease issued by KIA for the development of mine site and roads located on Inuit Owned Lands (IOL).

AREVA will work with The Department of Fisheries and Oceans (DFO) through an authorization process to occur concurrently with the environmental review process to obtain any required Fisheries Authorizations.

An Inuit Impact and Benefit Agreement (IIBA) is required and will be negotiated between AREVA and the Designated Inuit Organization as per the Nunavut Land Claims Agreement, to ensure that the Project provides appropriate benefits and that compensation is received for any negative impacts of mining activities on local communities, the land and traditional way of life.

Other permits and licences will be required in order for this Project to proceed. Table 1.1 presents the major authorizations that will be required and Table 1.2 presents applicable legislation and responsible authorities for potential related approvals that may be required (list may not be inclusive).

Table 1.1 Major Permits and Licences Required for the Kiggavik Project

Permit/License	Agency	Activity
Project Certificate	Nunavut Impact Review Board	Required to Proceed with Project Development
Licence to Prep Site and Construct	Canadian Nuclear Safety Commission	Required to Proceed with Project Development
Licence to Operate	Canadian Nuclear Safety Commission	Required to Proceed with Project Development
Inuit Impact and Benefit Agreement	Kivalliq Inuit Association	Required to Proceed with Project Development
Type A Water Licence	Nunavut Water Board	Water use and waste disposal; discharge limits to the receiving environment
Class A Land Use Permit	Indian and Northern Affairs Canada	Development of mine and roads on Crown Land
Land Use Licence	Kivalliq Inuit Association	Development of mine and roads on Inuit Owned Land
Fisheries Authorization	Department of Fisheries and Oceans	Authorization for harmful alteration, destruction or disturbance of fish habitat (HADD) and appropriate compensation
Navigable Water Permit	Transport Canada	Required if parts of the development interfere with navigation i.e. bridges or culverts

Table 1.2 Legislation and Responsible Authorities for Potential Permits, Licences, and Authorizations for the Kiggavik Project

Legislation/Act	Responsible Authorities		
	Federal	Territorial	IPGs/DIO
Arctic Waters Pollution Prevention Act (AWPPR)	INAC		
Business Corporations Act (Nunavut)		DOJ-NU	
Nuclear Safety and Control Act, 2000 (Canadian Nuclear Safety Commission Rules of Procedure) (General Nuclear Safety and Control Regulations) (Radiaton Protection Regulations) (Uranium Mines and Mills Regulations) (Nuclear Substances and Radiation Devices Regulations) (Packaging and Transport of Nuclear Substances Regulations) (Nuclear Non-Proliferation Import and Export Control Regulations) (CNSC Cost Recovery Fees Regulations)	CNSC		
Canadian Environmental Protection Act	EC		
Commissioner's Land Act		CGS-NU	
Canada National Parks Act	PCH		
Canada Wildlife Act	EC		
Engineers, Geologists and Geophysicists Act (Nunavut)		DOJ-NU	
Emergency Medical Aid Act (Nunavut)		HandSS-NU	
Environmental Protection Act (Nunavut) (Spill Contingency Planning and Reporting Regulations (Nunavut))		DOE-NU	
Explosive Use Act (Nunavut) (Explosive Use Regulations (Nunavut))		WCB-NU	
Explosives Act (Explosives Regulations)	NRCan		
Fisheries Act (Canada) (Metal Mining Effluent Regulations) (Northwest Territories Fisheries Regulations)(NWTFR)	DFO/EC		
Fire Prevention Act (Nunavut) (Fire Prevention Regulations (Nunavut)) (Propane Cylinder Storage Regulations (Nunavut))		CGS-NU	
Labor Standards Act (Nunavut))		DOJ-NU	
Migratory Birds Convention Act, 1994	EC		
Navigable Waters Protection Act	TC		
Mine Health and Safety Act (Nunavut) (Mine Health and Safety Regulations (Nunavut))		DOJ-NU	
Nunavut Archaeological and Palaeontological Sites Regulations (Nunavut)		CLEY-NU	
Nunavut Land Claim Agreement			

Legislation/Act	Responsible Authorities		
	Federal	Territorial	IPGs/DIO
(LUP Compliance) (Project Certificate) (Land Use) (Mineral Rights) (IIBA)			NPC NIRB Regional DIO NTI Regional DIO
Nunavut Waters and Nunavut Surface Rights Tribunal Act NWT Waters Regulations (Water Licence) (Inspection)	INAC		NWB
Public Health Act (Nunavut) Camp Sanitation Regulations (Nunavut)		HandSS-NU	
Transportation of Dangerous Goods Act (Transportation of Dangerous Goods Regulations)	TC		
Transportation of Dangerous Goods Act (Nunavut) (Transportation of Dangerous Goods Regulations (Nunavut))		CGS-NU	
Territorial Lands Act (Canada Mining Regulations) (Territorial Dredging Regulations) (Territorial Lands Regulations) (Territorial Lands Use Regulations) (Territorial Quarrying Regulations)	INAC		
Territorial Parks Act (Nunavut) (Territorial Parks Regulations (Nunavut)		DOE-NU	
Wildlife Act Nunavut (Wildlife Sanctuaries Regulations (Nunavut))		DOE-NU	
Worker's Compensation Act (Nunavut) (Worker's Compensation Regulations (Nunavut)) (Camp Sanitation Regulations (Nunavut)		WCB-NU	

INAC=Indian and Northern Affairs Canada, DOJ-NU= Department of Justice-Govt of Nunavut, CNSC=Canadian Nuclear Safety Commission, EC=Environment Canada, CGS-NU=Department of Community & Government Services, PCH=Parks Canada, HandSS-NU=Dept of Health & Social Services, DOE-NU=Dept of Environment, WCB-NU=Worker's Compensation Board, NRCan=Natural Resources Canada, CLEY-NU=Dept of Culture Language Elders and Youth, NPC=Nunavut Planning Commission, NIRB=Nunavut Impact Review Board, DIO=Designated Inuit Organization, NTI=Nunavut Tunngavik Incorporated, NWB=Nunavut Water Board,

1.5.1 DFO Operational Statement of Conformity

The following Department of Fisheries and Oceans (DFO) Nunavut Operational Statement (OS) activities may apply to the Kiggavik Project:

- Bridge Maintenance
- Clear Span Bridge
- Culvert Maintenance
- Ice Bridge
- Installation of Moorings

AREVA agrees to meet the conditions of the five Operational Statements described above and incorporate measures to protect fish and fish habitat as outlined in the applicable DFO Operational Statement. A signed letter to that effect is included in Appendix IV.

1.6 Project Proponent

Project Ownership

The Kiggavik and Sissons Projects are owned through joint venture agreements by AREVA Resources Canada Inc, UG Canada (collectively, "AREVA"), Japan-Canada Uranium Co. Ltd. ("JCU") and Daewoo International Corp. ("Daewoo"). ARC is the operator of both Projects. The Kiggavik and Sissons projects are currently in the process of being amalgamated into one joint venture which will be referred to as the **Kiggavik Project**, operated by AREVA.

AREVA Corporate Structure

AREVA Resources Canada Inc. is a Canadian company, headquartered in Saskatoon, Saskatchewan. The company is a 100% subsidiary of the AREVA group of companies headquartered in Paris, France. AREVA is a world leader in nuclear energy, electricity transmission and distribution, with manufacturing facilities in over 47 countries and a sales network in over 100 countries. Over 70,000 people are employed by AREVA worldwide.

AREVA's corporate goal is to provide a comprehensive scope of services in every aspect of the nuclear fuel cycle (Figure 1.5), and of power reactor supply and services. The uranium concentrate provided by AREVA Resources Canada Inc. enters the nuclear fuel cycle at the front end.

AREVA Resources Canada Inc. represents a major investment by the Mining Business Unit of the AREVA Group, which holds world-wide gold and uranium interests. The other significant uranium production projects, in addition to Saskatchewan operations, are two production centers in Niger, advanced development projects in Namibia and Niger, and *in situ* leach production centers in Kazakhstan. The AREVA Group also has extensive experience in reclamation and decommissioning at former uranium production sites in France, in Gabon and in the United States.

In Canada, AREVA Resources Canada Inc. (AREVA) activities can be broadly grouped into projects where it is the operator, those it does not operate but holds an equity interest, and exploration activities. In the past 40 years, AREVA, and its predecessor companies, have been involved in uranium exploration and in project development and operation in Saskatchewan's Athabasca Basin. Projects operated by AREVA in northern Saskatchewan include Cluff Lake (being decommissioned), McClean Lake, and Midwest. AREVA also has significant minority interests in the Cigar Lake, McArthur River, and Key Lake projects. The company maintains active exploration programs in Nunavut, Saskatchewan, Quebec and Alberta.

AREVA's Approach to Sustainable Development

The Saskatchewan uranium industry has been practicing the principles of sustainable development since the early 1980's. The social partnership and high level of environmental protection achieved by the uranium operations have allowed economic development to occur in the north today without compromising the future of the land or the people. AREVA is committed to maintaining and enhancing this balance between environmental, social, and economic performance.

Sustainable development, as defined in the Brundtland report (United Nations 1987), is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development fosters long-term protection of the environment and its inhabitants. Its success hinges on balancing three aspects, which are: environmental protection (including worker occupational health and safety), social responsibility, and economic performance.

The highest priority for AREVA is providing a safe and healthy workplace for its employees. This is achieved through a comprehensive and effective radiation protection program at its sites, in addition to conventional occupational health and safety programs. The successful policies and programs currently in place at the McClean Lake Operation will be adapted and applied for use at the Kiggavik Project. The success of these programs is evident in McClean Lake Operation's exemplary performance with respect to worker exposure and safety records.

AREVA is also committed to the principle that activities related to the Kiggavik Project are a temporary use of the land, and is committed to protecting the environment in both the short and the long term. The operational focus is minimizing waste production, and having in place appropriate waste management facilities and systems, and effective mitigation measures. As well, reclamation and decommissioning strategies to ensure long-term protection are an integral part of initial facility design and ongoing operations. As various activities come to an end during the operational period, progressive reclamation, where appropriate, will be undertaken to return the land to a stable state, capable of supporting its former use.

Sustainable development also involves consideration of nearby communities and embracing local social responsibility and social partnerships. Various initiatives and programs, developed through partnership, are in place to continually improve dialogue and enhance trust and support among employees and in the communities impacted by the project activities, and to increase the capacity for these community members to participate in the developments. Northern residents will benefit economically from the developments, either directly through employment, or indirectly through participation by northern businesses. Currently, about 480 AREVA employees and contractors work at McClean Lake, of which over 50% of the workforce are residents of northern Saskatchewan, and about a third of the workforce are residents of the Athabasca Basin. AREVA continually seeks to increase the current level of northern participation through a range of scholarships and apprenticeships that are made available to northern residents. This commitment will be carried through to Nunavut with the Kiggavik Project.

Economic performance is the third component of sustainable development. It is the economic success of the operation which supports the environmental and social requirements and commitments. Thus, the development must also ensure long-term profitable growth to the owners and shareholders who provide the necessary funds to operate existing operations and to develop new projects. From a broader perspective, uranium, the product from the proposed Project, contributes to national and international sustainable development through its use to generate nuclear power.

1.7 Document Scope and Organization

This document is intended to fulfill the information requirements outlined in the Screening Part 2 Form (Project Specific Information Requirements) of the Nunavut Impact Review Board. To facilitate review of the document, a conformity table has been included with the Part 2 form in Appendix II. Due to the t stage of Project development, for some requirements only preliminary information is currently available; AREVA commits to full development and evaluation of all aspects of the baseline environmental and socioeconomic conditions, Project design, Project effects, and mitigationmeasures during the Environmental Assessment phase.

This Project Proposal has been organized into the following sections:

Section 1 provides a general introduction to AREVA, the Kiggavik Project, and the required approvals, permits, and licenses under both territorial and federal regulatory frameworks.

Section 2 provides a Project description, with the objective of identifying and characterizing Project components/activities that may interact with the environment during normal operations or during malfunctions or accidents. This section also includes those components that have the potential to result in post-operational long-term environmental effects.

Section 3 presents AREVA's ongoing and future public consultation activities, as well as those that were undertaken in 2006 and 2007. It also summarizes the questions and issues that were raised by the public (participants) through the various means that were made available.

Section 4 discusses how traditional knowledge will be collected and incorporated into the environmental assessment and final Project design.

Section 5 provides a broad description of the existing biophysical environment. The objective of this section is to identify and characterize the environmental components that may interact with the Project.

Section 6 provides a broad description of the existing socioeconomic environment. The objective of this section is to identify and characterize the socioeconomic components, including community well-being, employment, and training, that may interact with the Project.

Section 7 presents the preliminary evaluation of Project-environmental interactions, assessment of potential effects and consideration of mitigation measures. Human health and socioeconomic considerations are included in this section.

Section 8 considers cumulative effects of the Project with other projects that may overlap in time and/or in space. This includes potential future developments within the Kivalliq Region, as well as potential interactions with other developments in Nunavut.

Section 9 provides a general discussion on potential effects of the environment on the Project, such as short and long term climate change.

Section 10 presents the proposed organizational management strategy and the integrated policies and programs that guide all Project activities.

1.8 Supporting Documents

To support the information contained in this Project Proposal, there are a number of documents available to reviewers upon request. The available documents are listed as follows:

1. Technical Information Document, Kiggavik Project, Nunavut. Golder Associates, 2008.
2. Preliminary Assessment of the Thermal Conditions at the Kiggavik-Sissons Site, Nunavut. SRK Consulting, 2008.
3. Air Dispersion Analysis of Project Effects on Standard Pollutants, Radon-222, TSP and Associated Metals and Radioactive Elements, Kiggavik Project. SENES Consultants Limited, July 2008.
4. Screening Level Environmental Effects Assessment, Proposed Kiggavik Project. SENES Consultants Limited, July 2008.

KIGGAVIK PROJECT

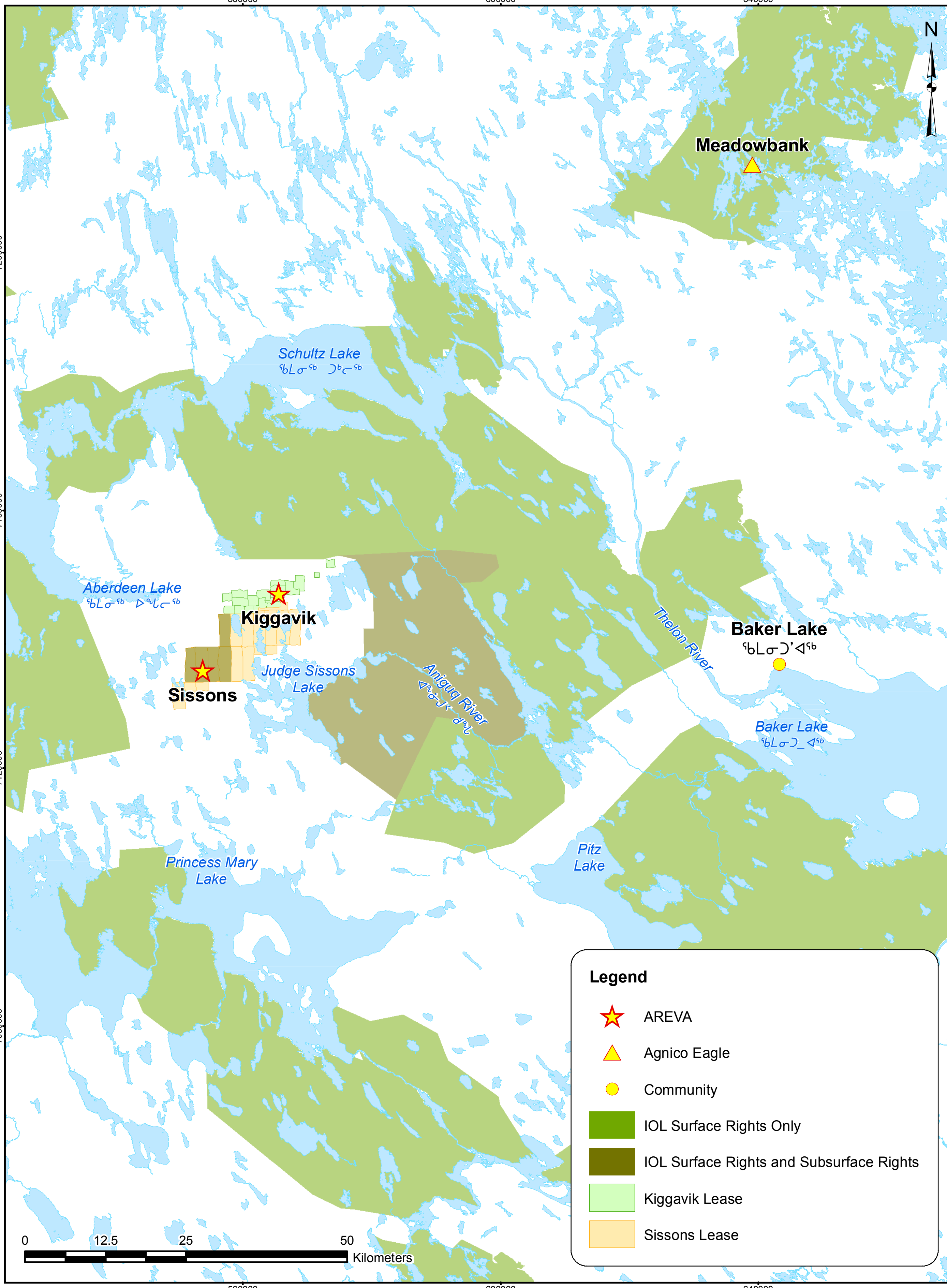
Project Proposal

SECTION 1

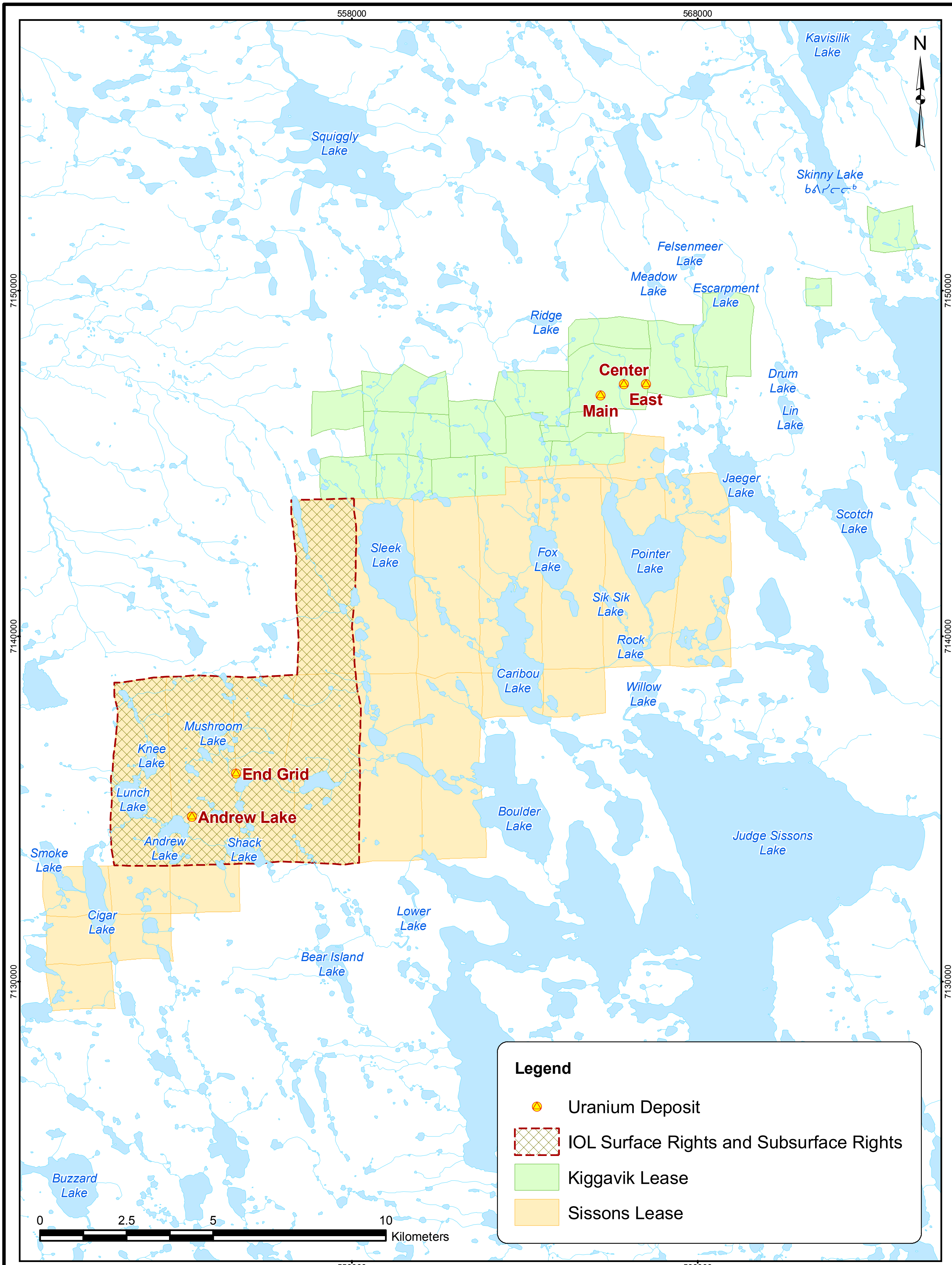
LIST OF FIGURES

Figure 1.1: Location of Proposed Kiggavik Project in Nunavut
Figure 1.2: Location of Proposed Kiggavik Project Sites
Figure 1.3: Location of Kiggavik and Sissons Leases
Figure 1.4: Existing Kiggavik Exploration Camp
Figure 1.5: AREVA Core Business Divisions

KIGGAVIK PROJECT	Scale: 1:25,000,000	AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5
LOCATION OF PROPOSED KIGGAVIK PROJECT IN NUNAVUT FIGURE 1.1	Creator: CDC Date: 10/31/08 Drawing:	



KIGGAVIK PROJECT	Scale: 1:800,000	AREVA	AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5
LOCATION OF PROPOSED KIGGAVIK PROJECT SITES FIGURE 1.2	Creator: CDC Date: 10/31/08 Drawing:		



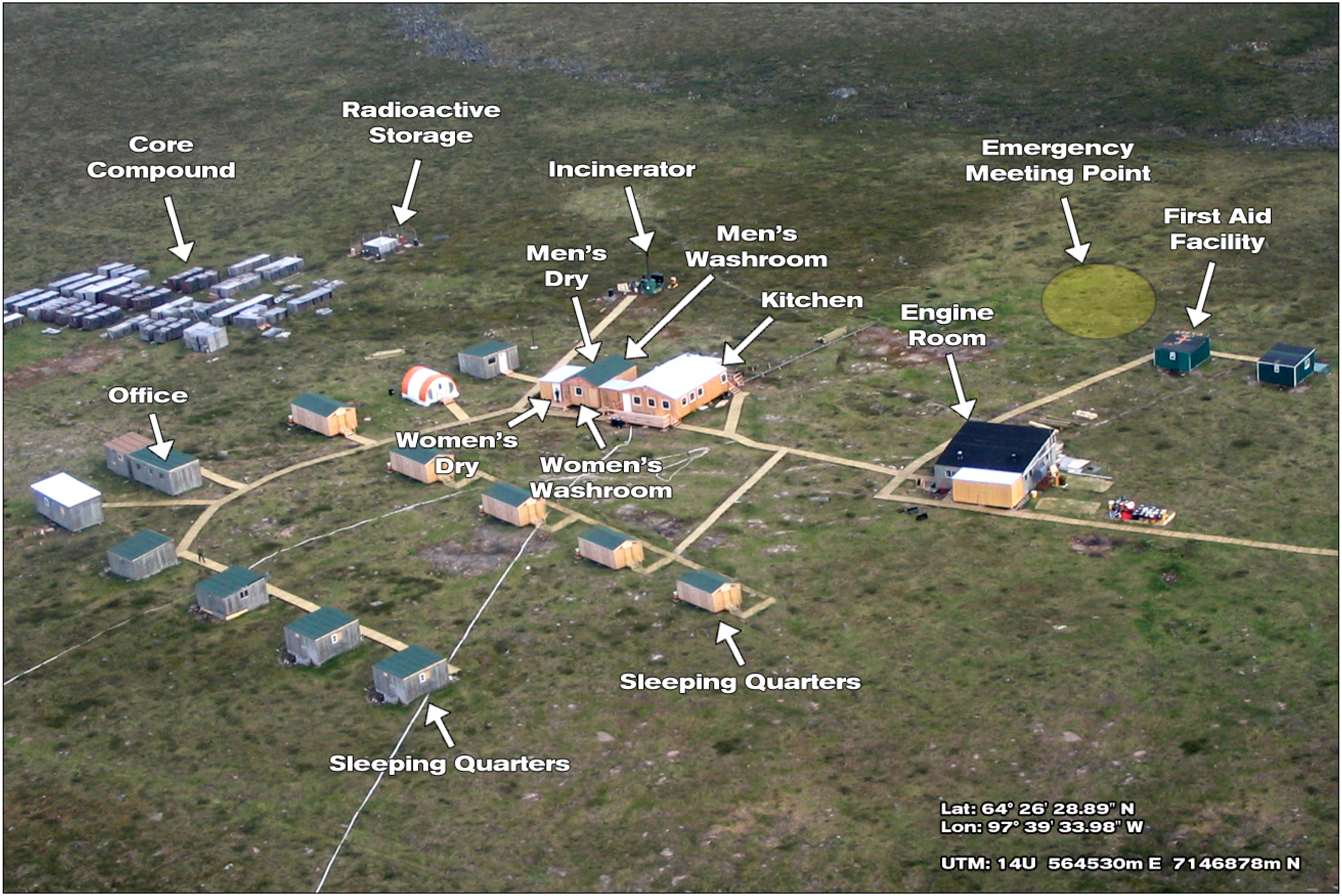
KIGGAVIK PROJECT

LOCATION OF KIGGAVIK AND SISSONS LEASES
FIGURE 1.3

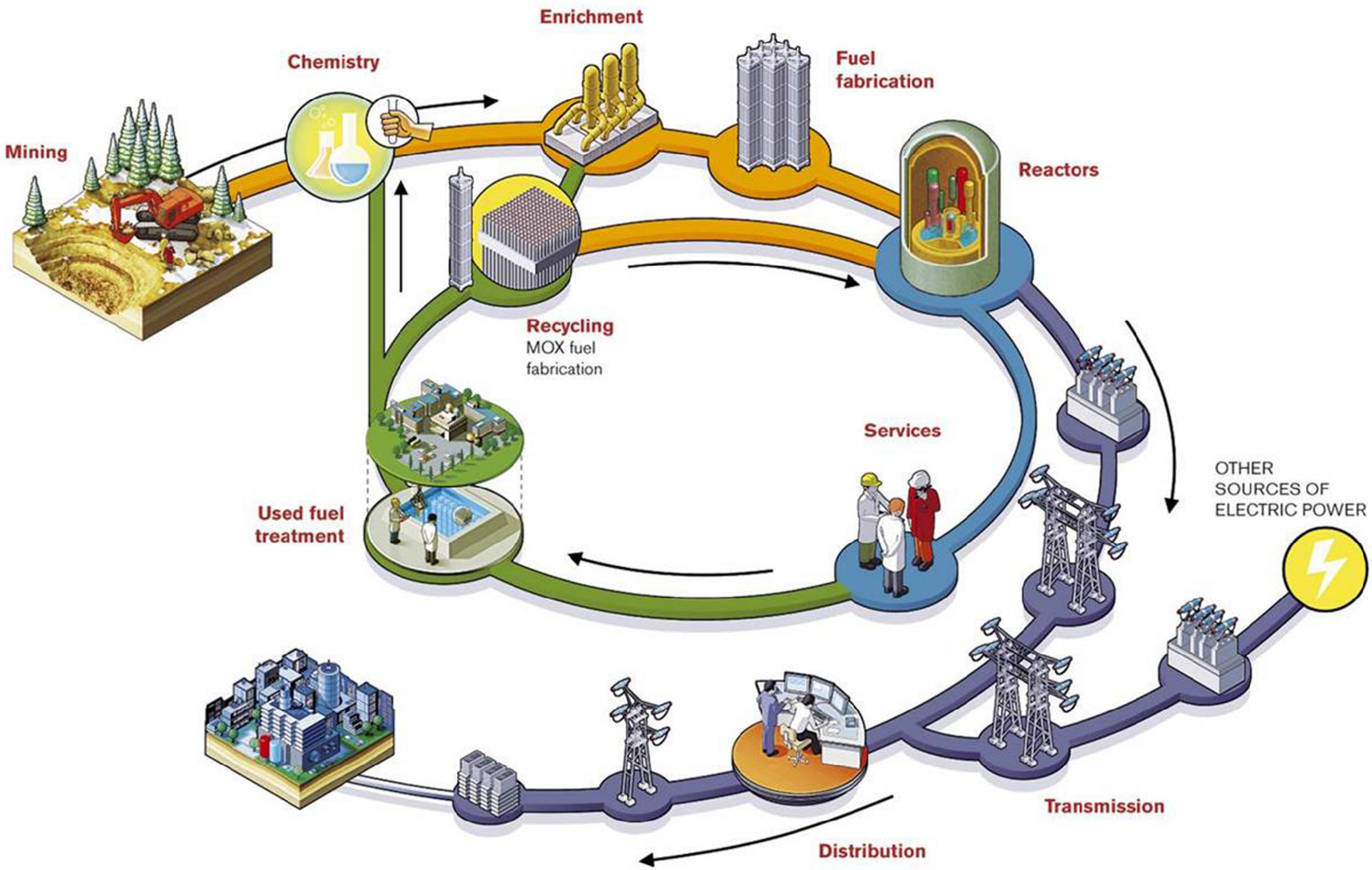
Scale: 1:145,000
Creator: CDC
Date: 10/31/08
Drawing:

AREVA

AREVA Resources Canada Inc
P.O. Box 9204
817-45th Street West
Saskatoon, Sk. S7K 3X5



KIGGAVIK PROJECT	Scale:	AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5
EXISTING KIGGAVIK EXPLORATION CAMP FIGURE 1.4	Creator: CDC Date: 10/31/08 Drawing:	



KIGGAVIK PROJECT	Scale:	AREVA	AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5
AREVA CORE BUSINESS DIVISIONS FIGURE 1.5	Creator: CDC Date: 10/31/08 Drawing:		

KIGGAVIK PROJECT

Project Proposal

SECTION 2

TABLE OF CONTENTS

SECTION **PAGE**

2 PROJECT DESCRIPTION.......... 2-1

2.1 Introduction 2-1

2.1.1 Basic Configuration 2-1

2.1.2 Project Schedule 2-2

2.2 Geology and Resources 2-2

2.2.1 Kiggavik Site Geology 2-2

2.2.2 Sissons Site Geology 2-4

2.2.3 Project Resources and Reserves 2-5

2.3 Mining.......... 2-6

2.3.1 General.......... 2-6

2.3.2 Production Schedule 2-6

2.3.3 Kiggavik Mines 2-6

2.3.3.1 East Zone 2-8

2.3.3.2 Center Zone.......... 2-8

2.3.3.3 Main Zone.......... 2-9

2.3.3.4 Dewatering at Kiggavik.......... 2-9

2.3.4 Sissons Mines 2-9

2.3.4.1 Andrew Lake Open Pit.......... 2-10

2.3.4.2 End Grid Underground Mine.......... 2-11

2.3.4.3 Dewatering at Sissons.......... 2-13

2.3.5 Alternatives.......... 2-14

2.4 Waste Rock Management.......... 2-15

2.4.1 Introduction.......... 2-15

2.4.2 Waste Rock Characterization 2-15

2.4.3 Special Waste Characterization 2-17

2.4.4 Quantities 2-17

2.4.5 Management Plan 2-18

2.5 Process Description.......... 2-20

2.5.1 Milling Design Considerations and Selection 2-20
2.5.2 Process Description....2-21
2.5.2.1 Ore Handling....2-21
2.5.2.2 Grinding 2-21
2.5.2.3 Leaching 2-21
2.5.2.4 Resin-in-Pulp 2-22
2.5.2.5 Solvent Extraction (SX)....2-22
2.5.2.6 Impurity Precipitation 2-23
2.5.2.7 Uranium Precipitation 2-23
2.5.2.8 Yellowcake Packaging....2-23
2.5.2.9 Tailings Neutralization 2-23
2.5.2.10 Reagent Preparation....2-24
2.5.3 Alternatives....2-26
2.5.3.1 Reagent Options....2-26
2.5.3.2 Solid-Liquid Separation Options 2-26
2.5.3.3 Product Purity 2-26
2.5.3.4 By-Product Processing 2-27

2.6 Tailings Management....2-27
2.6.1 Concept 2-27
2.6.2 Tailings Properties....2-28
2.6.3 Production Schedule 2-28
2.6.4 Tailings Preparation....2-29
2.6.5 Tailings Placement 2-29
2.6.6 Decommissioning 2-30

2.7 Water and Waste Management 2-30
2.7.1 Fresh Water Use 2-31
2.7.1.1 Site Requirements 2-31
2.7.1.2 Sources of Fresh Water....2-31
2.7.2 Water Treatment....2-34
2.7.2.1 Kiggavik Water Treatment 2-34
2.7.2.2 Sissons Water Treatment 2-34
2.7.2.3 Domestic Water Treatment....2-34
2.7.3 Treated Effluent Discharge....2-34
2.7.4 Wastewater and Sewage....2-35
2.7.5 Dewatering of Andrew Lake 2-36
2.7.6 Solid Waste Management 2-36
2.7.6.1 Domestic Waste....2-36
2.7.6.2 Industrial Waste....2-36
2.7.6.3 Contaminated Waste 2-36
2.7.6.4 Hazardous Waste 2-36

2.8 Site Infrastructure 2-37
2.8.1 Power Supply and Facilities 2-37
2.8.1.1 Power House 2-38
2.8.1.2 Site Power Distribution 2-39
2.8.1.3 Fuel Storage and Distribution 2-40
2.8.1.4 Site Power Alternatives 2-40
2.8.2 Communications Systems 2-40
2.8.3 Airstrip 2-41
2.8.3.1 Airstrip Design and Construction 2-41
2.8.3.2 Airstrip Location 2-42
2.8.4 Site Haul Road 2-42
2.8.5 Explosives 2-43
2.8.6 Hazardous Materials 2-43
2.8.7 Site Accommodations 2-44

2.9 Logistics and Transportation 2-45
2.9.1 General 2-45
2.9.2 Project Shipping Quantities 2-46
2.9.3 Marine Transportation 2-48
2.9.3.1 Ocean-going vessels 2-48
2.9.3.2 Tug-Barge Fleet 2-48
2.9.4 Baker Lake Facilities 2-49
2.9.4.1 Facility Location 2-49
2.9.4.2 Wharf 2-49
2.9.4.3 Tank Farm and Fuel Loading 2-50
2.9.4.4 Storage Facilities 2-50
2.9.5 Road Transportation 2-51
2.9.5.1 All-Weather Road Options 2-52
2.9.5.2 Winter Road Option 2-54
2.9.6 Yellowcake Transportation 2-55
2.9.6.1 Air Shipment of Yellowcake 2-55
2.9.6.2 Marine Shipment of Yellowcake 2-55
2.9.7 Personnel Transportation 2-56
2.9.8 Summary of Transportation Alternatives 2-56

2.10 Decommissioning and Reclamation 2-57
2.10.1 Kiggavik 2-57
2.10.2 Sissons 2-60
2.10.3 Baker Lake Area 2-61
2.10.4 Monitoring 2-61

2.11 Summary of Project Alternatives 2-62

LIST OF TABLES

Table 2.1 Resources and Reserves……………………………………………………………..2-5
Table 2.2 Mine Design Parameters for Kiggavik Deposits…………………………………………2-8
Table 2.3 Andrew Lake Surface Mine Design Parameters………………………………..……….2-11
Table 2.4 Estimated Quantities of Waste Rock and Overburden Materials……..………………….2-18
Table 2.5 Summary of Unit Processes for Mill Options……………………………………………2-21
Table 2.6 Tailings Properties and Operational Data…………………………………………………2-26
Table 2.7 Project Processing Water Requirements…………………………………………...……2-31
Table 2.8 Monthly Water Storage in East Storage Reservoir………………………………..……2-33
Table 2.9 Proposed Water Sources and Water Withdrawal Rates……………..………………….2-33
Table 2.10 Summary of Logistics Strategies…………………………………………………….....2-45
Table 2.11 Estimated Annual Supplies……………………………………………………………….2-47
Table 2.12 Baker Lake Facility Fuel Tanks…………………………………………………….…….2-50
Table 2.13 Baker Lake Facility Dry Storage Requirements……………………………………......2-51
Table 2.14 Summary of Access Road Options………………………………………………………2-52
Table 2.15 Summary of Transportation Options……………………………………………………...2-56
Table 2.16 Summary of Project Alternatives…………………………………………………………2-63

2 PROJECT DESCRIPTION

2.1 Introduction

2.1.1 Basic Configuration

There are three main geographical areas incorporated in the Kiggavik Project; these are the Kiggavik site, the Sissons site and the Baker Lake dock site. The main base of operations will be the Kiggavik site, which will include open pit mining, power generation, ore processing, warehousing, administration and personnel accommodation. The proposed activities at Sissons include open pit mining, underground mining, and the ancillary activities required to support these mining operations. Layouts of the mining sites are shown in Figures 2.1, 2.2 and 2.3 while conceptual views are shown in Figures 2.4 and 2.5. The dock site at Baker Lake will serve as a transfer and storage facility for materials and supplies en route to Kiggavik.

The components associated with each of these areas are summarized as follows:

Kiggavik

- Open pit mines: East Zone, Center Zone and Main Zone
- Explosives storage
- Waste rock and special waste management facilities
- Ore pad
- Mill facility
- Water treatment facilities
- Water storage facility
- Tailings management facilities
- Power house and fuel storage
- Aerodrome
- Warehouse
- Main maintenance shop
- Main administration complex
- Dry facilities
- Accommodation complex

Sissons

- Open pit mine: Andrew Lake
- Underground mine: End Grid
- Satellite explosives storage
- Waste rock and special waste management facilities
- Water treatment plant

- Ore pad
- Backfill plant
- Fuel storage
- Satellite maintenance shop
- Satellite administration offices
- Dry facilities

Baker Lake

- Wharf
- Fuel storage
- Warehouse and laydown area
- Satellite administration and community liaison office

2.1.2 Project Schedule

The preliminary schedule for the Project is shown in Figure 2.6. Note that this schedule assumes that the Project receives the requisite permits, approvals and licenses, as discussed in Section 1.5, by 2012. Following regulatory approvals, the decision to proceed with the Project will be taken, contingent on updated Project economics representative of conditions at that time. The preliminary schedule assumes that a positive development decision is made immediately following regulatory approvals.

Based on the above assumptions, mid-2012 is the earliest that mobilization and preliminary construction at the Baker Lake facility and the Kiggavik site could begin. Mining and ore stockpiling at the Kiggavik site would begin in 2015 while the mill facility is constructed. Mill construction would be completed by 2017 and uranium concentrate, also referred to as yellowcake, production would begin before the end of that year. Mining at Sissons would begin in 2018. Current reserves indicate a mill operating life of approximately 15 years at 3,000 tonnes U per year. However, the potential development of additional deposits in the Project area could extend operating life. It is anticipated that decommissioning activities would begin in 2032 and require at least 5 years, followed by a monitoring period to ensure site performance is predictable and acceptable.

2.2 Geology and Resources

Refer to Section 5.4.1 for a description of regional geology.

2.2.1 Kiggavik Site Geology

Structurally, the area around Kiggavik is situated between two regional fault zones, the Thelon fault to the north and the Sissons fault to the south. The Kiggavik deposit occurs about 2 km south of the faulted contact of the Thelon sandstone with the basement metasedimentary units. The basement host rocks are a sequence of meta-arkoses and meta-pelites, which are overlain by orthoquartzites.

Three ore zones have been defined in the Kiggavik area; namely Main, Center, and East. Main and Center Zones are located 600 m apart and follow a 65˚ east-northeast trending shear zone. East Zone is located approximately 500 m further east of Center Zone (Figure 2.7).

Within Main Zone, two major parallel lenses have developed and are elongated north-northeast along strike. Two minor lenses have also been identified. The main lenses sub-crop to the west and plunge at approximately 25˚ in the 65˚ ENE direction, each with a strike length of approximately 300 m. The lenses are controlled by the intersection of the 65° ENE fault zone with a prominent 95° E fault dipping 55° N, which forms the contact between the granite and metasediments. Variation in width and thickness of the ore lenses can be seen from section to section, but thickness of each is generally 20 to 30 m (ranging between 20 to 50 m). The main ore lenses in the metasediments end at a depth of approximately 150 to 190 m below surface. Uranium mineralization adjacent to the NW-SE trending diabase dyke, which cuts through the middle of the deposit, was intersected within the granite to a depth of over 300 m. Despite the presence of cross-cutting fault zones, there is currently no evidence to suggest that the ore is terminated or significantly displaced by faulting.

The Center Zone deposit shows two defined ore lenses, the Upper lens in the hanging wall and the Lower lens in the footwall of an orthoquartzite horizon. The lenses closely follow the shallow dip of the orthoquartzite unit to the north. The mineralization reaches a thickness of 30 m in each lens. The lateral extents of the ore lenses are approximately 150 m along strike by 100 m wide. Almost all of the mineralization lies within 100 m from surface.

East Zone is similar to Center Zone in that it is approximately 150 m along strike by 100 wide, and all mineralization is located within 60 m of surface.

Uranium mineralization is hosted for the most part in altered metasediments (mainly metaarkose, metapelites and sericite schists) and to a much lesser extent in altered granite and intrusive rocks, with the exception of the diabase. The mineralization is finely disseminated along foliation planes and/or in veinlets parallel to the foliation, but can also be found as fracture infill and coating along cross-cutting structures.

The two major uranium minerals are pitchblende and coffinite. Secondary uranium minerals are not common. Fine-grained uranophane occurs in weathered rocks at surface but also occasionally at greater depth. Pitchblende and coffinite are often associated with marcasite and pyrite. Other sulphides or accessory metals are present only in minor amounts, characterizing the single elemental composition common in the Kiggavik ore zones.

The uranium mineralization is associated with an intensive alteration halo. The alteration is characterized by desilification, and by the conversion of feldspar and mica to clay minerals consisting mainly of illite and sericite

2.2.2 Sissons Site Geology

The Sissons deposits (Andrew Lake and End Grid), located approximately 17 km southwest of Kiggavik, are situated in a belt of Aphebian pelitic and arenitic metasediments which overlie Archean granitic gneisses and granodiorites. These Archean and Aphebian age lithologies have been metamorphosed and strongly tectonized during the Hudsonian Orogeny, and have been intruded by lamprohyres, syenites and fluorine-bearing granites.

Andrew Lake

The Andrew Lake deposit is located along a major east-northeast structure (Figure 2.8). Near the deposit this structure takes a NE direction due to the presence of a granite batholith. Several episodes of hydraulic brecciation have occurred in the region, mainly hosted within the granite and syenite units, but also to a lesser extent within the metasediment, paragneiss, mylonite and lamprohyre units.

Sub-vertical faults are the dominant tectonic structures in the area and govern the extension of the mineralized zones. Mineralization is situated between 70 m and 270 m from surface. Three mineralized lenses have been identified:

- Upper lens - situated to the north and is associated with intercalated metagreywackes and metapelites that have been strongly altered (illitization, hematization).
- Lower lens - located in the centre of the deposit and is associated with altered paragneiss.
- New lens - situated to the south and is associated with metasediment units (metagreywackes and metapelites).

The Upper and New lenses are situated above a quartz breccia unit and are separated by an intrusive granite. This sequence overlies the paragneiss unit which hosts the Lower lens.

Mineralization, predominantly in the form of pitchblende, appears to be controlled by the lithologies within the steeply dipping northeast trending shear zones. Locally, remobilisation of the mineralization along fractures and tension faults creates areas of higher grade mineralization.

End Grid

The End Grid deposit is located within an east-northeast sequence of Proterozic metasediments, consisting mainly of psammitic metagreywackes with intercalations of metapelites and quartzites. This sequence is intruded by granites, quartzo-feldspathic porphyries, syenites and lamprophyres. A fluorine-bearing granitic batholith is located along the northwest side of the deposit which contains elevated uranium concentrations.

The End Grid deposit is related to the same major structure as the Andrew Lake deposit, but with a northeasterly direction (Figure 2.8). Several subvertical northeast, northwest and north-northwest faults subdivide the metasediments into horst and graben structures which control the location and extent of the mineralized zones.

Mineralization is located between 250 m and 450 m from surface. Two main mineralized zones have been identified:

- South pod - associated with intercalated metagreywackes and metapelites that have been strongly altered (illite, sericite, and hematite)
- North pod - hosted within the same lithological sequence and has similar alteration features to the South pod

The mineralization consists mainly of pitchblende, which is found in the strongly tectonized and altered metasediments. The dominant controls appear to be steeply dipping tension faults and hydraulic breccias.

2.2.3 Project Resources and Reserves

Resources for the three deposits found in the Kiggavik area (Main, Center and East Zones) and the two deposits found in the Sissons area (Andrew Lake and End Grid) have been estimated separately. The geological resources have been calculated by ordinary kriging of 3 meter composite data and simulation techniques were used to quantify the uncertainty of the resource estimates. The total quantity of geological resources and reserves, as currently estimated, are shown in Table 2.1.

Table 2.1 Resources and Reserves

Deposit	Geological Resources				Reserves	
	Ore	Grade	Estimated Metal		Estimated Metal	
	(kT)	(% U)	(t U)	(lbs U_3O_8)	(t U)	(lbs U_3O_8)
Kiggavik	5,673	0.274	15,544	40,367,820	12,967	33,676,416
Andrew Lake	6,036	0.377	22,756	59,096,605	20,108	52,221,385
End Grid	10,535	0.126	13,274	34,472,838	10,841	28,154,493
Total	22,244	0.232	51,574	133,937,262	43,917	114,052,294

The geological resources and estimated recoverable reserves for the Kiggavik Project will be updated in 2008/2009 to reflect ongoing engineering work and additional drilling data collected during the 2007 and 2008 field seasons.

Geological exploration in the area is expected to continue throughout construction and over the life of the Project. Previous exploration programs have identified uranium mineralization on the Granite and Bong grids in the vicinity of the Kiggavik site (up to 33 m @ 0.41%U at Bong and 14.6m@ 0.38% U at Granite). The potential for additional resources in the Kiggavik area is considered to be good.

2.3 Mining

2.3.1 General

Both open pit and underground mining methods have been selected for the Kiggavik Project. Open pit mines are proposed for the three Kiggavik deposits and the Andrew Lake deposit, while an underground mine is proposed for the End Grid deposit. The current mine designs will be further improved based on on-going geotechnical, hydrogeological and mining studies.

The mining plan has been integrated with the tailings management strategy to ensure that sufficient mined-out pit volume is available for tailings management. Therefore, mining and ore-stockpiling at Kiggavik would begin as early as possible in the Project schedule, while mill start-up would be delayed approximately two to three years, until the first of two tailings management facilities is available.

2.3.2 Production Schedule

The preliminary production schedule, shown in Figure 2.9, is based upon a nominal annual mill production rate of 3,000 tonnes U, which requires a mine production rate of up to 675,000 tonnes of ore per year. Production rate is being optimized during the feasibility study and is expected to be within the range of 2,000 – 4,000 tonnes U per year.

Equipment procurement for the open pits starts in year 0 and continues in year 1 as production ramps up. Procurement for the underground mine (End Grid) starts in year 2. Mining of Center Zone and Main Zone are concurrent, although the start date will likely be staggered between Center Zone and Main Zone. Mining of Center Zone is complete in year 3, at which point milling will begin. Mining of the Andrew Lake open pit starts in year seven and is completed in year 17. Construction of the underground mine starts in year 2 and production starts in year 4. Mining continues throughout most of the Project life, and is complete in year 15.

2.3.3 Kiggavik Mines

The proposed Kiggavik site includes three open pits: East Zone, Center Zone and Main Zone. Open pit mining has been chosen since all three deposits occur near surface.

The current mine plan at the Kiggavik site is to:

- Excavate East Zone and stockpile the ore until completion of the open pit. Once this initial ore body has been mined out the pit would be converted to a water storage facility.

- Excavate Center Zone and stockpile the ore until completion of the open pit. Once this ore body has been mined out the Center Zone pit would be converted into an in-pit tailings management facility (TMF). The stockpiled ore material would then be processed at the Kiggavik mill and the resulting neutralized tailings would be managed in the Center TMF.
- Excavate Main Zone and process the ore; the tailings produced would be disposed of in Center TMF. Once Main Zone has been mined out the pit would be converted to a second TMF to accommodate the tailings produced from the processing of Sissons ore.

The average grade of ore from the Kiggavik deposits will be approximately 0.5% U, but may range from 0.2% - 0.6% U. The ore will be stockpiled near the mill on an ore pad sized to store all the ore from the East Zone and Center Zone Pits, which will be mined prior to start-up of the mill. The amount of ore to be stockpiled is estimated at 900,000 tonnes. The ore pad would be lined with a synthetic membrane and bermed for collection of drainage. During operation of the mill, all drainage is to be recycled to the mill for use as process water; prior to mill commissioning, drainage will be treated in the site water treatment plant prior to discharge (Section 2.7.2).

Mine waste rock from all three open pits will be managed at the Kiggavik site. Clean waste rock material deemed acceptable from the perspective of acid rock drainage and metal leaching will be used for construction. Clean waste rock not utilized for construction will be stockpiled at a location to the south of the pits. This location is downstream and predominantly downwind from both the open pits and the mill site. Runoff and drainage from the waste piles will be collected using ditches, such that the water can be recycled for use in the mill and/or treated for release if necessary.

Special waste will be segregated and temporarily stored during operation in a stockpile adjacent to the clean waste. Runoff and water percolating through the special waste pile will be collected using ditches and a holding pond, such that the water can be recycled for use in the mill and/or treated before release. During decommissioning of the site, special waste will be co-disposed with the tailings in the mined-out pits. Section 2.4 addresses waste rock management in more detail.

The three proposed open pits at Kiggavik will be mined using conventional drilling and blasting techniques, with ore and waste rock removal using mechanical excavators and trucks. Waste rock will be excavated using hydraulic excavators and front-end loaders, while ore will be loaded with a backhoe. Other mining equipment will include blast-hole drills, bulldozers, graders, water trucks, fuel/lubrication/service trucks, explosives transport and mixing truck, and pick-up trucks.

Explosives will be manufactured on site from ammonium nitrate and diesel fuel. Materials used in the manufacture of explosives will be stored in magazines constructed and operated in accordance with the Explosives Act (Canada). Explosives will be delivered to the active sites using an ANFO or emulsion delivery truck.

The open pit walls will be benched in stepped profile, with bench faces and catch berms to control falling rock, and overall slopes of approximately 45 degrees. The open pits will be accessed by ramps of suitable width to allow for two-way truck traffic with a safety berm on the pit side and a water collection ditch on the pit wall side.

Existing geotechnical data suggest that the potential for pit wall instabilities due to major faults is very limited. Bedding and foliation are dipping at shallow angles while two steep dipping joint sets may, to some extent, control the bench faces. The rock strength in the unaltered material, of which the majority of the pit walls will consist, is consistently greater than 50 MPa, with values of up to 250 MPa in the feldspar-porphyry lithology. Additional geotechnical field work will be conducted to confirm the current pit parameters, which are summarized in Table 2.2. Based on current measurements of permafrost depth in the Kiggavik area (approximately 200 m), all three pits will be entirely within the permafrost zone.

Table 2.2 Mine Design Parameters for Kiggavik Deposits

Parameter	East Zone	Center Zone	Main Zone
Pit size (Mbcm)	0.5	7.2	33.9
Pit maximum depth (m)	35	107	198
Pit maximum width (m)	125	205	545
Pit maximum length (m)	185	205	845
Overall slope angle	Min. 22° Max. 37°	36° in sector facing north 41° in sector facing south	40°
Ore (kT)	53	522	2,056

2.3.3.1 East Zone

The need for a freshwater management facility drives the design of the East Zone pit, which harbours limited resources.

2.3.3.2 Center Zone

Center Zone pit has been scheduled and designed to accommodate the need for a tailings management facility (TMF) early in the Project. The current design is shown in Figure 2.10. A small stream, shown in Figure 2.2, currently runs through the location of the open pit. It is proposed that this stream be diverted to the east to eventually drain into either the East Pit Storage Reservoir or the Jaegar Lake watershed.

2.3.3.3 Main Zone

The preliminary Main Zone pit has an 8-shaped form (Figure 2.11), as it targets extraction of the two main lenses of ore, which are separated by a diabase dyke. Some attention will be required for the pit slopes along the dyke, as the rock characteristics in that vicinity can be substantially different than those of the outer pit slopes. This design involves the creation of 2 ramps to access the 2 lobes of mineralization, which leads to a very conservative estimate of pit volume. Removing the diabase dyke pillar remains a design alternative as keeping only one ramp could lead to a much smaller pit volume.

The pit ultimate depth for Main Zone reaches 200 m. A phased approach may be appropriate, such that the first lens is mined in phase 1 and the second lens in phase 2. This option will be investigated during the feasibility study.

For Main Zone, the current design indicates that some ore (9%) is left outside the pit. Underground mining would be required to economically extract this material.

2.3.3.4 Dewatering at Kiggavik

The three open pits proposed for the Kiggavik area will be excavated entirely in permafrost and therefore significant issues relating to dewatering and groundwater quality management are not expected. Depressurization should not be required.

Some limited inflow of water into the pits is likely to occur. Sources of water flows into pits may include:

- Pit wall sources – seepage from melting of permafrost, seepage from unfrozen zones
- Surface sources – snow melt, surface run-off and undiverted surface water
- Subpermafrost water

Water that drains into the pit will be collected and directed to the mill for recycling or treatment prior to discharge. The subpermafrost regime will be monitored during operation, particularly at the Main Zone pit, to allow development of appropriate mitigation measures should upward hydraulic pressures occur beneath the pit floor. Further investigation of the hydrogeological conditions at the Kiggavik site is underway in order to confirm the expected pit inflow volumes and water quality.

2.3.4 Sissons Mines

The Sissons site is located approximately 17 km southwest of the Kiggavik site. There are two mines currently planned at Sissons, the Andrew Lake open pit and the End Grid underground mine. The Sissons general site layout is shown in Figure 2.3.

Ore mined at Sissons will be hauled to the Kiggavik mill for processing. There will be a small ore pad constructed at Sissons to provide a storage buffer for ore en route. This ore pad will be constructed to the same general specifications as the larger ore pad at Kiggavik, including installation of a synthetic membrane and berms for collection of drainage. Ore will be hauled from Sissons to the Kiggavik ore pad using either mine haul trucks or dedicated ore trailers that can be transported using standard tractors.

Sissons mine waste rock will be managed at the Sissons site. Clean waste rock material deemed acceptable in terms of acid-generating potential and metals leaching will be used for construction. Waste rock not utilized for construction will be managed on surface.

Special waste will be segregated during mining and managed in a separate temporary stockpile. Drainage from the stockpile will be collected, treated as necessary, and released. During decommissioning, Sissons special waste will be backfilled into the Andrew Lake open pit. Section 2.4 addresses waste rock management in more detail.

2.3.4.1 Andrew Lake Open Pit

The Andrew Lake deposit extends to approximately 300 m below surface and therefore potential extraction methods include both open pit and underground techniques. Surface mining at Andrew Lake is considered to be more advantageous than underground mining in terms of reliability, water management, flexibility of operation, safety and the general working environment.

The preliminary pit design is shown in Figure 2.12. The pit extends to 272 m below surface; a small volume of ore is left in place as it is not economical to extract via surface mining. The bottom of the Andrew Lake pit is expected to extend below the permafrost horizon, which is estimated to occur at 250 – 275 m below surface. Further pit optimization is on-going.

Parameters for the open pit design are shown in Table 2.3. Interpretation of existing geological records suggests that the major fracture zones in the Andrew Lake are vertical and/or steeply dipping. A marker horizon recognized as a fault breccia is identified as gently dipping towards the northeast at a shallow angle. However, this horizon appears to be generally silicified and does not constitute a true shear zone that could impact the overall stability of the southwest quadrant of the open pit. Further geotechnical data will be collected to optimize the pit design.

The mining cycle and equipment used at Andrew Lake will be similar to that proposed for the Kiggavik open pits (Section 2.3.3).

In addition to the uranium resources associated with the Andrew Lake deposit, potential gold and platinum resources have been identified. Evaluation of the opportunity to recover these resources is on-going; however, recent studies have suggested recovery may not be economical.

Table 2.3 Andrew Lake Surface Mine Design Parameters

Parameter	Andrew Lake
Pit size	44 Mbcm
Pit maximum depth	272 m
Pit maximum width	730 m
Pit maximum length	730 m
Overall slope angle	38 º
Ore	3,559 kT

2.3.4.2 End Grid Underground Mine

The End Grid mineralization is located from 250 m to 450 m below surface; therefore, only underground mining methods are considered for this deposit. As the rock is expected to be of poor quality, the only viable method may be underhand drift-and-fill.

Underhand drift-and-fill is suitable for poor to very poor quality rock. It is generally considered a safer mining method as the ceilings of the excavations are composed of an engineered product. The method involves removing the ore in horizontal slices from top down and then replacing it with cemented rock fill. The mining sequence then drops under the filled level and repeats the process working under the cemented rock fill. A conceptual plan is shown in Figure 2.13.

The maximum depth of the mine, as currently envisioned, would be 450 m, with approximately 2.8 million tonnes of ore removed. After driving the access crosscut to intersect the ore, the priority is to drift to the exhaust ventilation raise location. Until connection with the ventilation circuit is made, forced ventilation using auxiliary fans and ventilation tubing will be required.

During production, a drill-blast-muck-support cycle would be required. Rock bolting, screening and shotcreting are proposed as methods of ground support and for radiation shielding. Diesel, electrical and compressed air operated equipment would be used, including scooptrams, haulage trucks, hydroelectric jumbos, rock bolters, scissor lifts and shotcrete carriers.

Further geotechnical studies are on-going to confirm the choice of mining method.

Underground Access

From a cost and an operational flexibility perspective, a ramp is the preferred option for access to the underground workings. However, a shaft is a possible alternative, as it would allow for a shorter period between the start of construction and production.

The proposed access ramp has a 15% inclination and would connect the surface to the 100 m depth. A stope ramp (a decline from the 100 m level to the 450 m level) would then be used to access the production levels at greater depths.

In the case of a production shaft, a shaft would be required from surface to 450 m depth but a stope ramp would also be required from 100 m to 450 m depth to develop the production levels.

Mine Ventilation

Ventilation is a critical factor in an underground uranium mining operation. The ventilation air flow will be designed to exceed requirements based on both radon exhalation rates and operating diesel power.

The mine ventilation system will be based on a one-pass system, which means fresh air is not re-used. The main fresh air fans will be installed on surface together with the air heating system for the winter months. The fan will push air into the openings creating positive pressure in the mine. A surface exhaust air fan will also be installed and most of the exhaust air will exit through it.

The computation of maximum available air velocity through the ramp and through return air raises indicates that fresh air will need to be supplied through a raise in addition to the supply from the ramp.

Further study of ventilation requirements will be completed during the feasibility study.

Mine Backfill

Cemented rock fill (CRF) is proposed to constitute the End Grid mine backfill.

Preparation of cemented rock fill is a relatively straightforward process whereby minus 50 mm to minus 75 mm suitable crushed waste rock is mixed with cement. The backfill is then brought to the mine opening using haul trucks or suitably equipped boreholes. Backfill aggregate will be sourced from the stronger, more competent metamorphic rock mined as waste rock from Andrew Lake and/or End Grid.

For mining of End Grid, it is estimated that approximately 205,000 tonnes of aggregate and 15,000 tonnes of cement will be required per year.

While CRF is routinely used at several southern mining operations, there is a need to modify the process to ensure it will work in an arctic climate. Despite the severe winter climate, a surface plant has been selected instead of an underground plant, due to the need to heat the aggregate. Hot water appears to be the simplest and most efficient means of heating aggregate. The backfill from the surface plant will be trucked underground to the drifts via the ramp.

2.3.4.3 Dewatering at Sissons

At the Sissons site, End Grid extends into the deep groundwater regime beneath the permafrost, while Andrew Lake is expected to breach the permafrost horizon at the final stages of mine life.

Preliminary hydrogeological models have been constructed to estimate groundwater inflows at the proposed Andrew Lake and End Grid mines; these models also consider aspects of groundwater quality related to deep saline groundwater. The predictions presented here are based on regional data; further site-specific hydrogeological testing is on-going.

The management and treatment of water collected at the mine sites is discussed in detail in Section 2.7.2.

Predicted Inflows to the Mines

Simulation results can be summarized as follows:

- *Andrew Lake*
  Mining of the Andrew Lake Pit is expected to extend below permafrost in the final years of mining. The results of model simulations predict groundwater inflow to the ultimate pit will be approximately 240 m^3/day and that the average total dissolved solids concentration in this flow will be approximately 3,000 mg/l.

- *End Grid*
  Modeling simulations for the ultimate End Grid underground mine predict the average groundwater inflow to be approximately 2,100 m^3/day. The predicted range for total dissolved solids ranges from 6,000 mg/l at the end of Year 1 of mining to 10,000 mg/l at the end of Year 6. During Years 6 to 10, the total dissolved solids concentration is predicted to remain relatively unchanged at approximately 10,000 mg/l.

Depressurization

During the development of the open pit or decline, pressure heads beneath the permafrost will initially be 260 m or greater when the mine first penetrates beneath the permafrost. If these pressures are determined to be high enough to generate stability concerns, or the inflow volumes are considered to be difficult to manage, then prior depressurization will need to be implemented.

An effective depressurization system would likely consist of vertical or sub-vertical boreholes drilled from a bay excavated in the access to underground workings. The boreholes could either be allowed to flow under artesian conditions, or pumps could be installed (if larger diameter holes are drilled) to provide additional lowering of water levels. The water would be redirected to a sump located at the borehole collar elevation and then pumped to ground surface.

Presently, groundwater inflows to the mines are predicted to be relatively small. However, if it is necessary to separate water that has contacted the orebody from non-contact water, collection galleries could be installed around the lateral boundaries of the orebody.

Surface Dewatering

The Andrew Lake deposit occurs under the northern edge of Andrew Lake. It is proposed that a portion of the lake be dyked and dewatered. The mean depth of the lake is 0.2 m and therefore the dyke is not expected to be a large structure. The dyke will be engineered and constructed in accordance with standard practice in permafrost regions. Small fish frequent Andrew Lake and therefore the dyked area will be fished-out prior to dewatering. The fish-out will be done in consultation with the local communities and regulators.

Given the shallow nature and small size of the lake, an alternative to partial dewatering is complete dewatering of Andrew Lake and diversion of inflows. The relative impacts of the two options will be assessed further during the EA.

2.3.5 Alternatives

The mine designs presented in the previous sections are considered the preferred options at this stage; however there are several alternatives, particularly for Andrew Lake, that may be considered based on the results of the feasibility study and/or the environmental assessment.

Three mining options have been identified for Andrew Lake:

- Option 1 Solely an open pit (as described in Section 2.3.4.1)
- Option 2 Solely an underground mine
- Option 3 An open pit to 195 m depth followed by an underground mine

As an alternative to the open pit, Andrew Lake could be mined by an underground method. Due to the need for having a tailings disposal facility operational when the Andrew Lake and End Grid ores are mined, the first years of production by the underground mines would be stockpiled before being milled. A decline portal common to both End Grid and Andrew Lake would be constructed.

Alternatively, a hybrid open pit / underground option could be considered, whereby mining starts with an open pit and then concludes via underground methods. Based on preliminary pit optimization, there is a cluster of smaller pits, which are limited in depth to approximately 195 m. The remainder of the ore would be extracted using underground mining methods. Several underground mining methods have been proposed for this hybrid option. Underhand cut and fill and Sub Level Retreat (SLR) have been developed conceptually.

Further evaluation of these alternatives are on-going as part of the feasibility study.

2.4 Waste Rock Management

2.4.1 Introduction

Waste rock is the material that must be excavated to gain access to the orebody during mining operations. Waste materials may be generally categorized according to their origin and nature. Overburden refers to unconsolidated surficial soils that lie above the bedrock horizon. Clean waste rock refers to mined bedrock with low contaminant levels and no acid generating potential. Special waste refers to material with significant contaminant concentration or acid generating potential.

2.4.2 Waste Rock Characterization

Summary of Information from the 1990 EA

Some characterization of the Kiggavik waste rock material was completed as part of the 1990 Feasibility Study and EA, including metal content analysis of waste rock, acid-base accounting (ABA) and leach tests. In general the reported values of sulphide contents and potential constituents of concern were relatively low. However the detection limits were relatively high and the majority of the constituents were reported to be less than detection. Furthermore there was little to no indication of leach test procedures so that the potential for interpretation of the test results is limited.

Screening Analysis on Selected Cores Collected in 2006

In order to update the historical waste rock characterization work to current practice, several core samples were collected from the covered core racks at site in July 2006. The samples were selected to provide a representative selection of rock materials from the Kiggavik and Sissons deposits that had been drilled in the 1980s. Twenty-three core samples of ore and rock outside of the ore zones were collected. The samples included four from within the ore zones and nineteen from locations outside the ore zones. Thirteen samples originated in the Kiggavik area, nine samples were from the Andrew Lake area and one, an ore sample, was from the End Grid deposit. The core samples were subjected to screening analyses that included acid base accounting, metals assay and a 24-hour leach test with distilled water using a water solids ratio of 3 to1.

The results can be summarized as follows:

- The overall average sulphur content of the samples was low (0.09% S). The sulphur content is represented by sulphide with little or no sulphate even though the core samples have been in (covered) storage for more than 15 years. The highest sulphur content (1.25% S) was observed for a Kiggavik schist sample.
- The average neutralization potential of the samples was also low (12 kg-$CaCO_3$/t), represented mainly by the carbonate content (Carb-NP = 10 kg-$CaCO_3$/t). However, most samples exhibited NP/AP ratios greater than three, with a few exceptions.

- The contents of most elements that are typical constituents of potential concern at uranium deposits in northern Saskatchewan were generally low in non-ore samples. Specifically, the non-ore samples exhibited low contents of arsenic (<3 ppm), molybdenum (<7 ppm), nickel (<40 ppm) and selenium (<0.6 ppm).
- The leachate from all but one sample had pH values above 5. Seven samples had pH values between 5 and 6. One sample exhibited leachate with a pH of less than 4.
- The leachate in the sample with pH of less than 4 also had elevated concentrations of several constituents of potential concerns (i.e., cobalt, copper, nickel, sulphur, uranium and zinc), which would represent substantial soluble loads to drainage if this rock was stored in stockpiles on surface.
- Uranium and zinc exhibited elevated concentrations in leachate from several samples.

Although there are indications that some stored samples have reacted, and that acid generation has occurred, the results of the short-term leach tests in 2006 indicate that most samples have not oxidized or leached constituents during storage since the late 1980s.

2007 Program

Drilling resumed at Kiggavik and Sissons in 2007 and a complementary waste rock characterization program was initiated in October 2007 based on fresh waste rock samples. Twenty-five waste rock samples, representing various lithologies, were collected at specific 0.5 m intervals, usually 3 or 5 different depths in each borehole. Core samples were characterized using metal assays, mineralogy and ABA. Sequential leach tests were also conducted on the drill core samples to determine the total inventory of soluble metals on the solids and to evaluate the implications for potential disposal and long-term management of waste rock.

The results of the testing confirmed the following:

- Metal concentrations are generally near or below average crustal abundance, with the exception of uranium.
- The majority of the samples contained low to undetectable sulphide contents and would not be expected to generate acid when exposed in surface stockpiles.
- The leachability of metals from the fresh waste material is low, and not likely to represent an issue with respect to drainage from surface stockpiles.
- A few samples exhibited measurable sulphide contents, suggesting that acid generation could be a risk in some materials.

Further testing is on-going to better delineate any areas of concern and to determine a chemical signature for identification of potentially problematic materials (special waste).

2.4.3 Special Waste Characterization

Preliminary special waste characterization was conducted on special waste composites prepared from samples collected during the 2007 drilling program. Three composites, two from Kiggavik deposits and one from the Sissons deposits, were prepared in order to evaluate the metals content, ABA and leaching behaviour for a range of special waste uranium concentrations. Each composite consisted of at least 12 samples of 0.5 m core intervals from the peripheries of the mineralized zones; composite uranium contents were as follows:

- Kiggavik composites: 360 ppm U and 970 ppm U
- Sissons composites: 860 ppm U

The special waste composites were subjected to screening analyses that included acid base accounting, metals assay, modified SWEP leach testing, and meteoric water mobility (percolation) testing. The results of the testing are summarized as follows:

- The composites contained undetectable sulphide contents.
- The composites were deemed non acid-generating.
- Leachability of the composites under near neutral meteoric conditions was low.

In addition, high grade special waste composites were evaluated to assist in the development of appropriate milling cut-off grades. The composites had the following uranium contents:

- Kiggavik composite: 1700 ppm U
- Sissons composite: 1920 ppm U

Of these two high grade composites, testing indicated that the Kiggavik composite had detectable sulphide content (0.21% S) and was potentially acid-generating.

Further testing is on-going to investigate the variability in special waste behaviour to be expected and to develop an appropriate segregation strategy for clean and special waste, including proposed sampling and monitoring during mining.

2.4.4 Quantities

A production rate for waste rock material has been estimated based on the proposed mine plan. Table 2.4 provides a preliminary estimate of material volumes. The “split” between special waste, clean waste rock and overburden soil is considered a conservative estimate, such that the volume of special waste is likely over-estimated. The overburden, of which there will be about 3.5 million m^3, will be comprised mainly of frozen sand and gravel, and granite boulders with some zones of silt and glacial till. The clean overburden will be stockpiled for use in reclamation while the contaminated overburden, if any, will be placed in the main waste rock piles and covered with clean waste rock.

Table 2.4 Estimated Quantities of Waste Rock and Overburden Materials

	Volume (bcm)		
	Overburden	**Waste Rock**	**Special Waste**
Kiggavik			
East Zone	68,784	296,000	103,130
Centre Zone	523,336	5,433,676	1,016,883
Main Zone	1,504,401	27,471,274	4,005,195
Total	2,096,521	33,200,949	5,125,208
Sissons			
Andrew Lake	1,624,484	39,082,553	1,694,762
End Grid	-	-	364,000

2.4.5 Management Plan

General

Based on the preliminary waste rock characterization study results the majority of the waste rock is expected to be suitable for general construction and will be used during the first years of mining operations in the construction of haul roads, pads, berms, etc.

During mining, waste rock will be segregated according to uranium grade as determined by radiometric scanning. In addition, portable x-ray fluorescence (XRF) analysis is proposed for metal content screening. The XRF method was recently tested during mining at the AREVA McClean Lake operation in northern Saskatchewan and has been proven a reliable and effective means of segregating waste rock. The applicability of this method to Kiggavik waste rock will be demonstrated prior to commencement of mining.

Kiggavik

Under the preferred option, one clean waste rock stockpile will be constructed to accommodate the clean material that is not used for construction. Approximately 33,000,000 m^3 of clean waste rock will be generated during open pit mining. The proposed stockpile will cover an area of about 200 ha and will be located to the south of the Main Zone open pit (Figure 2.2). Based on the open pit mine plan, the ultimate volume of the waste rock pile is estimated to be on the order of 50 million m^3, based on a conservative swelling factor of 1.5. Excavated waste rock will be loaded on trucks and hauled to the waste rock pile.

The waste rock pile will be designed in order to meet appropriate physical stability criteria. A layered approach to stockpile construction is proposed to increase the overall stockpile stability. The layered placement creates a high uniform density while minimizing segregation to create a stockpile with minimal permeability to air and water penetration. The method also reduces settlement and therefore further enhances overall stockpile stability. At this stage it is assumed that the stockpile will be 40 m high, constructed in approximately 10 - 20 m lifts with 10 - 20 m wide catchments remaining at the completion of each lift. Experience to date has indicated that this configuration will result in a stable stockpile face with an overall slope of 3:1 to 4:1. The catchments will also act as a slope break and minimize erosion caused by surface runoff.

The final layout of the waste rock pile will be optimized in order to minimize the number of catchments affected by the facilities, control seepage, provide a suitable buffer distance with the nearest large lake (Pointer Lake), conform generally with the natural relief and minimize haul distances. The stockpile will be surrounded by perimeter ditches designed to collect drainage water. Drainage affecting the Kiggavik waste rock pile will largely consist of direct precipitation, with minor amounts of surrounding catchment runoff, impinging the pile perimeter. As discussed in Section 2.4.2 preliminary geochemical testing suggests there are limited concerns with respect to ARD and metal leaching from the waste rock.

It is proposed to manage segregated special waste from the Kiggavik pits during operation in a surface stockpile with drainage collection, recycling, and treatment when necessary. This material will then be placed on top of the tailings in the TMFs during the decommissioning phase.

Sissons

At Andrew Lake it is proposed to manage the clean waste rock in several stockpiles (i.e., from 1 to 3) covering a total surface area of approximately 400 ha. These stockpiles will be designed in a manner similar to that of the Kiggavik waste rock pile. Based on the open pit mine plan, the ultimate volume of the Sissons waste rock pile(s) is estimated to be on the order 60 million m^3, based on a conservative swelling factor of 1.5. Excavated waste rock will be loaded on trucks and hauled to the waste rock pile(s).

Current drainage patterns in the area surrounding the Andrew Lake pit may need to be altered in order to safely and economically place waste rock on surface. The impacts of any surface water diversions will be assessed in the DEIS.

It is proposed to manage special waste from the Andrew Lake pit during operation in a temporary surface stockpile with drainage collection and treatment. This material will then be placed at the bottom of the Andrew Lake pit during the decommissioning phase.

At End Grid it is proposed to stockpile waste rock from the ramp extraction with the Andrew Lake waste rock. Some waste rock from End Grid will be stockpiled and crushed to be used in mine backfill.

2.5 Process Description

2.5.1 Milling Design Considerations and Selection

The milling process is an important factor in the environmental and economic performance of the Project. The milling design approach has been focused upon a number of considerations in order to tailor the process to the site, as both the environment and location of Kiggavik present several unique challenges and opportunities.

In addition to maximizing uranium recovery, the primary mill design considerations are as follows:

- **Water management**. The milling process will primarily determine the amount of fresh water required, the volume of water that can be recycled, and the effluent treatment required.
- **Tailings characteristics**. The milling process will determine the chemistry, rheology, consolidation density and porewater characteristics of the tailings. In turn, the consolidation density impacts the water balance as the volume of water potentially trapped within the clay-rich tailings mass can be significant.
- **Reagents**. The type of reagents used will influence the quality of mill effluent and hence the water treatment processes required. In addition, the quantities of reagents required impact significantly upon the transportation costs for the site.
- **Radiation protection**. While the current grade estimates of Kiggavik and Sissons ores are considerably less than that of deposits typically mined in northern Saskatchewan, radiation protection measures similar to those applied at the McClean Lake operation would be implemented at Kiggavik.

A number of process options have been evaluated against these design considerations. A preferred option, which exploits resin-in-pulp (RIP) technology, has been selected for further metallurgical bench-scale and pilot-scale testing. RIP involves the use of small beads coated with a resin that is selective for aqueous phase uranium complexes. It is expected that testing will confirm the technical feasibility of the RIP process, provide engineering design data and provide further information for environmental and associated risk assessments. Mill processes similar to that operated at McClean Lake, for which technical viability has already been demonstrated on an industrial scale, are also being tested on Kiggavik Project samples to ensure that a technically viable design is available.

The capacity of the current mill design is 625,000 tonnes of ore per year, to produce 3,000 tonnes of U per year. Further evaluation of the optimal mill rate, ranging from 2,000 to 4,000 tonnes of U per year, will be conducted during the feasibility study. It is possible that other deposits in the Kiggavik area, apart from those included in this proposal, may be processed at the Kiggavik mill, if appropriate regulatory approvals are obtained.

2.5.2 Process Description

The Kiggavik mill will be composed of a number of unit processes, or circuits, that extract uranium from ore and produce the packaged uranium product commonly referred to as yellowcake. This section will describe the major unit processes and the associated facilities for the preferred process, RIP. If the results of the feasibility study suggest that one of the alternative processes, as discussed in Section 2.5.3, is more advantageous, then the alternative will be presented and evaluated in detail in the DEIS. For each process option, the combinations of unit processes possible are summarized in Table 2.5 and shown schematically in Figures 2.14 and 2.15.

Table 2.5 Summary of Unit Processes for Mill Options

Unit Process	RIP - Based Mill	McClean Lake - Based Mill
Ore Handling	✓	✓
Grinding	✓	✓
Leaching	✓	✓
Resin-in-pulp	✓	×
Solid-liquid separation	×	CCD, CCC or Filtration
Solvent Extraction	Possibly	✓
Impurity precipitation	✓	✓
Uranium precipitation, drying and packaging	✓	✓
Tailings Neutralization and TMF	✓	✓

CCD: counter-current decantation, CCC: counter-current cycloning

2.5.2.1 Ore Handling

Ore will be trucked from the mine sites to the Kiggavik mill where it is stockpiled at a lined ore pad. Based on radiometric scans performed at the mine site, ore will be sorted at the pad into low, medium and high grade stockpiles. Ore from the stockpiles is fed via loader to the grizzly screen, and the ore then enters the grinding circuit.

2.5.2.2 Grinding

The grinding circuit will consist of autogenous/semi-autogenous mills and ball mills for grinding and cyclones for classification. The ground slurry would then be thickened to recover water, which is recycled to the grinding mills. Thickened slurry is transferred to leaching circuit.

2.5.2.3 Leaching

The leaching stage solubilizes uranium and other components from the ground ore by the addition of appropriate chemicals. Sulphuric acid and an oxidant are added to the ore slurry under carefully controlled conditions. Potential oxidants include oxygen, hydrogen peroxide, air and sulphur dioxide.

Leaching temperature may range from ambient to 50°C (controlled with steam) depending upon the ore characteristics. Some or all of the leach tanks may be pressurized up to 2 bar to improve leach efficiency.

2.5.2.4 Resin-in-Pulp

Resin-in-pulp generally consists of two main stages: extraction, whereby the uranium is transferred from the aqueous phase to the resin surface via an ion-exchange process, and elution, whereby the uranium is transferred from the resin surface back to a clean aqueous phase. The loaded resin beads and spent ore slurry are separated prior to elution via screening.

The resin-in-pulp circuit would likely include a carousel system for contacting the barren resin and pregnant (U-containing) leach slurry. The tanks loaded with resin and pregnant slurry are agitated to facilitate adsorption of uranium from the aqueous phase to the resin phase. The loaded resin is then screened from the leach slurry and rinsed with sulphuric acid in elution columns. The elution stage results in concentrated eluate containing uranium, sulphate, and possibly impurities such as iron. The concentrated eluate flows through sand filters for clarification and heat exchangers for heat recovery prior to transfer to the solvent extraction circuit.

Eluted, or barren, resin is transported back to the resin-in-pulp carousel system for re-use in extraction. The resin is expected to degrade with age and attrition, thus fresh resin will be added to the circuit as required. The expected rate of resin loss and any impact on tailings characteristics is being evaluated further during the feasibility study.

2.5.2.5 Solvent Extraction (SX)

There are two main stages in the SX circuit: extraction, whereby the uranium is taken up into the solvent phase, and stripping, whereby the uranium is stripped from the solvent back into a clean aqueous phase. If the eluate from RIP is sufficiently pure, it is possible that SX will not be required in the Kiggavik mill. Additional metallurgical testing is being performed to confirm this.

The organic phase, or extractant, would consist of amine, isodecanol and kerosene. The solvent extraction circuit would be housed in a separate building to mitigate the fire hazard associated with the solvent. The uranium is transferred from the eluate to the organic solvent, which has a high affinity for uranium, but not for most other dissolved metals contained in the aqueous solution. The uranium rich organic solvent is readily separated from the aqueous solution in a settler due to the immiscibility of the two solutions. Residual organic is removed from the barren aqueous solution, or raffinate, in an after-settler and voraxial separator. A portion of the raffinate could be recycled to elution makeup while the remainder is bled to the tailings neutralization circuit.

Pregnant, or uranium-containing, organic from the extraction stage would then be contacted with strip solution. The uranium is transferred from the organic phase to the aqueous phase, referred to as pregnant strip solution. The barren organic solution is forwarded to an acid wash stage where the organic is water washed to recover acid prior to recycle to the extraction cells. The barren organic is periodically scrubbed with sodium carbonate solution to remove deleterious metals that gradually build up in the organic solution.

2.5.2.6 Impurity Precipitation

The gypsum and impurity precipitation circuit removes sulphate and other impurities as needed from the uranium-containing solution. The solution would be diluted to reduce acidity and then lime would be added to precipitate sulphate as gypsum. Ferric sulphate may be added, if required, to precipitate impurities such as arsenic or molybdenum. The uranium-containing purified solution is then separated from the precipitated solids in a thickener and belt filter. The gypsum cake would be recycled to the RIP tanks for recovery of any entrained uranium solution.

2.5.2.7 Uranium Precipitation

Purified uranium pregnant strip solution would be discharged from the gypsum thickener into yellowcake precipitation tanks. Hydrogen peroxide is added to precipitate uranium peroxide and magnesium oxide added to control pH. The precipitated uranium solids are then concentrated in a yellowcake thickener. An organic flocculant is added to the slurry to assist settling. The barren strip is clarified in sand filters to remove suspended yellowcake particles. The clean barren strip solution is then recycled to the stripping circuit with excess bleeding to the tailings neutralization circuit. The thickened solids from the yellowcake thickener are further dewatered in a yellowcake centrifuge. The dewatered yellowcake will then be dried or calcined to produce a final product with low moisture content.

2.5.2.8 Yellowcake Packaging

The yellowcake handling circuit would include an automated yellowcake drum packaging facility within a dust proof enclosure serviced by a dedicated dust scrubber. Yellowcake would be discharged from the product surge bin to the packaging system which fills steel drums. Each sealed drum containing approximately 400 kg of yellowcake would then be stored in a designated area prior to shipping off site.

2.5.2.9 Tailings Neutralization

The tailings neutralization circuit treats the leach residue from the resin-in-pulp circuit, bleed raffinate from the solvent extraction circuit (if present), barren strip from the uranium precipitation circuit and other small miscellaneous flows requiring neutralization and treatment. Ferric sulphate, barium chloride and lime are added for the removal of radium-226, transition metals and heavy metals as well as to ensure near neutral terminal pH. The soluble metals are precipitated with low residual metal values remaining in solution. Slurry from the final tailings neutralization tank is pumped to the tailings management facility. Depending upon the consolidation density resulting from the selected process, a tailings thickener may be included to recover water and increase density prior to tailings deposition. In all cases, tailings decant will be recovered and recycled to the mill from the tailings facility.

Ferric sulphate addition to tailings neutralization has been included in the current design, however, the levels of soluble arsenic and molybdenum are expected to be low and it is possible that this reagent will not be required.

2.5.2.10 Reagent Preparation

A number of reagents will be required to operate the mill process; these reagents and the proposed methods of storage are described as follows:

Barium Chloride

Barium chloride would be used in the tailings neutralization circuit and the conventional water treatment plant to precipitate radium. Barium chloride would be delivered to the site in bulk containers and transferred to a storage tank for use in the process.

Ferric Sulphate

Ferric sulphate would be used to remove dissolved arsenic and other transition metals in the tailings pore water discharged to the Tailings Management Facilities (TMFs) and in the water treatment effluent. Ferric sulphate would also be added to the gypsum precipitation process to remove any remaining arsenic and molybdenum from the solution, if required.

The reagent will be shipped to site in bulk containers and transferred to a concentrated ferric sulphate tank. The ferric sulphate will then be mixed in a mix tank. The dilute solution is stored in a distribution tank for delivery by pump as required to the process.

Flocculants

Flocculants would be used in various plant thickeners to enhance the settling characteristics of solids. The dry flocculants would be delivered to site by container in bulk totes. Flocculant mixing systems, including agitated day tanks and pumps, would prepare the reagents.

Hydrogen Peroxide

Hydrogen peroxide is proposed for use in the yellowcake precipitation circuit to precipitate uranium peroxide. Hydrogen peroxide would be delivered via ISO container either as a 50% or 70% solution. The preparation circuit would include a dilution water system, day tank and distribution system. If an “impure” yellowcake is produced (Section 2.5.3.3), hydrogen peroxide may not be required.

Lime

Lime would be primarily used to neutralize the leached tailings, to precipitate gypsum, and for pH adjustment in the water treatment plant. Quicklime (CaO) would be delivered to site by container into a lime silo with vent and activator. The quicklime would be converted to hydrated lime ($Ca(OH)_2$) in a lime slaking ball mill, in closed circuit with a cyclone. The slaked lime would then be delivered via lime loops to feed the process circuits.

Magnesia

Magnesia would be used in the uranium precipitation circuit to increase pH and precipitate residual uranium from solution. The reagent would be delivered in a solid form by ISO container and stored in a storage silo including vent and activator. The solid magnesia would be added via screw feeder to a mix tank for preparation of the slurry and then delivered via pump to the process.

Oxygen

Oxygen for the leaching process would be produced on-site in a Vacuum Pressure Swing Adsorption (VPSA) (or similar) oxygen plant. Depending upon reagent selection, oxygen may not be required (Section 2.5.3.1).

Sodium Carbonate

Sodium carbonate would be used for regenerating organic in SX. The reagent would be delivered to site by container and transferred to a storage silo with vent and activator. Steam and process water would be added to the sodium carbonate mix tank to prepare the solution prior to use in the plant.

Solvent Extraction Reagents

Kerosene, amine and isodecanol would be used in the SX circuit. Amine extracts the uranium from the pregnant aqueous solution. Isodecanol would be used as a phase modifier and kerosene used as a diluent. The reagents would be delivered to site via ISO containers. Kerosene would be stored in storage tanks, while amine and isodecanol would be transferred to totes and added to the solvent extraction circuit by hand pump.

These reagents will not be used if further testing indicates that the solvent extraction circuit is not required.

Sulphuric Acid Plant

Sulphuric acid (93%) would be produced on site in an acid plant. The production of sulphuric acid involves the process of burning sulphur in the presence of dried ambient air, reacting the products in a catalyst bed, and recovering the reacted components in an air absorption solution to produce sulphuric acid. Waste heat in the form of superheated steam is also produced as part of the reaction.

2.5.3 Alternatives

2.5.3.1 Reagent Options

In order to optimize environmental performance and transportation costs, a number of alternative process reagents are currently being tested. These include:

- Oxidants: sodium chlorate, hydrogen peroxide, sulphur dioxide/air
- Eluant / Strip solution: sodium chloride, sodium carbonate
- pH control in precipitation: sodium hydroxide, calcium hydroxide

The selection of reagents will be based on the considerations discussed in Section 2.5.1 and the impact of the chosen reagents on water and effluent management, tailings characteristics, and hazardous goods management will be fully evaluated in the DEIS.

2.5.3.2 Solid-Liquid Separation Options

If further study indicates that the resin-in-pulp process is not suitable for the Kiggavik Project, an alternative process, based on the McClean Lake mill, will be assessed in the DEIS. There are three solid-liquid separation alternatives associated with this option, all of which have been demonstrated in operating uranium mills. These unit processes could be employed either separately or in combination at Kiggavik. The alternatives are:

- Counter-current decantation (CCD)
- Counter-current cycloning (CCC)
- Filtration

The alternate processes would require similar reagents as described for the RIP process, except that resin beads would not be required.

2.5.3.3 Product Purity

Yellowcake typically consists of relatively pure uranium oxides or peroxides that meet refinery specifications. One potentially viable option at Kiggavik is to precipitate an “impure” yellowcake for shipment and further processing at the McClean Lake operation. This could reduce the capital cost of the mill (by reducing the number of circuits) and reduce the quantities and types of reagents that must be shipped to site. The economics of this option and the characteristics of the “impure” yellowcake are under investigation.

2.5.3.4 By-Product Processing

There are minor amounts of precious and platinum-group metals associated with the Andrew Lake deposit. The technical viability and economics of recovering these metals are currently under investigation as part of the feasibility study. If the recovery of these values is warranted, details regarding reagent volumes, process selection, and waste products will be described and assessed as part of the DEIS.

2.6 Tailings Management

2.6.1 Concept

The proposed tailings management approach for the Kiggavik Project is modelled after AREVA's McClean Lake operation in northern Saskatchewan and is based on the "in-pit tailings management facility" concept. This concept eliminates the need for an engineered surface tailings facility and represents the approach accepted by the regulatory agencies at all three uranium mills currently operating in northern Saskatchewan.

Approximately 10.7 million tonnes of tailings will be produced by mining and processing ores from the Kiggavik and Sissons deposits, requiring an estimated containment volume of 20 million m^3. Kiggavik and Sissons ore will be hauled to the Kiggavik mill for processing, and thus the resulting tailings will be managed at the Kiggavik site using the in-pit disposal concept. In-pit disposal provides better isolation and security than available with standard above-ground disposal schemes. As well, hydraulic gradients encountered below the water table within natural systems are substantially lower than those that develop in surface tailings impoundments. Lower hydraulic gradients result in a lower flux of contaminants out of the facility. Additionally, since greater depths of tailings may be stored within a pit than at the surface, tailings may achieve a greater degree of consolidation, thus achieving lower hydraulic conductivities than are feasible in above-ground facilities.

The overall tailings management system at the Kiggavik site will be comprised of the tailings preparation circuit within the Kiggavik mill, the tailings delivery system, and the Center Zone and Main Zone tailings management facilities (TMFs). The tailings preparation circuit associated with the Kiggavik mill will be used to treat and neutralize tailings for the removal of soluble contaminants and to thicken the resulting tailings slurry prior to disposal. Following the preparation process, tailings will be pumped from the mill to the TMF.

The Center Zone and Main Zone mined out pits will serve as the repository for all tailings resulting from uranium processing of Kiggavik and Sissons ore at the Kiggavik mill. The facility will be designed to minimize environmental effects due to tailings disposal throughout operations and for the decommissioned facility, by application of appropriate mitigation measures.

2.6.2 Tailings Properties

Properties of the tailings relevant to the design of a tailings management facility are presented in Table 2.6. The tailings tonnage is estimated to be approximately 18% greater than the ore tonnage due to the generation of gypsum in the milling process.

Based on laboratory test data and recent simulations the tailings discharge slurry density is expected to range between 22% and 36% solids by weight. Based on the results of a metallurgical testing program, it has been estimated that the settled density would be low, on the order of 40% solids by weight or 0.533 tonnes/m^3. Therefore, the effluent liberated as the tailings consolidate would range from approximately 200 m^3/day to 3,900 m^3/day.

The volume of the deposited tailings after consolidation is estimated at approximately 20,000,000 m^3.

The temperature of the tailings slurry ranges from 15 to 25^{o}C as it discharges from the mill.

Table 2.6 Tailings Properties and Operational Data

Milling rate	625,000 tonnes/year (for 330 days/yr)
Tailings production • Tailings / Ore • Annual • Total	 1.185 tonne tailings per tonne of ore 740,625 tonnes / year 10,696,995 tonnes
Discharge slurry • % solids by weight	 22 % to 36% (to be confirmed)
Deposited tailings • % solids by weight • Dry density • Volume	 40 % 0.533 tonnes/m^3 20,069,409 m^3

2.6.3 Production Schedule

Figure 2.16 presents projected annual tailings production at the Kiggavik mill, based on the mill production schedule. In total, approximately 10.7 million tonnes of tailings solids are expected to be generated from processing of Kiggavik and Sissons ore sources, requiring an estimated containment volume of 20 million m^3.

It is assumed that only 85% (or 6.1 Mbcm) of the mined-out Center Zone open pit will be available for tailings disposal due to irregularities around the rim of the pit. This volume, which corresponds to approximately 30% of the total volume of tailings, would accommodate approximately 4.5 years of production. The Main Zone TMF would then receive tailings production for the remainder of the Project operating life.

2.6.4 Tailings Preparation

Disposal of thickened tailings will be incorporated to minimize the initial water content and segregation of the tailings during subaqueous deposition. Thickened tailings will accelerate the consolidation and minimize the hydraulic conductivity of the tailings mass. This will provide a means to minimize the long-term solute flux out of the TMF by limiting its advective component through the tailings mass, thereby leaving diffusion as the primary process of solute release from the decommissioned facility.

Engineered Tailings Geochemistry

Adjustments to the tailings neutralization and treatment process in the mill will be incorporated in the tailings management system design. Addition of barium chloride to the neutralization circuit will remove radium-226 from solution. The controlled addition of a chemical reagent to the neutralization circuit may be required to remove contaminants (i.e., ferric sulphate in the case of arsenic removal). Lime and acid will be also added to control the solution pH within the optimum range to maximize the efficiency of metal precipitation and for adjustment to final deposition pH.

Reagent addition in the tailings neutralization circuit allows consistent control of soluble concentrations of constituents of concern within the tailings. This reduces variability in the chemistry of placed tailings and reduces source concentrations within the tailings pore water to acceptable levels. A reduction in concentrations of contaminants at the source results in a minimization of contaminant loadings to the receiving environment over the long-term.

2.6.5 Tailings Placement

Subaqueous Deposition

Subaqueous tailings deposition reduces worker exposure to dust, gamma radiation, and radon compared to subaerial placement methods, therefore providing enhanced worker protection. This method also eliminates freezing of the tailings after deposition, which would hinder consolidation of the tailings mass. Freezing of tailings, either during operation or decommissioning, is not an inherent part of the proposed TMF design.

The tailings will be deposited in the TMF through a vertical deposition pipe that will extend from the placement barge, through the pit water cover (subaqueous deposition), injecting the slurry just below the top of the previously placed tailings. The length of the deposition pipe will be adjusted manually to ensure tailings are deposited at the desired depth. A slurry diffuser may be used to dissipate the energy of the slurry at the outlet of the tremie pipe, as required to reduce scour during placement.

The tailings deposition barge may be moved in the TMF by adding or subtracting sections of the walkway, or by moving the entire walkway (and barge) to different anchor points on ‘shore’. An ice-free condition will be maintained around the barge in winter by pumping water through a distribution header around the barge.

The final TMF design may include a drainage system (either bottom or horizontal) if further testing indicates that the rate of natural tailings consolidation would not sufficiently reduce hydraulic conductivity.

Spill Prevention and Response

Dual containment pipelines or utilidors will be used for all pumping of water and tailings associated with the Center Zone and Main Zone TMF operations. This system will provide protection against spills.

2.6.6 Decommissioning

The decommissioning plan for the Kiggavik TMF includes the placement of a waste rock and surficial till cover over the tailings mass, with the cover extending to the natural ground surface. This cover will allow enhanced consolidation of the tailings mass, which will result in lower tailings hydraulic conductivities. This option will also eliminate the potential issue of quality of overlying pond water for the decommissioned facility. A diversion ditch (or berm) will be installed around the pit perimeters in order to prevent surface run-off from entering the pit areas.

Post-decommissioning long-term effects associated with an in-pit tailings management facility are discussed in Section 7.

2.7 Water and Waste Management

The overall water management strategy is shown in Figure 2.17. Fresh water will primarily be supplied by deeper lakes to the north and east of the Kiggavik site.

Significant recycle of process water, site drainage, and treated effluent would be an integral part of the water management strategy. Note that the balance presented here is based on conservative assumptions and it is anticipated that significant improvements can be achieved in recycle rates. Confirmation and further optimization of the water balance is on-going and will be dependent on milling rates and process selection.

Waste streams from the Project include treated process effluent, hazardous industrial wastes, domestic wastewater and solid waste, and treated sewage.

2.7.1 Fresh Water Use

2.7.1.1 Site Requirements

Both Kiggavik and Sissons will require fresh water, but Kiggavik will be the largest consumer due to requirements of the mill process.

The main water-consuming components of the Project and the estimated water requirements for each are listed in Table 2.7. A significant portion of the water required for the process will consist of recycled water, thus the fresh water requirements are less than the total water requirements. Conservative estimates indicate that at least 20% of the process water can be sourced from recycle water. The Project is committed to achieving higher recycle rates; however, until confirmatory data is available, it is believed prudent to propose a conservative value.

Table 2.7 Project Processing Water Requirements

	Estimated Total Water Requirements(1)		Estimated Fresh Water Requirements
	Daily (m^3)	**Annually (m^3)**	**Annually (m^3)**
Mill Process(2)	3,660	1,208,000	966,400
Accommodation Complex(3)	100	36,500	36,500
Kiggavik Site(3)	60	21,900	21,900
Sissons Site(3)	30	10,950	10,950
Contingency (10%)	-	127,700	103,600
Total Water	-	1,405,000	1,139,400

(1) Based on 3,000 tonnes U per year production
(2) Assumes 330 operating days per year for process water
(3) Assumes 365 days per year for potable water

2.7.1.2 Sources of Fresh Water

Site hydrology is reviewed in Section 5.8. The Kiggavik and Sissons sites are located within the Anigaq River watershed. In order to reduce the extent of any potential impacts, water intake and discharge will preferentially occur within this same watershed. DFO's "Freshwater Intake End-Of-Pipe Fish Screen" guidelines will be applied to prevent entrapment of fish.

Seasonal freezing of all streams and many lakes in the area places constraints on the source of fresh water. Firstly, the lake must be deep enough to permit use of a screened intake pump. This minimum depth is estimated at 4 m. Secondly, the lake must have sufficient volume such that the required withdrawal does not have an adverse impact on fish habitat.

During summer months, it is assumed water can be drawn from running streams in the area provided that withdrawal from any water course does not exceed 10% of the total volumetric flow.

The lakes that have been identified as potential water sources are shown in Figure 2.18. They are:

- Kavisilik Lake
- Scotch Lake
- Siamese Lake
- Skinny Lake
- Mushroom Lake

Bathymetry data suggests that there is significant under-ice volume available in Kavisilik, Scotch and Skinny Lakes. Siamese Lake is quite large and may be an appropriate water source; however, bathymetry data are not yet available for this waterbody. Smaller lakes in closer proximity to Kiggavik may be suitable as alternative sources of potable water. Mushroom Lake is proposed as a water supply for the Sissons operation only.

The proposed Kiggavik system will draw water from Kavisilik, Scotch and Skinny Lakes with optional use of Siamese Lake (if bathymetry data indicates it is sufficiently deep). As two of these lakes are northeast of the site, a single pipeline could be used for transport. The use of more than one water source should reduce the potential impact on any one lake and will also provide redundancy in case of operational issues with one of the systems. It is also proposed that nearby streams could be used if necessary during the summer months. Details of the proposed water intake locations and pipelines will be included in the DEIS.

In order to reduce the volume of fresh water drawn directly from lakes, it is proposed that East Pit, which would be mined out after the first year of operations, be converted to the East Storage Reservoir. This reservoir would be used to collect and store surface drainage for use in the mill as clean water, particularly during the winter. The annual flow of site surface drainage to the pit has been estimated on a preliminary basis at 888,000 m^3. This includes diversion of a small stream that currently flows through the proposed location of Center Pit.

While over 880,000 m^3 of surface drainage is theoretically available for diversion to East Storage Reservoir, the volume of the storage reservoir is estimated at 500,000 m^3. However, with concurrent use and collection of surface drainage over the summer months, a significant greater volume can be captured. Table 2.8 shows water requirements and intake sources on a monthly basis. The volumes of surface drainage per month are based upon fractionating the total estimated annual surface drainage (888,000 m^3) by the mean discharge volume as a percentage of annual volume for Qinguq Creek. Further study is required to confirm these assumptions and provide minimum flows to be expected during drought years. For the purposes of the proposed system, it is assumed that only 75 % of the drainage is successfully captured, such that the total directed to East Storage Reservoir is 610,000

m^3/a. The potential impact of this diversion on the downstream watershed will be assessed in the DEIS.

Table 2.8 Monthly Water Storage in East Storage Reservoir

Month	Monthly Volumes in 000's m^3			
	Surface Drainage	Volume Stored	Storage Reservoir Level at Month End	Volume Withdrawn
January	0	0	126	98
February	0	0	28	98
March	0	0	0	28
April	0	0	0	0
May	21	21	0	21
June	498	498	400	98
July	171	98	400	98
August	75	75	400	75
September	105	105	500	5
October	18	18	420	98
November	0	0	322	98
December	0	0	224	98
Total	**888**	**815**	-	**815**
Conservative Total (75%)		**610**		

Table 2.9 summarizes the proposed fresh water withdrawals for the project. All fresh water entering the system will be chlorinated to control bacteria that could foul pipes, pumps and tanks.

Table 2.9 Proposed Water Sources and Water Withdrawal Rates

	Estimated Fresh Water Requirements (m^3)		Proposed Water Source Withdrawals (m^3/a)			
	Annually	Including 10% Contingency	East Pit Reservoir	Skinny Lake	Kavisilik Lake	Mushroom Lake
Mill Process	966,400	1,063,000	610,000	-	453,000	-
Accommodation Complex	36,500	40,150	-	40,150	-	-
Kiggavik Site	21,900	24,100	-	24,100	-	-
Sissons Site	10,950	12,000	-	-	-	12,000
Total Water	**1,035,750**	**1,139,400**	**610,000**	**64,250**	**453,000**	**12,000**
Under-Ice Withdrawal(1):				48,200	339,800	9,000
Percentage of Estimated Under-Ice Volume (%):				**1.8**	**2.3**	**2.7**

(1) Assumes 9-month ice cover per year

2.7.2 Water Treatment

2.7.2.1 Kiggavik Water Treatment

Major sources of water to be treated at Kiggavik would include:

- Process effluent
- Pit water
- Site drainage, including ore pad and special waste drainage
- Domestic wastewater

In practice, most of the pit water and site drainage would be recycled to the mill, and therefore the primary streams to be treated would be mill effluent and domestic wastewater.

These streams will be treated in a combined membrane and chemical treatment plant to meet effluent discharge criteria as established during the regulatory process.

2.7.2.2 Sissons Water Treatment

Water to be treated at Sissons includes:

- Underground mine water
- Pit water
- Site and stockpile drainage
- Domestic waste water

Water at Sissons, which is expected to be brackish, will be treated in a portable membrane water treatment plant prior to discharge into Judge Sissons Lake. Disposal options for the brine are currently being established.

2.7.2.3 Domestic Water Treatment

Potable water at both Kiggavik and Sissons will be treated via reverse osmosis and chlorinated as required to be accordance with territorial drinking water guidelines. Two plants are proposed, one located near the Sissons dry facility and the other located near the Kiggavik accommodation complex.

2.7.3 Treated Effluent Discharge

Discharge from the Kiggavik and Sissons water treatment plants will be directed to one of several lined monitoring ponds. Once a pond is full, the contained treated effluent would be analyzed for all constituents of concern. If the analysis indicates that the effluent has been treated to specifications, the pond contents would be pumped via pipeline to the receiving waterbody. The discharge pipeline would be heat-traced to prevent freezing.

If analysis of a monitoring pond sample indicates that effluent does not meet specifications, pond contents would be recycled back to the water treatment plant for re-treatment, or to the mill for recycling. This system ensures that all effluent directed to the environment is within specification.

Two alternatives for the receiving waterbody are proposed to encompass the range of effluent scenarios possible, as shown in Figure 2.19.

- Sik Sik Lake
  - Treated effluent would be discharged to Sik Sik Lake (approximately 7 km from Kiggavik) on a year–round basis, however, the construction of a small dam across the outlet of Sik Sik would allow retention of effluent during the winter for release during summer when downstream waterbodies are actively flowing.
  - Preliminary aquatic studies indicate that Sik Sik Lake is fish-bearing. As Sik Sik Lake freezes completely in the winter, it is assumed that these fish are migrating to the lake during the summer months. By placing a dam across the outlet, it may be assumed that fish will no longer be able to migrate into the lake, representing a loss of fish habitat. However, the increased depth of the altered lake may permit fish to survive year round.
  - The environmental benefit of this system stems from the ability to control release into the downstream watershed. Effluent would not be released into the stagnant under-ice water of larger fish habitats. Flow could be easily controlled to ensure that there is no impact to fish habitat or bank erosion in downstream channels.
- Judge Sissons Lake
  - Treated effluent would be discharged to Judge Sissons Lake on a year-round basis.
  - Discharge would be via a diffuser placed in a deep zone of the lake.
  - Operation would be more difficult due to the relatively long distance to the lake (approximately 13 km).

Regardless of the scenario, it is proposed that effluent be discharged into the Judge Sissons watershed, which is part of the Aniguq drainage basin.

Preliminary impact assessments for the proposed options are presented in Section 7. Further confirmation and comparison of the two options is on-going.

2.7.4 Wastewater and Sewage

Sewage, including black and grey waters, will be managed in accordance with all territorial guidelines and regulations. It is proposed that all discharge from the accommodation complex, estimated at 40,000 m^3/ year, be treated in either a membrane sewage treatment plant or a biological treatment plant with discharge to the Kiggavik effluent treatment plant. Treatment sludge would be hauled to a sludge management area in the Kiggavik waste rock pile. Details of the location of all waste management areas and management of sewage during construction will be provided in the DEIS.

2.7.5 Dewatering of Andrew Lake

The northern corner of Andrew Lake overlies the proposed location of Andrew Lake pit (Figure 2.20). Although the depth of Andrew Lake is approximately 20 cm, aquatics studies have indicated that the lake is fish-frequented.

One option is to construct a dyke across the north-east quadrant of Andrew Lake and dewater/fish-out the area overlying the proposed open pit. Approximately 133,000 m^2 of lake area, or approximately 27,000 m^3 of volume, will need to be dewatered to provide adequate buffer between the pit edge and the dyke. A second option is to dewater the entire lake. In either case, fish habitat compensation will be required. Only water that meets discharge criteria would be released directly to the environment. A detailed dewatering plan will be created in consultation with regulators and stakeholders prior to any dewatering activity.

2.7.6 Solid Waste Management

2.7.6.1 Domestic Waste

Solid domestic wastes that originate from the accommodation complex or the offices will be sorted into recyclables (paper and cans) and non-recyclables. The recyclables will be transported off-site to a recycling facility. Domestic non-recyclables will be disposed of in landfills located in specified areas of the Kiggavik and Sissons clean waste rock piles. Food wastes will be incinerated to minimize interactions with wildlife. The incinerator will be operated in compliance with all applicable federal, territorial and local regulations. It is estimated that the total volume of domestic waste will be 1,900 m^3/year.

2.7.6.2 Industrial Waste

Industrial wastes, defined as non-combustible and non-contaminated materials originating from construction and operation, will be landfilled in a designated area of the Kiggavik clean waste rock pile. Details on the expected volume and location of the disposal area will be included in the DEIS.

2.7.6.3 Contaminated Waste

Conventional waste materials that originate from operational areas may be chemically or radiologically contaminated. These materials are collected in dumpsters and transported for burial within the hydraulic containment areas of the TMFs.

2.7.6.4 Hazardous Waste

Hazardous substances and waste dangerous goods, consisting of waste oil/fuel filters, waste antifreeze, waste oil and waste batteries are collected in designated containers and transported for recycling or disposal at an off-site registered facility. A hazardous materials storage area will be designated and used to store hazardous goods for shipment. Hydrocarbon-contaminated soil and snow will be placed in soil farms located on the Kiggavik and Sissons clean waste rock piles for remediation. Management plans for the soil farms will be included in the DEIS.

2.8 Site Infrastructure

Geographically, the Project mine site can be considered to consist of infrastructure in three main areas: Kiggavik, Sissons and the aerodrome, and the roads connecting these areas. The main infrastructure at each site is listed as follows:

- Kiggavik
  - Mill
  - Water Treatment
  - Power house and fuel storage
  - Accommodation complex
  - Warehouse
  - Maintenance Shop
  - Administration
- Sissons
  - Satellite offices
  - Satellite maintenance shop and wash bays
  - Water Treatment
  - Backfill plant
- Aerodrome
  - Airstrip
  - Air Terminal

The mill and water treatment plants are discussed in Sections 2.5 and 2.7 respectively.

The mill, power house, administration building, and accommodation complex will be interconnected with an arctic corridor. The arctic corridor is an elevated, heated walkway used to dispatch power cables, heating pipes, fire water, and potable water to the larger components of the facility. The corridor also allows personnel to walk with relative comfort and safety between the accommodations complex and the major operating buildings of the site.

2.8.1 Power Supply and Facilities

A power generation and distribution plan has been proposed for the Project based upon conservative estimates of power requirements. Further studies to reduce the power requirements of the site are being considered as part of the feasibility study. The current power requirements, based on a 3,000 t U per year operation, are summarized as follows:

- Up to 158 GWh electric power per year (104 GWh milling power)

- Up to 66.8 million litres of diesel fuel for power generation, mobile equipment, etc.
- Up to 5.7 million litres propane for process heat and back-up heating
- Maximum instantaneous power load for the site: 21.4 MW
- Power house sizing: N+2
- Heat is recovered from the power house. However it is insufficient to match the heat needs in winter, therefore boilers will also be installed.

2.8.1.1 Power House

The proposed power house would be a single building located adjacent to the mill facility. The building would be designed to accommodate a maximum of nine generator-sets and ancillary equipment. It will be equipped with day tank fuel storage, exterior radiators, silencers and heat recovery systems.

The proposed placement of the power house, as shown in Figure 2.2, permits heavy truck access from the access road, close proximity to major heating and power loads, reasonable access to the 25 kV substation and transmission line to Sissons, good access to the emergency/construction power modules while allowing for the maintenance and accommodations complex to be generally upstream from the exhaust and associated noise from the power house and maintenance complex.

The engines proposed for the Project are EMD 20-710 or similar (Caterpillar 3616 and Wartsila 12V32). There would be 9 generator-sets at the Kiggavik power house with 7 of them operational at any one time (for a 3,000 tonne-U per year operation). Each unit would be rated for 3.595 MW_e continuous duty. Three-phase electricity would be generated at 4160 V, 60 Hz. The generators are connected to a 3000 A split bus, connected by a normally open tie breaker. The split bus configuration allows continued service or partial system isolation when required.

A power distribution centre would contain the 4160 V bus and breakers. Feeder breakers would supply 4160 V loads at Kiggavik. Two breakers would be connected to two 6 MVA, 4160 V to 25 kV step-up transformers supplying the transmission line to Sissons.

A proposed secondary distribution centre (SDC) would supply 4160 V and 600 V loads within the generating station. Blackstart power for the generating station would be provided by a three-phase, 160 kW 600 V generator-set connected through the SDC.

Heavy fuel for power generation has also been suggested in order to improve efficiency. Currently the preferred option uses only light arctic fuel, which avoids logistics drawbacks associated with a multiplicity of fuels, and is considered environmentally more acceptable. However, further studies may consider the heavy fuel option in more detail.

Two insulated and housed 90,000 L fuel tanks and header connections would be located adjacent to the plant, to be replenished via pipeline from the proposed Kiggavik tank farm.

The compressed air engine starting system will provide air from two main receiver tanks to auxiliary receiver/surge tanks at each engine. The compressed air system provides sufficient capacity to start a single engine at a time.

The general ventilation system for each engine bay includes tempered plant air to offset the engine exhaust and general ventilation to accommodate heat radiated from the engine block. Station HVAC loads are based on heat recovery from low temperature after coolers, using glycol heat lines and unit heaters.

A standpipe and hose system and a pre-action dry sprinkler system, to zone and protect the structure, will provide basic fire protection. Insulated firewater tanks and fire pumps will be required. The power house building will also be fitted with a Siamese connection. The fuel control dog house will be provided with a chemical suppression system.

Acoustic enclosures with an egress behind the engine will be constructed for each generator-set. Heat exchangers are supported above the egress corridor.

2.8.1.2 Site Power Distribution

Traditional overhead transmission systems utilize wood poles or steel towers strung with non-insulated steel-reinforced aluminium conductors. Overhead lines experience many challenges in arctic environments, including:

- Increased failure rate in severe weather conditions
- Specialized crews and equipment required for maintenance
- Higher line losses with equivalent-sized conductors

The method currently proposed for distribution of power to Sissons is the “Teck on Tundra” transmission system. Teck cable failure rates are not influenced by severe weather conditions in the same manner as overhead lines. Teck on Tundra lines also require less time for repairs, and less specific skills for the maintenance crews. The cables would be identified, protected from damage, and spliced according to regulatory standards.

The proposed system would consist of a single three-conductor Teck cable placed directly on the ground. Lengths of Teck cable would be interconnected with 25 kV power junction boxes every 500 meters. At the Sissons site, a step-down transformer, vacuum breakers, load break switches, capacitors and associated equipment would be required to provide 4.16 kV service to mine loads.

The Teck cable would be installed along a cable route approximately parallel to the proposed haul road and through road crossings where required.

2.8.1.3 Fuel Storage and Distribution

Storage of diesel fuel requires tank farms at both Kiggavik and Baker Lake. These proposed facilities are sized to meet an assumed yearly site consumption of 70 ML diesel fuel (for a 3,000 tonne-U per year operation). The Baker Lake facility is discussed in Section 2.9.4.

The number of tanks at Kiggavik would be dependent on the road option selected and will range from 2 to 6 tanks, each of 10 ML capacity. The tank farm will require a minimum of 2 loading and fuelling stations. The rate of diesel fuel transfer will be approximately 27,000 L/h. All fuel being loaded onto the B-train trucks would be done at a reduced pressure by increasing the diameter of the piping.

Two dispensing facilities will also be built in Kiggavik, to service the mine and mill. Since a large quantity of the site fuel requirements will be consumed at the power house, the placement of the fuel storage facility will allow for simple refuelling operations, by underground pipeline or utilidor, between this facility and the power house day tanks. In addition, some satellite storage will be required at the Sissons site.

Tank and secondary containment design will be in accordance with all federal, territorial, and local guidelines and regulations. A base of coarse gravel overlain by a fine gravel layer would provide a foundation for the proposed dyke area. An anchored synthetic membrane will be used to ensure containment. All piping will be constructed over the berm walls rather than penetrate through it.

2.8.1.4 Site Power Alternatives

Alternative sources of power may be proposed to supplement the conventional power house described in the previous sections. Possible alternatives include wind power and solar power generation during summer months.

Alternatives to the Teck-on-Tundra system for the delivery of power to the Sissons site include conventional overhead power lines and a satellite generator at the Sissons site.

2.8.2 Communications Systems

A satellite telecommunications system will be used on-site to provide voice, data, fax, Internet and video capabilities to the main Kiggavik site, the Sissons operations and the airstrip. On-site operating and access road communications will be via an extensive radio network. Communications will be designed to comply with all applicable codes and with suitable redundancy to prevent loss of data or communications capability.

2.8.3 Airstrip

The Kiggavik Project proposal includes an airstrip to facilitate transportation of employees, perishable goods and yellowcake. Logistics strategies and volumes are discussed in Section 2.9, while the following sections describe the infrastructure required.

2.8.3.1 Airstrip Design and Construction

All design parameters used for the proposed airstrip are based on Transport Canada's Aerodrome Standards and Recommended Practices TP312E, 4th Edition. The design aircraft conservatively assumed is the Boeing 737-200 (Code C Aircraft).

The proposed airstrip is shown in Figure 2.21 and includes the following components:

- A runway 2,000 m in length and 45 m in width
- An aircraft turning D on the south end
- A graded area capable of supporting an aircraft on either side of the runway
- A 150 m long Runway End Safety Areas at both ends of the runway
- A taxiway 23 m wide with 6 m graded shoulders
- An apron for two aircraft with sufficient space for servicing and independent arrival/departure
- A single storey pre-fabricated Air Terminal Building (ATB) to provide passenger/cargo shelter as well as space for the Field Electrical Centre (FEC). The ATB would have an area for ground vehicle parking associated with it.

All snow clearing, cargo handling, passenger assistance, baggage handling, fuelling, surface maintenance and electrical maintenance will be provided by either mine site equipment and personnel or contractors.

Neither an aircraft fuel facility nor wildlife fencing have been included in the current design, but may be included in future design revisions.

Three-phase electrical power will be provided to the aerodrome site from the mine site. Electrical controls and regulators would be contained in a separate room from the ATB lighting/heating systems. The ATB would also contain the Aircraft Control of Aerodrome Lighting (ARCAL) antenna, aerodrome beacon, aircraft ground power units and apron flood lighting. The ARCAL will allow pilots to control the aerodrome lighting with no assistance from the aerodrome personnel.

The selected site will not be stripped or grubbed in order to preserve the permafrost. The total embankment structure will be a minimum of 2.0 m thick and constructed primarily from processed mine waste rock with a maximum particle size of 200 mm. The runway, taxiway, apron, and ground vehicle parking areas will be surfaced with 0.2 m of 20 mm minus crushed granular base materials. All waste rock materials to be used in construction will be tested for acid rock drainage and metal leaching potentials prior to use.

The estimated material quantities required for construction the airstrip and associated infrastructure is summarized as follows:

- 20 mm minus surfacing material – 36,650 m^3.
- 200 mm minus subgrade rock fill – 611,000 m^3.

Construction would be expected to last for 6 to 8 months. The schedule would be tailored to allow landing of smaller aircrafts on a shorter runway in the early stages of the Project. Some use of borrow source material would be required during this early construction phase. The volume and source of any quarry material will be included in the DEIS.

2.8.3.2 Airstrip Location

Two locations have been identified as potential sites for the Kiggavik airstrip; these are shown in Figure 2.22. The preferred option is the Drumlin Site, as a small ridge runs down the length of the proposed runway, facilitating drainage. However, onsite observations suggest fog may be an issue at this site; and therefore an alternative site has been identified at Pointer Lake. This site is less desirable as drainage would likely require more control and the current location of the mill and stockpiles may have to be adjusted to provide adequate approach clearance.

2.8.4 Site Haul Road

A haul road (approximately 20 km) will be constructed between the Sissons deposits and the Kiggavik site. The heaviest trucks to use this road would be ore haulage trucks with a maximum gross weight of 250 tonnes when loaded. Based on this, the haul road would be designed as follows:

- Maximum travelling speed: 60 km/h
- Minimum width of surface: 20 m
- Minimum safety berm height if embankment is over 3 m high: 2.2m
- Maximum grade: 5%

An alternative to standard haul trucks would be the use of ore tractor/trailers. In this case, the road design requirements would be less stringent such that the maximum speed could be increased to 80 km/h and the minimum width of the road could be reduced to 10 – 15 m.

The haul road will be constructed from clean waste rock. The maximum amounts of material required are estimated as follows:

- Minus 200 mm subgrade fill: 982,600 m^3
- Minus 20 mm surfacing material: 39,800 m^3

The proposed route is shown in Figure 2.23. The road alignment will be optimized to avoid any archaeological sites, major water crossing where possible, and to maintain a suitable buffer zone between the road and major waterbodies.

2.8.5 Explosives

As described in Section 2.3, explosives will be manufactured on site from ammonium nitrate and diesel fuel. Materials used in the manufacture of explosives will be stored in magazines constructed and operated in accordance with all applicable federal and territorial regulations. It is proposed to have two main surface magazines, one at Kiggavik and one at Sissons, in addition to day storage and underground magazines.

2.8.6 Hazardous Materials

There will be a number of materials and supplies required for the proposed Project that are considered hazardous. The largest volume materials expected to be shipped from the site and to the site are as follows:

To the Project Site:

- Petroleum products (diesel fuel, gasoline, kerosene, lubricants, hydraulic fluids, solvents, oil)
- Propane
- Hydrogen peroxide (possibly)
- Amine (possibly)
- Isodecanol (possibly)
- Ammonium Nitrate
- Sulphur

From the Project Site:

- Uranium concentrate (yellowcake)
- Waste oil, diesel
- Waste solvents/paints
- Spent batteries

Hazardous goods will be shipped to site in approved containers and in accordance with all applicable regulations. Appropriate spill contingency measures will be developed prior to Project commissioning in consultation with regulators and local communities.

Hazardous materials handled at the Baker Lake Storage Facility and at Kiggavik will be managed through appropriate storage and transfer of the goods, in addition to training of all employees. All management plans, procedures and facility designs will be in accordance with WHMIS and other federal and territorial regulations. Storage and containment details will be included in the DEIS. Quantities of materials required at site are listed in Section 2.9.2.

Handling of yellowcake will be in accordance with all federal and territorial regulations and licenses. The product will be packaged via a packaging circuit designed to minimize worker and environmental exposures. Packaged drums will be sealed and stored in a designated location until shipment. Shipment of yellowcake is discussed in Section 2.9.6.

2.8.7 Site Accommodations

The estimated workforce onsite when the Project reaches full production is approximately 300 people (based on annual 3,000 tonne U production). Accordingly, a 300-room accommodation complex has been designed.

The proposed complex will be located on a ridge approximately 300 meters northwest (predominantly upwind) of the mill site. The buildings will be connected by an arctic corridor (utilidor). Siting of both the mill and accommodation complex will be confirmed by geotechnical investigations during the upcoming field seasons.

The complex design is summarized as follows:

- 300 single-bed rooms with self-contained bathrooms
- Floor area: 12,000 to 15,700 m^2.
- Complex core built on site, modular residential wings shipped to the site.
- Recreational areas
- Infirmary
- Food services
- Potable water treated by membrane filtration
- Sewage treatment via membrane filtration
- Incinerator for management of wastes (as appropriate)
- Mechanical and electrical systems designed to optimize efficiency

Onsite construction and modules installation would require two summer seasons; during the first summer, foundations would be installed for the core and modules. The core would be erected and residential wings installed the following year.

Three different designs have been evaluated for this accommodation building:

- *Option 1*: A single building, with a central core for the main common facilities and four residential wings.
- *Option 2*: Common areas are located in separate facilities along a main street. Bedrooms are located in four residential wings.
- *Option 3*: Residential units are broken into smaller wings and core facilities are separated to create a hillside “village” connected to a main indoor street.

Total personnel on-site is expected to peak at 600 during the construction phase. It is proposed that the accommodation complex be constructed at the front end of the construction stage, such that 300 people could be housed in the permanent complex, with the remainder housed in a temporary construction camp.

2.9 Logistics and Transportation

2.9.1 General

The Kiggavik Project will require fuel, reagents, supplies and personnel in order to successfully operate and therefore a reliable logistics system is one of the criteria for Project design. This system also includes provision to supply yellowcake product to the market on a year-round basis. The general logistics strategies proposed for fuel, supplies, personnel and yellowcake are summarized in Table 2.10.

Table 2.10 Summary of Logistics Strategies

Item	Approximate Quantities	Method
Fuel	70 ML annually	▪ Ship to Churchill via ocean-going vessel or rail ▪ Ship from Churchill to Baker Lake via barge or ferry ▪ Ship from Baker Lake to Kiggavik via tanker truck
Reagents and Supplies	81,000 tonnes annually	▪ Ship to Churchill via ocean-going vessel or rail ▪ Ship from Churchill to Baker Lake via barge or ferry ▪ Ship from Baker Lake to Kiggavik via truck ▪ Perishable goods to be transported by air
Personnel	200 - 300 people every 1 – 2 weeks	Air from pick-up point to Kiggavik and return
Yellowcake	3,600 tonnes annually (3,000 tonnes as U)	▪ Truck to Baker Lake port, barge to Churchill, then rail to southern Canada ▪ Air from Kiggavik to southern Canada

Figure 2.24 provides the primary routing for fuel and supplies, which conceptually can be broken into three components: from the point of origin to Churchill, Churchill to Baker Lake, and Baker Lake to Kiggavik.

Based on public consultations, the potential for a transfer site at Chesterfield Inlet will be investigated during the feasibility study. This dock site could possibly replace, or supplement, the transfer of supplies at Churchill.

In addition to existing infrastructure, the following components are required to support the proposed system:

- Tug - barge fleet
- Baker Lake dock and storage facility
- Access road from Baker Lake to Kiggavik

The following sub-sections describe the strategy for each segment of the route and also discusses the off-site infrastructure listed above. On-site transportation infrastructure (aerodrome, site storage) is discussed in Section 2.8.

2.9.2 Project Shipping Quantities

The annual estimated quantities of supplies for the site are listed in Table 2.11. The largest tonnages are for diesel fuel, cement (for underground mine backfill), and lime and sulphur (mill reagents). The total diesel fuel requirement is approximately 57,000 tonnes while the dry goods and reagents total almost 81,000 tonnes. These quantities are dependent upon process selection.

A number of the site supplies listed are hazardous goods; these will be shipped in accordance with international, federal, and territorial regulations. Fuel will be shipped in bulk and non-hazardous material will be shipped in standard sea-containers. Hazardous goods will be transported either in product-specific ISO containers or, in the case of smaller volumes, as palletized sealed drums.

Approximately 3,600 tonnes of yellowcake (based on a 3,000 tonne-U operation) also needs to be shipped from Kiggavik to the south annually. Proposed packaging and transport of yellowcake is discussed in Section 2.9.6.

Table 2.11 Estimated Annual Supplies

Supplies	Annual requirement (tonnes)	Annual requirement (TEUs)[1]
Propane	2,875	160
Reagents		
Flocculant A	38	2
Flocculant B	3	0
Amine[2]	625	35
Isodecanol[2]	31	2
Kerosene[2]	31	2
Hydrogen peroxide[2]	938	52
Magnesium oxide MgO	1,063	59
Lime CaO	36,250	2,014
Defoamer	0.444	0
Sulphur	18,750	1,042
Barium chloride	46	3
Ferric sulphate	375	21
Sodium carbonate	188	10
Other milling supplies		
Grinding balls	625	35
Resins	150	9
Product drums 55 US gallon	224	12
Milling supplies	1,000	56
Mining & construction supplies		
Cement	15,408	856
Blast materials	1,200	67
Mining supplies	500	28
Other supplies		
Food (dry)	450	25
General supplies	350	19
Total dry goods	**80,968**	**4,498**
Diesel fuel	**56,776**	

(1) TEU = Twenty-foot container equivalent unit
(2) Possibly

2.9.3 Marine Transportation

There are two primary proposed segments of marine transport to be considered. The first is marine shipment via ocean-going vessel through Hudson Strait and Hudson Bay to Churchill or Chesterfield Inlet. The second is marine shipment via tug-barge from Churchill or Chesterfield Inlet to Baker Lake.

2.9.3.1 Ocean-going vessels

Two types of ocean-going vessels will be required to service the Kiggavik Project, these are fuel tankers and containerships.

Diesel fuel will likely be transported to Churchill by Ice-Class 30,000-tonne tankers. In order to deliver 57,000 tonnes of fuel, two round-trips to Churchill will be required. Dry goods will be delivered to Churchill either by Ice-Class containership (800-1000 TEU-capacity) or via rail. Assuming 1000 TEU-capacity containerships are used, a maximum of 5 round-trips will be required to deliver the dry goods required. The number of trips via vessel may be reduced by the use of rail transport to Churchill. This is an alternative for some goods and reagents.

2.9.3.2 Tug-Barge Fleet

Barges will be used to transport goods and fuel from the Port of Churchill to the Baker Lake storage facility (see Section 2.9.4). Tugs and barges will travel north from Churchill and then navigate through Chesterfield Inlet to Baker Lake. The tug-barge system proposed has an Articulated Tug Barge (ATB) configuration, whereby the nose of the tug fits into a deep notch in the stern of the barge. This configuration provides more manoeuvrability than the standard tow-behind system.

The proposed barges would have a 7,500-tonne capacity (approximately 370 sea-containers) and a double-hull for containment. In order to maximize flexibility, the barges would be dual purpose, such that they could transport either fuel or dry goods. Fuel transfer would be via 2 positive displacement cargo pumps capable of receiving and pumping at a maximum rate of 500 tonnes per hour. Given the current lack of availability of these types of barges, it is anticipated that the Project would commission their construction in collaboration with a shipping partner.

The proposed tugs are 4,500 hp twin screw Ice Class units with twin independent rudders for high manoeuvrability. The tugs will be designed with dual redundancy such that in case of a critical component failure, the tug/barge will remain under control.

During normal operation, each tug would transport two barges (one in articulated configuration, one towed behind) to the mouth of Chesterfield Inlet, then one barge would be anchored near Helicopter Island and the tug would transport the other barge through Chesterfield Narrows to the Baker Lake dock facility in the articulated configuration. The tug would then return to the anchored barge and transport it to the dock facility.

In order to transport the required supplies and fuel during the barging season with an appropriate contingency allowance, the proposed fleet will consist of 5 barges and 3 tugs. In total, 23 barge deliveries will be made to the Baker Lake dock facilities from the beginning of August to the end of September.

A potential alternative to tugs and barges is the use of ferries to transport materials between the transfer point and Baker Lake. Further investigation of the viability of this option will be conducted during the feasibility study.

2.9.4 Baker Lake Facilities

The proposed facilities at Baker Lake consist of a wharf, tank farm, storage facility, laydown area and all the ancillary equipment required to transfer and transport fuel and materials.

2.9.4.1 Facility Location

Several locations on the shore of Baker Lake have been identified as possible dock sites. The location of the storage facility is dependent on the road option selected for access to Kiggavik (refer to Section 2.9.5). Recent feedback from public consultation (Section 3) has indicated that there are concerns with some locations and alternative sites may be more suitable. Therefore, alternatives are being investigated. Possible locations will be assessed based on:

- Bathymetry: a suitably deep site (>5 m) that is not subject to shifting sedimentation patterns is required
- Proximity to the community: a facility further away from the community is desired in order to reduce disturbance. However, access to the facility will be important for local employees. These will be competing factors that will require input from the community.
- Potential impacts on valued ecosystem components (VECs), including fish habitat, archaeological sites, recreational sites, and wildlife habitat.
- Potential interaction with other projects in the Baker Lake area

2.9.4.2 Wharf

The wharf will be constructed to allow docking of two barges at a suitable distance from shore. The wharf may be a permanent structure, or alternatively, a temporary structure that can be removed from the water at the end of each barging season. Further investigation of the viability and potential impacts of these systems will be explored during the feasibility study.

Offloading of fuel to the tank farm will be via a pipeline constructed on the dock. All pipes and connections will be dually contained to prevent spills and will be designed in accordance with all international, federal, territorial and local guidelines and regulations.

Cranes and mobile equipment will be used to offload and transfer sea-containers and other materials to the laydown area or warehouse. Heated storage will be available for temperature-sensitive materials.

2.9.4.3 Tank Farm and Fuel Loading

Fuel will be stored in 10 ML tanks within secondary containment that is constructed with appropriate fill and an anchored geotextile membrane. Tank and secondary containment design, construction and maintenance will be in accordance with all federal, territorial and local guidelines and regulations. The total volume of the tank farm will be dependent on the selection of access road, as the length of storage time required varies among the road options. The road options are discussed in detail in Section 2.9.5.

Fuel will be shipped to Kiggavik from the Baker Lake Facility in standard B-train trucks. Fuel will be transferred to the trucks from the tank farm via loading/unloading stations located outside the dyked area. All transfer stations located outside the dyked area will include re-supply spill basins. The fuel stations will also be provided with a truck turn-around area

Table 2.12 shows the number of 10 ML tanks and transfer stations required at the Baker Lake Facility for the various road types (Section 2.9.5). The number of tanks required is based on a trade-off study assessing the cost of trucks versus the cost of storage at both Baker Lake and Kiggavik. Therefore, the year-round all-weather road requires more storage than the seasonal all-weather road, however fewer trucks are required in this case.

Table 2.12 Baker Lake Facility Fuel Tanks

Road Option	**Number of 10 ML Tanks**	**Total Storage Volume (ML)**	**Number of Loading/Unloading Stations**
Winter Road	7	70	3
Seasonal All-Weather Road	4	40	2
All-Weather Road	6	60	2

2.9.4.4 Storage Facilities

Adequate storage area in the Baker Lake Facility will be required for the containers and other materials that will be shipped to site. The storage requirements for the various road options are shown in Table 2.13.

Table 2.13 Baker Lake Facility Dry Storage Requirements

Road Option	Storage capacity (TEUs)	Storage capacity (t)
Winter Road	4,500	81,000
Seasonal All-Weather Road	2,500	45,000
All-Weather Road	4,300	78,000

2.9.5 Road Transportation

Based on the current estimate of site supplies, a total of 3920 truck-trips are required, broken down as follows:

- 1370 tanker-truck loads of fuel
- 2550 truck-loads of dry goods

There is currently a winter trail connecting Baker Lake to the Kiggavik area, however construction and maintenance of a more substantial access road by AREVA will be required.

During the pre-feasibility study, a number of road options were developed, including all-weather road options and a winter road option. The road option chosen will determine, in part, the preferred location and size of the Baker Lake Storage Facility. If the route begins on the north shore of Baker Lake, the Thelon River must be crossed to reach Kiggavik. A route starting on the south shore would not require major river crossings, however, it would be less accessible from the community of Baker Lake.

The options that have been identified include:

- All-weather road, north route:
  - Thelon bridge crossing
  - Thelon cable-ferry / ice bridge crossing
- All-weather road, south route
- Winter road

These options are shown in Figure 2.25 and summarized in Table 2.14.

Based on recent consultations with the community of Baker Lake, AREVA is revisiting potential dock sites on the south shore of Baker Lake during the feasibility study. A final selection of the road to be proposed and assessed in the DEIS will be made after confirmation of suitable wharf locations and further consultation with the community. The current options are presented here for comparison and discussion.

Table 2.14 Summary of Access Road Options

Option	Dock Location on Baker Lake	Major Water Crossings	Road Length (km)	Operating Window (months per year)	Traffic Volume (round-trips per day)
AWR North Route	North shore	Thelon River, bridge crossing	90	12	11
	North shore	Thelon River, cable ferry / ice bridge crossing	90	6	22
AWR South Route	South shore, Huqlik Island	Baker Lake, causeway	95	12	11
	South shore		110	12	11
Winter Road	North/South shore	N/A	92	3	43

2.9.5.1 All-Weather Road Options

Regardless of the route chosen, construction of the all-weather road will be primarily based on a fill-only approach, such that a fill base of suitable thickness is placed to protect the permafrost. The subgrade fill would be minus 200 mm well-graded material capped with minus 20 mm crushed rock. In order to promote safety and ease animal crossings, the minimum side slopes would be 3:1. An example road cross-section is shown in Figure 2.26. Construction would be conducted either in the winter or via end-dump methods to protect the tundra during the summer months.

Road alignments for each all-weather option were selected based on air reconnaissance of surficial geology and drainage. Profiles for the selected alignments will be included in the DEIS. Potential borrow sources have also been identified along each of the routes, as shown on Figure 2.27. Further reconnaissance and geotechnical investigations of alignments and borrow sources will be conducted in upcoming field seasons. Any material to be used in construction would be assessed for acid rock drainage and metal leaching potential prior to use.

If an all-weather road is chosen for site access, it is intended that the road would have controlled public access, provided that safety can be maintained and Kiggavik truck traffic is not impeded. However, it is recognized that public access may impact wildlife harvesting in areas that were previously more difficult to harvest. AREVA proposes to support on-going monitoring of wildlife in collaboration with local hunter-trapper organizations (HTOs).

The maximum speed on an all-weather road would be 80 km/h, and the largest vehicles permitted on the road would be standard highway legal transport trucks. For safety in case of inclement weather, the final design will include heated refuge stations along the route. No measures are currently proposed for management of dust from the site access road.

Annual maintenance on the road would include re-grading of surfaces and slopes as needed and inspection for changes in surface and permafrost stability. Annual inspections of water crossings would be conducted and any deficiencies corrected. In addition, personnel would be available for minor repairs year-round as needed.

2.9.5.1.1 North All-Weather Route

The proposed north all-weather route generally follows alongside the existing ATV trail north of Baker Lake and crosses the Thelon River. Two possible methods of crossing the river have been identified: a bridge option and a cable-ferry/ice bridge option.

The bridge option would allow the road to remain open year-round by providing consistent access to the west bank of the Thelon River. The selected location for the bridge, as shown in Figure 2.25, was chosen based on the advice of the Baker Lake Community Liaison Committee and the following items:

- Shortest feasible crossing
- Stability of the river banks
- Hydrological conditions
- Ice conditions at breakup
- Access to the location

Traffic volumes are anticipated to be light enough on the road that a single lane bridge will be sufficient. The proposed bridge is based on providing 16 m of clearance for navigation as shown in Figure 2.28. To maintain a 16 m clearance the bridge would be 435 m long and would consist of 5 spans. It should be noted that further investigation of the size of vessels that can feasibily navigate the Thelon River is required in order to finalize the required clearance. The current value of 16 m has been chosen as a conservative figure.

The suggested bridge design is as follows:

- Single lane traffic on a 3.7 m driving lane with shoulders for a clear bridge width of 5.7 m between the guardrails.
- Five spans utilizing four piers in the river.
- The superstructure comprises steel plate girders with pre-fabricated concrete deck panels.
- Rock socket steel pile foundations would likely be used for the abutments.

Building a bridge is a significant project in terms of costs and schedule. Alternative water crossing methods have been investigated. The most feasible alternative to the bridge is the use of a cable ferry in the summer and an ice bridge in the winter. This option would provide only seasonal access to

Kiggavik and may be difficult to operate. Further investigation of the options will be conducted during the feasibility study.

2.9.5.1.2 South All-Weather Route

The current south all-weather route begins on the southwest shore of Baker Lake and continues to the west to Kiggavik.

There are some advantages to the south route, including avoidance of major river crossings and reduced disturbance to the community of Baker Lake. However, employee access would be more difficult. A number of dock site locations are being explored as part of the feasibility study. One option is to construct a facility on Huqlik Island, however, recent community consultations have indicated that Huqlik Island is a valued ecosystem and therefore may not be an appropriate location for either docking facilities or a causeway to the mainland. Thus, alternative locations for a dock on the south shore are being studied in more detail.

2.9.5.2 Winter Road Option

The proposed winter access route is shown in Figure 2.25. Approximately 50% of the route passes over ice while the remainder is overland. In order to protect the tundra from heavy traffic, a thin permanent pad of granular material would be placed on the overland parts of the route. Parts of the over-ice traverse are assumed to cross fish-bearing waterbodies.

The road would be re-constructed every year by clearing the overland portions and flooding the over-ice portions. Potential water sources and the volume of water to be withdrawn for flooding will be developed and detailed in the DEIS.

The maximum proposed speed on the winter road is 30 km/h. Trucks would travel in convoys for safety and heated refuge stations would be placed along the route.

As the available operating timeframe for a winter road could be a significant technical issue, a preliminary investigation of the seasonal duration has been performed. Evaluation of the Tibbitt to Contwoyto Winter Road (TCWR), which services the diamond mines in central NWT, has led to a relatively good correlation between the Freezing Index and number of operating road days. Based on climatic normals for Baker Lake, it has been estimated that 83-88 operating days would be available for a winter road from Baker Lake to Kiggavik, provided that winter road construction practices such as are employed on the TCWR are also utilized on the Kiggavik Road.

The winter road option would pose significant industrial challenges to the operation in terms of contingency supply delivery outside of the road operating season and in terms of operating costs.

2.9.6 Yellowcake Transportation

Based on a 3,000 tonne U per year operation, approximately 3,600 tonnes of yellowcake will be produced each year at Kiggavik. The yellowcake will be packaged in steel 55-gallon drums and sealed, with each drum holding approximately 400 kg of yellowcake. The site will produce approximately 9,000 drums of yellowcake annually, which will be loaded into sea-containers. Limitations apply to transportation of radioactive goods, and it has been estimated that a maximum of 35 drums may be loaded into a container to maintain a Transportation Index of less than 6. It is therefore expected that 256 sea-containers will be shipped to the south annually. Once in southern Canada, yellowcake will be transported to either a North American refinery or to an eastern port for shipment to a European destination.

Two possibilities have been identified for the transportation of yellowcake from Kiggavik to southern Canada:

- Direct air transport from Kiggavik to Churchill, Manitoba or Points North, Saskatchewan. The yellowcake would then be shipped via rail (Churchill) or truck (Points North). This option would be available for year-round shipping.
- Truck transport to Baker Lake and shipment with returning barges to Churchill, Manitoba. The yellowcake would then be shipped via rail. This option would only be viable during the barging season; therefore for the remainder of the year, yellowcake would be shipped by air.

2.9.6.1 Air Shipment of Yellowcake

For the proposed air transport of yellowcake, the product would be flown using a Hercules aircraft (or similar). One sea-container of 35 drums would be shipped per flight to maintain the Transportation Index below 6. The weight of the container would be well within the 18 tonnes payload of the aircraft.

Dangerous Goods Regulations require that the separation between passengers (pilots) and radioactive material (TI index ~6) be at least 1.15 m. In addition, a properly designed Emergency Response and Action Plan (ERAP) and training program will be required. These will be developed in consultation with Transport Canada, the CNSC, local communities, and any other concerned parties.

Air shipment of all product containers from Kiggavik would require approximately 5 trips per week. The plane would be mobilized once per week, and it would make 5 return trips from the site to Churchill or Points North, before returning to its origin location.

2.9.6.2 Marine Shipment of Yellowcake

If Baker Lake is accessible from Kiggavik during the barging season (ie. an all-weather road option is selected), a portion of the yellowcake produced could be shipped to Churchill with the returning barges. Given a TI of 6 per container, it is expected that each barge could transport 6 containers per trip from Baker Lake to Churchill. Assuming there are 16 barge trips to Churchill each summer, this allows shipping 96 containers of product by barge. The remaining 160 containers of yellowcake would be shipped via air directly from Kiggavik.

Additional security and emergency response measures will be developed for the main routes and Baker Lake storage facility for the marine shipment option.

2.9.7 Personnel Transportation

It is proposed that personnel would be transported to site from communities in the Kivalliq via air. Both commercial flights and regular charters would be utilized. The shift schedule will be fly in / fly out on a 7 – 14 day rotation. The current manpower estimates for a 3,000 tonne U/year operation are approximately 300 people per shift.

2.9.8 Summary of Transportation Alternatives

A series of options for transportation have been discussed throughout the preceding sections. These alternatives are summarized in Table 2.15.

Table 2.15 Summary of Transportation Options

Project Component	Options
Location of Marine Transfer Point	1. Churchill 2. Chesterfield Inlet
Location of Baker Lake Dock and Storage Facility	1. North Shore of Baker Lake, to east of community 2. South Shore, location to be determined 3. South Shore, Huqlik Island
Access Road to Kiggavik	1. North All-Weather Route with Thelon Bridge 2. North All-Weather Route with Thelon cable ferry – ice bridge 3. South All-Weather Route 4. Winter Road
Transportation of Yellowcake	1. Air Transport to Churchill or Points North 2. Road/Marine Transport via Baker Lake during the barging season (2 months). Air transport during remaining 10 months.

AREVA will finalize the options to be assessed and presented in the DEIS based on upcoming field investigations, public consultations, traditional knowledge and regulatory input.

2.10 Decommissioning and Reclamation

Upon completion of mining and milling activities at Kiggavik, it is the intent of the Project to decommission all facilities for which there is no beneficial use and to return the land to a stable, self-sustaining condition suitable for traditional uses that is as close as practical to its natural state.

AREVA's preferred decommissioning policy is to begin reclamation as soon as possible after individual operations are complete, including waste rock piles and tailings facilities. On-going reclamation activities, as part of the overall Closure and Reclamation Plan, will be developed and monitored in consultation with regulatory agencies and community stakeholders. This on-going reclamation program will ensure that, when the entire site is ready for decommissioning at the end of the Project, AREVA will have gained valuable experience in reclamation in the Arctic environment. This Arctic experience will expand on the experience already gained from the Cluff Lake decommissioning and progressive reclamation work performed at other AREVA-operated northern mines.

The objectives of decommissioning are to remove, minimize, and control potential contaminant sources and thereby mitigate potential adverse environmental effects associated with the property. This would include demolition of site facilities and remediation of any site areas that may have residual contamination. The major decommissioning steps are summarized in the following sections.

2.10.1 Kiggavik

General Infrastructure

The Project includes facilities that are not directly involved in the mining and milling of uranium, such as the accommodation complex, acid plant, aerodrome, water supply, and power house; these buildings are not expected to contain radioactive materials and for the most part should be salvageable. Salvageable buildings, surface structures, and equipment will be dismantled and demobilized from the site. Non-salvageable buildings and structures will be dismantled or demolished and disposed of in either Center or Main TMF.

Concrete structures and foundations will be removed, destroyed or buried below the final ground surface or the final regraded surface. All disturbed areas will be regraded to suit the surrounding topography. Cover materials may be required for erosion and dust control. Revegetation of disturbed areas with suitable native species to restore the vegetation community will be performed.

Fuel Tank Farm

Any residual fuel will be emptied into tanker trucks, and the tank farm disassembled and removed.

Site roads

All site roads not required for post-closure monitoring will be decommissioned and the terrain restored. Culverts will be removed and original drainage patterns restored.

If any areas are found to have been locally contaminated, the contaminated soils will be removed for disposal in the tailings area and replaced with clean material.

Airstrip

Airstrip reclamation will involve removing culverts, re-contouring fill slopes for wildlife access, and scarifying the gravel surface to facilitate natural vegetation. A cover may be required for erosion and dust control.

However, the airstrip will be left for others to use if requested by government agencies or by a third party willing to assume responsibility.

Mill Building

Prior to mill demolition, any loose contaminated materials inside the mill building will be removed and transported to the tailings area for disposal. Any materials which are determined to be salvageable will be monitored to ensure they meet all applicable requirements for release from the site, and then transported from the site to the Baker Lake dock site. These requirements will vary depending on future use. For example, materials with some residual contamination could be transported, with suitable packaging, to another uranium production site, but could not be released for unrestricted use. All equipment and building materials which are not salvageable will be disposed of in the TMF. After the buildings have been leveled, if no contamination is present, concrete pads will be left to naturally frost shatter.

All hazardous materials and reagents would be shipped either to another AREVA facility for use or to appropriate hazardous waste disposal facilities.

Water Treatment Plant

The water treatment plant would be left in place during decommissioning, reclamation, and closure monitoring activities. Upon determination that all site water meets water quality guidelines, the plant would be dismantled. The disposal location would be dependent on the residual contamination of the structure. Either a site will be prepared at Kiggavik for containment of contaminated materials or they would be shipped to another active AREVA site for disposal.

Ore Stockpile

Any residual ore or sub-grade ore stockpiled and left at the end of the operation will be placed in one of the TMFs. The area of the stockpiles will then be covered with clean overburden to reduce any residual activity levels to background, and to encourage revegetation.

East Zone Water Management Facility

East Zone will be allowed to flood once closure activities are complete. The water quality within the flooded pit will be monitored and managed via water treatment (if required) until the water consistently meets decommissioning water quality objectives.

Center Zone and Main Zone Tailings Management Facilities

Closure of both tailings facilities will include the placement of a thick layer of sand (approximately 2 m thick) then of an erosion barrier consisting of a thick layer of non acid generating waste rock over the tailings. The surface of the final cover will be graded and revegetated to blend into the existing topography. Berms will be constructed to direct surface drainage away from the facilities. This design will be evaluated further during detailed engineering in consultation with regulators, stakeholders and incorporating the experience of other mining operations in the north.

Waste Rock Stockpiles

Preliminary geochemical testing suggests there are limited concerns with respect to acid rock drainage and metal leaching from the clean waste rock.

Clean waste rock from the Kiggavik and Andrew Lake open pits not used for site development purposes will be deposited in the main waste rock stockpile facility until the end of mine operations. Although all rock placed in the waste rock pile is expected to freeze, facility design in terms of permanent physical stability is not dependant on freezing.

Waste rock piles will be designed in order to meet appropriate physical stability criteria. The target end land use of the waste rock pile area after decommissioning will be wildlife habitat. Therefore, the aim of the closure plan will be to promote, to the extent practical, rehabilitation of the land to this use. Closure of the waste rock pile will include the placement of a layer of approximately 1m of compacted clean waste rock, which will be then covered with clean overburden material to encourage revegetation prior to final monitoring. Revegetation trials will be conducted prior to final reclamation. The final surface of the waste rock pile will be regraded to blend into the existing topography and to enhance conditions for wildlife access. Key elements of the plan will include construction of ramps to allow safe caribou transit across the pile slopes.

The special waste stockpiles will be placed in the TMFs or the mined-out Andrew Lake pit.

Water Management System

Once no longer required, all berms would be breached and natural drainage patterns restored at the site. Ditches will be stabilized where they pass through overburden; ditch portions in bedrock will remain as constructed. To the greatest extent possible, remaining ditches will be altered to return drainage to pre-disturbance conditions. Any contaminated materials would be recovered and placed in the TMF prior to restoring drainage.

If Sik Sik Lake is used as a treated effluent reservoir, monitoring of the water and sediment quality in the reservoir would be conducted to ensure that guidelines are met prior to breaching the dam and restoring natural drainage.

All water intakes and diffusers will be sealed off and the piping removed.

2.10.2 Sissons

Andrew Lake Open Pit

The preferred method of decommissioning of the Andrew Lake pit is as follows:

- Andrew Lake pit will be backfilled with the Sissons special waste rock and covered with till. This will result in the pit being only partially filled.
- If feasible, fish habitat structures may be included in the pit to provide compensation for earlier Project impacts on fish habitat.
- The water in the pit lake would be monitored and treated as required until water quality objectives are met.
- The Andrew Lake dam would be breached and allowed to flood the pit.

Waste Rock Stockpiles

The proposed decommissioning of the Andrew Lake clean waste rock pile is identical to that of the Kiggavik waste rock pile (Section 2.10.1).

End Grid Underground Mine

Mine planning and design during the feasibility study will include progressive closure of completed mining zones. All underground openings at surface, including ventilation raises and the access portal, will be sealed off in a structurally stable manner and reclaimed.

2.10.3 Baker Lake Area

Current Project plans include complete decommissioning of all structures in the Baker Lake area. However, if community stakeholders wish to assume responsibility for the infrastructure, and regulatory approval is obtained, some or all of the following components could be left in place.

Access Road

The all-weather road would be decommissioned and regraded to facilitate wildlife movement. Any associated infrastructure (bridge, ferry, causeway, etc) would be dismantled and removed. The shoreline would be returned as close as practical to the pre-disturbance condition.

If a winter road has been used for site access, the pad built for over-land sections would be scarified to encourage revegetation.

Fuel Tank Farm

The fuel tank farm will be emptied, with any viable fuel sold to local users, and any hazardous waste shipped to licensed handlers for disposal. The tank farm would be disassembled and removed.

Storage Structures

Any structures, materials, and equipment not required for future use by the community will be dismantled and demobilized from the site.

Dock Site

The dock structure will be dismantled and demobilized from the site. The shoreline and lake bottom will be returned as close as practical to its pre-disturbance condition.

2.10.4 Monitoring

Once the Project has been decommissioned and reclaimed to the satisfaction of the regulatory agencies, the site will enter a period of post-decommissioning monitoring to demonstrate that the site is safe to be returned to the land-owners. The details of the monitoring plan will be developed in consultation with regulators and stakeholders.

Based on AREVA’s Cluff Lake experience, at least 5 years of post-closure comprehensive monitoring has currently been assumed in the decommissioning plan. However, long-term monitoring will continue until regulatory agencies and land owners agree to cessation.

2.11 Summary of Project Alternatives

A number of design alternatives have been discussed throughout the preceding Project description. These alternatives are summarized in Table 2.16.

Table 2.16 Summary of Project Alternatives

Project Component		Preliminary Design Basis	Alternatives
General	Production rate	3,000 tonnes U per year	2,000 to 4,000 tonnes U per year
Mining	Main Zone mine design	8-shaped form with diabase dyke in place	• Removal of diabase dyke • Underground methods
	Andrew Lake mining method	Open pit only	• Underground methods • Hybrid, open pit and underground
	End Grid mining underground access	Decline	Shaft
	Ore haulage method	Ore trailers	Haul trucks
Milling	Mill process	Resin-in-pulp process	Conventional “McClean Lake” processes
	Product purity	Conventional yellowcake	“Impure” yellowcake
Water Management	Treated effluent discharge receiving waterbody	Sik Sik Lake Reservoir	Judge Sissons Lake
	Dewatering Andrew Lake	Partial dewatering	Complete dewatering
On-Site Infrastructure	Airstrip location	Drumlin Airstrip	Pointer Lake Airstrip
	Power transmission	Teck-on-Tundra	Overhead Lines
Logistics	Marine transfer	Port of Churchill	Chesterfield Inlet
	Marine vessels	Tug-barge	Ferries
	Baker Lake Dock Facility location	None specified	• North shore • South shore
	Access road route	None specified	• North route • South route • Winter route
	Thelon River crossing (north route only)	Bridge	Cable ferry – ice bridge
	Yellowcake transport	None specified	• Road, marine and air • Air only

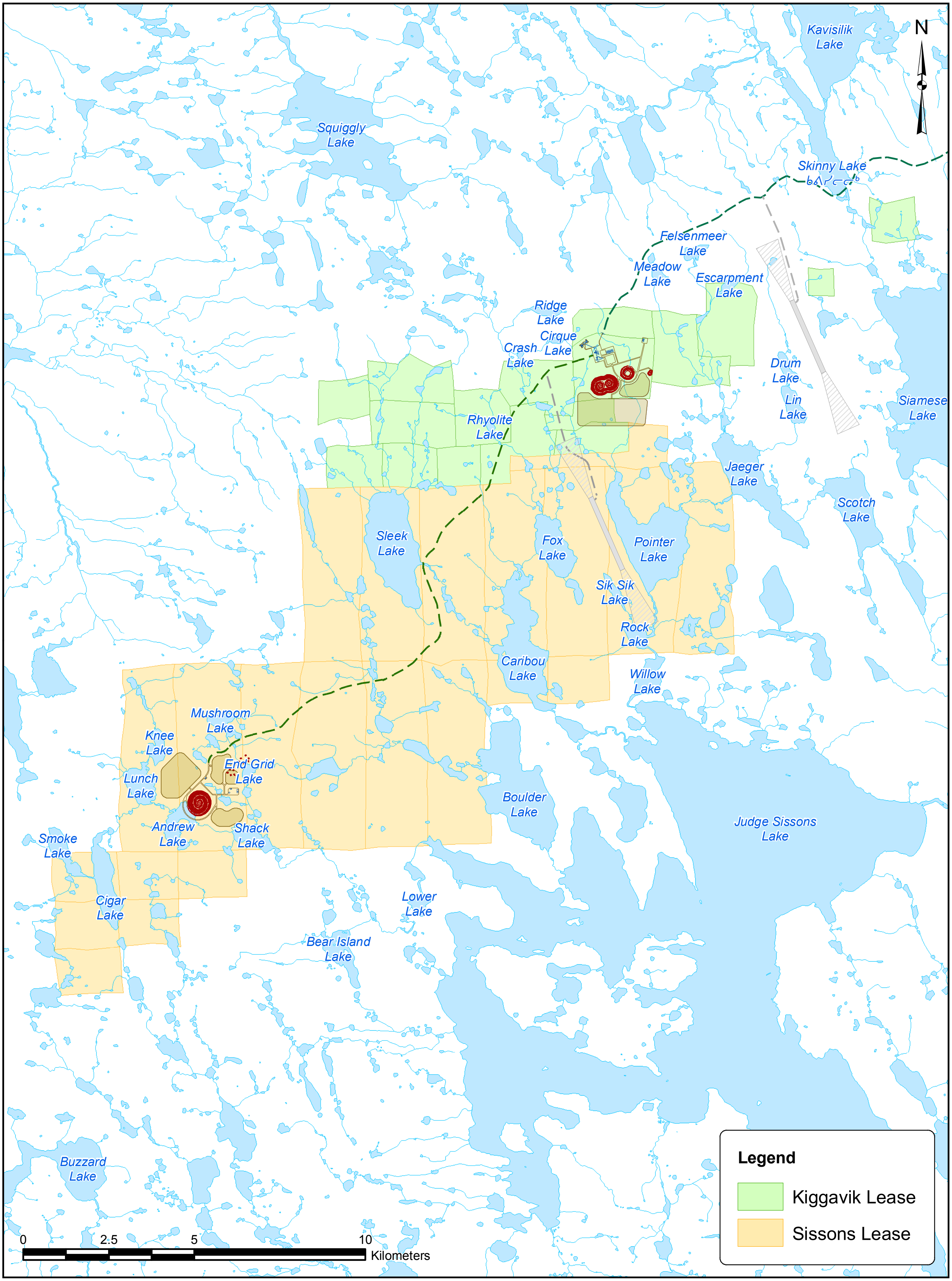
KIGGAVIK PROJECT

Project Proposal

SECTION 2

LIST OF FIGURES

Figure 2.1: Proposed Layout of Kiggavik Project
Figure 2.2: Proposed Layout Kiggavik
Figure 2.3: Proposed Layout Sissons
Figure 2.4: Conceptual Kiggavik Layout
Figure 2.5: Conceptual Sissons Layout
Figure 2.6: Overall Project Schedule
Figure 2.7: Key Kiggavik Area Geological Features
Figure 2.8: Key Sissons Area Geological Features
Figure 2.9: Proposed Production Schedule
Figure 2.10: Proposed Center Pit Design
Figure 2.11: Proposed Main Pit Design
Figure 2.12: Proposed Andrew Lake Pit Design
Figure 2.13: Proposed Endgrid Underground Design
Figure 2.14: Flowsheet of Resin-in-Pulp Process Options
Figure 2.15: Flowsheet of Alternative Process
Figure 2.16: Projected Tailings Production Schedule
Figure 2.17: Proposed Water Management System
Figure 2.18: Potential Fresh Water Sources
Figure 2.19: Potential Treated Effluent Discharge Receptors
Figure 2.20: Location of Andrew Lake Pit Relative to Andrew Lake
Figure 2.21: Proposed Airstrip Conceptual Design
Figure 2.22: Airstrip Options
Figure 2.23: Proposed Haul Road
Figure 2.24: Proposed Transportation Routes
Figure 2.25: Access Road Route Options
Figure 2.26: Typical All-Weather Access Road Cross-Section
Figure 2.27: Potential Borrow Locations
Figure 2.28: Proposed Thelon Bridge – Conceptual Design



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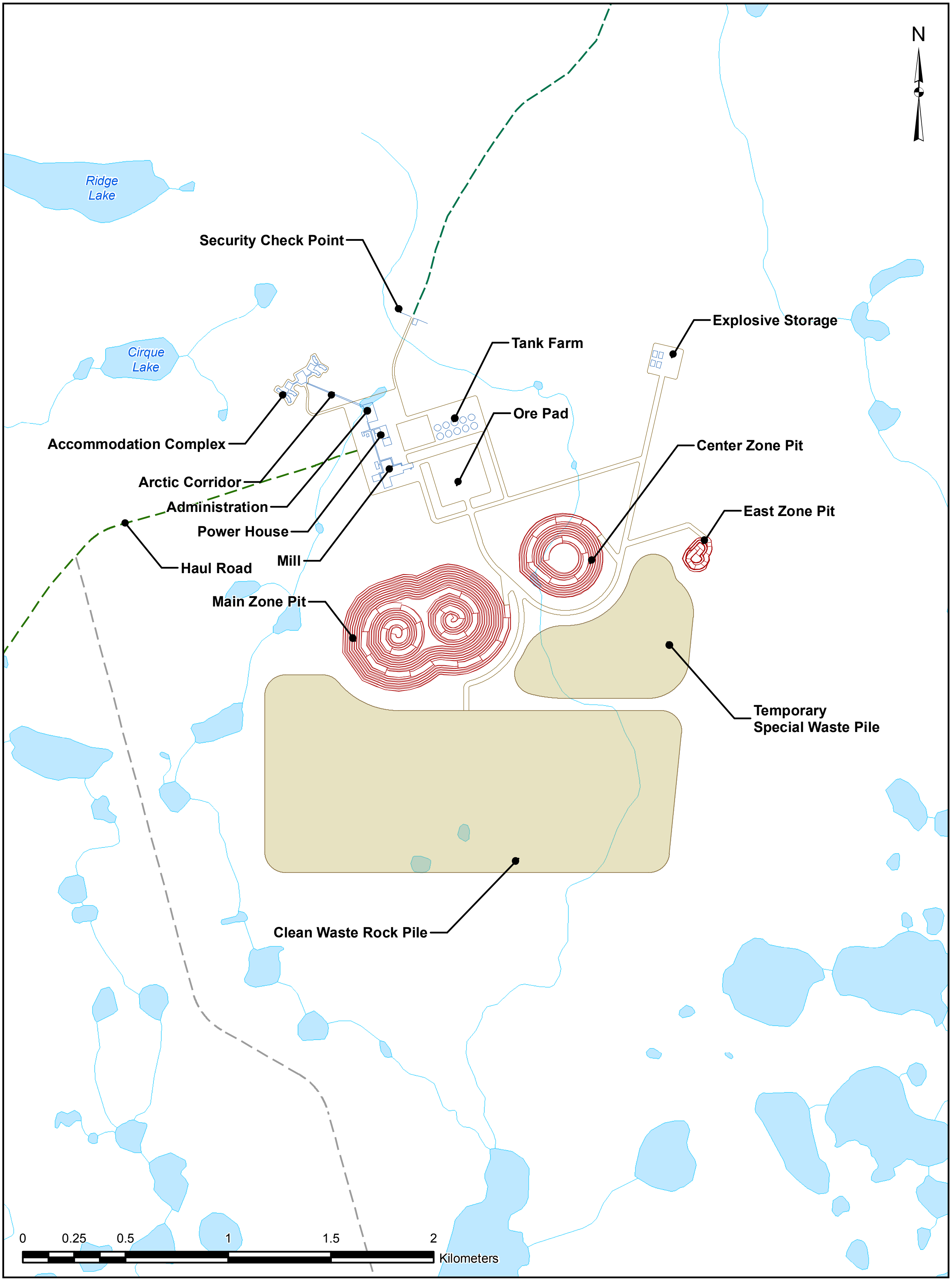
PROPOSED LAYOUT OF KIGGAVIK PROJECT FIGURE 2.1	Creator: CDC Date: 10/31/08 Drawing:		



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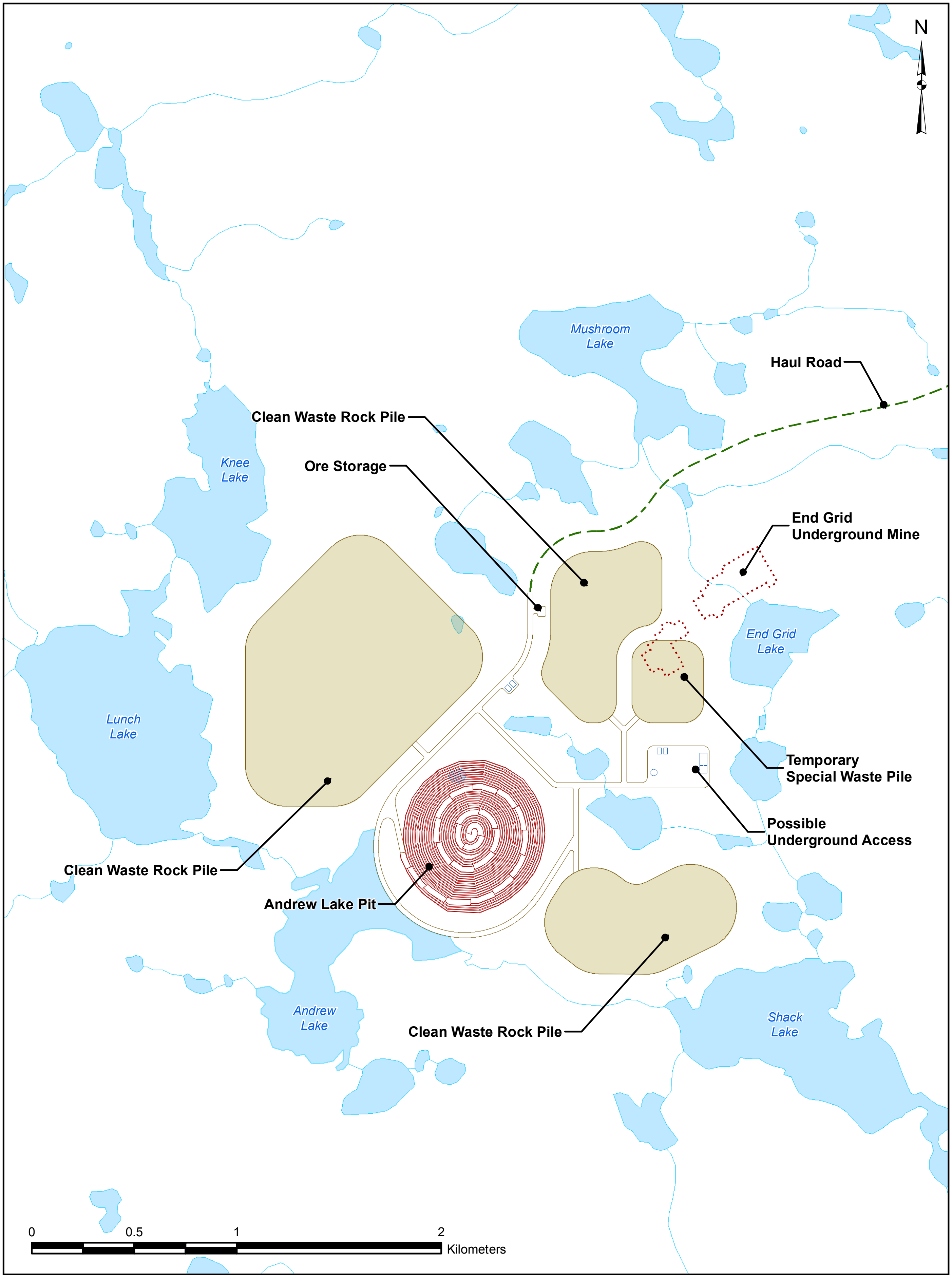
PROPOSED LAYOUT KIGGAVIK FIGURE 2.2	Creator: CDC Date: 10/31/08 Drawing:		AREVA	AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5



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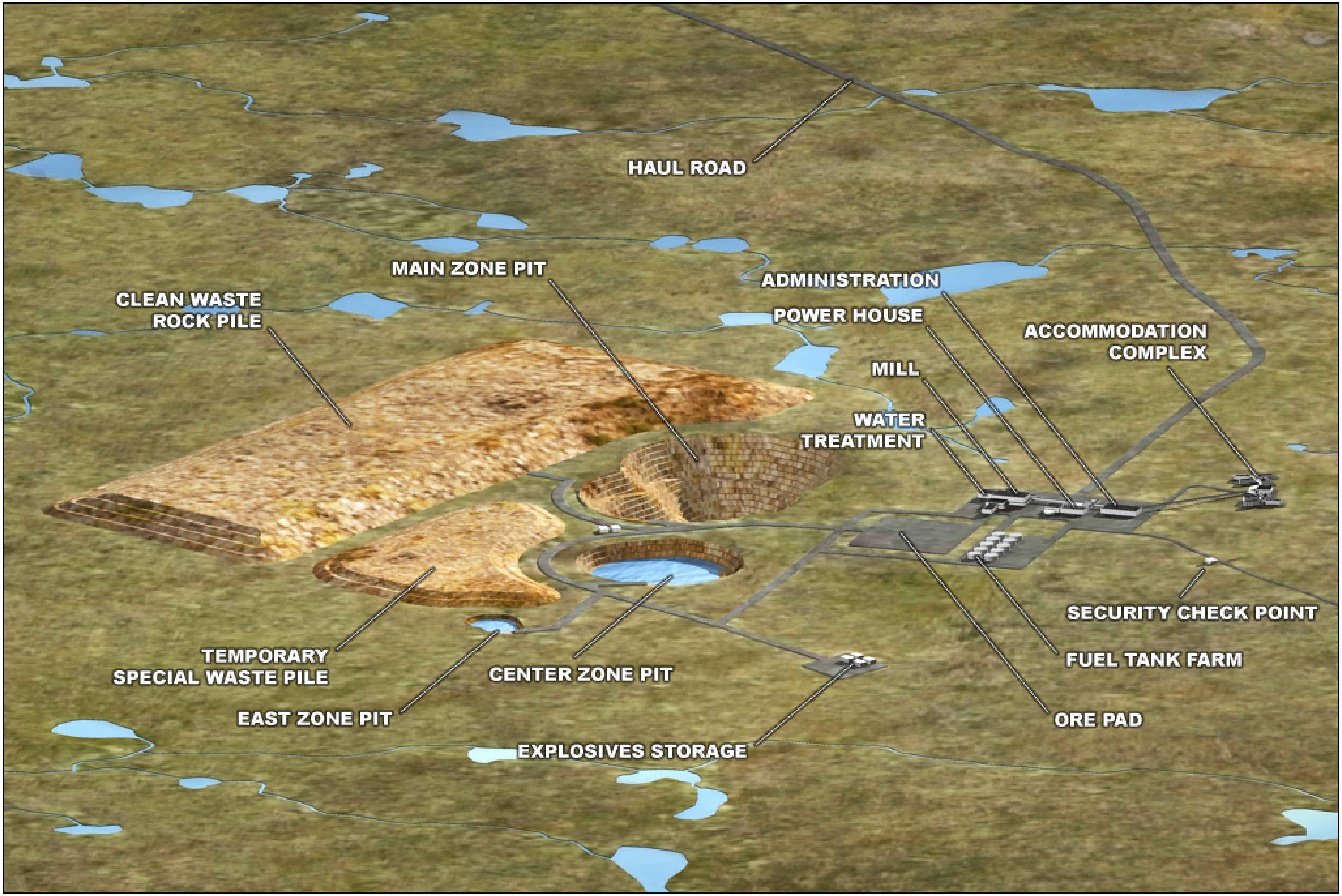

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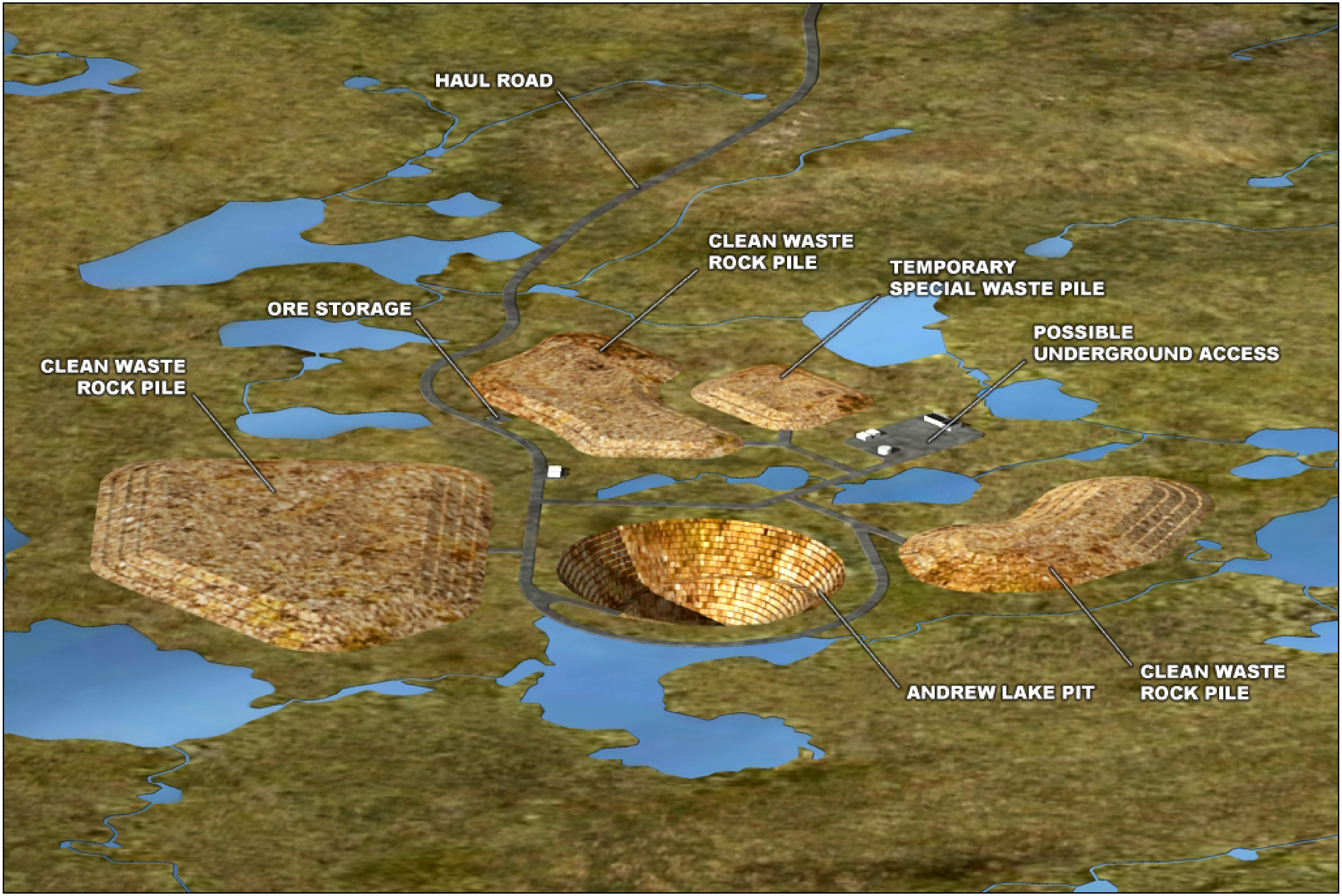
CONCEPTUAL KIGGAVIK LAYOUT FIGURE 2.4	Creator: CDC Date: 10/31/08 Drawing:		



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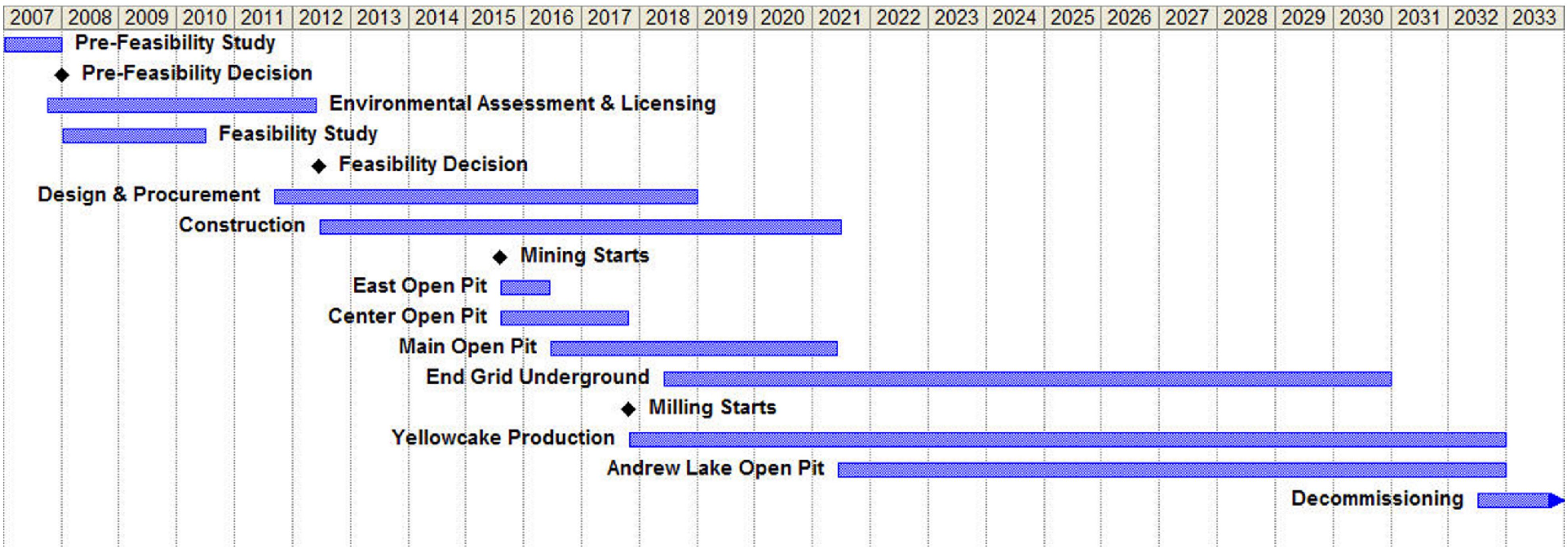
CONCEPTUAL SISSONS LAYOUT FIGURE 2.5	Creator: CDC Date: 10/31/08 Drawing:	AREVA	



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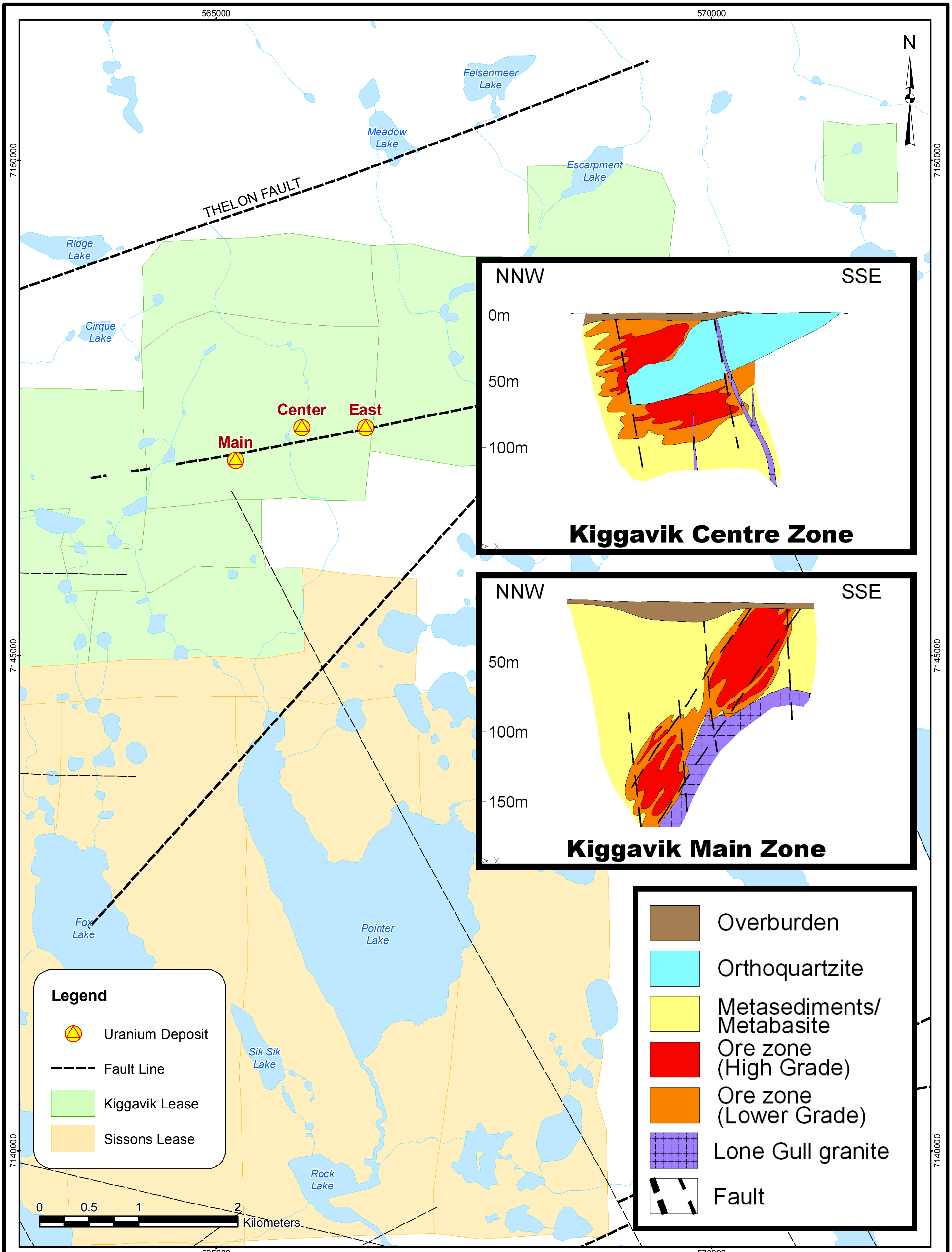
OVERALL PROJECT SCHEDULE FIGURE 2.6	Creator: CDC Date: 10/31/08 Drawing:	



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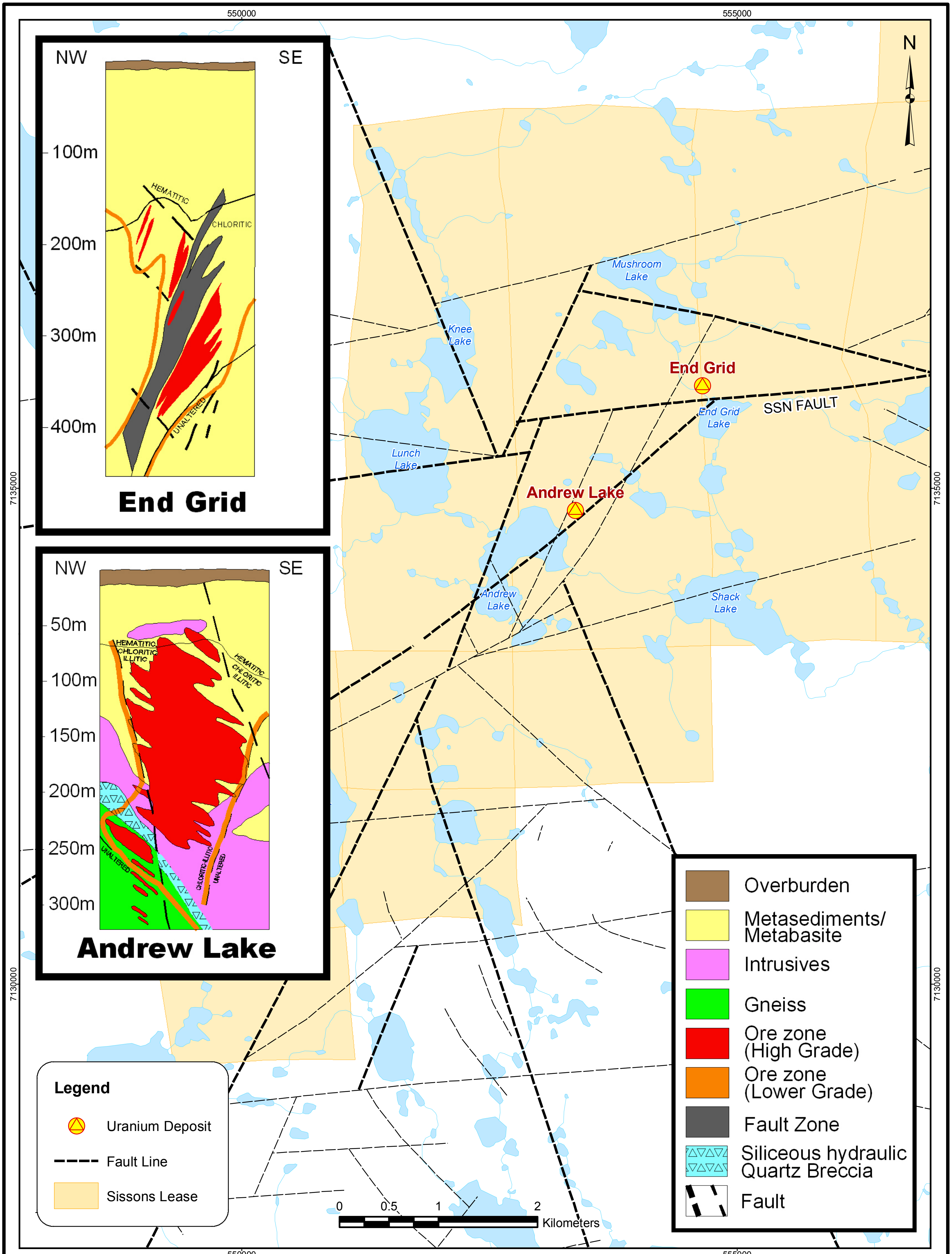
KEY KIGGAVIK AREA GEOLOGICAL FEATURES FIGURE 2.7	Creator: CDC Date: 10/31/08 Drawing:			



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KEY SISSONS AREA GEOLOGICAL FEATURES FIGURE 2.8	Creator: CDC Date: 10/31/08 Drawing:		

		0 YR	1 YR	2 YR	3 YR	4 YR	5 YR	6 YR	7 YR	8 YR	9 YR	10 YR	11 YR	12 YR	13 YR	14 YR	15 YR	16 YR	17 YR
		Procure equip																	
EAST ZONE																			
Ore bcm's	22,918		22,918																
Ore Kt	53		53																
Grade U%	0.533		0.533																
Metal TU	282		282																
Waste Kt	1,282		1,282																
Special Waste bcm	103,130		103,130																
Waste rock bcm	296,000		296,000																
Overburden bcm	68,784		68,784																
Total bcm's	490,832		490,832																
CENTRE ZONE																			
Ore bcm's	225,974		86,580	108,225	31,169														
Ore Kt	522		200	250	72														
Grade U%	0.575		0.575	0.575	0.575														
Metal TU	3,002		1,150	1,438	414														
Waste Kt	18,830		6,164	8,260	4,406														
Special Waste bcm	1,016,883		389,610	487,013	140,260														
Waste rock bcm	5,433,676		1,370,039	2,572,153	1,491,484														
Overburden bcm	523,336		523,336																
Total bcm's	7,199,869		2,369,565	3,167,391	1,662,913														
MAIN ZONE																			
Ore bcm's	890,043			86,580	129,870	173,160	173,160	173,160	154,113										
Ore Kt	2,056			200	300	400	400	400	356										
Grade U%	0.471			0.471	0.471	0.471	0.471	0.471	0.471										
Metal TU	9,684			942	1,413	1,884	1,884	1,884	1,677										
Waste Kt	89,048			9,601	19,160	19,160	19,203	16,002	5,922										
Special Waste bcm	4,005,195			389,610	584,416	779,221	779,221	779,221	693,506										
Waste rock bcm	27,471,274			2,474,377	5,819,760	6,196,866	6,332,836	5,147,619	1,499,816										
Overburden bcm	1,504,401			692,042	692,042	120,318													
Total bcm's	33,870,913			3,642,609	7,226,087	7,269,565	7,285,217	6,100,000	2,347,435										
ANDREW LAKE																			
Ore bcm's	1,540,693									86,580	151,515	179,221	173,160	183,983	183,983	183,983	177,489	134,199	86,580
Ore Kt	3,559									200	350	414	400	425	425	425	410	310	200
Grade U%	0.565									0.565	0.565	0.565	0.565	0.565	0.565	0.565	0.565	0.565	0.565
Metal TU	20,108									1,130	1,978	2,339	2,260	2,401	2,401	2,401	2,317	1,752	1,130
Waste Kt	114,485								5,987	11,975	14,241	14,242	14,242	13,056	14,242	9,499	9,499	4,756	2,746
Special Waste bcm	1,694,762									95,238	166,667	197,143	190,476	202,381	202,381	202,381	195,238	147,619	95,238
Waste rock bcm	39,082,553								1,275,190	3,657,638	5,107,905	5,077,549	5,084,190	4,633,201	5,072,332	3,315,810	3,322,925	1,613,834	921,979
Overburden bcm	1,624,484								942,201	682,283									
Total bcm's	43,942,492								2,217,391	4,521,739	5,426,087	5,453,913	5,447,826	5,019,565	5,458,696	3,702,174	3,695,652	1,895,652	1,103,797
END GRID		Capex	underground	development															
Ore Kt	2,838					180	250	250	250	250	250	250	250	250	250	250	158		
Grade U%	0.382					0.382	0.382	0.382	0.382	0.382	0.382	0.382	0.382	0.382	0.382	0.382	0.382		
Metal TU	10,841					688	955	955	955	955	955	955	955	955	955	955	604		
Milling																			
Ore Kt	**9,027**				222	625	625	625	625	625	625	625	625	625	625	625	625	625	680
Grade U%	**0.486%**				0.486%	0.486%	0.486%	0.486%	0.486%	0.486%	0.486%	0.486%	0.486%	0.486%	0.486%	0.486%	0.486%	0.486%	0.486%
Metal TU	**43,913**				1,080	3,040	3,040	3,040	3,040	3,040	3,040	3,040	3,040	3,040	3,040	3,040	3,040	3,040	3,308

KIGGAVIK PROJECT

PROPOSED PRODUCTION SCHEDULE
FIGURE 2.9

Scale:
Creator: CDC
Date: 10/31/08
Drawing:

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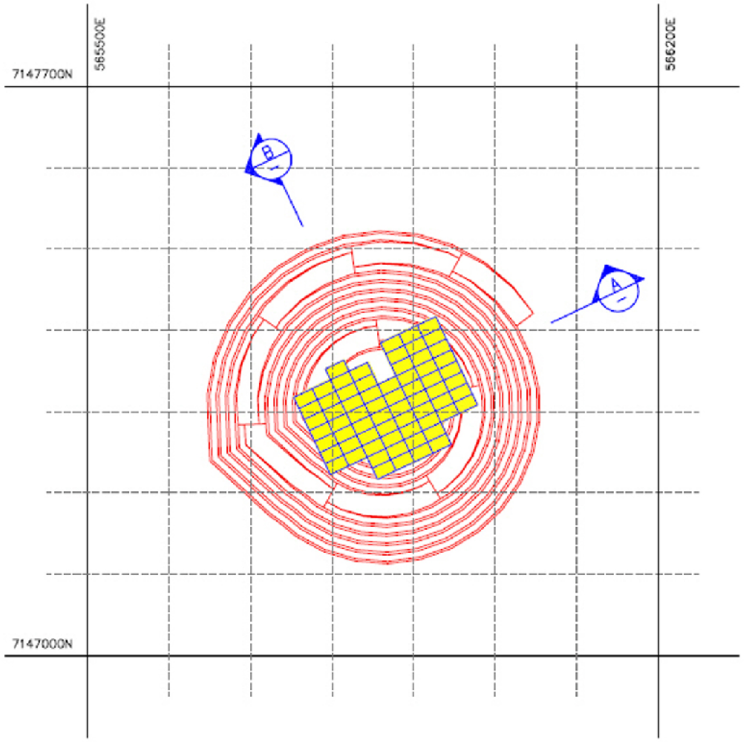
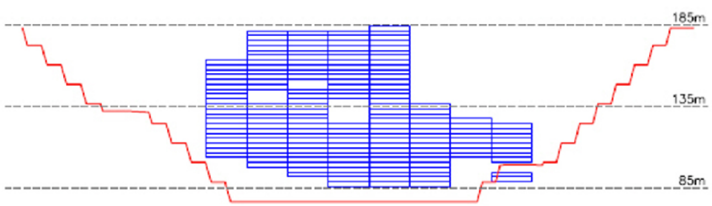
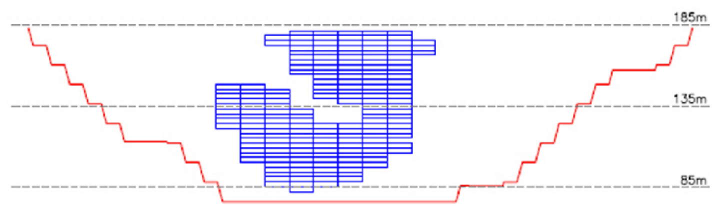


PLAN VIEW
1:10

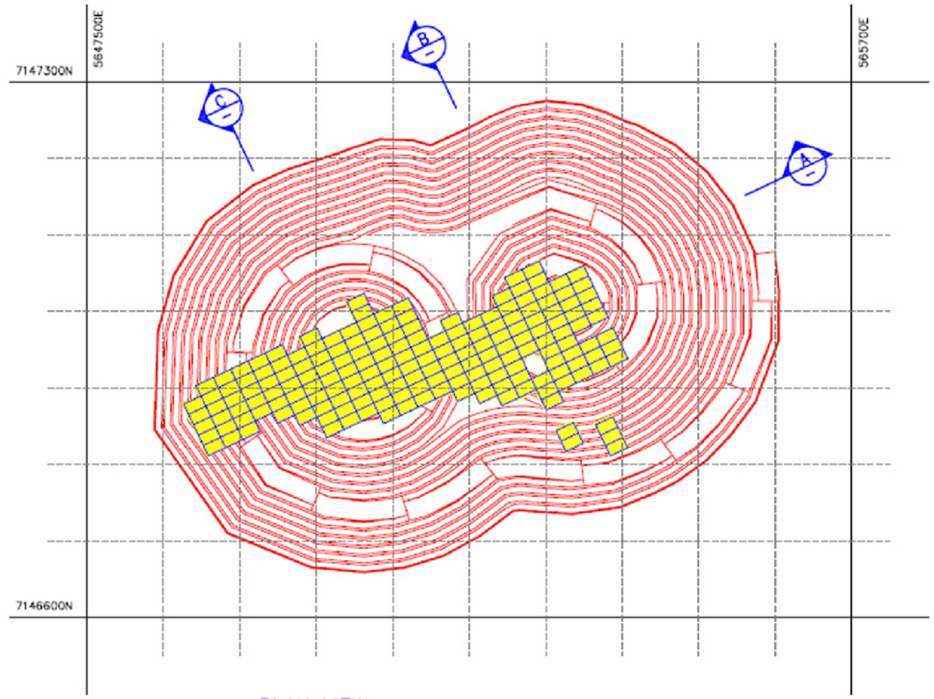


SECTION A
1:5

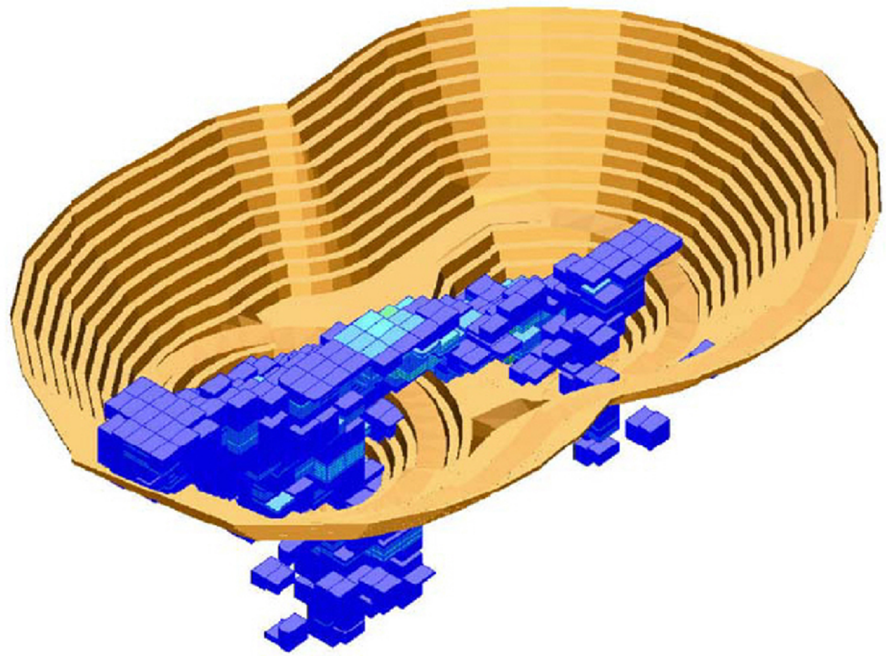


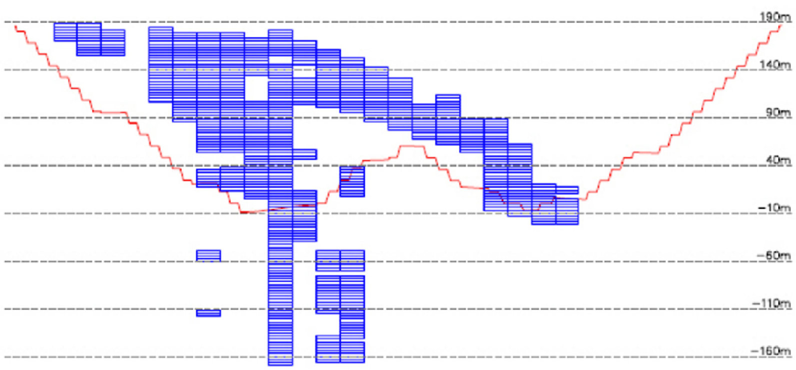
SECTION B
1:5

KIGGAVIK PROJECT	Scale:	AREVA	AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5
PROPOSED CENTER PIT DESIGN FIGURE 2.10	Creator: CDC Date: 10/31/08 Drawing:		

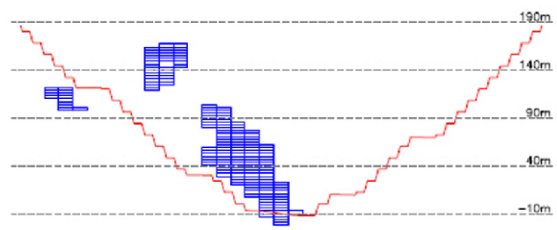


PLAN VIEW
1:10

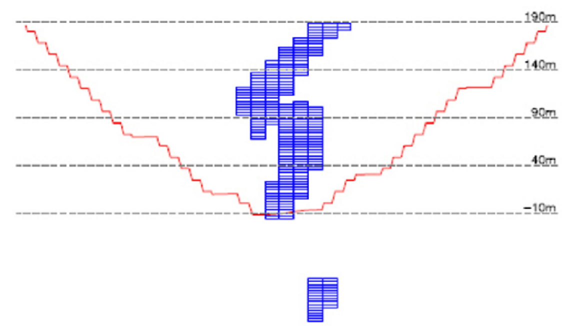




SECTION A
1:8

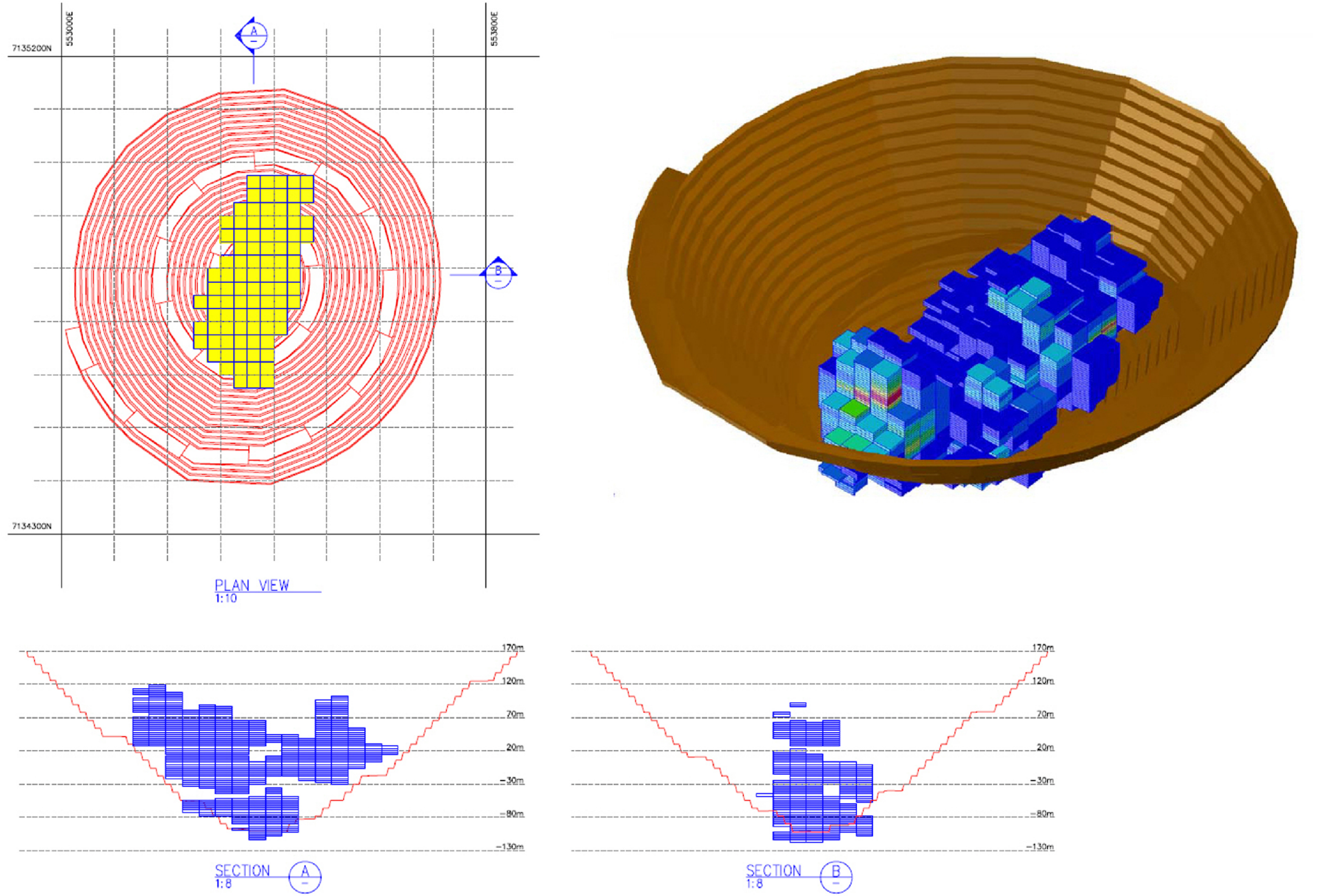


SECTION B
1:8



SECTION C
1:8

KIGGAVIK PROJECT	Scale:		AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5
PROPOSED MAIN PIT DESIGN FIGURE 2.11	Creator: CDC Date: 10/31/08 Drawing:	AREVA	



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PROPOSED ANDREW LAKE PIT DESIGN FIGURE 2.12	Creator: CDC
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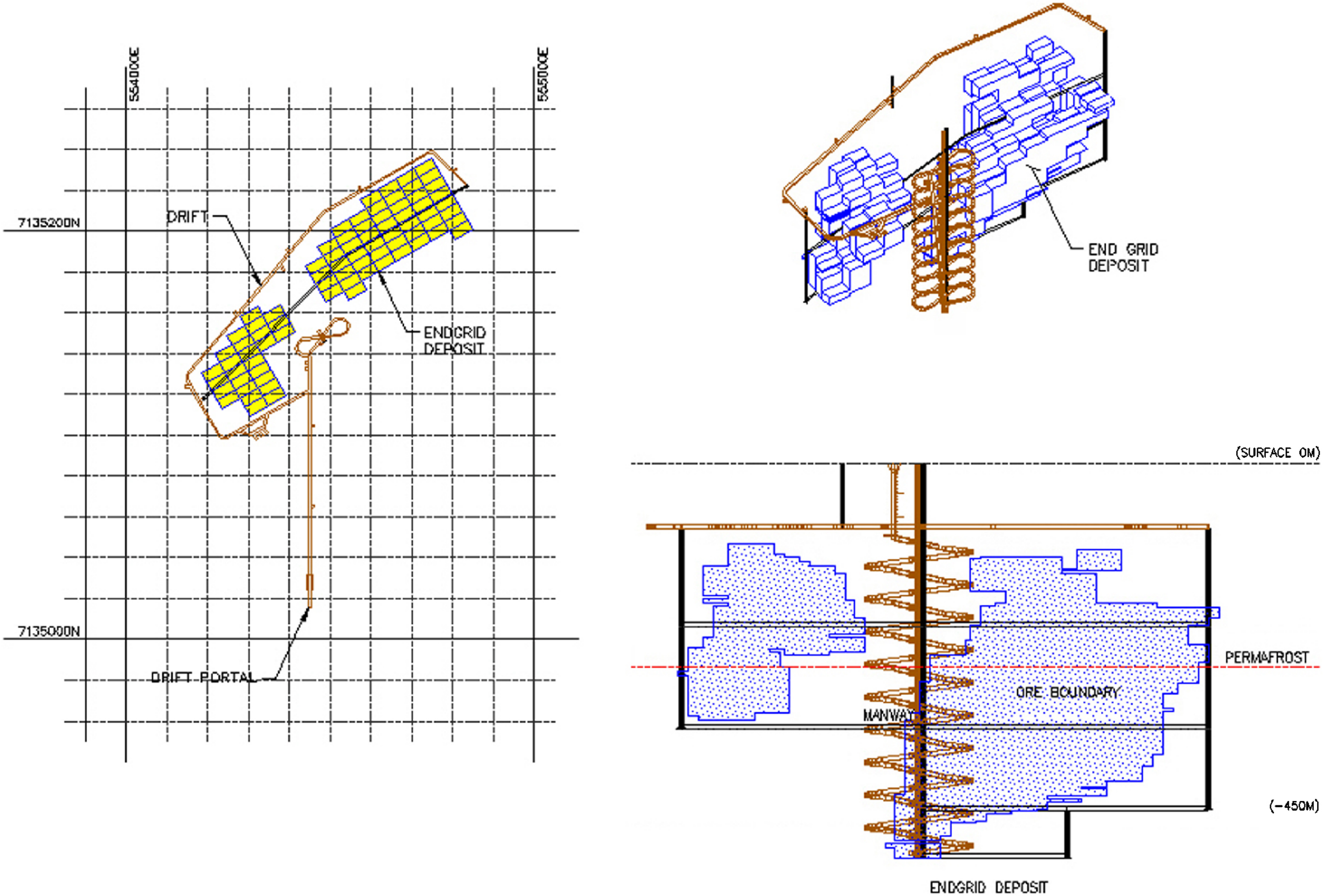

KIGGAVIK PROJECT	Scale:	
PROPOSED ENDGRID UNDERGROUND DESIGN FIGURE 2.13	Creator: CDC	AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5
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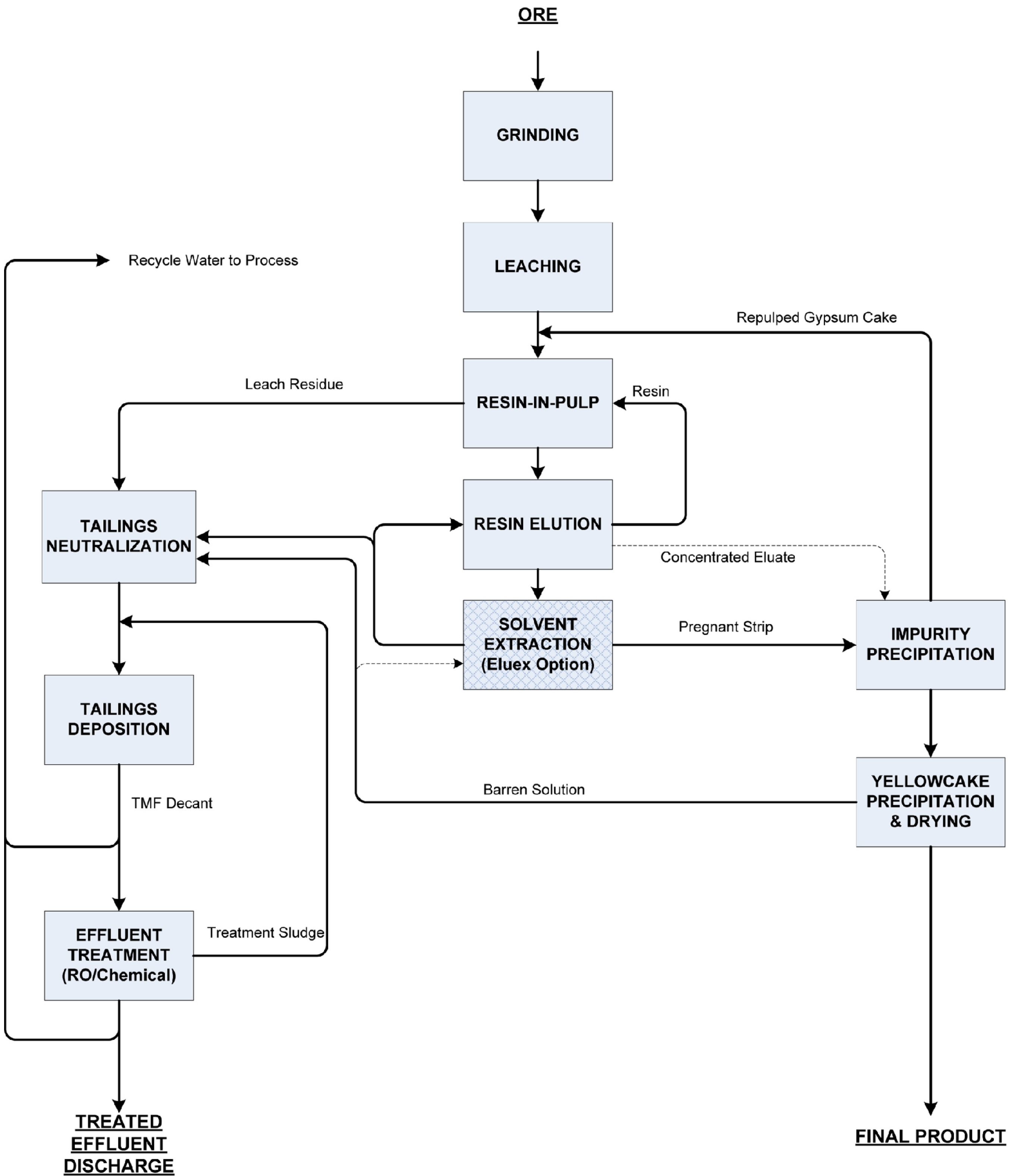
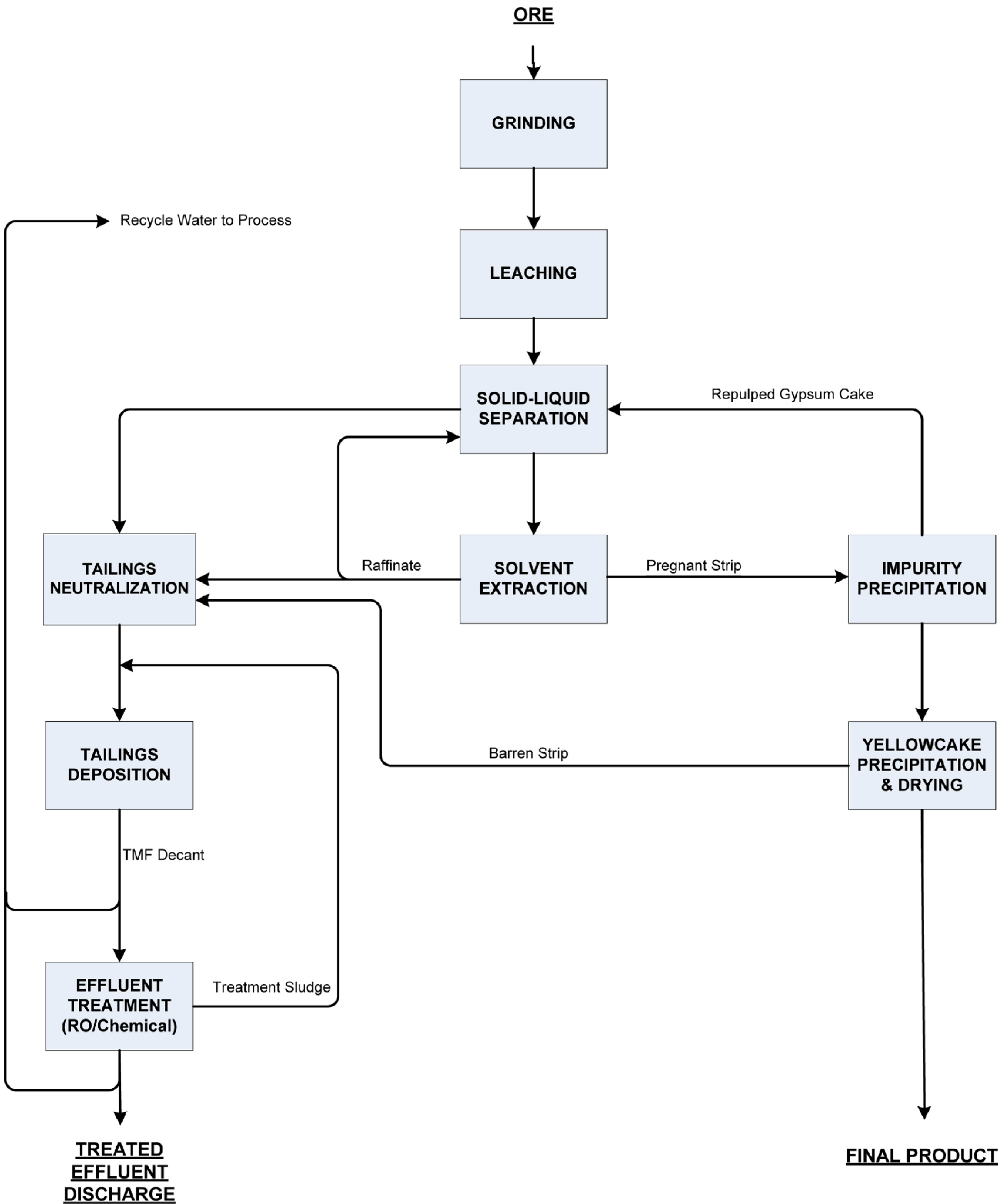


KIGGAVIK PROJECT	Scale:	AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5
FLOWSHEET OF RESIN-IN-PULP PROCESS OPTIONS FIGURE 2.14	Creator: CDC Date: 10/31/08 Drawing:	



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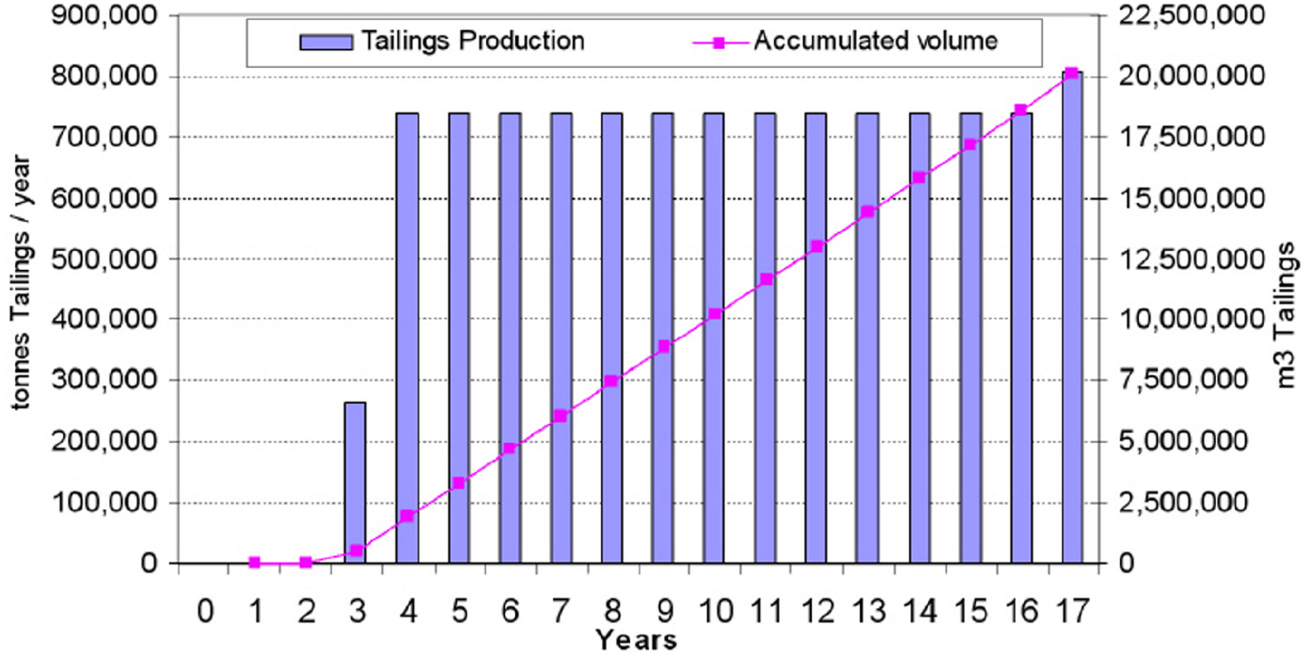
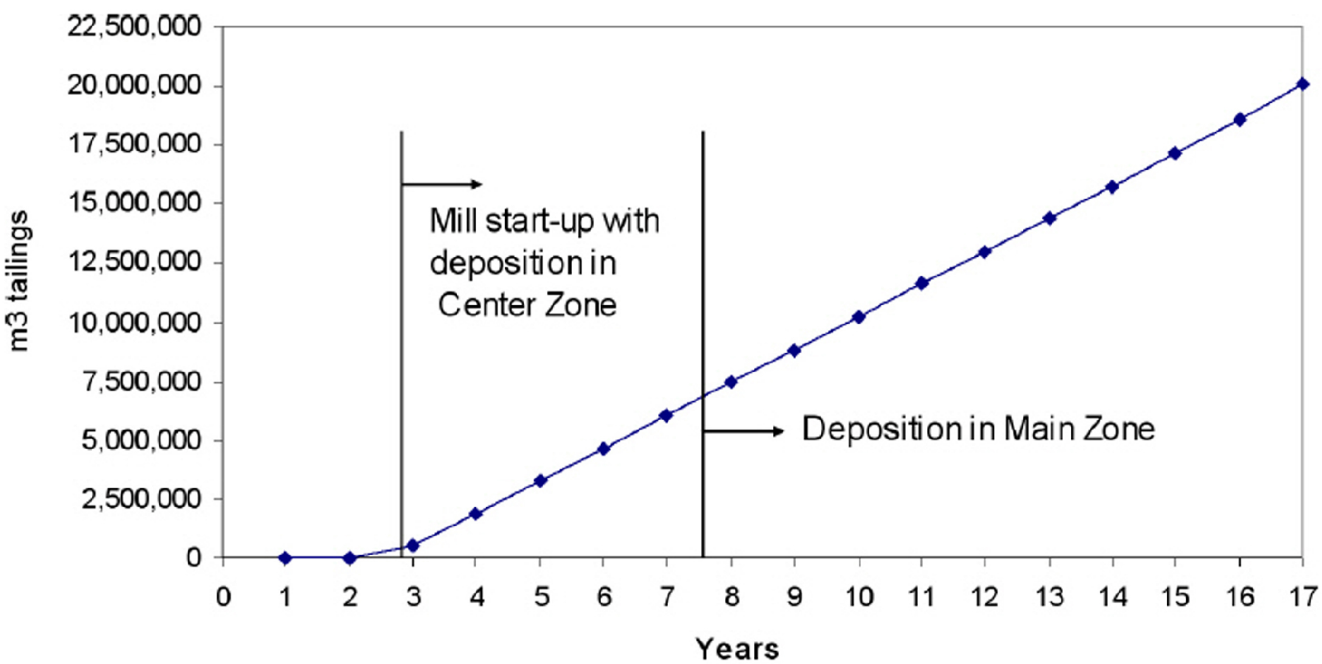
FLOWSHEET OF ALTERNATIVE PROCESS FIGURE 2.15	Creator: CDC Date: 10/31/08 Drawing:		





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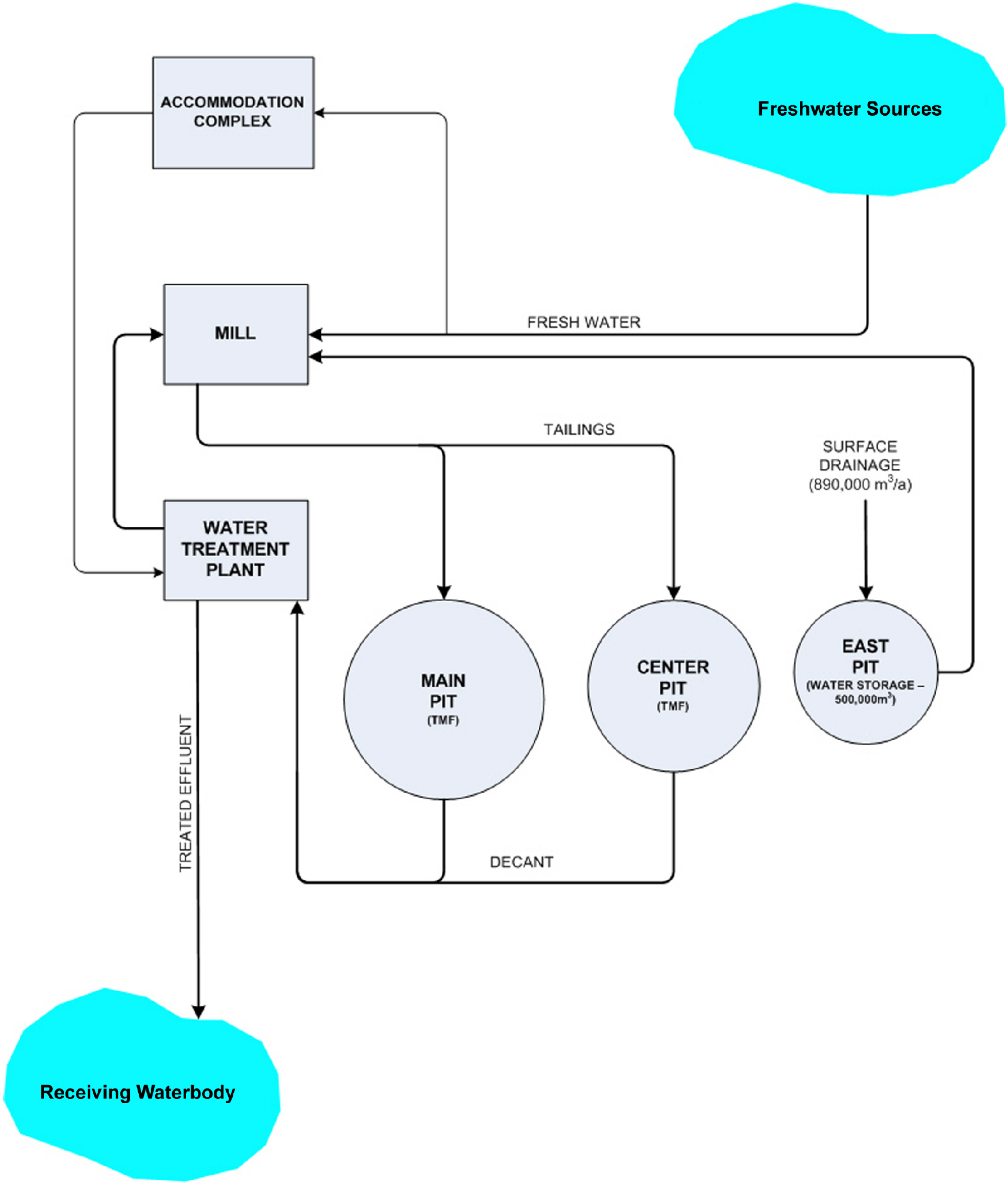
PROJECTED TAILINGS PRODUCTION SCHEDULE FIGURE 2.16	Creator: CDC Date: 10/31/08 Drawing:	AREVA	



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PROPOSED WATER MANAGEMENT SYSTEM FIGURE 2.17	Creator: CDC		
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	Drawing:		

KIGGAVIK PROJECT	Scale: 1:165,000
POTENTIAL FRESH WATER SOURCES FIGURE 2.18	Creator: CDC
	Date: 10/31/08
	Drawing:

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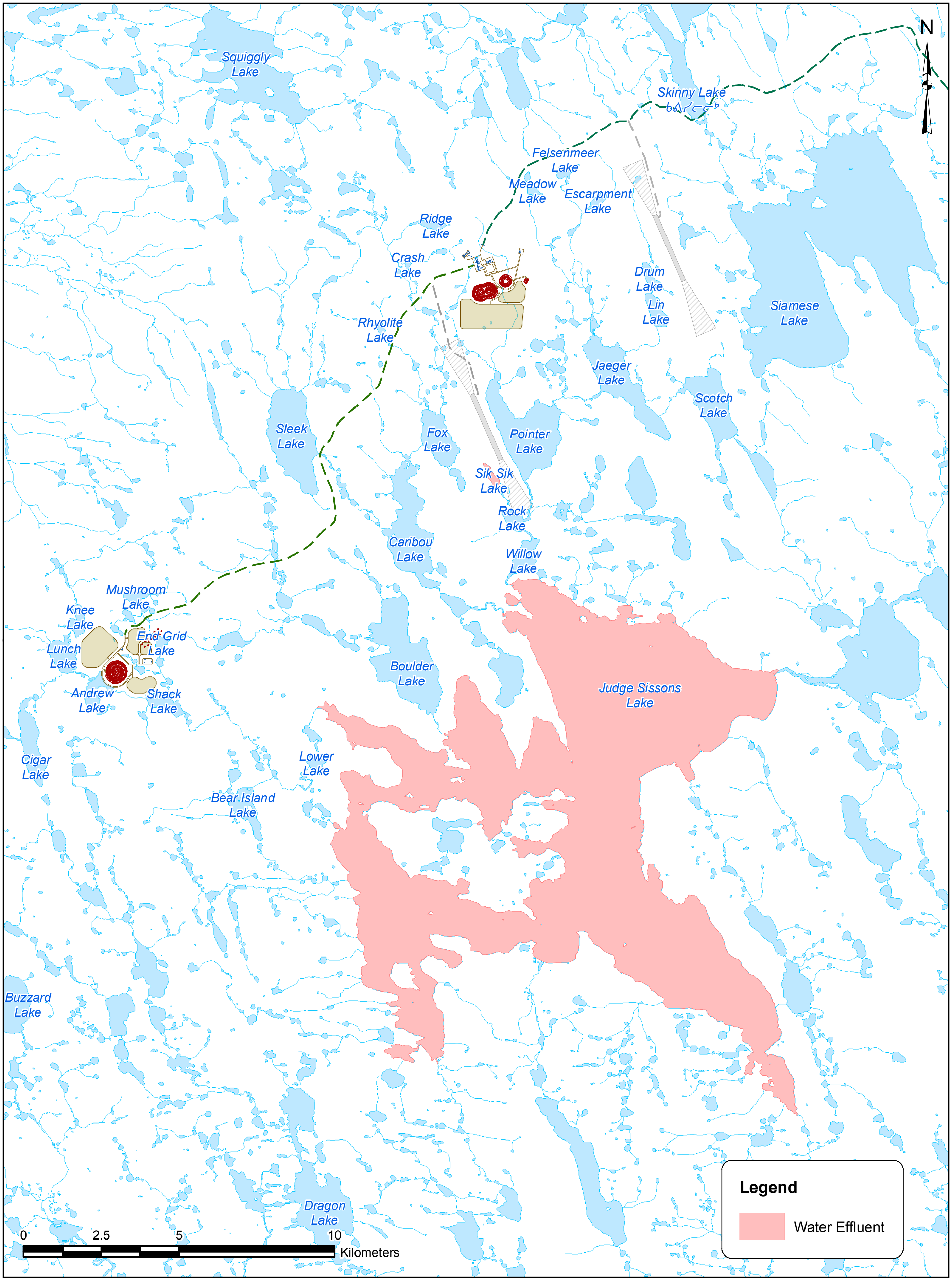
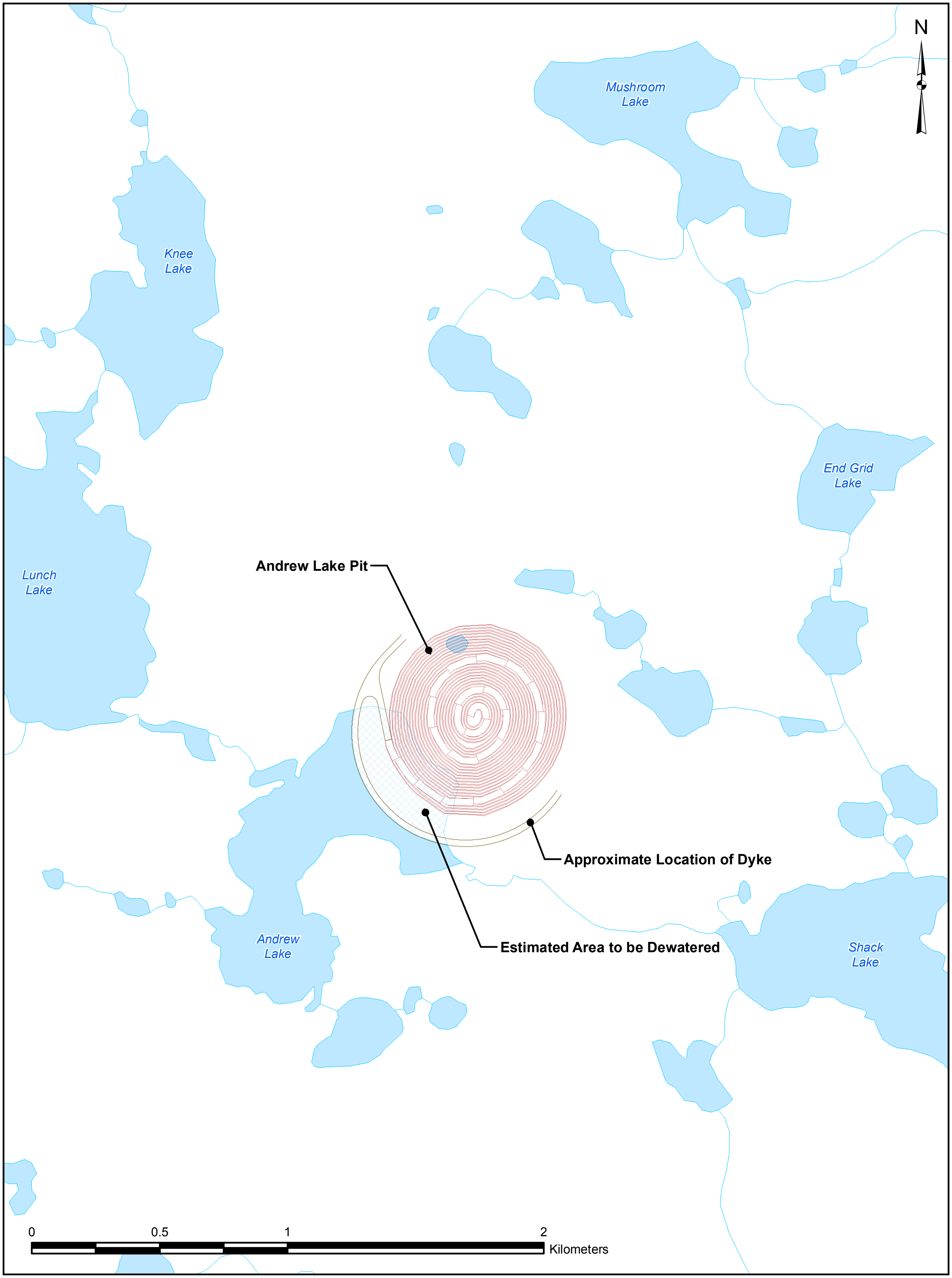


KIGGAVIK PROJECT	Scale: 1:165,000	AREVA	AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5
POTENTIAL TREATED EFFLUENT DISCHARGE RECEPTORS FIGURE 2.19	Creator: CDC Date: 10/31/08 Drawing:		



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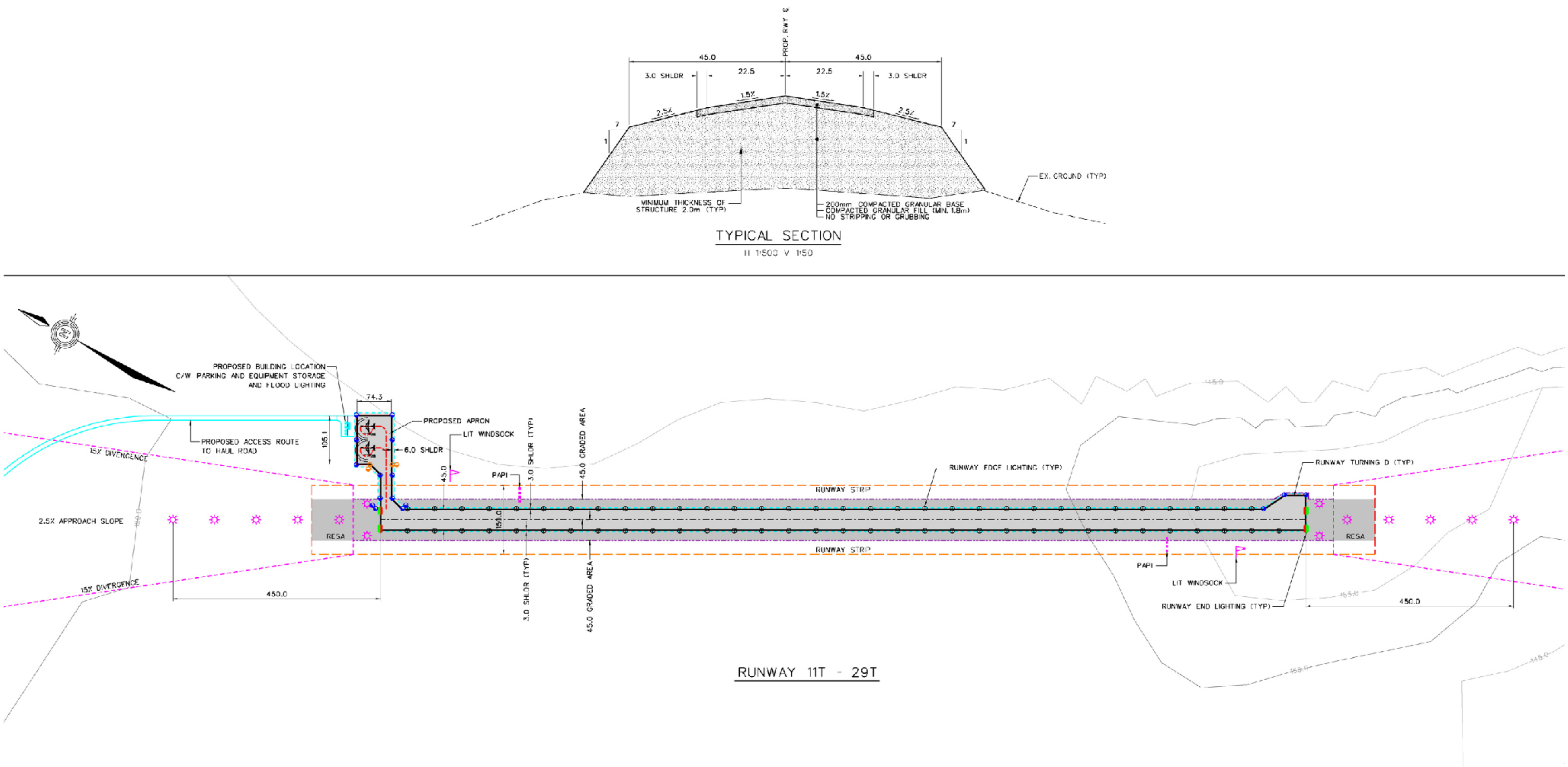
LOCATION OF ANDREW LAKE PIT RELATIVE TO ANDREW LAKE FIGURE 2.20	Creator: CDC Date: 10/31/08 Drawing:			



KIGGAVIK PROJECT	Scale:
PROPOSED AIRSTRIP CONCEPTUAL DESIGN FIGURE 2.21	Creator: CDC Date: 10/31/08 Drawing:

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KIGGAVIK PROJECT	Scale: 1:80,000		AREVA	AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5
AIRSTRIP OPTIONS FIGURE 2.22	Creator: CDC			
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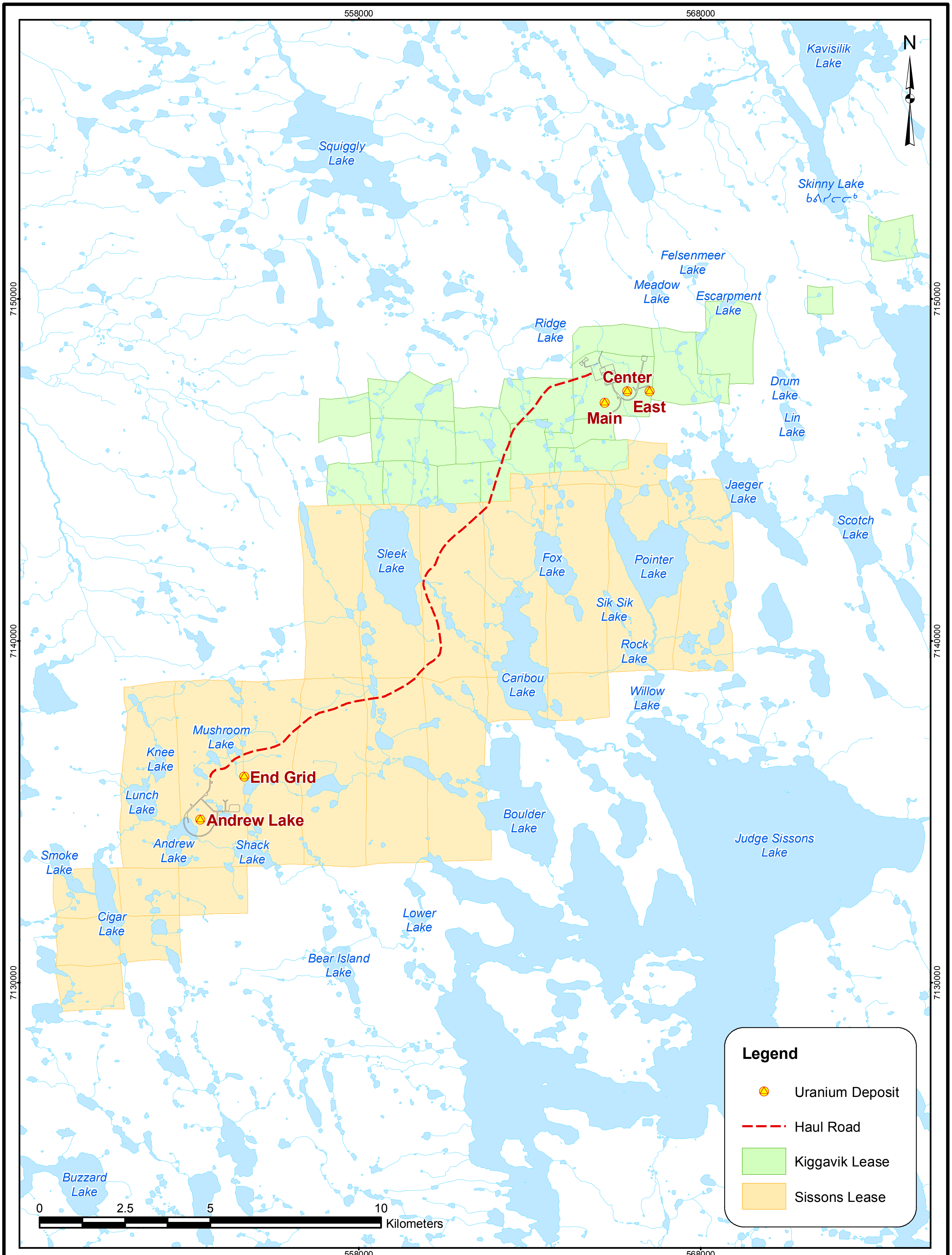
	Drawing:			



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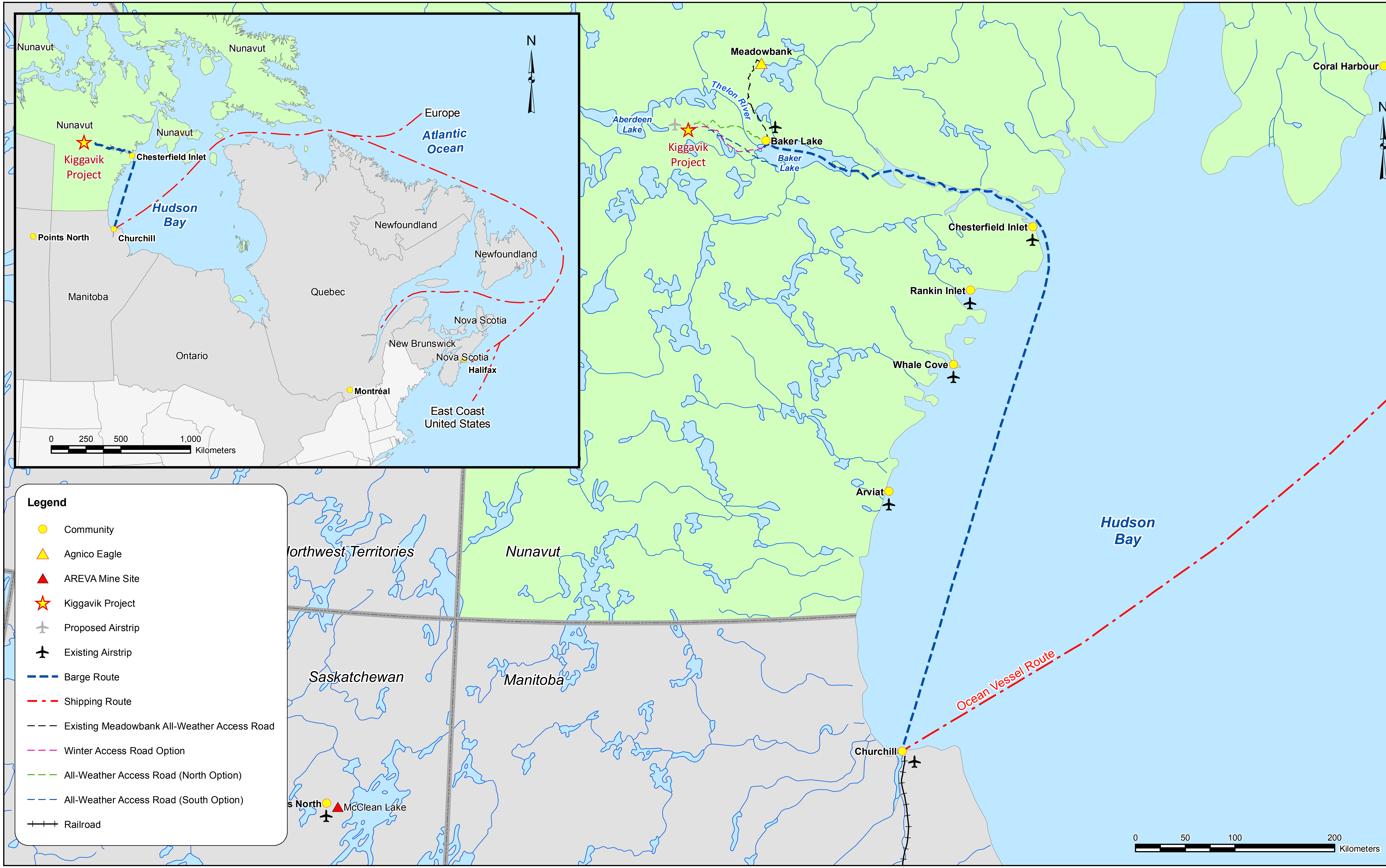
PROPOSED HAUL ROAD FIGURE 2.23	Creator: CDC Date: 10/31/08 Drawing:		

AREVA



KIGGAVIK PROJECT

PROPOSED TRANSPORTATION ROUTES
FIGURE 2.24

Scale: 1:3,500,000
Creator: CDC
Date: 10/31/08
Drawing:

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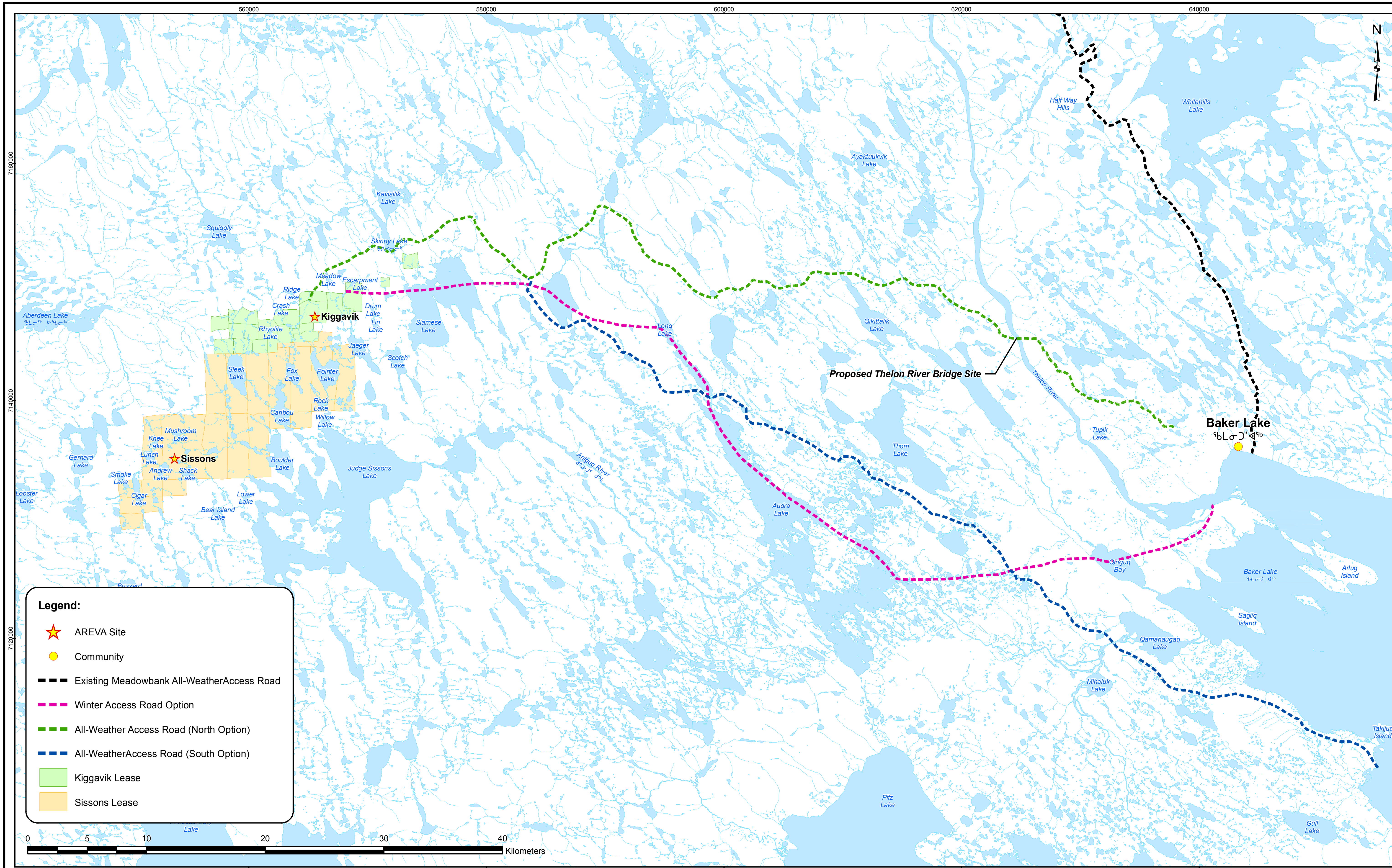

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ACCESS ROAD ROUTE OPTIONS FIGURE 2.25	Creator: CDC
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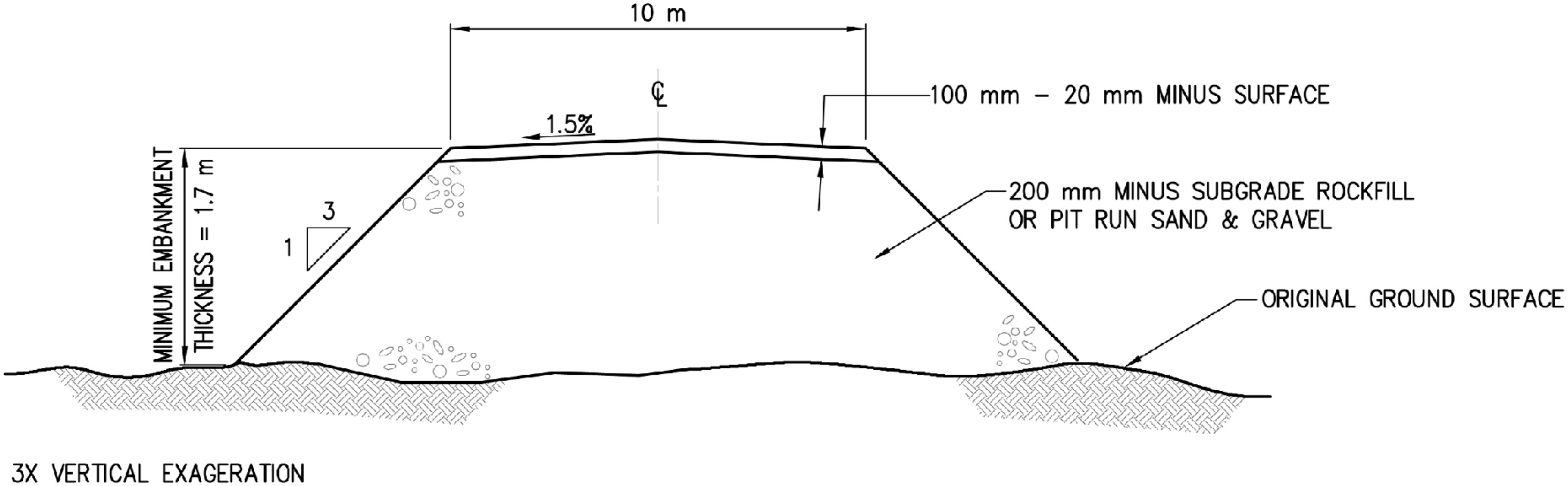

KIGGAVIK PROJECT	Scale:
TYPICAL ALL-WEATHER ACCESS ROAD CROSS-SECTION FIGURE 2.26	Creator: CDC Date: 10/31/08 Drawing:

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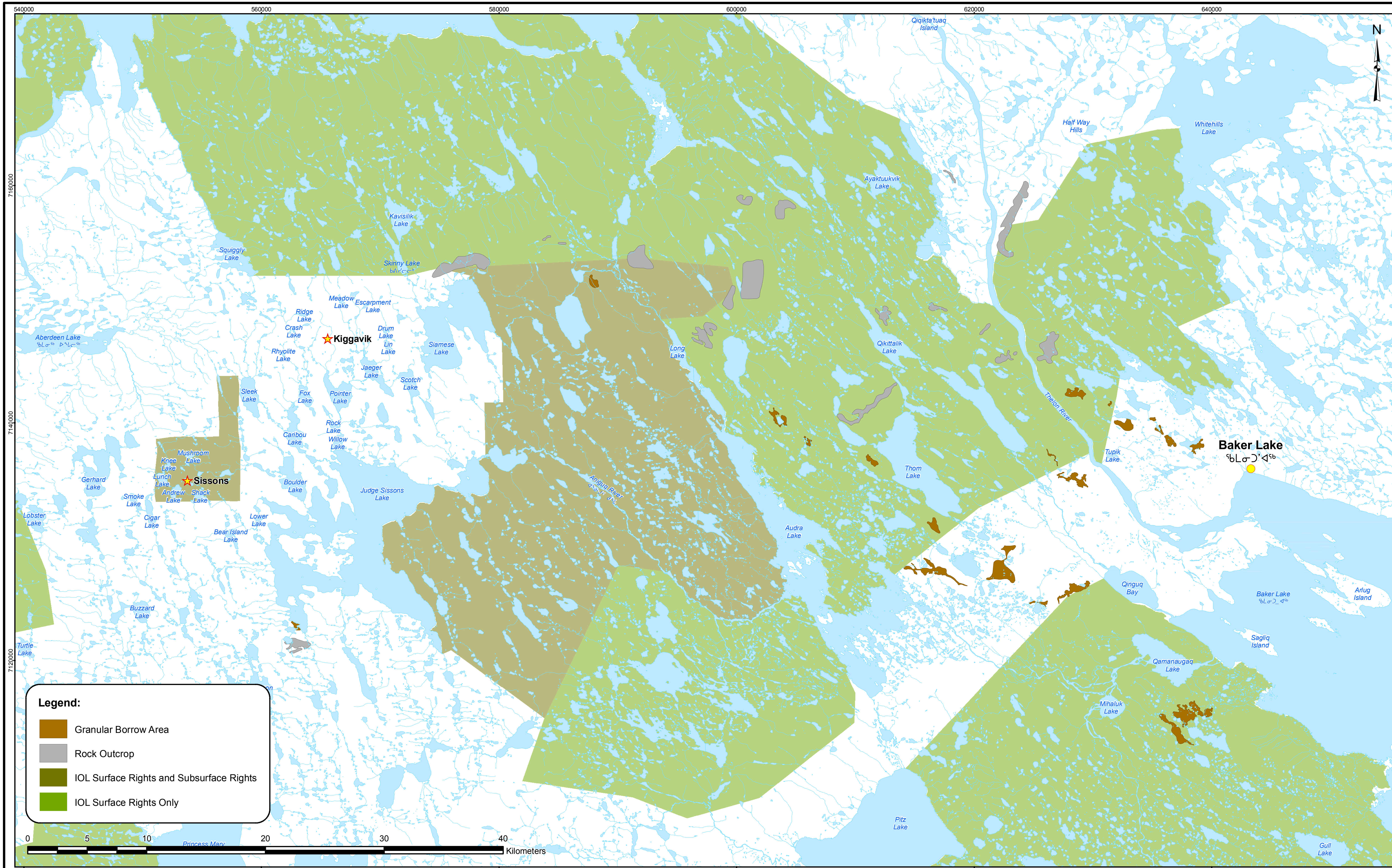
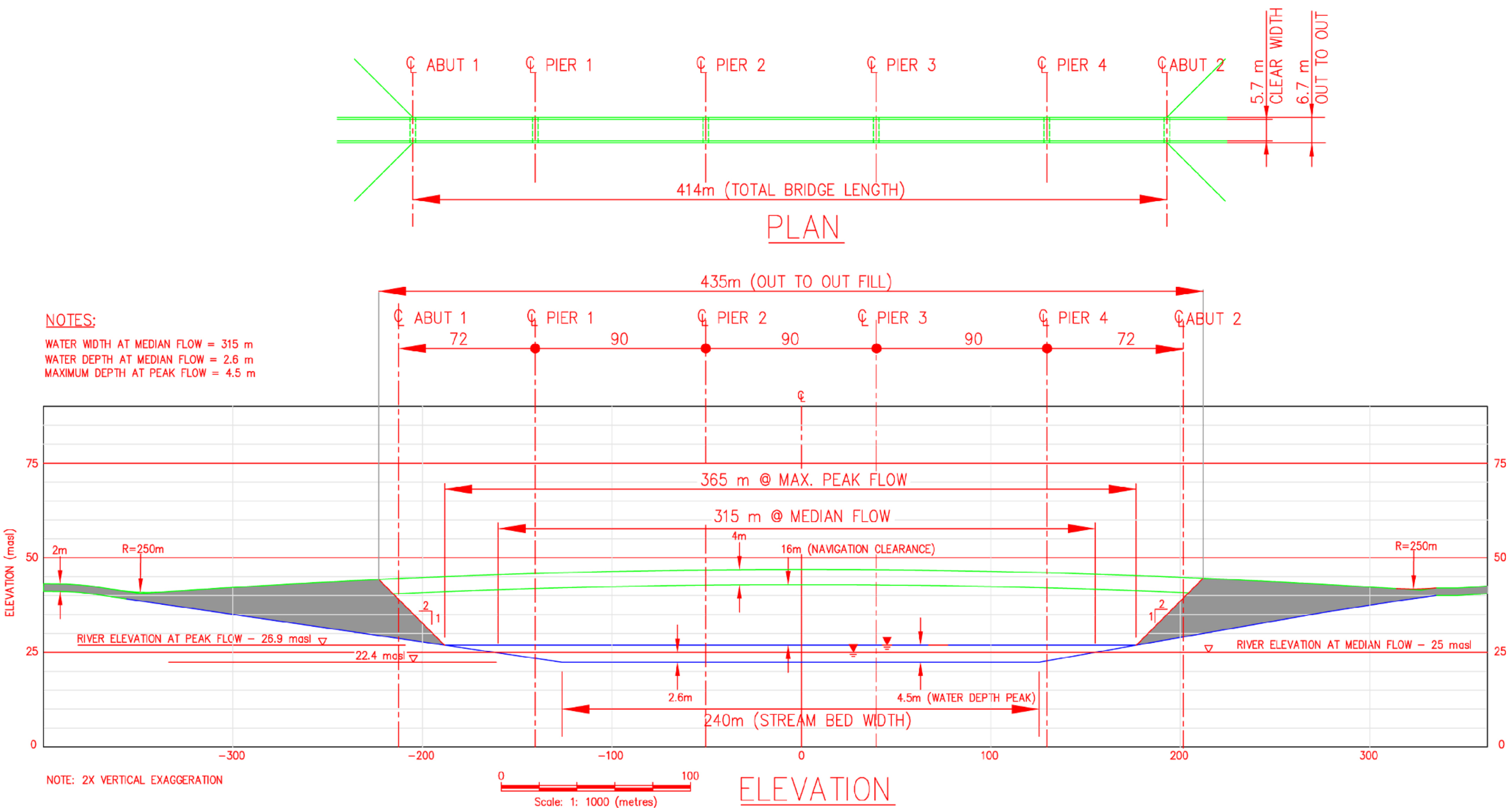
817-45th Street West
Saskatoon, Sk. S7K 3X5



KIGGAVIK PROJECT	Scale: 1:290,000	AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5
POTENTIAL BORROW LOCATIONS FIGURE 2.27	Creator: CDC Date: 10/31/08 Drawing:	



KIGGAVIK PROJECT	Scale:
PROPOSED THELON BRIDGE - CONCEPTUAL DESIGN FIGURE 2.28	Creator: CDC
	Date: 10/31/08
	Drawing:

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KIGGAVIK PROJECT

Project Proposal

SECTION 3

TABLE OF CONTENTS

SECTION **PAGE**

3 PUBLIC CONSULTATION 3-1

3.1 Introduction 3-1

3.2 Information Office 3-1

3.3 Liaison Committees 3-1

3.3.1 Community Liaison Committee 3-1

3.3.2 Regional Liaison Committee 3-2

3.4 Meetings with Organizations 3-3

3.4.1 Project Initiatives 3-3

3.4.2 Inuit Organizations and Institutions of Public Government 3-5

3.4.3 Other Organizations 3-6

3.4.4 Kiggavik Site Tours 3-6

3.4.5 Saskatchewan Minesite Tours 3-6

3.4.6 Participation in Inuit Organizations and IPG Initiatives 3-7

3.5 Summary of Comments 3-8

3.6 Future Consultations 3-9

3 PUBLIC CONSULTATION

3.1 Introduction

Public participation is an essential component of AREVA's sustainable development model for mining projects and is one of the 5 guiding principles used by the Nunavut Impact Review Board. AREVA began public participation initiatives for the Kiggavik Project in 2005, two years prior to the resumption of work on the site.

AREVA has adopted a phased approach to public participation. This initial phase covers the time from May 2005, when interest in the Kiggavik Project resumed following 8 years of care and maintenance to October 31, 2008, shortly before the release of the Project Proposal.

3.2 Information Office

The Kiggavik Project places a high emphasis on maintaining a consistent presence in Baker Lake. To that end, a Community Liaison Officer was hired in May 2006 and an information office was opened in August 2006 (Figure 3.1). The opening of the office was celebrated with a grand opening on October 26, 2006 where the community was invited to attend and invitations were sent to out of town stakeholders. The grand opening consisted of an open house and a community feast. More than 300 people signed the guest book for the grand opening of the office.

Since October 2006, the Project information office has been open to the public every weekday afternoon. Project information is displayed and fact sheets are available on AREVA, the Kiggavik Project, and uranium mining in general. The Community Liaison Officer is available to speak with visitors in both English and Inuktituk.

The Baker Lake office is also used for specific community input events. Since the end of March, 2008, potential options for road access between Baker Lake and Kiggavik have been displayed for public comment. The Information Officer periodically makes a radio announcement inviting people to view and comment on the road options. These comments are recorded for review by the Project team.

3.3 Liaison Committees

Ongoing dialogue between AREVA and the community ensures that the community is aware of, and has input into, Project activities. AREVA has established a community liaison committee in Baker Lake, the community geographically closest to the site, as well as a Kivalliq regional liaison committee.

3.3.1 Community Liaison Committee

The Baker Lake Community Liaison Committee (CLC) has been in place since December of 2006. The concept of a Kiggavik Community Liaison Committee was presented to the Baker Lake Hamlet

Council on October 24, 2006 and received the endorsement of Council. The Baker Lake CLC now has members from:

- District Education Authority
- Hunters and Trappers
- Hamlet Council
- Elders Group
- Youth Group
- Health Committee
- Justice Committee
- Baker Lake Business
- Aberdeen Lake people (Akilinirtmiut)

Members are appointed to the committee by their respective organizations.

The Baker Lake CLC meets about 10 times per year. By October 31, 2008, the committee had held 17 meetings, approximately one per month beginning in December of 2006.

CLC meetings are advertised and open to the public. The Chair is elected from community members and meetings are conducted in English and Inuktitut with a translator present. Meetings are well attended and are typically 2 to 3 hours in length. A summary of meetings activities is announced over the local radio and minutes are recorded. Topics discussed at CLC meetings to date include:

- Update of Project activities (field programs, environmental baseline work, permits)
- Project consultations
- Input on road and dock options and on fuel storage
- IQ program
- Communication materials
- Visits by Aboriginal Groups
- Local employment opportunities
- Sponsorships
- Member topics (topics the members or their organizations wish to discuss).

3.3.2 Regional Liaison Committee

A Regional Liaison Committee was established in 2007 to facilitate ongoing dialogue with the 7 Kivalliq communities. At AREVA's request, each community appointed a representative to the committee. The Regional Liaison Committee met as follows:

- in Rankin Inlet in December 2007;
- in Saskatchewan in May 2008; including a tour of the McClean Lake Operation and the Cluff Lake decommissioned site; and,
- in Baker Lake in August 26 2008.

A translator is available for these meetings and minutes are recorded. The Regional Liaison Committee is expected to meet from 2-4 times per year as required to maintain ongoing dialogue between the Project and the region.

Topics discussed at Regional Committee meetings have included:

- Training and employment opportunities for people in the Kivalliq region
- The need to communicate with each community in the Kivalliq region
- The need to make business opportunities known to Kivalliq businesses

3.4 Meetings with Organizations

AREVA has met with and made presentations to various organizations in the 7 communities in the Kivalliq region. Some events were requested by AREVA and some organizations invited AREVA to speak about the Project. The following sub-sections summarize the meetings in 2005, 2006, 2007 and 2008 (to date).

3.4.1 Project Initiatives

Hamlet Councils

- Baker Lake Council
  - May 2005 - Introductory meeting and Project presentation
  - March 2006 - Follow-up meeting
  - October 2006 - Meeting to initiate the Community Liaison Committee
  - March 2008 - Meeting regarding road options and the proposed consultations
  - May 2008 - Update on road consultations and introduction to Project socioeconomic assessment consultant
- Rankin Inlet Hamlet Council
  - March 2007 - Introductory meeting and Project overview
- Chesterfield Inlet Hamlet Council
  - March 2007 - Introductory meeting and Project overview
  - April 2008 - Project update and presentation on uranium mining by SENES Consultants (follow-up to a request at the August 2007 community meeting)
  - May 2008 – Introduction of Project socioeconomic assessment consultants and marine baseline consultants (marine baseline studies were committed as a result of comments at the April 2008 meeting)
- Arviat Hamlet Council
  - February 2007 - Introductory meeting and Project overview
  - April 2007 - Follow-up meeting
- Whale Cove Hamlet Council
  - August 2007 - Introductory meeting and Project overview
- Coral Harbour Council
  - June 2008 - Introductory meeting and Project overview

- Repulse Bay
  - June 2008 - Introductory meeting and Project overview

Hunter and Trapper Organizations (HTOs)

- Baker Lake HTO
  - March 2006 - Introductory meeting
  - November 2006 - Meeting regarding participating in Community Liaison Committee
  - May 2007 - Meeting with traditional hunters from the Athabasca region of Saskatchewan (requested at the March 2006 meeting)
  - March 2008 - Presentation on road options
  - August 2008 - Meeting regarding marine baseline monitoring
- Chesterfield Inlet HTO
  - March 2008 - Project update and presentation on uranium mining by SENES Consultants (follow-up to a request at the August 2007 RLC meeting)
  - May 2008 - Introduction of the Project socioeconomic assessment consultants and marine baseline consultants (marine baseline studies were committed as a result of comments at the April 2008 community meeting)

Community Land and Resources Committees

- Baker Lake CLARC
  - March 2006 - Introductory meeting
  - March 2008 - Meeting regarding possible road options and the proposed consultations

Community Meetings

- Baker Lake Community, August 2007 - Summary of archaeological survey findings
- Chesterfield Inlet Community
  - August 2007 - Project overview
  - April 2008 - Project update and presentation on uranium mining by SENES Consultants (follow-up to request at August 2007 community meeting)

Wildlife Organizations

- Kivalliq Wildlife Management Board
  - April 2007 - Project Update and Wildlife Protection Presentations at a regular meeting in Rankin Inlet
  - May 2008 - Project Update and Wildlife Protection Presentations at a regular meeting in Rankin Inlet
- Beverly Qamanirjuaq Caribou Management Board (BQCMB)

  - November 2006 - Project Update and Wildlife Protection Presentations at a regular meeting in Winnipeg
  - June 2007 - Project Update and Wildlife Protection Presentations at a regular meeting in Thompson. A 5 year contribution agreement for joint research was signed by AREVA and the BQCMB at this meeting
  - November 2007 - Project Update and Wildlife Protection Presentations at a regular meeting in Winnipeg
  - May 2008 - Project Update and Wildlife Protection Presentations at a regular meeting in Fort Smith

Educational Institutions

- Baker Lake High School, April 2006 – Presentation on mining to high school class and participation in job fair
- Chesterfield Inlet High School, March 2007 – Presentation on mining to high school class
- Kivalliq Partners Outreach Program, Rankin Inlet, March 2008 – Presentation on mining and the Kiggavik Project to outreach class
- Arctic College, Baker Lake Campus, April 2008 – Presentation to pre-mining class
- Inukshuk High School, Iqaluit, April 2008 – Presentation to high school students during Nunavut Mining Symposium
- Kivalliq Science Fair, Baker Lake, September 2008 – Presentations on geology and on job opportunities in mining

3.4.2 Inuit Organizations and Institutions of Public Government

Nunavut Tunngavik Inc. (NTI)

- Meeting with staff in Cambridge Bay, May 2005 and April 2006
- Meeting with staff in Vancouver, January 2008
- Presentation to Land Planning Advisory Committee (LPAC), March 2005
- Presentation to Land Planning Advisory Committee (LPAC), March 2006

Kivalliq Inuit Association (KIA)

- Project updates to KIA Board at regular and special meetings:
  - February 2006 in Rankin Inlet
  - January 2007 in Rankin Inlet
  - October 2007 in Rankin Inlet
  - April 2008 in Arviat
  - October 2008
- Meeting and Project update presentation to KIA Officers and staff in Vancouver, January 2008

3.4.3 Other Organizations

- Kivalliq Chamber of Commerce
    - March 2006, Rankin Inlet – Project update at AGM
    - March 2007, Rankin Inlet – Project update and job prospects at AGM
    - March 2008, Rankin Inlet – Project update at AGM
- Baker Lake Concerned Citizens Committee, May 2007 – hosted a meeting between the committee and traditional Athabascan hunters and trappers
- Kivalliq Mayors Meeting, Baker Lake, November 2007 – Project overview
- Inuit Heritage Trust, November 2007 – Project overview

3.4.4 Kiggavik Site Tours

AREVA has hosted several tour groups at the Kiggavik site, as follows:

- August 2006, a group of Baker Lake elders visited Kiggavik to see the site following a cleanup in 2004 and 2005.
- At the suggestion of the Baker Lake CLARC, AREVA has taken several groups of Akilinirtmiut people (Aberdeen Lake people) to Kiggavik and surrounding areas as this group traditionally lived in proximity of the site. The visits included traditional homelands and were carried out as follows:
    - July 27, 2006 – two trips, 12 people total to Aberdeen and Beverly Lakes and to the Kiggavik site (Figure 3.2)
    - July 28, 2006 – one trip, 3 people to Aberdeen and Beverly Lakes and to Kiggavik
    - August 24, 2006 - one trip, 3 people to Aberdeen Lake and to Kiggavik
    - August 17, 2007 – one trip, 4 people to Aberdeen Lake, Shultz Lake and Kiggavik (Figure 3.3)
- In August 2007 and August 2008, the Community Liaison Committee visited the Kiggavik site and toured the exploration operation (Figure 3.4)
- In August 2008, the Kivalliq Regional Liaison Committee visited the Kiggavik site
- In June 2008, the Project hosted a tour which included the premier of Nunavut, mayor of Baker Lake, Minister of Economic Development and the Baker Lake MLA (Figure 3.5).

3.4.5 Saskatchewan Minesite Tours

Since 2005, AREVA has taken 8 groups of people from Nunavut to tour uranium mines operating in Saskatchewan. The tours have typically included the McClean Lake open pit mine and mill operated by AREVA, the McArthur River underground mine operated by Cameco Corporation, and the decommissioned Cluff Lake mill, open pit and underground mine operated by AREVA. The tours were as follows:

- September 2005 – Group of 14 representatives from governments and co-management boards visited McArthur River and McClean Lake and held meetings in Saskatoon with

Saskatchewan Environment, Canadian Nuclear Safety Commission (CNSC) and Environmental Quality Committee members.

- September 2005 – Group of 32 visitors from NTI, the three RIA's and the mayor of Baker Lake visited McArthur River and McClean Lake and met with Saskatchewan northerners who have worked with uranium mines.
- October 2005 – Group of 11 councillors, elders, students, hunter/trappers and business people from Baker Lake visited McArthur River and McClean Lake (Figure 3.6).
- September 2007 – Nunavut Planning Commission commissioners and staff visited McArthur River, McClean Lake, and Cluff Lake.
- May 2008 – Regional Liaison Committee members toured McClean Lake and Cluff Lake.
- June 2008 – Government of Nunavut employees from various departments toured McClean Lake and Cluff Lake.
- July 2008 – Kivalliq Inuit Association board members and staff
- October 2008 – Kiggavik Community Liaison Committee, Kivalliq Wildlife Board and a teacher and four students from the Mineral and Energy Class at Jonah Amitnaaq High School

3.4.6 Participation in Inuit Organizations and IPG Initiatives

KIA Uranium Information Sessions

In April 2007, AREVA participated in Uranium Information Sessions sponsored by the Kivalliq Inuit Association in six Kivalliq communities. A similar session had been held in Baker Lake the previous October. The sessions were as follows:

- Rankin Inlet, April 10, 2007
- Chesterfield Inlet, April 11, 2007
- Arviat, April 12, 2007
- Whale Cove, April 12, 2007
- Coral Harbour, April 13, 2007
- Repulse Bay, April 13, 2007 (Figure 3.7)

The Uranium Information Sessions were public meetings that were advertised in advance and translated. At each information session, SENES Consultants Ltd. gave a presentation about uranium and uranium mining, the CNSC gave a presentation on regulation of the nuclear industry in Canada and AREVA gave a presentation about the Kiggavik Project. The sessions were attended by about 400 people. KIA prepared a report on the meetings, including comments made by participants.

NTI Uranium Policy Information Sessions

AREVA participated in the NTI Land Planning Advisory Committee uranium policy meetings. Two sessions were held:

- May 28, 2007 in Baker Lake
- May 29, 2007 in Kugluktuk

The meetings were public, with the objective of obtaining input from Inuit on the draft NTI Uranium Policy. The meetings were advertised and translated. The meetings included the following presentations:

- Environment and Health Aspects of Uranium Exploration and Mining by SENES Consultants Ltd.
- Regulatory Overview by the CNSC
- Exploration Overview and Saskatchewan Experience by AREVA.

NTI issued minutes of the meetings, including the questions asked.

NPC Uranium Workshop

AREVA participated in the Uranium Mining in the Kivalliq Workshop held in Baker Lake June 5-7, 2007, hosted by the Nunavut Planning Commission. Approximately 100 participants representing the federal and territorial governments, HTOs and CLARCs, institutions of public government (IPGs), non-governmental organizations (NGOs), industry and the public attended the workshop. The workshop was held to provide IPGs with an opportunity to review the social, cultural, economic and environmental issues and opportunities associated with uranium mining in the Kivalliq region, as required under Term 3.5 of the Keewatin Land Use Plan. The public forum permitted the public to participate. On June 27, 2007, the Nunavut Planning Commission passed a resolution declaring that the requirements of Term 3.5 of the Keewatin Land Use Plan had been met.

The presentations made by AREVA at the workshop were:

- Uranium Industry Overview
- Environmental Issues Related to Uranium Mines and Community and Stakeholder Involvement in Protection Programs
- Involving Communities and Stakeholders to Ensure Caribou Protection
- Working Towards a Common Goal – Community Involvement
- Function and Composition of Baker Lake Community Liaison Committee, Key Issues to Date, Future Challenges
- Community Preparation, Issues and Challenges: Employment and Business Opportunities

3.5 Summary of Comments

Questions, comments and concerns raised during Kiggavik public consultation activities are recorded for review and follow-up by the Project team. A summary of these items, collected between April 2005 and October 31, 2008, is as follows:

- Uranium
  - What is uranium used for
  - Will uranium from Kiggavik be used for weapons
  - What will the product look like

    - Can uranium mined in Nunavut be used to produce power in Nunavut
- Uranium Mining and Milling
    - What is the schedule (when will the work start and end)
    - Type of operation (underground, open pit, mill)
    - How will tailings be managed
    - How will mining take place on permafrost and tundra in a harsh climate
    - What will be left after mining is over
- Training and Employment
    - Opportunities for Inuit
    - Number of jobs available
    - How will people apply for work
    - Timing and types of training
    - Educational requirements and opportunities for uneducated people
    - Types of work rotations
- Worker Protection
    - How will workers be kept safe
    - Will workers be harmed from radiation
- Environmental Protection
    - What type of monitoring will take place
    - Will caribou be harmed
    - Will marine mammals be harmed by increased barging
    - Will water be contaminated
    - Will air be contaminated
    - Will country food be contaminated
    - Will the tundra be contaminated
    - Will contamination get to Baker Lake
- Infrastructure and Logistics
    - How will materials get to the site
    - How will uranium leave the site
    - Will there be a road and will people be able to use the road
    - Will there be local wildlife monitors on the barges bringing materials

3.6 Future Consultations

Consultation activities for the Kiggavik Project are modified to meet the requirements of each Project phase. Consultations to date have been conducted to support the prefeasibility and feasibility study phases. The next phase for consultation is the environmental assessment phase. While consultation during this phase will be guided by NIRB, AREVA will continue with the ongoing consultation activities that have been developed thus far. These include:

- The Baker Lake Information Office;
- Local Community Liaison Officer(s);
- Ongoing dialogue through Community and Regional Liaison Committees and community update meetings;

- Tours to the Kiggavik site and Saskatchewan minesites;
- Periodic stakeholder analysis and communication planning activities.

KIGGAVIK PROJECT

Project Proposal

SECTION 3

LIST OF FIGURES

Figure 3.1 The AREVA Baker Lake Information Office
Figure 3.2 Aberdeen Lake Visit; July 27, 2006
Figure 3.3 Shultz Lake Visit; August 17, 2007
Figure 3.4 The Baker Lake CLC Inspecting Core at Kiggavik, August 2007
Figure 3.5 Premier and Delegation Examining Core at the Kiggavik site, June 12, 2008
Figure 3.6 Nunavut Group tour at McClean Lake, October 2005
Figure 3.7 KIA Uranium Information Session at Repulse Bay, April 13, 2007

Figure 3.1 The AREVA Baker Lake Information Office

Figure 3.2 Aberdeen Lake Visit; July 27, 2006

Figure 3.3 Shultz Lake Visit; August 17, 2007

Figure 3.4 The Baker Lake CLC Inspecting Core at Kiggavik, August 2007

Figure 3.5 Premier and Delegation Examining Core at the Kiggavik site, June 12, 2008

Figure 3.6 Nunavut Group tour at McClean Lake, October 2005

Figure 3.7 KIA Uranium Information Session at Repulse Bay, April 13, 2007

KIGGAVIK PROJECT

Project Proposal

SECTION 4

TABLE OF CONTENTS

SECTION **PAGE**

4 TRADITIONAL KNOWLEDGE 4-1

4.1 Introduction 4-1

4.2 Methods 4-2

4 TRADITIONAL KNOWLEDGE

4.1 Introduction

Traditional knowledge, or Inuit Qaujimajatuqangit (IQ), includes Inuit knowledge and insights and incorporates values (including consensus building, collaboration and environmental stewardship) that guide Inuit relationships with the land and its resources, as well as social and cultural life. IQ is invaluable to environmental and social impact assessment, because it includes a wealth of information both on biophysical resources over time and on factors that have affected, and will continue to affect, community health and well being.

The integration of IQ into the Kiggavik Project development work, including the environmental assessment work, is therefore a priority of AREVA. The importance of integration of IQ into Project development on the part of communities has been clear during numerous meetings with people, governments at all levels and local organizations. To date, Inuit traditional knowledge has been sought to advance Project decision making (for example, on appropriate locations for the Project access road) and to inform baseline data collection (for example, the Community Liaison Committee has provided advice on the questions to be used for gathering IQ).

The description on the existing socioeconomic environment (Section 6) provides some data on traditional use of the land and waters in Kivalliq, on the part of all seven communities in the region. The data indicate that most Kivalliq adults (about 60%) hunted and fished at the time of the last census, in 2000 (Statistics Canada, 2002a). Although plant gathering and trapping were less practiced, these activities were still important to household economies for many families. Studies of the Nunavut Wildlife Management Board, reported in 2004, indicate that over the period 1996 to 2001, the population of hunters in Kivalliq was stable, such that harvesting continued to be practiced by the same numbers of people. The interests of hunters and trappers at a local level are represented by Hunting and Trapping Organizations (HTOs) in all seven communities.

Early indications from Baker Lake suggest that the immediate area of the Kiggavik Project is not believed to be a frequently used harvesting area, either at present or in the past, although fishing has been important in the larger lakes to the north and south of the Project and caribou migrate nearby. However, the marine transportation route, which follows Chesterfield Inlet through to Baker Lake, traverses and/or bypasses lands and waters used for land and marine hunting. The Project access road, between Baker Lake and the mine site, also has potential to affect land and waters, and their resources.

In order to capture the knowledge and experience of community members about the environment, work planning for the DEIS includes an IQ component. AREVA has obtained a socioeconomic and traditional knowledge research license from the Nunavut Research Institute to research IQ. IQ results, as well as socioeconomic results as may be relevant, are important to obtain early, as these results will be used as input into Project development, including environmental baseline programs, identification of valuable environmental and socioeconomic components, impact assessments, framing of mitigation and benefit enhancement measures and design decisions as the Project advances.

4.2 Methods

The IQ component, as described in this section, focuses on land, water and resource availability, quality and use by people, particularly those in Baker Lake and Chesterfield Inlet, the two Kivalliq communities where there is the most potential for environmental effects on traditional activity. The socioeconomic work, described in Section 6, will also address IQ, as this is related to community well being.

The baseline IQ work related to land, water and resource use, is expected to include the following:

- review of special purpose studies, planning documents, available IQ data (for example from the Kivalliq Inuit Association) and information from Meadowbank and other Nunavut mines;
- meetings with community leadership and organizations to discuss the proposed IQ data collection programs, to obtain input on preferred methodologies and timing, to identify participants (see below) and to address any concerns, for example with regard to confidentiality;
- interviews of elders and HTO members in order to describe historical and current traditional activities on the land and water, including:
  - hunting (land animal, birds and marine life) in the Project areas;
  - migration routes, birthing and nesting areas, mineral licks of large species;
  - trapping;
  - fishing and spawning areas;
  - plant harvesting;
  - camps, caches, cabins, burial, spiritual and archaeological sites;
  - locations/boundaries of traditional activity and sites, as well as seasonal patterns and cultural use of species harvested; and
  - observed recent changes in species health, species distribution, water and weather.

  The IQ interview parameters listed above may be amended, contingent on the content of the terms of reference provided by the Nunavut Impact Review Board, ongoing consultations with communities, documentation and data review and/or any early expectations on potential mitigation and benefits measures;

- presentation and discussion of the results of data collection with communities, to validate the results;
- reporting of results; and
- distribution of results to environmental and socioeconomic disciplines, such that IQ results can inform data collection programs; impact assessments and particularly measures the Project will

put in place to mitigate potential for environmental effects and effects on livelihoods and health;

IQ information will be collected primarily by Inuit investigator(s) – at the time of writing some early work has been initiated in Baker Lake and discussions have begun with the Chesterfield Inlet HTO.

In addition to the above, IQ information is expected to become available to various environmental discipline specialists in the course of their baseline data collection. Most baseline data will be collected with the assistance and participation of Inuit, primarily from Baker Lake and Chesterfield Inlet. Examples include the participation of people from Chesterfield Inlet in identifying areas where marine mammals are likely to congregate for purposes of marine studies and participation of people from Baker Lake in fresh water aquatic studies.

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Statistics Canada, 2002a. *2001 Aboriginal Peoples Survey Community Profiles*, http://www12.statcan.ca/english/profil01aps/home.cfm, accessed May 2008

KIGGAVIK PROJECT

Project Proposal

SECTION 5

TABLE OF CONTENTS

SECTION **PAGE**

5 DESCRIPTION OF THE EXISTING BIOPHYSICAL ENVIRONMENT....................................5-1

5.1 Potential Valued Ecosystem Components 5-1

5.2 Regional Setting 5-2

5.3 Topography...5-2

5.4 Geology 5-2

5.4.1 Regional Geology 5-2

5.4.2 Surface Geology..5-3

5.5 Climate 5-4

5.5.1 Regional Climate 5-4

5.5.2 Local Climate..5-5

5.5.3 Evaporation and Evapotranspiration 5-6

5.6 Air Quality 5-6

5.7 Noise Levels 5-6

5.8 Surface Hydrology 5-6

5.8.1 Regional Data...5-6

5.8.2 Local Drainage Patterns..5-7

5.8.3 Lake Level Monitoring Stations 5-8

5.9 Permafrost and Hydrogeology..5-9

5.9.1 Permafrost..5-9

5.9.2 Groundwater Flow Regime..5-10

5.9.3 Groundwater Quality..5-12

5.10 Freshwater Environment 5-12

5.10.1 Surface Water Quality 5-13

5.10.2 Sediment Quality 5-14

5.10.3 Fish...5-14

5.10.4 Fish Habitat 5-15

5.10.5 Benthic Invertebrate Community 5-15

5.10.6 Phytoplankton..5-16

5.10.7 Zooplankton....5-16

5.11 Marine Environment....5-17

5.11.1 Marine Water....5-17

5.11.1.1 Water and Sediment Quality....5-17

5.11.1.2 Physical Processes....5-17

5.11.2 Marine Aquatic Life....5-18

5.11.2.1 Marine Phytoplankton....5-18

5.11.2.2 Marine Zooplankton....5-18

5.11.2.3 Marine Benthic Invertebrates....5-18

5.11.2.4 Marine Fish....5-19

5.11.3 Marine Wildlife....5-19

5.11.4 Marine Species of Concern....5-23

5.12 Terrestrial Environment....5-23

5.12.1 Soils....5-24

5.12.1.1 Soil Surveys....5-24

5.12.1.2 Soil Chemistry....5-24

5.12.2 Vegetation....5-25

5.12.2.1 Vegetation Chemistry....5-27

5.12.3 Wildlife and Wildlife Habitat....5-28

5.12.3.1 Baseline Study Areas....5-28

5.12.3.2 Barren-ground Caribou....5-29

5.12.3.3 Muskoxen....5-31

5.12.3.4 Grizzly Bears....5-31

5.12.3.5 Wolverine....5-31

5.12.3.6 Other Predators....5-31

5.12.3.7 Small Mammals....5-32

5.12.3.8 Birds....5-32

5.12.3.9 Species of Concern....5-34

LIST OF TABLES

Table 5.1 Extreme Rainfall (mm) Statistics for Baker Lake Climate Station....5-5

Table 5.2 Stream Discharge Measurements in 2007....5-9

Table 5.3 Status of Marine Mammals Present in Hudson Bay and Chesterfield Inlet....5-23

Table 5.4 Area and Proportion of Ecological Landscape Classification Units within the RSA....5-27

Table 5.5 Mammal Species Observed within the Project Area....5-28

Table 5.6 Bird Species Recorded in the Kiggavik RSA....5-33

Table 5.7 Species at Risk Observed or Expected in the Kiggavik RSA....5-34

5 DESCRIPTION OF THE EXISTING BIOPHYSICAL ENVIRONMENT

5.1 Potential Valued Ecosystem Components

AREVA has developed, based on informal community consultation and previous Part 5 reviews in Nunavut, the following list of potential valued ecosystem components (VECs) for the Project:

- Physical Environment:
  - Air quality
  - Noise
  - Surface water, quality and quantity
  - Sediment quality
  - Permafrost
  - Groundwater, quality and quantity
  - Marine environment, water and sediments quality
  - Soils and landforms
- Biological Environment:
  - Fish habitat
  - Lake trout
  - Arctic char
  - Arctic grayling
  - Caribou
  - Grizzly bear
  - Wolverine
  - Muskoxen
  - Raptors
  - Upland breeding birds
  - Vegetation and associated biodiversity
  - Marine mammals

It is anticipated that this list of VECs will be further refined through the regulatory scoping process and through continued public consultation.

The following sections summarize existing baseline information on the biophysical environment. More detailed information on many of the VECs is available in the Kiggavik Project Technical Information Document (TID) (see Section 1.8). For most components, recent baseline data from 2007 and historical baseline data gathered during the 1980s and early 1990s is currently available. It is expected that, through on-going studies during 2008 and 2009, an additional one to two years of baseline data (including associated traditional knowledge), will be incorporated in the Draft Environmental Impact Statement (DEIS).

5.2 Regional Setting

The Kiggavik Project is located in the Southern Arctic ecozone. The location of the Kiggavik site, associated transportation satellite sites, and major regional environmental sanctuaries are shown in Figure 5.1. Major lakes in the region include Baker Lake to the east, Pitz and Princess Mary lakes to the south, Aberdeen Lake to the west, and Schultz Lake to the north.

The Thelon River, which enters Baker Lake just west of the community of Baker Lake, is one of the major watercourses in the Kivalliq Region. The Thelon has been a designated Heritage River since 1990 and is frequently used for recreational and tourism purposes. The Kazan River, which flows into Baker Lake from the south, is also a designated Heritage River.

The Thelon Wildlife Sanctuary, located approximately 100 km west of the Kiggavik site, is the largest wildlife refuge in Canada. The Queen Maud Migratory Bird Sanctuary is approximately 200 km to the north of the site, while the Ukkusiksalik National Park is located approximately 300 km to the north-east. No Project activities are proposed in these areas.

Caribou from at least five herds may occur within the Project areas at various times of the year. The five herds, Beverly, Ahiak, Qamanirjuaq, Wager Bay and Lorillard, are described in more detail in Section 5.12.3.2.

5.3 Topography

The site is located in the “Barrenlands”, well north of the tree line in the continuous permafrost zone. For the most part, the area has a gently rolling topography with a few low escarpments associated mainly with east-west trending faults. In the Kiggavik area ground surface elevations vary from 140 m near Pointer Lake to 265 m at the peak of the hill northeast of the proposed site for the accommodation complex. In the Sissons area, ground surface elevations vary from 166 m near Andrew Lake to 215 m at the peak of the hill northeast of the End Grid area.

5.4 Geology

5.4.1 Regional Geology

The Kiggavik, Andrew Lake and End Grid deposits are located in the Rae Province at the southwest termination of the Archean Woodburn Group, a typical “greenstone belt” or “supracrustal sequence” consisting of a lower (mafic/ultramafic) metavolcanic assemblage and an upper metasedimentary (metagreywacke and quartzite) assemblage (Ashton, 1982).

Supracrustal rocks of the Woodburn Group are in tectonic contact with, and structurally overlie, Archean “basement gneisses” which are predominantly granitic with a minor amphibolitic component.

The Meso-Proterozoic Dubawnt Supergroup (Gall et al., 1992) unconformably overlies the Archean rocks of the Woodburn Group and is subdivided, from bottom to top, into the Baker Lake, Wharton and Barrensland Groups (Figure 5.2).

At Sissons, the Archean rocks have gently-dipping foliations, and show evidence of small-scale recumbent folding and low angle thrusting. Mylonitic textures in both the “basement gneisses” and the Woodburn Group mark the location of these thrusts.

In contrast, syn-mineralization brittle deformation zones are steeply-dipping. The principal structures observed in the vicinity of the Project area trend east-northeast and north-northeast and are interpreted to be a conjugate set. The main faults studied to date are referred to as the Sissons North and Buzzard Lake faults and the Andrew Lake Fault (Figure 5.3).

Structurally controlled uranium mineralization at Kiggavik, Andrew Lake and End Grid is hosted mainly in deformed metavolcanics and/or metagrewackes of the Woodburn Group. The mineralization is hosted, to a lesser extent, in all of the other minor rock types, including iron formation, syenite and lamprophyre dykes, granite, granitic gneiss etc. There is however, no mineralization hosted in the Mackenzie diabase which cuts through Kiggavik.

Previous exploration records suggest that white stone suitable for carving may exist outside of the uranium deposit at Andrew Lake. Further evaluation would be required to determine if the carving stone could be a potential by-product of the mining operation.

5.4.2 Surface Geology

In general, the surficial deposits in the Project area comprise mainly granular glacial till overlying Precambrian intrusive igneous and metamorphic bedrock that are typically quartzite, schist or granite. The glacial till is typically well-graded silty sand with some gravel, cobbles and occasional boulders. Sandstone has also been encountered locally.

A typical soil profile in the Kiggavik area consists of a shallow organic soil layer underlain by glacial tills varying in thickness from less than 1 m on ridges to more than 4 m in depressions. Competent bedrock is typically found at a depth of 4 to 5 m. Post-glacial frost action has shattered much of the bedrock found near surface. Large areas of boulders exist on the ground surface where the finer constituents of the glacial till have been removed by erosion or the boulders have been brought to surface in response to freeze-thaw action in the active layer.

The thickness of the active layer is highly variable and is directly dependent on the type and thickness of the organic cover and the glacial till. In general, the active layer thickness was determined to be in the order of 1 to 2 m except where bedrock is found very close to or outcropping at the ground surface. Where bedrock outcrops, the active layer could be as thick as 5 m or more.

The glacial till overburden soils often display considerable amounts of visible ice in the form of ice lenses. Massive ice bodies with thicknesses of over 1 m were also encountered in some of the boreholes drilled during the site investigations carried out in the 1980s. These till materials are therefore prone to considerable settlement if thawed. Minor disturbance of the ground surface is often sufficient enough to initiate thaw and lead to thermokarst formation or the initiation of flow slides if it occurs on even very gentle slopes. The sensitivity of these materials to disturbance can be clearly seen along the Thelon River where numerous flow slides are visible, even on satellite imagery.

Frost action has also contributed to the shattering of the near surface bedrock, often to considerable depth. Where the fracturing occurs below the depth of the active layer, the fractures are typically ice filled.

5.5 Climate

The Project area has an Arctic continental climate characterized by cold temperatures, low precipitation and high winds. The winters are long and cold and the summers short and warm; these are separated by very short transitional seasons. The closest permanent weather station to the Kiggavik site is located at the Baker Lake airport.

5.5.1 Regional Climate

Data have been collected at the Baker Lake weather station since 1946 and are considered the most representative of conditions at the Kiggavik site based on close proximity and the long period of record. This information was used for previous environmental assessments for the Kiggavik Project (BEAK 1990a, 1990b), and for other nearby mining projects in Nunavut (Cumberland Resources 2003).

Figure 5.4 presents the 1971 to 2000 climate normals for Baker Lake (Environment Canada [EC] 2008). The data can be summarized as follows:

- Monthly average temperatures from -21.3 to 11.4^{o}C
- Degree days below 18^{o}C = 10,860
- Extreme temperature range -50.6^{o}C to 31^{o}C
- Extreme wind chill -71.5^{o}C
- Only 156 mm rain per year and 130 mm of snow for a total yearly precipitation of 270 mm (i.e., arctic desert). Winter snowfall is light but considerable snow drifting occurs often resulting in poor visibility and deep snow packs against obstacles and in depressions
- The average monthly wind speed ranges from 19 to 25 km/h but can reach as much as 177 km/h. Major winter storms and wind are from the northwest
- At winter solstice, there are only 3 ½ hours of daylight. At summer solstice, there are 21 hours of daylight

EC also maintains a record of Adjusted Historical Climate Data, where precipitation and temperature records have been adjusted for a number of northern climate stations (EC 2007). The main adjustment is for snow gauge undercatch which provides for a more accurate representation of snowfall than is provided in the standard climate normals data. In the case of Baker Lake, the adjusted precipitation is 27% greater than reported in climate normals.

Extreme rainfall statistics were estimated for Baker Lake (Hogg and Carr 1985; BEAK 1990a). The intensity-duration-frequency rainfall data determined for Baker Lake are provided in Table 5.1.

Table 5.1 Extreme Rainfall (mm) Statistics for Baker Lake Climate Station

Duration	Return Period (years)					
	2	5	10	20	50	100
24 hours	24.4	33.2	39.1	44.7	51.9	57.4
12 hours	16.1	20.6	23.5	26.3	30.0	32.7
6 hours	11.9	15.0	17.1	19.0	21.6	23.5
1 hour	5.2	6.8	7.8	8.9	10.2	11.1
15 minutes	2.2	3.3	4.0	4.6	5.5	6.2

EC also provides adjusted temperature records for Baker Lake as illustrated in Figure 5.4. The mean daily temperature for Baker Lake is estimated to be -12^{o}C. Over the period of 1971 to 2000, July was typically the warmest month at the Baker Lake climate station and January was the coolest month. The months with adjusted daily temperatures above 0^{o}C were June, July, August and September. The months with adjusted monthly precipitation above 50 mm were July, August, September, and October.

5.5.2 Local Climate

Local meteorological data have been collected near the Kiggavik site as part of a short-term research study in 1982 and 1983 (Roulet and Woo 1986) and another study over a one year period from September 1990 – August 1991 (Senes Consultants Limited [Senes] 1992). Air temperature, wind speed and direction, and humidity were collected at Kiggavik during the study conducted by Senes (1992). These data were subsequently presented and compared to short-term records from Baker Lake. The conclusions of the study included the following points for the period 1990-1991 (Senes 1992):

- average annual wind speeds at Kiggavik were 10% higher than at Baker Lake;

- mean daily temperatures were approximately 1°C lower at Kiggavik than recorded at Baker Lake, although daily maximums were not as high and daily minimums were not as low as those at Baker Lake; and
- average seasonal wind speeds were 14% higher at Baker Lake than Kiggavik for December-February, but 58% higher at Kiggavik than Baker Lake during June-August.

Average annual percent frequency of the most frequent wind directions (N, NNW, NW) was similar at the two sites; however, Kiggavik experiences more winds in the easterly direction, compared with the ESE direction at Baker Lake.

5.5.3 Evaporation and Evapotranspiration

Factors that influence evaporation and evapotranspiration rates include temperature, precipitation, relative humidity, wind speed, and net radiation. Water loss by evapotranspiration has previously been estimated for the Kiggavik Project area using Thornthwaite and Blaney-Criddle methods (BEAK 1989). Evapotranspiration estimates using the pan evaporation method ranged from 150 mm/year at Baker Lake to 232 mm/year at the Meadowbank Project.

5.6 Air Quality

Air quality at the Project site is considered to be pristine as there are no industrial activities or roads in the area. In the absence of major wildlife migrations, the vegetative cover and the coarse nature of the soil on the tundra should produce little dust. There is some natural background radioactivity due to the shallow nature of the Kiggavik deposits. Air quality measurements in the Project areas (including Baker Lake) are on-going in environmental baseline work.

5.7 Noise Levels

The natural noise level in the Kiggavik area is very low as there are no industrial operations or communities within audible distance. Other than the occasional aircraft, only natural sources, such as wildlife, precipitation and wind contribute to the noise at site.

Noise at Baker Lake is generally dependent upon proximity to the community, which has a dock, laydown area, traffic and an airport.

5.8 Surface Hydrology

5.8.1 Regional Data

The Kiggavik and Sissons deposits are located within the Anigaq River watershed, which drains into the western end of Baker Lake. Baker Lake is a freshwater lake, approximately 80 km long and 25 km wide and is fed by several rivers, the largest being the Thelon River and the Kazan River, both of which drain large areas of Nunavut freshwater into the lake (Stewart and Lockhart 2004). Baker Lake drains into Chesterfield Inlet, which subsequently drains to Hudson Bay. Watersheds that are adjacent to that of the Anigaq River system include the Thelon River and Qinguq Creek (Figure 5.5).

The Water Survey of Canada (WSC) has operated a number of hydrometric monitoring stations within the region. There are six streamflow stations within 100 km of the Project area. Of these stations, only two were operated between 1994 and 2008: the Dubawnt River at the Outlet of Marjorie Lake (06KC003), and the Thelon River below the Outlet of Schultz Lake (06MA006). During the 2008 field season, two additional stations were re-activated: at Qinguq Creek and the Anigaq River.

Unit area runoff was estimated for three WSC stations near the Project over the period of record (Golder 2007). Despite a wide range of drainage areas, mean annual unit-area runoff ranged from 0.0061 $m^3/s/km^2$ to 0.0063 $m^3/s/km^2$ for the Thelon River, the Anigaq River, and Qinguq Creek, which are closest to the Kiggavik site. Mean unit-area runoff was estimated to be 0.0058 $m^3/s/km^2$ for the six WSC stations within 100 km of the Project.

Flood magnitude and frequency estimates were calculated for Qinguq Creek based on the WSC daily dataset (EC 2006). These results are provided in Appendix V. The Qinguq Creek data were used due to the proximity of the station to the Project, the size of drainage basin, and the period of record. The one in two year flood for Qinguq Creek was estimated to be 48.3 m^3/s, while the one in ten year flood was 82.3 m^3/s.

The Log-Pearson III distribution was fit to the maximum annual discharge values over a total of 23 years (i.e., 1970 to 1978, 1981 to 1994). It is noted that all of the annual peak discharge events occurred between the dates of May 28 and June 30 over the period of record.

A flow duration analysis was also conducted for Qinguq Creek. Qinguq Creek ceases to flow during the winter season as the water freezes to the bottom of the stream bed. The flow duration analysis presented in Appendix V includes the analysis of 8,572 recorded and infilled[1] daily data over the period 1969-1994, and also includes the zero flow conditions over the winter periods. The frequency of exceedance describes the percentage of time that a flow may be exceeded on a daily basis. The data indicates that a zero flow condition is expected to be exceeded 40% of the time (and conversely, zero flow conditions may be expected for 60% of the year).

5.8.2 Local Drainage Patterns

There are four local watersheds surrounding the Kiggavik and Sissons deposits, these are the Boulder Lake system, the Lower Lake system, the Caribou Lake system, and the Willow Lake system. The Kiggavik deposits occur within the Willow Lake system, while the Sissons deposits occur within the Lower Lake system. All four systems flow into Judge Sissons Lake (Figure 5.5). Judge Sissons Lake

[1] Missing data over the assumed period of ice coverage (October through May) were assigned zero discharge values.

is drained by the Anigaq River, which flows eastwardly into Baker Lake. Skinny and Kavisilik Lakes, to the northeast of the Kiggavik site, drain to the Anigaq River via Audra Lake. Whilst all of the streams in the immediate vicinity of the Project site eventually drain into the Anigaq River system, one stream that was monitored in the 2007 field season (Outflow of Squiggly Lake) drains into the Thelon River, whose watershed lies adjacent to that within which the Project is found.

A series of hydrology field programs have been completed for the Kiggavik Project over the past decades, including studies in 1988, 1989, 1991, 2007 and 2008 (data not yet available). In general, watersheds in the Kiggavik area are highly responsive during the snowmelt period with high volumes of water transported in a relatively short period of time.

During the field hydrology investigations in 2007, a total of twelve stream discharge monitoring stations and seven lake elevation monitoring stations were installed near the Project (Figure 5.5). Stream discharge and water level measurements recorded over the 2007 field season are presented in Table 5.2. Monthly discharge measurements were estimated based upon data that was collected using instantaneous stage recorders that were installed for the open water period. Initial stage discharge curves were created for the streamflow stations, and these data are to be augmented with the measurements taken in 2008 and 2009.

5.8.3 Lake Level Monitoring Stations

Currently there are no regional stations that collect lake elevation data within 100 km of the Project site. The closest WSC lake level monitoring station that is currently operational is located at Ennadai Lake, which is approximately 400 km southwest of the Kiggavik site.

Lake elevation data were not collected during the 1988, 1989, or 1991 field programs at the Kiggavik site. However, in a study by Roulet and Woo (1988), lake elevation data near the Kiggavik site was collected on one small lake during part of the open water period in 1983. This study basin was approximately 1.36 km^2 in size and located between Squiggly and Sleek Lakes.

The following seven lakes were monitored in 2007 and 2008 at the same frequency as stream discharge was monitored: Pointer Lake, Unknown Lake upstream of Fox Lake, Judge Sissons Lake, Squiggly Lake, Skinny Lake, Kavisilik Lake, and Siamese Lake (Figure 5.5). Lake elevations are measured relative to local benchmarks in the uplands adjacent to the lakes. Lake levels were highest in spring and lowest in mid-summer or fall.

Table 5.2 Stream Discharge Measurements in 2007

Station	Description	Instantaneous Measurements		Calculated Monthly Measurements	
		Discharge (m^3/s)	Date	Discharge (m^3/s)	Month
SF1	Outlfow of Skinny Lake	0.024	3-Aug-07	n/a	
		0.524	19-Sep-07	n/a	
SF2	Fox Lake Inflow	0.704	14-Jun-07	0.992	Jun
				0.065	Jul
		0.004	2-Aug-07	0.089	Aug
		0.046	18-Sep-07	0.073	Sep
SF3	Northeast Inflow of Pointer Lake	0.054	15-Jun-07	n/a	
SF4	Outflow of Siksik Lake	0.362	16-Jun-07	n/a	
		n/a	31-Jul-07	n/a	
		n/a	18-Sep-07	n/a	
SF5	Outflow of Pointer Lake	0.058	31-Jul-07	n/a	
		0.24	18-Sep-07	n/a	
SF6	Outflow of Shack Lake	2.946	16-Jun-07	3.5	Jun
				0.355	Jul
		0.023	3-Aug-07	0.138	Aug
		0.234	18-Sep-07	0.32	Sep
SF7	Anigaq River	6.857	14-Jun-07	12.3	Jun
		5.639	31-Jul-07	6.70	Jul
				2.89	Aug
		2.766	17-Sep-07	2.00	Sep
SF8	Outflow of Siamese Lake	0.889	2-Aug-07	n/a	
		0.413	19-Sep-07	n/a	
SF9	Outflow of Squiggly Lake	3.003	18-Jun-07	3.211	Jun
				0.486	Jul
		0.24	1-Aug-07	0.489	Aug
		0.436	19-Sep-07	0.386	Sep
SF10	Tributary to the Northeast Inflow	0.054	15-Jun-07	n/a	
	of Pointer Lake	0	1-Aug-07	n/a	
		0.003	18-Sep-07	n/a	
SF11	Northwest Inflow of Pointer Lake	1.442	15-Jun-07	n/a	
		0.012	18-Sep-07	n/a	
SF12	Outflow of Jaeger Lake	0.065	20-Sep-07	n/a	

5.9 Permafrost and Hydrogeology

5.9.1 Permafrost

The immediate Project area, the community of Baker Lake, and the proposed access road routes are located within the continuous permafrost zone of Canada (NRC 2007). In the Kiggavik and Sissons areas, permafrost is reflected in well developed patterned ground at most sites (Geomatics International 1991). Patterning is primarily sorted circles, sorted stripes, sorted nets, sorted steps and sorted polygons depending on slope and materials. Sorted circles, nets and steps occur on the glacial till material where there is sufficient fine material. Sorted polygons are confined to glaciofluvial deposits likely due to the high proportion of stone and cobble sized material (Geomatics International 1991). No ice wedges were identified during historical surveys. Evidence of active cryoturbation was found in several locations, where platy stones were thrust upward through the moss-heath tundra.

Deep thermistor strings were installed at Kiggavik in 1989 and Sissons in 1990 and 1991. Deep and shallow thermistor strings were also installed in new boreholes as part of the 2007 field program. The ground temperatures measured at Sissons indicate that the bottom of the permafrost is about 250 m to 275 m below the ground surface. The permafrost appears to be about 50 m shallower at Kiggavik.

The work in progress and more detailed information on the thermal conditions at the Kiggavik and Sissons sites are available in Supporting Document No. 2 (Section 1.8).

5.9.2 Groundwater Flow Regime

Within permafrost conditions, the frozen ground is generally considered to be virtually impermeable to groundwater flow. As a result, in areas of continuous permafrost, groundwater flow occurs beneath the permafrost (i.e., deep groundwater regime) and in the shallow active layer above the permafrost.

Shallow Groundwater Flow Regime

Some ephemeral and limited flow is expected within the shallow active layer above the permafrost from approximately June to September.

Geotechnical investigations were carried out at various potential development sites during the 1980s (i.e., plant site, accommodation complex, Pointer Lake airstrip, mine haul road, etc). These investigations included shallow boreholes and test pits. In general, the maximum observed thaw depths were in the 1 to 2 m range. On flat-lying surface not exposed to flowing water active layer depths in glacial till were noted to be on the order of 1 m. Under similar conditions on flat areas of well-graded sand and gravel, an active layer of 1.5 m was suggested. The depth of the active zone was also noted to increase adjacent to water bodies or in areas where the shattered bedrock occurs at shallow depths. Hydraulic conductivity values ranging from 10^{-6} m/s to 10^{-7} m/s were reported for the local glacial till, suggesting limited ground flow within the shallow active layer.

Deep Groundwater Flow Regime

The deep groundwater flow in the Project areas takes place in fractured basement rock. The host rock lithology is expected to exhibit a very low primary (matrix supported) hydraulic conductivity, with the main flow related to secondary conductivity such as faults, fractures and jointing. Cross cutting dykes are also expected to be a potential enhanced flow path due to the brittle nature of the material and some fracturing at the interface between the dyke and the host rock.

There are currently no-site specific hydraulic conductivity data for deep bedrock at either the Kiggavik or Sissons sites. Based on field data published for similar hydrogeological conditions, the bulk hydraulic conductivity of the rock mass is expected to be lower than 5×10^{-7} m/s near surface and is expected to decrease with depth. Locally a hydraulic conductivity as high 1×10^{-5} m/s is expected for the fault zones and the highly fractured rock mass. Hydraulic (packer) testing will be carried out at the Kiggavik and Sissons sites below the permafrost during the 2008 drilling program to confirm these assumptions.

In areas of continuous permafrost, the deep groundwater regime is connected by taliks (unfrozen ground) located beneath large lakes. If a lake is large enough, the talik extends down to the deep groundwater regime (“open talik”).

Talik development is partly dependent upon maintaining an unfrozen lake bottom through the winter months. Most lakes in the vicinity of the Kiggavik and Sissons sites are relatively shallow and many freeze to the bottom in winter. Assuming that a 2 m thick ice coverage is developed during winter conditions, it is estimated that approximately 15 lakes in the vicinity of the Kiggavik and Sissons sites are sufficiently deep to remain permanently unfrozen. Thermal conditions below these relatively deep, permanently unfrozen lakes could potentially support “open” talik formation. Among these lakes is Mushroom Lake, Judge Sissons Lake, Ridge Lake, Skinny Lake, Squiggly Lake and potentially Pointer Lake.

The presence of the thick and low permeability permafrost beneath land located between large lakes results in negligible recharge to the deep groundwater flow from these areas. Smaller lakes generally have taliks that do not extend down to the deep groundwater regime and do not influence the groundwater flow in the deep regime. Consequently, recharge to the deep groundwater flow regime is predominantly limited to areas of “open” talik beneath large surface water bodies. Generally the driving force for groundwater beneath the permafrost is the elevation of lakes with “open” taliks. Groundwater flows from higher elevation lakes to lakes located at lower elevations. To a lesser degree, groundwater flow beneath the permafrost is influenced by density differences due to the upward diffusion of deep seated brines (density driven flow).

The deep groundwater flow direction in the Kiggavik area, as interpreted using surface elevations of assumed “open” talik lakes, is south toward Judge Sissons Lake with a calculated gradient on the order of 0.007 m/m. In the Sissons area, the deep groundwater flow direction in the vicinity of the proposed Andrew Lake Pit and End Grid underground mines is southeast also toward Judge Sissons Lake with a calculated gradient of less than 0.005 m/m.

As an example, Figure 5.6 presents a north-south cross-section, through the Kiggavik area, illustrating the expected groundwater and permafrost conditions from Ridge Lake to Judge Sissons Lake

The presence of the permafrost layer produces a confined flow system across the region. This in turn can produce flowing artesian groundwater pressures in the deep aquifer that could produce discharge from any underground or open pit mines that pierce the permafrost layer.

5.9.3 Groundwater Quality

In the Canadian Shield, it has been observed that concentrations of total dissolved solids (TDS) and chloride in groundwater increase with depth, primarily in response to upward diffusion of deep-seated brines. There are currently no site-specific data for either TDS or chloride concentrations in deep groundwater at the Kiggavik Project.

Shallow groundwater samples were collected during the 1980s from seeps in the active zone, in the Kiggavik Main Zone area and at a reference site. In parallel “frozen water” samples were collected from the upper part of the permafrost during shallow geotechnical investigations. These frozen samples were thawed, filtered and analyzed. In general these shallow groundwater samples were found to contain higher concentrations of major ions than surface water samples. Samples collected in the vicinity of Main Zone were characterized by above background concentrations of metals and uranium.

Samples of drill return water were collected during the 1990s from holes drilled at Andrew Lake and End Grid. Some of these samples are considered to have been diluted by drilling water and therefore are not considered representative of deep groundwater. Samples that are considered to be reasonably representative were collected from mineralized holes and are characterized by relatively elevated uranium concentrations (i.e. up to 2.4 mg/L).

Results from the 2008 and 2009 hydrogeochemical sampling campaigns will be included in the DEIS.

5.10 Freshwater Environment

A number of environmental studies have been conducted on the freshwater (aquatics) environment in the Project area since 1975. The following sections summarize the aquatic baseline information collected up to and including 2007. The aquatics disciplines include:

- water quality;
- sediment chemistry;
- fish;
- fish habitat;
- benthic invertebrate communities;
- phytoplankton; and
- zooplankton.

The particular studies conducted for each waterbody of interest are listed in Appendix V. In addition, Supporting Document No. 1 (Section 1.8) details the aquatic baseline information collected up to and including 2007.

Aquatic baseline studies are on-going in the immediate Project area, along the access road routes (including the Thelon River), the transportation transfer site(s) and Baker Lake. This data will be incorporated into the DEIS.

5.10.1 Surface Water Quality

Field water quality studies have been performed to document existing baseline concentrations of trace metals, radionuclides, nutrients and major ions in watersheds in the immediate Project area and in Baker Lake. The lakes sampled from 1979 to 2007 are shown in Appendix V. Sampling methods included surface grab samples, samples from below the surface of each water body, and ice samples. Information was also collected on limnology parameters.

The results of the various surveys show that surface waters in the Project area remain ice-covered for most of the year, with ice thawing in June (smaller lakes) and July (larger lakes). Ice begins forming again by September. Judge Sissons lake is much larger than the other lakes surveyed in the area, and is typically slower to warm and lose its ice cover. The water temperature data indicates that the lakes are typically cold, monomictic lakes during the ice-free season. Monomictic lakes are not thermally stratified and vertical mixing occurs, which is supported by relatively uniform temperature, dissolved oxygen, pH and conductivity measurements. Temperatures within the lakes show little variation with depth during the summer ice-free period.

Results of the chemical analysis show that generally, the Project area waters are relatively low in both conductivity and concentrations of most dissolved substances. Low nutrient (phosphorous) concentrations suggest that local lakes are relatively unproductive (i.e., oligotrophic or ultra oligotrophic) (BEAK 1990b).

Additional surveys on Baker Lake have been conducted during 2008; the results will be included in the DEIS. Surveys included physical structure of the water column (Secchi depth, surface temperature, salinity, dissolved oxygen) and water quality (conductivity, temperature and depth (CTD), total dissolved solids, major dissolved anions and cations, major nutrients, pH, total suspended solids and turbidity, total metals, radionuclides).

Information pertaining to water movement within, into and out of Chesterfield Inlet will be collected by literature searches of appropriate databases and input from Baker Lake residents. Preliminary review suggests that Baker Lake acts primarily as a freshwater lake and hence is lacustrine in nature; though the extent to which saltwater influences Baker Lake is presently not well understood.

5.10.2 Sediment Quality

Between 1979 and 2007, lake sediment field studies were carried out and broadly covered lakes in the Project area (Appendix V). The objectives were to collect baseline information on sediment particle size characteristics, sediment chemistry, and sedimentation rates.

Sediment surveys were conducted on Baker Lake during 2008; these investigations included measurements of sediment size characteristics, total nitrogen, hydrocarbon concentrations, total metals, and radionuclides.

All sediment quality data will be included in the DEIS and compared to the Canadian Council of Ministers of the Environment (CCME) Interim Sediment Quality Guidelines (ISQG), benchmarks published by the Canadian Nuclear Safety Commission, Probable Effect Levels (PEL), and Lowest Effect Levels (LEL).

5.10.3 Fish

All of the sub-basins within the immediate Project area have been surveyed for fish communities, with a variety of investigations conducted over the past 30 years. The sampling methods, intensity and areas sampled have differed between surveys. The methods used to capture fish have included gill nets, dip nets, angling, minnow traps, angling, beach seines, and electrofishing. The fish species distribution in the Project area and Baker Lake from 1975 to 2007 is included in Appendix V.

Eight fish species, representing six different families, have been captured, including: Arctic char, lake trout, lake cisco, round whitefish, ninespine stickleback, burbot, slimy sculpin, and Arctic grayling. Three additional species of fish have been captured in Baker Lake, including: longnose sucker, lake whitefish, and fourhorn sculpin.

Fish communities in Project area lakes are dominated by lake trout and Arctic grayling, with round whitefish, cisco, burbot, ninespine stickleback and sculpin also present in some waterbodies. Within the study area, shallow lakes that freeze to the bottom appear not to support overwintering fish populations. Deeper lakes, with tributaries that do not offer fish passage, tend to have limited fish communities due to their isolation. Shallow lakes with larger inlet and outlet streams, have periodic winterkills but are readily repopulated from elsewhere in the watershed. Judge Sissons Lake has a full complement of all the species found within the local sub-basins. Arctic char were not found to inhabit the upper Aniguq watershed, suggesting there may be a barrier to upstream movements closer to Baker Lake.

Baker Lake has the largest number of fish species of the lakes studied. Species of fish that are likely to be predominant in Baker Lake are lake trout and whitefish; these constitute a large portion of the diet of the local community. In addition, fourhorn sculpin, longnose sucker and arctic char were caught in Baker Lake. Further sampling and consultations with local harvesters will be completed to ensure that knowledge of the type of fish and the type of fish habitat in Baker Lake is well documented within the baseline assessment.

5.10.4 Fish Habitat

Important features in evaluating aquatic habitat within a study area relate to the diversity of habitat available. This includes the availability and quality of refuge and cover habitat, over wintering habitat, deep water habitat, spawning habitat, rearing habitat, and foraging habitat. Appendix V presents the physical characteristics of the lakes studied to date.

Bathymetry surveys for several lakes were completed during the 1979, 1980, and 1986 field programs. During the 1990 and 1991 field survey, fish habitats were mapped using sonar in several lakes. Information was collected on mean depth (m), surface area (ha) and volume (m^3). Information was also collected on pH, conductivity, total dissolved solids and alkalinity. The results of the bathymetry surveys showed that lakes in the upland headwaters of Judge Sissons Lake drainage are typically small and relatively deep (BEAK 1987).

In 2007, a fish habitat assessment was conducted to document and map the types and distribution of fish habitat within the study area. Characteristics, such as shoreline substrate type, presence/absence of aquatic vegetation, shoreline slope, bank stability, channel units, and water depth at sampling locations were recorded. Habitat maps were prepared for the lakes sampled in 2007; these are included in Supporting Document No.1.

5.10.5 Benthic Invertebrate Community

Benthic invertebrates are generally sampled because they are responsive to changes within their environment due to their close contact with bottom sediments, and because they feed on algae, bacteria, and detritus. Benthos are considered significant due to their ability, to a certain degree, to bioaccumulate stable and radioactive trace elements that could be associated with a mining operation. They are also less motile than fish and can therefore provide a better indicator of local environmental conditions. The reliance of fish on benthos as a food resource base renders these aquatic organisms significant to the aquatic ecosystem as a whole and to the local communities that rely on them.

Benthic invertebrate community (BIC) samples were collected between 1979 and 1991 in the Project area. More recently, several lakes in the Kiggavik area were sampled during 2007 and 2008, to obtain information on natural variability and benthic invertebrate community composition (Golder 2008a). The results of the 2007 sampling are summarized in Appendix V. All current and historical data is available in Supporting Document No.1.

Sampling of Baker Lake benthic invertebrates occurred during the summer 2008 program with focus on community density and taxonomic composition. The results of this program will be included in the DEIS.

5.10.6 Phytoplankton

Phytoplankton constitute a large portion of the base of the aquatic food web, being consumed by zooplankton and benthic invertebrates which are in turn consumed by fish. Phytoplankton biomass and taxonomic composition can be affected by environmental changes and have been widely used to examine effects of nutrient loading and metal pollution on lake ecosystems.

Field studies were carried out in August of 1979 and August 1989 to document the existing baseline conditions and evaluate the effectiveness of monitoring plankton communities as a measure of environmental change. Phytoplankton communities in the Kiggavik study area lakes showed characteristics typical of unproductive Canadian Shield lakes (BEAK 1990b). Total phytoplankton biomasses were low; and generally ranged between 100 mg/cm^3 and 300 mg/cm^3.

Aquatic environmental studies were commenced in the Andrew Lake area in August 1990 to collect additional baseline data (BEAK 1990b). All samples collected in August of 1990 were very rich in species and contained species typical of shallow tundra pond habitats (BEAK 1992). A large range of biomass (65 mg/m^3 to 783 mg/m^3) indicated high inter-lake variability.

Baseline studies were continued in 1991 and included a winter phytoplankton sampling survey, which was conducted in early March 1991. This survey was timed in order to document the conditions of the under-ice environment.

More recently, phytoplankton baseline sampling was conducted during the summer of 2008; the results of this program will be included in the DEIS.

5.10.7 Zooplankton

Zooplankton is the heterotrophic component of aquatic plankton and is an important link in the aquatic food web. As consumers of phytoplankton and prey to many fish species they often provide a good indication of the natural state of an ecosystem.

Field studies were carried out in 1979, 1989, 1990, and 1991 to determine baseline conditions and evaluate the effectiveness of monitoring the zooplankton communities to measure environmental change at the Project site (BEAK 1990b).

Most of the species encountered during the sampling events were reported to occur at similar low densities in the Saqvaqjuac lakes (BEAK 1990b). Relative to other Canadian Shield lakes, the densities of crustacean zooplankton were low, reflecting relatively low biological productivity of Project area lakes. Zooplankton communities sampled in the area in 1979 and 1989 were found to be extremely variable in terms of species composition and numbers of organisms. BEAK (1990b) concluded that zooplankton would likely offer little potential for operational monitoring with the exception of identifying gross changes to the local environment.

Zooplankton sampling, with focus on taxonomic composition and abundance, has been performed during the summer of 2008. The results of this program will be included in the DEIS.

5.11 Marine Environment

The Project will be transporting supplies to Baker Lake via the marine shipping routes from Churchill through Chesterfield Inlet. Therefore, baseline information on this marine environment, including water and sediment quality, marine organisms and fish, and marine mammals and birds, has been collected. These studies will continue in 2009.

5.11.1 Marine Water

5.11.1.1 Water and Sediment Quality

Baseline marine water column structure characteristic samplings were carried out near the community of Chesterfield Inlet during 2007 (Nunami 2008). Most water quality sampling was completed during the ebb tides.

Water temperature ranged from 6.2 to 8.0°C. Conductivity and salinity values ranged between 5.00 and 5.23 S/m and 31.4 and 33.1‰, respectively. Shorelines around Chesterfield Inlet were typically composed of flat bedrock which transitions to subtidal cobble, gravel and sand. Intertidal habitat consists of a sand/mudflat with a gently sloping grade, dominated by moderately dense rockweed cover (Nunami 2008).

5.11.1.2 Physical Processes

Baker Lake drains to the east through the Chesterfield Narrows, which empties into Chesterfield Inlet. Chesterfield Inlet is a salt-water tidal corridor, 200 km long, joining Hudson Bay with Baker Lake. Canadian Hydrographic Service bathymetric charts are available for the Chesterfield Inlet area (station 5140). Chesterfield inlet experiences large semi-diurnal tides with maximum tidal heights during 2007 reaching approximately 4.0 m and the minimums reaching approximately 1.0 m (Government of Canada).

Northern coastal areas and estuaries in the vicinity of Chesterfield Inlet are characterized by clear waters and very deep photic zones that permit extensive growth of attached algae (M. Bergman pers. comm. cited in (Schneider-Vieira et al. 1993).

5.11.2 Marine Aquatic Life

5.11.2.1 Marine Phytoplankton

Primary productivity, a measure of phytoplankton abundance, in the Arctic Ocean is limited by the long ice-covered season which reduces or eliminates light availability for photosynthesis. Phytoplanktons constitute a large portion of the base of the marine aquatic food web. They are consumed by zooplankton and benthic invertebrates which are in turn consumed by fish. Phytoplankton biomass and taxonomic composition can be affected by environmental changes and have been widely used to examine effects of nutrient loading and metal pollution on ecosystems.

A few studies have focused on phytoplankton biomass in Chesterfield Inlet and lend information to the baseline conditions of the phytoplankton community of the marine environment (Welch et al. 1991; Anderson 1979; Anderson et al. 1981).

To supplement the phytoplankton baseline information from the literature review, marine phytoplankton sampling was conducted during the summer of 2008 and will be repeated in 2009.

5.11.2.2 Marine Zooplankton

As in freshwater systems, marine zooplanktons are consumers of phytoplankton and are an important part of the marine ecosystem. Zooplankton abundance and taxanomic assemblage provides a good indication of the natural state of an ecosystem.

Few studies provide information on the taxonomic composition of zooplankton in Chesterfield Inlet. Siferd et al. (1997) investigated the seasonal distribution of sympagic amphipods near Chesterfield Inlet and discovered that the most common species of amphipods were *Ischyrocerus anguipes, Pontogeneia inermis, Apherusa megalops* and *Weyprechtia pinguis.*

To supplement the zooplankton baseline information from the literature review, sampling was conducted during the summer of 2008 and will be repeated in 2009.

5.11.2.3 Marine Benthic Invertebrates

A small amount of information was collected during a 2007 study for the classification of fish and fish habitat in Chesterfield Inlet. Invertebrates, including clams, mussels, snails and gastropods, were found to be relatively sparse throughout the area with the exception of the sandflats to the east of Chesterfield Inlet (Nunami 2008). Further sampling was carried out during the summer of 2008.

5.11.2.4 Marine Fish

Several fish species of Chesterfield Inlet play important roles in the ecological, economic and cultural health of the local communities.

Shorelines around Chesterfield Inlet are typically composed of flat bedrock which transitions to subtidal cobble, gravel and sand. Intertidal habitat consists of a sand/mudflat with a gently sloping grade dominated by moderately dense rockweed cover. The mid to low intertidal zones have low diversities of red seaweeds.

Arctic cod, arctic sculpin, arctic char, fourhorn sculpin and banded gunnel use sand and boulder benthic habitats around the mouth of Chesterfield Inlet.

Other fish species caught in Chesterfield Inlet area included lake trout in freshwater during the winter season. Arctic char may also be found within Chesterfield Inlet as they typically migrate into the Inlet area in the first few weeks of July when the ice has cleared (Nunami 2008).

Data in Appendix V details the species of fish that likely inhabit Chesterfield Inlet and their habitat types.

5.11.3 Marine Wildlife

Marine wildlife that may occur near Chesterfield Inlet includes seals, walruses, belugas, bowheads, killer whales, polar bears, and birds. The key species and their status are summarized in Section 5.11.4.

Further information on marine mammals that may be encountered along the shipping route will be collected during 2008 and 2009 between Chesterfield Inlet and Baker Lake using aerial surveys. Surveys will include Chesterfield Inlet and a portion of the west coast of Hudson Bay. Traditional knowledge will form an important component of the baseline information on marine wildlife.

Seals

Harbour, ringed and bearded seals are inhabitants of Hudson Bay (Lunn et al. 1997). Harbour and bearded seals inhabit the areas within Chesterfield Inlet (Canadian Circumpolar Institute 1992).

The harbour seal is a species that prefers open water. It has been noted to have a strong preference for fresh water and is often found in estuaries, rivers and lakes. On occasion it can be found far away from the ocean environment around these preferred habitats (Mansfield 1967).

There are thought to be approximately one million ringed seals in the eastern Arctic. Ringed seals are found throughout Nunavut year-round; however, during the winter non-breeders will migrate to flow edges and will move to areas where food is available and mature adults will stay in preferred habitats under nearshore stable ice (Government of the Northwest Territories 2000, Internet site).

There are no population estimates for the bearded seal in Nunavut. Results from the Arctic Marine Proceedings held in 1994 suggest that bearded seals are likely to be present throughout the shipping route in Hudson Bay to Churchill as well as in Chesterfield Inlet. Bearded seals are permanent residents in Nunavut and the Arctic (Freshwater Institute 1994). They are more commonly observed as solitary individuals and are found along almost all coastal areas of Nunavut (Government of the Northwest Territories 2000, Internet site).

Bearded seals are important subsistence for the Inuit of Nunavut. They are used for their tough, flexible hide, which is used for lines, traces, kayak coverings and boot soles (Government of the Northwest Territories 2000, Internet site).

Walruses (Hudson Bay – Davis Strait stock)

Walruses in this area are designated as a species of special concern (COSEWIC 2006).

Habitat needs of walruses include large areas of shallow, open water (80 m or less), which support an abundant clam community. They require haul-out on land in Hudson Bay during the summer season where they congregate on low, rocky shores with steep subtidal zones.

Walruses inhabit the coastal areas in Hudson Bay and most likely they will be found hauled-out along the shores. There are no reports on the presence of walruses within Chesterfield Inlet. Further information on potential walrus habitat in the Chesterfield Inlet area will be collected during the 2008 and 2009 marine mammal surveys.

Beluga Whale (Western Hudson Bay Population)

This beluga whale population is designated as a species of special concern and population estimates are 50,000 (approximate) (COSEWIC 2004b).

The western Hudson Bay belugas concentrate in the summer around the Churchill River estuary. They arrive in mid-June and build in numbers until late July. They then migrate northward along the west coast of Hudson Bay during late July and August (Sergeant 1973 in (COSEWIC 2004b). By early September the population moves east (Martin et al. 2001 in COSEWIC 2004) out of the Project area. Inuit knowledge suggests that there are a certain number of belugas, possibly another population, that are year-round inhabitants of the southern and northwestern Hudson Bay (Jonkel 1969; McDonald et al. 2002 in COSEWIC 2004). A member of the Baker Lake Hunters and Trappers Association noted that 5 belugas had once migrated up through Chesterfield Inlet into Baker Lake (Hunters and Trappers

Association of Nunavut 1992). More information on the possible presence of beluga whales in Chesterfield Inlet will be collected through Inuit consultations and marine mammal surveys in 2008/2009.

Narwhal (Hudson Bay population)

There are approximately 2,100 mature individuals of narwhals in this population and they are designated as a species of special concern (COSEWIC 2004a).

Narwhals inhabit Hudson Bay during the summer months. From June to September they prefer coastal areas that offer deep water and shelter from the wind (Finley 1976, Kingsley et al. 1994, Richard et al. 1994 in COSEWIC 2004). They tend to congregate along the waters to the east coast of Southampton Island (Richard 1991). In the Hudson Bay they are rarely seen west of Southampton Island or along the west coast of Hudson Bay unless they are avoiding predation by killer whales (W. Angalik pers comm. in Stewart et al. 1991 in COSEWIC 2004). Mating reaches its peak in mid-April, and most calves are produced in July and August.

One narwhal was caught by a hunter between 1997 and 1998 in Whale Cove (DFO 1998) and three carcasses have been found along the Ontario coast of Hudson Bay (Johnston 1961 in COSEWIC 2004). Hunting for narwhal skin and their commercially valuable tusk ivory occurs throughout Nunavut. The annual fishing quota for Chesterfield Inlet is 5 narwhals (DFO 1998).

It is not clear how far narwhals travel into Chesterfield Inlet. Surveys are planned in 2008/2009 to explore this further.

Bowhead Whale (Hudson Bay-Foxe Basin population)

This bowhead whale population is designated as a threatened species (COSEWIC 2005).

Bowhead whales inhabit Hudson Bay during the summer months. They enter the bay during spring migration in April and some scattered individuals have been observed along the west coast (Reeves and Mitchell 1990). In September and October, whales migrate east of out of Hudson Bay into Hudson Strait. Presently, the greatest threat to their population is increased predation by killer whales due to reduced ice coverage in northern waters; this may also affect their distribution in Hudson Bay in the future (Cosens and Blouw 2003, Wheatly pers comm. 2004 in COSEWIC 2005). The sustainable removal rate from the Hudson Bay-Foxe Basin population has been estimated at one whale per two or three years (DFO 1999).

Most research on bowhead reactions to man-made noise has shown that whales react to man-made sources of underwater noise by avoiding the source area. Reactions appear to vary by season, habitat and behavioural state (Richardson et al. 1995; Richardson and Malme 1995).

It is not currently clear how far into Chesterfield Inlet bowhead whales travel. Surveys in 2008/2009 will explore this further.

Killer Whale

The presence of killer whales in Hudson Bay has been increasing since the mid-1900s before which they were not reported in the area (Reeves and Mitchell 1988). There have been reports of killer whales within Chesterfield Inlet and down the Western Hudson Bay coast (Higdon 2007).

There is very little information on killer whale in this region.

Polar Bear (Western Hudson Bay (WH) population and the Foxe Basin (FB) population)

Both populations are designated as species of special concern (2008) (COSEWIC).

Population estimates are 1200 (WH in 1995 from Lunn et al 1997 in COSEWIC 2002) and 2300 (FB in 1996 from Taylor, unpub data in (COSEWIC 2002), however there is significant debate on the status and abundance of polar bear populations in this area.

Polar bears are harvested in Chesterfield Inlet and throughout Western Hudson Bay by Inuit; they play a large role in the economic, ecological and cultural aspects of those communities. Harvest of the Western Hudson Bay population is thought to be sustainable (COSEWIC 2002).

The range of the Foxe Basin and Western Hudson Bay populations of polar bears appears to overlap with the proposed shipping route through Chesterfield Inlet and Hudson Bay. The populations concentrate on Southampton Island and along the Wager Bay coast during the ice-free season when shipping activities are expected. During the open water season polar bears spend approximately 4 months on shore surviving on stored fat and whatever limited food they can find on land. Their concentration along the Wager Bay coast suggests that they may be present along the coast of Hudson Bay and Chesterfield Inlet during the ice-free season (Taylor and Lee 1995; Taylor, unpub data in COSEWIC 2002).

It is important to note that the future distribution of polar bears throughout Hudson Bay may experience significant change due to alterations in sea-ice cover in relation to climate change. Decreases in sea-ice cover, earlier break-up and later ice-freezing has the potential to keep more polar bears in coastal areas and could have detrimental effects on population abundance. Residents from Arviat and Rankin Inlet have also noted an increase in the number of polar bears during the ice-free season (Stirling and Parkinson 2006).

Marine Birds

The most common species of water birds observed in the Baker Lake and Chesterfield Inlet area are the Canada goose, long-tailed duck, and the common loon. Others that have been sighted are the arctic, red-throated, and yellow-billed loons and the whistling swan (Hohn 1967).

5.11.4 Marine Species of Concern

There are no fish present in Chesterfield Inlet that are listed under the Species at Risk Act (SARA) or designated by COSEWIC as species of concern although arctic char are listed under the International Union for Conservation of Nature (IUCN) red list for threatened species as a species of lower risk and least concern.

See Table 5.3 for a list of marine mammals and their status within Western Hudson Bay and Chesterfield Inlet.

Table 5.3 Status of Marine Mammals Present in Hudson Bay and Chesterfield Inlet

Species	Scientific name	SARA schedule	COSEWIC Status
Narwhal	*Monodon monoceros*	Not currently Scheduled	Special Concern
Bowhead Whale	*Balaena mysticetus*	Not currently Scheduled	Threatened
Beluga whale: Western Hudson Bay population	*Delphinapterus leucas*	Not currently Scheduled	Special Concern
Polar Bear	*Ursus maritimus*	Not currently Scheduled	Special Concern
Killer Whale	*Orcinus orca*	Not currently Scheduled	Not listed
Ringed seal	*Phoca hispida*	Not currently Scheduled	Not at risk
Harbour Seal	*Phoca vitulina*	Not currently Scheduled	Not at risk
Walrus	*Odobenus rosmarus*	Not currently Scheduled	Special Concern

5.12 Terrestrial Environment

Formal and informal baseline studies have been completed periodically since 1978 to study the terrestrial environment in the local and regional areas surrounding the Project. In 2007, AREVA began collecting additional terrestrial baseline data for the Project. The following sections summarize the baseline information currently available on the soil, vegetation and wildlife of the Kiggavik Project area. Additional detail is available in Supporting Document No. 1.

5.12.1 Soils

5.12.1.1 Soil Surveys

Soils within the Project study area are primarily Cryosolic soils (permafrost affected soils); one Regosolic soil was documented. Cryosolic soils (permafrost affected soils) are defined as soils that have been formed in either mineral or organic materials that have permafrost either within 1 m of the surface or within 2 m if the soil has been strongly cryoturbated laterally within the active layer, as indicated by disrupted, mixed, or broken horizons. Regosolic soils tend to develop on unstable material and in cold and dry climatic conditions which limit soil development. These soils are not affected by permafrost within 1 m of the surface.

5.12.1.2 Soil Chemistry

During the 1980's, composite soil samples were collected along two perpendicular substrates (N-S and E-W) that intersected at the Kiggavik site (Figure 5.7). The drainage of the area sampled was to the south towards wet, hummocky terrain, whereas the terrain along the east-west transect had a gentle slope to the west. The main mechanism of mineral dispersion within the Project study area is likely snowmelt runoff as there have been large pulses of meltwater in short periods of time documented for the area. The meltwater has a pattern of extensive surface flow not confined to a stream channel and is likely to entrain and transport soluble and particulate elements down the topographic gradient.

The samples revealed distinct anomalies of the natural radionuclides at Main Zone and Center Zone. Uranium-238 (U-238), radium-226 (Ra-226), and bismuth-214 (Bi-214) activities were three to four orders of magnitude greater at Main Zone compared to the transect average. In Centre Zone, which was lightly buried under glacial drift, the activities were about 100 times that of the average. Activities fell, however, to very low levels about 200 m from Main Zone. The substrate also revealed a detectable dispersion pattern of U-238 and Ra-226, reflecting down gradient hydrologic transport mechanisms.

In 2007, permanent sample plots (PSPs) were established within the Project Area to measure baseline radionuclide and trace metal concentrations in soil and vegetation. Three PSPs were established within the Kiggavik lease area and three within the Sissons lease area (Figure 5.8). Mineral and organic soil samples (peat) were collected from the PSPs. Mineral soil samples were analyzed for basic soil chemistry, cations and anions, metals, and radionuclides. Organic soil samples (peat) were analyzed for metals and radionuclides.

The results of the soil chemical analysis of mineral and organic soils (peat) samples are available in Appendix V. The basic soil chemistry, cation, and anion values are typical of the tundra, where mineral soils are generally low in nutrients and acidic (pH ~5). Mineral soils in the study area have low soluble salts as indicated by low electrical conductivity.

5.12.2 Vegetation

The Project study area is located in the Keewatin lowland ecoprovince of the Southern Arctic ecozone. The Project encompasses, from northwest to south, portions of three major ecoregions: Black River Plain in the north, Dubawnt Lake Plain/Upland in the central area and the Maguse River Upland in the southeast corner.

The study area is within the barrenlands where heath tundra, rock-boulder fields and lakes and ponds dominate the landscape. Since the study area is above the tree line, the tallest vegetation is characterized by Dwarf Birch and willows. Small ericaceous shrubs, sedges, cottongrasses, lichens, mosses and a few herbaceous species are the most common plant species.

Only two rare plants listed under COSEWIC and SARA occur in Nunavut: Felt-leaf Willow (Special Concern) and the moss, Porsild’s Bryum. Neither of these species occurs within or in close proximity to the study area.

An initial vegetation classification, based on physiognomic appearance, was conducted in 1989. Seven major vegetation associations were identified throughout the study area: Rock Barrens, Lichen Steppe, Lichen-Heath, Moss-Heath, Dwarf Shrub, Sedge Meadow and Tussock Meadow.

More recently, an Ecological Land Classification (ELC) for a 7,200 km^2 study area was completed in 2007. The ELC involved acquiring a Landsat Thematic Mapper image, collecting training areas and then classifying the image into polygons with distinct vegetation communities. The nine vegetation communities, including Bare Ground, Bedrock Lichen, Heath Boulder, Heath Tundra, Riparian Low Shrub, Sedge Wetland, Tussock-Hummock, Willow-Boulder and Water, are described in more detail below.

Bare Ground

The Bare Ground vegetation community is characterized by very low vascular plant cover due to human disturbance or areas of open tundra (i.e., esker complexes).

Bedrock Lichen

The Bedrock Lichen vegetation association is typical of bedrock outcrops that have undergone little weathering. Due to poor nutrient and xeric moisture regimes, vegetation cover is sparse. Plant species that do occur include Boreal Fescue, Baffin Fescue, Awned Haircap Moss, Hedwig’s Rock Moss, Green Map Lichen and Frosted Rocktripe.

Heath Boulder

The Heath Boulder class is an open mat plant community interspersed with boulders. Shrubby plants may include Dwarf Birch, Labrador Tea, Cranberry, Blueberry, Crowberry, and Alpine Azalea.

Heath Tundra

Heath Tundra is a closed mat community with vegetation covering at least 70% of the ground. Shrub species are common and include all of the species listed for Heath Boulder above. Herb and moss layers are not well developed while lichens, which are more common, include several species of *Cetraria*, *Cladina*, *Cladonia* and others.

Riparian Low Shrub

The Riparian Low Shrub ELC unit occurs in areas of active water seepage through boulder fields and boulder streams. Dwarf Birch is the dominant vegetation, but willows are also present. Bluejoint and Water Sedge, along with Crowberry, Labrador Tea and mosses, are common plant species.

Sedge Wetland

The Sedge Wetland vegetation association is characterized by wetland complexes with standing water dominated with non-tussock plant species such as Water Sedge, Stiff Sedge (*Carex bigelowii*), and Cottongrass.

Tussock-Hummock

Plants belonging to the sedge family and cottongrasses are dominant in this vegetation unit. These sites are drier and less frequently flooded than sedge wetlands. Tussocks produce hummocks or mounds that are invaded by Bog Rosemary, Cloudberry, Labrador Tea, Blueberry and Cranberry. Sphagnum mosses typically occupy the troughs between hummocks. Older and larger hummocks typically are colonized by Dwarf Birch and willow.

Willow-Boulder

The Willow-Boulder ELC follows active stream courses or pond and lake shorelines, usually with a cobble or boulder substrate. Willow species are the dominant shrub species, but Dwarf Birch is also common. Other plant species include Dwarf Raspberry, Dwarf Marsh Violet, Cloudberry, grasses, sedges and Common Horsetail.

Water

The Water ELC includes all waterbodies present on the landscape. Some emergent and/or submergent vegetation may be present.

Within the study area, the Water and Tussock-Hummock ELC units make up the majority of the landscape. Table 5.4 provides preliminary calculations of the area and proportion of ELC units in the 2007 Regional Study Area (RSA).

Table 5.4 Area and Proportion of Ecological Landscape Classification Units within the RSA

Ecological Landscape Classification Unit	Area (ha)	Proportion of RSA (%)
Bare Ground	2,425	0.3
Bedrock Lichen	30,648	4.3
Heath Boulder	29,380	4.1
Heath Tundra	161,777	22.5
Riparian Low Shrub	13,071	1.8
Sedge Wetland	69,805	9.7
Tussock-Hummock	212,979	29.6
Water	199,593	27.7
Willow-Boulder	321	0.0
Total	**720,000**	**100**

To support the ELC, ground-based vegetation surveys and collection of traditional knowledge will be on-going through 2008 and 2009.

5.12.2.1 Vegetation Chemistry

The accumulation of metals and radionuclides by plants is important due to the potential for food chain transfer to wildlife and humans. Over the last three decades, several radiation and heavy metal vegetation baseline collections have been carried out in the immediate Project area. The first vegetation chemistry survey was undertaken by Kershaw et al. (1983), which included collection and analysis of lichens to obtain background levels of radionuclides and trace metals. In Svoboda et al. (1985), various taxa of vegetation at the Kiggavik site and surrounding area were sampled to provide additional baseline radionuclide information. BEAK (1988) also provided trace metal and radionuclide concentrations for the vegetation of the Project area. All baseline information is available in Supporting Document No. 1 (Section 1.8).

During 2007, permanent sample plots (PSPs) were established in the Kiggavik and Sissons lease areas (three sites each), near the deposits to measure baseline radionuclide and trace metal concentrations in soil and vegetation (Figure 5.8). Primary forage species of herbivorous mammals and birds were collected for chemical analysis, including: lichen, willow, dwarf birch, fruit and foliage from blueberry plants, and sedge. Vegetation samples were collected from the same area the soil samples were collected.

The vegetation samples were analyzed for 25 metals and four radionuclides; the results of the chemical analyses are available in Appendix V. Generally, analyte concentrations from vegetation collected from both Sissons and Kiggavik lease areas were similar to each other, regardless of plant type. The exceptions to this were lichen and blueberry foliage in the Sissons area, and lichen, willow, and birch in the Kiggavik area.

5.12.3 Wildlife and Wildlife Habitat

Terrestrial wildlife has been studied at the Project site via several surveys between 1979 and 1989, and most recently in 2007 and 2008. Similar studies are planned for 2009.

Mammal species that have been recorded within the study area to date are listed in Table 5.5.

Table 5.5 Mammal Species Observed within the Project Area

Common Name	Scientific Name	Nunavut Conservation Status
Ungulates		
Barren-ground Caribou	*Rangifer tarandus*	Secure
Muskoxen	*Ovibos moschatus*	Secure
Carnivores		
Arctic Fox	*Vulpes lagopus*	Secure
Grizzly Bear	*Ursus arctos*	Sensitive
Wolverine	*Gulo gulo*	Sensitive
Wolf	*Canis lupus*	Sensitive
Small Mammals		
Arctic Ground Squirrel	*Spermophilus parryii*	Secure
Arctic Hare	*Lepus arcticus*	Secure

5.12.3.1 Baseline Study Areas

Since the 1980s, a number of Regional Study Areas (RSAs) and Local Study Areas (LSAs) have been used at the Project site. In 2007, a 7,200 km^2 RSA was established. For 2008, the RSA consists of a 9,060 km^2 area that includes an approximate 25 km buffer around all Project facilities including several proposed access road options. The RSA is bordered by the Kazan River and the Hamlet of Baker

Lake to the east, Pitz and Princess Mary lakes to the south, Aberdeen Lake to the west, and Schultz Lake and the Thelon River to the north (see Figure 5.9). The LSA is a 450 km^2 area that encompasses the Kiggavik and Sissons lease areas and an approximate 5 km buffer around all proposed facilities (Figure 5.10).

The 2008 RSA was chosen to account for the large home ranges of wide-ranging species such as Barren-ground Caribou and Grizzly Bear, while the LSA was established for investigations of smaller, more localized seasonal movements and ranges.

5.12.3.2 Barren-ground Caribou

Barren-ground Caribou is one of the most important wildlife species, both biologically and culturally, in the Baker Lake area. Caribou have traditionally been the primary food source for Inuit in the region and continue to be an important food source. Historical data suggests that the Kiggavik site may occur within the post-calving and late summer ranges for the Beverly caribou herd. However, recent radio-collaring data and on-site observations do not indicate large aggregations of caribou in these seasons within the study area. Further study will verify current distribution and abundance of caribou within the Project area.

Surveys in 2007 and 2008 documented caribou on a regular basis. On an August 2007 aerial survey, 24 groups of caribou, totaling 37 individuals were observed. Group size ranged from one to eight, and 96% did not contain calves. On weekly surveys within the Kiggavik LSA, a total of nineteen groups of caribou, totaling 66 individuals, were observed. Group size ranged from one to nine, and 95% did not contain calves. Over the course of the 2007 field season (June to September), a total of 247 observations were recorded (includes systematic and incidental observations).

Caribou from at least five herds may occur within the Kiggavik RSA at various times of the year. The five herds, Beverly, Ahiak, Qamanirjuaq, Wager Bay and Lorillard, are described in more detail below. In general, the Kiggavik RSA does not appear to currently provide critical calving, post-calving or rutting habitat for any of the five herds.

Beverly

The current status of the Beverly Caribou Herd is not well known. The last population survey of the Beverly herd was completed in 1994, which estimated the number of caribou at 276,000. A previous survey in 1984 estimated the herd size at 264,000 animals. Current sentiment among researchers is that the herd numbers have declined dramatically since 1994. Recent collaring of as many as 50 cows and scheduled population surveys by the Government of the Northwest Territories should provide new information on this herd.

Traditionally, the Beverly herd calves northwest of the Project area, near Beverly Lake and the Thelon River system. From 1957-1974, these traditional calving grounds covered an area from 810 km^2 to

11,409 km^2, although the exact location of the calving grounds changes from year to year. Between 1957 and 1974, the southeast portion of the traditional grounds was used, while from 1980 to 1999, the northern portion was primarily used. More recently, the Beverly calving ground has moved further north, near Gary, Sand and Deep Rose lakes (Figure 5.11). In all years where data has been recorded, the calving grounds have been well outside the Kiggavik RSA.

Based on government surveys completed from 1948 through 1990, the Kiggavik Project area has historically been used by the Beverly herd during post-calving movements. Recent satellite-collaring data suggests that most of the post-calving movement is outside the Kiggavik study area (D. Johnson, GNWT, pers. comm., 2008).

Ahiak

Based on 2001 to 2007 satellite-collaring data, the seasonal range of the Ahiak herd during the summer dispersal and fall migration periods overlaps the Project area. The fall and spring migration leads some animals through and to the south of the Thelon Game Sanctuary. Many of the caribou observed in the Kiggavik RSA during the late summer and fall may be animals from this herd. In most years, the herd winters in the barrens, but in some years, the herd moves into the boreal forests in the area northwest of the Saskatchewan border.

Qamanirjuaq

The Qamanirjuaq Caribou Herd calving grounds are located southeast of the Kiggavik study area. Post-calving movements begin soon after calving occurs, and cows and calves begin moving to the northern edge of the calving grounds south of Baker Lake and east of the Kazan River. Based on government surveys completed from 1948 through 1990, the historical post-calving ground is southeast and outside of the Kiggavik area. The western boundary of the Qamanirjuaq herd range is not well defined, and there is considerable overlap with the Beverly herd, particularly in the winter range. The herd was estimated at 496,000 individuals in 1994.

Wager Bay

The Wager Bay Caribou Herd calves in the Wager Bay area and at the base of the Melville Peninsula. Satellite-collaring data between 2000 and 2006 indicate that a few animals move into the Kiggavik study area during the early winter season. The majority of the herd appears to stay north of the Thelon River system.

Lorillard

The Lorillard Caribou Herd calves between Chesterfield Inlet and Wager Bay. During the post-calving season and late summer seasons, most animals start moving west eventually wintering in a large area north of Baker Lake and the Thelon River system. Some radio-collared animals have spent the fall, rut and early winter seasons within the Kiggavik RSA.

5.12.3.3 Muskoxen

Muskoxen occur throughout Nunavut where they are currently listed as 'secure'. They have been seen regularly within and in the vicinity of the Kiggavik RSA in previous studies in the 1970s, 1980s and 1990s as well as the 2007 and 2008 surveys. During weekly and daily surveys in 2007, ten groups of muskoxen, totaling 54 individuals were documented. Group size ranged from 1 to 28 individuals and 25% contained calves.

5.12.3.4 Grizzly Bears

Grizzly Bears are of special concern nationally and considered 'sensitive' in Nunavut. Griizzly Bears are solitary animals with very large home ranges (e.g., 7,000 km^2 for males and 2,000 km^2 for females). Grizzly Bears have been seen occasionally within the Kiggavik RSA. In 2007, bears and bear sign were observed incidentally on eight occasions. Four sightings were of bears, while the other records were of tracks, digs for Arctic Ground Squirrels, willow chews and one inactive den site.

5.12.3.5 Wolverine

Wolverines are of special concern nationally and considered 'sensitive' in Nunavut. Male Wolverines have much larger home ranges than females with males occupying territories from 230 km^2 to 1,580 km^2, and females from about 50 km^2 to 400 km^2. Long-range movements usually occur during juvenile dispersal. Although Wolverines have been only sporadically reported within the Project study area, they are expected to occur given the regular sightings within the Meadowbank RSA and animals trapped each year by Baker Lake residents.

5.12.3.6 Other Predators

Other carnivorous species occurring within the Kiggavik study area are Gray (Arctic) Wolf, listed as 'sensitive' in Nunavut, Arctic Fox and Ermine. During the 2007 baseline studies, wolves were seen incidentally on three occasions: one feeding on a caribou kill and two traveling. As well, one active den site, and one inactive and temporary den site was documented. The principal prey for wolves is caribou while Muskoxen serve as a secondary food source. Small mammals and birds are hunted as necessary.

Arctic Foxes have been seen regularly in the study area during field surveys in 1979, 1991 and 2007. Arctic Fox are opportunistic predators feeding on a variety of prey including small mammals and birds, and are attracted to human infrastructure. Ermine, one of the smallest predators in the study area, is also expected to occur.

5.12.3.7 Small Mammals

Surveys specific to small mammals have not been conducted. However, incidental sightings of Arctic Hare have been documented and other species are expected to occur including Northern Red-backed Vole, Collared Lemming, Meadow Vole and Brown Lemming. Small mammals are important prey for all Arctic predators as well as raptors such as Rough-legged Hawk, Peregrine Falcon, Gyrfalcon and Snowy Owl.

5.12.3.8 Birds

Birds occurring in the RSA are typical to those occurring in other tundra habitats of Nunavut. A list of species recorded to date is provided in Table 5.6.

Terrestrial Breeding Birds

A total of 29 species of songbirds, shorebirds and ptarmigan were detected during transect surveys in the Project area during the 1979 and 1980 studies. The mean breeding bird density per km of transect was 2.8 birds and 47.2 birds per 100 ha. Seven of the 10 most common species were upland birds: Lapland Longspur, Ptarmigan, Horned Lark, Dunlin, American Golden Plover, Baird’s Sandpiper and Sandhill Crane.

Waterfowl

Waterfowl observed during the 1979 and 1980 breeding bird transects within the Kiggavik study area included Pacific Loon, Canada Goose, Snow Goose, Long-tailed Duck, Greater Scaup, Herring Gull, Glaucous Gull and Arctic Tern. Long-tailed Duck and Canada Goose were the most common species.

A Snow Goose nesting colony is found at the mouth of the Kazan River and in a bay along the Aniguq River, along the southwest shore of Baker Lake. Isolated nests can be found scattered along this portion of the shoreline. Snow Geese are known to stage along the shores of Baker Lake in the fall, generally leaving by mid-September. Ducks in general nest in low numbers in the Baker Lake area.

Raptors

Six species of raptors have been observed in the Project area and in order of abundance are Rough-legged Hawk, Peregrine Falcon, Short-eared Owl, Gyrfalcon, Snowy Owl and Bald Eagle. Peregrine Falcon and Short-eared Owl are federally listed species. During the 2007 baseline studies, one active falcon nest, three inactive nests, and seven birds in flight were observed. Of the seven flying birds, three were confirmed as Peregrine Falcons.

Important areas for nesting raptors include the banks of the Thelon River and the north shore of Schultz Lake to the northeast end of Aberdeen Lake, the south shore of Aberdeen Lake, and several other smaller areas. One active Peregrine Falcon nest was observed on an escarpment to the east of the south end of Skinny Lake, a few kilometres from proposed Project facilities. Generally, suitable nest sites for raptors are lacking within the Kiggavik LSA.

Table 5.6 Bird Species Recorded in the Kiggavik RSA

Common Name	Scientific Name	Status in RSA	Nunavut Conservation Status
Red-throated Loon	*Gavia stellata*	Possible summer resident	Secure
Pacific Loon	*Gavia pacifica*	Possible summer resident	Secure
Greater White-fronted Goose	*Anser albifrons*	Migrant/ summer resident	Secure
Snow Goose	*Chen caerulescens*	Migrant	Secure
Canada Goose	*Branta canadensis*	Summer resident	Secure
Tundra Swan	*Cygnus columbianus*	Migrant	Secure
Northern Pintail	*Anas acuta*	Summer resident	Sensitive
Greater Scaup	*Aythya marila*	Summer resident	Undetermined
King Eider	*Somateria spectabilis*	Migrant	Sensitive
Common eider	*Somateria mollissima*	Migrant	Sensitive
Long-tailed Duck	*Clangula hyemalis*	Summer resident	Secure
Red-breasted Merganser	*Mergus serrator*	Summer resident	Secure
Bald Eagle	*Haliaeetus leucocephalus*	Vagrant	Vagrant
Rough-legged Hawk	*Buteo lagopus*	Possible summer resident	Secure
Gyrfalcon	*Falco rusticolus*	Summer resident	Secure
Peregrine Falcon	*Falco peregrinus*	Summer resident	May be at risk
Willow Ptarmigan	*Lagopus lagopus*	Summer resident	Secure
Rock Ptarmigan	*Lagopus mutus*	Summer resident	Sensitive
Sandhill Crane	*Grus canadensis*	Summer resident	Secure
Black-bellied Plover	*Pluvialis squatarola*	Migrant	Secure
American Golden Plover	*Pluvialis dominica*	Summer resident	Secure
Least Sandpiper	*Calidris minutilla*	Migrant	Sensitive
Baird’s Sandpiper	*Calidris bairdii*	Migrant	Secure
Pectoral Sandpiper	*Calidris melanotos*	Summer resident	Secure
Dunlin	*Calidris alpina*	Migrant	Secure
Long-tailed Jaeger	*Stercorarius longicaudus*	Summer resident	Secure
Parasitic Jaeger	*Stercorarius parasiticus*	Summer resident	Secure
Herring Gull	*Larus argentatus*	Summer resident	Secure
Glaucous Gull	*Larus hyperboreus*	Migrant	Secure
Arctic Tern	*Sterna paradisaea*	Migrant	Secure
Snowy Owl	*Bubo scandiacus*	Summer resident	Secure
Short-eared Owl	*Asio flammeus*	Migrant	Sensitive
Horned Lark	*Eremophila alpestris*	Summer resident	Sensitive
American Pipit	*Anthus rubescens*	Summer resident	Sensitive
American Tree Sparrow	*Spizella arborea*	Summer resident	Sensitive
Savannah Sparrow	*Passerculus sandwichensis*	Summer resident	Secure
Lapland Longspur	*Calcarius lapponicus*	Summer resident	Secure
Common Redpoll	*Carduelis flammea*	Summer resident	Secure

5.12.3.9 Species of Concern

Species at Risk lists created by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the Nunavut Wild Species 2000 Report (Government of Nunavut 2001) have been reviewed. Species listed as Endangered, Threatened or Special Concern by COSEWIC (2007) or the Species at Risk Act (SARA; 2008 internet site), considered to be 'sensitive' by the Government of Nunavut and are likely to occur within the study area are listed in Table 5.7. None of the federally listed species are on Schedule 1 of the SARA. Once a species is listed on Schedule 1, recovery strategies are developed and measures to protect the species are developed.

Table 5.7 Species at Risk Observed or Expected in the Kiggavik RSA

Species	Scientific Name	Nunavut Status	COSEWIC status	SARA Category of Concern
Mammals				
Gray Wolf	*Canis lupus*	Sensitive	No status	No status
Grizzly Bear (northwestern population)	*Ursus arctos*	Sensitive	Special Concern	No status
Wolverine (western population)	*Gulo gulo*	Sensitive	Special Concern	No status
Birds				
American Pipit	*Anthus rubescens*	Sensitive	No status	No status
American Tree Sparrow	*Spizella arborea*	May be at risk	No status	No status
Common Eider	*Somateria mollissima*	Sensitive	No status	No status
Horned Lark	*Eremophila alpestris*	Sensitive	No status	No status
King Eider	*Somateria spectabilis*	Sensitive	No status	No status
Least Sandpiper	*Calidris minutilla*	Sensitive	No status	No status
Northern Pintail	*Anas acuta*	Sensitive	No status	No status
Peregrine Falcon	*Falco peregrinus* ssp. *tundrius*	May be at risk	Special Concern	No status
Red-necked Phalarope	*Phalaropus lobatus*	Sensitive	No status	No status
Rock Ptarmigan	*Lagapus mutus*	Sensitive	No status	No status
Semipalmated Sandpiper	*Calidris pusilla*	Sensitive	No status	No status
Short-eared Owl	*Asio flammeus*	Sensitive	Special Concern	Special Concern Schedule 3
Snow Bunting	*Plectrophenax nivalis*	Sensitive	No status	No status
White-crowned Sparrow	*Zonotrichia leucophrys*	Sensitive	No status	No status

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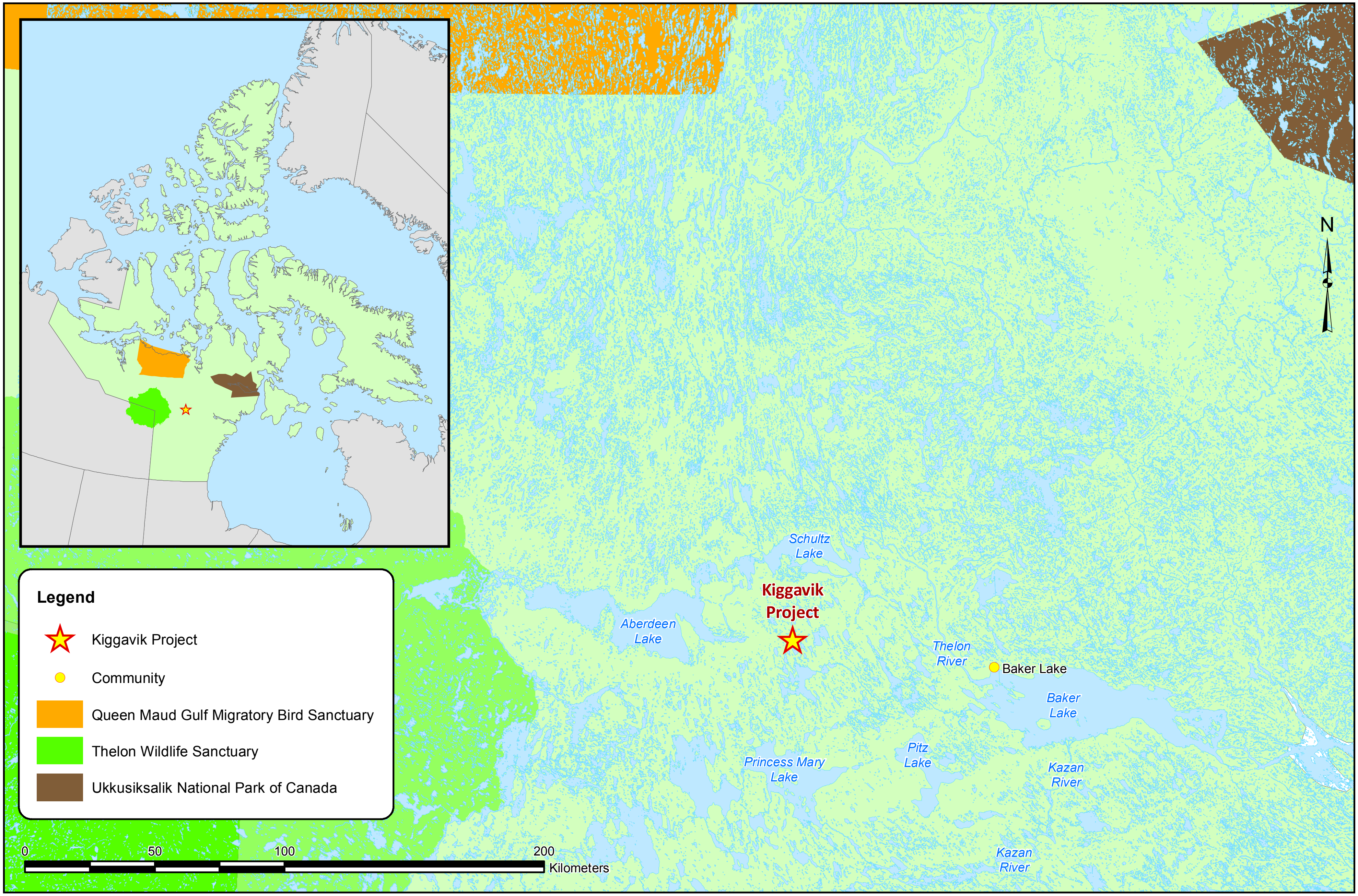
KIGGAVIK PROJECT

Project Proposal

SECTION 5

LIST OF FIGURES

Figure 5.1: Proximity of Project to Designated Environmental Areas
Figure 5.2: Regional Geology
Figure 5.3: Fault Structures
Figure 5.4: Temperature and Precipitation For Baker Lake
Figure 5.5: Local Drainage Boundaries and Monitoring Locations
Figure 5.6: Predicted Groundwater Flow Patterns
Figure 5.7: Composite Soil Sampling Transect
Figure 5.8: Permanent Sample Plot Locations - 2007
Figure 5.9: Regional Study Area - 2008
Figure 5.10: Local Study Area - 2008
Figure 5.11: Beverly Herd Traditional Calving Grounds



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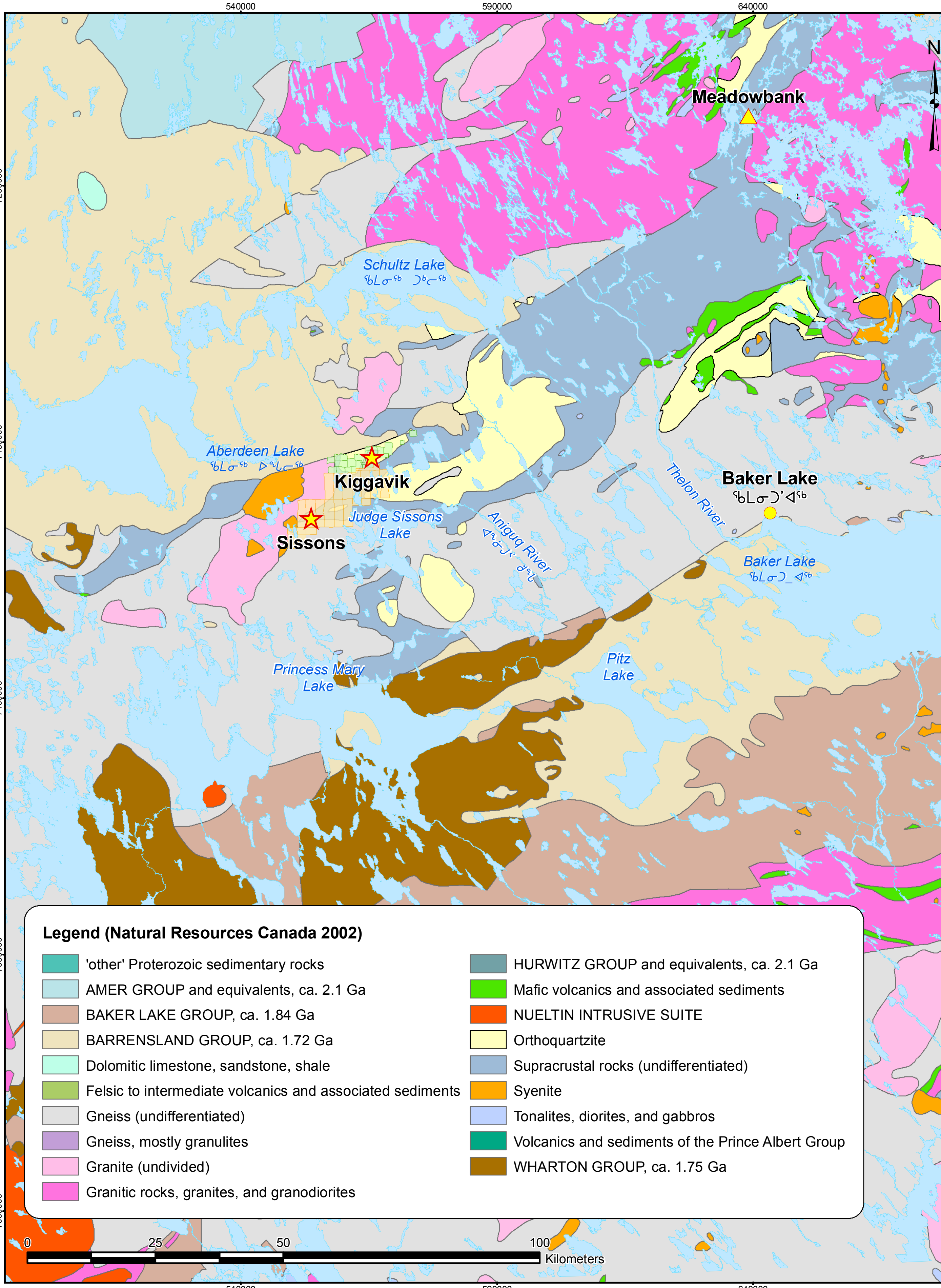
Saskatoon, Sk. S7K 3X5



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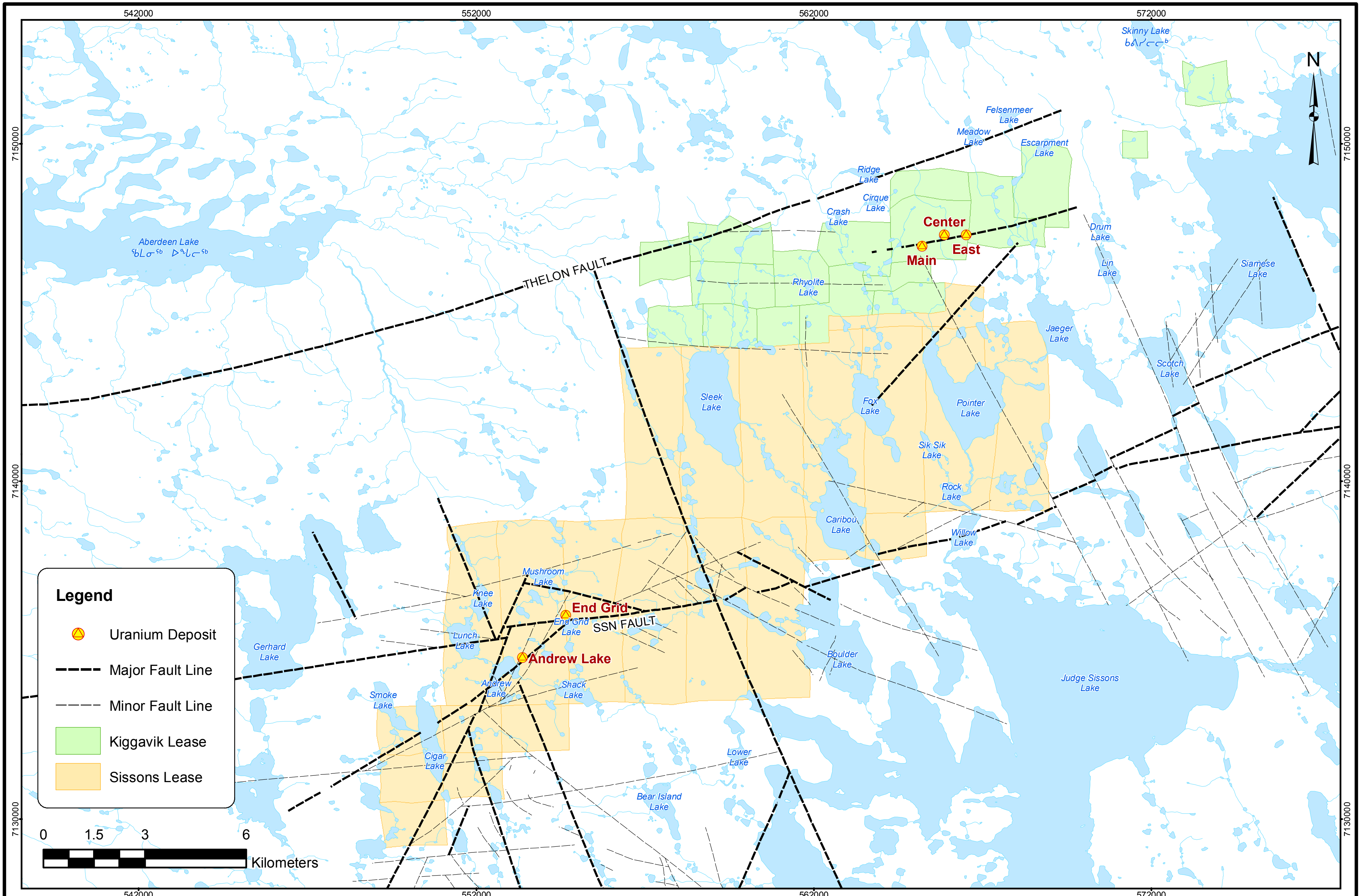

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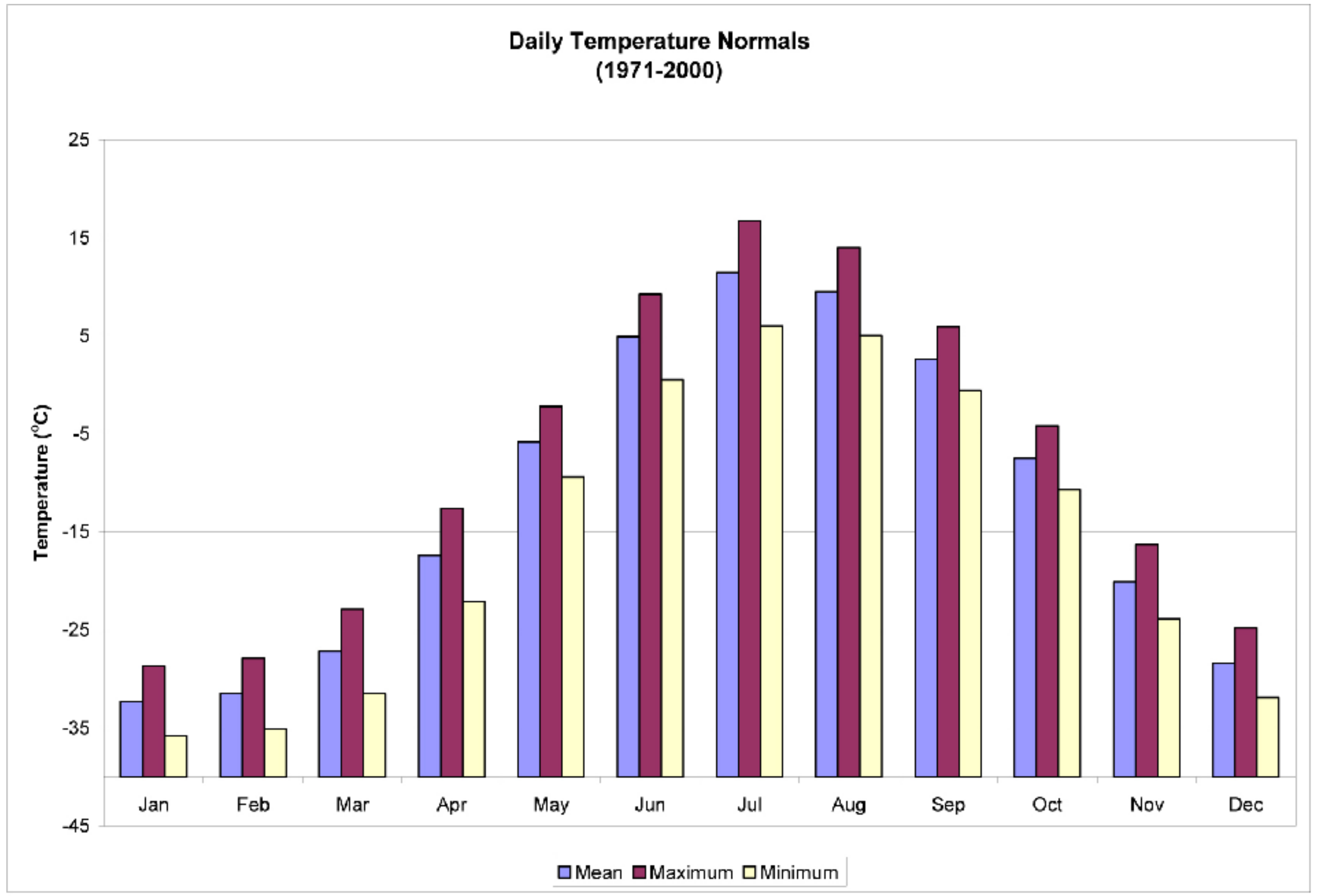

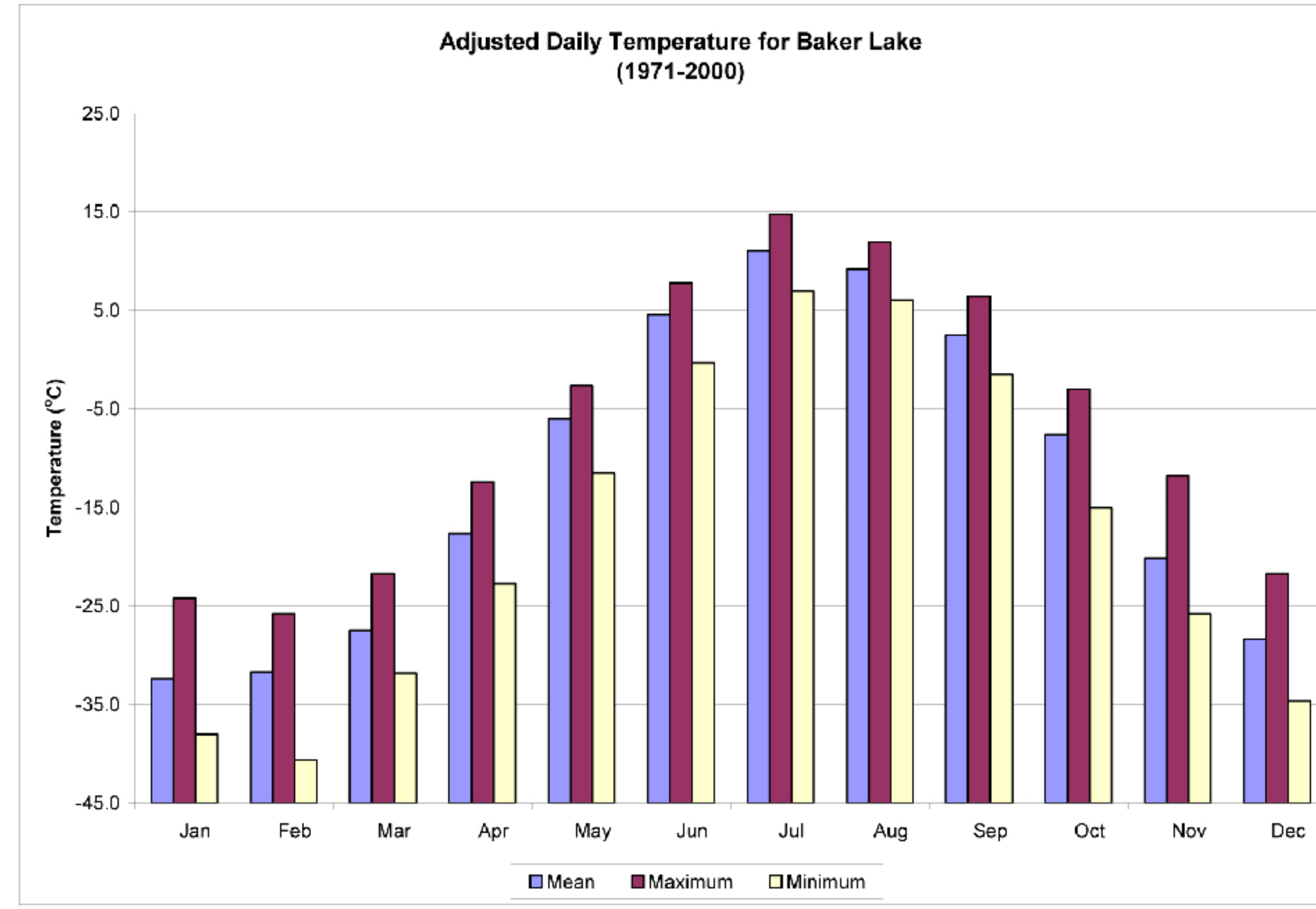

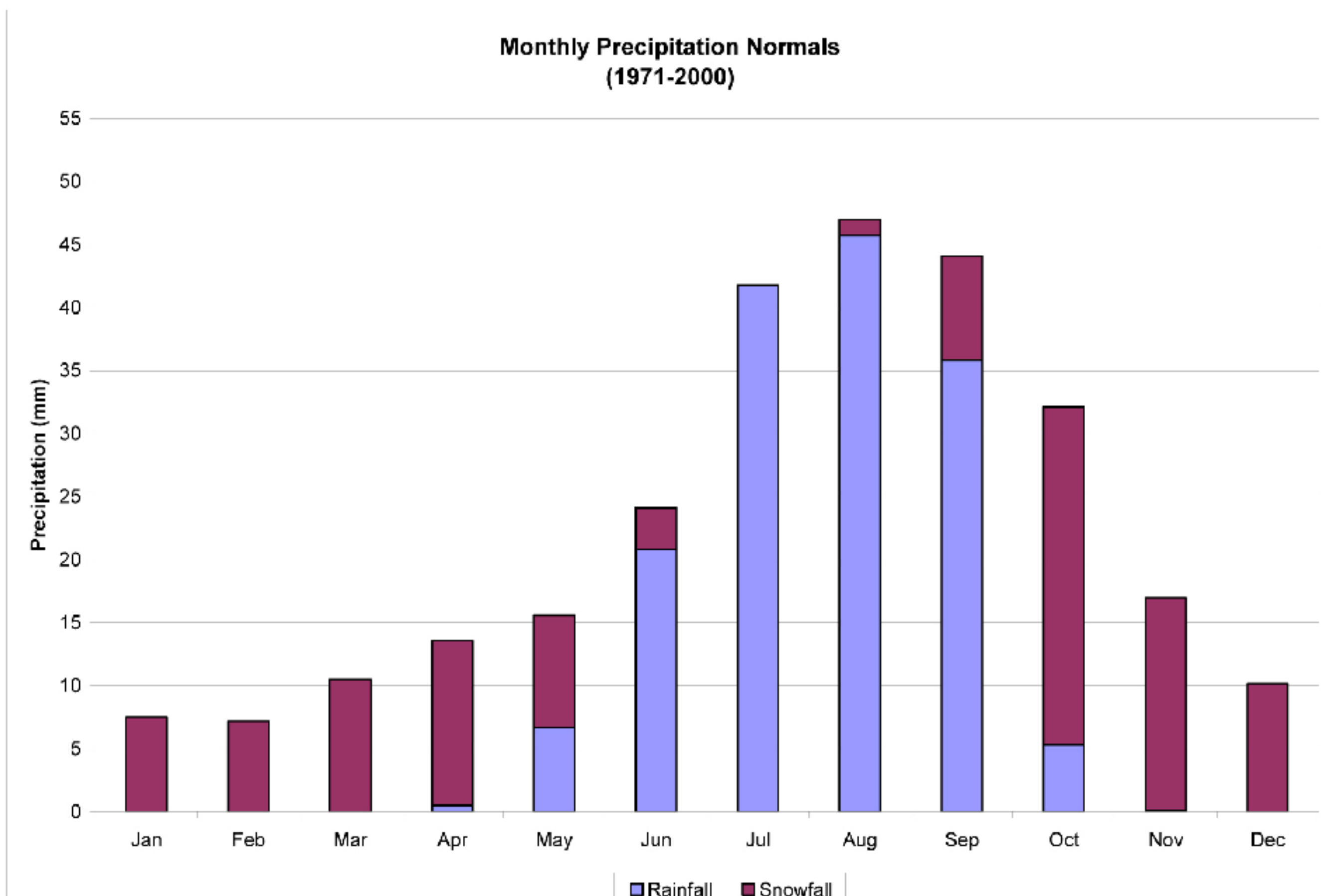

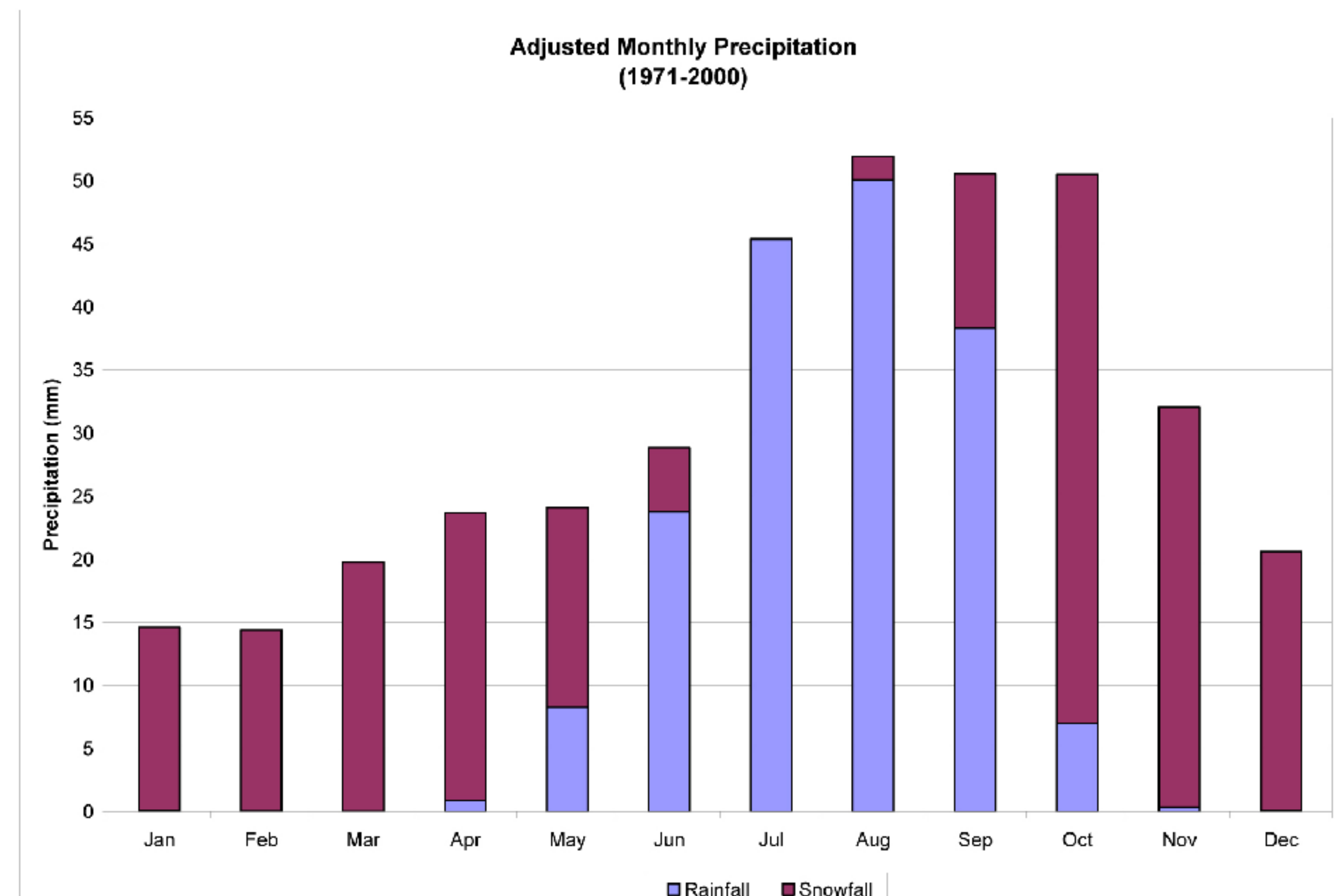

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TEMPERATURE AND PRECIPITATION FOR BAKER LAKE FIGURE 5.4	Creator: CDC
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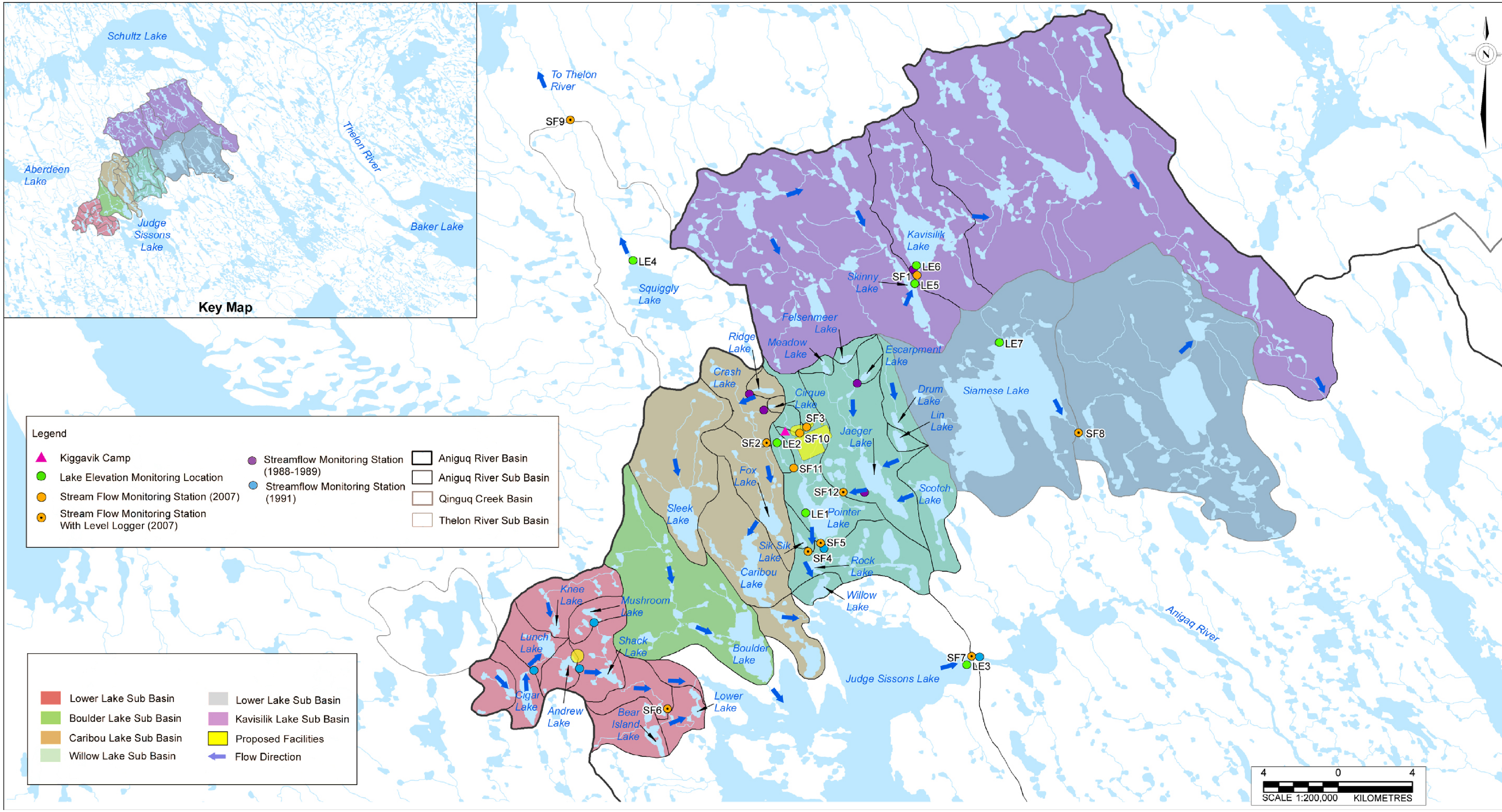

KIGGAVIK PROJECT

LOCAL DRAINAGE BOUNDARIES AND MONITORING LOCATIONS

FIGURE 5.5

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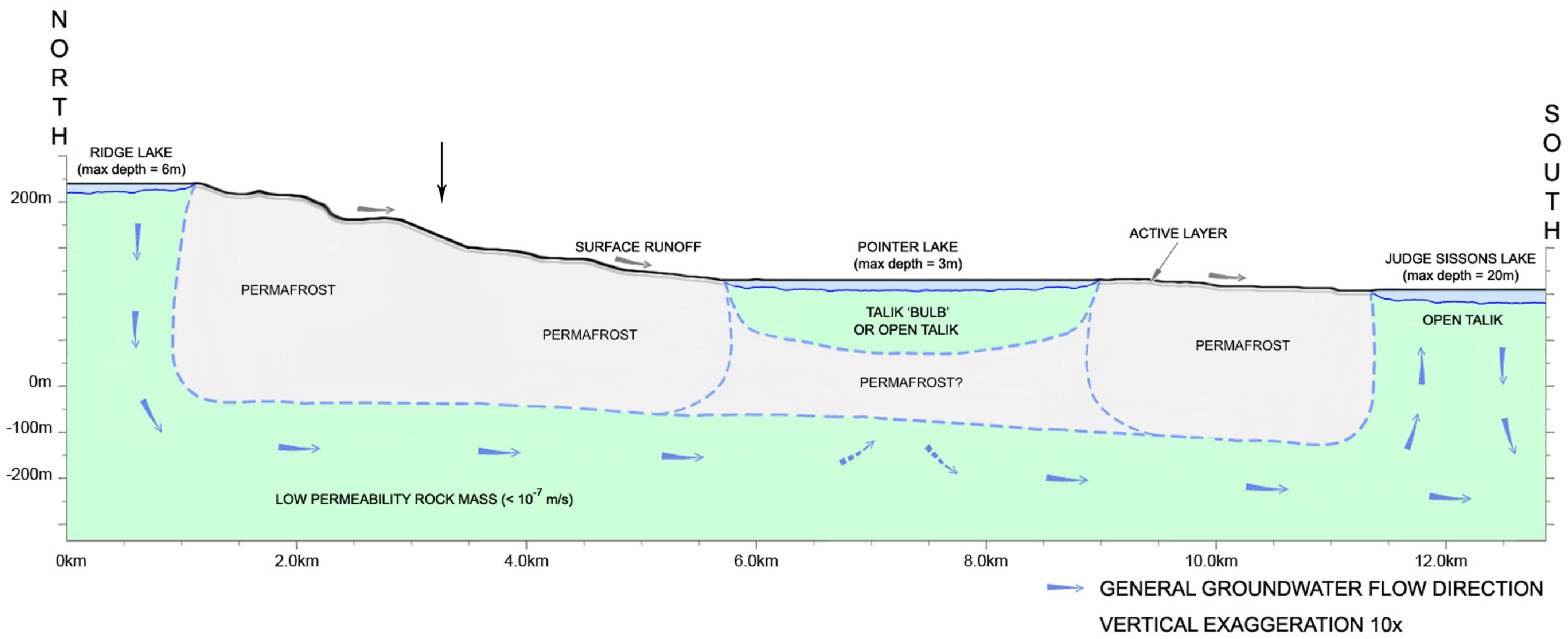

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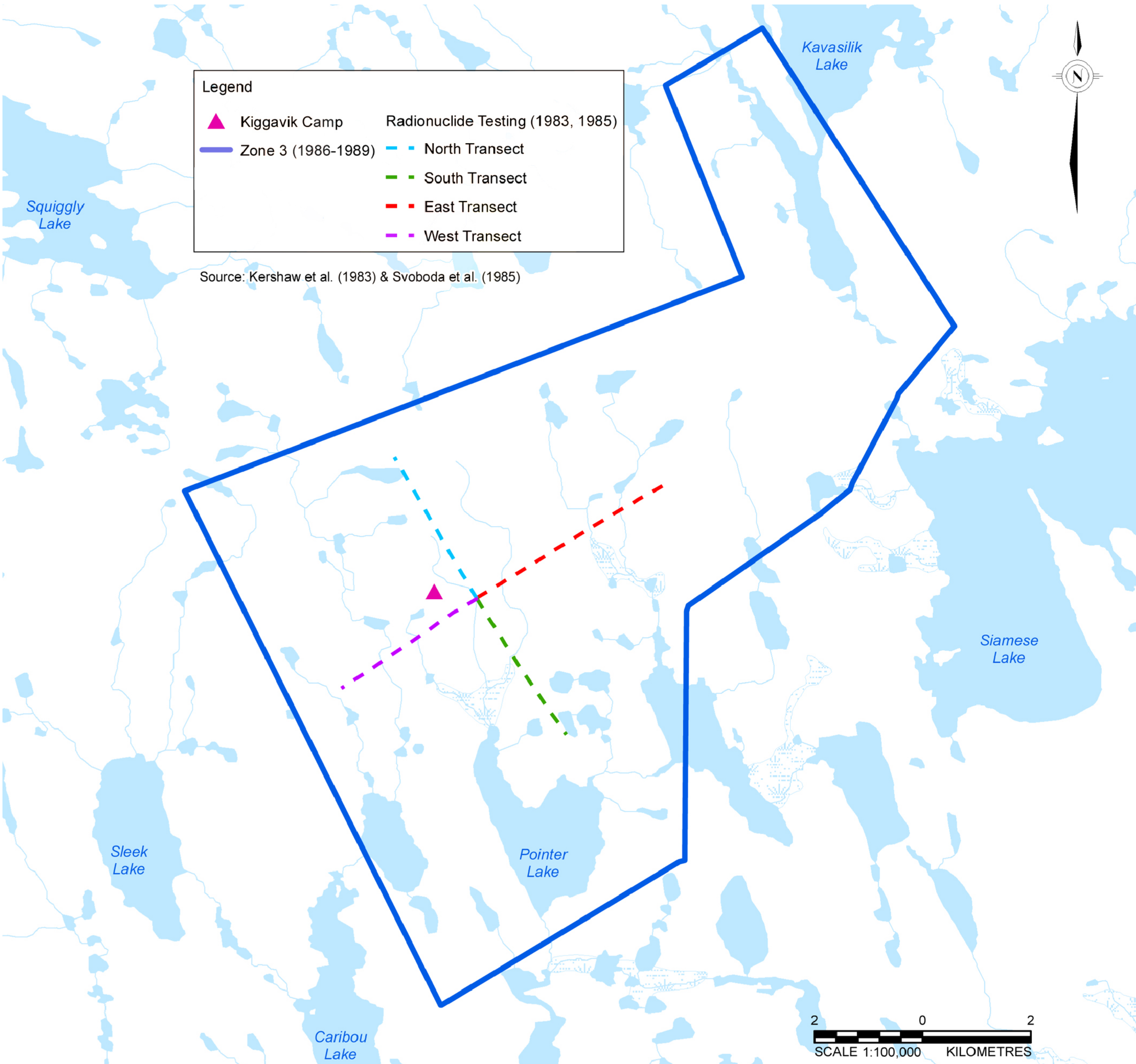
PREDICTED GROUNDWATER FLOW PATTERNS FIGURE 5.6	Creator: CDC Date: 10/31/08 Drawing:		



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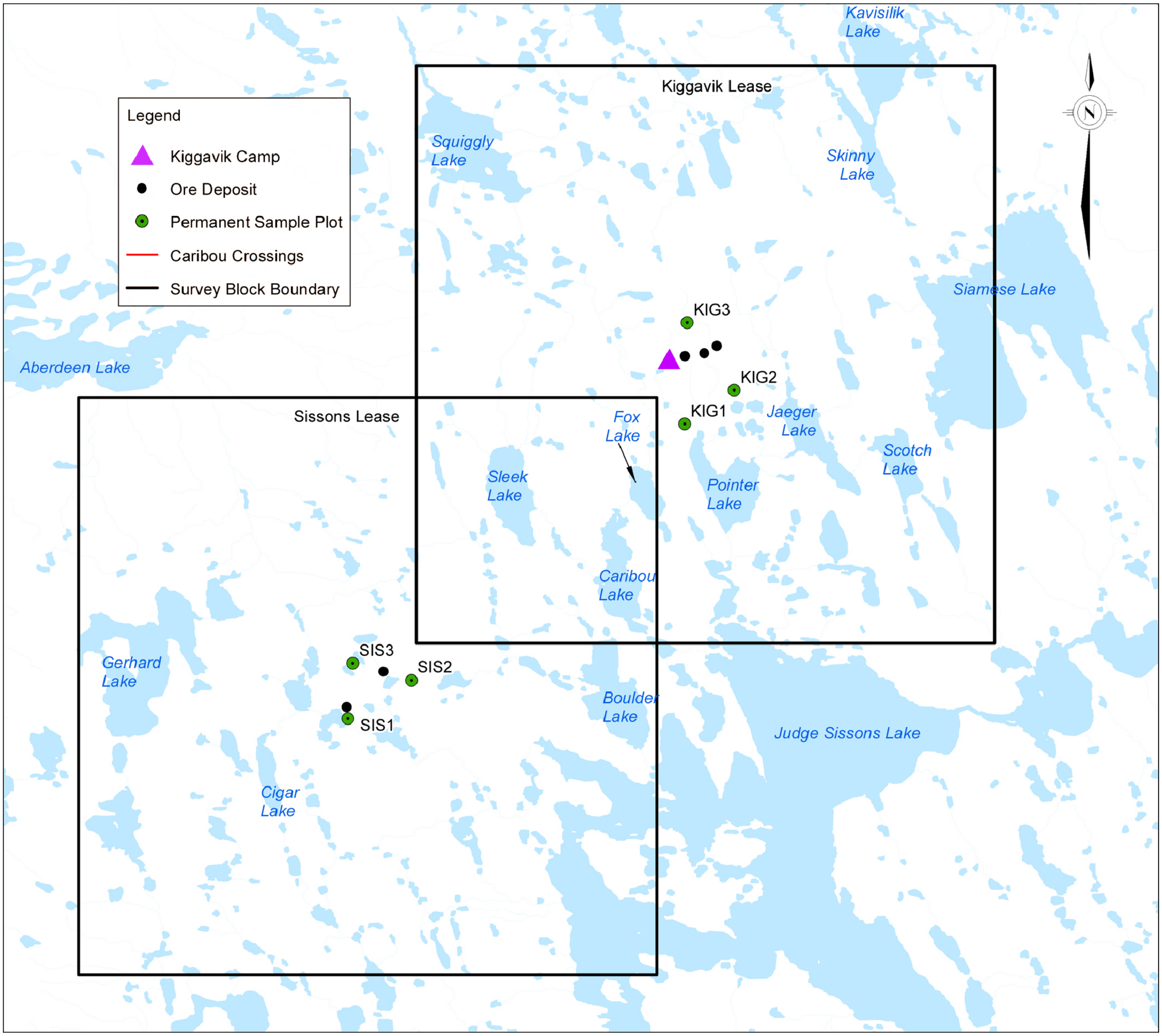
COMPOSITE SOIL SAMPLING TRANSECT - 1980s FIGURE 5.7	Creator: CDC Date: 10/31/08 Drawing:	



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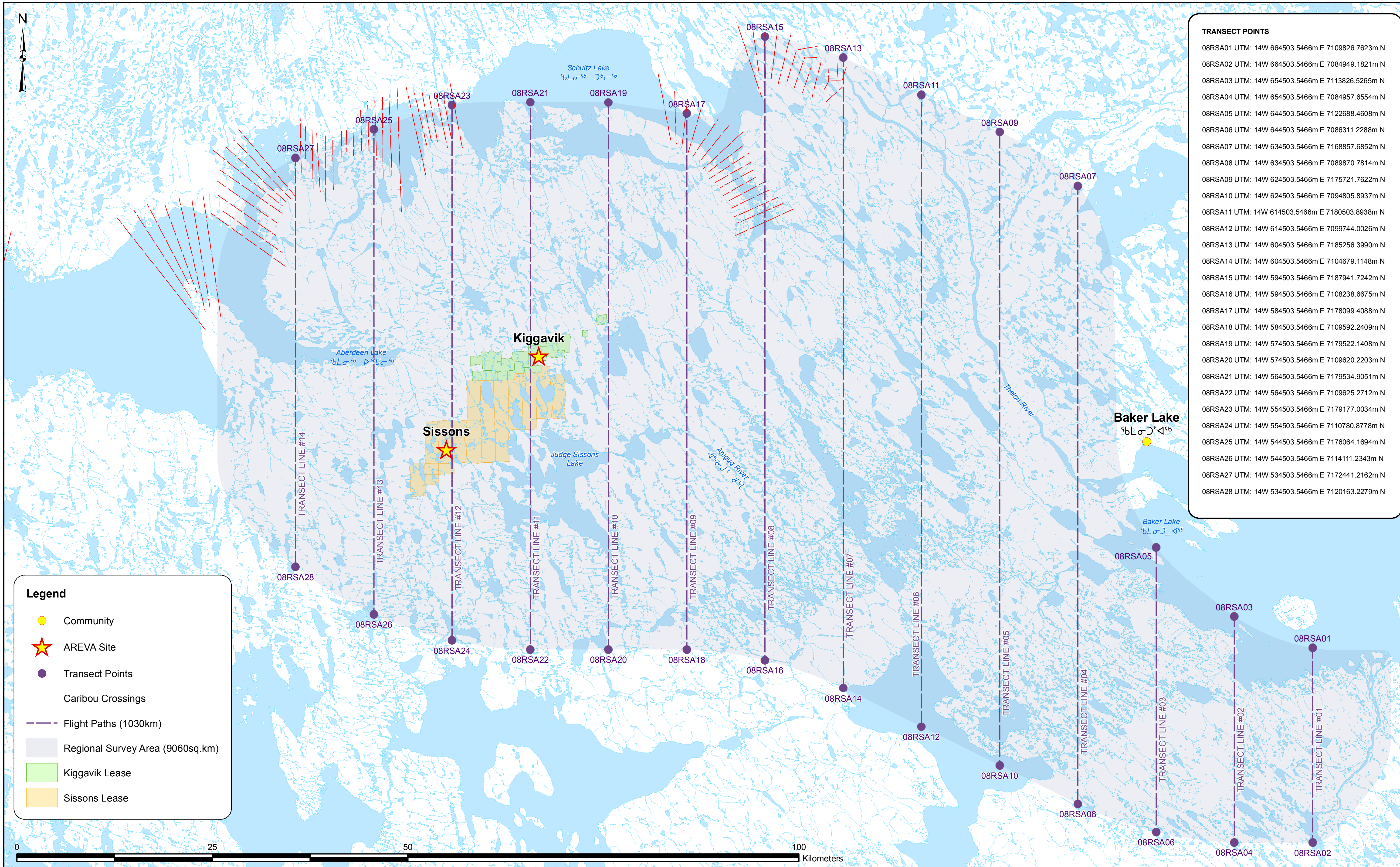
PERMANENT SAMPLE PLOT LOCATIONS - 2007 FIGURE 5.8	Creator: CDC Date: 10/31/08 Drawing:		



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REGIONAL STUDY AREA - 2008 FIGURE 5.9	Creator: CDC	
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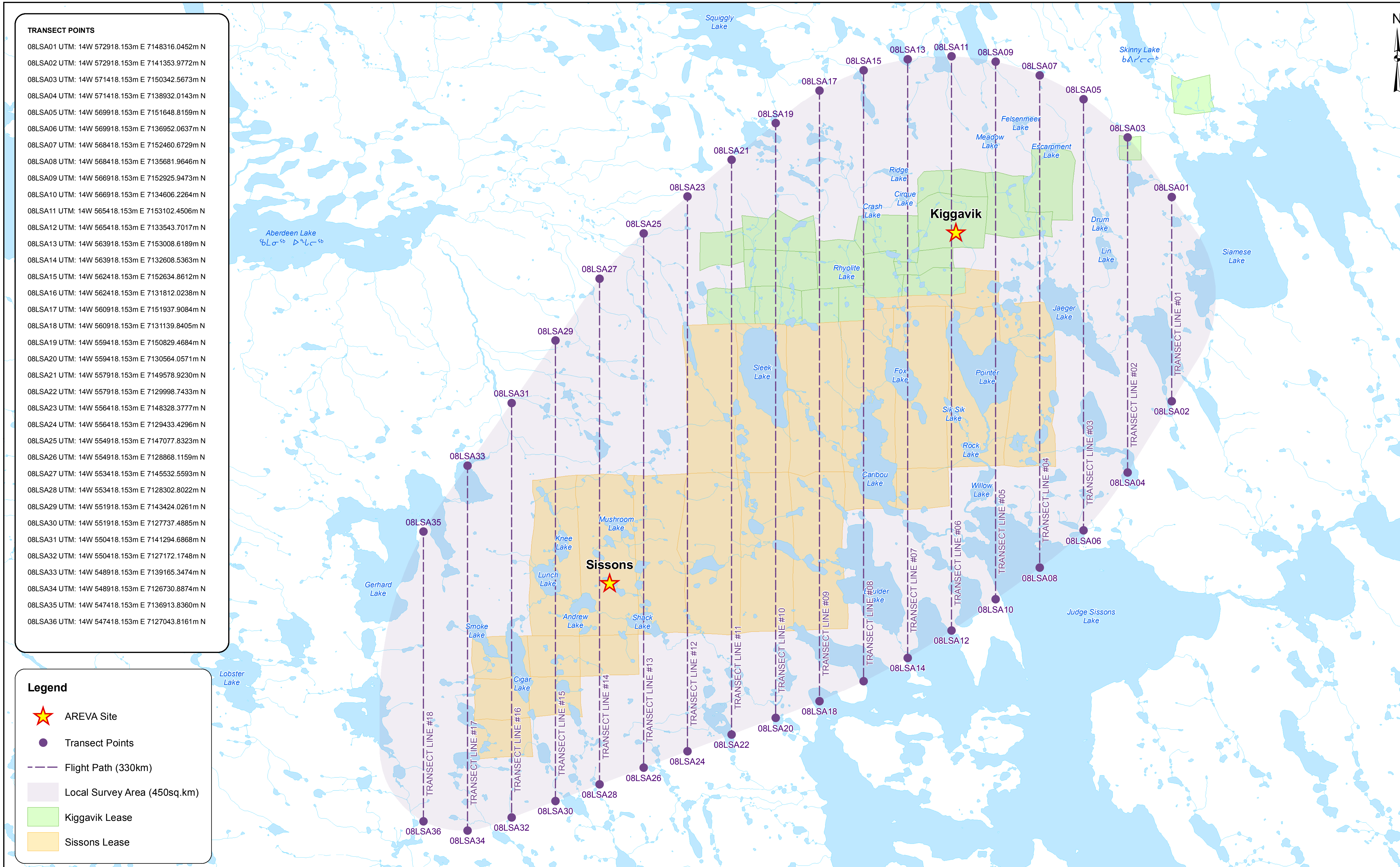

KIGGAVIK PROJECT

LOCAL STUDY AREA - 2008
FIGURE 5.10

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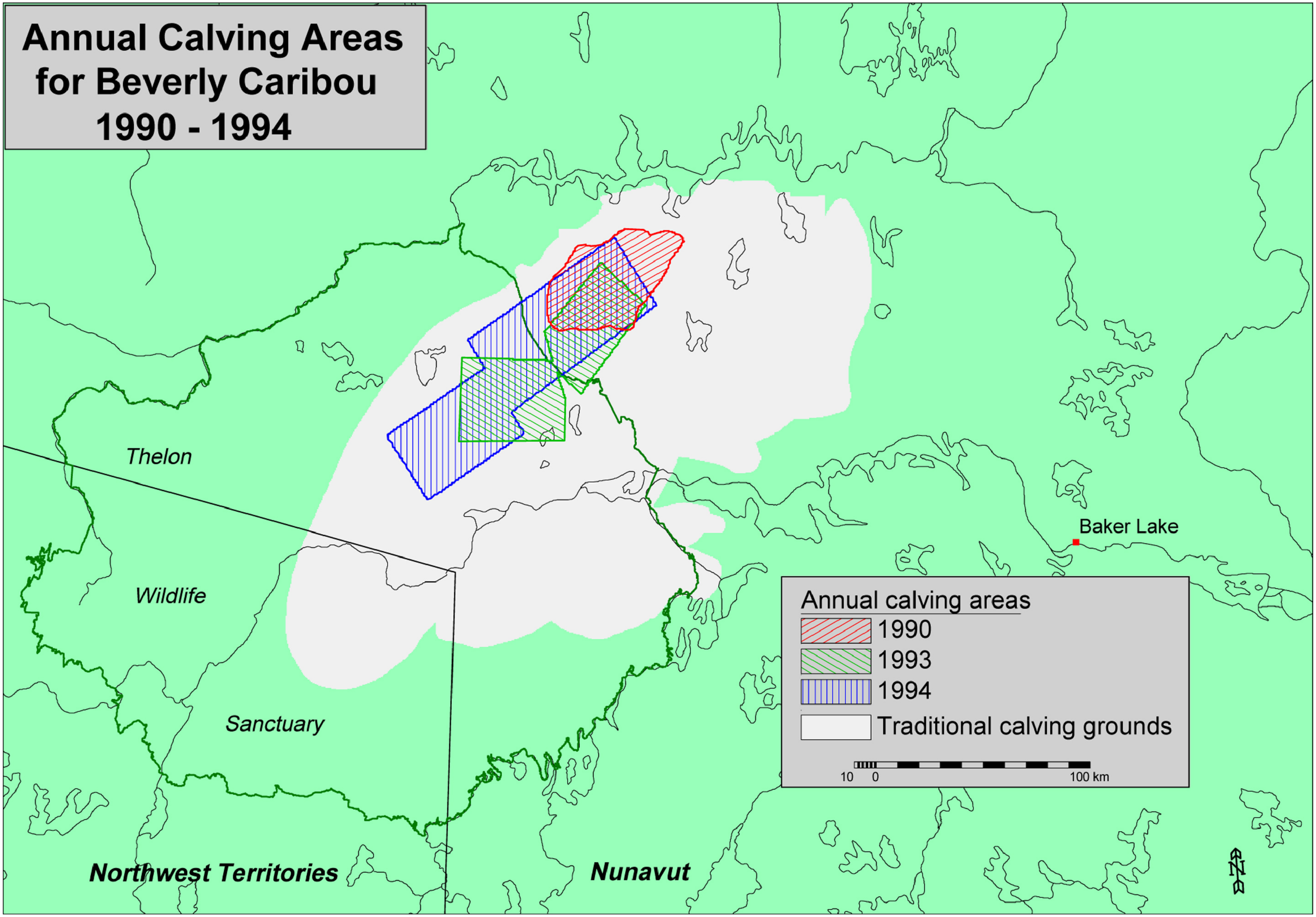

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BEVERLY HERD TRADITIONAL CALVING GROUNDS FIGURE 5.11	Creator: CDC Date: 10/31/08 Drawing:	Source: Beverly and Qamanirjuaq Caribou Management Board		

KIGGAVIK PROJECT

Project Proposal

SECTION 6

TABLE OF CONTENTS

SECTION **PAGE**

6 DESCRIPTION OF THE EXISTING SOCIOECONOMIC CONDITIONS................................6-1

6.1 Introduction 6-1

6.2 Potential Valued Socioeconomic Components...6-1

6.3 Archaeology and Culturally-Significant Sites..6-2

6.4 Palaeontological Component of Surface and Bedrock Geology 6-3

6.5 Regional Population...6-3

6.6 Community Profiles 6-5

6.7 Land and Resource Use 6-9

6.7.1 Land Management...6-9

6.7.2 Traditional Land Use and Harvest Activities..6-9

6.7.3 Non Traditional Economy 6-11

6.8 Health 6-14

6.9 Socioeconomic Baseline Work 6-15

LIST OF TABLES

Table 6.1 Labour Force Characteristics, 2001 and 2006……………………………………………6-4

Table 6.2 Registered Hunters by Community and Year……………………………………..…..6-11

6 DESCRIPTION OF THE EXISTING SOCIOECONOMIC CONDITIONS

6.1 Introduction

The Kiggavik Project is located in the Kivalliq region of Nunavut (Figure 6.1).The closest settlement to the Project site is Baker Lake, approximately 80 km to the east. Chesterfield Inlet is a further 190 km east, and is located on the Project's marine transportation route. There is potential for both environmental and socioeconomic effects and benefits in these two settlements. The other five settlements in Kivalliq Region – Rankin Inlet, Whale Cove, Arviat, Coral Harbour and Repulse Bay – are also expected to be affected by the Project, primarily through the potential for employment, training and business opportunities. The seven Kivalliq communities would therefore be included in the socioeconomic study area for the Project.

The description of the socioeconomic environment in Kivalliq, as included in this section, is not based on any data collected during a baseline field program, but only on available secondary data and published document review. Most socioeconomic data come from Statistics Canada, reporting on the 2006 census. It is expected that a more complete socioeconomic baseline description of Kivalliq and its seven communities will be completed as the Project advances.

Archaeological baseline data was originally collected in the immediate Kiggavik area during the late 1980's for Urangesellschaft. Additional surveys were conducted during the 2007 and 2008 field seasons, under Permit Nos. 2007-015A and 2008-024A respectively, issued by the Department of Culture, Language, Elders and Youth (CLEY), Nunavut. As the locations and layout of the Project components are further developed, heritage resource studies at those areas potentially affected by the project will be on-going.

6.2 Potential Valued Socioeconomic Components

Based on review of other projects proposed in Nunavut and informal community consultation, potential valued socioeconomic components (VSECs) include the following:

- employment;
- education and training;
- business opportunities;
- community health and well being;
- traditional culture;
- social and physical services and infrastructure;
- economic and fiscal benefits; and
- heritage sites.

It is anticipated that this list of VSECs will be further developed through the regulatory scoping process and through continued public consultation.

6.3 Archaeology and Culturally-Significant Sites

Archaeological impact assessments for areas potentially affected by the proposed Kiggavik Project were first conducted in the late 1980's by Max Friesen (1989 and 2001). Areas assessed under Permit Nos. 88-646 and 89-664 included several sites previously proposed by Urangesellschaft: 1) a limestone quarry and associated winter access road; 2) deep water harbour sites located in Chesterfield Narrows; 3) a barge dock and road to the town of Baker Lake; 4) the winter road from Baker Lake to the project area; 5) and the main mine site. A total of 53 sites were recorded. Note that several of these surveys included sites that are not part of the current Project.

The previous surveys conducted at the main mine site included assessment of proposed open pits, camp areas, roads, and related infrastructure. No heritage resources were observed at that time. However, assessment of water intake and gravel source areas at the south end of Skinny Lake resulted in the identification of 23 heritage resources. Many of these sites were excavated during the 1989 field season. The sites are located on points of high ground overlooking Skinny Lake and are interpreted as lookouts for hunters monitoring caribou movements. They consist largely of surface scatters and stone tent rings that produced projectile points dating to the Middle or Late Taltheilei Tradition. Twenty sites were also identified along the north shore of the east arm of Aberdeen Lake, while assessing a previously proposed access road which is not a component of the current Project. Sites consisted of stone features associated with lookouts, caribou drive systems, campsites, food storage, and occasional burials. All were attributed to precontact and historic Inuit occupations.

During the 2007 archaeological reconnaissance (under Permit No. 2007-015A), a total of 17 previously unrecorded sites were identified (LcLe 19 to 22, LcLf 12 to 22, and LdLe 8 to 9). The reconnaissance focused on several main areas of interest. These areas included an existing runway located approximately 12 km west of the main camp, an alternate runway north of this location, the Kiggavik and Sissons deposit areas, existing exploration fuel cache, and the area surrounding the existing exploration camp. Four potential permanent runways were also investigated as well as the south end of Skinny Lake where it is proposed that the water intake for the mill may be located. In addition, several pre-recorded sites were revisited including sites along the north shore of the east arm of Aberdeen Lake. Finally, a brief helicopter survey was completed of the proposed all-weather access route to Baker Lake.

The largest concentrations of sites found in 2007 were in the vicinity of Skinny Lake and Aberdeen Lake. At Skinny Lake, sites identified during this survey included small sites containing chipping debris. Several previously recorded sites along the shores of Skinny Lake were also revisited. These contained numerous tent rings, hearths, and artifacts. Near Aberdeen Lake, large sites were discovered along an ancient beach ridge. Several formed stone tools including projectile points and bifacial knives were collected from this location. At Aberdeen Lake, where the archaeological surveys conducted in the late 1980s recorded several sites along the north shore of the east arm; sites were briefly revisited for comparison purposes.

Archaeological baseline surveys continued in 2008 under Permit No. 2008-024A. The 2008 survey focused on the haulage route between Kiggavik and Sissons and the all-weather access road (north route). A total of 35 new sites were identified and nine previously recorded sites were re-visited. Of the newly recorded sites, the most common feature was the hunting cache. Thirteen sites contained a total of 31 caches. Although the majority of these features were opened, several were not and caribou bone was visible within them. Tent rings/squares were the next most common feature, with a total of 25 features identified at 18 campsites. Eight hearths/firepits were recorded, most often found within the tent rings. Eight hunting blinds, five inuksuit, three qarmats and two sets of kayak stands were also recorded. Lastly, four lithic scatter sites were identified, which consisted primarily of flakes from stone tool manufacture. One spear point and one biface knife were collected from these sites.

Other archaeological assessments related to mining projects in the Baker Lake region were conducted in 1999 and 2003 (Permit No. 03-012A) as part of the Meadowbank Project (Cumberland Resources Ltd. 2005). This included assessments of the Meadowbank mine site area located approximately 70 km north of the Hamlet of Baker Lake, a winter road route to the mine site, and a storage and marshalling area east of the Hamlet of Baker Lake. A total of 42 new sites were recorded and eight sites were revisited. The majority were interpreted as relatively recent, temporary campsites.

Additional archaeological baseline studies are planned for the Project areas in 2009. These data will be included in the DEIS.

6.4 Palaeontological Component of Surface and Bedrock Geology

No fossils have been noted to date by geologists, archaeologists, or other field staff during exploration in the Kiggavik Project area.

6.5 Regional Population

Kivalliq Region's population is estimated to have grown from 7,557 to 8,348 people between 2001 and 2006, for a growth rate of 10.5%. Between 1996 and 2001, the population growth rate, at 10.0%, was comparable. Figure 6.2 illustrates the variability in population sizes and growth rates between the seven communities. Rankin Inlet, Arviat and Baker Lake are the larger communities, all with populations over 1,500. The remaining four communities have populations in the neighbourhood of 500. The fastest growing communities were Repulse Bay (22.2% between 2001 and 2006), Whale Cove (15.5%) and Baker Lake (14.7%).

The population is young, with a median age of 21.1, slightly higher than the median age of 20.3 in 2001 and about 2 years lower than that of Nunavut as a whole. Single parent households make up 27% of households, a figure that is comparable to the rest of Nunavut. The population is about 90% Inuit. Inuktitut is the mother tongue of 81% of people and the language most spoken at home for almost 60% of the population – in the smaller communities the Inuit population and use of Inuktitut in the home is generally greater than in the larger communities. About 90% of residents have knowledge of English, and only about 2% have knowledge of French (Statistics Canada 2007).

The economy of Kivalliq includes both land based and wage sectors. Activity on the land provides nutritional food, strengthens Inuit culture and can generate cash income (through for example, sale of natural and artistic products, outfitting, etc.). As of 2001, land based activity was reported to be stable in most communities (NWMB 2004) and provided livelihood resources to well over half the population, predominantly caribou and fish (Statistics Canada, 2002a). The land based sector is described in the *Keewatin* (now Kivalliq) *Regional Land Use Plan* as being ". . . generally based on non monetary exchange, private ownership of modes of production, family . . . and transactions which provide for subsistence and do not increase profits or accumulate capital for its own sake" (NPC 2002). The plan also emphasizes the desire of people in Kivalliq to develop a stronger wage economy, especially employment opportunities for youth, while maintaining the traditional lifestyle of Inuit.

Participation in the wage sector provides income to supplement the livelihood resources coming from the land based sector, that is, from hunting, trapping, fishing and other natural resource gathering. As well, wages generate cash which facilitates land based economic activity.

With regard to employment, people in Kivalliq appeared in 2006 to be slightly worse off on average than in Nunavut as a whole. Although unemployment rates were comparable (at 15.7% in Kivalliq and 15.6% in Nunavut), there were fewer participants in the labour force in Kivalliq, perhaps a result of more discouraged workers no longer looking for jobs. Median earnings and incomes were lower in Kivalliq than Nunavut, fewer people over 15 years of age earned any income in the previous year, and there was more dependence on government transfers. Single parent families are more likely to be poor – in Kivalliq median after tax incomes for these families were $20,416 as compared to married couple families, which were $56,240.

Table 6.1 provides some indication of labour force characteristic changes in Kivalliq between 2001 and 2006. Both the 15 years and over population and the labour force have grown by 16 to 17% (as compared to population growth of less than 11%). While unemployment rates have gone down, the participation rate has decreased more, again indicating discouragement in looking for work rather than economic improvement between 2001 and 2006.

Education levels also compare unfavourably to those in Nunavut. Kivalliq people in 2006 were more likely to have no certificate, diploma or degree (65% of the population over 15 years of age as compared to 57% for Nunavut). The education statistics suggest that educational achievement is lowest in the 15 to 24 year age cohort – there is a significant challenge in Kivalliq to get children through high school.

Table 6.1 Labour Force Characteristics, 2001 and 2006

Characteristic	2001	2006
Population 15 years and over	4,510	5,255
Labour Force	2,775	3,240
Participation Rate	66.9	61.7
Unemployment Rate	18.6	15.7

Source: Statistics Canada 2002b and 2007

6.6 Community Profiles

In addition to characteristics general to most of the Kivalliq communities as described above, the individual communities have characteristics that are distinctive. Much of what follows is based on i) Statistics Canada census and survey data including the *Aboriginal Peoples Survey*, collected in 2001 and 2006, some of which is included as Appendix VI; and ii) the most recent survey of harvesting, collected over the period 1996 to 2001 by the Nunavut Wildlife Management Board (NWMB). The harvest survey did not attempt to capture harvests for commercial purposes. It is noted that communities do not always agree with census and survey results.

Baker Lake

Baker Lake (or Qamanittuaq) is the Kivalliq community closest to the proposed Project, and is located near the geographical centre of Canada. The only inland community in Nunavut, in 2006 Baker Lake had a population of 1,728, which had grown since 2001 by 14.7%.

At the time of the census in 2006, the Meadowbank project had not yet been approved. That project is currently in its construction phase and there have been an increasing number of mineral exploration companies operating out of Baker Lake over the last two years, including AREVA. These events appear to have generated significant changes in the hamlet, particularly in employment and business activity. Recent changes in Baker Lake may include increased returns to business, particularly in hospitality, transport and expediting; and competition for qualified staff. Thus 2006 data for Baker Lake, which indicate lower than Kivalliq average earnings and incomes, a higher than average unemployment rate and more dependence of government transfers, may not approximate current conditions.

Data from the *2001 Aboriginal Peoples Survey* indicate that 53% of adults had hunted in the previous 12 months, 62% had fished, 55% had gathered wild plants (e.g. berries and sweet grass), and 8% had trapped. Most of this activity was done to get food – 96% of hunting and 91% of fishing and gathering was reported to be for food (Statistics Canada 2002a). However, the number of registered hunters decreased between 1996 and 2001.

The NWMB results show that most hunters hunted caribou – the survey estimated that the five year mean annual harvest was 2,480 animals. Hunting of wolf and arctic fox were far behind, at 91 and 122 animals respectively. Canada geese and ptarmigan were also harvested, again at rates under 200 animals per year. There is a lot of fishing, particularly of lake trout (at over 4,000 fish taken) and arctic char (552 fish). It is noted that feedback on the survey from people in Baker Lake suggested that estimates for wolf, Canada geese and arctic char harvests seemed low.

Chesterfield Inlet

Chesterfield Inlet (or Igluligaardjuq, meaning place with a few houses) is the smallest community in Kivalliq. The community is located near the inlet that bears its name, which extends from Hudson Bay to Baker Lake. The population of Chesterfield Inlet in 2006 was 332, a decrease since 2001 of 3.8%.

Chesterfield Inlet appears to be quite challenged in terms of educational achievement in young people, few of whom have managed to complete high school. However, incomes and harvesting are comparatively high and there is less dependence on government transfers for livelihoods than seen elsewhere in Kivalliq (excepting Rankin Inlet).

With regard to traditional activity, most hunting and gathering is for food. Fishermen fish for household consumption but are also able to sell to a community fish processing plant. According to the *Aboriginal Peoples Survey*, 63% of Chesterfield Inlet residents had hunted, 79% had fished and 79% had gathered plants in the previous 12 months (Statistics Canada 2002a).

Again, most hunters took caribou (mean annual harvest was estimated at 655 animals) but seal, beluga and arctic fox were also hunted, with an estimated 92, 17 and 81 animals harvested respectively. Snow geese, Canada geese, ptarmigan, lake trout and arctic char were also harvested. As for Baker Lake, the community does not agree with estimated five year annual mean harvest numbers in many cases. Nevertheless, primary dependence is clearly on caribou and lake trout.

Rankin Inlet

Rankin Inlet (or Kangiqliniq) is the largest community in Kivalliq. Its 2006 population was 2,358, an increase of 8.3% over 2001.

Rankin Inlet has the largest non aboriginal population, at 16% of the total and people are more likely to speak English in this community. Land based activity is not as prevalent as in other Kivalliq communities – there are fewer hunters on a per capita basis and harvests are proportionately smaller.

Rankin Inlet has a more highly diversified workforce, more services and businesses, a higher participation rate, a lower unemployment rate, and higher incomes than in the rest of Kivalliq. It is home to the Kivalliq Inuit Association and has a Nunavut Arctic College campus. Rankin Inlet, like Baker Lake, is experiencing a small economic boom as a result of being the closest large community with comparably good infrastructure and services for a number of mining activities. Rankin Inlet is also an air transport hub for the rest of Kivalliq.

Whale Cove

Whale Cove (or Tikirarjuaq) is located between Rankin Inlet and Arviat on Hudson Bay. In 2006, Whale Cover had a population of 353, an increase of 15.7% over 2001. Whale Cove is the community with the highest percentage of Inuit in Kivalliq, proportionately more people speak Inuktitut in the home, at 87%, and the community is often described as relatively traditional. The population is one of the youngest in Kivalliq, with a median age of 19.1 years. Whale Cove also has the highest percentage of lone parent families, at over 30%, all them of them reportedly headed by women.

In Whale Cove, 59% of adults had hunted in 2000, 71% had fished and 47% had gathered plants. Hunting is primarily for food, with caribou again the most important species, although arctic fox, seal and snow and Canada geese were also hunted. Arctic char was more commonly fished than lake trout.

Perhaps reflecting their more traditional lifestyle, the people of Whale Cove are the least likely to be in the wage economy workforce – less than half of adults either are working or looking for work.

Arviat

Arviat is the second largest community in Kivalliq, with a population of 2,060 in 2006, an increase of 8.5% over 2001. It is the most southern community in Nunavut.

In 2001, nearly all adults who hunted or fished in the previous 12 months had done so for food – 64% of adults had hunted, 70% had fished, 15% had trapped, and 57% had gathered plants. The number of registered hunters increased between 1996 and 2001.

Caribou is again the main species hunted, but wolf, beluga and seal are also important resources. Snow and Canada geese, arctic char and lake trout are also harvested. In contrast to other communities, the take for arctic char is very high in Arviat, at an estimated 4,262 fish, about three times more than lake trout. Further, this number of char does not include the commercial fishery, although some of the fish may have been sold.

Arviat has made some good progress towards integrating the land based and wage economies, with incomes being generated from traditional activities. Pelts are sold to the Northern Store, Eskimo Point Lumber Supply and the Padlei Co-op. Kiluk Ltd. employs seamstresses to make handcrafted clothing. Numerous artists sell carvings made of soapstone, caribou antler and ivory, as well as wall hangings and paintings (KSO, website 2008). There are also outfitters. Arviat (along with Whale Cove) has a comparatively low labour force participation rate (which refers to the wage economy) and a low unemployment rate.

Coral Harbour

Coral Harbour (or Sallit) is located on the Southampton Island in Hudson Bay. The population in 2006 was 769, and had increased by 8.0% over 2001. As in other remote, more traditional communities, Coral Harbour's population is very young and 95% of people have Inuktitut as their mother tongue.

In the 12 months previous to 2001, 65% of adults had hunted, 73% had fished, 43% had gathered plants and 16% had trapped. However between 1996 and 2001 the number of registered hunters decreased. As for the rest of Kivalliq, caribou was most commonly hunted, as well as seal and arctic fox in numbers proportionately higher than seen in most other Kivalliq communities. The number of arctic fox harvested was likely in the order of 1,500 to 2,000 per year by 2001, compared to harvests in the low hundreds in other, sometimes larger, communities. The arctic fox hunt is an important source of cash income, as most pelts are sold. Snow geese and ptarmigan harvests were also in the thousands, and although the bird hunt is considered more popular than fishing, the five year mean annual harvest estimate for fish was almost 6,700.

Coral Harbour has comparatively low incomes, and high unemployment.

Repulse Bay

Repulse Bay (or Naujaat) is the most northern of the Kivalliq communities. In 2006 the population was 748, 22.2% higher then in 2001, making it the fastest growing population in Kivalliq. 95% of the population is Inuit, Inuktitut is the mother tongue of 93% of people, and Repulse Bay has proportionately more people speaking Inuktitut in the home than any other Kivalliq community.

In Repulse Bay the harvesting rates in the 12 months prior to 2001 were the highest of all seven communities. All hunters and fishermen harvested for food and nearly all those who had gathered plants also did so for food – 72% of adults had hunted, 78% had fished, 75% had gathered plants, and 25% had trapped. Repulse Bay appears to have the highest dependence on land based resources for livelihoods.

The most commonly hunted species in 2001 was reported to be seal, followed closely by caribou. Narwhal, beluga, arctic fox and wolf were also commonly hunted. Birds were not often hunted (only 12% of hunters). Arctic char is fished – reported harvests were 100 times higher for char than lake trout. There is some commercialization of fishing, primarily through local sale in the community, including through the HTO and the Co-op.

In 2006, the situation with the wage economy in Repulse Bay compares unfavourably with the rest of Kivalliq. Median incomes were the lowest, at less than $11,000, government transfers accounted for 26.3% of total incomes and the unemployment rate was 34.5%, over twice the Kivalliq unemployment rate. Over 80% of the adult population had not completed high school.

6.7 Land and Resource Use

6.7.1 Land Management

The Nunavut Planning Commission (NPC), established under the *Nunavut Land Claims Agreement* (NLCA), is responsible for land use planning and environmental management in the territory. NPC's main function is to develop land use plans, policies and objectives that guide resource use and development, emphasizing the protection and promotion of the existing and future well being of the people and communities of the Nunavut Settlement Area.

The Kiggavik Project site is located within the boundaries of the *Keewatin Regional Land Use Plan*. Before 1999, Kivalliq Region existed under slightly different boundaries as Keewatin Region, Northwest Territories. The land use plan serves as the first level of review for development proposals.

Although the southern boundary of the Kivalliq planning region is the 60^{th} parallel, the Inuit in Kivalliq have aboriginal interests in areas of northern Manitoba and Saskatchewan. Likewise, the Dene in northern Manitoba and Saskatchewan have an aboriginal interest in the southernmost part of the Kivalliq. These aboriginal interests are largely related to traditional territories and the migration of the caribou herds, which are fundamental to historical and current livelihoods in Kivalliq.

Sustainable development is the overriding principle guiding land use planning in Kivalliq. The NPC has adopted the following definition of sustainable development: management of human relationships to the natural environment in such a way that economic, social and cultural needs are met, and ecological processes and natural diversity are maintained; with consideration of the well being of social, ecological and economic systems and recognition that quality of life depends upon all these.

Conformity criteria for projects are interpreted by NPC in accordance with several principles in addition to sustainable development. These include the well being of Nunavut residents, Inuit and Inuit owned lands, the protection of environmental integrity, compatibility with municipal land use plans, support for regional economic development and encouragement of multiple land uses. The onus is on potential land users and developers to demonstrate that their activities will not harm the environment and wildlife or have a negative effect on life in the communities (NPC 2002).

6.7.2 Traditional Land Use and Harvest Activities

Although six of Kivalliq's seven communities are located on the shores of Hudson Bay and hunt marine mammals and fish, there is high dependence for livelihoods in all communities on land resources, particularly caribou, fresh water fish and to a lesser extent arctic fox and wolf. The fall polar bear hunt is also very important – this occurs in all seven communities and, through the sale of tags, has been a very important cash resource for some tag owners. Walrus are also a resource harvested in more northern parts of the Kivalliq.

Of great importance are the caribou, the main food staple of Inuit. In Kivalliq, caribou are taken primarily from the Qamanirjuaq herd although hunters from Baker Lake also hunt the Beverly herd (NPC 2002). The Beverly and Qamanirjuaq Caribou Management Board's most recent estimates of the populations of the Qamanirjuaq and Beverly herds are 496,000 and 276,000 respectively (BQCMB 2008).

Subsistence harvest activities are actively practiced by a significant proportion of the Kivalliq population. The *2001 Aboriginal People's Survey* reports that approximately 57% of adults (aged 15 years and over) in Kivalliq Region reported hunting activity in the previous twelve months; nearly all of these incidences were for food. Fishing was a yet more common activity, with participation of approximately 69% of adults, also primarily for consumption. Plant gathering and trapping activities were more variable between communities, but still important. Additional harvest data from the survey are included in Appendix VI.

Country food replaces expensive store bought food – harvesting consistently provides a higher yield of food per dollar spent than can be bought with money earned from wage labour and is also a better source of nutrients, such as iron, magnesium and calcium, than imported food (NPC 2002).

The interests of hunters and trappers at a local level are represented by Hunting and Trapping Organizations (HTOs). Government funding, through the Nunavut Department of Environment, is provided through the Grants and Contributions in Support of Harvesters Policy. All seven communities in the Kivalliq region have local HTOs.

Detailed information regarding participation in traditional activities for residents of the seven Kivalliq communities is available from the *Nunavut Wildlife Harvest Survey* (NWMB 2004). Conducted between 1996 and 2001, this survey remains the most recent and comprehensive study of subsistence wildlife use throughout Nunavut (including hunting, trapping, gathering and fishing of mammals, birds (and their eggs and feathers), fish and shellfish, but not including commercial harvests).

For the purposes of the survey, a hunter was defined as someone who was an NCLA beneficiary, who was 16 years of age or older at the time of the survey, and who participated in hunting, fishing, or trapping of animals at any time during the year. Hunters were classified either as intensive, active or occasional[1] hunters. Table 6.2 summarizes the number of registered hunters by community and year. In most communities, most hunters are occasional and very few (as a proportion of the Inuit

[1] An intensive hunter is one who repeatedly and regularly engages in all or nearly all of the various types of hunting activities during the annual cycle, and who always has country food in the household; an active hunter is one who regularly engages in some of the major harvesting activities during the annual cycle (e.g. ice-edge seal hunting, char fishing, or caribou hunting), participation in the activity may be short but intense and time commitment is more than day-trips or an occasional weekend; an occasional hunter is one who occasionally, but not regularly, participates in hunting activities (e.g. a day or two of caribou hunting or waterfowl hunting, or rod-and-reel fishing every now and then), and participation is usually short-term, such as day-trips or weekend outings (NWMB 2004).

population) are intensive. Baker Lake, Rankin Inlet and Arviat, the three largest and more economically diversified communities, have the highest percentages of occasional hunters, while the smaller communities have high proportions of active hunters in addition to occasional ones. Coral Harbour is the exception, with an equal number of occasional and active hunters.

Table 6.2 Registered Hunters by Community and Year

Community	1996/97			1997/98			1998/99			1999/00			2000/01		
	O	A	I	O	A	I	O	A	I	O	A	I	O	A	I
Arviat	309	64	6	309	65	6	312	69	6	315	74	6	312	74	7
Baker Lake	264	62	1	263	60	1	252	62	2	240	60	2	234	63	2
Chesterfield Inlet	40	21	11	45	23	11	46	23	11	43	24	10	47	29	9
Coral Harbour	113	110	33	112	111	31	124	110	32	105	108	31	94	104	28
Rankin Inlet	238	86	55	240	80	52	235	80	52	228	82	54	226	83	53
Repulse Bay	108	55	6	105	52	6	103	48	6	103	43	6	96	44	6
Whale Cove	32	16	2	32	16	2	31	16	0	32	18	0	30	18	1

Note: O=occasional, A=active and I=intensive hunters
Source: NWMB 2004

Overall, the numbers show some stability over the period 1996 to 2001. More recent data are needed to determine the extent to which hunting is practiced since 2001.

Traditional knowledge studies are required to establish geographic ranges of current (and previous) land uses. Early indications from Baker Lake suggest that the immediate area of the Kiggavik Project is not believed to be a frequently used harvesting area although fishing has been important in the larger lakes to the north and south of the Project and caribou migrate nearby. The marine transportation route, which follows Chesterfield Inlet through to Baker Lake, likely does traverse lands and waters used for both land and marine hunting.

6.7.3 Non Traditional Economy

Although current land and resource use throughout Kivalliq is largely traditional use and the economy continues to rely on transfers from the Government of Canada, there has been some development of the wage economy. Mining and tourism are growing economic sectors in Kivalliq and in Nunavut as a whole.

Nunavut's and Kivalliq's governments and people have indicated that a balance between potentially incompatible land uses is desirable, emphasizing the importance of combining environmental protection, economic well being (including opportunities to earn wages) and maintenance of traditional cultures. This objective is reflected both in Nunavut's Economic Development Strategy (SEDS, 2004) and the Keewatin Land Use Plan (NPC, 2002).

Mining

The mining sector is increasingly important to the economy of Nunavut. Taking into consideration the exploration interest in Nunavut, it is possible that mining will represent a major source of investment, infrastructure, employment and contribution to gross domestic product (GDP) in the near to mid term future. In preparation, and to ensure that more of the benefits of mining stay within the territory, the government and Nunavut Arctic College are cooperating to introduce more mining related trades training programs.

Exploration expenditures increased from $179 million in 2005 to $323 million in 2007 (NRCan 2008). In 2006, Nunavut's real GDP grew faster than that of any province or territory except Alberta, advancing 3.4% on the heels of a decline of 0.2% in 2005. The government attributes much of this growth to mining activity (Nunavut Department of Finance 2008).

At least some of the 53 exploration properties in Kivalliq might be expected to become mines. Of these, 26 are under evaluation for their uranium potential. It is noted that Nunavut has placed some conditions on the mining of uranium, related to health and safety, environmental protection, distribution of benefits and public acceptance.

Data in Appendix VI summarizes existing mineral exploration and mining developments in the Kivalliq Region (not including the proposed Kiggavik Project).

Tourism

Tourism is a priority sector for economic development in Nunavut. Tourism is largely non consumptive (excluding hunting, which can contribute large amounts to individuals in communities), can have minimal environmental effects, provides good employment and is considered an economic activity that is consistent with efforts to maintain the integrity of traditional cultures.

The Government of Nunavut estimates that the tourism sector in the territory accounts for about $26 million in economic activity and attracts approximately 13,000 people each year, primarily from Canada, the United States and Europe. Activities include visiting territorial and national parks and heritage river systems, wildlife viewing, hiking, fishing and hunting. Many of these activities take place in the eight protected areas in Kivalliq. Nunavut also promotes their arts and crafts sector. Less than 20% of tourist dollars are estimated to be spent in Kivalliq.

In 2006, Nunavut's first *Visitor Exit Survey* was done. It confirmed that approximately 9,300 travelers visited Nunavut between June and October of that year. Half of these travelers visited for business purposes and more than one third for leisure or to visit family and friends (Nunavut Department of Finance 2008).

The Government of Nunavut expects the tourism industry to grow in coming years as a result of the growing level of awareness of climate change and its impacts on the Arctic, its people and their traditional cultures. The government recognizes the need to construct tourism related infrastructure while ensuring that Inuit are the primary economic and social beneficiaries of tourism and that the very cultural and ecological values that attract visitors to Nunavut must be protected (Nunavut Department of Finance 2008).

Commercial Harvesting and Fishing

While hunting and fishing are traditional land uses, engagement in commercial harvesting has become an important part of the wage economy of Kivalliq and Nunavut.

The fishing industry in Nunavut focuses primarily on two species, shrimp and turbot. Inshore fishing of arctic char also accounts for a small percentage of Nunavut's total catch. Although landings were down slightly in 2007, the fishing industry has experienced growth over the past five years (Nunavut Department of Finance 2008). Contributing to the growth of the industry were greater allocations of turbot and shrimp, investments in offshore fishing vessels, and increased participation by Inuit. The GN also cites Inuit participation in continued training and certification through the Nunavut Fisheries Training Consortium as contributing to the growth of the industry.

There are two meat processing plants in the territory, one of which, Kivalliq Arctic Foods in Rankin Inlet, processes arctic char and caribou. The combined sales from both plants total more than $2.2 million annually and are a source of local employment (Nunavut Department of Finance 2008). Kivalliq's caribou meat products are exported to clients in the United States as well as the European Union (Mason et. al. 2007).

Commercial sealing helps to finance subsistence harvesting. The GN's Fur Pricing Program purchases 6,000 to 9,000 skins each year, providing more than $500,000 in income for more than 800 hunters. Additionally, Nunavut Arctic College offered a pilot training course in 2007 in Fur Production and Design to teach Inuit the knowledge and skills needed to design and produce sealskin clothing for markets. The college's main campus is in Iqaluit with regional campuses in Kivalliq in Rankin Inlet and Coral Harbour.

Local and Regional Transportation

Rankin Inlet is the major transportation link to the rest of the territory and the rest of Canada. Air and marine transportation systems are used to move goods and people over long distances.

There are regular flights between all seven communities and Rankin Inlet, which has frequent flights to Iqaluit, Churchill, Winnipeg and Yellowknife. Community supplies normally come in the summer months from Churchill by barge or from Montreal by ship. There are no highways or railroads in

Kivalliq. ATVs and snowmobiles are popular forms of personal transportation but cars and trucks are becoming more numerous (NPC 2002).

6.8 Health

Health, as defined by the World Health Organization, is a state of complete physical, mental and social well being and not merely the absence of disease or infirmity. The determinants of health are social and economic as well as physical. They include social support networks, employment and working conditions, social environments, physical environments, education, healthy child development, biology and genetic endowment, culture, health services, personal health practices and coping skills, gender and income and social status (Public Health Agency of Canada 2003).

The 2001 Aboriginal Peoples Survey Community Profiles (Statistics Canada 2002a) provide some health data for communities in Kivalliq. Health characteristics available are general heath condition, those who saw or talked to a health professional in the past 12 months, and the number of those diagnosed with long term health conditions. In all communities most people said that their health was in good to excellent condition. For those who reported health in fair or poor condition, data are available for only Baker Lake, Coral Harbour, and Whale Cove. (This is for Statistics Canada's confidentiality reasons, which requires that very small sample size results not be reported. The deduction is therefore that very few people in these other communities report poor health.) In Baker Lake 20% of adults reported fair or poor health, in Coral Harbour 16% and in Whale Cove 18%. This is above the average for Nunavut as a whole where 10% of adults reported fair or poor health, and for Kivalliq where 7% report fair or poor health. Additional health data are included in Appendix VI.

Overall, approximately one third of adults in Kivalliq had seen or talked on the telephone with a family doctor or practitioner about physical, emotional or mental health in the 12 months prior to the survey. More than twice as many had seen or spoken to a nurse in the same period. Approximately 36% of Kivalliq adults reported having been diagnosed with a long term health condition. The lowest incidence was reported for Rankin Inlet (28.7%) and highest for Baker Lake (41.7%).

All of the communities have at least some health services available, with others provided on a periodic basis by fly in specialists, including doctors, physiotherapists, dentists, and/or optometrists. Health centre staff and services generally correspond to the size of the community and its particular needs. In addition to a well staffed health centre, Rankin Inlet has a new 10 bed hospital but for most medical emergencies or procedures patients are transported to larger centres such as Churchill and Winnipeg.

Nevertheless, Kivalliq and it communities continue to experience severe health challenges, and in general health indicators are well below those typical of southern Canada. Under the broader definition of health, there is concern about substance abuse, mental illness, family dysfunction, nutrition, crime, violence and women's rights. Finally, there are concerns about contamination of country foods – including radiation levels in caribou from radioactive fallout occurred during the period of above ground nuclear testing the 1950s and early 1960s – such that INAC has established a Northern Contaminants Program, to “work towards reducing . . . and eliminating contaminants in traditional/country foods” (INAC 2006).

6.9 Socioeconomic Baseline Work

AREVA has obtained a socioeconomic and traditional knowledge (IQ) research license from the Nunavut Research Institute. The traditional knowledge work planned under this research license is described in Section 4. The socioeconomic work under the license is expected to be conducted in all seven Kivalliq communities. The potential for Project effects is expected to vary between the seven communities. Detailed socioeconomic work planning would take into account the potential for effects and therefore data collection would not necessarily be exactly the same in all communities.

It is expected that the baseline socioeconomic work would include the following;

- review of regional and territorial census data, literature surveys, special purpose studies, socioeconomic monitoring reports, planning documents, and information from Meadowbank and other Nunavut mines;
- meetings with community leadership and organizations to discuss the proposed socioeconomic data collection programs, to obtain input on preferred methodologies and timing, to identify participants (see below) and to address any concerns, for example with regard to confidentiality;
- interviews of key informants and the organization of focus group discussions (for example with women, elders, young adults, rotational workers), in order to describe socioeconomic conditions and trends in potentially affected communities – of particularly importance will be to ensure that Inuit perspectives of determinants of health and well being are understood. Socioeconomic parameters investigated would include:

    - demography (population, population growth rates, birth and death rates, age and gender distribution, settlement and migration patterns);
    - economic activity (employment, income and education);
    - natural resource use (access to and use of land, water and other natural resources);
    - social services (access to health care, child and elder care, education, other social services);
    - public health (determinants of health, incidence of disease, maternal health, nutrition);
    - public safety (crime rates, availability and capacity of policing, firefighting, emergency medical services, emergency response planning);
    - other defining characteristics of community well being (family functionality, social and cultural values, belief systems);
    - housing availability and costs;
    - public infrastructure;

- o recreational facilities;
- o political and social organization (leadership, participation, decision making, gender issues); and
- o public perceptions of the Project.

The socioeconomic parameters listed above may be amended, contingent on the content of the any terms of reference provided by the Nunavut Impact Review Board, ongoing consultations with communities, documentation and data review and/or any early expectations on potential mitigation and benefits measures.

Subsequent to the field programs, the socioeconomic baseline report will be drafted and presented to communities in order to discuss and validate the results.

In addition, the socioeconomic baseline work would envisage information exchange and sharing with other environmental assessment disciplines, including particularly IQ work on land and water resources, and work on biological disciplines (terrestrial, aquatic and marine biology), such that results of each discipline are reflected in the others as appropriate to adequately understand the interrelationships that will determine both the significance of potential Project effects and culturally appropriate responses to these on the part of AREVA.

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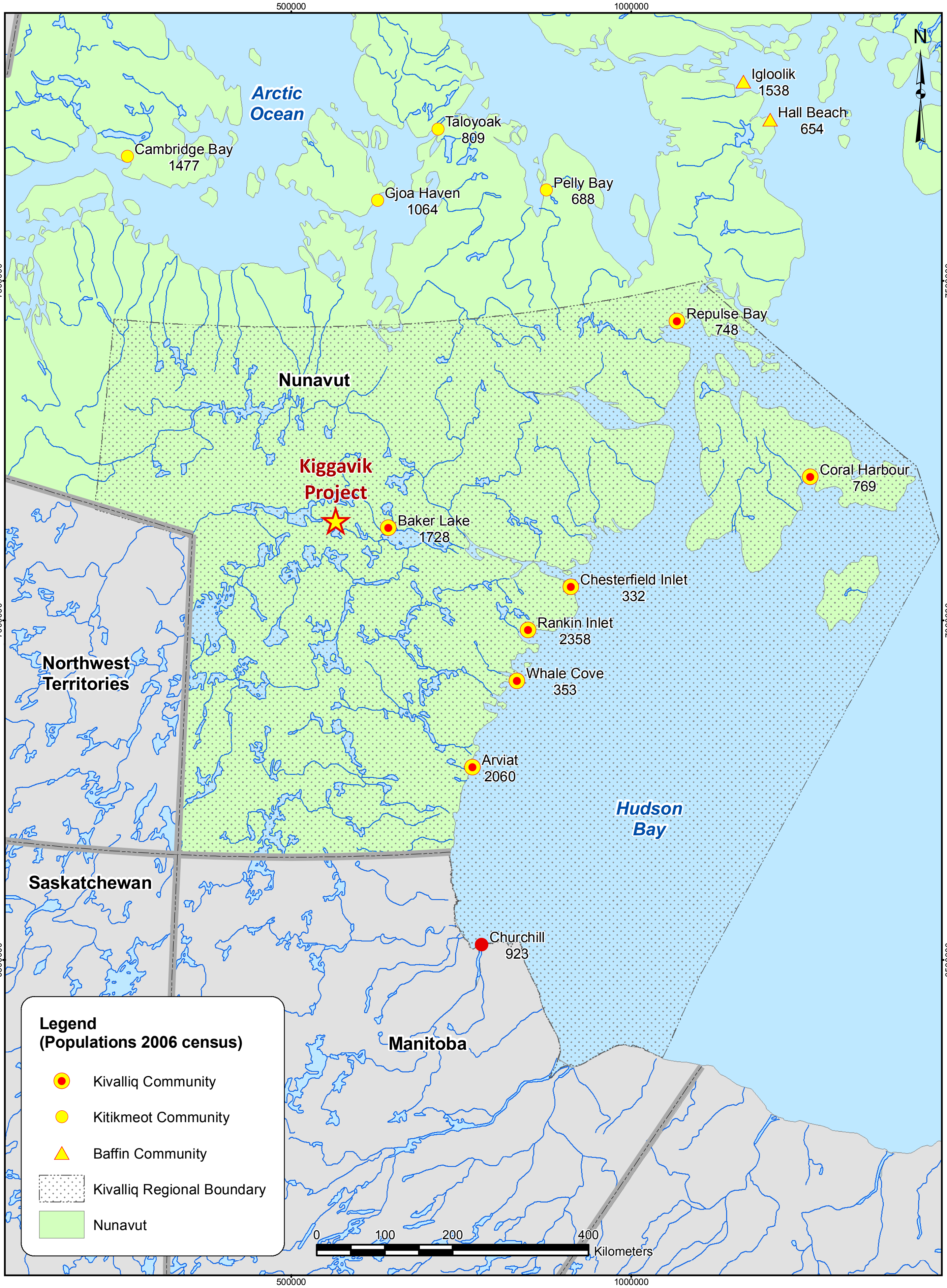
KIGGAVIK PROJECT

Project Proposal

<u>SECTION 6</u>

LIST OF FIGURES

Figure 6.1: The Kivalliq Region of Nunavut
Figure 6.2: Population of Kivalliq Communities 1996 - 2006



KIGGAVIK PROJECT

THE KIVALLIQ REGION OF NUNAVUT
FIGURE 6.1

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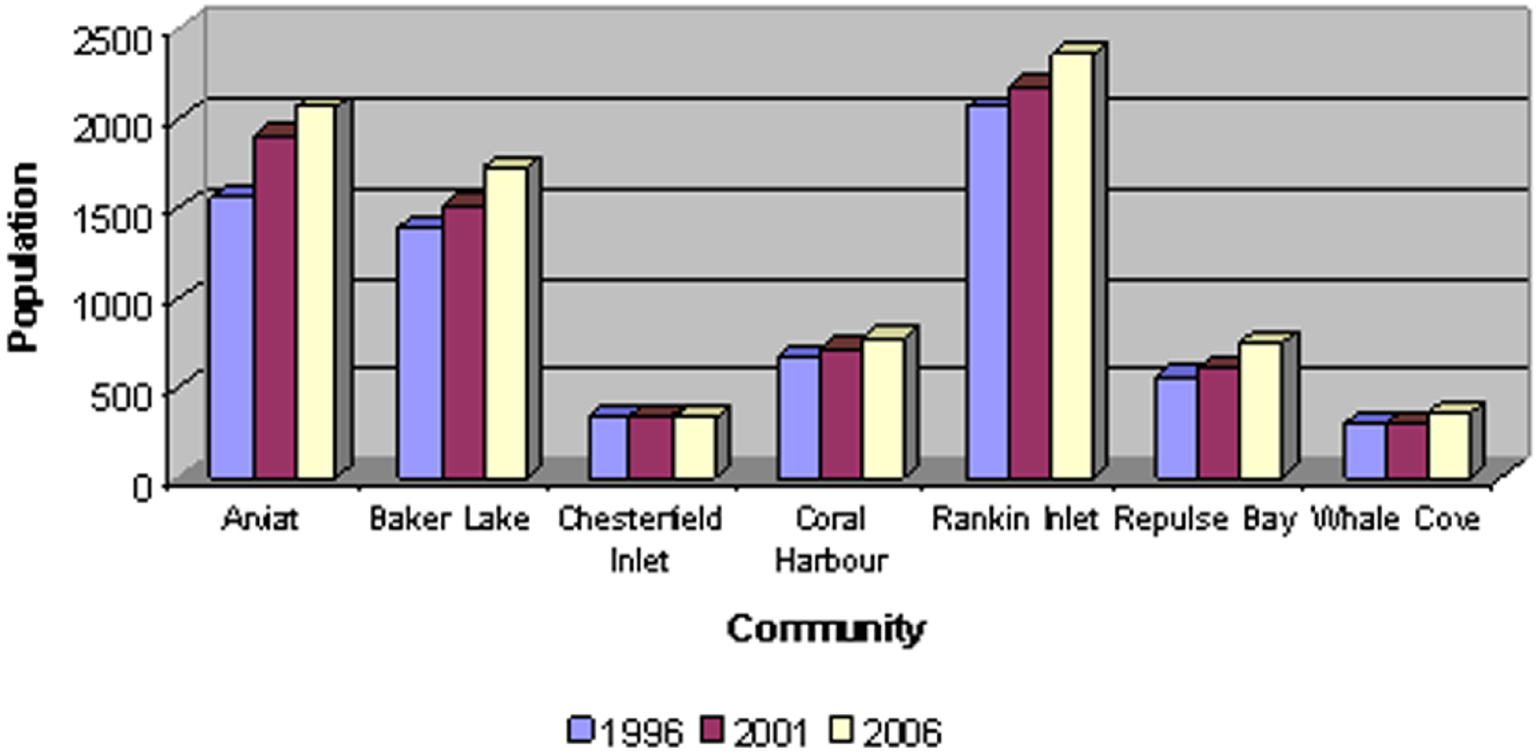
Creator: CDC
Date: 10/31/08
Drawing:

AREVA

AREVA Resources Canada Inc
P.O. Box 9204
817-45th Street West
Saskatoon, Sk. S7K 3X5



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POPULATION OF KIVALLIQ COMMUNITIES 1996-2006 FIGURE 6.2	Creator: CDC Date: 10/31/08 Drawing:		

KIGGAVIK PROJECT

Project Proposal

SECTION 7

TABLE OF CONTENTS

SECTION **PAGE**

7 POTENTIAL ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION 7-1

7.1 Identification of Potential Environmental Effects..7-1

7.2 Potential Effects on the Biophysical Environment 7-2

7.2.1 Effects on Air Quality 7-2
7.2.2 Effects on Noise Levels 7-4
7.2.3 Effects on Ground Stability and Permafrost...7-5
7.2.4 Effects on Groundwater 7-5
7.2.5 Effects on the Freshwater Environment 7-6
7.2.5.1 Effects on Water and Sediment Quality 7-6
7.2.5.2 Effects on Aquatic Organisms, Fish and Fish Habitat..........................7-9
7.2.6 Effects on the Marine Environment 7-11
7.2.6.1 Effects on Marine Water and Sediment Quality 7-11
7.2.6.2 Effects on Marine Organisms, Fish and Fish Habitat.........................7-12
7.2.6.3 Effects on Marine Wildlife 7-12
7.2.7 Effects on the Terrestrial Environment 7-14
7.2.7.1 Effects on Soil...7-14
7.2.7.2 Effects on Vegetation..7-14
7.2.7.3 Effects on Terrestrial Wildlife 7-15
7.2.7.4 Effects on Birds...7-16

7.3 Ecological and Human Health Risk Assessments 7-17

7.3.1 Ecological Assessment..7-18
7.3.2 Human Health Assessment 7-19

7.4 Potential Effects on Heritage Resources 7-19

7.5 Potential Socioeconomic Effects...7-20

7.5.1 Employment...7-22
7.5.2 Education and Training..7-22
7.5.3 Business 7-23
7.5.4 Increased Incomes 7-23

7.5.5 Maintenance of Traditional Ways of Life 7-23
7.5.6 Individual and Community Well Being 7-24
7.5.7 Public Health and Safety 7-25
7.5.8 Infrastructure and Social Services 7-26
7.5.9 Community Investment 7-26
7.5.10 Territorial Economic and Fiscal Benefits 7-26
7.5.11 Socioeconomic Mitigation and Benefit Enhancement 7-27

7.6 Potential for Transboundary Effects 7-33

7 POTENTIAL ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION

7.1 Identification of Potential Environmental Effects

The Kiggavik Project has the potential to impact the biophysical and human environments through components associated with all phases of Project life, including the construction, operation, decommissioning, and post-decommissioning periods. Preliminary identification of effects has considered the full scope of the Project, including the operating mine sites and associated infrastructure, the access road, and the marine transportation route. The potential environmental effects currently identified for the Project are summarized in Appendix II as contained within NIRB's Project Specific Information Requirements (Part 2 form). Mitigation measures for many of the potential effects are described in the following sections. Further evaluation of the environmental effects of the Project and development of appropriate mitigative measures are on-going as part of the feasibility and environmental assessment (EA) phases.

The components of the biophysical environment that could potentially be affected by the Project are as follows:

- Air quality
- Noise
- Ground stability and permafrost
- Groundwater quality
- Surface water drainage
- Marine and freshwater quality
- Marine and freshwater sediment quality
- Marine and freshwater aquatic organisms
- Marine and freshwater fish and fish habitat
- Marine wildlife
- Soils and landforms
- Terrestrial wildlife
- Terrestrial vegetation

The potential human and socioeconomic components that may be affected by the Project are as follows:

- Human health
- Heritage sites
- Employment opportunities and incomes
- Education and training opportunities
- Business opportunities
- Traditional lifestyles and community well-being
- Infrastructure and social services

The potential biophysical and socioeconomic effects are discussed separately in Sections 7.2 and 7.5, respectively. The biophysical and human health components are integrated via preliminary ecological and human health risk assessments in Section 7.3.

7.2 Potential Effects on the Biophysical Environment

7.2.1 Effects on Air Quality

There will be the potential for effects on air quality during the construction, operation, decommissioning, and post-decommissioning phases of the Project. At various stages, constituents of concern could include: radon-222, airborne dust (including total suspended particulates (TSP), radioactive constituents, and/or metals), as well as, standard pollutants (NO_x, SO_2, CO_2).

During the construction phase, the primary sources of air emissions will be earth-moving and blasting activities, vehicular exhausts, and power generation.

Sources of atmospheric emissions during the operational phase include: drilling, blasting, loading, hauling and unloading of mine waste rock and ore; air exhaust from underground mining; wind erosion of stockpiled ore and mine wastes; ore handling; activities related to the milling operation and tailings disposal, as well as emissions from on-site vehicular movement. Sources of conventional air pollutants besides vehicle exhausts include on-site power generation and acid production facilities. Trucks moving supplies to the Kiggavik site and product to market along the access road connecting Kiggavik to Baker Lake will also contribute dust and standard pollutants.

During decommissioning and post-decommissioning, the principal constituent of potential concern is expected to be radon-222 associated with dust from the clean waste piles left on surface, until vegetation is re-established. Tailings produced from milling the ores will be disposed in two of the mined out pits at the Kiggavik site and will be in a saturated state at mine closure and therefore, a negligible source of radon-222 in comparison to the waste rock piles.

To evaluate the effects of the Project on the atmospheric environment, air dispersion modelling was performed using the CALMET/CALPUFF modeling package. While a current state-of-the-art dispersion model was used for this application, it is noted that the assessment was undertaken at a screening level commensurate with the level of design detail available at the current stage of Project development. The following is a summary of this assessment; the complete report is available as Supporting Document No.3 (see Section 1.8).

Summary of Atmospheric Dispersion Modelling

The screening level air quality assessment was undertaken to evaluate the effects that activities associated with the mining and processing of uranium ore and the mining and management of mine wastes at the proposed Project would have on radon-222, airborne dust (including total suspended particulates (TSP)), radioactive constituents (uranium-238 and its progeny), and metals (e.g. arsenic, molybdenum, nickel, selenium and zinc), as well as, standard pollutants (NO_x and SO_2) levels in the local atmospheric environment and in the community of Baker Lake. Emission estimates for the noted constituents were derived from operating records at other sites, in particular AREVA's McClean Lake Operation in northern Saskatchewan, as well as from the use of published emission factors.

The assessment was carried out for a maximum production year (i.e. year with maximum expected atmospheric emissions) and for the post-decommissioning period following site reclamation. The predicted effects on air quality were assessed against federal air quality standards where applicable or against air quality reference levels established in other jurisdictions.

The results of the screening level assessment demonstrated that the proposed Project would not have adverse effects on most of the modelled constituents. One exception was the predicted maximum 1-hour NO_2 level at the Kiggavik mill site. The predicted effect at this location was attributable to the assumption made about the height of the stacks on the individual power generation units that will be installed in a building close to the mill complex. This aspect will be investigated further at the next level of design to mitigate any on-site effects of the operation. The other exception was the predicted maximum 24-hour TSP levels which were shown to exceed the maximum acceptable standard in the vicinity of the Kiggavik Project site. However, the analysis did not take into account any reduction in dust emissions due to natural causes (i.e. wet or frozen ground conditions) or operating procedures that can be implemented to reduce dust emissions during adverse weather conditions. This aspect will also be investigated further in the next phase of the assessment.

In the post-decommissioning phase, the modelling indicated that the only residual effect of the Project on local air quality would be slightly higher radon-222 levels in close proximity to the mine waste piles left on surface. These piles would be contoured, covered and vegetated at closure to mitigate wind erosion (i.e. minimize dusting) and to mitigate visual effects.

It is estimated that the Project will emit 200,000 tonnes of carbon dioxide equivalents per year. This emission, although offset by the use of yellowcake to produce nuclear fuel, will contribute to climate change.

Predicted effects of the Project on air quality in Baker Lake, the closest community to the mine site, were predicted by preliminary modelling. The effects on key constituents of concern were shown to be not measurable nor distinguishable from baseline levels in the community during the operating or post-decommissioning phases.

Proposed Mitigation

Further design of the Project will be linked with the detailed air quality risk assessments to reduce emissions to acceptable levels. Closure monitoring and appropriate reclamation of waste rock stockpiles are proposed to reduce any residual radon-222 emissions.

Generation of dust and standard pollutants during construction will be managed via dust suppression and source control where necessary. Some construction activities may be staged to avoid critical wildlife periods if necessary.

7.2.2 Effects on Noise Levels

The primary sources of noise associated with the Project are as follows:

- Mining equipment operation
- Blasting
- Underground ventilation fans
- Haul trucks or ore trailers travelling between Sissons and Kiggavik and unloading at stockpiles
- Milling equipment noise, particularly at the grinding circuit
- Water intake pumps
- Aircraft operation
- Transport trucks travelling along the access road
- General construction of infrastructure and roads
- Marine operations required for the transport of materials and goods to the dock facility at Baker Lake
- Loading and unloading ship materials and goods as well as general port activity (people, equipment, vehicles)

The noise generated at the Kiggavik and Sissons mine sites may have negative impacts on wildlife, human health, and recreational land-use. In addition to these impacts, noise from the Baker Lake dock facility and along the access road may also affect community well being. The majority of noise on the marine route, both airborne and underwater, is expected to be produced in and around the terminal site in Baker Lake where the ships will be loaded and offloaded and when they depart the terminal. Noise will be produced from the ship throughout the proposed shipping route but will be localized around the vessel.

Proposed Mitigation

Noise generated at the Kiggavik and Sissons mine sites and on the access road will be mitigated through engineering control at the equipment source, shielding where possible, and through use of personal protective equipment. Further evaluation of the possible impacts to terrestrial and marine wildlife will be conducted during the EA phase. Possible mitigative measures include reduced travel and operational activity during particularly sensitive periods. In addition, wildlife monitoring is proposed during all phases of the Project to better understand impacts and the efficacy of mitigation, with the objective of continuous improvement.

7.2.3 Effects on Ground Stability and Permafrost

Project activities that may impact ground stability and permafrost are:

- Construction of infrastructure on the tundra, including roads, foundations and the airstrip
- Open pit mining at Kiggavik and Andrew Lake
- Underground mining at End Grid
- Borrow source quarrying along the proposed access road

Any disturbance of the tundra surface, particularly cut and fill, may result in thawing of the permafrost and thaw settlement of the tundra. Improperly designed excavations in poor quality rock, such as exists at Sissons, can lead to ground fall. Instability in the underground access decline could potentially lead to subsidence on the surface.

Proposed Mitigation

Road and infrastructure construction will minimize the use of cut and fill and will use pads of sufficient thickness to protect the permafrost. Culverts will be used to prevent damming of water. Design and construction of foundations will be performed by qualified personnel experienced in Arctic engineering.

Ground stability will be maintained in excavations through the gathering of sufficient geotechnical design data, the appropriate application of mining techniques, and on-going construction and operational monitoring.

7.2.4 Effects on Groundwater

The following Project activities have the potential to impact groundwater:

- In-pit disposal of the tailings during the operating, decommissioning and post-decommissioning phases
- Open pit mining below the permafrost at Andrew Lake
- Underground mining below the permafrost at End Grid
- Eventual decommissioning/flooding of East Zone open pit
- Eventual decommissioning/flooding of Andrew Lake open pit

Post-decommissioning long-term effects associated with an in-pit tailings management facility (TMF) derive mainly from the potential release of soluble contaminants from the tailings to the surrounding groundwater system and subsequent transport to surface water receptors. The key components that control the release and transport of contaminants include the chemical and physical properties of the tailings within the decommissioned TMF and the groundwater and surface flow regime in the area of the TMF.

In the Kiggavik area, the presence of permafrost conditions and the expected low hydraulic conductivity of both the tailings and the host rock are elements suggesting that contaminant release associated with tailings management may not be an issue for the Project. This will be confirmed as part of the EA through in-situ hydraulic tests and numerical modelling. In particular, the potential for fracture flow between the TMFs and Pointer Lake (the closest surface water receptor located down-gradient) will be assessed.

The two open pits used as TMFs (Center and Main Zones) will be excavated entirely within permafrost. During operation and decommissioning, the surrounding permafrost rock will be sufficiently impervious that pore fluids within the tailings will be effectively contained, although the mining of the pits and the deposition of the tailings will likely have an effect on the permafrost in the immediate vicinity of the pits.

In the longer term (>500 years), it is anticipated that the permafrost could disappear as a consequence of climate change. However, the unfrozen host rock (competent metasediments and granite) surrounding the TMF is expected to exhibit a low hydraulic conductivity ($<10^{-7}$ m/s) with the main potential for flow related to a few faults and fractured zones. Similarly, the consolidated tailings are expected to exhibit a low hydraulic conductivity. As a result, the potential for long-term flux of contaminants out of the facility through the groundwater pathway appears to be limited.

Open-pit and underground mining dewatering effects are not expected to alter the groundwater regime. However, the potential for impact as a result of mine dewatering at Andrew Lake and End Grid will be explored via hydrogeological tests and groundwater flow modelling.

Proposed Mitigation

Mitigation by design for the in-pit TMFs could include additional methods of tailings containment and bottom gravity drains or horizontal drains to enhance self-weight and cover related consolidation.

If mitigation of mine dewatering effects is required, proposed methods include freezing and grouting. The salinity of deep groundwater flowing into the underground mine is expected to increase during mining and will require treatment so that only high quality treated water is released into the environment.

7.2.5 Effects on the Freshwater Environment

Potential effects of the Project on the freshwater environment existing at the mine sites, along the access road and at Baker Lake include potential contamination of water and sediments, alterations to drainage, and impacts to aquatic life, fish and fish habitat. These potential effects and proposed mitigation measures are discussed in the following two sections.

7.2.5.1 Effects on Water and Sediment Quality

Freshwater and sediment quality could be impacted by the following Project activities:

- discharge of treated effluent meeting effluent discharge regulatory requirements, but potentially containing low concentrations of some radioactive and non-radioactive constituents (metals, TDS, TSS, ammonia)
- subaqueous disposal of mill tailings
- surface disposal of clean waste rock
- surface storage of ore and special waste rock
- construction of roads, bridges, dams, berms, and wharfs
- transportation of reagent, fuel, and yellowcake
- ANFO use (release of nitrogen compounds)

Water and sediment quality in Pointer Lake has the potential to be contaminated through general mill site runoff and/or seepage of pore water from the tailings management facilities (TMFs). The potential for TMF seepage and proposed mitigation is discussed in Section 7.2.4.

Contaminated runoff from ore, special waste, and clean waste stockpiles at both the Kiggavik and Sissons sites could reach surface waterbodies and contaminate water and sediments with radioactive constituents, metals, or excess acidity.

Construction activities at the mine sites, along the access road and at Baker Lake have the potential to impact water, primarily through the possible increase in total suspended solids (TSS). Construction activities planned at the dock facility such as the construction of a wharf, fuel storage and warehouse could generate dust and contribute to elevated levels of TSS in a localized area in Baker Lake. Release of contaminated dust into the water column could impact sediment quality. Likewise, construction of the road and associated bridges would disturb sediments along streams and rivers, increasing TSS in a localized area. Berms and dams will be used at site to control site drainage and treated effluent discharge. Construction and dewatering activities could increase TSS, particularly in Andrew Lake and downstream of Sik Sik Lake (Rock and Willow lakes).

Fuel, reagent and yellowcake handling and transportation from the Baker Lake dock facility to Kiggavik has the potential to introduce fuel (hydrocarbons) and other hazardous goods to the freshwater environment, including streams and lakes along the access road, the Thelon River, and Baker Lake. Although yellowcake is transported in sealed drums, collisions on the access road could damage the drums and potentially release radioactive material.

To assess the fate of radioactive and non-radioactive constituents from the discharge of treated effluent in the aquatic environment, a watershed dispersion model was employed to predict changes in surface water and sediment quality in the receiving environment. The following section summarizes the results of this aquatic environment effects assessment. The detailed report is available as Supporting Document No. 4 (Section 1.8).

Summary of Watershed Dispersion Modeling

Excess mill process water and contaminated site drainage water will be processed through a state-of-the-art water treatment system to produce a high quality effluent for discharge to the environment. To take into account uncertainties in both the quantity and quality of the treated effluents at this stage in the design, two discharge scenarios were defined for the screening level assessment:

- The Low Flow Scenario (LFS) is based on current best estimates of the expected volume of excess water requiring treatment and the performance of the treatment systems. Under the LFS, the treated effluent would be discharged to Sik Sik Lake, which would be developed as a storage reservoir with release of the stored effluent to downstream waterbodies (Rock, Willow and Judge Sissons lakes) at a controlled rate over the spring to fall period (i.e. over a four month period).
- The High Flow Scenario (HFS) is based on current upper bound estimates of the potential volume and quality of the treated effluents from the treatment systems. The effluent in the HFS would be discharged directly to Judge Sissons Lake on a continuous basis year round.

The watershed dispersion model applied in the assessment was modified to take into account the natural influence of freeze-thaw effects on lake water quality. One of the effects of ice formation is the exclusion of dissolved ions from the ice phase resulting in an increase in the dissolved solids content in the remaining liquid phase. Because Sik Sik, Rock and Willow lakes are quite shallow, it is expected that these water bodies will freeze solid during a typical winter. Judge Sissons Lake by contrast is a much larger lake (mean depth of 4.6 m, maximum depth of 17 m and total volume of 439 million m^3) and thus only partially freezes during the winter period. These lakes are located in the Anigaq River basin which drains into the western edge of Baker Lake (Figure 5.5).

Discharge of the treated effluent to Sik Sik Lake is predicted to potentially impact water and sediment quality in the lake during the winter months when a majority of the water column is expected to freeze. It is noted however, that the high values are expected to occur only following the onset of ice formation and decrease to low concentrations during the spring melt. Effects on water quality in Rock and Willow lakes are expected to be much less due to the seasonal release of effluent from Sik Sik Reservoir. Exceedances of water quality guidelines are predicted to occur only during the winter months when the water volume remaining in each lake is reduced to a small fraction of the total lake volume. Discharge of the treated effluent was predicted to have only a minor effect on sediment quality in Rock and Willow lakes. Therefore, preliminary assessments suggest that discharge of treated effluent through Rock and Willow lakes would have no significant effect on water and sediment quality.

In Judge Sissons Lake, the effects of both modelled scenarios on lake water and sediment quality were predicted to be very small relative to baseline levels and did not result in exceedance of applicable water or sediment quality guidelines. The possibility of meromictic conditions (layering effects) developing in Judge Sissons Lake was also assessed and determined to be very unlikely. In conclusion, discharge of treated effluent is predicted, on a preliminary basis, to have no significant adverse effects on Judge Sissons Lake water and sediment quality.

Proposed Mitigation

Proposed mitigative measures to reduce the impact of the Project on freshwater and sediment quality include:

- Appropriate water treatment of all effluent to be discharged. Both membrane and conventional chemical water treatment methods are currently under investigation.
- Construct monitoring ponds and implement procedures to ensure that all effluent meets discharge criteria prior to discharge
- Use dual containment, or utilidors, for transfers of contaminated water for treatment to prevent spills
- Minimize fresh water required and the volume of treated effluent discharged through process selection and recycling of process and mine water
- Implement extensive environmental monitoring and administrative action limits to ensure compliance with all regulatory commitments and rapid response to accidents or malfunctions
- Develop an Andrew Lake dewatering plan in consultation with regulators and stakeholders to control the release of TSS
- Use appropriate measures and best practices to ensure disturbance of sediments is minimized during construction
- The potential for spills during transportation and operation will be managed through the diligent implementation of materials transport procedures, and Spill Contingency and Emergency Response Plans. These plans and procedures will be developed in consultation with regulators and stakeholders. Hazardous and radioactive materials are to be transported in approved ISO and IP3 containers to reduce the likelihood of spill during a transport accident. All fuel and reagent off-loading lines will have dual-containment to prevent releases
- All outdoor process and fuel tanks will be within secondary containment and process sumps will be used to prevent impacts due to spills or leaks

7.2.5.2 Effects on Aquatic Organisms, Fish and Fish Habitat

The Project activities that may affect aquatic organisms, fish and aquatic habitats include:

- Freshwater withdrawal
- Treated effluent discharge
- Construction of Sik Sik dam
- Runoff diversion to East Pit
- Partial dewatering of Andrew Lake

- Construction of roads
- Construction of berms to collect site drainage and reduce infiltration
- Construction of bridges and culverts along access road
- Construction of wharf and dock facility on Baker Lake
- Blasting activities

All potential freshwater sources are fish-bearing lakes, and therefore there is the potential for impact on fish and fish habitat through drawdown or injury/mortality through the intake line. In addition, if the winter access road is selected, water withdrawal for winter flooding of the over-water portions will be required. Therefore, there exists the potential for drawdown of the lakes along the route.

If treated effluent is discharged to Sik Sik Lake, the lake would not be suitable as fish habitat during operation and therefore habitat compensation, including possible creation of new habitat and remediation of Sik Sik at site closure, will be required.

A small seasonal stream which flows directly over the location of the Center Zone deposit will be diverted to gain access to the deposit. It is proposed to divert a portion of this water to the mined-out East Pit for site use during winter. Further study of the baseline flow regime is on-going to determine the expected impact of diversion of this water for site use.

Andrew Lake must be partially dewatered in order to access the underlying deposit. As the lake is fish-bearing, the dewatering will lead to loss of fish habitat and may alter local drainage patterns. Further study of the potential effects will be conducted during the EA phase.

Potential Project effects on water and sediment quality, as discussed in Section 7.2.5.1, could also lead to contamination of aquatic organisms and fish through toxic loading in the food chain, reduced reproductive success, and direct mortality. Refer to Section 7.3 for an assessment of the effects of treated effluent discharge on aquatic organisms and fish.

Proposed Mitigation

Proposed mitigation measures to reduce the impact of the Project on the freshwater organisms, fish and fish habitats include:

- Ensure appropriate water treatment of all effluent, as discussed in the previous section
- Ensure freshwater sources have sufficient under-ice volume to prevent drawdown and impact on fish habitat. Maintain more than one freshwater source to prevent drawdown during dry years
- Maximize use of site drainage and water recycling (minimizing under-ice withdrawal) through construction of a water storage facility (East Pit)
- Use best management practices with respect to freshwater pump intake screens

- Develop a fish habitat compensation plan in consultation with regulators and stakeholders to compensate for unavoidable impacts, such as the dewatering of Andrew Lake. This may include construction of finger dykes or other fish habitat.
- Wharf design will avoid harmful alterations to habitat where practical. A fish habitat compensation plan will be developed in consultation with regulators and local stakeholders if impact is unavoidable. Further baseline study on fish habitat at the potential dock facility locations is required.
- Use appropriate measures to ensure disturbance of sediments is minimized during construction
- Ensure construction in sensitive habitat is done during non-critical periods and implement best practices for management of sediments and dust
- Ensure stream diversions, bridges and water-crossings allow passage of fish and maintain habitat whenever possible
- Where possible, maintain appropriate blasting distances from sensitive fish habitat. Develop fish habitat compensation for cases where adequate distance cannot be maintained.
- Mitigation for transportation and process spills as described in Section 7.2.5.1.

7.2.6 Effects on the Marine Environment

The marine environment of Chesterfield Inlet and down the west coast of Hudson Bay may be impacted by the Project components associated with marine transportation. Fuel, reagents, and possibly yellowcake will be transported between Churchill and Baker Lake (and return) via barges. Barge traffic through Chesterfield Inlet will be increased as a result of the Project, creating additional noise and risk of accident/malfunction. The potential effects on marine VECs and proposed mitigation are discussed in the following sub-sections.

7.2.6.1 Effects on Marine Water and Sediment Quality

Marine water and sediment quality could be impacted through shipping accidents or malfunctions. The primary accidents of concern are collision or grounding. Accidents could cause spillage of fuel, reagents or yellowcake drums, potentially contaminating water, sediments, and shoreline with hydrocarbons, hazardous chemicals or yellowcake. Grounding would disturb sediments, impacting water quality by increasing TSS.

In general, the risk of spill is considered of greater concern through Chesterfield Inlet due to lower currents and tides as compared to the more open ocean environment of Hudson Bay.

Proposed Mitigation

Spill prevention measures will include barge design (redundancy of critical functions and double-hull), employee and contractor training, and the development and continuous improvement of hazardous goods transport and navigation procedures. Hazardous goods will be packaged according to best practices and regulatory requirements. Local monitors will be on board vessels at the discretion of local communities.

For potential accidental spills from vessels a Spill Response Plan will be developed specifically for marine transportation components and will be in place for all vessel activities. All equipment, vessels, vehicles, and the dock facility will contain the required spill kits suitable for the volume and types of hazardous goods present.

7.2.6.2 Effects on Marine Organisms, Fish and Fish Habitat

The potential contamination of water and sediments via transportation accidents or malfunctions would also impact marine organisms and fish. Release of fuel, reagents or yellowcake into the environment could create toxic conditions for species in the water, sediments and along the shoreline. Increase of TSS due to grounding would reduce the quality of fish habitat, could potentially smother fish eggs and lead to a reduction in the reproductive capacity of marine fish.

Noise from transport activities has the potential to alter the movement of fish, for example the migration of Arctic char through Chesterfield Inlet (avoidance behaviour) and if loud enough could cause harmful effects on fish health.

Proposed mitigation

Mitigation measures for the effects of accidents and malfunctions on marine organisms and fish are as described in Section 7.2.6.1.

Possible mitigation measures for the effects of noise on marine fish include engineering controls (ship design) and reduced travel during sensitive periods.

7.2.6.3 Effects on Marine Wildlife

The potential effects of the Project on marine wildlife are as follows:

- Disruption to movement
- Disturbance to normal behaviours
- Direct and indirect mortality
- Changes in health

Disruption to wildlife movement describes the alteration in the animal's normal movement patterns as a result of Project activities. Shipping through Chesterfield Inlet to Baker Lake and through Hudson Bay to Churchill could potentially disrupt the movement of marine mammals and marine birds that use these areas. Since Hudson Bay and surrounding rivers become ice-free regions during the proposed timing of shipping, disruption to movement as a result of ice-breaking should not be an issue in Hudson Bay or Chesterfield Inlet.

During the open-water season it is possible that the presence of vessels will cause avoidance behaviour by some marine mammals. Such avoidance behaviour could exclude some marine mammals from their habitat or could potentially cause alterations in their migration patterns through the shipping lanes. The effects of increased traffic in Chesterfield Inlet are expected to be greater than potential effects in Hudson Bay due to the lower level of traffic through Chesterfield Inlet at present.

Increased vessel use in Chesterfield Inlet could potentially cause changes in the daily movement and annual migration of some water birds.

Disruption to normal marine wildlife behaviour describes any change to natural marine wildlife behaviour as a result of the Project. There could be a variety of possible alterations to marine wildlife behaviour; however, due to the short (60 day) shipping season the effects of increased traffic within the shipping lane on behaviour is expected to be minimal. If there is an effect on marine wildlife behaviour by increased vessel use it is expected that it would be short-term and localized to the areas directly adjacent.

Changes to marine wildlife movement and behaviour may potentially cause detrimental health effects on the individual and population of that species. Avoidance behaviour of marine wildlife due to the physical presence of the vessel or due to the noise produced from the vessel may exclude certain species from preferred breeding, nesting or calving grounds. Avoidance of such areas could cause reduced reproductive success and could potentially have detrimental effects on the abundance of various populations. Avoidance behaviour has been observed in narwhals and belugas by Inuit (Remnant and Thomas 1992; Stewart et al. 1995; Kilabuk 1998 in (COSEWIC 2004b); Gonzalez 2001 in (COSEWIC 2004a)); while walruses and harbour seals have been observed to abandon haul-out sites (Born et al. 1995; Richardson et al. 1995).

Direct mortality could result from increased vessel traffic if marine mammals and birds were to collide with the ships. Such occurrences are expected to be rare, especially in the case of marine birds. However, some mortality of marine mammals is possible. Incident of vessel-marine mammal strikes are related to vessel speed and size of marine mammal. Mammals that are most likely to be in the Project area are smaller (seals, belugas, narwhal more likely than bowheads) and hence strikes are unlikely.

Indirect mortality may result from a reduction in health due to the collision of marine wildlife with shipping traffic from the Project or as a result of a hazardous goods spill.

Proposed Mitigation

The following measures are proposed to minimize potential effects of the Project on marine wildlife:

- Avoid sensitive or important areas (as determined during baseline work)
- Avoid sounding horns in sensitive or important areas
- Avoid sounding horns during sensitive periods of time (ex. bird migrations)
- Develop a Hazardous Goods Emergency Spill Response Plan
- Develop a Marine Wildlife Monitoring Plan
- Place wildlife observers on vessels and reduce speed, as necessary, in the presence of marine mammals

Further identification and development of mitigation measures will be conducted, with the involvement of local communities, during the EA phase.

7.2.7 Effects on the Terrestrial Environment

7.2.7.1 Effects on Soil

There will be some impact on the terrestrial environment, including soils and vegetation, as a result of the Project footprint. The tundra will be covered with a fill layer to protect the permafrost (see Section 7.2.3), however, this cover will result in loss of productive soil. The proposed Project footprint in the Kiggavik and Sissons areas is estimated at approximately 1,600 hectares, while the all-weather access road would cover approximately 220 hectares. There may also be loss of productive tundra at the Baker Lake dock site depending upon its location. There will also be effects on eskers through the quarrying of material for road construction purposes.

Finally, there is the potential for contamination of soils through spills of reagents, fuel or process streams.

Proposed Mitigation

The Project will be constructed to minimize the footprint, while maintaining sufficient distances between operating and non-operating buildings as required by the Occupational Health and Safety and Radiation Protection Programs (Section 10). Clean mine waste rock will preferentially be used for construction where possible to minimize disturbance to eskers.

The potential for spills will be managed through the diligent implementation of materials transport procedures, and Spill Contingency and Emergency Response Plans. These plans and procedures will be developed in consultation with regulators and stakeholders.

7.2.7.2 Effects on Vegetation

Infrastructure development will result in direct and indirect impacts to vegetation communities. Direct impacts include the loss of vegetation, while indirect effects include habitat degradation due to increased particulate deposition, potential introduction of invasive plant species, alteration of local hydrology and effects related to spills. Direct effects occur primarily during the construction phase, while indirect effects may occur throughout the life of the Project.

Dust deposition on vegetation may result in physical and physiological damage to plants as well as alter the microclimate of an area. Although the issue of invasive plants is generally of less concern in the Arctic setting than in southern areas, recent studies on Arctic flora have indicated that invasive species have become more prevalent. Disruption of hydrological patterns due to Project infrastructure and drainage control structures may result in changes in vegetation communities. Wetter communities (e.g., Sedge Wetland) may be most susceptible to changes in the hydrological regime. Hazardous materials spills generally result in localized impacts to flora.

Proposed Mitigation

The greatest opportunity to minimize impacts to vegetation communities is to limit the overall size of the Project footprint. Other mitigation measures include fugitive dust management systems (e.g., dust suppressant and low road speeds), ensuring machinery on site has been thoroughly washed to avoid introducing foreign seeds to the environment, and restoring altered hydrological patterns as soon as possible.

7.2.7.3 Effects on Terrestrial Wildlife

Potential Project-related impacts on wildlife include habitat loss, disruption of movement patterns, mortality, changes in behaviour and associated reduced reproductive success, and habituation of wildlife to human sites.

All forms of wildlife may be negatively impacted through the consumption of radioactive and non-radioactive contaminants in the environment. See Section 7.3 for a preliminary assessment of this risk to wildlife and humans.

Proposed Mitigation

Numerous mitigation options are available to reduce impacts to terrestrial wildlife. Habitat loss can be minimized by limiting the Project footprint, using existing disturbed areas, and avoiding areas of high sensitivity or high suitability for key species (e.g., riparian and wetland habitats, eskers, denning areas, bird nesting sites and wildlife movement corridors).

The greatest potential effects to wildlife movement occur as a result of blockage, disruption and impediments to seasonal and dispersal movements. Maintenance of wildlife movement patterns can be achieved by ensuring that access and haul roads have a low profile, that speed limits are maintained at all times, and that shipments are convoyed whenever possible. As well, wildlife must always be given right-of-way and vehicle movements can be restricted if large aggregations of some species are present in close proximity to Project facilities. Some species such as migrating caribou may be the most susceptible to a disruption in movement patterns, particularly during spring and fall migrations through the regional area. As noted above, vehicle movements and other operations can be restricted at such times.

Road-related wildlife mortality can be greatly curtailed by minimizing speed limits on haul roads, giving wildlife right-of-way and restricting vehicle movements during periods of high wildlife activity. Mortality associated with other mine infrastructure can be minimized by using fencing or diversions to direct wildlife away from high activity areas or high hazard areas. To avoid habituation of scavengers such as grizzly bear, wolverine and Arctic fox to the mine site, care must be taken to incinerate all food wastes, store all aromatic substances and other attractants in air tight containers, prohibit feeding of wildlife by employees, and ensure that an appropriate sewage management system is in place. Implementation of bear safety procedures and training of environmental protection staff is also a key component of an effective mitigation strategy. Establishing a no hunting and trapping policy for mine employees will also ensure that mine-related wildlife mortality is reduced.

Some wildlife species are easily disturbed by human activity while other species become quickly habituated. Species that are disturbed may avoid important habitats and/or reduce key behaviours such as feeding, breeding or watching for predators. Disturbance to wildlife behaviour can be minimized or avoided by ensuring low travel speeds on roadways, using defined flight corridors, establishing a minimum flight altitude, and implementing a no harassment policy. Avoidance of sensitive windows for wildlife (e.g., fall migration for caribou) is also an important consideration in reducing impacts to wildlife behaviour.

Other mitigation measures include implementing management plans to help avoid sensitive wildlife periods, complying with Caribou Protection Measures, minimizing visual and sensory disturbances such as lighting and blasting near wildlife, and implementing an employee wildlife education program. A key long-term mitigation tool will be to reclaim disturbed areas at closure.

7.2.7.4 Effects on Birds

Potential effects of the Project on upland breeding birds include habitat loss, disturbance of behavioural patterns leading to abandonment of nesting (e.g., noise, lighting), road-related mortality, and chemical contamination of the food chain.

Nesting raptors are particularly susceptible to Project-related disturbance. Impacts on nest fidelity and nesting success may occur due to sensory and auditory disturbances from roads and other Project-related activities. Loss of habitat and associated prey base is also a potential impact, although unlikely to be significant because of the wide-ranging foraging tendencies of most raptor species. Other minor potential impacts include road-related mortality (unlikely) and toxic chemical contamination of the food chain.

Habitat loss and sensory disturbance of nesting waterfowl are the primary mine-related impacts for these species. Disturbances may include noise, lighting, and vehicle movements. Collisions with transmission lines may also be an issue in certain areas. An unlikely potential impact is reduced wildlife health in waterfowl feeding or reproducing in lakes with elevated concentrations of harmful constituents.

Proposed Mitigation

Potential mitigation measures include avoiding sensitive nesting areas, enforcing low speed limits on roads, establishing flight corridors and heights, convoying shipments whenever possible, muffling noise and reclaiming disturbed habitats at closure.

Impacts to nesting raptors can be mitigated by implementing nest-specific management plans. Components of the plan may include establishing buffers around nests within which disturbance is restricted and setting seasonal exclusion windows.

More detailed mitigation options will be developed in a Wildlife Mitigation and Monitoring Plan for the Project.

7.3 Ecological and Human Health Risk Assessments

Screening level ecological and human health risk assessments have been undertaken to evaluate integrated Project effects on aquatic life, terrestrial wildlife, and people due to discharge of treated mill effluent and atmospheric emissions from operational activities at the Project site.

The screening level risk assessments were conducted using a pathways modeling approach and took into consideration baseline levels of constituents of potential concern in the environment as well as the incremental atmospheric and aquatic effects of the Project as described in Sections 7.2.1 and 7.2.5.

The two water management scenarios defined for the aquatic environment effects assessment (Section 7.2.5) were carried through to the ecological and human health assessments. These two scenarios are as follows:

- The Low Flow Scenario (LFS) is based on best estimates of the expected volume of excess water requiring treatment and the performance of the water treatment systems. Under the LFS, the treated effluent would be discharged to Sik Sik Lake, which would be developed as a storage reservoir with release of the stored effluent to downstream waterbodies (Rock, Willow and Judge Sissons lakes) at a controlled rate over the spring to fall period (i.e. over a four month period).
- The High Flow Scenario (HFS) is based on the upper bound estimates of the expected volume and quality of treated effluent. The effluent in the HFS would be discharged directly to Judge Sissons Lake on a continuous basis year round.

The following sections summarize the results of the ecological and human health risk assessments. Refer to Supporting Document No. 4 (Section 1.8) for further details.

7.3.1 Ecological Assessment

The assessment of potential impacts to ecological receptors from Project activities considered exposure from air, soil, vegetation and aquatic pathways. Ecological receptors were chosen to capture various levels of exposure. Aquatic receptors included phytoplankton, zooplankton, aquatic plants (pondweed), benthic invertebrates, forage fish (burbot and white roundfish) and predatory fish (Arctic grayling, cisco, Arctic char and lake trout). Terrestrial receptors included Arctic ground squirrel, bear, caribou, falcon, fox, merganser, muskoxen, ptarmigan, sandpiper, Tundra swan, and wolf.

The calculated radiation doses (from radionuclides) and intakes (from non-radionuclides) were compared to selected and well-accepted benchmarks. Potential adverse effects on ecological receptors were examined using a simple screening index (or hazard quotient) value approach.

Under the Low Flow Scenario (LFS), all screening index values for aquatic receptors exposed to radiological constituents were below one indicating that the model predicts there are no potential adverse radiological effects in the Sik Sik Reservoir or the three downstream lakes. For non-radiological constituents, the screening index values were all less than one in summer months, however, in winter months, copper, lead and zinc concentrations can exceed the selected benchmarks in Rock and Willow lakes. However, as these lakes are likely to be completely frozen in the winter, the likelihood of aquatic species being present in them during the winter is low.

Under the High Flow Scenario (HFS), the effluent will be discharged directly to the Judge Sissons Lake, and therefore there will be no impact on the water/sediment quality in Sik Sik, Rock and Willow lakes, nor on the ecological receptors associated solely with these lakes. For Judge Sissons Lake, all screening index values for aquatic receptors exposed to radiological constituents and non-radiological constituents were below one in summer and winter, indicating that the model predicts no potential effects in this lake.

Screening index values for exposure of terrestrial receptors to radiological constituents were all well below the benchmark value of one in both the LFS and HFS. For non-radiological constituents, the most restrictive benchmarks were exceeded for Arctic ground squirrel and ptarmigan exposed to some constituents; however, there were no exceedances predicted when exposures levels were compared to no observable adverse effects level (NOAEL) toxicity reference values or lowest observed adverse effects level (LOAEL) toxicity reference levels. In general, the majority of the exposure estimates were attributed to baseline levels with the Project incremental effects contributing a very small fraction of the total exposure.

In conclusion, preliminary assessment suggests that the Project activities modeled pose minimal risk of adverse effects on aquatic or terrestrial species in the Project area. Further evaluation is required as design, baseline, and traditional knowledge work advance.

7.3.2 Human Health Assessment

Both members of the public and non-nuclear workers were included in the human health risk assessment. The human receptors included permanent residents of the Baker Lake community, a hunter/trapper on Judge Sissons Lake and non-nuclear workers at the Project site. Exposure pathways considered for the human receptors included: radon progeny and dust inhalation; water, vegetable, fruit and meat ingestion; inadverdent soil ingestion; and dermal contact with soil.

The calculated radiation doses (from radionuclides) and intakes (from non-radionuclides) were compared to selected and well-accepted benchmarks. Potential adverse effects on human health were examined using a simple screening index (or hazard quotient) value approach.

The findings of the health assessment were similar in both water management scenarios. The highest predicted total incremental radiological dose was estimated for a non-nuclear energy worker at the campsite of 77 µSv/y, based on the individual spending 50% of their time at the campsite and the other 50% of their time in Baker Lake. The majority of dose was related to dust and radon progeny inhalation while at the campsite. Ingestion accounted for an insignificant fraction of dose for all receptors. All dose estimates were below the Canadian Nuclear Safety Commission regulatory incremental dose limit of 1,000 µSv/y for members of the public and the Health Canada dose constraint limit of 300 µSv/y. The incremental radiological dose to residents of Baker Lake was estimated to equal less than 1 µSv/y.

Of the other constituents carried through the health assessment, only arsenic is known to have carcinogenic effects. The calculated incremental risks to all individuals considered in the assessment were less than the Health Canada “essentially negligible” risk level. Hence, preliminary assessments suggest that the Project poses minimal risk of effects to members of the public with respect to arsenic exposure.

With respect to the remaining constituents, the estimated total intakes (including baseline and incremental levels) were compared to toxicity reference values. The assessment did not consider the contribution of store bought foods to the total intake of each of the constituents of potential concern. The analysis showed that exposure from the ingestion pathway is dominated by caribou and drinking water for all constituents. In all cases, the estimates intakes were found to be less than the reference value, predicting that the Project poses minimal risk of adverse effects.

To strengthen the risk analysis in the next phase of the Project, more site specific data will be gathered on a number of environmental compartments including, radon and dust levels in air and constituent concentrations in area soils and aquatic and terrestrial vegetation.

7.4 Potential Effects on Heritage Resources

There is the potential for Project impact on archaeological sites through the construction of roads, infrastructure, and pipelines. Particular areas of concern include the south shore of Skinny Lake, which is a proposed fresh water source and lies along the proposed access route; and the banks of the Thelon River, which is crossed by the proposed north access route. Refer to Section 6.3 for archaeological sites identified thus far in the Project area.

Proposed Mitigation

All roads, infrastructure and pipelines will be planned and constructed to avoid heritage sites wherever possible. When avoidance of the site is not practical, such as for any sites located within the proposed open pit boundaries, a mitigation plan will be developed in consultation with regulators and local stakeholders, particularly the Department of Culture, Language, Elders and Youth (CLEY). It is proposed that archaeologists and Inuit observers be on-site during all construction activities to ensure that any previously unknown heritage sites are identified.

7.5 Potential Socioeconomic Effects

Current understanding of the key socioeconomic issues related to the Kiggavik Project is based on community consultations and document review. AREVA has initiated consultations with the seven communities in the Kivalliq Region, including local authorities, community organizations and leadership and the general population. These are described in Section 3. AREVA has also reviewed documentation related to other large projects in the Kivalliq Region and elsewhere in Nunavut. Key issues identified to date include:

- The seven communities have limited employment opportunities (although the ongoing construction of the Meadowbank Project outside Baker Lake is creating potential to change this). People expect the Kiggavik Project to create employment opportunities across Kivalliq.
- Business opportunities are also expected. Business activity creates additional jobs and wealth beyond that generated by direct employment and is preferred by people whose personal circumstances make rotational employment a difficult choice.
- There is concern in some communities that economic benefits of projects are not always distributed according to the potential for negative effects.
- While rapid increases in employment benefit many, subsequent effects on local businesses – who must compete in the labour market for workers – include rapid turnover of staff, difficulties in identifying replacement staff, increased training costs and lost productivity.
- Large projects have potential for environmental effects on land, water, wildlife, fish and other natural resources. There are two aspects to this i) many people still depend on such resources for at least a part of their livelihoods; and ii) traditional use of such resources is fundamental to people’s sense of identity and well being.
- Environmental effects, including visual effects, can have a negative effect on tourism, a priority economic development sector in Nunavut.

- While participation in the wage economy is critical to the economic and social well being of the Inuit, continued land based economic activity needs to be accommodated. Participation in the wage economy should not be at the expense of retention, at the community level, of traditional skills, values, and language.
- While people look forward to increased incomes and many individuals and families will benefit in terms of household economies and health as a result, there is some concern that new disposable income can lead to poor personal choices, related to drugs, alcohol, gambling and other negative social behaviours. These are in turn associated with poor parenting, domestic violence, crime, and suicide affecting not only individual but community well being overall.
- Social and physical infrastructure and services are often ill-equipped to deal with any increased demand as a result of a large project. There are many potential linkages. As examples, changed behaviours can put pressures on health and policing services, population growth can result in more crowded housing, and the use of any community infrastructure by a project can mean reduced availability for community needs.
- Concerns about environmental protection, health and safety of people (including workers) and emergency response planning, which are general to large projects, are increased because the resource is uranium in the case of the Kiggavik Project.
- The construction of an access road between Baker Lake and the Project, which could possibly be used by the people of Baker Lake, raises not only opportunity for improved access to land, but also concerns about traffic, road safety, and wildlife populations.
- The Project will be expected to demonstrate a positive economic effect not only on the economy of Kivalliq and its seven communities but also on Nunavut. There is also an expectation of fiscal benefits.
- Cumulative effects are of significant interest, especially in Baker Lake and Chesterfield Inlet, given that the Meadowbank Project is under construction and that many other exploration projects are underway across the region.
- There is a requirement to take full account of traditional knowledge in the assessment of Project effects, and the development and implementation of mitigation and benefit enhancement measures and monitoring programs.
- Consultation with governments at all levels, as well as people in communities, will be required throughout the development and implementation of the Project. There is also a requirement for participation of governments and people in Project decisions that may affect them.

The list of issues above indicates that people are concerned about the potential for negative effects and have expectations that benefits will be enhanced in order to ensure that communities in proximity to the Project see significant benefits. The list provides an early indication of valued components that will be emphasized for investigation as work proceeds to advance the Project through its life cycle. However, the list also indicates that people are concerned about the processes used to complete that work, including the assessment of effects and the development and implementation of measures to mitigate negative effects and enhance benefits.

Based on key issues as identified to date, AREVA's current expectations on the potential for Project effects of most concern are as described in the following sections. It is noted that most of these effects are interrelated, and can be mutually reinforcing, in both positive and negative ways.

Additional detail on Project effects will be developed as:

- more consultation with potentially affected communities is completed;
- discussions are advanced with authorities including the Nunavut Impact Review Board, the Government of Nunavut, the Kivalliq Inuit Association, individual community leadership and federal agencies;
- socioeconomic baseline data are collected; and
- Project decisions on design and operational policy and practice are optimized.

7.5.1 Employment

The Project will include a preferential hiring program for people in the Kivalliq region. It is expected that workforce participation rates will go up, as discouraged people who have stopped looking for work re-enter the workforce. Unemployment rates are expected to decrease. It is unlikely that most jobs will go to Inuit during construction and the early years of operations, as mines have workforce education, skill and experience requirements that are not presently met in Nunavut. However, more than half of mining jobs may be either particularly appropriate to Inuit skills (such as environmental monitoring), are semi skilled and/or are quickly learned. It is expected that the proportion of Inuit workers will increase over time with job experience and training. Also, businesses contracted to supply the Project will require new employees. Further, with increased hiring by the Project and supply businesses, individuals and businesses will spend more on local goods and services. This in turn will induce more employment, as people in the community organize to provide additional goods and services demanded by others with new disposable income.

7.5.2 Education and Training

The Project will have an education and training program intended to enhance access to Project activities for people in Kivalliq. It is AREVA policy to provide on the job training to all employees, intended both to improve skills needed for better job performance and promotion and to broaden the skill base of employees so that their enhanced abilities can be applied elsewhere in the economy. Training in heavy equipment operation and maintenance, accounting and clerical work, construction trades, catering, environmental studies, health and safety, computers and information technology, is transferable to other employment sectors, even if provided in a mining sector context. AREVA also recognizes the need for a broader based Project education and training strategy to prepare people for employment. This strategy would include work with Nunavut education authorities and institutions to motivate and prepare youth for employment. Such training will contribute to maximizing Inuit employment by the Project and its suppliers.

7.5.3 Business

The Project will include a preferential procurement program for businesses in Kivalliq. There will be opportunities for new businesses to form and for existing businesses to expand in response to the Project's supply needs. There will be some challenges, as existing businesses are few, tend to be small, have high costs and often serve only the consumption needs of local residents (SEDS Group, 2003). However, local business participation in the Project is expected to grow with time, particularly with the implementation of measures to assist that participation.

There is however some potential for attractive mine employment to put pressures on the local economy and labour force – this already appears to be happening in Baker Lake in response to the Meadowbank Project. To the extent that the Project draws labour from other economic activity rather than from the pool of unemployed (many of whom may be the more difficult to employ for demanding, rotational mining jobs), there may be negative effects on local businesses and service delivery. There are costs to replacing employees. However, the labour force adjustments (moving less skilled into more skilled positions economy wide) represent an increase in labour force capacity that is an important overall benefit.

7.5.4 Increased Incomes

Employment and business creation associated with the Project will increase the income levels of some individuals and their families, and of the community as a whole. As well, increased income is the stimulus for induced economic activity, and therefore not only the individual AREVA employees and the employees of supply businesses benefit, but others in the community will see more employment and more income, further increasing the total wages paid in the community.

Increased income is associated, overall, with increased individual and household well being. It is this association that appears to motivate the great emphasis given in consultations, to employment and business opportunities through the Project. Also, the economic strategies of all levels of government in Nunavut are importantly based on the creation of wage economy opportunities, as a primary means towards enhancing individual, household and community well being. It is acknowledged that there are important potential downsides to increased incomes, particularly at the level of certain individuals.

7.5.5 Maintenance of Traditional Ways of Life

The social, cultural, and economic importance of traditional ways of life to the quality of life in Nunavut 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 government policy. Inuit Qaujimajatuqangit (IQ) encompasses knowledge of the land and its resources; the passing down of this knowledge through generations; skills in applying this knowledge to livelihoods; and a value system that rests on responsible resource use, respect, sharing, cooperation, group decision making, healing, and counselling. Traditional ways of life provide for livelihoods, confirm the identity of a people and are increasingly understood as essential for social and emotional well being, at individual, household and community levels.

In the absence of good environmental mitigation measures, the Project may constrain productivity of some lands, waters and resources used for subsistence activities related to traditional ways of life, whether subsistence or commercial. This in turn would affect livelihoods. The marine environment in Chesterfield Inlet and the caribou migration routes are of concern in this regard. Tourist resources, generally considered a culturally appropriate sector of economic activity, could also be negatively affected, specifically on the Thelon River.

More indirect effects on traditional ways of life are also possible. Regardless of the degree to which AREVA may be successful in increasing Inuit participation in the Project in culturally appropriate ways, for some people formal sector employment may be a disincentive to traditional ways of life; employees and businesses will function within AREVA’s corporate culture, policies, language, and operational requirements; cross cultural contact will increase and may result in some undervaluing of traditional ways of life; and any loss of language will make communication between generations – a critical component of IQ – difficult. This is particularly important for the youngest members in the local population, who need encouragement and support in integrating the knowledge of elders into their lives.

Finally, it is noted that traditional land and resource use has increasingly involved inputs that come at comparatively high cost, including vehicles, fuel and equipment. There is some evidence from the Northwest Territories that increased disposable incomes, in combination with work schedules organized to enable extended periods of not working, has contributed to an observed increase in trapping, hunting and fishing (GNWT, 2006).

7.5.6 Individual and Community Well Being

In addition to potential effects on traditional ways of life and the relationship between these and individual and community well being, a number of other linkages between the Project and individual and community well being may result in effects.

There are large anticipated benefits of increased income, related to improvements in socioeconomic conditions. However, higher disposable incomes can also cause negative effects at the individual, household, and community levels if that income is not well managed. There is an association between greater disposable income and poor lifestyle choices, including the potential for increased drug and alcohol use, gambling and inappropriate sexual activity. On the other hand, regular well paid employment may lead to increased feelings of self worth, improved capacity to care for loved ones and substance-free periods while on site. These can decrease the motivation and the opportunity for abuse.

There is some potential for increasing inequity in income distribution in the community, which could lead to social conflict and contribute to social problems such as crime. Not all people will be able to access Project related opportunities, and more vulnerable subpopulations (such as women, elders and the less employable) are of particular concern. Retention of traditional values such as respect, cooperation, and sharing may also be negatively affected by greater income inequity.

Rotational work schedules can have both positive and negative effects on well being. Positive effects can include reduced cross cultural contact within communities, the availability of time and resources for traditional activity, and more workforce discipline while on the job. Negative effects can include family stress, family conflict between generations and between spouses, breakdown of traditional values of sharing and mutual support, undervaluing traditional ways of life, and increased substance abuse.

Construction and operation of the Project may create population growth, particularly in Baker Lake. The Project will not move workers from elsewhere into Baker Lake, with the exception of a very few out-of-area employees engaged at transport and storage facilities near the community. Fly in - fly out transport to work from Kivalliq points of hire will enable Project employees to remain in their home communities. However, as the mining sector develops around Baker Lake, labour shortages elsewhere in the Hamlet’s economy may be expected, such as business and service delivery organizations that do not have the resources to fly employees in and out. Population growth has both positive and negative consequent effects – of particular concern are housing and other infrastructure pressures.

7.5.7 Public Health and Safety

There are public health concerns associated with the Project. The health and safety record of AREVA in its mines in Saskatchewan has not only been consistently good, it has improved over time. Monitoring of exposure to radiation in workers and in Project discharges indicates that exposures are a small fraction of regulatory requirements, and are considered to be as low as reasonably achievable (AREVA, undated a).

Increased vehicle and vessel traffic in Baker Lake and along the marine transportation route, with the consequent potential for more accidents, also represents a risk to public health. To the extent that the people of Baker Lake use any eventual winter or all weather access road, there is a risk of traffic accidents here as well. A potential public safety benefit of the Project is the construction of the all weather access road, insofar as it will be a well traveled and monitored road.

Finally, there is always some risk associated with large projects. Accidents and malfunctions related to transport of materials and/or operation at the mine site have potential to release contaminants into the environment, affecting natural resources consumed by people.

7.5.8 Infrastructure and Social Services

There are potential negative effects to existing infrastructure related to Project demands on physical infrastructure in Baker Lake such as roads, other transportation facilities, telecommunications and utilities. Social services could be affected by increased demands for health, policing, education, and housing as a result of population growth and/or as a result of effects on individual and community well being. Any inability of social services to meet an increase in demand in the communities could contribute to a dynamic of more social problems and yet greater demand, incurring additional costs to social services and governments. Meeting the operational needs of the mine (including its workforce) with Project rather than community resources will help limit pressures for the delivery of public sector goods and services.

Some infrastructure and social services could potentially benefit from the Project. Construction of an access road between Baker Lake and the Kiggavik site, and a dock facility in Baker Lake could represent contributions to infrastructure development. There may be other new infrastructure built to meet Project requirements that could be shared with communities, including use to enhance access to remote areas by tourists. Contingent on the resident patterns of Project employees, rotational schedules and consequent transport requirements, commercial air services in Kivalliq could improve.

Enhanced incomes will provide a measure of capacity building and economic security which have potential to reduce social problems coincident with poverty. A consequent effect could be less dependence on government resources, from social assistance payments to mental health services to policing of antisocial behaviours. Reduced dependence on government resources may also free up such resources for other uses.

7.5.9 Community Investment

The well being of communities is expected to increase as a result of the Inuit Impact Benefit Agreement (IIBA). The IIBA will formalize contributions to community initiatives in addition to job creation and business opportunities. Considering that the Project may have potential negative effects on individuals and communities that can be neither clearly identified nor directly mitigated (such as effects on traditional ways of life or of poor choices made by individuals with increased incomes), support for community initiatives is a means to enhance the net local benefit resulting from Project development.

7.5.10 Territorial Economic and Fiscal Benefits

The Kiggavik Project is expected to bring economic growth and diversification to the territory as a whole. Such benefits are generated through higher employment, and increased spending in Nunavut by the Project, by suppliers and by the newly employed. The Project is a large one by Nunavut standards. Statistics Canada economic modelling for the smaller Meadowbank Project suggested that economic effects would include:

- diversification of the economy and skills base as indirect jobs would be created in i) finance, insurance, real estate, and renting and leasing; ii) professional, scientific, and technical services; iii) government; iv) wholesale trade; and v) transportation and warehousing; and
- consequent higher tax revenues to both Nunavut and Canada.

It is noted in this regard that the Nunavut Economic Development Strategy (2003) and the more recent Northern Vision: A Stronger North and a Better Canada (2007) emphasize sustainable development, including benefiting from the wealth of non-renewable resources to generate economic growth, provide employment and fund programs to enhance individual and community well being.

7.5.11 Socioeconomic Mitigation and Benefit Enhancement

The development of the Project will be consistent with AREVA corporate standards for environmental protection, radiation protection, health and safety of workers and the public, consultation with affected communities and participation in the social and economic development of affected communities (AREVA, undated b). Accordingly, effect mitigation and benefit enhancement measures will be developed and implemented consistent with the following principles:

- There will be consultation throughout Project development to define priorities, needs, and preferences of affected people, and to decide how mitigation and enhancement measures will be implemented.
- The development 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.
- Development of mitigation and benefit enhancement measures will be conducted in an environment of accountability and transparency.
- Sustainability criteria will be incorporated by emphasizing the need to enable regional participation in employment and business opportunities, training, and partnerships with governments and community.

AREVA would expect that as the Project advances, mitigation and benefit enhancement will be approached through a variety of means. These include:

- The negotiation of an IIBA which includes socioeconomic undertakings expected to enhance the potential for benefit through assistance directed at affected people such that they are better positioned to access Project opportunities;
- Project design choices made for specific Project components in order to reduce the potential for negative impact – this would include, for example, incorporating the results of current discussions with the community of Baker Lake with regard to the best option for access road routing;

- The implementation of best practice corporate policies and practices that reduce the potential for negative impact and/or enhance the potential for benefit – this would include, for example, employee skill based and health and safety training to facilitate Inuit access to Project economic opportunities;
- The implementation of measures to address Project specific socioeconomic effects that are well defined, are at least somewhat predictable in their significance and are susceptible to mitigation or enhancement by AREVA – this would include, for example, compensation where traditional activity is interfered with;
- Ongoing consultation with affected people and other Project stakeholders – consultation throughout the development, construction, operation, closure and post closure phases of the Project achieves multiple objectives, including contributing to the effectiveness of impact mitigation and benefit enhancement; and
- Monitoring contributes to demonstrating Project benefits, furthers the understanding of the effectiveness of impact mitigation and benefit enhancement measures and provides a mechanism to capture any unpredictable and/or evolving impacts, such that socioeconomic management can be adjusted.

Potential mitigation and benefit enhancement measures are outlined below. The presentation is by category, rather than by potential impact. These and other measures will be more fully developed during the environmental assessment and IIBA negotiation processes.

Employment

Project-specific initiatives will be implemented to enhance access to employment. There are real barriers to employment with the Project for many Inuit. It is important that wage employment not conflict with subsistence activity that is both economically but also socially and culturally critical to livelihoods and individual and community well being. Under-representation in the workforce by women may be for lack of opportunity rather than lack of desire to participate. Cross cultural challenges can represent a strong disincentive to participation. Few jobs at the mine will require less than a Grade 10 education, and many will require a Grade 12 education.

To address barriers, the following can be considered. While the focus of these measures would be on Kivalliq's seven communities, second priority would go to Nunavut communities as warranted and relevant:

- preferential hiring of Kivalliq residents, where they have formal or equivalent qualifications for any Project job;
- points of hire in at least all seven Kivalliq communities, and funding transport to the mine site, to facilitate access to Project employment;
- providing timely detailed information to Kivalliq residents on workforce requirements, job descriptions, qualifications, and performance criteria;

- reviewing educational, training, and language requirements for Project positions and conducting prior learning assessments with a view to accepting experience in lieu of qualifications (equivalencies) where legal and consistent with health and safety policies;
- designing recruitment methods, advertisements, application procedures, interview protocols, selection procedures, orientation to the workplace programs and training and promotion decision making to reduce artificial barriers;
- providing career development, on the job training, and management training programs to enhance employee satisfaction and promotion;
- conducting exit interviews in an effort to increase understanding of barriers that prevent successful long term employment and using this understanding to create other, more effective initiatives;
- providing cross cultural training to all employees to facilitate the integration of Inuit employees into the workforce;
- implementing measures to support and validate traditional activity, accommodating country food consumption during work rotations, supporting the use of Inuktitut where feasible in the workplace and other measures as may be developed with Inuit workers;
- having an Inuit elder on-site as a mentor and advisor to Inuit workers;
- putting in place an employee assistance program to address individual and family problems that threaten an individual's ability to continue working;
- enforcing zero tolerance policies for the use of personal firearms, controlled substances, alcohol, harassment, and vehicle misuse towards establishing the workforce discipline which encourages health, safety, learning, retention and advancement of Inuit employees; and
- including in the evaluation criteria for subcontractors the extent to which they intend to use and support Kivalliq labour in meeting their contractual obligations

Business

Where local businesses have little or no experience with the mining sector, Project specific initiatives can be implemented to allow these businesses to successfully bid on procurement contracts. Businesses in Kivalliq are gaining experience with the mining sector, although with the exception of the Meadowbank Project, most activity is associated with exploration. Few existing business have the breadth, depth, or human and financial resources needed to bid on large contracts. There is still limited local experience with quality control and with the exigencies of supplying large, time sensitive operations.

AREVA is committed to enhancing the capacity of Inuit companies to supply goods and services to the Project; specific measures to achieve this will be developed in consultation with communities and economic development agencies. As in the case of employment, the focus of these measures would be on Kivalliq's seven communities, while second priority would go to other Nunavut businesses as warranted and relevant.

Education & Training

Targeted education and training initiatives can enhance the potential of Inuit to access employment and business opportunities created by the Project. AREVA also recognizes that poor educational performance contributes both to lack of economic opportunity and to social challenges that are the consequence of unemployment and poverty. As well, there is a general concern, particularly among the elders, that traditional knowledge is being lost.

The promotion of education and training is therefore intended to address Project requirements and to contribute to long term participation in both the wage and land based economies in the interests of sustainable development. The following can be considered:

- establishing entry level trainee positions, with a view to providing trainees with needed skills to graduate out of the trainee positions, creating new openings for trainees;
- begin training of local workers for operational jobs during Project construction;
- establishing apprenticeship positions for qualified Inuit;
- providing other on the job training as appropriate in areas such as health and safety training, skills training, management training, career development, personal financial management and life skills to enhance job performance, retention and advancement;
- supporting efforts on the part of employees to upgrade their education as a means towards job advancement, including employment of an on-site teacher;
- cooperating with Nunavut agencies in training programs for Inuit firms and towards the development and implementation of high school and post secondary courses with mining sector content;
- providing summer employment programs and cooperative education opportunities at the mine site to provide job experience to young people;
- providing information to Kivalliq communities on all Project-related training opportunities; and
- establishing a scholarship fund for post secondary education.

Workforce Management

Workforce management policies are intended to minimize contact between the people of Baker Lake and non-Inuit employees, to control inappropriate behaviours when the inevitable contact does occur, to ensure that Inuit employees have the opportunity to engage in traditional activities, and to provide workplace conditions that accommodate Inuit culture. Workforce management measures that can be considered include:

- establishment and enforcement, as part of the terms of employment, of a code of conduct governing behaviour, promoting cultural awareness and sensitivity;

- cross cultural training of all employees to encourage mutual understanding and respect in interactions of Inuit and non Inuit employees;
- provision of facilities to meet all reasonable needs of out of area workers, such that workers need not use Baker Lake facilities;
- fly in - fly out work schedules that see employees removed directly to their home communities when they are not working;
- measures intended to create workplace conditions that accommodate Inuit needs, including provision of country foods, facilitation of the workplace use of Inuktitut and rotational and leave provisions that acknowledge the need to engage in traditional activities, insofar are these are consistent with safe and effective Project operations.

Public Health & Safety

Project public health and safety risks will be managed using best health and safety, and radiation protection practice (plans; health, safety, and radiation protection training; enforcement of health and safety rules). Uranium mining is now more strictly and aggressively regulated and monitored than any other type of mining in Canada and consequently AREVA has developed comprehensive programs to comply with, and where possible exceed, regulatory expectations. Refer to Section 10 for further discussion of these programs.

Emergency response planning is intended to ensure that potential damages can be contained in the event of a Project accident. There is some concern that neither Baker Lake nor Chesterfield Inlet has the requisite facilities, staff or equipment to respond to emergencies, something that will be considered in framing emergency response plans (ERAP). Project traffic represents the most tangible risk to the people of Baker Lake. Mitigation would include controls on the use of firearms along the access road; driver training; enforcement of driver codes of conduct that govern speeds particularly but also the principles of considerate driving; scheduling traffic so as to minimize safety hazards; and public education on road and water safety.

Negative Income and Other Effects on Community Well Being

Negative effects from increased income are largely the result of individual spending choices and the inequities introduced between different segments of society. Other negative effects related to the Project could result from population growth and an increase in cross cultural contact. Effects on community well being of this type include strains on infrastructure and services, threats to public health and safety, social conflict, reduction in the practice of traditional ways of life, etc. These are more likely to be experienced in communities where the number of people participating in the Project is large relative to the whole community population, where the sum of individual decisions has some potential to spill over to the community.

None of these effects would be directly within AREVA's control to mitigate completely. It is in AREVA's interest, however, to provide support to both individuals and communities in managing the potential indirect negative effects of the Project. It is also important to recognize that the increased economic activity the Project represents is generally considered to be of overall benefit, particularly in a context of alleviating high unemployment and poor incomes, which in themselves have significant negative effects on families and on communities.

The following measures can be considered to mitigate the potential for the above kinds of negative effects:

- as part of the terms of employment, a confidential assistance program to employees and their families would be provided, one that can competently address, in a culturally sensitive and knowledgeable fashion, the full range of work and life issues that may arise for an individual employee – these would include problems with drug and alcohol abuse, other addictions including gambling, inappropriate sexual behaviours, personal financial management, adjustment to change and stress, and family relationships;
- in the longer term, measures described above to maximize Inuit participation and employee advancement are expected to create a critical mass of role models and thus encourage youth to work towards achieving the skills needed to participate in both the wage and land based economies;
- education and training initiatives would provide people with many of the tools they need to take advantage of Project created opportunities and to thereby improve their quality of life;
- implementation of employment policies and procedures, as outlined above, would give value to and enable traditional activities; and
- support for community initiatives in Kivalliq, through the IIBA and other mechanisms that may be identified, would address community priorities towards enhanced economic, social and cultural community wellness.

Compensation

Although no economic losses as a result of effects on traditional or commercial resources are anticipated at this point, in the event that Project operations should have unforeseen consequences, compensation may be required. AREVA would expect to negotiate compensation with affected individuals based on estimates of foregone harvests and the value of that harvest, taking into consideration cultural loss. The IIBA also would be expected to address the issue of compensation in the event of unforeseen losses, for example wildlife hits along the access road.

Socioeconomic Monitoring

An important component of the mitigation of Project socioeconomic effects is monitoring, which is a process that uses quantitative and qualitative data to understand, not simply identify, change that occurs against identified benchmarks. Only in understanding the reasons or underlying causes of any observed change can monitoring generate the results needed to improve the Project's operations. It has proven very difficult in northern Canada, a context of rapid change even without large resource extraction projects, to attribute cause or responsibility for observed changes in socioeconomic parameters.

AREVA's monitoring objectives will include:

- recording the uptake of employment, training and business opportunities over time on the part of Inuit, and analyzing the trends in uptake against expectations and any established targets;
- determining the effectiveness of other socioeconomic mitigation and benefit enhancement undertakings that may be made in course of Project development, including for example, the effectiveness of training programs, employee assistance programs, measures to accommodate Inuit culture in the workplace, traffic control measures, etc.;
- analyzing and explaining any changes in community well being in Baker Lake against pre-Project levels of well being; and
- tracking community experience of the Project, in order to capture any unforeseen effects that AREVA would need to address in the interests of participating in the economic and social development of Kivalliq communities.

AREVA would expect to develop a socioeconomic monitoring program to achieve the above objectives, consistent with IIBA monitoring requirements and any ongoing socioeconomic monitoring being implemented by others. The program would require identification of all participants in the process; agreement on monitoring objectives; establishment of the questions to be answered by the monitoring; identification of key performance indicators and sources of information on those indicators; the selection of benchmarks against which changes in indicators are to be analysed; the development of methodology for data collection and analysis; and agreement on roles and responsibilities of various parties, most importantly for managing the monitoring program, data collection and analysis, reporting, use of monitoring results and funding.

7.6 Potential for Transboundary Effects

The three Project operational sites (Kiggavik site, Sissons site, and Baker Lake dock and storage site), the access road connecting them, and the marine transportation route through Baker Lake and Chesterfield Inlet, are all within the territory of Nunavut. The majority of the potential effects of the Project will be at, or in close proximity to, these operational areas. However, several species, including caribou, migratory birds, and grizzly bears, found in the Kiggavik area may travel outside the territory of Nunavut. Similarly, marine wildlife, including seals, beluga and narwhal, may migrate throughout Hudson Bay and beyond. The mitigation measures discussed within the preceding sections are expected to minimize impacts to these species in the vicinity of the Project sites.

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SECTION 8

TABLE OF CONTENTS

SECTION **PAGE**

8 POTENTIAL CUMULATIVE EFFECTS 8-1

8.1 Biophysical Cumulative Effects 8-1

8.1.1 Air Quality 8-2
8.1.2 Noise 8-2
8.1.3 Unique Landforms 8-2
8.1.4 Heritage Sites 8-2
8.1.5 Surface Water and Groundwater 8-2
8.1.6 Terrestrial Wildlife 8-3
8.1.7 Birds 8-4
8.1.8 Marine Mammals 8-5
8.1.9 Marine and Freshwater Fish 8-5

8.2 Social, Cultural, and Economic Cumulative Effects 8-5

8 POTENTIAL CUMULATIVE EFFECTS

Section 7 of NIRB's Screening Part 2 Form, Project Specific Information Requirements (PSIR) requests that the proponent discuss how project effects interact with "...the effects of relevant past, present, and reasonably foreseeable projects in a regional context". Cumulative effects result from the combined effects of multiple activities occurring in an area, over time, potentially leading to a greater environmental impact than those of an individual action. It will determine if a Project effect, in combination with effects from other actions, may cause a significant change now or in the future in the characteristics of the valued ecosystem component (VEC) after the application of mitigation for the project (Hegmann et al 1999).

The following sections discuss the preliminary identification of cumulative effects on both the biophysical and socioeconomic environments. Further study of these effects will be completed during the EA phase.

8.1 Biophysical Cumulative Effects

For the purposes of identifying potential cumulative biophysical environmental effects, Appendix VII identifies past, present, and reasonably foreseeable developments, and their potential effects, within a 300 km radius of the proposed Kiggavik Project. This radius was selected as a first approach to encompass the life history patterns and ranges of biophysical components that may be subject to cumulative effects. Though a more detailed review of each project identified will be conducted for the DEIS, it is anticipated that effects from numerous projects in the region may act cumulatively with those from the proposed Project.

Potential effects on the physical environment associated with the Kiggavik Project which may overlap spatially and temporally with other projects in the region include:

- reduction in air quality
- increase in noise
- degradation of unique landforms
- degradation of heritage sites
- impacts on surface water and groundwater quality - determined by watersheds

Potential effects on the biological environment which may overlap spatially and temporally with other projects in the region include:

- habitat loss or alteration,
- disturbance or disruption of movement patterns,
- increased human interaction
- indirect or direct mortality
- acoustic disturbance

Regionally-based projects, including the Kiggavik Project, have the potential to affect various landscape-level biological environmental components including:

- terrestrial wildlife (including caribou, muskox, grizzly bear and other carnivores, small and medium sized mammals),
- birds,
- marine mammals (including beluga whale, seals, polar bear, walrus, and narwhal), and
- marine and freshwater fish.

8.1.1 Air Quality

Emissions from other future industrial operations near the Project area could create cumulative effects with Kiggavik emissions. Future industrial operations near the Kiggavik site may make use of the proposed access road, increasing noise and dust in the area between Baker Lake and Kiggavik.

8.1.2 Noise

Through the marine shipping route and use of the dock facility at Baker Lake, the Kiggavik Project will contribute to noise in the marine and shore environments. In addition, future users of the Kiggavik access road could contribute to noise and dust.

8.1.3 Unique Landforms

It is expected that many development projects in the north would propose to make use of existing borrow sources, or eskers, for granular construction materials. The potential development of several projects in the Baker Lake area could deplete these sources and reduce community utility of the eskers.

8.1.4 Heritage Sites

Increasing use of the land by multiple construction projects could threaten archaeological sites.

8.1.5 Surface Water and Groundwater

There are no projects currently identified that would impact the Judge Sissons sub-basin (in which the proposed Project would operate), and therefore potential cumulative effects would likely be solely related to dust and spills along the access road (if there are multiple users). See Section 8.1.9 for a discussion on potential effects on Baker Lake.

8.1.6 Terrestrial Wildlife

Barren-ground Caribou

Interactions between regional development activities and caribou may occur given the extensive array of projects within the Baker Lake region and the intersecting migratory routes and calving grounds of the caribou herds. Caribou management in the area requires high level intergovernmental coordination and the cooperation of local developers and communities.

Given the large range of caribou, port, road, mine and associated construction and operation of these developments could result in increased human interaction and access to caribou herds.

Muskox

The migration range of muskox is not as large as those of caribou. However, they are known to be sensitive to disturbance and over-hunting and are only recently re-establishing populations in parts of Nunavut. Areas to the south of the proposed Project area (Princess Mary Lake) are considered to be some of the most important muskox ranges south of the Thelon River (Canadian Circumpolar Institute 1992) and individuals could be subject to effects from spatially or temporally overlapping projects in the area.

Barren-ground Grizzly Bear

Grizzly bear have large home ranges and are particularly sensitive to human disturbance. Individuals could be affected by numerous projects throughout the region. Projects can also act as attractants and result in the habituation of a bear. Such interactions can lead to human-bear conflicts and result in the death of the bear.

Other Carnivores

Carnivores such as wolf, wolverine, arctic fox, and ermine are distributed throughout the region and prey upon various mammals and birds (e.g. snowshoe hare, ground squirrel, voles, lemming and ptarmigan). Projects may act as attractants and result in the habituation should it become known as a source of food. Such interactions can lead to human interaction and conflicts, resulting in death of the animal.

Small and Medium-sized Mammals

Small mammals, such as arctic hares, arctic ground squirrels, lemmings, and voles are important prey species for many mammalian predators (e.g., wolves, grizzly bear, arctic fox, ermine) and raptors (rough-legged hawk, snowy owl, peregrine falcon and gyrfalcon) in the tundra ecosystem. Loss of habitat could decrease the populations of these prey species.

8.1.7 Birds

No Important Bird Areas (IBA's) are identified within the area considered by this cumulative effects analysis[1].

Migratory birds have large ranges and have the potential to be affected by many projects in the Kivalliq Region. The Kiggavik Project areas and proposed access routes, including vessel operation, encompasses the range of many migratory bird species. Projects in the area have the potential to act as attractants i.e. lighting, water management and tailings ponds, and could result in the indirect and direct mortality of migratory birds.

Waterfowl and Shorebirds

Waterfowl including ducks, white-fronted, snow, and Canada geese, sandhill cranes, swans, dunlins, golden plovers, Baird's sandpipers, gulls and arctic terns migrate through and utilize the region for staging, molting nesting and brooding areas (Canadian Circumpolar Institute 1992). Chesterfield Inlet is also important as a waterfowl molting and brooding area.

Raptors

Raptors including peregrine falcons, gyrfalcons, rough-legged hawks and golden eagles occur in the region and will nest on suitable cliff faces; with nesting areas for peregrines and gyrfalcons being considered critical for survival (Canadian Circumpolar Institute 1992). Short-eared and snowy owl are also known to occur within the region.

It will be important to identify and monitor nest sites and ensure that potential impacts on these critical habitat features are minimized.

Passerines and Other Birds

In the Baker Lake area, at least 16 species of passerines are known to occur (Staniforth 2002).

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[1] Information obtained from the Canadian BirdLife International co-partners (Bird Studies Canada and Nature Canada) on-line IBA Site Directory. http://www.bsc-eoc.org/iba/canmap.jsp [Date acquired: May 27, 2008].

8.1.8 Marine Mammals

Increased vessel traffic during the summer months will include fuel and dry goods delivered to Churchill and the subsequent barging of these goods from Churchill, through Chesterfield Inlet to Baker Lake during summer. Potential cumulative effects on marine wildlife occurs with increased shipping/barge traffic to Churchill and subsequently Baker Lake.

8.1.9 Marine and Freshwater Fish

The regional aquatic environment of the area consists of numerous ponds, streams and lakes that support a variety of aquatic life.

A fresh water port terminal along with a warehouse and fuel storage facility will be constructed on Baker Lake. Vessel operations associated with the Project will increase the number of vessels operating in the area and contribute to the overall cumulative effects of vessel activity on fish species in Baker Lake and Chesterfield Inlet.

8.2 Social, Cultural, and Economic Cumulative Effects

Given the acceleration of mineral exploration in Kivalliq, and the potential for at least some of these exploration projects to be developed as mines, cumulative effects are of particular concern to people. Potential effects of the Kiggavik Project, and effectiveness of mitigation and benefit enhancement measures, will need to be assessed in Baker Lake and Chesterfield Inlet taking into consideration current and expected effects of the Meadowbank Project as it moves through its construction and operations phases. While the future of exploration projects elsewhere in Kivalliq cannot be known at this time, the concentration of activities in the region suggests that additional projects may come on stream within the foreseeable future.

Public sector initiatives in a territory as new and rapidly changing as Nunavut will also influence cumulative socioeconomic impacts through public policy and program and service delivery. People’s capacity to adapt to the effects of climate change, rapidly increasing telecommunication access to the outside world, and other forces unrelated to mining projects will also influence how people experience and perceive potential cumulative effects.

For the above reasons, and because the Kiggavik Project is still only in an exploration phase, the potential cumulative socioeconomic effects is presented as a list of observations only, as follows:

- The experience of Kivalliq workers and businesses with meeting requirements for the Project will enhance their capacity to realize economic benefits from any other new mining sector projects in the Kivalliq or elsewhere in Nunavut. Much of this enhanced capacity is relevant to participation in other parts of the formal wage economy as well.

- Although there are challenges associated with increased income and achieving the right mix of land based and wage based livelihoods, employment in the wage economy and the economic opportunities associated with mining and other resource extraction projects are expected to have demonstrable effects on improving quality of life in Nunavut.
- Shortages of qualified labour and of business capacity to supply projects and also other community needs are reported to be already occurring in Baker Lake as a result of one project. Exceeding Nunavut's capacity to supply goods and services could lead to inflationary pressures and leakage of economic benefits to non-Nunavut labour and business.
- Whereas the Project is not expected, in and of itself, to have significant effects on traditional land use areas, effects on traditional ways of life should be minimized. There are real constraints to how much land can be released to resource extraction development before such effects accumulate and become significant.
- Participation by Inuit people in the wage economy will have a range of unpredictable effects that could be both positive and negative. As best practice develops and communities gain experience on how to manage participation in such projects to their greatest advantage, the choices made by individuals and governments will be better informed. Increased integration into the wage economy will nevertheless have irreversible effects on the social and cultural fabric of communities.
- Mining projects are by their nature short to medium term projects that close, potentially bringing an end to benefit streams to people and governments – the closure of a successful project creates potential for a significant negative economic shock, particularly to smaller, nearby communities. Therefore, managing an economy largely dependent for employment and government revenues on mining projects may be challenging. AREVA adheres to the principles of sustainable development, with a focus on regional development, to mitigate potential negative effects.
- In general, economic development in northern Canada is increasingly being planned in a context of improved understanding of impacts, respect for the unique culture of the Inuit, community self determination, sharing of industry learning and resources, and improvement of government services. The capacity to ensure that non-renewable resource extraction benefits Inuit communities increases with every project proposed and developed.

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KIGGAVIK PROJECT

Project Proposal

SECTION 9

TABLE OF CONTENTS

SECTION **PAGE**

9 POTENTIAL EFFECTS OF THE ENVIRONMENT ON THE PROJECT 9-1

9.1 Seismic Events 9-1

9.2 Meteorological Effects 9-1

9.3 Climate Change 9-1

9 POTENTIAL EFFECTS OF THE ENVIRONMENT ON THE PROJECT

This section provides a preliminary discussion of the potential effects of the environment on the Kiggavik Project. Further identification and evaluation of potential effects, including atypical geologic or climatic events, will be included in the DEIS. The design of the Project and the proposed management plans will be adjusted as appropriate to mitigate risks to personnel, local communities, the environment, and the operation.

9.1 Seismic Events

Seismic events, such as earthquakes, have the potential to damage Project buildings and equipment, earthworks structures, roads and bridges. The potential infrastructure damage creates associated risks to human safety and risk of environmental impact due to spills and breach of containment. As suggested by Figure 9.1, the risk of significant seismic events in the Kiggavik area is currently considered low, however, further risk assessment will be performed to ensure that any potentially significant risks are mitigated.

9.2 Meteorological Effects

The meteorological effects that may affect the Project consist primarily of local and regional variations from mean climatic conditions, including extended drought, severe temperatures, major precipitation, severe wind and blizzards.

These extreme weather conditions could potentially have the following impacts on the Project:

- Increased risk to personnel safety;
- Damage to infrastructure and process stream containment;
- Upsets to the site water balance resulting in excess effluent or lack of sufficient fresh water; and,
- Difficulties in transporting personnel, supplies and perishable goods to site due to reductions in shipping windows.

Further analysis and development of mitigation for these potential effects will be included in the DEIS. Analysis and mitigation will include consideration of the experience gained by AREVA in northern Saskatchewan and other existing projects in the Arctic.

9.3 Climate Change

Long term climatic effects, including climate change, have the potential to affect the Project during both the operational and decommissioned phases. Climate change during operation could affect the site water balance, the stability of mining faces, the site heat balance, transportation of supplies and the stability of foundations and roads. After mine closure, climate change could affect the movement of groundwater and surface water through decommissioned tailings and waste rock facilities; and could also affect the vegetative covers existing on these facilities.

Further evaluation of the potential impact of climate change on the Project will be addressed during in the DEIS and appropriate mitigation will be included in the final Project design. Given the uncertain nature of long term climatic predictions, the general design strategy should be conservative, such that it will be assumed that regional water flows may change and that the zone of continuous permafrost may progressively withdraw from the region.

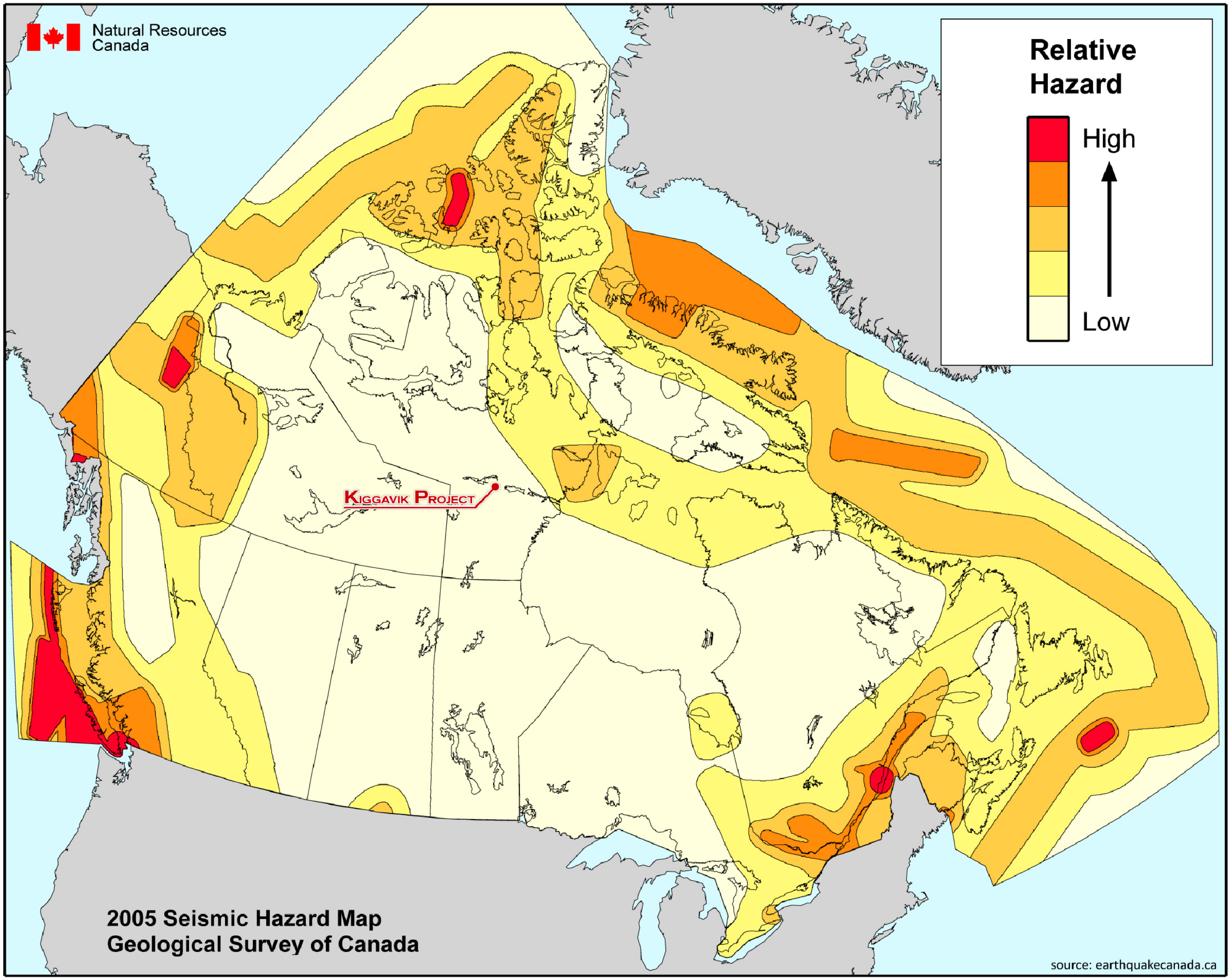
KIGGAVIK PROJECT

Project Proposal

SECTION 9

LIST OF FIGURES

Figure 9.1: Seismic Hazard Map - 2005



Canada

KIGGAVIK PROJECT	Scale:	AREVA	AREVA Resources Canada Inc P.O. Box 9204 817-45th Street West Saskatoon, Sk. S7K 3X5
SEISMIC HAZARD MAP - 2005 FIGURE 9.1	Creator: CDC Date: 10/31/08 Drawing:		

KIGGAVIK PROJECT

Project Proposal

SECTION 10

TABLE OF CONTENTS

SECTION **PAGE**

10 ORGANIZATIONAL MANAGEMENT AND KEY PROGRAMS 10-1

10.1 Organizational Management and Operational Approach 10-1

10.1.1 Organization Management 10-1

10.1.2 Operating Policies 10-2

10.1.3 Kiggavik Project Integrated Quality Management System............................10-2

10.2 Key Programs and Management Plans 10-3

10.2.1 Environmental Protection 10-3

10.2.1.1 AREVA's Integrated Environmental Protection Approach 10-3

10.2.1.2 Environmental Management System..10-4

10.2.1.3 Environmental Protection Program...10-5

10.2.2 Radiation Protection 10-5

10.2.3 Occupational Health and Safety 10-6

10.2.4 Emergency Preparedness 10-7

10.2.5 Training...10-8

10.2.6 Security...10-8

10 ORGANIZATIONAL MANAGEMENT AND KEY PROGRAMS

This section provides an overview of the proposed Kiggavik organizational structure and management systems during operation, including key programs and plans to be implemented in support of operational goals. The Project will draw extensively on the organizational and operating experience of the Saskatchewan sites; however the Kiggavik programs will be adapted to reflect the unique characteristics of the Kivalliq region through public consultations, regulatory processes and benchmarking with existing Arctic operations.

10.1 Organizational Management and Operational Approach

10.1.1 Organization Management

Operationally the Project will be organized in a manner reflective of the existing McClean Lake Operation. The General Manager of the Kiggavik Operation would be responsible for all on-site operations (including Baker Lake facilities), general site management, and liaison with regulators on matters concerning the operating licences and permits. The General Manager would report to the Vice-President, Operations, and through that position to the President and CEO of AREVA.

The corporate departments in Saskatoon will provide a combination of technical support and oversight of site operations, and will also be responsible for the development of new projects. Licensing of the latter will be done through a project team approach involving both corporate and site staff, with the Vice-President, Environment, Science and Technology, and Vice President, Regulatory Affairs and Licensing responsible for overall co-ordination of environmental assessments and licensing within AREVA.

The organizational structure planned for the construction phase will be different from the operational model; both structures will be presented in more detail in the DEIS.

The corporate office in Saskatoon would carry out formal, written communication with the public and employees through weekly and monthly publications. Informal communications with the public and employees would be carried out by Kiggavik, Baker Lake, and corporate staff. Scheduled meetings, tours and on site presentations would be carried out with community and regional liaison committees or other citizen and monitoring committees that are established through the regulatory and consultation process. The existing AREVA Baker Lake office would be expanded to continue interfacing directly with Kivalliq communities on matters of public interest.

10.1.2 Operating Policies

AREVA has identified seven key areas that will be integral to the successful operation of the Kiggavik site. These are:

- Quality
- Health and Safety
- Radiation Protection
- Environmental Protection
- Human Resources and Training
- Economic Viability
- Social Aspects

AREVA's policies in these seven key areas are documented in the corporate Integrated Quality Management System (IQMS) Manual and are replicated in Appendix VIII. These policies are established by senior management and approved by the President and Chief Executive Officer.

A set of programs specific to each key area will be developed, however conformance to the umbrella policies would be maintained through a number of important common features. For example, all of the programs would require that:

- employees and contractors conduct operations in compliance with corporate policies and directives, applicable environmental laws, regulations, licence and permit conditions;
- programs are implemented, maintained and evaluated for their efficiency in achieving established goals, in ensuring the safety of individuals, in maintaining and improving quality of operations and in protection of environment during operation;
- employees are required to participate in the established programs; and
- employees receive the instruction and training required to achieve established goals and targets of the mining, milling and Baker Lake facilities.

10.1.3 Kiggavik Project Integrated Quality Management System

An Integrated Quality Management System (IQMS), structured around occupational function, will be in place for the Project. At the operating sites, workers would be either employed in a production process or fulfill a support service role. Employees involved in process work would be affiliated with two departments: mine/surface operations or mill operations. The support services activities would be required to support the process and include general infrastructure services, radiation protection, training, personnel, health, safety, environmental protection and logistics. All employees are required to safely produce the final uranium concentrate product.

Within the IQMS, quality would be defined as 'the consistent achievement of product, process and support service requirements.' The principle objectives of the quality system are to provide assurance to all stakeholders that AREVA's operations are conducted consistently as approved and to achieve continual improvement in the operations.

The IQMS in place at the McClean Lake Operation is comprehensive and will be used as a template for development of the Kiggavik IQMS. The activities of all of the Operations' employees are included in the system. Each of the key process and support service activities are managed by a department head. The department heads are responsible for maintaining and improving quality in their respective departments. This approach establishes clean lines of accountability and responsibility with respect to quality.

10.2 Key Programs and Management Plans

An Environment, Health and Safety Program has been established at the active Kiggavik exploration site. This program administers a number of management plans developed specifically for exploration at Kiggavik:

- Radiation Protection Plan
- Waste Management Plan
- Emergency Response Plan
- Wildlife Mitigation and Monitoring Plan
- Spill Contingency Plan
- Abandonment and Restoration Plan
- Noise Abatement Plan

These plans will continue to be implemented and improved at Kiggavik. As these plans represent AREVA's growing experience in Nunavut, they will be used, in concert with McClean Lake programs and plans, as a reference point for the creation of plans specific to Project development, operation and closure.

The following sections provide discussion on the key programs and associated plans that are envisioned for the Project. All programs will be appropriately scoped to include the Kiggavik mine and mill sites, the access road, and the Baker Lake facility.

10.2.1 Environmental Protection

10.2.1.1 AREVA's Integrated Environmental Protection Approach

The framework for AREVA's integrated approach to environmental protection is based on continual improvement, incorporating the concepts of both a precautionary approach and adaptive management. Continual improvement in facility processes and operational practices are identified based on analyses of performance data. Operational performance is continually monitored to confirm acceptability of the operations, identify additional mitigation measures where needed, and to update predictions of environmental effects based on analyses of operational and environmental data. As well, environmental monitoring and follow-up programs are continually reviewed for improvement opportunities. This integrated approach allows a conservative, or precautionary approach to decision making when uncertainties are higher, as may be the case prior to the start of operation.

As time progresses, uncertainties are reduced through demonstration of the physical performance of the facility, its mitigative features, and confirmation or revision of the predictions supporting the environmental assessment and licensing approvals. The focus thus shifts from the precautionary approach initially required in the face of uncertainties to adaptive management.

Optimization of performance, and of monitoring, and follow-up programs, is achieved through continual improvement based on experience. If necessary, additional mitigation measures can be implemented from amongst the contingency measures identified at the time of original regulatory approvals.

AREVA's integrated approach to environmental protection is documented in a series of detailed technical information documents (TIDs). The first TID for the Kiggavik Project has been produced and the future series of Kiggavik TIDs are intended to function as 'living' documents that are maintained, and updated as new relevant information is obtained, consistent with the integrated approach to environmental protection. These documents assist in implementing the integrated approach to environmental protection by clearly stating the methodology and results from the most recent technical work.

10.2.1.2 Environmental Management System

The environmental management system (EMS) of the McClean Lake Operation, which is embedded within the overall site IQMS, is certified to the ISO 14001:2004 standard. It is the objective of the Kiggavik Project to attain this certification as well. The EMS provides the structure for operational control of environmental issues, both current and future. Establishment of the EMS is similar to, and follows from, the environmental assessment (EA) process in that it involves an examination of possible environmental effects as a result of interactions between the operation and the environment. Once the significant interactions are identified and grouped, appropriate environmental protection objectives are established, consistent with initially meeting, and then continuously improving on, EA predictions.

As part of the ISO 14001 certification process, a comprehensive review is undertaken of all potential environmental effects from site activities. This allows establishment of broad objectives which can then be broken down into individual measurable targets. At McClean Lake, these cover everything from internal guidelines on minimizing land disturbance and optimizing fuel usage, to meeting or surpassing all regulatory requirements. In addition to the formal processes in this EMS, the enhanced awareness at all staff levels, of both the importance of environmental protection and the contribution of each individual, is an important benefit. Continual improvement is both an underlying company objective, and a formal process requirement for ISO 14001 certification, and thus opportunities for improvement are continually identified and implemented.

10.2.1.3 Environmental Protection Program

In addition to the EMS, the environmental protection program for the Project will include a number of individual plans and elements, including:

- Environmental monitoring and compliance assessment - including air quality, water quality, sediment quality, and additional VECs as required. This monitoring plan will be developed with the input of regulators and community stakeholders.
- Waste Management Plan - to guide operation of various waste management facilities, including storage and disposal of domestic, industrial, chemically or radiologically contaminated waste, and hazardous substances. Each operational department will be responsible for sorting of wastes into appropriate categories and containers. Recycling will be encouraged and facilitated where possible.
- Spill Contingency Plan - including measures for prevention and mitigation of hazardous and radioactive materials spills. An important component of this plan will be to specify the training required by employees and contractors working at all Project sites.
- Wildlife Management Plan - including provisions for employee awareness and training, mitigation measures, noise abatement and wildlife monitoring. One of the key goals of the plan will be to achieve continuous reduction in impacts to wildlife. AREVA will actively seek the involvement of local hunters and trappers in the development and operation of this plan.
- Preliminary Decommissioning Plan and Financial Assurance - to be integrated with the Environmental Protection Program to ensure that the experience gained through progressive reclamation activities is incorporated into the long-term plan for site closure and monitoring. The Preliminary Decommissioning Plan (PDP) provides the basis for estimating the amount of Financial Assurance to be provided by the Project owners for future decommissioning.

10.2.2 Radiation Protection

Radiation protection practice has its foundation in the ALARA principle (As Low As Reasonably Achievable). The commitment to maintain worker doses ALARA is established as a policy within the AREVA Integrated Quality Management System (IQMS).

The radiation protection program for the Project would be designed to meet the regulatory requirements of the Canadian Nuclear Safety and Control Act, Nunavut Occupational Health and Safety Regulations, and the internal requirements of AREVA.

The radiation protection program would include the following administrative and program elements:

- Administrative elements consist of measures used to track, manage and review information gathered from program element.
    - Defined organizational structure and responsibility
    - Radiation protection training
    - A Code of Practice which identifies actions to be taken when specified radiological levels or individual effective doses are reached.
    - Radiation protection documentation comprised of procedures and associated work instructions
    - Change management and document control
    - Program reviews by management

- Program elements consist of day-to-day operational practices and procedures that monitor and help minimize exposure to workers.
    - Implementation and review of ALARA practices in radiation protection
    - Dosimetry monitoring to measure worker exposures to radiation and to demonstrate compliance with regulatory dose limits and operating targets identified in the Code of Practice
    - Radiological monitoring to measure radiological conditions, detect abnormal conditions and to estimate individual radiation exposures.
    - Management of radioisotopes used in mining and milling operations
    - Transport of radioactive materials
    - Emergency preparedness

10.2.3 Occupational Health and Safety

AREVA is committed to maintaining a comprehensive occupational health and safety (OH&S) program aimed at accident prevention and risk management, so that a healthy and safe workplace can be provided for all employees and contractors. The OH&S program at the McClean Lake Operation is certified to the OHSAS 18001 standard. It is the objective of the Kiggavik Project to attain this certification as well.

The Project OH&S program will be designed to meet the regulatory requirements of the Canadian Nuclear Safety and Control Act, Nunavut Mine Health and Safety Act, and the internal requirements of AREVA.

The OH&S program will be comprised of several components, listed below, that implement the corporate occupational health and safety policy:

- Structure and responsibility
- Safety training

- Communication and promotion of safety
- 5-point safety system
- Occupational hygiene
- Employee health and wellness
- Inspections and monitoring activities
- Reporting requirements
- Emergency preparedness

Responsibility and ownership for personal safety is based on the concept of the Internal Responsibility System (IRS). The IRS is a model framework, which describes in general terms the accountabilities, responsibilities and work relationships of workers and management to ensure a safe and healthy workplace. The IRS encourages all employees at all levels of the organization to take personal ownership for safety performance and the resolution of safety concerns without third party involvement.

This commitment to provide a healthy and safe workplace comes from all employees and involves all employees in the steps of managing risks. Risks are an everyday part of life and that is even more evident in an industrial work setting. Accordingly, personal commitment and ownership of safety issues are the first steps in risk management.

A well equipped health centre will be maintained at the project site. Adequately trained staff in sufficient numbers will be available at all times to meet the requirements of the Nunavut Mine Health and Safety Regulations. Relevant procedures and standard practices will be devised, implemented and used by the health centre staff. Medical personnel in charge of the site Health Centre would be responsible for the proper treatment and disposition of an injured or ill employee, in consultation with the company's medical advisor as required.

10.2.4 Emergency Preparedness

The Environment, Health and Safety (EHS) group will be responsible for ensuring that an Emergency Response Plan is established and maintained to adequately respond to:

- incidents of personal injury;
- fire or explosion;
- uncontrolled release of hazardous materials;
- confined space rescue; and
- other high risk hazards as identified by department heads.

An Emergency Response Team will be established to respond to emergencies at both the Kiggavik and Baker Lake sites and along the access road. Each department head will be responsible for ensuring that designated Emergency Response Team members within his/her area attend regular training sessions. The Safety group will be responsible for ensuring that each major geographical area within the Operation has a designated marshalling point and that its location is well communicated to employees, contractors and visitors.

10.2.5 Training

The Kiggavik Project will have a systematic approach to training (SAT) program for identifying and providing the training required by site employees. Within this structured approach:

- each department will identify the training needs for individual employees to ensure that they are trained to perform their job.
- the Training Group will identify the required regulatory training.
- training materials and lesson plans will then developed on site or purchased from outside sources.
- training will be delivered by site staff or provided by outside contracted services.
- the Training Group will retain a summary of all training records.
- job observations will be conducted periodically to ensure that learning has taken place and that tasks are being performed as designed.
- the EHS group will monitor regulatory changes that may necessitate changes in training requirements.

Significant facility changes will also be monitored to ascertain if the changes result in a revision or creation of a training module.

To provide a trained workforce for the start of operations and to ensure that workers from the Kivalliq region participate early, the training program will begin during the construction phase. Local workers will be recruited and will enter a program consisting of a combination of formal training, provided by AREVA and/or by participating educational institutions, and job training at other mining facilities.

Additional discussion of employment and training, as they apply to the mitigation of potential Project socioeconomic effects, are included in Section 7.5.

10.2.6 Security

Security for the Project will include the following:

- monitoring and controlling vehicles and personnel coming onto both the Kiggavik and Baker Lake sites;
- night patrol of all facilities and outlying areas;
- monitoring and controlling vehicles and personnel leaving the sites; and
- monitoring and controlling vehicles using the access road from Baker Lake to Kiggavik.

All incoming vehicles will pass through a security gate located at the boundary of each property. The names and licence numbers will be recorded, as well as the time of entry. A weigh scale will be available for weighing bulk supplies. All personnel will be required to obtain permission of the General Manager before they will be allowed access to or from the sites. However, relevant regulatory agency personnel with proper identification will be entitled to unlimited access to both facilities.

All vehicles leaving the mine site and the Baker Lake facility will be checked by security at the gates. This includes a visual inspection of contents of trucks and the sleepers on the highway tractors. Security personnel will check any paperwork required by drivers and record the departure time. Security personnel will also have the authority to search vehicles. Personnel and materials, including personal luggage, will also be subject to search while entering or leaving the site via the airstrip.