Kiggavik Project

Draft Environmental Impact Statement

Addendum

April 2012

APPROVAL FOR USE

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FOREWORD

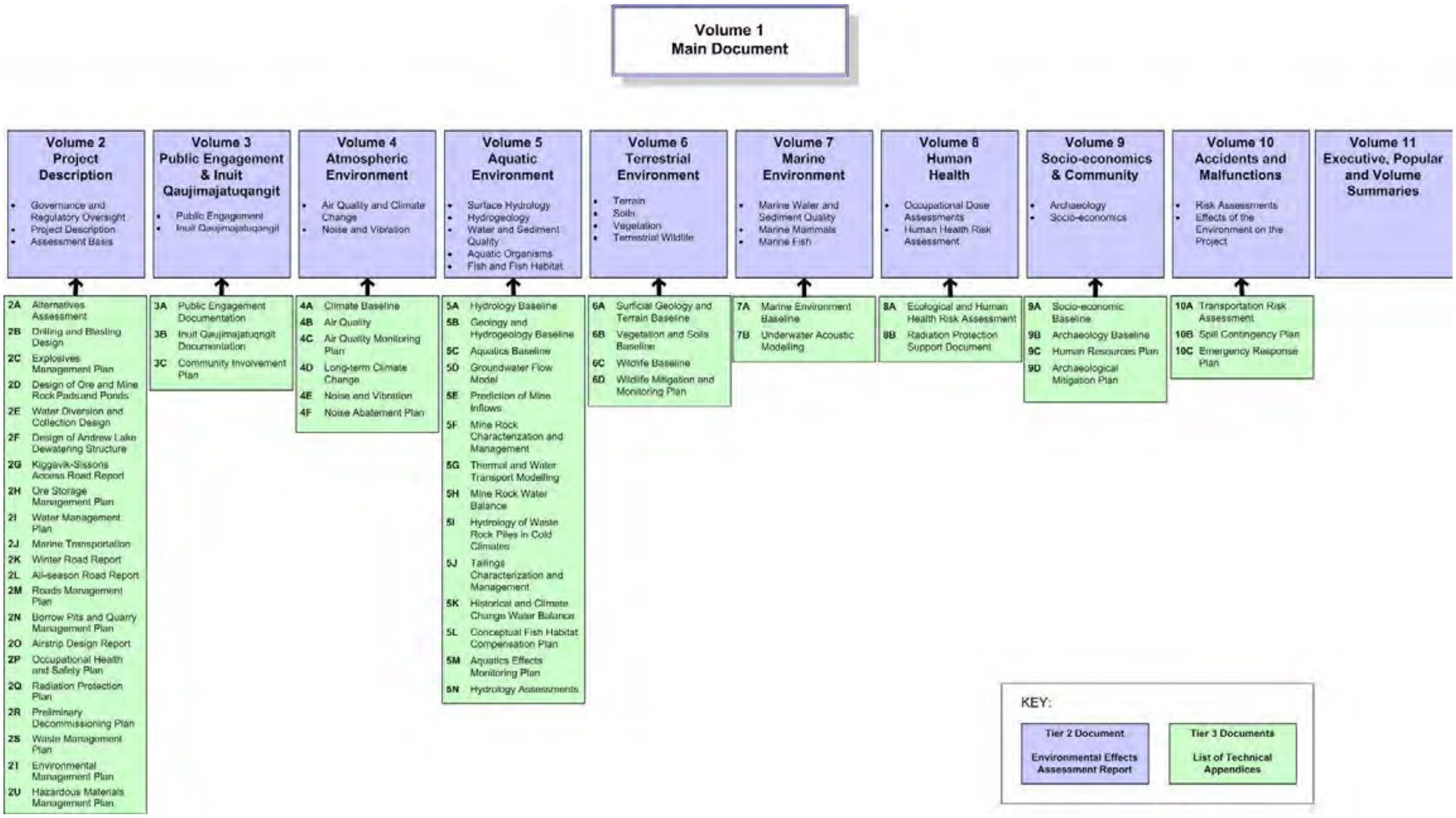
The enclosed document forms part of the Kiggavik Project Environmental Impact Statement (EIS) submission. The submission has been prepared for the Nunavut Impact Review Board by AREVA Resources Canada Inc to fulfill the requirements of the "Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc's Kiggavik Project (NIRB File No. 09MN003)".

The EIS submission consists of a number of documents, as shown in the attached road map. These documents have been categorized into tiers, as follows:

- Tier 1 document (Volume 1) provides a plain language summary of the Environmental Impact Statement.
- Tier 2 documents (Volumes 2 to 11) contain technical information and provide the details of the assessments of potential Project environmental effects for each environmental compartment.
- The Tier 2 documents each have a number of technical appendices, which comprise the Tier 3 supporting documents. These include the environmental baseline reports, design reports, modeling reports and details of other studies undertaken to support the assessments of environmental effects.

This addendum supplements the original EIS submission that was received by the NIRB on January 3, 2012.

ROAD MAP TO THE ENVIRONMENTAL IMPACT STATEMENT



PROJECT FACT SHEET

Location	• Kivalliq Region of Nunavut, approximately 80 km west of Baker Lake. • The Project includes two sites: Kiggavik and Sissons (collectively called the Kiggavik Project). • The Kiggavik site is located at approximately 64°26'36.14"N and 97°38'16.27"W. • The Sissons site is located approximately 17 km southwest of Kiggavik at 64°20'17.61"N and 97°53'14.03"W. • The Kiggavik and Sissons sites are composed of 37 mineral leases, covering 45,639 acres.
Resources	• The total quantity of resources is currently estimated at approximately 51,000 tonnes uranium (133 million lbs U_3O_8) at an average grade of 0.46% uranium.
Life of Mine	• Approximately 12 years of operation, based on studies to date. It is anticipated that pre-operational construction will require 3 years while remaining post-operational decommissioning activities will require 5 years. • Under favourable market conditions, construction of the Project could begin as early as 2017.
Mining	• There are five individual mines proposed for the Project: East Zone, Center Zone and Main Zone at the Kiggavik site; End Grid and Andrew Lake at the Sissons site. • The three Kiggavik deposits and the Andrew Lake deposit will be mined by truck-shovel open pit, while End Grid will be an underground mine.
Mine Rock	• Mine rock will be segregated into material suitable for use in construction (Type 1), non-acid generating (Type 2), and potentially problematic material (Type 3). • Type 2 and Type 3 rock will be managed in surface stockpiles during operation. • Upon completion of mining, Type 3 mine rock will be backfilled into mined-out pits.
Mill	• The ore will be processed in a mill at the Kiggavik site to produce approximately 3,800 tonnes uranium (9.9 million lbs U3O8) per year as a uranium concentrate, commonly referred to as yellowcake.
Tailings	• The mill tailings will be managed at in-pit tailings management facilities constructed using the mined-out East Zone, Centre Zone and Main Zone open pits at the Kiggavik site. • Administrative and action levels will be used to control and optimize tailings preparation performance for key parameters.
Water Management	• A purpose-built-pit will be constructed at the Kiggavik site to optimize water management, storage, and recycling. • All mill effluent, tailings reclaim, and site drainage will be treated prior to discharge to meet the Metals Mining Effluent Regulations and site-specific derived effluent release targets. • Administrative and action levels will be used to control and optimize water treatment plant performance for key elements.

Site Infrastructure	• Power will be supplied by on-site diesel generators. • The operation will be fly-in/fly-out on a 7 to 14 day schedule with on-site employees housed in a permanent accommodations complex.
Access	• Access to the site will be provided by either a winter or all-season road between Baker Lake and Kiggavik. Supplies will be shipped to a dock facility at Baker Lake during the summer barge season and trucked to Kiggavik via the road. • An airstrip will be constructed and operated at site for transportation of personnel and yellowcake.
Environment	• Site-specific environmental studies have been on-going since 2007 • Public engagement and collection of Inuit Qaujimajatuqangit has been on-going since 2006; this information is integrated into the environmental effects assessment reports • AREVA's approach has been to integrate environmental assessment and decommissioning requirements into the Project design cycle to enhance mitigation of effects by design and to support the development of management, mitigation, and contingency plans to protect the environment
Benefits	• AREVA is negotiating an Inuit Impact Benefit Agreement with the Kivalliq Inuit Association • The total taxes and royalties to be paid on the Kiggavik project would be approximately $1 billion, payable to Nunavut Tunngavik Inc., Government of Nunavut, and Government of Canada. • The Project is expected to employ up to 750 people during construction and 400-600 people during operation.

Distribution List: See Distribution List in Tier 1, Volume 1 of the Draft Environmental Impact Statement

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1 INTRODUCTION

1.1 OVERVIEW

This addendum and the revised Conformity Table (Tier 1, Volume 1, Appendix 1A) are provided to facilitate the Nunavut Impact Review Board (NIRB) conformity review of the Kiggavik Project Draft Environmental Impact Statement (DEIS).

The Kiggavik Project DEIS was accepted as received by the NIRB on January 3, 2012. On January 18, 2012 the NIRB determined the Kiggavik DEIS did not conform to the Guidelines for the Preparation of an Impact Assessment for the Kiggavik Project citing an insufficiently detailed conformity table as the primary reason (NIRB, 2012). It is acknowledged that the initial conformity table often did not provide cross-referencing in-depth, and in some circumstances, contained cross-referencing errors.

The revised conformity table has been expanded to include, where appropriate, in-depth cross-referencing to facilitate the conformity review. For those areas where the DEIS was determined by NIRB not to conform, to partially conform, or to potentially conform, the cross-referencing in depth and supporting text provided in the conformity table will aid the conformity review. For those guidelines for which insufficient information is presented in the DEIS, addition information and context is provided in this addendum to facilitate the conformity review. Individual numbers were assigned to each requirement within the NIRB assigned guideline numbers to further facilitate cross-referencing to this addendum.

As with the revised conformity table, this addendum is structured according to the NIRB guidelines. However, there are a number of key conformity issues that will facilitate the conformity review. These issues include:

- The environmental assessment screening methodology (Section 8.1),
- The application of the precautionary principle (Section 2.1), and
- The timeline describing when additional information will become available to support future permitting and licensing (Section 9.1).

It is recommended that these key sections be reviewed prior to the detailed review of the conformity table.

2 GUIDELINE 2.0 – GUIDING PRINCIPLES

2.1 PRECAUTIONARY PRINCIPLE

GUIDELINE 2.4/REQUIREMENT 10, 11, 13

As described in the DEIS Guidelines from the NIRB, a precautionary approach is to be applied to all planned undertaking of a proposed project. To meet this requirement, proponents must:

1. Demonstrate that the proposed Project is examined in a manner consistent with the precautionary principle in order to ensure that they do not cause serious or irreversible damage to the environment (UNCED 1992);
2. Outline the assumptions made about the effects of the proposed Project and the approaches to minimize these effects, including assumptions that are developed where scientific uncertainty exists;
3. Identify any follow-up and monitoring activities planned, particularly in areas where scientific uncertainty exists in the prediction of effects; and
4. Present public views on the acceptability of these effects.

To ensure that the potential for irreversible damage to the environment as a result of the Kiggavik Project is minimized, the environmental assessment (EA) recognized areas of uncertainty and used conservative assumptions and approaches throughout all steps of the EA process, including issues scoping, interpretation of the data, effects evaluations, identification of impact mitigation and adaptive management.

In addressing the above requirements of the NIRB, the EA approach underscored the precautionary principle through several different means, including:

- Use of worst-case assumptions regarding specific project features and activities in the assessment basis,
- Use of conservative bounding in assessment scoping,
- Consideration of public views throughout the EA,
- Identification of data uncertainties and assumptions in the effects assessment (i.e. technical boundaries) and evaluation of potential Project and cumulative effects; consideration of certainty in the effects predictions, and

- Application of mitigation measures and identification of certainty in the effectiveness of the mitigation.

Assessment Basis

Where specific Projects design features or activities could span a range of possible values, the most conservative values (e.g., the largest geographic scope, the longest duration, highest volumes or emission rates) were used to ensure that the effects assessments adequately bound the full range of possible design performance. In the case of assessing biophysical Project effects, the values with the greatest potential to result in an adverse effect were used. In the case of socio-economic benefits, the values with the greatest potential to result in the lowest benefit were used. The assessment basis is detailed in Tier 2, Volume 2, Section 20, pages 20-1 to 20-10. Table 20.1-1 (Tier 2, Volume 2, Section 20) outlines the Project parameter base case and the assessment case.

A key example of how a conservative approach was taken in the assessment basis includes use of a 25-year Project life based on maximum tailings storage capacity, as opposed to 14 years based on current ore reserves and the expected production rate. Another example is the assessment of freshwater requirements at the full usage rate, although planned permeate and site drainage recycling are estimated to reduce this usage to approximately one-quarter of that estimate.

In addition to the assessment basis, discipline-specific assessments also adopted a conservative approach. For example, in the air quality assessment, maximum bounding scenarios (as well as planned phased operational scenarios) were used to assess theoretical worst-case air emissions and atmospheric concentrations that could result from construction and operational activities of the Project (Tier 2, Volume 4, Section 4.6, page 4-21). In the case of maximum operations, the scenario assumed that all mining activities would occur simultaneously at their maximum level of operation to ensure that the assessment considered the greatest potential effect of site activities on ambient air quality so to ensure that any modifications to the production schedule would be within the bounds of the assessment scenario. In addition, it was conservatively assumed that construction would occur over a two year period as opposed to three to four years, thus condensing construction activities into a shorter timeframe resulting in greater emission estimates than what would occur over a longer period of time. This same rationale was also applied to key closure activities (Appendix 4B, Section 2.1, page 2-7). This approach to the air quality assessment provided a worst-case scenario as a basis for assessing the effects of Project emissions on other environmental components such as soil quality, vegetation quality, and wildlife habitat. Similar conservative assumptions were applied across the disciplines presented in the DEIS.

Assessment Scoping

A conservative approach was also taken in defining Local Assessment Areas (LAA) and Regional Assessment Areas (RAA). In the case of the wildlife assessment, a 2.5 km disturbance buffer was applied to both the all-season road and mine site LAAs to ensure that they encompassed a sufficiently broad area for assessing effects of vehicle traffic and noise on wide ranging species, and provided the necessary flexibility in the assessment for any potential shifts in the routing alignment (Volume 6, Section 5.7.1.2, page 5-18). Similarly, the RAA incorporated all Project features and associated LAA buffers based on known caribou water crossing locations along the Thelon River Basin, critical areas identified through Inuit Qaujimajatuqangit (IQ) studies, and areas with similar conditions to those found in the LAA to allow the RAA to be used as a reference area for monitoring potential changes as the Project proceeds (Volume 5, Section 5.7.1.3, page 5-21.

A conservative approach was also applied in bounding the cumulative effects assessment through development of a comprehensive project inclusion list, which not only included large industrial projects but also a wide range of landscape level activities such as aircraft use, recreational and traditional hunting, and mining exploration (Volume 1, Appendix 1B, Section B-1, page 1-3). This was intended to ensure the assessment considered a broad range of existing and likely future sources of potential disturbances that could act cumulatively with residual effects of the Project.

In addition to the above, the scoping for each Valued Component (VC) also included consideration of technical boundaries, which identify limitations to the data used in the effects analysis. Identification of such boundaries considers whether there are gaps in the data or contradictory data, and whether access to the data or the field has been restricted. These boundaries provide the basis from which the assessment of environmental effects and cumulative effects is made, and are a determining factor in the assessor's certainty of the accuracy of the assessment. In the case of air quality, a number of technical limitations to the assessment were identified through scoping (Tier 2, Volume 4-Part A, Section 4.7, page 4-23). These were overcome by using conservative estimation techniques that likely resulted in an overestimation of actual emissions and predicted effects on air quality and climate change (Technical Appendix 4B, Section 4.2, page 4-11). Similarly, the wildlife assessment was subject to a number of technical and scientific limitations due to limited or no information. These were identified in the assessment (Volume 6, Section 11.9, page 11-19) and were addressed through a conservative approach to the effects evaluations and assigning of a low or medium confidence in the effects predictions (Volume 6, Table 13.2-4, page 13-28).

Public Views

A fundamental objective of the environmental assessment is public participation and engagement in the process to ensure that concerns related to the Kiggavik Project are fully considered and addressed in the planning of the Project and the DEIS. AREVA has undertaken extensive engagement with potentially affected communities, Kivalliq residents, Inuit Organizations and other governments to seek input on:

- Traditional and contemporary land and resource use,
- Traditional knowledge,
- Identification of issues and concerns related to the Project,
- Selection of VCs, and
- Evaluation of potential Project effects and their significance.

As part of these engagement activities, the assessment team gained an understanding of how local residents viewed the Project and the acceptability of its potential effects on the environment and its people (Tier 2, Volume 3, Section 4.2). A number of specific issues and concerns regarding the Project were identified through public engagement, and these were considered as an integral part of the scoping process. Specifically, where a high level of concern or uncertainty or high societal value was placed on a certain environmental feature or quality, this was considered a high priority to address in the EA (Tier 2, Volume 3-Part 1, Section 5.1.2).

As described in the environmental assessment methodology for the Project, the ranking scheme applied in the scoping process takes a precautionary approach whereby any interaction with a meaningful degree of concern or uncertainty is assigned the highest priority to ensure that a detailed analysis of the potential effect is undertaken. This is exemplified in the marine assessment, where a detailed analysis of potential effects of marine shipping on fish was undertaken due to community concerns related to the potential for underwater noise to physically harm, disrupt and or displace fish and disrupt fishing that occurs at fish camps along Chesterfield Inlet (Volume 7, Section 7.1, page 7-1), despite the low frequency and low probability of disturbance from Project marine vessel traffic.

Effects Assessment

Where lack of scientific data, uncertainty in the overall understanding of the ecosystem or limitations in accurately foreseeing future conditions existed for a specific VC, it was necessary to make assumptions about potential Project and cumulative effects based on best available information. This included published and unpublished literature, research from similar northern mining projects, animal behaviour studies and ecology theory. In these cases, assessors were explicit about the basis from which the assumptions were made. In the case of the wildlife assessment, information used to make assumptions for various impact predictions on caribou were identified throughout the assessment. For example, assumptions for assessing change in mortality risk were described in the analytical methods (Volume 6, Section 13.2.1.1, page 13-6), and in the effects mechanisms and linkages section (Volume 6, Section 13.2.1.3, page 13-23).

Where limitations or uncertainties existed, these were further taken into consideration when evaluating the likelihood that a Project effect or cumulative effect might occur during the Project, and the certainty associated with the prediction of Project and cumulative effects. For example, in assessing the combined effects of the Project on vegetation, prediction of the magnitude of the overall effect relied on professional judgment due to lack of an understanding about how multiple disturbances may affect the VC (Volume 6, Section 9.5, page 9-46). In this case, confidence in the effect prediction was considered to be moderate and follow-up and monitoring programs were recommended to increase certainty and elevate confidence in the assessment conclusion. Refer to Tier 2, Volume 2, Section 17, Pages 17-1 to 17-9 for AREVA's approach and commitment to Environmental Monitoring and Management Plans.

Mitigation Measures

Given the precautionary approach taken in the effects analysis and evaluation, mitigation measures are considered to be conservative as they are based on worst-case effects predictions. For example, a number of general and activity-specific mitigation measures have been recommended to further reduce air emissions beyond design-based mitigation, which was shown through dispersion modeling studies to minimize the potential effects on air quality even under worst-case scenarios (Tier 2, Volume 4, Section 6.1.3, page 6-6).

As outlined in the environmental assessment methodology for the Project, the assessment includes a discussion of the expected success of the Project design features, mitigation measures and environmental protection measures in effectively reducing the environmental effects. Where certainty of mitigation success is low, this was factored into the significance determination for the Project effect or cumulative effect. The certainty of mitigation success for cumulative effects also took into account AREVA's ability to implement mitigation measures verses the need for others to participate and/or enforce (e.g. mitigation measures for caribou as outlined in Tier 2, Volume 5, Section 13.3.2.5).

Conclusion

As a result of these various conservative approaches, the assessment of Project effects and cumulative effects for the Kiggavik Project, as well as the mitigation and management of these potential effects, fully embodies the precautionary principles as outlined by the NIRB. By overestimating potential environmental effects and basing environmental protection measures and mitigation measures on these estimates, the assessment implicitly includes several means to ensure that the potential for serious or irreversible damage is minimized, while also committing to measures that will meet or exceed the needs to prevent environmental degradation.

3 GUIDELINE 3.0 – SCOPE OF THE NIRB ASSESSMENT

3.1 NLCA SECTIONS 12.5.2 & 12.5.5 –ECOSYSTEM INTEGRITY

GUIDELINE 3.1/REQUIREMENT 28

The Draft Environmental Impact Statement determined that the Kiggavik Project would not unduly prejudice the ecosystem integrity of the Nunavut Settlement Area.

Project-environment interactions were comprehensively identified, design-based and other mitigation measures were considered; and residual effects assessed for significance according to effect direction, magnitude, geographic extent, frequency, reversibility, likelihood and context. The confidence associated with these determinations was also considered.

The Project assessment identified both positive and adverse effects with none of the adverse ecosystem effects being significant or threatening ecosystem integrity. This determination was based on a precautionary approach to the assessment of potential effects (Refer to Addendum Section 2.1 for more information on the use of the precautionary principle throughout the Kiggavik DEIS). Tier 1, Volume 1 summarizes key DEIS findings and concludes the ability to maintain ecosystem integrity in the last paragraph. Tier 1, Volume 1, Appendix 1F contains the significance determinations concluded for each discipline. Addendum Section 10 includes an overall assessment conclusion.

3.2 NLCA SECTIONS 12.5.2 & 12.5.5 – PERFORMANCE BONDS

GUIDELINE 3.1/REQUIREMENT 32

Performance bonding, or financial assurance, is required by regulators at various stages of project development to ensure funds are in place to decommission the site should circumstances develop such that the proponent is unable to finance decommissioning. AREVA and the Kiggavik Joint Venture (JV) Partners have financial assurances currently in place for the exploration site. The financial assurance estimates were updated in 2011 and steps are being taken to update the corresponding assurance in place.

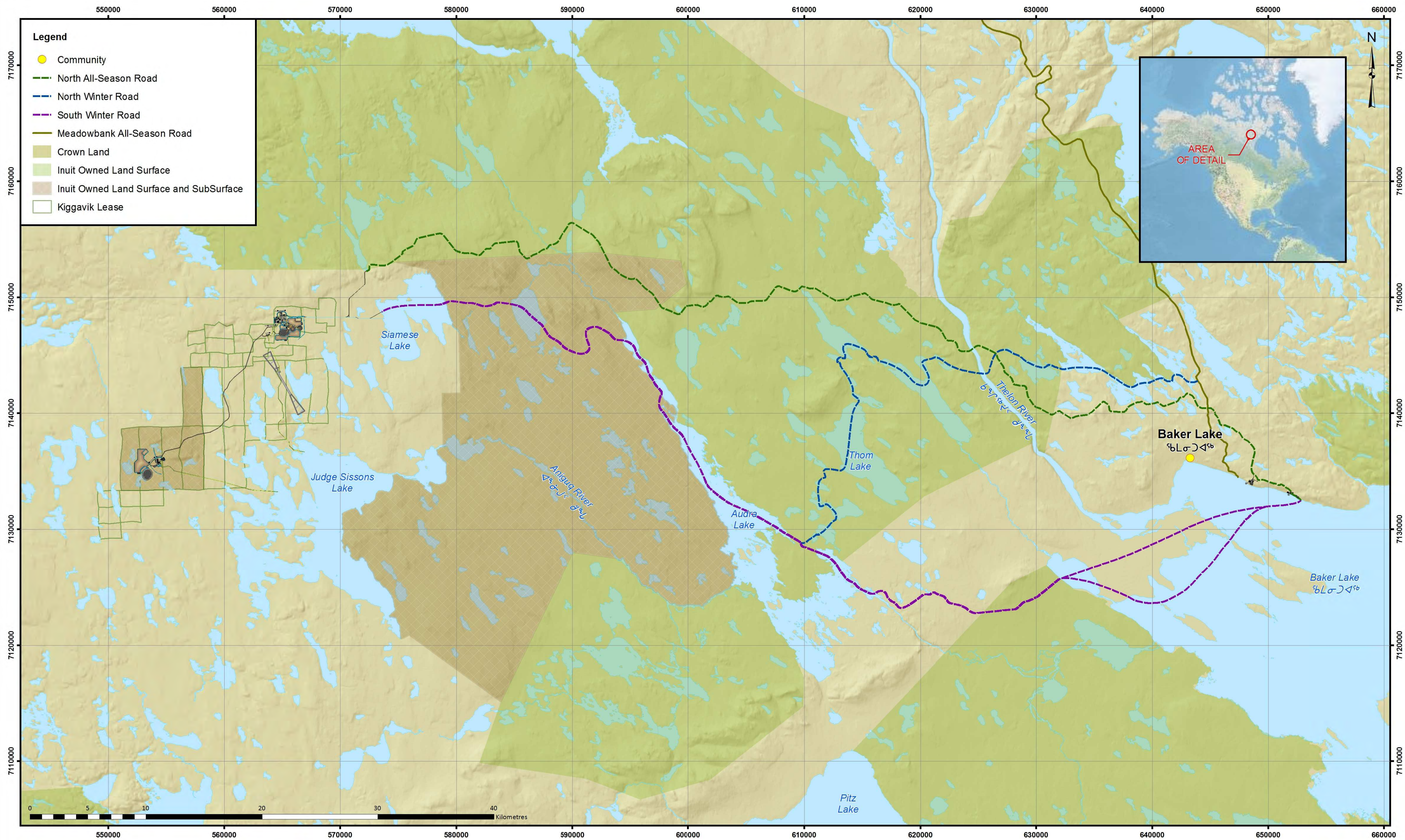
The Preliminary Decommissioning Plan (Tier 3, Appendix 2R) of the Kiggavik DEIS, provides a cost estimate to decommission the proposed Kiggavik mine development site at $159 million (CAD). AREVA and the JV partners will provide financial assurance as required by the land and water administrators. Currently the Kivalliq Inuit Association, Aboriginal Affairs and Northern Development and the Nunavut Water Board all require assurances to be in place for projects to advance into construction and operation. As part of the permitting process, updated estimates will be provided based on the detailed engineering plans.

4 GUIDELINES 4.0 PRESENTATION

4.1 DATA PRESENTATION AND LAND TENURE – INUIT-OWNED AND CROWN LAND

GUIDELINE 4.5/REQUIREMENT 72 and GUIDELINE 5.4/REQUIREMENT 95

Figure 2.3-1: Project Components on Inuit Owned Land (IOL) located in Tier 2, Volume 2, Section 2.2 on Page 2-19 depicts land as either IOL-Surface or IOL-Surface and Subsurface with remaining land assumed to be Crown Land. The following Figure 2.3-1 (revised March 30, 2012) has added Crown land to the legend for ease of identification. Please see Tier 2, Volume 2, Sections 2.2 (Pages 2-2 to 2-5) for text related to existing land and mineral tenure and sections 2.3.5.1 (Page 2-18), 2.3.5.2 (Page 2-20) and 2.3.5.7 (Page 2-22) for information on the three land holders in Nunavut.



Projection: NAD 1983 UTM Zone 14N
Creator: CDC
Date: 03/30/2012 Scale: 1:300,000
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Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 2.3-1
PROJECT COMPONENTS ON INUIT OWNED LAND

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 2

Kiggavik Project

AREVA

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5 GUIDELINE 5.0 – INTRODUCTION

5.1 REGULATORY REGIME - TAX OBLIGATIONS

GUIDELINE 5.2/REQUIREMENT 92

Steps taken by AREVA to ensure Project tax obligations will be met include an understanding of tax obligations with the Government of Nunavut (GN) through familiarity with GN requirements and in particular, familiarity with the *Payroll Tax Act*, C.S.N.W.T. 1993, c. 11 and the *Petroleum Products Tax Act*, R.S.N.W.T. 1988, c. P-5.

AREVA is committed to compliance with applicable policies and regulations as detailed in the AREVA corporate experience and operational record found in Tier 1, Volume 1, Section 1.6.4.3 (Page 14). Both the *Payroll Tax Act* and the *Petroleum Products Tax Act* include sections related to Offences and Punishments should a non-compliance occur.

5.2 REGULATORY REGIME – FUEL TAX REBATE

GUIDELINE 5.2/REQUIREMENT 93

The fuel tax rebate with the GN is an optional program and it is one item to be considered in the negotiation of a Development Partnership Agreement. The Development Partnership Agreement is a voluntary agreement between the GN and a proponent and it is administered by the Department of Economic Development and Transportation in cooperation with the Department of Finance. Negotiations and resulting agreements are intended to identify and capitalize on mutually beneficial infrastructure development and training initiatives for Nunavummiut. A Development Partnership Agreement must be obtained to qualify for the optional fuel tax rebate. Proponents can initiate negotiations with a letter of intent as early as a Part 5 or Part 6 project review decision under the *Nunavut Land Claims Agreement*. AREVA has not submitted a letter of intent to initiate negotiations at the submission of the DEIS in December 2011 nor at the submission of this addendum; however, AREVA does intent to initiate discussions related to the Development Partnership Agreement.

6 GUIDELINE 6.0 COMPONENTS AND ACTIVITIES

6.1 ALTERNATIVES

6.1.1 Power Supply Alternatives

GUIDELINE 6.4/REQUIREMENT 131

Due to the site being remote from any large scale power generation source, all power will be generated at site. Viable power supply alternatives evaluated in the DEIS include:

1. Wind generation with diesel generation
2. Decentralized diesel Internal Combustion Engine (ICE) generation
3. Centralized diesel ICE generation
4. Decentralized diesel Turbine and
5. Centralized diesel Turbine

A summary of the wind power supply alternative that was screened out for the Project, as well as the rationale for not including other power supply alternatives is provided below.

6.1.1.1 Wind

Wind power generation combined with a full diesel generation set was considered as a power supply alternative (see Tier 3, Appendix 2A, Section 3, Pages 19 to 23). Seven 810 kW wind turbines were considered, having the capabilities of generating 5.6 MW of power. It was estimated that adding wind power generation as a power source for the Project would save up to 6% total diesel consumption per year. While wind power generation could reduce greenhouse gas emissions from the Project, the potential sensitivity of wildlife to turbine flicker and noise was considered of greater concern. As such, wind power generation was screened out during the evaluation process.

Recently, the Diavik diamond mine announced construction of a wind farm at the mine site to help off-set the amount of diesel fuel required to meet its energy needs. The proposed wind farm is anticipated to reduce the mine's total diesel consumption by about 10%. AREVA will continue to monitor the feasibility and effectiveness of this power supply initiative at the Diavik diamond mine for meeting the energy needs of the Kiggavik Project.

6.1.1.2 Solar Energy

Solar energy was screened out as a power supply alternative early in the Project design phase due to the geographical location of the Project, as well as the amount of power required for the Project. The amount of sunlight (and solar radiation) the Project location receives fluctuates substantially throughout the year. The historical weather data from the Baker Lake weather station shows that daylight can occur for up to 20 hours in June, but could be as little as 4 hours in December (see Figure 2 in Tier 3, Appendix 4D for further details). Of that daylight, it is anticipated that only a portion of this daylight time period would generate solar energy. As well, the time period when electricity and thermal energy would be at its greatest demand would likely be during the winter months due to cold winter temperatures when solar energy generation would be at its lowest. Finally, the number of solar power cells required to generate enough power for the Project is not feasible, and would likely increase the size of the Project footprint. substantially. As such, solar energy was not included as a power supply alternative.

6.1.1.3 Hydro

Hydro was screened out as a power supply alternative early in the Project design phase due to environmental impact this power source would have, as well as its feasibility in relation to the lifespan of the Project. Development of a hydro-electric dam would likely affect fish and wildlife populations and their habitat. The capital costs of constructing a hydro-electric dam would make the Project unfeasible, based on the projected lifespan of the Project. As such, hydro was not included as a power supply alternative.

6.1.1.4 Geothermal Energy

Geothermal energy was screened out as a power supply alternative early in the Project design phase due to the environmental impact, as well as the uncertainty whether the Project is located in an area of feasible geothermal potential in relation to the lifespan of the Project. The Project is located within the continuous permafrost zone, and the environmental effects caused by drilling and operating a geothermal energy system on permafrost was of concern. The risk and capital costs associated with geothermal exploration in an area unknown for geothermal potential also contributed to geothermal energy not being included as a viable power supply alternative.

6.1.2 Mine Waste Alternatives

GUIDELINE 6.4/REQUIREMENT 133

Additional information on the use of best practice as it applies to mine waste is presented in the following sections. For further information on alternatives analysis please refer to Tier 2, Appendix 2A, Sections 6 and 9.

6.1.2.1 Mine Waste – Tailings and Waste Rock

It is recognized that the assessment of mine waste disposal alternatives can be an important decision-making tool, which has recently led to substantial work in this area. An example is the recent Environment Canada (EC) Guidelines for the Assessment of Alternatives for Mine Waste Disposal (EC 2011), which apply when a proponent is considering using a natural water body frequented by fish as a tailings impoundment area (TIA). In such situations, the guidelines outline the general theory of multiple criteria decision analysis (MCDA) and the specific tools derived there from, as appropriate frameworks for decision-making. Multiple Accounts Analysis (MAA), one of the tools derived from the general theory of MCDA, was successfully applied in the environmental assessment of the Meadowbank gold mine in Nunavut, and is referenced as an example in the Environment Canada guidelines (EC 2011). The proposed tailings and waste rock management plans for the Kiggavik Project do not consider the development of a TIA in a natural water body frequented by fish, and therefore the EC guidelines do not apply. It is also noted that no water or place associated with northern Saskatchewan uranium mining developments are listed in Schedule 2 "Tailings Impoundment Areas" of the Metal Mining Effluent Regulations (MMER) under the *Fisheries Act*.

The Canadian Nuclear Safety Commission has also recently published (March 2012) a regulatory document on the Management of Uranium Mine Waste Rock and Mill Tailings (CNSC 2012a). Broad stakeholder consultation was undertaken during the development of this regulatory document, and it is our understanding that this consultation included both Fisheries and Oceans Canada and Environment Canada. The CNSC regulatory document sets out the requirements for the sound management of mine waste rock and mill tailings over the life of the project to ensure the protection of the environment and the health and safety of people. Prior to publication, this regulatory document was presented to the Canadian Nuclear Safety Commission during a public meeting. During the deliberations of the Commission Tribunal, it was noted that "The modern mines in Saskatchewan have set the standard for best practice by using open pits for the management of tailings and the most problematic forms of waste rock." (CNSC 2012b).

This best practice standard for tailings and waste rock management has been adopted for the Kiggavik Project, and has been outlined in the EIS. Tier 2, Volume 2, Section 8 and supporting appendices outline the proposed in-pit tailing management facilities and the details of tailings preparation. Tier 2, Volume 2, Section 6 and supporting appendices outline the proposed mine rock management plan, including the proposed mine rock segregation criteria, to ensure that problematic forms of waste rock are managed appropriately. The segregation criteria include the characterization of mine rock materials in terms of their acid generation potential, and loadings of constituents of potential concern (i.e. the potential of the material to produce acid rock drainage (ARD) and metal leachate (ML); see NIRB Guidelines 8.1.8 and 8.1.9; individual guideline numbers 609 and 626).

Thus, the proposed mine waste management plans outlined for the Kiggavik Project reflect best management practice as developed and AREVA's McClean Lake Operation in northern Saskatchewan and are consistent with the intent of the recently released CNSC regulatory document RD/GD 370 Management of Uranium Mine Waste Rock and Mill Tailings (CNSC 2012).

The identification of this best practice was the result of previous and currently implemented alternatives being evaluated.

6.1.2.2 Mine Waste - Other

The following provides additional support that the waste management support facilities and waste management principles outlined in Tier 2, Volume 2A, Section 6, and Tier 2, Volume 2S and Volume 2U, represent risk-informed best practice of mine waste management in remote mine locations.

The waste management principles outlined in Volume 2A, Section 6, embrace the concepts of waste segregation and containment, diversion through reuse and recycling where appropriate, storage of materials in areas designated to minimize potential environmental interactions and/or incineration of wastes to minimize attracting wildlife. The principles build on the mine waste management initiatives that have evolved in the mining industry in northern Saskatchewan, and are in alignment with the mine waste management practices in Nunavut and elsewhere in Canada. In addition to meeting all legal requirements, the waste management principles and practices will become part of the ISO 14001 certification process for the Kiggavik Project, which will characterize the environmental aspects of the mine waste management plans and be subject to the continual improvement process.

6.2 MINING, TRANSPORT AND PROCESSING

GUIDELINE 6.6.1.2/REQUIREMENT 174 and GUIDELINE 6.6.1.3/REQUIREMENT 188

The proposed Project production schedule is shown in Table 5.3-1 (Tier 2, Volume 2, Page 5.4). Yearly average extraction and production rates and quantities of ore are included in Table 5.3.1.

The following table summarizes daily average extraction rates as calculated from the yearly extraction rates shown in Table 5.3.1.

Table 5.3-1 Daily Average Ore Extraction and Production Rates

Daily Average Production Rates (bcm/day and tonnes/day)

	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	Total
East Zone Open Pit															
Volume (bcm*1000)	7.4														7
Mine Rock (t*1000)	18.3														18
Ore (t*1000)	0.2														0.2
Centre Zone Open Pit															
Volume (bcm*1000)	18.8														19
Mine Rock (t*1000)	44.0														44
Ore (t*1000)	2.3														2.3
Main Zone Open Pit															
Volume (bcm*1000)	5.7	24.8	13.5	24.4	10.4										79
Mine Rock (t*1000)	10.7	64.0	28.3	62.0	25.3										190
Ore (t*1000)	0.0	1.1	1.1	3.1	2.3										7.5
Andrew Lake Open Pit															
Volume (bcm*1000)			5.4	17.1	3.8	18.9	28.0	8.8	6.3	6.3	3.1	3.2	3.2	1.1	105
Mine Rock (t*1000)			10.4	46.1	10.3	47.5	74.1	22.8	14.9	15.4	8.0	7.6	6.9	1.0	265
Ore (t*1000)						0.4	1.3	0.9	1.9	1.3	0.4	0.8	1.5	1.6	10.0
End Grid Undeground Mine															
Mine Rock (t*1000)				0.4	0.5	0.3	0.1	0.2	0.2	0.2	0.1				2
Ore (t*1000)				0.0	0.0	0.3	0.7	1.0	1.0	1.0	1.0	1.0	1.0	0.4	7

6.3 LANDFILL AND LANDFARM FACILITIES – EFFECTIVENESS AND VIABILITY

GUIDELINE 6.6.4.4/REQUIREMENT 255, 260

Waste management techniques for the proposed landfills and landfarm are based largely on operational experience gained at AREVA's McClean Lake Operation located in Northern Saskatchewan, as well as at Agnico Eagle's Meadowbank Project. Proposed disposal and reclamation methods represent current industry practices that have been demonstrated to effectively manage domestic, industrial, and contaminated wastes.

6.3.1 Landfill

Landfills proposed for the Kiggavik Project include two industrial landfills located on mine rock piles and one contaminated landfill for chemically/radiologically contaminated waste located on the perimeter of the Tailings Management Facility (TMF). Industrial landfills will not contain contaminated materials and runoff will be directed to the mine rock sedimentation ponds. Runoff from the contaminated landfill is directed to the TMF. Upon closure of the Project site, compacted till covers approximately one meter in depth will be constructed over the industrial landfills and the contents of the contaminated landfill will be disposed of in the TMF. Refer to Technical Appendix 2S – Waste Management Plan.

6.3.2 Landfarm

A landfarm is proposed for the remediation of petroleum hydrocarbon contaminated soils and snow/ice as a result of fuel spills. Landfarming, a form of bioremediation, represents the biological removal process of hydrocarbons from contaminated soils. Bioremediation is increasingly viewed as an appropriate remediation technology for hydrocarbon contaminated polar soils. Experiments conducted in the Arctic indicate that landfarming and biopiles may be useful approaches (Aislabie et al. 2006).

A number of studies in both Arctic and Antarctic regions have shown that microorganisms naturally occurring in harsh environments are capable of degrading petroleum hydrocarbons (Paudyn et al. 2007, McCarthy et al. 2004, Mphegko and Cloete 2004, Ferguson et al. 2003). Studies suggest that landfarming in polar regions is effective, however, microbial activity is limited by a combination of unfavourable conditions including low temperature, moisture, and nutrients. Therefore, nutrient addition and aeration of landfarmed soils during the short summer season are key components for effective remediation and are proposed operational considerations for the Kiggavik landfarm.

Recent examples of successful remediation of petroleum hydrocarbon contaminated soils in Arctic regions include the landfarming of diesel contaminated soils at the former military base at Resolution Island, Nunavut (Paudyn et al. 2007) and the successful treatment of 3,600 m^3 of sandy soil by landfarming on site at Barrow, Alaska (McCarthy et al. 2004).

Recognizing that the bioremediation process is slowed by extreme environmental conditions, landfarming of hydrocarbon contaminated soils represents the best option for treatment and reuse of these soils as a result of operations at the Kiggavik Project. Reclaimed soils are proposed to be used as cover material for the industrial landfills, thereby reducing the amount of virgin soils that must be obtained during decommissioning. Refer to Technical Appendix 10B – Spill Contingency and Landfarm Management Plan for further detail.

Alternatively, contaminated soils could be stockpiled in a designated area on the mine rock pile for future disposal in the TMF upon decommissioning of the site. This offers a less intensive solution to managing hydrocarbon contaminated soils but would preclude soil remediation and re-use.

6.4 HUNTING AND TRAVEL ROUTES

6.4.1 Relationship to Ground Transportation

GUIDELINE 6.6.5/REQUIREMENT 277

Nunavummiut travel the land and hunt caribou throughout the year. IQ data from Baker Lake found in Tier 2, Volume 3-Part 2, Section 4.1 provides information on travel and hunting locations between Baker Lake and the Kiggavik site. Within this section, Figures 4.2-1 and 4.2-2 illustrate caribou and land use information from the Baker Lake study area, respectively.

Tier 2, Volume 6, Section 13.2.3.5 on Pages 13-91 to 13-93 details effects to caribou migration and examines the frequency that caribou may occur along the proposed road routes. The presence of caribou is likely an influencing factor in determining hunting frequency in particular areas so the presence/absence of caribou along the proposed road route is used here as one estimate of hunting use in the proposed road route corridors. The assessment states: "Collar data from the migratory caribou herds during the migratory period and the known locations of the current calving grounds suggests that few caribou will interact with the Project during the migration seasons…."

The location of the north all-season road immediately east of the Thelon River is close to a known All-Terrain Vehicle (ATV) and snowmobile route. The proposed Thelon River crossing, only necessary with the north all-season road alternative, is also in proximity to existing Thelon River crossing sites (For more information see Tier 3, Appendix 2L: All-Season Road Report). The location of the winter road avoids the ATV and snowmobile trail east of the Thelon River. However, the winter road crosses a caching area around Aniguq Lake and the travel route between Aniguq Lake and Judge Sissons Lake (Figure 4.2-2 of Tier 2, Volume 3 Part 2 Section 4.1).

6.4.2 Relationship to Marine Shipping

GUIDELINE 6.6.6/REQUIREMENT 289

Marine shipping routes and seasons are shown in Tier 2, Volume 2, Section 10.3, Pages 10-2 to 10-5. Marine shipping will take place between mid July and mid October. Hunting times and marine wildlife hunted is provided in Tier 2, Volume 7 Section 5, Pages 5-1 to 5-6. Hunting areas and wildlife hunted are provided in Tier 2, Volume 3 Part 2, Section 4.2, Pages 3-17 to 3-20.

Tier 2 Volume 7 and Tier 2 Volume 3 Part 2 indicate that hunting of marine mammals takes place in Hudson Bay in the area of Chesterfield Inlet, Rankin Inlet and Whale Cove. Beluga whales are hunted up to 35 km offshore (Tier 2 Volume 7 page 5-2). Tier 2 Volume 2 Figure 10.3-1 shows that the shipping route from Churchill to Chesterfield Inlet is travelled more than 50 km from shore until approximately Rankin Inlet and then gets closer to shore as it approaches Chesterfield Inlet. There is the possibility of marine mammals to be hunted in the vicinity of shipping routes between Rankin Inlet and Chesterfield Inlet.

6.5 TIMING OF ENGINEERING AND OTHER DETAIL

6.5.1 Landfill and Landfarm Engineering Detail

GUIDELINE 6.6.4.4/REQUIREMENT 256

As indicated above, locations for the proposed landfills and landfarm have been selected based on operational experience and take advantage of proposed site features to provide additional barriers to potential contaminant migration into the surrounding environment. The final landfill and landfarm designs will be developed during the detailed engineering and design phase for the Kiggavik Project and will be provided at the licensing and permitting stage. See Addendum Section 9.1 for more detail on the timing of engineering and other detail.

6.5.2 Air Transportation – Maintenance Schedules

GUIDELINE 6.6.7/REQUIREMENT 304

Aircraft that may be used include: Lockheed C-130 Hercules, Lockheed Hercules L382G, Boeing 737-200, ATR 42-300, ATR 72-200, Beech 1900, King Air, and various single-engine helicopters. Maintenance schedules will conform to all requirements as outlined for the specific type of aircraft selected and in accordance with the Operating Certificate for the airline. In addition to requiring aircraft providers to comply with regulations, AREVA requires aircraft services to pass periodic audits carried out by third parties. These begin before the service is used and then on a frequency of usually one or two years. Based on AREVA's third party audits, a list of approved carriers is released several times a year. These audits include a review of personnel, licenses, insurance, flight operations, safety program and records, maintenance program and quality assurance program. The maintenance audit includes personnel training and records, publications, parts, facilities, tools and equipment.

6.5.3 Borrow Pit and Quarry Sites – Estimates of quantities required from each Site and Annually

GUIDELINE 6.6.8/REQUIREMENT 312, 314

Approximately thirty potential bedrock quarries have been identified to provide rock and granular material for road construction (Tier 2, Volume 2, Section 12.7).

There are three access road alternatives considered in the DEIS with the north winter road being the preferred alternative (See Tier 3, Appendix 2A, Section 10: Access Road Alternatives Assessment). Preliminary Quarry selection and prioritization is included in the DEIS.

Upon completion of the EA and final road selection/routing, there will be further prioritization of sites to be used and quantities taken from each. Accessibility, haul distance, source material volume, extent of overburden and absence of acid rock drainage or metal leaching potential will continue to influence selection. Prioritization of sites will also depend on the presence of active or newly discovered raptor nests, conformation of archaeological work and other factors. For more information on preliminary selection work on quarry sites see Tier 3, Appendix 2G Section 2.2.4; Tier 3, Appendix 2N, Sections 2 and 3 Tier 3, Volume 2L, Section 2.3.

6.6 SHIPPING ROUTES AND BATHYMETRY

GUIDELINE 6.6.6/REQUIREMENT 286, 291

6.6.1 Shipping Routes

The current shipping route through Hudson Strait provides access for resupply for a number of communities along the coast of Hudson Bay, industrial activities (e.g., Meadowbank Mine, Meliadine Mine), and the import and export of goods and supplies from the Port of Churchill (which has been operating since 1931) (Port of Churchill, 2012). Community re-supply involves a variety of vessel types including tankers, general cargo, container ships, and tug/barge combinations. As with community re-supply vessels, Project-related shipping will follow established shipping routes through Hudson Strait and west across northern Hudson Bay to Chesterfield Inlet or directly southwest to the Port of Churchill.

The shipping route (as illustrated in Tier 1, Volume 7, Figure 4.5-1) leaves the Davis Strait (1,000 – >3,000m depth) and enters Hudson Strait, travelling along the middle of the Strait (200 to 499m depth), and entering northern Hudson Bay. Depths in northern Hudson Bay are <200 m deep throughout most of the Bay. The shipping route from Chesterfield Inlet south to Churchill is in waters <200 m deep.

Major marine shipping routes and course scale bathymetry for these routes are provided by Transport Canada (Transport Canada 2012). Figure 4.5-1 in Tier 2, Volume 7 shows the shipping routes for the Kiggavik Project, as well as the available bathymetry through Hudson Strait and the west coast of Hudson Bay, along Chesterfield Inlet to Baker Lake. The bathymetry of Chesterfield Inlet is provided in Tier 3, Appendix 7A, Figure 5.1-1. Marine Charts 5002, 5620, 5621, 5622, 5623, 5624, 5625 and 5626 are provided in Tier 3, Appendix 2J, Attachment A.

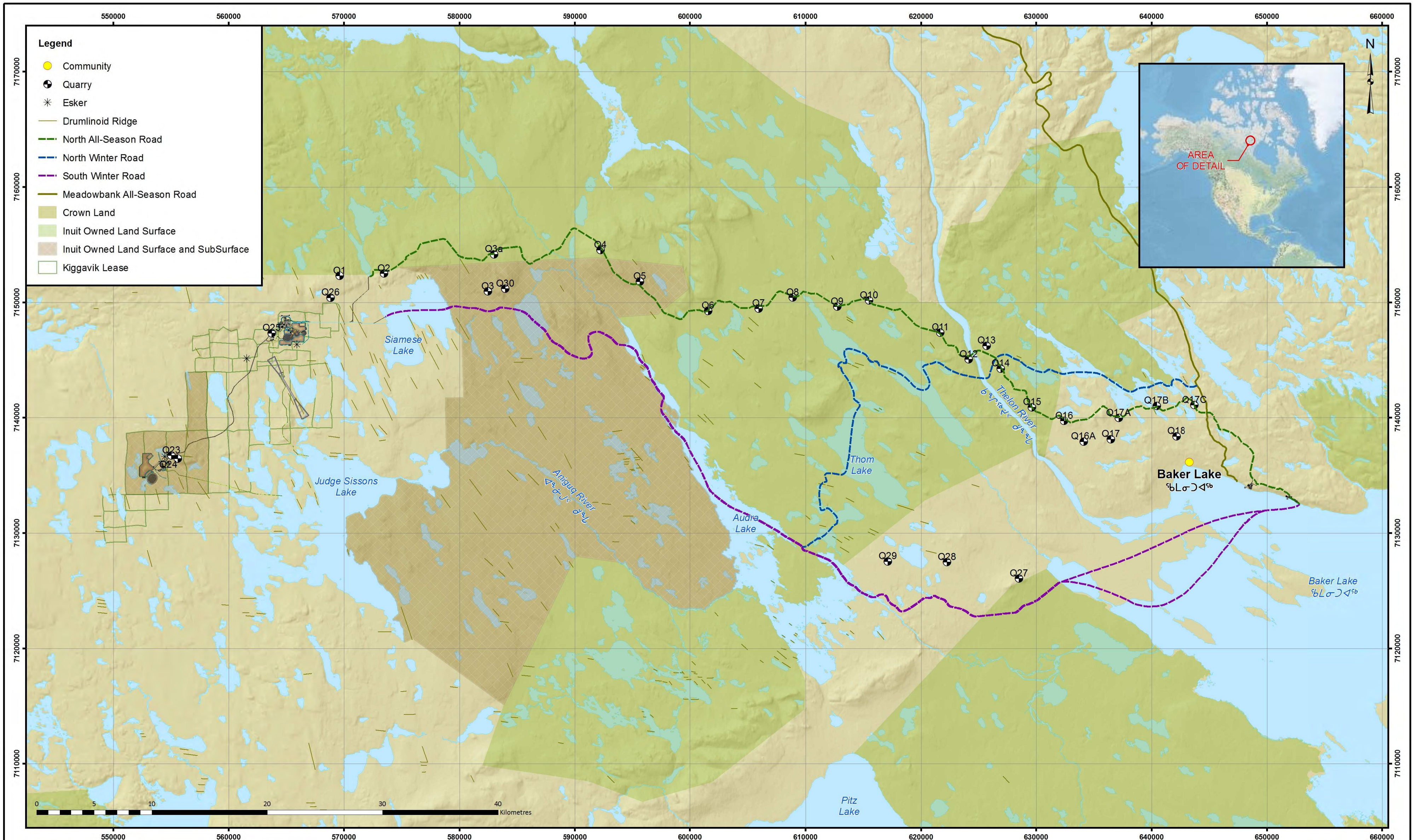
6.6.2 Regulatory Requirements

All vessels transiting through the Hudson Strait will abide by the *Arctic Water Pollution Prevention Act*. Under this Act, vessel movement may be restricted if there is ice present (applicable above 60N in the Hudson Strait).This Act restricts vessel type and time of year (e.g., Type C Class are permitted from July 1 to November 15). In addition, all vessels will meet or exceed the requirements of the *Shipping Act* (e.g., ballast management, bilge management, equipment standards, safety standards).

6.7 BORROW PIT AND QUARRY LOCATIONS

GUIDELINE 6.6.8/REQUIREMENT 309

Figure 12.7-1 (Tier 2, Volume 2, Section 12.7, Page 12-12) has been updated (March 28, 2012) to include known esker locations in addition to land ownership and major waterbodies and courses.



Projection: NAD 1983 UTM Zone 14N
Creator: CDC
Date: 03/28/2012 Scale: 1:300,000
File:
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 12.7-1
QUARRY SITE LOCATIONS

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 2

Kiggavik Project

AREVA

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

Table 6.5-1 below lists the land ownership and distances to known eskers and major waterbodies and courses for each quarry

Quarry ID	Quarry Location				Land Ownership		Geographic Features		
	UTM Coordinates				Inuit Owned Land	Crown Land	Distance from Nearest Known Eskers (km)	Distance from Nearest Waterbody (km)	Distance from Nearest Watercourse (km)
	Easting	Northing	Zone	Datum					
Q1	569611	7152296	14N	NAD 83	X		7.02	1.86	0.80
Q2	573460	7152497	14N	NAD 83	X		9.76	1.13	0.29
Q3	582450	7150953	14N	NAD 83	X		17.20	2.08	0.58
Q3A	582966	7154168	14N	NAD 83		X	18.80	3.34	0.11
Q4	592218	7154534	14N	NAD 83		X	27.59	2.26	0.78
Q5	595620	7151802	14N	NAD 83	X		30.24	1.15	0.52
Q6	601558	7149269	14N	NAD 83		X	35.80	1.46	0.23
Q7	605945	7149463	14N	NAD 83		X	40.19	1.55	0.14
Q8	608894	7150419	14N	NAD 83		X	43.21	0.89	0.34
Q9	612751	7149630	14N	NAD 83		X	46.99	0.93	0.25
Q10	615476	7150167	14N	NAD 83		X	48.95	1.81	0.58
Q11	621693	7147387	14N	NAD 83		X	48.93	1.51	0.64
Q12	624160	7145056	14N	NAD 83		X	48.20	0.45	0.20
Q13	625694	7146238	14N	NAD 83		X	49.95	1.17	0.39
Q14	626916	7144255	14N	NAD 83		X	48.82	0.76	0.75
Q15	629612	7140904	14N	NAD 83		X	47.62	1.35	0.65
Q16	632427	7139721	14N	NAD 83	X		48.90	0.71	1.12
Q16A	634129	7137930	14N	NAD 83	X		48.63	2.01	0.50
Q17	636456	7138142	14N	NAD 83	X		50.36	0.84	1.05
Q17A	637158	7139983	14N	NAD 83	X		52.18	0.72	0.80
Q17B	640436	7141029	14N	NAD 83	X		55.19	0.31	0.30
Q17C	643710	7141092	14N	NAD 83	X		57.65	0.25	0.54
Q18	642133	7138389	14N	NAD 83	X		55.12	1.57	0.66

Quarry ID	Quarry Location				Land Ownership		Geographic Features		
	UTM Coordinates				Inuit Owned Land	Crown Land	Distance from Nearest Known Eskers (km)	Distance from Nearest Waterbody (km)	Distance from Nearest Watercourse (km)
	Easting	Northing	Zone	Datum					
Q19	360790	7133164	15N	NAD 83	X		59.02	0.40	0.26
Q20	361203	7132996	15N	NAD 83	X		59.30	0.44	0.16
Q21	362651	7132132	15N	NAD 83	X		60.15	0.36	0.34
Q22	363681	7131929	15N	NAD 83	X		60.80	0.54	0.22
Q23	555021	7136725	14N	NAD 83	X		0.59	0.43	0.08
Q24	555557	7136455	14N	NAD 83	X		1.13	1.00	0.20
Q25	563707	7147330	14N	NAD 83	X		2.37	1.61	0.69
Q26	568829	7150404	14N	NAD 83	X		5.01	0.84	0.38
Q27	628481	7126064	14N	NAD 83	X		36.26	2.52	1.74
Q28	622273	7127483	14N	NAD 83	X		32.58	1.23	0.81
Q29	617110	7127542	14N	NAD 83	X		29.54	1.19	0.26
Q30	583943	7151184	14N	NAD 83	X		18.71	1.60	0.13

7 GUIDELINES 7.0 –ASSESSMENT METHODOLOGY

7.1 PUBLIC PARTICIPATION – PROJECT SUPPORT AND OPPOSITION

GUIDELINE 7.1/REQUIREMENT 341

7.1.1 Support and Opposition for the Kiggavik Project

Throughout the community engagement activities listed in Tier 2, Volume 3-Part 1, some of the comments made by participants were supportive and some were opposed to the Project. In 2006 and 2007, resolutions supporting the Kiggavik Project to proceed into the EA process were passed by the Kivalliq Inuit Association and the Councils of the seven Kivalliq communities.

The consultation tour of the seven Kivalliq communities carried out by the Kivalliq Inuit Association in January and February of 2010 (Tier 2, Volume 3-Part 1, Section 3.5.3) included a questionnaire. The results were reported in the report "Results of the 2010 KIA Community Engagement Tour for the Proposed Kiggavik Project, Kivalliq Inuit Association, April 2010. One of the questions asked was "What is the overall level of community support for the project?" The survey results showed a consistently high level of support for the project. With 391 questionnaires completed, 76% responded in support across the communities and 11% of respondents gave the Project a rating of poor or fair.

Screening comments provided to the NIRB as part of the Kiggavik Project included opposition to the Project stated by the Lutsel K'e First Nation, the Baker Lake Concerned Citizens Committee and by some individuals.

7.1.2 Support and Opposition for the Nuclear Industry

A number of initiatives have taken place in Nunavut over the last six years for Inuit and Land Claim Organizations and territorial and federal government departments to better understand Beneficiary and Nunavummiut support and opposition for uranium mining. These initiatives, which are described in Section 3.5.3 of Tier 2, Volume 3-Part 1, also aimed to provide information.

The Workshop on uranium mining carried out by the Nunavut Planning Commission in June 2007 (NPC June 2007) included several organizations. Both support and opposition to the industry were voiced. The GN Public Forums on uranium mining aimed to provide a panel of experts in order to engage Nunavummiut and provide a two-way conversation about the future of uranium mining in Nunavut.

Nunavummiut Makitagunarningit (Makita) is a non-profit group that started in 2009. Their press release "About Nunavummiut Makitagunarningit" states "We are an independent, non-governmental organization – a 'public interest group' of concerned Nunavummiut who want to make sure that there is a source of accurate information on uranium issues available to Inuit beneficiaries of the Nunavut Land Claims Agreement, and to the Nunavut public at large." Makita has hosted at least two public meetings in Iqaluit and one in Baker Lake where views opposing uranium mining were given.

Please see Tier 2, Volume 2, Section 2.3.2, Page 2-13 to 2-16 for the Policy framework for uranium development including the Nunavut Tunngavik Inc. Uranium Policy, the GN Guiding Principles for Uranium Development and conformance with the Keewatin Regional Land Use Plan.

7.2 TRANSBOUNDARY EFFECTS

GUIDELINE 2.1/REQUIREMENT 4 and GUIDELINE 7.12/REQUIREMENT 480, 482, 483

Transboundary effects were discussed in Tier 1, Volume 1, Section 8.8 of the DEIS. Additional information on transboundary effects was provided for specific Valued Components (VCs), as appropriate, in the Tier 2 Technical Assessment Reports submitted with the DEIS.

7.2.1 Definition

The Nunavut Impact Review Board (2007; Guide 2) defines transboundary effects as "Environmental effects / impacts which occur across provincial, territorial, or international boundaries".

The final Guidelines for the DEIS provide more detailed guidance on the assessment of transboundary effects; specifically:

- In relation to the well-being of residents of Canada outside the Nunavut Settlement Area; "Significant transboundary biophysical and socio-economic effects directly related to this Project must be included in the EIS in order to ensure the NIRB's assessment of the well-being of Canadians outside of the Nunavut Settlement Area." (page 4);

- In relation to the determination of the Regional Study Area, "The Proponent is advised to duly consider the transboundary implications of impacts to identified VECs/VSECs as results of air transportation and marine shipping for the Project." (page 34);

- In relation to the assessment of cumulative effects; "The Proponent shall give due consideration to the potential for cumulative effects that may be transboundary";

Section 7.12 of the Guidelines state: "Transboundary impacts, for the purpose of the current Guidelines, are defined as those effects linked directly to the activities of the Project inside the [Nunavut Settlement Area] (NSA), which occur across provincial, territorial, international boundaries or may occur outside of the NSA. The Proponent shall give due consideration to the potential for transboundary impacts which may be a result from interactions between the effects of the Project in the NSA, and the effects of projects located outside the NSA. The potential for transboundary impacts related to cumulative effects associated with this Project shall also be defined.

Where feasible, the potential for transboundary impacts should be considered for all VECs and VSECs identified by the Proponent, with specific consideration given to the potential for transboundary impacts associated with marine shipping on marine mammals, migratory birds and seabirds, and their habitat, as well as the large migration range of land mammals such as caribou. Any residual effects which have the potential to occur outside of the NSA shall also be included in the Proponent's evaluation of transboundary impacts."

7.2.2 Mechanism

Transboundary effects can potentially occur through two different mechanisms:

- Project activities or project effects extend across a territorial, provincial or international boundary. This might include effects such as air emissions, noise emissions; or changes in surface water quality; or

- Where terrestrial or marine biota migrate across a jurisdictional boundary, residual environmental effects from a project on that species or group of species may interact with environmental effects from projects or activities in another jurisdiction or vice versa.

7.2.3 Potential for Transboundary Effects on the Terrestrial Environment

The potential for transboundary effects was considered in the assessment of environmental effects on each of the Valued Environmental Components (VECs) and Valued Socio-Economic Components (VSECs) considered in the effects assessment for the terrestrial environment.

For the large majority of the VECs, the geographic scope of potential project effects is within the immediate area of the Project (i.e., the mine area and the access road) as evidenced by the Local Assessment Area (LAA) and the Regional Assessment Area (RAA) (See definition of LAA and RAA in Section 3.2.4 in Volumes 4, 5, 6, 7 and 8 and Section 4.4 of Volume 9, under Assessment Boundaries). No transboundary effects would occur as a result of project effects associated with the atmospheric environment, above-ground noise, groundwater, surface water, terrain, soils, vegetation and most terrestrial wildlife species.

The exception was barren ground caribou. The assessment of cumulative effects on caribou for mortality risk and habitat availability explicitly included a RAA that extended well beyond the boundaries of Nunavut into northern Manitoba and Saskatchewan, as well as the Northwest Territories. Predicted project effects on caribou include direct mortality (collisions), direct and indirect habitat loss (Project footprint, dust and sensory disturbance), and possible avoidance of Project area but no alteration to migration patterns and no change to health. Predicted cumulative effects to caribou include a possible shift in proportional caribou herd take or an overall increase in harvest to the Qamanirjuaq herd given the development of the alternative all-season access road option and potential associated changes in harvest patterns.

The latter effect, in combination with harvesting of the same caribou populations outside of Nunavut, would be a transboundary effect. However, considering that none of the Project effects or the cumulative effects to caribou are significant, no significant adverse transboundary effects are predicted for caribou. As noted in the Tier 2, Volume 6, Section 13.3.2.5.1, AREVA will implement a number of measures to manage mortality risk associated with the Project (i.e., vehicle-wildlife collisions). In addition, AREVA will work with other industry proponents, government agencies and Inuit organizations to enhance monitoring of caribou herds and documentation of mortality; promote initiatives by Inuit organizations and caribou management boards to ensure the long term viability of the traditional, resident and sport harvest; and monitor and document caribou kills by communities (Section 13.3.2.5.2). To be most effective, these initiatives will need to involve parties in Nunavut as well as adjacent transboundary areas.

7.2.4 Potential for Transboundary Effects on the Human Environment

For effects on the human environment, the EA identified that effects on traditional use and cultural aspects will be experienced within the immediate area of the Project and Baker Lake. No transboundary effects are expected given that the Project is not predicted to result in significant adverse effects on terrestrial habitats and species of importance to traditional use and cultural values, including barren ground caribou (Tier 2, Volume 9, Section 12.2).

Social and economic effects are also expected to be greatest in the vicinity of the Project (i.e., Baker Lake and the Kivalliq region of Nunavut), followed by the remainder of Nunavut and other areas in Canada. As workers and a range of goods and services will be required from within Nunavut, as well as other parts of Canada and elsewhere, economic benefits and some social effects (e.g., worker migration or travel) will be transboundary (Tier 2, Volume 9, Section 13.3).

7.2.5 Potential for Transboundary Effects on the Marine Environment

The marine component of the Project will involve several different types of open water marine transport during construction and operations (see Tier 3, Appendix 2J: Marine Transportation) including:

- Dry cargo transport from southern ports to Chesterfield Inlet or Churchill through Hudson Strait using 3 to 6 cargo ships (3 to 6 round trips or 6 to 12 transits per year);
- Diesel fuel transport from southern ports to Chesterfield Inlet or Churchill through Hudson Strait using ice-class tankers (double hulled) (2-3 round trips per year; 4 to 6 transits);
- Dry cargo transport from southern ports to Chesterfield Inlet or Churchill through Hudson Strait using 5 articulated tugs/barge combinations (1 tug with two barges) (10 round trips or 20 transits per year through Hudson Strait);
- Dry cargo transport through western Hudson Bay using 5 articulated tugs/barge combinations (15 round trips or 31 transits per year) (one tug will overwinter in Churchill); and
- Dry cargo and fuel transport from Chesterfield Inlet to Baker Lake using articulated tugs/barge combinations (15-16 round trips or 31 transits per year). Barges would be custom-built for the project and would be dual purpose and double-hulled.

All tankers, cargo ships, tugs and barges will be chartered from a third party by AREVA. While the specific company has not yet been determined, it would likely be one of the existing marine transportation firms that currently supply the communities and other industry in the region. Operations of these vessels will be similar to that already in practice in Nunavut waters by these shipping companies.

The exact number of return trips for vessels traveling along Chesterfield Inlet will depend on the final size of the barge chosen (i.e., 5000t vs. 7500t) and the specific needs during construction and operations. Similarly, the exact number of return trips through Hudson Strait or transits to Churchill will depend on the size of vessel (i.e., 18,300 DWT vs. 30,000 DWT tankers; 660 TEU vs. 1000 TEU cargo ships) and the specific needs during construction and operations. Fewer vessel trips will be required if larger vessels are used.

Vessels will only operate during the open water season. No ice breaking activity is planned to allow the shipping season to begin earlier in the spring or to extend the shipping season in the fall. The conservative shipping operating season in Baker Lake is 1 August to 1 October. This will mean that the first vessel of the season in Hudson Strait may arrive by mid-July and the last vessel will transit through in mid-October. Vessels will follow the *Arctic Waters Pollution Prevention Act* for operating during this period in Hudson Strait, Hudson Bay and Chesterfield Inlet. Based on the conservative shipping operational season, the average number of transits are summarized in Table 7.2-1:

Table 7.2-1 Summary of Vessel Transits

Vessel Type	Geographic Area	Minimum Length of Operating Season (d)	Maximum Number of Transits per Year	Average Transit Frequency (Days per Transit)[1]
Cargo Ship	Hudson Strait and Hudson Bay	93	12	7.8
Tanker	Hudson Strait and Hudson Bay	93	6	15.5
Tug/Barges	Hudson Strait	93	20	4.7
Tug/Barges	Western Hudson Bay	93	31	3.0
Tug/Barges	Chesterfield Inlet	61	31	2.0

1. Conservative (i.e., minimum) length of the Operating Season (days) for the geographic area divided by the maximum number of transits

In Hudson Strait, transits will occur on average every 4.7 to 15.5 days, depending on the vessel. If all vessels (cargo ships, tankers and tug and barge combinations) through Hudson Strait traveled independently, a transit would occur on average every 2.4 days. In western Hudson Bay, the average transit interval for the articulated tug and barge configurations will be three days. However, during marine operations, vessels are more likely to travel in convoys, such that the interval between transits would be longer.

Within Hudson Strait and Hudson Bay, all vessels will follow the major shipping routes recommended by Transport Canada. In the open water area of Hudson Bay and Hudson Strait, all vessels will comply with federal legislation and regulations pertaining to aspects such as safe operations, ballast water management, bilge management, transportation of dangerous goods, and emergency response preparedness.

As noted in the assessment of project and cumulative environmental effects on the marine environment, the potential for effects such as behavioural changes associated with underwater noise, avoidance of vessels and vessel strikes is greatest in the confined channels along Chesterfield Inlet. As noted in Table 7.2-1, the average frequency of vessel transits is the highest for the several geographic areas considered in the DEIS (one transit every two days on average). Accordingly, the assessment of effects on marine biota was most detailed for this geographic area. AREVA also has committed to a suite of mitigation measures to minimize effects on marine fish, birds and mammals (e.g., marine environmental observers, safety zones for wildlife around a vessel; specialized vessel operating procedures when marine wildlife are encountered including reduced speeds or full stop of vessel).

Sea-going vessels will cross from the exclusive Economic Zone for Canada (and possibly international waters) into Nunavut during in-bound transits and out of Nunavut into Canadian and possibly international waters on outbound transits. Some cargo ships and articulated tug/barge combinations will cross between Nunavut and the Province of Manitoba (i.e., the Port of Churchill). Such transits are required to successfully construct and operate the Kiggavik Project.

Given that vessel operations with Hudson Bay and through Hudson Strait are transboundary, there will be transboundary effects primarily relating to:

- Air emissions from vessels
- Underwater noise from the vessels and vessel movements resulting in temporary avoidance and potential energetic stress in marine fish and marine mammals within the zone of esonification;

- Surface noise from the vessels, vessel presence and vessel movements resulting in sensory disturbance and potential energetic stress in marine birds;

- Potential for vessel –marine mammal collisions or vessel – marine bird collisions

- Potential for accidental spills of fuel due to a collision or malfunction

While vessel emissions will occur, these emissions will be transitory and will not result in significant adverse effects on air quality. In addition, as per federal requirements, vessels will be required to use lower sulphur content fuels when operating within Canadian Waters. Specifically, vessels will be required to meet the MARPOL Annex VI amendment regarding use of low sulphur fuel, as well as ongoing actions respecting the North American Emission Control Areas. Given these requirements, by 2015, sulphur in fuel will be 0.1%, which is a reduction of 96% from current fuel sulphur content. This reduction will dramatically reduce sulphur dioxide emissions and have a beneficial effect by also reducing particulate matter emissions.

Effects of underwater noise, surface noise and other sensory stimuli on marine biota are predicted to be transitory and of short duration (i.e., during the passing of a vessel, an animal in a single location will only be subject to the stimuli for a period of tens of minutes depending on the vessel speed), and restricted to an area within the immediate vicinity of the vessel. As is discussed in more detail in the environmental assessment for the marine environment (Tier 1, Volume 1, Section 8.4.2; Tier 2, Volume 7: Marine Environment), project effects and cumulative effects on marine fish and marine mammals are predicted to be not significant. Marine birds were not assessed in detail in the DEIS; as discussed in the addendum on screening of effects (see Addendum Section 8.1), during the scoping of the assessment, effects on marine birds were predicted to be not significant. In addition, AREVA committed to mitigation measures for marine birds that are proven and effective (i.e., route selection, reduced vessel speeds in Chesterfield Inlet, shielding of lighting).

It is recognized that shipping traffic is increasing in the Eastern Arctic, particularly in areas such as Hudson Strait. Existing vessel traffic associated with the Port of Churchill, community resupply in Nunavut, Manitoba and Quebec and mining projects such as the Meadowbank Mine already use Hudson Strait as the main shipping route into and out of Hudson Bay. Proposed projects such this Project, the Baffinland Mine and the Meliadine Mine will further increase vessel traffic in Hudson Strait. To address potential conflicts between shipping traffic and environmentally sensitive areas, particularly for marine birds and marine mammals, AREVA is prepared to work with federal agencies, Nunavut, shipping companies and other marine transportation users to identify preferred shipping routes and seasonal timing constraints to minimize shipping effects on these environmentally sensitive areas. Operational changes such as vessel speed reductions may also be useful in reducing the potential for vessel – marine mammal strikes, as well as underwater noise.

Transboundary effects could also occur in the event of a marine accident or malfunction, particularly if a collision or grounding led to a release of diesel fuel or bunker oil. The consequences of a fuel spill on the biophysical and human environment could range from inconsequential to severe depending on a number of factors, including:

- type of incident
- type and volume of materials released
- location of the incident and proximity to environmentally-sensitive areas, harvesting areas, coastal campsites or settlements
- time of year
- physical conditions at the time of the spill (e.g., wave regime, currents)
- type, timing and success of emergency response measures, including containment and removal
- type and effectiveness of clean-up and recovery activities

While the consequences of a spill could be severe, the risk of these types of incidents is moderate to low. The potential risk associated with a range of marine accidents and malfunctions was summarized in Volume 1, Section 10, and was discussed in detail in both Tier 2 and Tier 3 reports (For additional information see Tier 2, Volume 10: Accidents and Malfunctions; Tier 3, Appendix 10A: Transportation Risk Assessment; Tier 3, Appendix 2J: Marine Transportation Plan).

The marine risk assessment identified several moderate risk activities that are considered acceptable with stringent controls. Stringent protocols, emergency response capability, preventative measures such as double-hulled fuel barges and tankers, appropriate personal protective equipment, and pre-installed anchor systems will be employed to mitigate these risks. In addition, all vessels would comply with federal legislation and regulations with respect to emergency response planning, preparedness and ship-board emergency response equipment. AREVA will also prepare an Emergency Response Plan (ERP) prior to the start of construction for the Project.

7.2.6 Conclusions

As discussed in Tier 1, Volume 1, Section 8.8, transboundary effects are predicted to be not significant. Given that the Project effects and cumulative effects to caribou and other terrestrial environmental components are not significant, no significant adverse transboundary effects are predicted for the terrestrial environment. Similarly, effects of marine transportation are not expected to result in significant adverse effects on marine populations or their habitat that occurs in adjacent transboundary waters of Hudson Bay and Hudson Strait. While effects of an accidental fuel spill could result in important transboundary effects on the biophysical and/or human environment, the risk of such an event is considered moderate to low. Measures proposed by AREVA in combination with measures and planning required under federal legislation and regulations will help minimize the risk of accidents occurring.

8 GUIDELINE 8.0 – PROJECT ENVIRONMENT AND IMPACT ASSESSMENT

8.1 RATIONALE FOR SCREENING DECISIONS

8.1.1 Scoping Methodology

Scoping is a widely accepted best management practice in environmental assessment, and is intended to determine the appropriate content and extent of issues to be addressed in detail in an DEIS. The approach is also consistent with the NIRB guideline Section 1.3: Preparation and Review of the EIS, in which the NIRB states the "… expectation that the Proponent will focus its discussions on key issues, and will provide a level of detail appropriately weighted to the importance of the issue being analyzed. (NIRB 2011)". Scoping lays the foundation for the assessment stage (i.e., effects prediction and evaluation) by providing a structured approach for identifying and prioritizing issues of importance.

Key elements of a comprehensive scoping process include:

- identification of the range of regulator, community and scientific concerns about the Project and its actions;
- evaluation of these concerns to identify potentially significant issues (and elimination of those issues that are not); and
- organization and prioritization of those issues to focus the information that is critical for decision making, and that will be studied in detail in the environmental assessment.

One of the key objectives of scoping is to ensure that the environmental assessment is focused on important issues and potentially significant effects that need to be assessed in detail. A commonly used tool to assist in the scoping process is an interaction matrix that links Project activities and key environmental components. Specifically, the interaction matrix is used to guide the following steps:

1. Identify where interactions are likely to occur between the Project and the VC during each Project phase (construction, operation and maintenance, final closure and decommissioning, post-closure) based on potential overlap in space and time,

2. Prioritize each interaction according to the potential for an activity to cause an environmental effect, and
3. Justify the rankings for those interactions that will likely not be assessed in detail in the assessment.

For the Kiggavik DEIS, the rankings of Project-environment interactions were based on the following considerations as a means of ensuring that a precautionary approach was taken to the issues scoping process. Each of the following criteria was considered of importance in determining which project effects warranted a detailed evaluation in the assessment.

- Legal and Policy Criteria – Are there relevant policies stated in legislation, regulations and policy statements that need to be considered?
- Functional Criteria – How much is an environment component or system likely to change as a result of Project actions?
- Normative Criteria – What are the societal values placed on certain environmental features and qualities?
- Controversy – Is there controversy surrounding the issue?
- Uncertainty – Is there a meaningful degree of uncertainty with respect to the environmental effect or the effectiveness of planned mitigation?

To address each of these criteria, the assessor relied on the Project Description and Assessment Basis, as well as available information regarding the VC (published and unpublished information sources and field baseline studies), the effects literature, experience with similar northern mining projects, and best professional judgment related to each VC to identify where potential interactions could occur based on likely spatial and temporal overlap during each Project phase. This was undertaken based on a thorough consideration of all issues identified through regulatory and stakeholder engagement. Consideration was also given to the expected effectiveness of planned mitigation, including both best management practices, and mitigation by Project design. Where there was a meaningful degree of uncertainty related to the potential interactions, potential effects or the effectiveness of planned mitigation, a precautionary approach was taken in assigning rankings to the Project-environment interaction to ensure that a detailed analysis of the potential environmental effect was undertaken.

Through the scoping process, a number of potential interactions, potential effects and VCs were screened out from further consideration in the DEIS either because there is likely to be no interaction or no potential for substantive interaction between a Project activity and the VC to cause a potential environmental effect. In some cases, there is likely to be a potential interaction between a Project activity and a VC but it is not likely to be substantive in light of planned mitigation. In the latter case, such interactions are considered to be well understood, and mitigable with a high degree of certainty given proven technology and practices (See also Methodology Section 3.2.3 in Tier 2 Volumes 4, 5, 6, 7 and 8 and Tier 2, Volume 9 Section 4.2).

8.1.2 Potential Project-Environment Interactions Identified by the NIRB

A number of potential Project-environment interactions were highlighted by the NIRB as requiring further justification for screening decisions. Rationale for these screening decisions is provided below.

8.1.2.1 Air transportation and Soil Stability

GUIDELINE 8.1.3/REQUIREMENT 537

Tier 2, Volume 4-Part B, Tables 4.3-1, 4.3-2, and 4.3-3 presents the screening decisions for project-environment noise and vibration interactions during the construction, operation and final closure phases of the proposed Kiggavik Project. Within the application of this scoping methodology, the interactions of air transportation - vibration was classified as a "1" indicating a potential interaction between air transportation and the environment but the interaction is not likely to be substantive.

Tier 3, Appendix 2B, Table 7 provides a vibration damage benchmark of 25 peak particle velocity (PPV; (mm/s)) for soils sensitive to vibration such as loose sand or silts. Tier 3, Appendix 4E, Table 4.4.1 provides vibration source levels for a range of equipment types; the Table provides PPV values at a distance of 7.6 metres from the source. Although air craft are not included in the equipment listed in the Table, the values listed, in comparison to the benchmark for sensitive soils, provides a comparative basis to consider vibration effects of air transportation. As an example, to equate an aircraft to a large dozer, the PPV at 7.6 meters from the source is estimated to be 2.3 mm/s. This is well below the 25 mm/s PPV benchmark attributed to sensitive soils. This context justifies the screening classification of “1” for the interaction between air transportation vibration and the environment, indicating the interaction is not likely to be substantive.

8.1.2.2 Ice

8.1.2.2.1 Icebreaking

GUIDELINE 8.1.4, 8.1.12, 8.1.14, 8.1.15, 8.2.7/REQUIREMENT 554, 685, 714, 736, 820

The Marine Shipping Plan is based on a conservative operating season of 60 days, commencing on August 1 and completing on October 1 for the Baker Leg segment. Based on this. the first vessel transits in Hudson Strait and western Hudson Bay could occur during the latter half of July, while the last transit may occur during the first half of October.

As described in the DEIS and the Marine Transportation Report (Tier 3, Technical Appendix 2J, Section 5.2), the shipping plan is scheduled around open water operations only. No ice breaking activity, as defined by the use of an ice breaker prior to spring breakup or after fall freeze up, is planned. All vessels will have an ice class meeting Arctic Waters Pollution Prevention regulations for operating mid-July to the end of October in Zone 14, 15 and 16 which includes the Hudson Straight, Hudson Bay and Chesterfield Inlet/Baker Lake as a precautionary measure. Effects of ice breaking on the physical marine environment and associated marine biota were therefore not assessed for the Kiggavik Project.

8.1.2.2.2 Loose Spring Pack Ice and Pre-Freeze Up Late Fall/Early Winter Ice

As described in the DEIS and the Marine Transportation Report (Tier 3, Technical Appendix 2J, Section 5.2), the shipping plan is scheduled around open water operations only. Ice breaking is not proposed to extend the shipping season. Ship routing will be conducted so that the ships will be operating in largely open water ice conditions, in accordance with the Arctic Ice Regime Shipping System (AIRSS), for the type of vessels and the planned operating season used for the Project. While localized patches of partial ice cover (e.g., pieces of first year or multi-year ice) may be encountered during the defined open water shipping season, the vessel courses would be selected to maximize the travel through open water and to avoid ice floes and utilize areas of low sea ice concentrations. As a result, interactions between wildlife, which might temporarily use these localized patches of ice (e.g., seals or walrus for temporary haul-out; birds for resting), and project vessels are expected to be infrequent. Human travel on such ice cover is extremely unlikely; hence no effect on human travel on ice is expected.

8.1.2.3 Bird-aircraft Collisions

GUIDELINE 8.1.13/REQUIREMENT 705

Tier 2, Volume 6, Section 11.5, Table 11.5-1 presents the screening decisions for project-raptor and migratory bird interactions during the construction, operation and final closure phases of the proposed Kiggavik Project. Within the application of this scoping methodology, the interactions of air transportation – raptors and migratory birds was classified as a "1" indicating a potential interaction between air transportation and the environment but the interaction is not likely to be substantive.

Due to proximity of the airstrip to the road, mine and other infrastructure, the airstrip Zone of Influence (ZOI) was considered to be included in the road, mine and infrastructure ZOI.

The potential for collision of birds with aircraft is readily mitigated through project design standards for airstrips (e.g., avoidance of areas where birds are known to congregate, eliminate attraction of birds, deterring bird congregations during airstrip operation, etc.). Based on baseline bird data and historical data, there are no known areas of bird concentration in the vicinity of the airstrip or approaches.

Bird collision with aircraft is considered an accident/malfunction with potential threat to human life, and was considered a direct management issue rather than an issue of effect prediction and assessment.

Since submission of the DEIS, AREVA was made aware of Environment Canada’s suggested but unpublished guidelines for defining an airstrip ZOI using aircraft. The project team will enhance the effects assessment using those guidelines during the technical review process.

8.1.2.4 Attraction of birds to Project facilities and infrastructure

GUIDELINE 8.1.13/REQUIREMENT 708

Tier 2, Volume 6, Section 11.5, Table 11.5-1 presents the screening decisions for project-raptor and migratory bird interactions during the construction, operation and final closure phases of the proposed Kiggavik Project. Within the application of this scoping methodology, the interactions of infrastructure construction, maintenance and decommissioning – raptors and migratory birds were classified as a “0” (no interaction) or "1" indicating either that there is no potential for an interaction between infrastructure and the environment or that an interaction could occur but is not likely to be substantive.

The potential attraction of birds to Project facilities and infrastructure was deemed unlikely to be substantive due to straight-forward and proven design-based and activity-based mitigation as practiced in other northern mining sites (e.g., policy for not feeding wildlife, effective management of food wastes). Effects would be readily monitored (e.g., observations of roosting and nesting on Project facilities in wildlife sightings logs), and deterrence implemented as required.

Environment Canada guidelines (unpublished) "*Preventing Wildlife Attraction to Northern Industrial Sites*" (Environment Canada 2007 *Preliminary Document*) will likely provide guidance to on-site managers during operation of the mine.

8.1.2.5 Bird mortality due to structure or wire collisions

GUIDELINE 8.1.13/REQUIREMENT 709

Tier 2, Volume 6, Section 11.5, Table 11.5-1 presents the screening decisions for project-environment raptor and migratory bird interactions during the construction, operation and final closure phases of the proposed Kiggavik Project. Within the application of this scoping methodology, the interactions of infrastructure construction, maintenance and decommissioning – raptors and migratory birds were classified as a "0" (no interaction) or "1" indicating either that there is no potential for an interaction between infrastructure and the environment or that an interaction could occur but is not likely to be substantive.

The potential for bird mortality due to collisions with tall structures or overhead wires was deemed unlikely to be substantive due to straight-forward and proven design-based mitigation as practiced in other northern mining sites. "Tall" structures are not a component of this Project. Overhead wires for power generation are limited to a very small geographic area within the Project footprint where bird congregation is very unlikely, and in areas where it is known that birds do not currently congregate. No migratory pathways were identified where Project facilities will exist.

8.1.2.6 Wake effects to sediment and water and propeller wash effects to sediment

GUIDELINE 8.1.14/REQUIREMENT 719 and 720

Tier 2, Volume 7, Section 4.3.1, Table 4.3-1 presents the screening decisions for project-sediment and water quality interactions during the construction, operation and final closure of the proposed Kiggavik Project. Within the application of this scoping methodology, the interactions of marine transportation – sediment and water quality were classified as "1" indicating a potential interaction between infrastructure and the environment but the interaction is not likely to be substantive.

Vessel wake occurs when vessel movements create secondary waves (i.e., free surface waves that propagate out from the vessel). This could result in increased wave activity along the shoreline and cause shoreline erosion, which in turn could affect benthic invertebrates, marine vegetation, and sediment quality. Various sizes of dry cargo ships, tugs, barges and tankers have been studied and proposed for the Kiggavik Project ranging from articulating tug barge configurations to 1000 TEU container ships and ice class 30,000DWT fuel tankers (Tier 3, Appendix 2J).

Given that vessels will be moving slowly (8 to 10 knots) within Chesterfield Inlet, secondary wave heights will likely be less than 0.1 to 0.07 m at 10 to 100 m from the vessel (Moffatt and Nichol 2010). These wave heights are within the normal variation experienced during tidal cycles and storms within the inlet (Government of Canada, 2012). Further, habitat along the shoreline of Chesterfield Inlet is generally composed of bedrock and boulder or cobble beaches, which is not highly susceptible to erosion.

Marine vessels in Hudson Bay and Hudson Strait will use designated (routinely used) shipping routes in deep open water (200 m to 4,000 m). The main route through the Hudson Strait runs down the middle of the strait, approximately 60 km from shore at its narrowest point. The route to Churchill then runs south of Coasts Island, traveling approximately 52 km at the closest point to shore (Transport Canada, 2012). Waves generated by these vessels are expected be within the range of naturally occurring waves and are unlikely to affect shorelines adjacent to these areas due to the distance of the shipping routes offshore.

Propeller wash and wake are not expected to alter the sediment transport regime or result in any change to surficial sediment and seabed. As a result, effects on sediment quality (including sediment transport regime, surficial sediment and seabed), are not assessed further. Furthermore, effects on marine water quality resulting from changes in the sediment transport regime are not expected.

8.1.2.7 Seabirds

GUIDELINE 7.6, 8.1.3 and 8.1.13/REQUIREMENT 410, 428, 543, 710

Seabirds are a valued environmental component in Nunavut. While seabirds were not included in the detailed assessment of effects, potential effects were considered during the scoping of potential Project-bird interactions. Baseline information on seabirds is found in Tier 3, Appendix 7A, Section 7 and Addendum Section 8.5

Tier 2, Volume 7, Section 4.3.1, Table 4.3-1 presents the screening decisions for Project-environment seabird interactions during the construction, operation and final closure of the proposed Kiggavik Project. All possible Project-bird interactions ranked as a “0” (no interaction) or a “1” indicating either that there is no potential for an interaction between the Project and the environment or that an interaction could occur but is not likely to be substantive.

Marine birds use the marine environment for part or all of their life cycle, and there is the potential for the physical presence, movement and noise of marine vessels to adversely affect bird health, behaviour and their habitat. There is relatively little information available in the published literature regarding routine effects of disturbance on marine birds from development activities. Accepted guidelines indicate disturbance at a nesting colony is likely if human activity is audible, or is visible within 1 km (Chardine and Mendenhall 1998).

Key migratory bird marine habitat sites have been identified adjacent to the existing shipping route through Hudson Strait; however, the existing shipping route does not pass through any of these areas. For the most part, the key marine areas are associated with key terrestrial habitat, which means the key marine areas identified are primarily coastal marine habitat. The main shipping route transits along the middle of the Strait and therefore vessels travel as far from the key marine areas as possible (minimum distance of approximately 30 km). Given the seasonal occurrence of marine birds, the timing and extent of Project-related marine vessel traffic, the distance from vessel traffic to coastal areas, and the relative size of potential foraging areas in comparison to the locations that might be disturbed by vessel traffic, substantive effects on marine birds and their habitat (including Important Bird Areas (IBA), Migratory Bird Sanctuaries (MBS) and key migratory bird habitat sites) are not expected to occur. Therefore, Project interactions were all ranked as 1 and not considered further in the marine assessment.

Specific mechanisms through which marine transportation could affect marine bird populations and their habitat have been summarized for a similar Arctic environment, the Beaufort Sea (Environment Canada 2006; Dickson and Gilchrist 2002). These potential effects pathways and the rationale for not assessing them further in the assessment are discussed below.

Development activity in key offshore habitat (open-water leads): Although vessel transit through open leads may result in long-term loss of critical foraging habitat for migrating marine birds, marine transportation associated with the Kiggavik Project will occur only in the open-water season, and therefore will not interact with marine birds using open water leads.

Development activities in key coastal habitat: The existing Churchill terminal will be used for the Project, and therefore no new infrastructure will be constructed along the Hudson Bay or Chesterfield Inlet coast. Therefore, effects on availability of key coastal habitat are not expected to occur. There is potential for marine birds to use freshwater habitat at the Baker Lake dock site; however, it is not located near MBS, IBA, or key marine bird habitat. There is an increased risk of collision with built structures, particularly at night in the presence of artificial lights, which can cause pelagic seabirds to become disoriented (Black 2005). Literature focuses on pelagic marine birds as lights do not appear to affect coastal marine birds (Reed et al. 1985; Wiese et al. 2001). Standard lighting mitigations will be in place at the dock site (light shielding, limited lighting at night) to further reduce potential interaction.

Disturbance: sensory disturbance from development activities, such as operation of marine vessels, may result in temporary displacement of birds from important habitat. However, marine shipping associated with the Project will be infrequent (maximum of 31 barge deliveries to Baker Lake over 60 days of the open-water season), and shipping routes will be located at least 30 km from the coast at the narrowest point, and therefore will not interact with important habitat. Routine operation of marine vessels will be in compliance with standard management practice (e.g., *Canada Shipping Act, Arctic Shipping Pollution Prevention Regulations*), and is not expected to affect marine bird populations.

Offshore hydrocarbon spills: oil and fuel spills have the potential to cause mortality of large numbers of birds and cause degradation of key coastal and marine bird habitat. Fuel transfer between vessels will occur in Chesterfield Inlet near Helicopter Island. Vessels will be equipped with spill response equipment and any spills that may occur will be contained and cleaned up immediately. Accidents and malfunctions are assessed in Tier 2, Volume 10 of the DEIS.

8.2 HYDROLOGY AND HYDROGEOLOGY - NAVIGABILITY

GUIDELINE 8.1.7/REQUIREMENT 592

The *Navigable Waters Protection Act (NWPA)* applies to waters that have been deemed navigable and ensures the public's right to navigate Canada's waters without obstruction. The Navigable Waters Protection Program (NWPP) is guided by the NWPA and its regulations and administered by the Minister of Transport. To ensure that the Kiggavik Project complies with the *NWPA*, AREVA must apply for an application to the NWPP prior to construction of any proposed works that will be built or placed in, on, over, under, through or across any navigable water. Potentially navigable waters that may be affected by the Project include the proposed partial dewatering of Andrew Lake for the development of the Andrew Lake open pit and water crossings with the implementation of the all-season road alternative (See Tier 2, Volume 2, Section 12.3 and Tier 3, Appendix 2A, Section 10 for access road alternatives).

The number of water crossings along the proposed All Season Road has been minimized by careful route selection. At navigable crossings where the watercourse is greater than two meters in width, single-span bridges are proposed to preserve waterway navigation. At navigable crossings where the stream width is less than two meters, crossing structures will be designed to provide unimpeded navigation of the watercourse. Applications for all structures will be submitted to the Minister of Transport for approval. Anticipated water crossing structures are listed in Tier 2, Volume 2, Section 10.4.4.2, Page 10-20.

In the event that Andrew Lake is determined navigable by Transport Canada, the proposed dewatering of a portion of the lake for the development of the Andrew Lake open pit may be considered an impediment to the public's right to navigate. The proposed dewatering structure design options are indicated in Tier 3, Appendix 2F: Conceptual Design for Andrew Lake Dewatering Structure. The dewatering structure for the portion of Andrew Lake affected by the proposed open pit design will be optimized to reduce any effect the structure may have on the public's right to navigate, however, AREVA may be required to apply for an Order in Council as per Section 23 of the *NWPA.*

AREVA will apply for a determination of navigable waters affected by the Project at an advanced EA stage and prior to the detailed design phase. Upon finalization of navigable crossing structures at navigable water crossings, AREVA will request a work approval through the NWPP.

Refer to Tier 2, Volume 2, Section 2.3.5 and Addendum Section 9.1 for more information on licensing detail and timing.

8.3 GROUND WATER AND SURFACE WATER QUALITY

GUIDELINE 8.1.8/REQUIREMENT 603

Ground water at Kiggavik is not currently, nor likely in the future, to be used as a drinking water for a number of reasons including the availability of good quality drinking water from surface water sources and low hydraulic conductivity of the deep aquifer (For further information please see Tier 2, Volume 5, Section 5.2.6, Page 5-13).

Predicted surface water concentrations resulting from mass transport through the groundwater pathway are compared to Health Canada's Water Quality Guidelines (2010) in Tier 2, Volume 5, Section 7.2.2.5, Page 7-14, Table 7.2-2 and Section 7.4.1.3.5, Page 7-21, Table 7.4-1.

The following table originally found in Tier 3, Appendix 5C-Part 2, Table X.II-4 contained comparisons between water chemistry samples from various lakes sampled in 2008 to the Saskatchewan's Surface Water Quality Objectives (SSWQO) and the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines (CWQG). In addition, Health Canada's (2010) Canadian Drinking Water Quality (CDWQ) have been added for comparison to these additional lakes found in the Willow Lake Sub-Basin and the Lower Lake Sub-Basin. No additional samples were identified as exceeding the CDWQ, other than what was identified as exceeding the SSWQO and CWQG.

Table X.II-4

Water Chemistry Data for Lakes in the Kiggavik Project Area, Fall 2008

Parameter	Units	Guidelines			DL	Willow Lake Sub-Basin						Lower Lake Sub-Basin						
						Pointer Lake			Sik Sik Lake	Rock Lake	Willow Lake	Mushroom Lake	End Grid Lake	Cigar Lake	Knee Lake	Lunch Lake	Andrew Lake	Shack Lake
						PRL-001-F08	PRL-001-F08 (DUP 7-F08)	PRL-002-F08	SSL-001-F08	ROL-001-F08	WLL-001-F08	MSL-001-F08	EGL-001-F08	CGL-001-F08	KNL-001-F08	LUL-001-F08	ANL-001-F08	SHL-001-F08
		SSWQO[a]	CWQG[b]	CDWQ[c]		02-Sep-08		02-Sep-08	04-Sep-08	04-Sep-08	05-Sep-08	04-Sep-08	03-Sep-08	26-Aug-08	26-Aug-08	27-Aug-08	02-Sep-08	03-Sep-08
Conventional Parameters (Field-Measured)																		
Water Temperature	ºC	-	-	15*	-	8.28	8.28	8.90	7.64	7.55	7.49	8.21	9.06	8.65	6.01	7.03	8.09	9.11
pH	pH Unit	-	6.5-9.0	6.5-8.5*	-	6.94	6.94	6.65	7.56	7.50	7.07	6.96	7.56	6.36	6.82	7.42	7.52	7.65
Conventional Parameters (Laboratory-Measured)																		
pH	pH Unit	-	6.5-9.0	6.5-8.5*	0.07	6.76	6.77	6.82	7.55	6.99	7.03	7.07	7.13	6.83	7.54	7.32	7.14	7.14
Specific Conductivity	µS/cm	-	-	-	1	15	15	21	62	22	21	25	31	13	48	40	36	36
Total Alkalinity	mg $CaCO_3$/L	-	-	-	1	1	6	7	28	6	7	11	21	4	23	12	10	12
Total Hardness	mg $CaCO_3$/L	-	-	-	1	6	6	10	31	11	10	12	15	4	22	18	16	17
Total Dissolved Solids	mg/L	-	-	500*	1	15	17	57	58	27	23	25	34	13	41	39	34	38
Total Suspended Solids	mg/L	-	-	-	1	2	1	2	2	2	2	<1	2	<1	10	5	2	3
Turbidity	NTU	-	-	-	0.1	1	1.1	0.9	1.6	1.4	1.3	1.1	1.4	0.7	6	2.2	2.2	1.2
Nutrients																		
Ammonia as Nitrogen	mg N/L	1.98[d]	1.98[d]	-	0.01	0.06	0.02	0.08	<0.01	<0.01	0.02	<0.01	0.06	0.03	<0.01	0.06	0.04	0.02
Nitrate	mg N/L	-	13	10	[e]	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Nitrate and Nitrite as Nitrogen	mg N/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Kjeldahl Nitrogen	mg N/L	-	-	-	0.05	0.45	0.42	0.47	0.83	0.35	0.28	0.36	0.66	0.27	0.43	0.5	0.64	0.57
Total Nitrogen	mg/L	-	-	-	0.05	0.45	0.42	0.47	0.83	0.35	0.29	0.36	0.66	0.27	0.43	0.5	0.64	0.57
Total Phosphorus	mg/L	-	-	-	0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dissolved Phosphorus	mg/L	-	-	-	0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
Total Carbon	mg/L	-	-	-	1	4	6	8	18	7	4	7	12	4	13	10	10	11
Inorganic Carbon	mg/L	-	-	-	1	<1	2	2	7	2	2	3	5	1	6	3	3	3
Total Organic Carbon	mg/L	-	-	-	0.2	3.8	3.9	5.9	11	5.6	2.3	4.6	6.7	3.3	7.7	7	7.3	7.4
Dissolved Organic Carbon	mg/L	-	-	-	0.2	4.1	4.3	5.7	12	6.1	5	5	7.4	3.4	7.8	7.4	8.4	8.2
Major Ions																		
Bicarbonate	mg/L	-	-	-	1	1	7	9	34	7	9	13	26	5	28	15	12	15
Calcium	mg/L	-	-	-	0.1	1.6	1.6	2.4	7.8	2.6	2.4	3.0	3.9	1.1	6.2	4.7	4.3	4.4
Carbonate	mg/L	-	-	-	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloride	mg/L	-	-	250*	0.1	0.4	0.3	0.4	1.5	0.5	0.4	0.5	0.8	0.4	0.5	3.4	2.3	1.6
Fluoride	mg/L	-	-	1.5	0.01	0.02	0.02	0.04	0.1	0.1	0.04	0.09	0.09	0.07	0.45	0.29	0.22	0.18
Hydroxide	mg/L	-	-	-	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Magnesium	mg/L	-	-	-	0.1	0.6	0.6	0.9	2.7	1.0	0.9	1.0	1.4	0.4	1.7	1.5	1.4	1.4
Potassium	mg/L	-	-	-	0.1	0.3	0.2	0.5	0.7	0.3	0.2	0.3	0.4	0.2	0.4	0.4	0.5	0.4
Sodium	mg/L	-	-	200*	0.1	0.3	0.3	0.4	1.0	0.4	0.3	0.5	0.6	0.3	0.7	0.7	0.7	0.6
Sulphate	mg/L	-	-	500*	0.2	0.5	0.4	1.7	0.9	0.7	0.5	0.6	1.1	0.2	1.1	0.7	0.8	0.8
Sum of Ions	mg/L	-	-	-	1	5	10	15	49	13	14	19	34	8	39	26	22	24
Metals																		
Aluminum	mg/L	0.005-0.1[f]	0.005-0.1[f]	-	0.0005	0.0210	0.0190	0.0360	0.0180	0.0260	0.0240	0.0230	0.0220	0.0180	0.0570	0.0300	0.0310	0.0220
Antimony	mg/L	-	-	0.006	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Arsenic	µg/L	5	5	10	0.1	0.2	0.1	0.2	0.4	0.2	0.2	0.1	0.2	<0.1	0.2	0.2	0.1	0.2
Barium	mg/L	-	-	1	0.0005	0.0370	0.0370	0.0530	0.0920	0.0570	0.0480	0.0230	0.0300	0.0140	0.0980	0.0700	0.0550	0.0460
Beryllium	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron	mg/L	-	-	5	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Cadmium	mg/L	0.000017[g]	0.000017[g]	0.005	0.0001	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
Chromium	mg/L	-	0.0010/0.0089[h]	0.05	0.0005	<0.0005	<0.0005	0.0009	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0021	<0.0005
Cobalt	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001
Copper	mg/L	0.002[i]	0.002[i]	1.0*	0.0002	0.0008	0.0008	0.0015	0.0011	0.0008	0.0009	0.0009	0.0008	0.0005	0.0015	0.0013	0.0012	0.0011
Iron	mg/L	0.3	0.3	0.3*	0.0005	0.0450	0.0440	0.0630	0.1300	0.1200	0.0860	0.0650	0.0520	0.0290	0.3200	0.1400	0.1000	0.1200
Lead	mg/L	0.001[j]	0.001[j]	0.01	0.0001	0.0001	0.0001	0.0001	<0.0001	0.0001	0.0001	0.0001	<0.0001	0.0003	0.0002	0.0001	0.0001	0.0001
Manganese	mg/L	-	-	0.05*	0.0005	0.0024	0.0023	0.0020	0.0100	0.0036	0.0020	0.0055	0.0005	0.0033	0.0058	0.0061	0.0020	0.0025
Mercury	µg/L	0.026 [k]	0.026 [l]	1	0.05	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*
Molybdenum	mg/L	-	0.073	-	0.0001	<0.0001	<0.0001	0.0001	0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001
Nickel	mg/L	0.025[m]	0.025[m]	-	0.0001	0.0004	0.0004	0.0007	0.0007	0.0005	0.0004	0.0005	0.0006	0.0002	0.0006	0.0005	0.0005	0.0006
Selenium	mg/L	0.001[n]	0.001[n]	0.01	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Silver	mg/L	0.0001	0.0001	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Strontium	mg/L	-	-	-	0.0005	0.0130	0.0130	0.0180	0.0550	0.0230	0.0200	0.0200	0.0220	0.0084	0.0950	0.0810	0.0590	0.0450
Thallium	mg/L	-	0.0008	-	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

Table X.II-4
Water Chemistry Data for Lakes in the Kiggavik Project Area, Fall 2008

Parameter	Units	Guidelines			DL	Willow Lake Sub-Basin						Lower Lake Sub-Basin						
						Pointer Lake			Sik Sik Lake	Rock Lake	Willow Lake	Mushroom Lake	End Grid Lake	Cigar Lake	Knee Lake	Lunch Lake	Andrew Lake	Shack Lake
						PRL-001-F08	PRL-001-F08 (DUP 7-F08)	PRL-002-F08	SSL-001-F08	ROL-001-F08	WLL-001-F08	MSL-001-F08	EGL-001-F08	CGL-001-F08	KNL-001-F08	LUL-001-F08	ANL-001-F08	SHL-001-F08
		SSWQO[(a)]	CWQG[(b)]	CDWQ[(c)]		02-Sep-08		02-Sep-08	04-Sep-08	04-Sep-08	05-Sep-08	04-Sep-08	03-Sep-08	26-Aug-08	26-Aug-08	27-Aug-08	02-Sep-08	03-Sep-08
Tin	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Titanium	mg/L	-	-	-	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0004	0.0005	0.0002	<0.0002	0.0018	0.0005	0.0004	0.0002
Uranium	µg/L	15	-	20	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.1	0.2	<0.1
Vanadium	mg/L	-	-	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	<0.0001	0.0001	<0.0001	0.0002	0.0001	0.0001	0.0001
Zinc	mg/L	0.03	0.03	5.0*	0.0005	0.0058	0.0050	0.0087	0.0042	0.0023	0.0023	0.0015	0.0025	0.0059	0.0022	0.0044	0.0029	0.0045
Dissolved Metals																		
Aluminum	mg/L	-	-	-	0.0005	0.0110	0.0094	0.0240	0.0160	0.0160	0.0120	0.0094	0.0170	0.0100	0.0037	0.0081	0.0180	0.0120
Antimony	mg/L	-	-	-	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Arsenic	µg/L	-	-	-	0.1	0.2	0.2	0.2	0.4	0.2	0.2	0.1	0.2	<0.1	0.2	0.1	0.1	0.2
Barium	mg/L	-	-	-	0.0005	0.0400	0.0360	0.0520	0.0900	0.0570	0.0480	0.0230	0.0300	0.0130	0.0950	0.0670	0.0560	0.0480
Beryllium	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron	mg/L	-	-	-	0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	-	-	-	0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0044	<0.0005	<0.0005
Cobalt	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Copper	mg/L	-	-	-	0.0002	0.0008	0.0008	0.0013	0.0038	0.0008	0.0008	0.0008	0.0009	0.0006	0.0013	0.0012	0.0012	0.0010
Iron	mg/L	-	-	-	0.0005	0.0092	0.0088	0.0300	0.0470	0.0530	0.0360	0.0230	0.0600	0.0057	0.0420	0.0170	0.0450	0.0520
Lead	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	mg/L	-	-	-	0.0005	0.0150	<0.0005	0.0006	0.0007	0.0021	0.0005	0.0006	0.0013	<0.0005	0.0015	0.0005	0.0011	0.0012
Molybdenum	mg/L	-	-	-	0.0001	0.0004	<0.0001	<0.0001	0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001	0.0002	0.0001	<0.0001	<0.0001
Nickel	mg/L	-	-	-	0.0001	0.0004	0.0003	0.0007	0.0007	0.0005	0.0004	0.0004	0.0006	0.0002	0.0005	0.0004	0.0005	0.0006
Selenium	mg/L	-	-	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	<0.0001	0.0002	0.0002	<0.0001	<0.0001	<0.0001	0.0002	<0.0001
Silver	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Strontium	mg/L	-	-	-	0.0005	0.0220	0.0130	0.0180	0.0520	0.0230	0.0200	0.0200	0.0210	0.0083	0.0940	0.0790	0.0590	0.0450
Thallium	mg/L	-	-	-	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Tin	mg/L	-	-	-	0.0001	0.0002	0.0001	<0.0001	0.0001	0.0001	0.0001	0.0002	0.0062	0.0002	0.0002	0.0001	0.0001	0.0006
Titanium	mg/L	-	-	-	0.0002	<0.0002	0.0005	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Uranium	µg/L	-	-	-	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	0.1	0.1	<0.1
Vanadium	mg/L	-	-	-	0.0001	0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001
Zinc	mg/L	-	-	-	0.0005	0.0057	0.0067	0.0039	0.0029	0.0036	0.0061	0.0045	0.0065	0.0023	0.0037	0.0032	0.0023	0.0012
Radionuclides																		
Lead-210	Bq/L	-	-	0.2	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Polonium-210	Bq/L	-	-	-	0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	0.010	0.010	0.006
Radium-226	Bq/L	-	-	0.5	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	0.007	0.008	<0.005	<0.005	0.006
Thorium-228	Bq/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-230	Bq/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Thorium-232	Bq/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01

Table X.II-4
Water Chemistry Data for Lakes in the Kiggavik Project Area, Fall 2008

Parameter	Units	Guidelines			DL	Lower Lake Sub-Basin		Caribou Lake Sub-Basin						Judge Sissons Lake Sub-Basin					
						Lower Lake		Ridge Lake	Cirque Lake	Crash Lake	Fox Lake	Caribou Lake	Calf Lake	Judge Sissons Lake					
						LWL-001-F08	LWL-001-F08 (DUP 8-F08)	RDL-001-F08	CQL-001-F08	CRL-001-F08	FXL-001-F08	CBL-001-F08	CFL-001-F08	JSL-001-F08	JSL-002-F08	JSL-006-F08	JSL-007-F08	JSL-007-F08 (DUP 5-F08)	JSL-008-F08
		SSWQO[a]	CWQG[b]	CDWQ[c]		05-Sep-08		06-Sep-08	07-Sep-08	06-Sep-08	07-Sep-08	06-Sep-08	05-Sep-08	28-Aug-08	26-Aug-08	28-Aug-08	29-Aug-08		29-Aug-08
Conventional Parameters (Field-Measured)																			
Water Temperature	ºC	-	-	15*	-	6.92	6.92	6.59	5.96	4.71	6.44	6.97	7.14	10.40	11.49	8.80	7.79	7.79	6.95
pH	pH Unit	-	6.5-9.0	6.5-8.5*	-	7.08	7.08	7.13	7.04	7.01	7.07	7.13	6.89	7.02	6.68	6.91	7.04	7.04	7.02
Conventional Parameters (Laboratory-Measured)																			
pH	pH Unit	-	6.5-9.0	6.5-8.5*	0.07	7.30	7.27	6.94	6.48	7.01	6.79	6.98	7.00	7.13	7.25	7.18	7.16	7.15	7.20
Specific Conductivity	µS/cm	-	-	-	1	43	42	19	13	29	20	21	23	21	22	21	21	21	27
Total Alkalinity	mg $CaCO_3$/L	-	-	-	1	16	17	9	6	14	10	6	5	9	12	9	6	9	10
Total Hardness	mg $CaCO_3$/L	-	-	-	1	20	20	9	6	14	9	10	10	9	9	9	9	9	13
Total Dissolved Solids	mg/L	-	-	500*	1	45	46	17	19	35	21	24	24	15	16	17	16	18	32
Total Suspended Solids	mg/L	-	-	-	1	2	2	1	3	<1	<1	2	2	<1	<1	<1	<1	<1	2
Turbidity	NTU	-	-	-	0.1	1.2	1.2	1.2	2	3.1	0.7	1	1.5	0.4	0.4	0.5	1	1.2	1.5
Nutrients																			
Ammonia as Nitrogen	mg N/L	1.98[d]	1.98[d]	-	0.01	0.04	0.05	<0.01	0.02	<0.01	<0.01	0.02	0.03	0.04	0.02	0.04	0.05	<0.01	<0.01
Nitrate	mg N/L	-	13	10	[e]	<0.04	0.09	0.09	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Nitrate and Nitrite as Nitrogen	mg N/L	-	-	-	0.01	<0.01	0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Kjeldahl Nitrogen	mg N/L	-	-	-	0.05	0.6	0.79	0.21	0.26	0.28	0.32	0.36	0.45	0.19	0.18	0.19	0.24	0.27	0.44
Total Nitrogen	mg/L	-	-	-	0.05	0.6	0.81	0.23	0.26	0.28	0.32	0.36	0.45	0.19	0.18	0.19	0.24	0.27	0.44
Total Phosphorus	mg/L	-	-	-	0.01	0.09	<0.01	0.05	0.03	0.01	0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01
Dissolved Phosphorus	mg/L	-	-	-	0.01	0.07	0.04	0.05	<0.01	0.04	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Total Carbon	mg/L	-	-	-	1	13	13	6	5	10	7	6	7	5	6	5	7	5	10
Inorganic Carbon	mg/L	-	-	-	1	4	4	2	2	4	3	2	2	2	3	2	4	2	2
Total Organic Carbon	mg/L	-	-	-	0.2	9	9	3.9	3.6	6.7	4.4	4.4	5.3	2.7	2.6	2.6	3	2.9	7.8
Dissolved Organic Carbon	mg/L	-	-	-	0.2	10	9.5	3.4	2.6	4.7	3.3	4.2	4.7	2.7	3	2.8	2.8	3.2	8.2
Major Ions																			
Bicarbonate	mg/L	-	-	-	1	20	21	11	7	17	12	7	6	11	15	11	7	11	12
Calcium	mg/L	-	-	-	0.1	5.4	5.3	2.1	1.4	3.5	2.2	2.5	2.7	2.4	2.4	2.4	2.4	2.4	3.3
Carbonate	mg/L	-	-	-	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloride	mg/L	-	-	250*	0.1	1.1	1.1	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.7
Fluoride	mg/L	-	-	1.5	0.01	0.15	0.16	0.02	0.01	0.02	0.03	0.02	0.03	0.04	0.01	0.06	0.03	0.02	0.03
Hydroxide	mg/L	-	-	-	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Magnesium	mg/L	-	-	-	0.1	1.7	1.7	0.8	0.6	1.4	0.8	0.8	0.9	0.7	0.7	0.7	0.7	0.7	1.1
Potassium	mg/L	-	-	-	0.1	0.5	0.3	0.4	0.2	0.3	0.3	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4
Sodium	mg/L	-	-	200*	0.1	0.8	0.6	0.4	0.3	0.5	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.5
Sulphate	mg/L	-	-	500*	0.2	1.5	1.2	0.6	0.5	1.0	0.4	0.7	0.8	0.6	0.6	0.5	0.6	0.6	1.1
Sum of Ions	mg/L	-	-	-	1	31	31	16	10	24	17	12	12	16	20	16	12	16	19
Metals																			
Aluminum	mg/L	0.005-0.1[f]	0.005-0.1[f]	-	0.0005	0.0320	0.0260	0.0420	0.0620	**0.1200**	0.0130	0.0200	0.0240	0.0060	0.0020	0.0032	0.0130	0.0140	0.0420
Antimony	mg/L	-	-	0.006	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Arsenic	µg/L	5	5	10	0.1	0.3	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2
Barium	mg/L	-	-	1	0.0005	0.0460	0.0460	0.0540	0.0470	0.0760	0.0390	0.0300	0.0300	0.0290	0.0300	0.0290	0.0300	0.0300	0.0300
Beryllium	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron	mg/L	-	-	5	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/L	0.000017[g]	0.000017[g]	0.005	0.0001	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
Chromium	mg/L	-	0.0010/0.0089[h]	0.05	0.0005	<0.0005	<0.0005	**0.0022**	**0.0015**	0.0009	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	-	-	0.0001	0.0001	0.0001	<0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Copper	mg/L	0.002[i]	0.002[i]	1.0*	0.0002	0.0013	0.0012	0.0009	0.0009	0.0013	0.0006	0.0012	0.0009	0.0003	0.0003	0.0003	0.0003	0.0003	0.0009
Iron	mg/L	0.3	0.3	0.3*	0.0005	0.1800	0.1800	0.0440	0.1100	0.1600	0.0430	0.0440	0.0910	0.0290	0.0200	0.0280	0.0550	0.0560	0.1400
Lead	mg/L	0.001[j]	0.001[j]	0.01	0.0001	0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001
Manganese	mg/L	-	-	0.05*	0.0005	0.0049	0.0048	0.0018	0.0120	0.0038	0.0008	0.0019	0.0035	0.0040	0.0035	0.0040	0.0045	0.0046	0.0039
Mercury	µg/L	0.026 [k]	0.026 [l]	1	0.05	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*
Molybdenum	mg/L	-	0.073	-	0.0001	<0.0001	<0.0001	0.0002	0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0006	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	mg/L	0.025[m]	0.025[m]	-	0.0001	0.0009	0.0009	0.0005	0.0006	0.0010	0.0004	0.0005	0.0005	0.0004	0.0004	0.0002	0.0003	0.0003	0.0007
Selenium	mg/L	0.001[n]	0.001[n]	0.01	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.0001	<0.0001	<0.0001
Silver	mg/L	0.0001	0.0001	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Strontium	mg/L	-	-	-	0.0005	0.0420	0.0420	0.0150	0.0120	0.0210	0.0140	0.0140	0.0140	0.0140	0.0120	0.0120	0.0130	0.0130	0.0220
Thallium	mg/L	-	0.0008	-	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

Table X.II-4
Water Chemistry Data for Lakes in the Kiggavik Project Area, Fall 2008

Parameter	Units	Guidelines			DL	Lower Lake Sub-Basin		Caribou Lake Sub-Basin						Judge Sissons Lake Sub-Basin					
						Lower Lake		Ridge Lake	Cirque Lake	Crash Lake	Fox Lake	Caribou Lake	Calf Lake	Judge Sissons Lake					
						LWL-001-F08	LWL-001-F08 (DUP 8-F08)	RDL-001-F08	CQL-001-F08	CRL-001-F08	FXL-001-F08	CBL-001-F08	CFL-001-F08	JSL-001-F08	JSL-002-F08	JSL-006-F08	JSL-007-F08	JSL-007-F08 (DUP 5-F08)	JSL-008-F08
		SSWQO[(a)]	CWQG[(b)]	CDWQ[(c)]		05-Sep-08		06-Sep-08	07-Sep-08	06-Sep-08	07-Sep-08	06-Sep-08	05-Sep-08	28-Aug-08	26-Aug-08	28-Aug-08	29-Aug-08		29-Aug-08
Tin	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Titanium	mg/L	-	-	-	0.0002	0.0003	0.0003	0.0003	0.0008	0.0013	0.0002	0.0006	0.0004	0.0004	<0.0002	0.0003	0.0002	0.0002	0.0013
Uranium	µg/L	15	-	20	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	mg/L	-	-	-	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002	0.0001	0.0003	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Zinc	mg/L	0.03	0.03	5.0*	0.0005	0.0029	0.0050	0.0033	0.0043	0.0025	0.0059	0.0072	0.0075	0.0013	0.0013	0.0042	0.0013	0.0041	0.0024
Dissolved Metals																			
Aluminum	mg/L	-	-	-	0.0005	0.0170	0.0170	0.0100	0.0200	0.0700	0.0085	0.0087	0.0087	0.0019	0.0014	0.0019	0.0031	0.0028	0.0240
Antimony	mg/L	-	-	-	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Arsenic	µg/L	-	-	-	0.1	0.2	0.2	0.1	0.2	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2
Barium	mg/L	-	-	-	0.0005	0.0460	0.0450	0.0510	0.0440	0.0740	0.0390	0.0290	0.0300	0.0290	0.0280	0.0290	0.0290	0.0290	0.0300
Beryllium	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron	mg/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	-	-	-	0.0005	<0.0005	0.0006	<0.0005	0.0016	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0017	0.0029	<0.0005
Cobalt	mg/L	-	-	-	0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Copper	mg/L	-	-	-	0.0002	0.0013	0.0012	0.0007	0.0009	0.0013	0.0006	0.0011	0.0008	0.0006	0.0004	0.0004	0.0003	0.0004	0.0010
Iron	mg/L	-	-	-	0.0005	0.1000	0.1000	0.0120	0.0270	0.1100	0.0220	0.0160	0.0300	0.0050	0.0033	0.0072	0.0140	0.0140	0.0590
Lead	mg/L	-	-	-	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Manganese	mg/L	-	-	-	0.0005	0.0032	0.0031	<0.0005	0.0014	0.0033	0.0005	<0.0005	0.0008	<0.0005	<0.0005	0.0008	0.0008	0.0009	0.0022
Molybdenum	mg/L	-	-	-	0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Nickel	mg/L	-	-	-	0.0001	0.0009	0.0009	0.0004	0.0006	0.0010	0.0004	0.0004	0.0004	0.0003	0.0004	0.0002	0.0003	0.0003	0.0008
Selenium	mg/L	-	-	-	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001
Silver	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Strontium	mg/L	-	-	-	0.0005	0.0420	0.0420	0.0150	0.0120	0.0210	0.0150	0.0140	0.0140	0.0120	0.0120	0.0130	0.0130	0.0130	0.0220
Thallium	mg/L	-	-	-	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Tin	mg/L	-	-	-	0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	0.0002	0.0001	<0.0001	0.0001	<0.0001
Titanium	mg/L	-	-	-	0.0002	0.0002	<0.0002	<0.0002	0.0002	0.0009	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002
Uranium	µg/L	-	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	mg/L	-	-	-	0.0001	0.0001	0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Zinc	mg/L	-	-	-	0.0005	0.0072	0.0041	0.0030	0.0071	0.0043	0.0180	0.0038	0.0043	0.0092	0.0046	0.0029	0.0018	0.0021	0.0015
Radionuclides																			
Lead-210	Bq/L	-	-	0.2	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Polonium-210	Bq/L	-	-	-	0.005	<0.005	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Radium-226	Bq/L	-	-	0.5	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Thorium-228	Bq/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-230	Bq/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-232	Bq/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table X.II-4
Water Chemistry Data for Lakes in the Kiggavik Project Area, Fall 2008

Parameter	Units	Guidelines			DL	Siamese Lake Sub-Basin		Skinny Lake Sub-Basin	Squiggly Lake Sub-Basin	QA/QC	
						Siamese Lake		Skinny Lake	Squiggly Lake	Field Blank	Trip Blank
						SML-001-F08	SML-002-F08	SKL-001-F08	SQL-001-F08	FIELD BLANK-F08	TRIP BLANK-F08
		SSWQO[a]	CWQG[b]	CDWQ[c]		31-Aug-08	30-Aug-08	01-Sep-08	01-Sep-08	---	---
Conventional Parameters (Field-Measured)											
Water Temperature	ºC	-	-	15*	-	10.61	10.76	8.36	8.68	-	-
pH	pH Unit	-	6.5-9.0	6.5-8.5*	-	6.62	6.79	6.86	6.58	-	-
Conventional Parameters (Laboratory-Measured)											
pH	pH Unit	-	6.5-9.0	6.5-8.5*	0.07	6.88	7.03	6.71	6.61	5.54	4.68
Specific Conductivity	µS/cm	-	-	-	1	15	15	17	13	<1	<1
Total Alkalinity	mg $CaCO_3$/L	-	-	-	1	6	6	8	5	2	<1
Total Hardness	mg $CaCO_3$/L	-	-	-	1	7	6	7	6	<1	<1
Total Dissolved Solids	mg/L	-	-	500*	1	12	12	18	12	1	<1
Total Suspended Solids	mg/L	-	-	-	1	1	<1	<1	<1	<1	<1
Turbidity	NTU	-	-	-	0.1	0.5	0.4	0.5	0.5	0.1	<0.1
Nutrients											
Ammonia as Nitrogen	mg N/L	1.98[d]	1.98[d]	-	0.01	0.07	0.02	<0.01	<0.01	0.04	<0.01
Nitrate	mg N/L	-	13	10	[e]	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Nitrate and Nitrite as Nitrogen	mg N/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Kjeldahl Nitrogen	mg N/L	-	-	-	0.05	0.1	0.11	0.19	0.49	0.11	<0.05
Total Nitrogen	mg/L	-	-	-	0.05	0.1	0.11	0.19	0.49	0.11	<0.05
Total Phosphorus	mg/L	-	-	-	0.01	0.02	<0.01	0.01	<0.01	0.03	0.04
Dissolved Phosphorus	mg/L	-	-	-	0.01	0.04	<0.01	<0.01	0.01	-	-
Total Carbon	mg/L	-	-	-	1	4	4	5	3	<1	<1
Inorganic Carbon	mg/L	-	-	-	1	2	2	2	1	<1	<1
Total Organic Carbon	mg/L	-	-	-	0.2	2	2.3	3.2	1.9	0.2	0.4
Dissolved Organic Carbon	mg/L	-	-	-	0.2	2.4	2.1	2.2	1.3	-	-
Major Ions											
Bicarbonate	mg/L	-	-	-	1	7	7	10	6	2	<1
Calcium	mg/L	-	-	-	0.1	1.8	1.7	1.8	1.4	<0.1	<0.1
Carbonate	mg/L	-	-	-	1	<1	<1	<1	<1	<1	<1
Chloride	mg/L	-	-	250*	0.1	0.4	0.4	0.4	0.3	<0.1	<0.1
Fluoride	mg/L	-	-	1.5	0.01	<0.01	<0.01	0.15	<0.01	<0.01	<0.01
Hydroxide	mg/L	-	-	-	1	<1	<1	<1	<1	<1	<1
Magnesium	mg/L	-	-	-	0.1	0.5	0.5	0.7	0.5	<0.1	<0.1
Potassium	mg/L	-	-	-	0.1	0.3	0.2	0.2	0.3	<0.1	<0.1
Sodium	mg/L	-	-	200*	0.1	0.3	0.3	0.4	0.3	<0.1	<0.1
Sulphate	mg/L	-	-	500*	0.2	0.5	0.6	0.5	0.5	<0.2	<0.2
Sum of Ions	mg/L	-	-	-	1	11	11	14	9	2	<1
Metals											
Aluminum	mg/L	0.005-0.1[f]	0.005-0.1[f]	-	0.0005	0.0036	0.0040	0.0099	0.0077	<0.0005	0.0007
Antimony	mg/L	-	-	0.006	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Arsenic	µg/L	5	5	10	0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1
Barium	mg/L	-	-	1	0.0005	0.0500	0.0490	0.0430	0.0210	<0.0005	<0.0005
Beryllium	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron	mg/L	-	-	5	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/L	0.000017[g]	0.000017[g]	0.005	0.0001	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
Chromium	mg/L	-	0.0010/0.0089[h]	0.05	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Copper	mg/L	0.002[i]	0.002[i]	1.0*	0.0002	0.0003	0.0002	0.0005	0.0004	0.0002	0.0002
Iron	mg/L	0.3	0.3	0.3*	0.0005	0.0180	0.0140	0.0410	0.0140	0.0009	0.0016
Lead	mg/L	0.001[j]	0.001[j]	0.01	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001
Manganese	mg/L	-	-	0.05*	0.0005	0.0032	0.0027	0.0025	0.0016	<0.0005	<0.0005
Mercury	µg/L	0.026 [k]	0.026 [l]	1	0.05	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*
Molybdenum	mg/L	-	0.073	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	0.0001
Nickel	mg/L	0.025[m]	0.025[m]	-	0.0001	0.0002	0.0002	0.0003	0.0002	<0.0001	<0.0001
Selenium	mg/L	0.001[n]	0.001[n]	0.01	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001
Silver	mg/L	0.0001	0.0001	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Strontium	mg/L	-	-	-	0.0005	0.0140	0.0130	0.0120	0.0068	<0.0005	<0.0005
Thallium	mg/L	-	0.0008	-	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

Table X.II-4
Water Chemistry Data for Lakes in the Kiggavik Project Area, Fall 2008

Parameter	Units	Guidelines			DL	Siamese Lake Sub-Basin		Skinny Lake Sub-Basin	Squiggly Lake Sub-Basin	QA/QC	
						Siamese Lake		Skinny Lake	Squiggly Lake	Field Blank	Trip Blank
						SML-001-F08	SML-002-F08	SKL-001-F08	SQL-001-F08	FIELD BLANK-F08	TRIP BLANK-F08
		SSWQO[(a)]	CWQG[(b)]	CDWQ[(c)]		31-Aug-08	30-Aug-08	01-Sep-08	01-Sep-08	---	---
Tin	mg/L	-	-	-	0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001
Titanium	mg/L	-	-	-	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Uranium	µg/L	15	-	20	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Zinc	mg/L	0.03	0.03	5.0*	0.0005	0.0058	0.0068	0.0050	0.0085	0.0043	0.0042
Dissolved Metals											
Aluminum	mg/L	-	-	-	0.0005	0.0013	0.0016	0.0065	0.0036	-	-
Antimony	mg/L	-	-	-	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	-	-
Arsenic	µg/L	-	-	-	0.1	<0.1	<0.1	0.1	<0.1	-	-
Barium	mg/L	-	-	-	0.0005	0.0490	0.0470	0.0420	0.0210	-	-
Beryllium	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-
Boron	mg/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	-	-
Cadmium	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-
Chromium	mg/L	-	-	-	0.0005	0.0019	<0.0005	<0.0005	<0.0005	-	-
Cobalt	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-
Copper	mg/L	-	-	-	0.0002	0.0003	0.0002	0.0005	0.0003	-	-
Iron	mg/L	-	-	-	0.0005	0.0021	0.0022	0.0170	0.0035	-	-
Lead	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-
Manganese	mg/L	-	-	-	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-
Molybdenum	mg/L	-	-	-	0.0001	<0.0001	0.0001	<0.0001	<0.0001	-	-
Nickel	mg/L	-	-	-	0.0001	0.0002	0.0002	0.0003	0.0002	-	-
Selenium	mg/L	-	-	-	0.0001	0.0001	0.0001	<0.0001	<0.0001	-	-
Silver	mg/L	-	-	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-
Strontium	mg/L	-	-	-	0.0005	0.0140	0.0130	0.0130	0.0067	-	-
Thallium	mg/L	-	-	-	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	-	-
Tin	mg/L	-	-	-	0.0001	0.0002	0.0001	0.0010	0.0001	-	-
Titanium	mg/L	-	-	-	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	-	-
Uranium	µg/L	-	-	-	0.1	<0.1	<0.1	<0.1	<0.1	-	-
Vanadium	mg/L	-	-	-	0.0001	<0.0001	<0.0001	0.0001	<0.0001	-	-
Zinc	mg/L	-	-	-	0.0005	0.0043	0.0032	0.0047	0.0039	-	-
Radionuclides											
Lead-210	Bq/L	-	-	0.2	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Polonium-210	Bq/L	-	-	-	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Radium-226	Bq/L	-	-	0.5	0.005	0.006	0.009	<0.005	<0.005	0.005	<0.005
Thorium-228	Bq/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-230	Bq/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-232	Bq/L	-	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: Values that are equal to or exceed the SSWQO are bolded. Values that are equal to or exceed the CWQG are underlined. Values that are equal to or exceed the CDWQ are shaded. Non-detect values that are higher than one or more guideline are italized.

[(a)] = Saskatchewan Environment's (2006) Saskatchewan Surface Water Quality Objectives (SSWQO).

[(b)] = Canadian Council of Ministers of the Environment's (CCME) Canadian water quality guidelines (CWQG) for the protection of aquatic life - freshwater (CCME 2007).

[(c)] = Health Canada's (2010) Guidelines for Canadian Drinking Water Quality (CDWQ). Health-based maximum acceptable concentration (MAC) values are presented when available. Otherwise, aesthetic objective (AO) values are identified with an asterisk *.

[(d)] = The guidelines for ammonia are dependent on temperature and pH; therefore, the guideline for each station was calculated and the lowest overall value was used for screening.

[(e)] = Nitrate values were calculated using the equation Nitrate Concentration = Nitrate-Nitrite Concentration * 62/14; non-detect values were substituted with the detection limit in calculations.

[(f)] = The guidelines for aluminum are pH-dependent; the guideline is 0.005 mg/L at pH<6.5; 0.1 mg/L at pH≥6.5. Field pH values were used in the screening.

[(g)] = The guidelines for cadmium are hardness-dependent; at hardnesses ranging from 0 to 48.5 mg/L as $CaCO_3$, the guideline is 0.000017 mg/L.

[(h)] = The guideline for chromium is speciation-dependent; the guideline is 0.0089 mg/L for trivalent chromium and 0.0010 mg/L for hexavalent chromium.

[(i)] = The guidelines for copper are hardness-dependent; at hardnesses ranging from 0 to 120 mg/L as $CaCO_3$, the guideline is 0.002 mg/L.

[(j)] = The guidelines for lead are hardness-dependent; at hardnesses ranging from 0 to 60 mg/L as $CaCO_3$, the guideline is 0.001 mg/L.

[(k)] = Mercury objective is for inorganic mercury only.

[(l)] = Mercury guidelines differ depending on mercury type: inorganic mercury = 0.026 µg/L; methylmercury = 0.004 µg/L.

[(m)] = The guidelines for nickel are hardness-dependent; at hardnesses ranging from 0 to 60 mg/L as $CaCO_3$, the guideline is 0.025 mg/L.

[(n)] = Selenium guideline is based on waterborne exposure. However, selenium has a bioaccumulation pathway similar to mercury; therefore, the guideline may not be protective of effects through reproductive impairment due to maternal transfer, resulting in embryotoxicity and teratogenicity (Chapman et al. 2009).

DL = detection limit; QA/QC = quality assurance/quality control; ºC = degrees Celsius; mg/L = milligrams per litre; mg $CaCO_3$/L = milligrams of calcium carbonate per litre; µg/L = micrograms per litre; µS/cm = microSiemens per centimetre;

NTU = Nephelometric Turbidity Unit; Bq/L = Becquerels per litre; < = less than; - = not applicable or not collected; Aug = August; Sep = September.

8.4 FRESH WATER AQUATIC

GUIDELINE 8.1.10/REQUIREMENT 633, 638

The freshwater form of the Fourhorn Sculpin (*Myoxocephalus quadricornis)* is the only fish species (from both the freshwater and marine environments) that has the potential to occur within the Project study areas (SARA 2012, COSEWIC 2012). The *Species at Risk Act* (SARA 2012) lists the Fourhorn Sculpin as a species of Special Concern under Schedule 3 (species included in Schedule 3 were listed as species at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) prior to October 1999 and must be reassessed using revised criteria before they can be added to Schedule 1 of SARA), thereby having legislated protection under SARA. The freshwater form of Fourhorn Sculpins inhabits lakes in the Arctic where no other freshwater species occur (SARA 2012). While this species is identified as occurring within Nunavut, no historic records occur within the Project study areas (COSEWIC 2003, Scott and Crossman 1973). Further details on this species distribution and ecology can be found in Tier 3, Appendix 5C, section 11.2, Pages 11-12 to 11-70 and the assessment of effects for fish abundance and distribution is found in Tier 2, Volume 5, Section 11.2, Pages 11-7 to 11-9.

8.5 SEABIRDS - BASELINE

GUIDELINE 8.1.13/REQUIREMENT 696, 697, 698, 699

The following baseline information on marine birds is presented in the DEIS Appendix 7A-Marine Environment Baseline Report (Section 7, pages 7-1 and 7-2). Further details have been added for clarification.

The most common species of waterbirds observed in Baker Lake and Chesterfield Inlet area are Canada goose, long-tailed duck, and common loon (Hahn 2003). Red-throated, arctic and yellow-billed loons have also been observed in the area as well as tundra swan (Höhn 1969). The Kivalliq region of Nunavut represents an important migratory, staging, moulting, and nesting area for white-fronted, snow, and Canada geese, sandhill crane, tundra swan, dunlin, golden-plover species, Baird’s sandpiper, numerous gull species and arctic tern (Canadian Circumpolar Institute 1992).

Areas identified as MBS, IBA, and Wildlife Areas of Special Interest (WASI) specific to birds are considered sensitive habitat. The Important Bird Area (IBA) Program is an initiative between Bird Studies Canada, Nature Canada and BirdLife International for the international conservation of discrete sites that support threatened birds, large groups of birds, and birds restricted by range or by habitat. While a variety of migratory and non-migratory bird species may be found within the project area, no IBAs are identified within the LSA (Bird Studies Canada (BSC) 2011). Key marine bird terrestrial and marine habitat sites identified by the Canadian Wildlife Service (CWS) are considered sensitive habitat since they are considered by CWS to be essential to the welfare of various migratory bird species in Canada (Mallory and Fontaine 2004). The CWS established 16 bird sanctuaries in Canada to control and manage areas of importance for the protection of migratory birds, their nests and eggs. There are two MBS with coastal habitat that fall within or are adjacent to the RSA. Harry Gibbons MBS is situated in northern Hudson Bay on Southampton Island (supports 10% of the world's Snow Goose population) and McConnell River MBS (a large, primarily coastal marsh habitat for between 3 to 5% of the Arctic's breeding population of snow goose and Ross's goose) (IBA Canada 2009; Environment Canada 2011). The key terrestrial habitat sites identified by CWS correspond with the IBAs identified by BirdLife International. Three key terrestrial habitat sites overlap with the two MBS (McConnell River, Boas River and associated wetlands, East Bay–Native Bay), and several along the Hudson Strait shipping route (Fraser Island, Coats Island-Cape Pembroke, Markham Bay Islands, and Hantzsch Island). A variety of key marine habitat sites have been identified by CWS along the shipping route through Hudson Strait (Mallory and Fontaine 2004) which correspond with the IBP sites (Hantzsch Island, Button Islands, Akpatok Island, Digges Sound, Coats Island and Boas River). A WASI site for gyrfalcon and peregrine falcon is situated at Rankin Inlet. This area is considered sensitive habitat and is protected (Qamanirjuaq Critical Wildlife Area and Iqalugaarjuup Nunanga Territorial Park).

Ross's gull is known to breed and use coastal habitat within the southern RSA at the Port of Churchill. The species is nationally designated as Threatened by COSEWIC and listed in Schedule 1 of SARA. Ross's gull is more commonly seen in the Churchill area than anywhere else in Canada and represents only one of four breeding areas in the country (COSEWIC 2007). The last observation of Ross's Gull in the Churchill area was four individuals in 2005 (COSEWIC 2007). Nesting records were located inland but within 1 km from the Hudson Bay coastline, and individuals were also observed using coastline habitat in early August following the breeding season between early June and late July (Chartier and Cooke 1980).

The king eider is given special designation by the Government of Nunavut. The king eider has not been assessed by COSEWIC but is ranked as Sensitive in Nunavut due to national declines, which are at least partially attributed to international subsistence harvest. An estimated 20,000 are taken per year in Alaska and western Canadian Arctic but no estimates are available for eastern Arctic (Sea Duck Joint Venture 2003). King eider populations breeding in coastal areas of Hudson Bay are locally harvested at subsistence rates and commercially harvested (estimated at 20,000 individuals) during their wintering period in Greenland (Sea Duck Joint Venture 2003).

8.5.1 Marine Sensitive Habitat - Marine Fish, Anadromous Fish, and Marine Mammals

GUIDELINE 8.1.14/REQUIREMENT 715

The following summary is provided to highlight potentially sensitive areas for marine fish, anadromous fish, and marine mammals along the shipping routes (western Hudson Bay and through Hudson Strait) and barge route through Chesterfield Inlet. Parks Canada has identified key areas in Nunavut as part of an International Biological Program (IBP) (Nettleship and Smith 1975). These areas have been selected because they represent a diverse community. Six of these IBP sites occur along the Hudson Strait shipping route (Hantzsch Island, Button Islands, Akpatok Island, Digges Sound, Coats Island and Boas River) and one site is located south of Arviat (McConnell River). These IBP areas are identified as sensitive habitat. Many of the areas identified as important habitat by different agencies are overlapping or identical areas.

Marine Fish

The mouth of Chesterfield Inlet provides habitat for a variety of marine fish and invertebrates concentrating in this area. Arctic cod, Arctic sculpin, Arctic char, fourhorn sculpin, banded gunnel, and whitefish use sand and boulder habitat around the mouth of Chesterfield Inlet. Clams, blue mussels, and Icelandic scallops occur along the coast and an Icelandic scallop bed is identified in the mouth of Chesterfield Inlet (Mercier et al. 1994). This area is considered sensitive because of the number of species that use it.

Greenland halibut (or turbot) are commonly found in deep water at the eastern entrance to Hudson Strait (Stephenson and Hartwig 2010). This area overlaps with shrimp (Northern, Striped and Pink) area of abundance (Mercier et al. 1994; Stephenson and Hartwig 2010). These species are harvested commercially and therefore this area is considered sensitive habitat. Northern shrimp is fished year-round in Hudson Strait (DFO 2008).

Anadromous Fish

Arctic char are an anadromous fish which migrate downstream in the spring to marine waters (Richardson et al. 2001). The mouths and estuaries of Arctic char rivers are important aggregation areas for feeding and as an entry/exit way for fish moving upriver to overwinter and spawn and downriver to the sea for feeding. An Arctic char area of abundance is designated along the coast from north of Chesterfield Inlet to south of Arviat. This area is considered sensitive habitat due to the relatively short summer feeding season (they obtain most of their annual energy requirements) and the potential for interaction with Project activities.

Marine Mammals

Walrus are known to be present along the Hudson Strait shipping route, occurring on the north side of Chesterfield Inlet in the springtime (absent in the summer), and present year-round in northern Hudson Bay and western Hudson Strait (Orr and Rebizant 1987; COSEWIC 2006). Sensitive habitat for walrus includes the largest known Canadian haulout, located in northern Hudson Bay on Southampton Island (DFO 2002). Walrus typically follow the loose pack ice in the summer season (when shipping would occur); however they can also use terrestrial haulouts. Southampton Island is a well-known historical place where walrus occur in large numbers in the summer. Nearby Coates Island has also been identified as an important summer haulout (DFO 2002). Walrus haul out on land primarily for resting and are more susceptible to disturbance than while in the water (Richardson et al. 1995).

While beluga whales are distributed along the western coast of Hudson Bay, they are known to be concentrated in summer in an area south of Arviat (Stephenson and Hartwig 2010). This area has increased potential for overlap with ships travelling along the coast and is therefore considered sensitive habitat.

8.6 BENEFITS, ROYALTIES AND TAXATION –FUEL SOURCES

GUIDELINE 8.2.5/REQUIREMENT 794

The Kiggavik Project total peak annual fuel consumption has been estimated to be 65 million litres with an average of 49 million litres over the production period. Some early suggestions for Inuit and/or northern procurement preferences are outlined in Tier 2 Volume 2, Section 18.4: Business Development and Procurement in the Project Description and further weighting and preferences may be determined potentially through negotiations with the GN for the Development Partnership Agreement (see Addendum section 5.2 NIRB Guideline 5.2 on the fuel rebate and the GN Development Partnership Agreement). Given the quantity of fuel required, it is anticipated that fuel will be sourced at world competitive prices. Estimates of fuel to be sourced from the Government of Nunavut or other sources will depend on price offered, weightings to northern vendors agreed to in negotiations, ability to reliably deliver needed quantities and other factors. Reliable estimates may be expected at the licensing stage. Refer to Addendum Section 9.1 for more information on the timing of Project details.

8.7 ACCIDENT MALFUNCTIONS

GUIDELINE 8.4/REQUIREMENT 897

The estimated quantity and rate of contaminant released into the environment may be affected by several factors including size of the storage containment, degree of damage to the containment system, reason for release (e.g. leak, puncture of vessel, leaving a valve open), type of materials being released (e.g. liquid, solid or gas) and environmental conditions surrounding the incident. The form and characteristics of the contaminant are specific to the reagent in question; various chemicals will be stored and used in liquid, gas and solid forms. Characteristics of the contaminants vary according to the contaminant; it may be a compressed gas, flammable material, oxidizer, toxic and/or corrosive. Chemicals and reagents are assessed prior to being brought to site and risk precautions taken to ensure it is handled, stored and used safely. Refer to the Hazardous Management Plan (Tier 3, Appendix 2U) for a description of the different types of reagents at the Kiggavik site, dock site and mine site. This includes a description of how these are stored, estimated amounts of usage and a brief description on its characteristics. At this time, the detailed specifications for many reagent vessels, piping and tanks are not available thus it is not possible to provide an estimate for quantity of materials that could be released to the surrounding environment. The potential spill of petroleum chemicals including plausible scenarios, clean up and contingencies and storage tank sizes is assessed further in Tier 3, Appendix 10B: Spill Contingency and Landfarm Management. The contingency measures to prevent spills include routine monitoring systems, continual computerized monitoring controls, visual alarms, free board for ponds, double containment vessels and secondary containment surrounding storage vessels. There would need to be multilevel or catastrophic failures for a worst case situation to occur whereby the material would be released from an entire vessel or container. If the contingency measures are not adequate and a spill does occur, the spilled material would ultimately drain to the Tailings Management Facility and still be contained, thus effect on the environment is anticipated to be minor. The potential release of materials beyond the project footprint during transport is discussed in the Tier 3, Appendix 10A: Transport Risk Assessment.

9 GUIDELINE 9.0 – ENVIRONMENTAL MANAGEMENT SYSTEM

9.1 TIMELINE

GUIDELINE 9.1/REQUIREMENT 902

For a proposed Project to proceed to construction in Nunavut, it must gain approval at three primary milestones: 1) conformity with applicable land use plans, 2) a positive environmental assessment (EA) decision (should a review be required) with the accompanying Project Certificate and 3) the required licenses and permits.

The information requirements to achieve each of these milestones varies in proportion to the level of detail required for effective decision making. Applications for project authorization and an accompanying project proposal are sufficient for the Nunavut Planning Commission (NPC) to determine conformity with broad planning policies, objectives and goals. The project proposal is also used by the NIRB in screening the proposal to determine if a full environmental review is required. A Draft and Final Environmental Impact Statement (EIS) are submitted to the NIRB for an evaluation of whether or not the proposed project may unduly affect the ecosystem integrity of the Settlement Area. Licence and permit applications and documents contain the highest level of engineering and project detail.

9.1.1 Conformity with Land Use Plan

Article 11 of the *Nunavut Land Claims Agreement* (NLCA) requires all project proposals to be reviewed by the NPC for conformity with any applicable land use plans. Article 12 of the NLCA requires an assessment of the potential ecosystem and socioeconomic impacts.

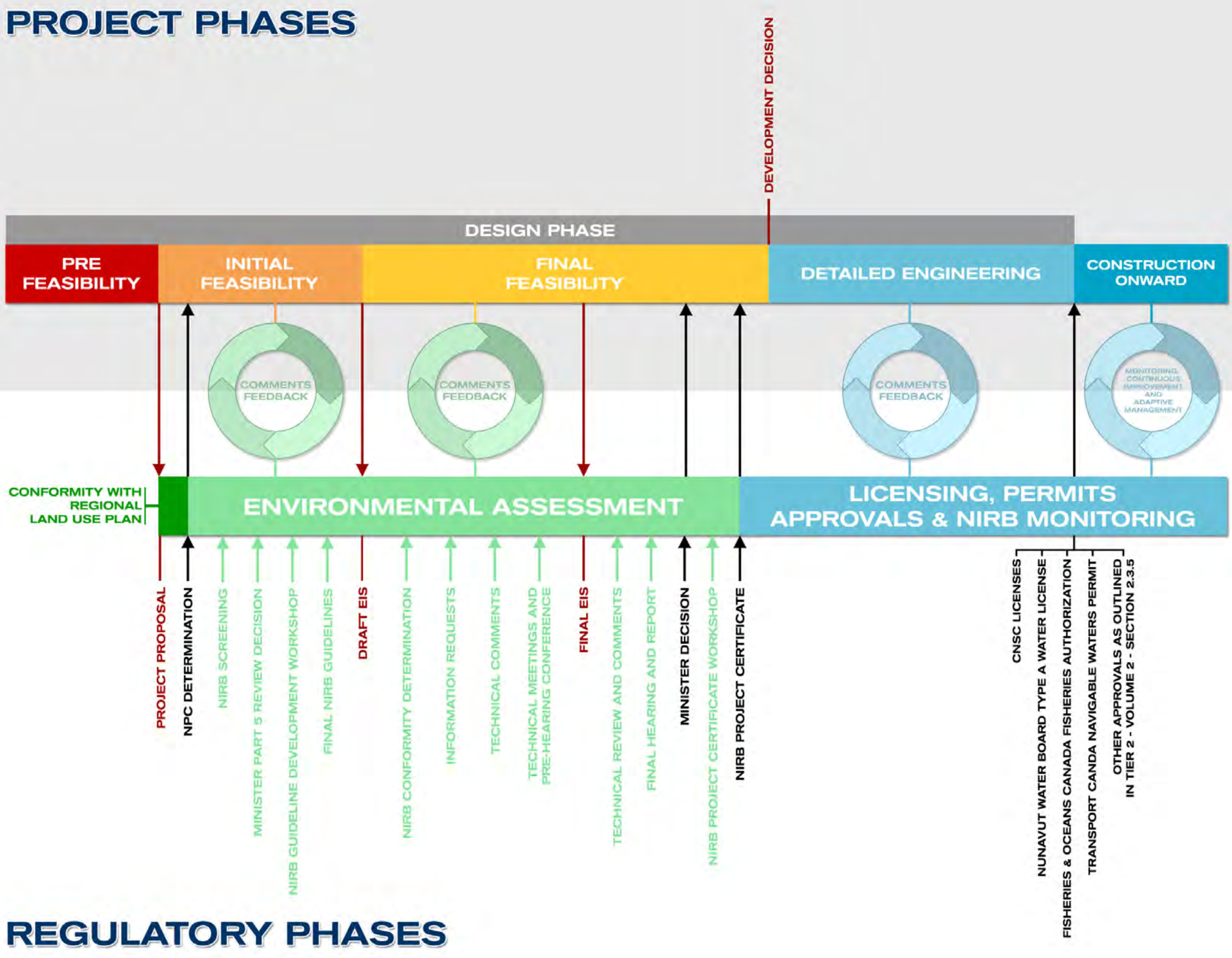
The Nunavut Impact Review Board (NIRB) cannot begin the EA review prior to a land use plan conformity determination by the NPC.

9.1.2 Environmental Assessment, and Licensing and Permitting

Unlike the strict linear requirement of acquiring land use conformity prior to the start of the EA, the EA and licensing/permitting processes can be sequential (the EA process is completed prior to the commencement of the licensing/permitting process) or concurrent (the EA and licensing/permitting process occur at the same time).

The information requirements of a concurrent EA and licensing/permitting process are much greater at the EA stage than a project advancing sequentially through the EA and licensing processes as the detail must satisfy both regulatory stages at once. Regardless of whether a project advances concurrently or sequentially through the regulatory process, there is a requirement that terms and conditions contained within an EA Project Certificate must be known and implemented by government departments and agencies that are responsible for issuing licenses and permits.

AREVA is currently proceeding with a sequential EA and licensing/permitting process for the Kiggavik Project. This process is outlined in the Figure below. The Figure depicts two timelines.


PROJECT PHASES
DEVELOPMENT DECISION
DESIGN PHASE
PRE FEASIBILITY
INITIAL FEASIBILITY
FINAL FEASIBILITY
DETAILED ENGINEERING
CONSTRUCTION ONWARD
COMMENTS FEEDBACK
COMMENTS FEEDBACK
COMMENTS FEEDBACK
MONITORING, CONTINUOUS IMPROVEMENT AND ADAPTIVE MANAGEMENT
CONFORMITY WITH REGIONAL LAND USE PLAN
ENVIRONMENTAL ASSESSMENT
LICENSING, PERMITS APPROVALS & NIRB MONITORING
PROJECT PROPOSAL
NPC DETERMINATION
NIRB SCREENING
MINISTER PART 5 REVIEW DECISION
NIRB GUIDELINE DEVELOPMENT WORKSHOP
FINAL NIRB GUIDELINES
DRAFT EIS
NIRB CONFORMITY DETERMINATION
INFORMATION REQUESTS
TECHNICAL COMMENTS
TECHNICAL MEETINGS AND PRE-HEARING CONFERENCE
FINAL EIS
TECHNICAL REVIEW AND COMMENTS
FINAL HEARING AND REPORT
MINISTER DECISION
NIRB PROJECT CERTIFICATE WORKSHOP
NIRB PROJECT CERTIFICATE
CNSC LICENSES
NUNAVUT WATER BOARD TYPE A WATER LICENSE
FISHERIES & OCEANS CANADA FISHERIES AUTHORIZATION
TRANSPORT CANDA NAVIGABLE WATERS PERMIT
OTHER APPROVALS AS OUTLINED IN TIER 2 - VOLUME 2 - SECTION 2.3.5
REGULATORY PHASES

The top timeline illustrates the sequence of project engineering and life of project milestones associated with business decisions. The bottom timeline illustrates the sequence of Project approval milestones associated with regulatory decisions. Timeline detail focuses on the main regulatory approvals stages.

As illustrated in the Figure, the sequential EA and licensing/permitting process allows for public and regulatory feedback to be incorporated into the design phase of the project. The process is iterative, incorporating mitigation measures and the re-evaluation of the facility design and the potential effects of the proposed activities. For example, comments and feedback during the development of the NIRB guidelines were considered as the initial feasibility studies were being undertaken and influenced the project description and assessment basis presented in the DEIS. A key example is the removal of marine shipping of uranium concentrate as a response to public feedback within this time period (AREVA letter to NIRB dated March 24, 2011). Similarly, during the review of the DEIS, feedback in the form of information requests and technical comments will be considered during the final feasibility design phase. This iterative process is shown in the figure by the design phase spanning the entire EA process with feedback loops between the EA regulatory process and the project design phases. Feedback through the DEIS review will be incorporated into the Final EIS.

This approach is consistent with the use of EA as the primary regulatory and planning tool by the NIRB (2011):

> "The EIS document is a tool used by NIRB to evaluate the potential environmental and socioeconomic impacts of a project proposal and to ensure the integrated planning of development proposals. The Proponent of a project proposal, prior to major decisions and commitments being made, prepares this in-depth document that identifies, predicts, evaluates and communicates information about the impacts of a development proposal on human health and the well being of the ecosystem (NIRB Guide 7)."

And the *Canadian Environmental Assessment Act* applied outside the Nunavut Settlement Area:

> "WHEREAS environmental assessment provides an effective means of integrating environmental factors into planning and decision-making processes in a manner that promotes sustainable development; (CEAA Preamble)"

The use of conservative bounding, worst case assumptions, an assessment basis and other means of applying the precautionary principle (refer to addendum section on precautionary principle) have been incorporated into the Kiggavik Project such that it can be assessed conservatively without licensing and permitting detail. The largest geographic scope, the longest duration, highest volumes or emission rates have been assessed, thus giving confidence that the actual values to be observed during construction, operation and decommissioning will be well within the approved assessment.

Management and monitoring plan detail is preliminary at the Draft EIS stage with plans created as frameworks within which further details will be added.

> "Although the information requirements of the [management plans] are intended to be as comprehensive as possible, it is recognized that various items may be dependent on the Proponent's development plans for the project, which will continue to be refined throughout the NIRB's review process. While some information required under these plans might not be available for the Proponent's Draft EIS submission, the proponent shall include a scheduled timeline relating to stages of the NIRB's review process or the later licensing/regulatory processes when this information will become available (i.e. Technical Meeting, Final EIS, Final Hearing, and Water Licensing) (Page 74 of NIRB 2011)."

A timeline has been built into the management plan section of the conformity table. This timeline indicates if detail will be available at the end of the EA process or at licensing often with a statement explaining the constraint in providing that detail within the *Draft* EIS.

Once a positive Minister's decision and NIRB project certificate are obtained, the final terms and conditions and project constraints will be known to AREVA. This will provide the necessary information upon which a development decision can be made, and detailed engineering can be finalized. The detailed engineering phase generates many of the details required to ensure the terms and conditions, and project constraints are effectively addressed and will also provide the basis upon which an effective licensing and permitting process (e.g. Nunavut Water Board, Canadian Nuclear Safety Commission (CNSC), Fisheries and Oceans and others) can be achieved.

Further detailed engineering supports licence and permit applications and approvals. This third level of project approval is used to demonstrate proponent competence and ability to implement the EA-approved project. Main licensing approvals include the CNSC Licence to Prepare and Construct, the Nunavut Water Board (NWB) Type A Water Licence, a Fisheries and Oceans Authorization and a Transport Canada Navigable Water Permit. Further details on licensing can be found in Tier 2, Volume 2, Section 2.3.5. The ability to obtain all required permits and licenses demonstrates that the proponent has the necessary procedures and quality management in place. It is at the completion of this stage that monitoring and management plans contain the full detail that is required for an operating site.

The CNSC requires a licence not only to prepare and construct but additionally at operation and decommissioning. In addition to regulatory monitoring, project modifications and adjustments throughout project life will require on-going regulatory communication and approvals.

9.2 WASTE ROCK MANAGEMENT PLAN

GUIDELINE 9.4.5/REQUIREMENT 981

In general frost-heave needs freeze/thaw cycles plus a source of water. The freeze/thaw cycle will always be present unless climate change becomes extreme; resulting in either the climate remains above or below 0 C. The potential issue is therefore to control/manage water. Water will eventually freeze in the waste rock dump and induce some deformation at the time of freezing. The frozen pore water will remain frozen unless it is located within the active zone. One strategy is to eliminate or at least minimise the presence of fines in the material that will be located in the active zone. This would provide good drainage capabilities, minimise water retention and consequently reduce the source for water for frost-heave. The lack of fines in the active zone would also eliminate the risk of transporting additional pore water by capillarity during the freezing process. It is a common cause for excessive frost-heave. A good example of frost-heave by capillarity is the formation of pingos. They are essentially “ice mountains”. Finally, it is important that the excess pore water that is mobile in the active zone can drain to zones that are not frost-heave susceptible.

It is AREVA understanding that the potential concern related to frost-heave in the context of waste rock management may be related to solifluction and particle displacement by frost jacking. Solifluction may occur along slopes in two steps: frost-heave followied by thawing. Frost-heave may occur along a vector that is normal (90°) to the slope of the ground surface. The subsequent thawing would induce a deformation that would be controlled by gravity, thus a downward vertical vector. The net movement would be a vector that is tangent to the slope of the ground surface. Solifluction requires frost-heave susceptible soils, thus poorly draining soils. Particle displacement by frost jacking is also caused by the combination of freeze and thaw. The freezing of the pore water first pushes the particle in a direction that is normal to the freeze front. Frost-heave process can also induce large stress loads in the same direction. The thawing of the displaced particle will follow a downward vertical vector, will not benefit from the load stresses induced by the frost-heave process and will be subject to particle interlocking that will restrict particle free movement. Excess pore water in the active zone would be again the main vehicle for frost-heave deformations.

In the case of waste rock piles, they are ultimately designed to control surface runoff, prevent excessive water accumulation in the pile (i.e. constant source of water) and can be processed to provide well-drainage material within the active zone. The stability of the slope should not be threatened if the piles are designed to minimise frost-heave deformation, and that the excess pore water escaping the dumps is properly managed.

9.3 MARINE SHIPPING PLAN

GUIDELINE 9.4.11/REQUIREMENT 1036

The majority of the shipping routes described in section 10.3.1 of Volume 2 are Navigable Waters that have pilotage requirements. There are two exceptions. Pilotage is compulsory in the St. Lawrence River between Montreal and Escoumins with pilotage provided by the Laurentian Pilotage Authority. Pilotage is also compulsory within the Churchill harbour which is provided by Great Lakes Pilotage Authority.

Pilotage is governed by the *Pilotage Act,* the Great Lakes Pilotage Regulations and the General Pilotage Regulations. AREVA will ensure the selected marine shipping contractor(s) adhere to all applicable shipping Acts and regulations pertaining to navigation along proposed shipping routes.

9.4 HAZARDOUS MATERIALS MANAGEMENT PLAN

GUIDELINE 9.4.8/REQUIREMENT 993,995

The current airstrip design is preliminary in nature. Further information will be provided upon completion of the detailed engineering and design. Efforts will be taken to prevent spills at the airstrip during operations by design, implementation of safety protocols, and adherence to aircraft refuelling and de-icing procedures.

The proposed emergency supply of jet fuel to be stored at the airstrip will be contained in double walled steel EnviroTanks or equivalent. This type of tank meets the requirements for secondary containment within its own structure. Further protection against spills will be provided by high level alarms, overfill preventers, and catch basins around each fill pipe. The fuel storage area will be inspected on a regular basis to promptly identify any leaks or spills. In addition, spill kits and fire suppression equipment will be available at the fuel storage area and other strategic locations at the airstrip.

Aircraft refuelling and de-icing will occur on the apron in a designated area that will be designed such that spills will be confined to the apron and be directed towards a catchment area to allow for collection. Petroleum contaminated soils will be excavated and transported to the Kiggavik landfarm for reclamation. Liquids contained in the catchment area will be collected with a vacuum truck and transferred to appropriate containers and stored at the designated hazardous materials storage area for shipment to a licensed recycling facility. Upon decommissioning, environmental sampling of soils will be conducted in the vicinity of potentially impacted areas at the airstrip. Any contaminated materials will be transferred to the TMF for disposal.

All hazardous materials generated as a result of aircraft maintenance (e.g. used oils, grease, glycols) will be stored in appropriate drums or suitable containers and transferred to the Kiggavik designated hazardous materials storage area. Refer to Technical Appendix 2U - Hazardous Materials Management Plan for further detail.

9.5 CULTURAL AND HERITAGE RESOURCES PROTECTION PLAN

GUIDELINE 9.5.3/REQUIREMENT 1130-31

Tier 2, Volume 2, Section 2.3.1.2 describes the applicable regulations and specifically, Table 2.3-1 lists the applicable federal acts and regulations for the proposed Kiggavik Project. The *Nunavut Act* and *Nunavut Archaeological and Paleontological Sites Regulations* (administered by the GN Department of Culture, Language, Elders, and Youth) applies to the management of potential impacts to identified cultural and heritage resources. The Archaeological Mitigation Plan (Tier 3, Appendix 9D) will be updated in the FEIS to include text that the Nunavut Archaeological and Paleontological Sites regulation under the Nunavut Act be will applied during construction, operation and decommissioning of the Kiggavik Project.

The Thelon River was nominated to become a river within the Canadian Heritage Rivers System (CHRS) in 1989. The values for which the river was originally nominated were natural heritage values, human heritage values and recreational values. As such, the planning and management program included information on land use framework, heritage management and protection and visitor services and facilities.

The Kiggavik Project is outside of the Thelon River watershed. As noted in Tier 2, Volume 9, Part 1, Section 12.1, Page 12-1, with the single exception of the of the cable ferry for users of the all-season access road (if built; see alternatives selection in Tier 2, Appendix 2A, Section 10) to cross the Thelon River, neither the Project nor any environmental effects will be observable to users of this river. If the all-season road is approved and constructed, the Thelon

River will be crossed in the summer with a cable ferry and an ice bridge in winter. As noted in the Road Management Plan (Tier 3, Appendix 2M), the cable which would operate the ferry lies on the river bottom after the ferry passes; therefore, small craft will be able to pass the crossing area without interference. Transport Canada Navigable Waters will be consulted in regards to any potential concerns to navigability should the all-season road alternative.

The Thelon River is 545 km in length and includes a management corridor which extends 1 km on each side of the river; the north all-season road and cable crossing represent a small fraction of the total length of the river.

Both the original CHRS Management Plan (Economic Development and Tourism, GNWT 1990) and the CHRS ten-year review (Department of Sustainable Parks and Tourism Division, 2000) noted low numbers of users:

- "Among the factors that will assist in river management are the essentially non-consumptive use of the resources, the low numbers of users, the high level of appreciation expressed by those users for the environment, the difficulty in removing artifacts coupled with legislation against removal and the location of the RCMP and conservation officers in Baker Lake (Economic Development and Tourism, GNWT 1990)."

- "The level of recreational activity on the Thelon River has remained relatively constant over the past ten years. Wilderness canoeing is the major activity utilizing the river corridor and numbers of parties using the river each year are low (Department of Sustainable Parks and Tourism Division, 2000)."

- "Local use of the river corridor is also very low. Winter season hunting activity is widespread closer to Baker Lake but activity diminishes significantly with distance from town. Summer activity is virtually non-existent although some boating activity up to the Beverly Lake area has been reported (Department of Sustainable Parks and Tourism Division, 2000)."

The ten-year review also noted community response regarding the Thelon heritage status and recommendations for the future as follows:

- "Community response on the Thelon River Achieving Heritage River System status:
  - o People believed the designation would lead to increased recognition and profile of the river.
    - People felt that there has been little effort on the part of the CHRS to promote the Thelon.
    - A second, and related, anticipated benefit of CHRS designation was economic spin-offs from tourism development. People's expectation was that tourism would increase as a result of CHRS designation and that

there would be a measure of employment and economic benefits in the community that would accompany such increases.

- Recommendations from this first ten year review included:
  - o Increasing tourism for the benefit of Baker Lake would seem to require activity in two areas: developing a broader base of activity and services associated with the river corridor; and, marketing the experiences effectively.
  - o Suggestion that developments and services to promote tourism should be undertaken by private sector ventures and not by government agencies. However, there may be a very important and significant role for government as a stimulus in the initiation of such ventures (Department of Sustainable Parks and Tourism Division, 2000)."

Although the proposed north all-season road would not provide services to improve tourism such as a lodge, campsites, etc., the road itself may provide access to the site, thereby increasing the opportunity for private businesses to develop these facilities. The proposed road may develop opportunities for travel along the Thelon River. This fits within the recommendations made in the ten year review of the Thelon as a CHRS river (Department of Sustainable Parks and Tourism Division, 2000). The recreational value (e.g. canoeing, kayaking, hiking, camping, wildlife viewing, fishing) along a section of the Thelon River may be improved with increased access.

In terms of protecting archaeological resources, the Archaeological Mitigation plan (Tier 3, Appendix 9D) would be applied to a north all-season road, should it be constructed, including the section of road occurring within the Thelon River management corridor (1 km on either side of the river).

9.6 CARE AND MAINTENANCE PLAN

GUIDELINE 9.6.1/REQUIREMENT 1162, 1163

Introduction

In the event of a temporary closure the following general measures and procedures will be adhered to in order to prepare for and maintain the temporary non-operational phase. Final closure is addressed in the Preliminary Decommissioning Plan (Tier 3, Appendix 2R).

Organization and Management

Any changes to organization and management as it relates to operations will maintain numbers and qualifications required for operational needs, services and health and safety and environmental programs.

Maintenance of Essential Programs

Details of the extent and duration of a temporary closure will be documented and provided to regulators. Facilities undergoing shutdown and any changes to processes or programs are highly dependent on the extent and duration of the temporary closure. Essential programs that are maintained regardless of temporary closure include the following: Safety, Health, Environment and Quality Programs: Environmental Monitoring Program (EMP), Environmental Code of Practice (ECOP), Radiation Code of Practice and Radiation Protection and Monitoring Programs. .Any adjustments to programs will be identified and communicated to applicable regulators.

Emergency response capability (equipment and manpower), including spill response and industrial fire team(s) will be maintained during a cessation of production activities.

Effluent Treatment

The Kiggavik water treatment plant will continue to treat and discharge to the Judge Sissons Control Station, any contaminated water from the dewatering of active open pits, pit tailings facilities, and water storage ponds to prevent potential surface or groundwater contamination. Appropriate freeboard will be maintained on any water holding structures to prevent potential spills.

The potable water and sewage treatment plants will be maintained as per operational procedures.

Waste Management

All hazardous wastes and mill reagents will continue to be managed in accordance with hazardous material protocols for operation. Should the mine move to decommissioning the hazardous material will be managed in accordance with the approved decommissioning plan. Extended care and maintenance periods may warrant removal of certain hazardous material from site.

Conventional Safety

Safety management systems involving the protection of workers and property will continue as conducted during operations. In addition the following actions will be taken to minimize the risk of injury or fire:

- Unnecessary propane lines will be purged with an inert gas and disconnected
- Electrical circuitry that is not required in the temporary shutdown will be physically disconnected
- Equipment that has the capacity for energy storage will be physically disconnected

- Fireguards will be employed when there is a possible chance of inadvertent combustion i.e. fuel tank reduction
- Lock-out procedures for non-operational equipment will be employed and all buildings not required will be locked and signed to prevent entry.

Radiation Safety

All buildings, vessels and potential confined spaces, not required during the cessation of operations, but contain radioactive materials that could potentially result in unsafe radioactive atmospheres will either be ventilated as per normal operating requirements or locked and signed to prevent inadvertent and/or unnecessary radiation exposure to workers.

All area and personal radiation dosimetry programs will continue as per site operating requirements.

Dams, Dykes and Other Containment Structures

Stability monitoring programs will be maintained for berms, dams and/or other containment structures where appropriate.

Site Access and Security, Pubic Safety

Appropriate measures will be implemented to control site access, to prevent unauthorized removal of materials and to ensure the identity of all persons on site will be maintained in a manner similar to that during the operating phase of the mine. In addition, the procedures and associated work instructions established in the Integrated Quality Management System (IQMS) for site security, shall apply during any temporary closure.

10 GUIDELINE 10.0 - CONCLUSION

The Kiggavik Project is predicted to provide a social and economic benefit to Nunavut and Canada. The Project falls within the Government of Nunavut's vision of facilitating economic and social development. A precautionary approach to protecting workers, the general public and the environment from potential adverse project effects is paramount with this Project through stringent regulatory compliance and industry-led best practices.

The majority of the Project-related residual effects are predicted to occur within a localized area, with most effects reversible. While some Project-related residual effects are predicted to extend beyond a localized area, the extent of these effects are assessed as not significant and not threatening the integrity or sustainability of environmental components within the Nunavut Settlement Area or Canada. Mitigation measures and monitoring procedures will prevent or reduce Project-related effects on the environment, and an adaptive management approach will facilitate continued improvement in environmental protection. Potential cumulative environmental and socio-economic effects can be prevented with collaborative efforts among various stakeholders including industry, communities, Inuit organizations and government. The absence of significant Project and cumulative environmental effects removes the potential for any significant transboundary effects. The development of the Kiggavik Project can be completed in an environmentally and socio-economically sustainable way that will benefit Nunavummiut while protecting the ecological integrity of the environment.

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APPENDIX A: MISSING PAGES (7-4 AND 7-5) FROM APPENDIX 8A: ECOLOGICAL AND HUMAN HEALTH RISK ASSESSMENT

concentrations in JSL-1 (for uranium, from 0.1 to 0.5 µg/L) compared with concentrations in JSL-4 (for uranium, from 0.1 to 0.12 µg/L).

The operation phase show the predicted water quality results under the assumed effluent release for the extended operation of Option 1, which considers discharge of the Kiggavik WTP to JSL-2 and Sissons WTP to JSL-8. The effluent is distributed throughout Judge Sissons Lake by natural flow processes and horizontal dispersion. Figure 7.2-1 illustrates the range of predicted water concentrations in each of the Judge Sissons Lake segments during the operation phase. Comparison of the baseline phase with the operation phase gives an indication of which COPC in the effluent have more of an influence on the water quality in the various Judge Sissons Lake segments. For example, comparison between the baseline and operation phase concentrations of uranium at JSL-1 shows that uranium in the effluent discharge creates a noticeable difference, while concentrations of thorium-230 are essentially the same between the two phases.

The final closure phase represents the predicted water quality under the bounding case decommissioning scenario with 22-years of Main Zone consolidation. As effluent releases are gradually decreased through this phase, Figure 7.2-1 shows that water quality is predicted to approach baseline concentrations as effluent discharge. The system is shown to respond relatively quickly to changes in the effluent release scenario.

Finally, the post-closure phase shows the recovery of predicted water quality for Judge Sissons Lake after effluent releases have stopped. Again, the system responds quickly and returns to baseline/pre-operation conditions, and the water effluent scenario assessed indicates that the Project does not have long-term impacts on the water quality of Judge Sissons Lake.

The associated water quality guidelines are indicated on the graphs. For the COPC with water quality guidelines available, predicted water concentrations of uranium, arsenic, lead, molybdenum, nickel, selenium, zinc, and un-ionized ammonia were below the guidelines in all segments of Judge Sissons Lake. For cadmium, predicted concentrations in water exceed the Canadian Water Quality Guideline (CWQG) of 0.017 µg/L at all points of the assessment, including baseline summer concentrations. Effluent discharge does have an influence on cadmium concentrations in water; however the baseline cadmium concentrations were taken to be at the detection limit of 0.05 µg/L, which is above the CWQG.

The CWQG for cadmium provided by CCME is dated as it is consistent with that presented in previous documents (CCME 1996). A more recent assessment of the aquatic toxicity information was considered in the evaluation of a water quality criterion for cadmium by the US EPA (2001). The US EPA developed a hardness-dependent criteria based on an assessment of the complete database of information (U.S. EPA 2009). As discussed previously, due to the presence of the ice cover in Judge Sissons Lake there is expected to be fluctuation concentrations during the year. This was examined for JSL-1 which is a shallow segment directly adjacent to the Kiggavik WTP discharge location and JSL-4 a larger segment that represents the outflow from the lake. Table 7.2-1 provides the estimated hardness; the calculated criterion following the EPA approach; and, the estimated cadmium concentration for JSL-1 and JSL-4 separately for the summer and winter periods. This table shows that cadmium levels are within the acceptable level during winter and only marginally above an appropriate comparison level during summer. It should be noted that the concentrations are total (i.e. reflect both baseline and Project effects) and baseline levels could not be reliably established (cadmium was not detected and was assumed to be present at 0.05 µg/L).

Table 7.2-1 Summary of Cadmium Water Concentrations and Appropriate Criteria for the Summer and Winter Periods

	Estimated Hardness (mg/L)	Calculated Cadmium Water Quality Criterion[(a)] (µg/L)	Estimated Cadmium Concentration in Water[(b)] (µg/L)
JSL-1			
Summer	13	0.06	0.070
Winter	115	0.27	0.44
JSL-4			
Summer	20	0.08	0.086
Winter	176	0.36	0.25

Note:
a Water quality criterion calculated following the approach adopted by the US EPA
b Concentrations include baseline level of <0.1 µg/L (taken to be 0.05 µg/L during the summer)

Predicted water quality for copper indicates that effluent from the Project has limited influence on the water quality in Judge Sissons Lake segments; however, copper concentrations in JSL-1 and JSL-7 exceed the CWQG. This is a baseline condition.

7.2.1 Predicted Downstream Impacts on Water Quality

An analysis was completed to evaluate the potential impacts on water quality downstream of Judge Sissons Lake. Judge Sissons Lake is part of the Anigaq River watershed and the Anigaq River ultimately drains into the western edge of Baker Lake, which in turn drains into Chesterfield Inlet and finally into Hudson Bay.

The outlet of Judge Sissons Lake is JSL-4 and the mean annual discharge from Judge Sissons Lake is 4.289 m^3/s (Appendix 5A). Mean daily discharge data from an hydrometric station (Environment Canada station name: 06MA007) located about 1 km downstream of Audra Lake was characterized to evaluate the potential impacts on water quality from natural water flow out of Judge Sissons Lake. Mean daily discharge data collected for 14 years between 1984 and 2010 was characterized by an average daily discharge rate of 14.976 m^3/s.