Kiggavik Project
Final Environmental Impact Statement

Tier 2 Volume 5
Aquatic Environment

September 2014

History of Revisions

Revision Number	Date	Details of Revisions
01	December 2011	Initial release Draft Environmental Impact Statement (DEIS)
02	September 2014	FINAL Environmental Impact Statement

Foreword

The enclosed document forms part of the Kiggavik Project Final Environmental Impact Statement (FEIS) submission, presenting potential environmental and social impacts to determine if the Project should proceed and if so, under what terms and conditions. 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)", to include new material or clarity provided during the review of the Draft Environmental Impact Statement, and to address company commitments and direction from the Nunavut Impact Review Board as outlined in the "Preliminary Hearing Conference Decision Concerning the Kiggavik Project (NIRB File No. 09MN003)".

The FEIS 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 Final Environmental Impact Statement.

- **Tier 2** documents (Volumes 2 to 10) contain technical information and provide the details of the assessments of potential Project environmental effects for each environmental compartment. Tier 2 Volume 11 contains executive, popular, and volume summaries in Inuktitut.

- 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, modelling reports and details of other studies undertaken to support the assessments of environmental effects. Management plans are provided as Tier 3 documents.

Volume 1 Main Document

Volume 2 Project Description and Assessment Basis

- Governance and Regulatory Oversight
- Project Description
- Assessment Basis

2A Alternatives Assessment
2B Drilling and Blasting Design
2C Explosives Management Plan
2D Design of Ore and Mine Rock Pads and Ponds
2E Water Diversion and Collection Design
2F Design of Andrew Lake Dewatering Structure
2G Kiggavik-Sissons Road Report
2H Ore Storage Management Plan
2I Water Management Plan
2J Marine Transportation
2K Winter Road Report
2L All-Season Road Report
2M Roads Management Plan
2N Borrow Pits and Quarry Management Plan
2O Mine Site Airstrip Report
2P Occupational Health and Safety Plan
2Q Radiation Protection Plan
2R Preliminary Decommissioning Plan
2S Waste Management Plan
2T Environmental Management Plan
2U Hazardous Materials Management Plan
2V Mine Geotechnical Reports

Volume 3 Public Engagement and Inuit Qaujimajatuqangit

Part 1
- Public Engagement

Part 2
- Inuit Qaujimajatuqangit

3A Public Engagement Documentation
3B Inuit Qaujimajatuqngit Documentation
3C Community Involvement Plan

Volume 4 Atmospheric Environment

Part 1
- Air Quality and Climate Change

Part 2
- Noise and Vibration

4A Climate Baseline
4B Air Dispersion Assessment
4C Air Quality Monitoring Plan
4D Baker Lake Long-Term Climate Scenario
4E Noise and Vibration Assessment
4F Noise Abatement Plan

Volume 5 Aquatic Environment

- Surface Hydrology
- Hydrogeology
- Water and Sediment Quality
- Aquatic Organisms
- Fish and Fish Habitat

5A Hydrology Baseline
5B Geology and Hydrogeology Baseline
5C Aquatics Baseline
5D Groundwater Flow Model
5E Prediction of Water Inflows to Kiggavik Project Mines
5F Mine Rock Characterization and Management
5G Thermal and Water Transport Modelling for the Waste Rock Piles and Tailings Management Facilities
5H Waste Rock Water Balance
5I Hydrology of Waste Rock Piles in Cold Climates
5J Tailings Characterization and Management
5K Historical and Climate Change Water Balance
5L Kiggavik Conceptual Fisheries Offsetting Plan
5M Aquatics Effects Monitoring Plan
5N Hydrology Assessments
5O Sediment and Erosion Control Plan
5P Technical Assessments of Water Withdrawal Locations and Baker Lake Dock Site

Volume 6 Terrestrial Environment

- Terrain
- Soils
- Vegetation
- Terrestrial Wildlife

6A Surficial Geology and Terrain Baseline
6B Vegetation and Soils Baseline
6C Wildlife Baseline
6D Wildlife Mitigation and Monitoring Plan

Volume 7 Marine Environment

- Marine Water and Sediment Quality
- Marine Mammals
- Marine Fish

7A Marine Environment Baseline
7B Underwater Acoustic Modelling

Volume 8 Human Health

- Occupational Dose Assessments
- Human Health Risk Assessment

8A Ecological and Human Health Risk Assessment
8B Radiation Protection Supporting Document

Volume 9 Socio-Economic Environment and Community

Part 1
- Socio-Economic Environment

Part 2
- Heritage Resources

9A Socio-Economic Baseline
9B Archaeology Baseline
9C Human Resources Development Plan
9D Archaeological Resource Management Plan

Volume 10 Accidents, Malfunctions and Effects of the Environment on the Project

- Risk Assessments
- Effects of the Environment on the Project

10A Transportation Risk Assessment
10B Spill Contingency and Landfarm Management Plan
10C Emergency Response Plan

Volume 11 Executive, Popular and Volume Summaries Translated into Inuktitut

KEY:

Tier 1 Document – Main Documents

Tier 2 Document – Environmental Effects Assessment Report

Tier 3 Document – Technical Appendices, Baseline Reports, Technical Development and Management Plans

Executive Summary

As per the guidelines issued by the Nunavut Impact Review Board (NIRB 2011), AREVA Resources Canada Inc. (AREVA) has prepared this volume of the Environmental Impact Statement (EIS) to assess the potential environmental effects of the Kiggavik Project (the Project) on the aquatic environment. Volume 5 focuses on the potential environmental effects of the proposed Project activities to surface hydrology, hydrogeology, water quality, sediment quality, aquatic organisms, fish habitat, and fish populations.

Scope of the Assessment for the Aquatic Environment

The NIRB developed the scope of the assessment for the Project based on input from Inuit, government and other stakeholders. Issues pertaining to the aquatic environment identified through consultation and engagement activities completed by AREVA have been incorporated into the effects assessment.

Inuit stakeholders have played a fundamental role in raising awareness of potential Project interactions with the aquatic environment. Through Inuit Qaujimajatuqangit (IQ) interviews and engagement activities, AREVA has learned about the importance of the aquatic environment to Kivalliq community members. This includes the value of aquatic resources to the Inuit way of life (IQ-RB01 2009[1], IQ-BL06 2008[2]), concerns and questions about potential for contamination of aquatic environment (EN-BL HTO Mar 2009[3], EN-BL HS Nov 2010[4]), and the importance of environmental protection (EN-BL OH Nov 2010[5], EN-BL OH Nov 2013[6], EN-AR NIRB May 2010[7]).

Valued environmental components (VECs) are major physical and biological components of the environment that, if affected by the Kiggavik Project, would be of concern to regulators, Inuit, local residents and resource users, and/or the general public. The aquatic environment VECs identified for this assessment are: groundwater, surface hydrology, water quality, sediment quality, aquatic organisms and fish habitat, and fish populations.

Interaction of the Project with the aquatic VECs may occur through various project activities or physical works. The main interactions with aquatic VECs are related to: water extraction, storage and discharge; alteration of drainage patterns and construction of diversion channels; dewatering of

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1 IQ-RB01 2009: *People drink water and get ice from the rivers. Many people won't drink tap water.*
2 IQ-BL06 2008: *One Elder said that their diet was fish only, as caribou were scare after moving to Baker Lake.*
3 EN-BL HTO Mar 2009: *What if wastes flow into the water surrounding the mine?*
4 EN-BL HS Nov 2010: *What happens if uranium gets into the groundwater?*
5 EN-BL OH Nov 2010: *Are you going to treat all of the water?*
6 EN-BL OH Nov 2013: *Are there fish in the lakes? Will they be safe?*
7 EN-AR NIRB May 2010: *Would like to see aquatic life in the lakes and rivers monitored.*

the Andrew Lake Pit; blasting in and near water bodies; release of treated effluent; and dust deposition.

The Kiggavik Project has numerous obligations to departments within federal and territorial governments, Inuit Organizations and Inuit Institutions of Public Government related to the aquatic environment. Federal agencies that are involved in groundwater and surface water related issues include Fisheries and Oceans Canada (DFO), Environment Canada, Natural Resources Canada, Health Canada, and Aboriginal Affairs and Northern Development Canada. Groundwater and surface water in Nunavut are governed by the territorial *Nunavut Waters and Nunavut Surface Rights Tribunal Act*. The Project must comply with DFO's Fisheries Protection Provisions as well as a number of other controls on effluent release, fish passage, water withdrawals and diversions. As a metal mine, the Project will also be required to submit to the Metal Mining Effluent Regulations (MMER). These regulations stipulate discharge limits on harmful substances and require monitoring of effluent chemistry, water quality, and the health of aquatic organisms in the receiving environment. The assessment of effects to the aquatic environment is spatially bound by three assessment areas: the Project footprint, the Local Assessment Area (LAA), and the Regional Assessment Area (RAA). For the purposes of the assessment, the Project footprint is the physical area covered by the Kiggavik and Sissons Mine Sites, as well as any associated Project infrastructure (i.e. utility corridors, roadways, water intake and treated water discharge structures, and airstrip). The LAA for the Project is bound by two separate regions; one that includes the lakes and tributary streams that may potentially be affected by Project activities or infrastructure, and another that includes the watercourses that could potentially be affected by the proposed winter access road corridor and the option to develop an all-season access road corridor. It is expected that any Project related effects would originate and be measurable within these boundaries. The Regional Assessment Area (RAA) for most of the aquatic VECs coincides with the LAA because all effects are contained within the LAA watersheds.

The temporal boundaries of the aquatic assessment are based on the timing and duration of effects over all phases of the Project, including construction, operation, final closure and post-closure. The total life span of the Project is expected to be 25 years, with post-closure activities extending beyond the final closure phase.

A residual environmental effect from the Project is considered significant if it adversely affects the long-term viability of a VEC. Determination of significance is based on standards or thresholds that have been identified for each VEC; professional judgement and experience with similar Projects may be used to determine significance where standards and thresholds are unavailable. If a change in a VEC resulting from the Project is within the range of natural variability for that VEC, or the change does not affect the integrity of the VEC in a measurable way, the effect is considered non-significant.

Scope of the Assessment for Groundwater

Existing Environment – Groundwater

The Project is located within the zone of continuous permafrost. Unfrozen ground conditions (i.e., "taliks") can develop beneath deep lakes that do not freeze to the bottom in winter. A 2 to 2.5 metre (m) thick ice coverage is assumed to occur in lakes at the Project site during winter; many lakes freeze to the bottom. However, a number of lakes do possess minimum dimensional and depth requirements to support an open talik that extends to the deep groundwater flow system. Taliks beneath larger lakes extend down to the deep groundwater regime.

Deep groundwater flows from high to low elevation. Groundwater near the Main Zone, Centre Zone and East Zone deposits flows south; near the Andrew Lake and End Grid deposits, groundwater tends to flow southeast. Concentrations of Total Dissolved Solids (TDS) are expected to be consistent with deep groundwater in the Canadian Shield (Frape and Fritz 1987).

Groundwater sources from both the active layer and from the deep groundwater below the permafrost are not presently used for drinking water. It is also considered unlikely that groundwater will be used as a drinking water source in the near future.

Environmental Effects Assessment for Groundwater

The effects assessment for groundwater includes two measurable parameters. The first is the elevation of lakes potentially affected by dewatering of mines that extend beneath the permafrost. This is considered an indicator of groundwater quantity because dewatering of open pit and underground mines commonly results in depressed groundwater levels near mines. This has the potential to impact lake levels in the Project area. The second indicator is the quality of the receiving surface water bodies potentially connected to the deep groundwater system. Groundwater represents a pathway for potential interactions between dissolved constituents in water originating from mining activities and surface water. Because the groundwater resource is not used in the Kiggavik Project area, surface water quality is considered the main measurable parameter of the potential long-term effects of the Project on the aquatic environment.

Effects of mine dewatering activities on groundwater levels below permafrost are predicted to be continuous during the mining period, but reversible in the medium-term, and are anticipated to have negligible ecological and socio-economic implications. The low hydraulic conductivity of the rock mass and the permafrost conditions will result in limited groundwater inflows to the proposed mines. No lake water level changes are predicted to result from mine dewatering activities. Therefore, residual adverse effects from the Project on groundwater quantity are not considered significant.

The assessment of potential long-term effects from groundwater and COPCs to surface waters in the Kiggavik and Sissons areas indicates minimal changes from background concentrations for COPCs in local lakes; predicted concentrations are well below water quality guidelines or are comparable to baseline concentrations. Therefore, potential effects to surface waters are expected to fall within the range of background concentrations (i.e., low magnitude). Model results show that effects on groundwater and surface water receptors are likely to be of low magntitude, given both current permafrost conditions and potential no-permafrost conditions that would result from dramatic climatic warming conditions.

Given the Project design features and the low hydraulic conductivity of the rock mass, Project effects on groundwater are not predicted to be significant.

Scope of the Assessment for Surface Hydrology

Existing Environment – Surface Hydrology

Streams near the Project display arctic nival characteristics; their hydrographs reflect a steep rising limb, peaking in approximately mid-June due to the onset of spring snowmelt, followed by receding flows for the remainder of the open water period. Rainfall events throughout the summer may temporarily reactivate the channels or cause secondary peaks. Streamflow typically ceases during winter months.

Lakes near the Project are typically ice covered from October through June, with mean maximum ice thickness near 2 m. Lake levels and volumes reach their peaks during the spring freshet in mid-June with levels and volumes typically decreasing throughout the remainder of the open-water season.

Environmental Effects Assessment for Surface Hydrology

Key surface hydrology issues identified during stakeholder engagement include changes to streamflow rates, as well as changes to lake levels and volumes, that may affect other components of the aquatic, terrestrial and socio-economic environments (EN-CI KIA Apr 2007[8], EN-BL OH Nov 2010[9]). Specific activities include the dewatering of ponds and standing water during site clearing and pad construction, dewatering the pit area of Andrew Lake, freshwater withdrawal from lakes, the collection of site and stockpile drainage, and the discharge of treated effluents.

Project design features and mitigation measures have been selected to most effectively minimize effects to surface hydrology. For example, large water bodies have been selected for water

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[8] EN-CI KIA Apr 2007: *How much water will they [AREVA] use?*
[9] EN-BL OH Nov 2010: *Will you divert water?*

withdrawal and effluent discharge locations so that changes to surface hydrology are minimized. The site water management system has been designed to recycle water, and where possible, to limit withdrawal requirements and discharge quantities. Activities associated with water withdrawal will follow DFO procedures that indicate that no more than 10 percent (%) of the under-ice volume is withdrawn from a lake during one ice covered season. Freshwater diversion channels will be constructed to direct clean water around the mine sites. Sedimentation ponds will limit sediment loading to the receiving aquatic environment from otherwise-uncontaminated runoff collected from within the mining area. Best Management Practices (BMPs) will be adopted for erosion control and sediment transport on all disturbed sites, including the core facilities areas and access roads, during construction, operations and decommissioning.

Mitigation measures and project design features are expected to effectively minimize effects to surface hydrology. Effects to flow rates are predicted to remain below 3% of the baseline peak flow. Changes in lake levels are predicted to be highest at Andrew Lake, with a short-term increase of approximately 24 centimetres (cm) during dewatering of the Andrew Lake Pit area. However, Andrew Lake dewatering will occur after the spring freshet has passed when water levels are naturally declining. The magnitude of all other potential changes in lake levels is estimated to be less than 8 cm. Changes to under-ice volumes will follow DFO's 10% withdrawal threshold during the ice-covered season. Runoff contributing drainage areas for Pointer Lake outflow and Andrew Lake outflow (the receiving environments for the Kiggavik and Sissons Sites, respectively) are predicted to decrease by less than 1% and 3% respectively.

During construction, and through operations and decommissioning, water levels, flow rates and water body volumes will be monitored at locations potentially affected by Project activities. These locations include Andrew Lake, Siamese Lake, Mushroom Lake, Judge Sissons Lake, and their respective outflow channels.

Scope of the Assessment for Water Quality

Existing Environment – Water Quality

Lakes in the LAA generally have similar water chemistry (Tier 3, Technical Appendix 5C). Lakes are characterized by low ionic strength and neutral to alkaline pH, low to high sensitivity to acidification, very soft to soft water hardness, and being nutrient poor (i.e., oligotrophic). Baseline water quality parameters are generally less than applicable guideline values.

Streams of the study area are characterized by low ionic strength, neutral to alkaline pH, low to high sensitivity to acidification, very soft water hardness, and oligotrophic conditions. Baseline water quality parameters are generally less than applicable guidelines.

Environmental Effects Assessment for Water Quality

Key water quality issues identified during stakeholder engagement include changes to surface water chemistry from treated effluent discharge from the Kiggavik and Sissons Water Treatment Plants (WTP); increased dust emissions and subsequent deposition of metals and particulates resulting from mine construction and operation; and acid deposition resulting from increased air emissions (EN-WC KIA Apr 2007[10], EN-KIV OH Oct 2009[11], EN-BL EL Mar 2009[12]). Potential alteration to surface water chemistry from these sources has the potential to affect aquatic organisms residing in LAA water bodies.

A number of mitigation measures and project design features will be implemented to limit Project effects to surface water quality. To reduce the potential effects of effluent release in the receiving environment, treated discharge water will be recycled to the mill for re-use in mill processes. The design of the WTPs will be optimized to support compliance with appropriate effluent quality regulations. Best management practices (BMPs) for dust control on roads and during the pit mining operation will be implemented to reduce deposition of particulates and metals in the Kiggavik Project area. To mitigate the release of acid generating materials to the atmosphere, scrubbers will be installed at the sulphuric acid plant, and emission control systems will be installed on the oil-fired power generators and/or product driers.

Modelling data indicate that changes to water quality in Judge Sissons Lake resulting from effluent discharges from the Kiggavik and Sissons WTPs are expected to occur during the operation and final closure stages of the Project, but values will return to baseline levels post-closure. Concentrations of COPCs are expected to be below guideline values, with the exception of cadmium, copper, selenium and zinc. For cadmium, it is expected that only the maximum concentrations during winter periods may exceed the hardness-dependent guideline. For selenium, in the shallowest segment of the lake the water quality will naturally be close to the guideline during the winter and with the contribution from the project it is possible that the guideline is exceeded. Other COPCs (e.g. copper and zinc) there is little change relative to baseline, and the guidelines are exceeded due to natural conditions. Mitigation measures and project design features are predicted to effectively minimize effects to surface water quality. Overall, no significant adverse effects on water quality are expected.

Changes in water quality resulting from dust deposition are predicted to be minor and will occur primarily during the period of high flows associated with spring runoff. Minor annual increases in metals, radionuclides and total suspended solids (TSS) will occur over the operational life of the mine (about 25 years), but concentrations are not expected to exceed any applicable water quality

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[10] EN-WC KIA Apr 2007: *there are a lot of rivers in that area. Will contaminants flow in the rivers or lakes?*
[11] EN-KIV OH Oct 2009: *What about water pollution?*
[12] EN-BL EL Mar 2009: *I am also concerned about the environmental assessment and how it is going to be completed, especially with the water testing. The animals drink the water, and it would be best to have all things safe for the animals.*

guideline or objective, or be measurable above natural background variation. Overall, no significant adverse effects on water quality are expected to occur due to dust deposition.

Variation in lake pH is expected to occur naturally over the operational life of the Project (about 25 years). These changes are in response to deposition of acids by precipitation, and the effects of seasonal freeze-thaw cycles on lake chemistry. Potential changes to lake pH due to increased acid deposition as a result of the Project are predicted to occur primarily during the summer open water period. However, any potential changes would be small (i.e., below the critical load value) and likely brief, due to the fast movement of water through exposed lakes. No significant adverse effects on water quality are expected, and no long-term trend towards increasing lake acidification are expected to result from the Project.

To comply with Nunavut regulatory requirements, wastewater and effluent water quality will be analysed and documented regularly throughout mine operations, decommissioning, and after mine closure, as part of compliance and follow-up monitoring. Water quality at effluent discharge locations in Judge Sissons Lake, as well as at the outlet of Judge Sissons Lake, will be monitored during the operations, closure and post-closure phases of the Project. Water withdrawal and wastewater/effluent discharge rates will be continually documented during the construction, operation, and closure phases of the mine. Air and dust emission levels and dust deposition will be monitored regularly near both the Kiggavik and Sissons mining operations, and adjacent to the ore haul road between the two sites to determine whether observed levels are similar to predicted levels. Water quality in lakes and streams adjacent to, and downstream of, the mine site LAA will be monitored to confirm that metals and radionuclide concentrations, TSS, acid deposition, and lake acidification are not surpassing acceptable levels. This monitoring will occur during the construction, operational and closure phases of the Project.

Scope of the Assessment for Sediment Quality

Existing Environment – Sediment Quality

Lake substrates vary from rock, boulder and sand in shallow areas to organic sediments in deeper depositional areas. Surficial light to dark brown sediments are typically 2 to 10 cm deep. Differences in sediment texture between smaller lakes and Judge Sissons Lake are attributed to the much greater depth of Judge Sissons Lake, and the varying depositional environment provided in deep lakes (BEAK 1990).

Overall, total metal concentrations were similar among the lakes in the LAA. Arsenic and chromium concentrations usually exceeded the Canadian Interim Sediment Quality Guideline (ISQG), but not the Probable Effects Level (PEL). Occasional exceedances of cadmium, copper, mercury, and zinc ISQGs, and the mercury and zinc PEL have been observed. Some exceedences of arsenic, chromium, copper, molybdenum, nickel, selenium, and vanadium Lowest Effects Levels (LELs) were also observed. Radionuclides were detected in almost all sediment samples, except those from Baker Lake, and were generally reported at concentrations below 0.3 Becquerels per gram dry weight (Bq/g dw). Concentrations of individual polycyclic aromatic hydrocarbons (PAHs) in Baker Lake sediments are expected to be well below ISQG, based on recent (2008) sampling (Tier 3, Technical Appendix 5C).

Environmental Effects Assessment for Sediment Quality

The key issue identified for sediment quality is the potential for the Project to change sediment chemistry, based on release of treated effluent from the Kiggavik and Sissons WTPs. Effluent discharge can affect water quality in the receiving environment and consequently affect the sediment through processes such as settling and adsorption. Contaminant levels in sediment can affect biota that reside in or on the sediment (e.g., bottom dwelling invertebrates), fish that feed on benthic organisms, as well as wildlife that may incidentally ingest sediment while feeding on aquatic biota. Because the potential effects to sediment are likely to occur in response to an alteration of water chemistry, the mitigation and project design features implemented to limit potential affects to sediment quality are similar to those described for water quality.

Mitigation measures and project design features are predicted to effectively minimize effects to sediment quality. Modelling data indicate that sediment concentrations of all COPCs with sediment quality guidelines are predicted to be below threshold concentrations in all segments of Judge Sissons Lake, with the exception of arsenic, copper and nickel. The concentration of these COPCs in sediment is expected to be slightly elevated compared to the conservative guidelines that predict minimal effects to aquatic organisms. This exceedance occurs during all phases of the assessment, including baseline. Given that baseline levels of all of the COPC in sediment are similar to those predicted by the future effluent release scenarios, it is not expected that the Project will have a substantial effect on levels of arsenic, copper and nickel in sediment.

Sediment quality will be monitored periodically during operations and decommissioning to confirm sediment quality predictions (Tier 3, Technical Appendix 5M).

Scope of the Assessment for Aquatic Organisms and Fish Habitat

Existing Environment – Aquatic Organisms and Fish Habitat

<u>Lakes</u>

Lakes in the mine site LAA are typically shallow (many with maximum depths less than 3 m) and the water is generally well mixed. Water clarity is usually greater than 2 m and is often equal to total depth. Shoreline substrate in lakes consists primarily of boulder, cobble, sand and silt substrates.

Shoreline slopes may vary from low to moderately steep. Shoreline vegetation is primarily grasses and low shrubs. In-lake cover for fish generally consists of inundated vegetation along the shoreline, and/or spaces between the coarse substrate; some lakes contain areas of emerging and/or underwater aquatic vegetation. Because ice thickness reaches approximately 2 m by the end of winter, many of the shallow lakes likely freeze to the bottom during winter. Smaller lakes generally start to become ice free in early June, with larger lakes becoming ice free in late June or early July. Because most lakes and ponds in the mine site LAA are shallow, most provide only seasonal foraging and rearing habitat for fish. Overwintering habitat is found in a few deeper (i.e., greater than [>] 3 m) lakes in the area.

Benthic invertebrate communities in lakes are characterized by low to moderate density and diversity. Taxa richness may vary from approximately four to 26 taxa per lake in the LAA (including Baker Lake), with chironomids as the dominant taxa. None of the taxa present are federally listed as being endangered or at risk species. Trace element concentrations of soft- and hard-bodied invertebrates in Judge Sissons Lake exhibit a large degree of spatial variability (Tier 3, Technical Appendix 5C).

Historical phytoplankton community data indicates lakes within the Project area exhibited characteristics typical of unproductive Canadian Shield lakes. Species richness tends to vary among lakes. Several unique phytoplankton taxa are present; however, none of these are federally or territorially listed.

Zooplankton communities are generally dominated by cladocerans or calanoid copepods, with rotifers consistently exhibiting the highest relative density. Several unique zooplankton taxa are present in LAA lakes; however, none of these are federally or territorially listed.

<u>Streams</u>

Streams in the LAA are typically dominated by run and flat habitats, while pool, pond, riffle and backwater habitats were observed less frequently. Some areas of high flow (i.e., cascades, rapids), and nearly dry or standing water conditions also occur later in the open water season. On average, streams are less than 1 m deep; however, depths may range from a few centimetres to greater than 7 m in the Thelon River. Substrates consist primarily of gravel, cobble, boulder and silt. Overhead cover may include undercut banks, overhanging vegetation and ledges. In-stream cover generally consists of submerged vegetation and spaces between coarse substrates, with some streams containing areas of emerging and/or underwater vegetation. Many of the larger stream systems in the LAA support Arctic grayling (*Thymallus arcticus*) spawning runs, while other fish species move into the streams during the open water period to forage, or to escape predatory fish in the over-wintering lakes.Stream benthic invertebrate communities are generally expected to have higher taxa richness than area lakes. Chironomids are the dominant taxa reported; however, a few streams are reportedly dominated by oligochaete worms or hydridae.

Stream periphyton communities are generally dominated by chlorophytes and diatoms. Taxonomic richness in periphytic communities is considered similar between sub-basins, with diatoms being the most taxonomically rich group within streams in the Project area. Several unique periphyton taxa are present in the LAA; however, none of these are territorially or federally listed.

Environmental Effects Assessment for Aquatic Organisms and Fish Habitat

Project activities have potential to result in changes to the abundance or distributions of aquatic organisms, or to the quality or distribution of fish habitat. Treated effluent discharge from the Kiggavik and Sissons WTPs may affect surface water quality. These changes can affect the concentration of COPC in aquatic biota (e.g., aquatic plants, benthic invertebrates, plankton). Project development activities may physically interact with and effect fish habitat which is of concern to community members (EN-CH OH Nov 2010[13]).

Potential toxicity to aquatic biota from treated effluent release will be mitigated by environmental control features incorporated into the design of the WTPs. The design of the WTP will focus on the production of effluent that complies with appropriate water quality guidelines. The roads constructed in association with the Project will be designed so that the natural flow paths intercepted by the route are preserved with adequately designed cross-drainage structures (i.e., culverts, bridges). Construction of stream crossings will be carried out in such a way that potential serious harm to fish and fish habitat are mitigated. Best management practices (BMPs) will be used during the construction of the Andrew Lake berm; sediment (turbidity) curtains will be installed prior to construction of the berm and before dewatering takes place. A fish rescue will be carried out prior to dewatering in order to minimize the potential for fish mortalities.

The assessment of change to the distribution (i.e., presence/absence of species) and abundance of aquatic organisms identified potential issues with cadmium exposure to zooplankton. It is expected that cadmium concentrations in select areas of Judge Sissons Lake will be elevated compared to baseline conditions. It is possible that in certain areas of the lake, some of the more sensitive zooplankton species will be affected; however, considering the low to moderate toxicity values predicted for zooplankton and the geographic extent of the effect, the zooplankton and the elevated concentrations are during the winter season, population of Judge Sisson Lake is expected to continue to function. Although there are residual effects, no appreciable adverse effects on the abundance and distribution of aquatic biota are expected due to changes in COPC concentrations in the receiving environment.

Aquatic organism populations and diversity will be monitored regularly during mine operation, closure and post-closure to determine whether effluent discharge from the WTPs is having measurable effects on VECs such as benthic macro-invertebrate populations (Tier 3, Technical Appendix 5M).

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[13] EN-CH OH Nov 2010: *Does a decommissioned lake have fish habitat?*

Under MMER, AREVA is also required to conduct an Environmental Effects Monitoring (EEM) program to determine if effluent release is having an effect on the receiving environment. These regulations require monitoring of effluent chemistry, effluent toxicity and water quality in the receiving environment. Biological monitoring of benthic invertebrate communities from areas exposed and unexposed to effluent is also required. These studies will be implemented according to the guidelines specified under MMER and will be designed using an adaptive approach, taking into account the special issues in northern Canada.

Some Project development activities could result in serious harm to fish as defined in the Fisheries Act. Although instream construction activities will be designed to reduce effects to fish and fish habitat, it is expected that these activities will result in a permanent loss or alteration of fish habitat. In order to address the concerns relating to fish habitat and serious harm to fish, a conceptual Fisheries Offsetting Plan (Tier 3, Technical Appendix 5L) has been developed. Following approval of the plan, and subsequent implementation of any offsetting works proposed therein, any residual effects from the Project on fisheries productivity will be fully offset.

Scope of the Assessment for Fish Populations

Existing Environment – Fish Populations

Information on fish distribution was based on historical records, IQ interviews, engagement data, and baseline surveys completed for the Kiggavik Project. Traditional and current fishing areas were identified during interviews and focus group discussions; this information was provided on both maps (in Tier 2, Volume 3, Part 2) and through recorded comments (e.g., EN-BL CLC 2007[14], IQ-BLE 2009[15]. IQ-RBH 2011[16], IQ- BL17 2008[17]).

Results of the fish surveys indicate that the fish community assemblages of Project area lakes and streams are typical of those described for the subarctic region. Arctic grayling (*Thymallus arcticus*) were the most widely distributed species in lakes and streams in the LAA, followed by lake trout (*Salvelinus namaycush*).

The following seven fish species are commonly encountered within the LAA: Arctic grayling, burbot (*Lota lota*), cisco (*Coregonus artedi*), lake trout, ninespine stickleback (*Pungitius pungitius*), round whitefish (*Prosopium cylindraceum*) and slimy sculpin (*Cottus cognatus*). These species were also present in Baker Lake, along with four additional species: Arctic char (*Salvelinus alpinus*), fourhorn sculpin (*Myoxocephalus quadricornis*), lake whitefish (*Coregonus clupeaformis*) and longnose sucker

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[14] EN-BL CLC 2007: *Someone said that at the Sissons Lake the fish meats are now way too soft when you even just pull them out.*
[15] IQ-BLE 2009: *Most Elders in Baker Lake focus groups noted that in the past, caribou and fish were the major source food*
[16] IQ-RBH 2011: *Char and lake trout are fished with nets in the summer.*
[17] IQ- BL17 2008: *Hagliq [area south of Baker Lake] is an important fishing area*

(*Catostomus catostomus*). Details on fish distribution in lakes and streams are provided Tier 3, Technical Appendix 5C.

The freshwater form of fourhorn sculpin is the only fish species within the Project area that is listed under the federal *Species at Risk Act* (SARA) and by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This form of fourhorn sculpin is listed as a species of Special Concern under Schedule 3 of SARA, and as a “Data Deficient” species by COSEWIC (COSEWIC 2003).

Environmental Effects Assessment for Fish Populations

Key issues identified for fish populations during stakeholder engagement are the possibility for effects from blasting in or near water and the potential for COPCs to effect fish health (EN-CI KIA 2010[18], EN-KIV OH 2009[19], EN-CH OH 2012[20]). The potential effects of fish consumption on people are outlined in the human health assessment (Tier 2, Volume 8).

Blasting activities have the potential to alter fish behavior or result in injury or mortality of fish, eggs, and larvae. Fisheries and Oceans Canada’s guidelines state that the instantaneous pressure change (IPC) produced by blasting cannot be greater than 50 kiloPascals (kPa) to provide adequate protection for fish populations. Therefore, appropriate setback distances must be used to comply with the 50 kPa guideline. Modelling for the Andrew Lake Pit construction indicated that blasting activities occurring in portions of the pit located near the bermed edge are too close to Andrew Lake to buffer the pressure change. Additional mitigation is therefore required. In addition, DFO also requires that the vibrations produced from explosions not exceed 13 millimetres per second (mm/s) peak particle velocity in a spawning bed during the period of egg incubation. Vibration modeling indicated that the Arctic grayling spawning habitat identified in the Andrew Lake outlet stream is too close to the blasting to be protected from vibration; therefore, blasting in this area will require mitigation. Potential mitigation measures available for blasting near Andrew Lake and the Andrew Lake outlet stream include the use of smaller charge sizes during the open water and/or incubation season to reduce the blasting setback distances; conducting the blasting program during the frozen water period to protect Andrew Lake fish populations; and blasting outside of the incubation period to protect Arctic grayling egg development in the Andrew Lake outlet stream.

Providing effective mitigation measures are enacted, and neither the IPC of 50 kPa, nor the vibration threshold of 13mm/s peak particle velocity are exceeded, no residual effect to fish populations is expected.

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[18] EN-CI KIA 2010: *Has the impact on lakes been considered? Will fish populations be affected?*
[19] EN-KIV OH 2009: *How will uranium affect our fish?*
[20] EN-CH OH 2012: *Are there fish in Andrew Lake?*

To calibrate and refine the ground vibration and IPC models, monitoring programs will be developed and completed on site, at locations away from fish bearing water bodies. This would provide site-tested ground vibration and IPC setback distance thresholds, prior to blasting programs commencing near fish sensitive water bodies.

Potential exposure of fish to COPCs in effluent will be mitigated by environmental control features incorporated into the design of the WTP. The design of the WTP will facilitate production of effluent that is within appropriate water quality criteria and guidelines (Tier 3, Technical Appendix 2I). Operational measures and other mitigation measures have also been incorporated into the Project plans to minimize Project-associated emissions.

The generic water quality guideline for selenium may be exceeded in the shallowest segments of Judge Sissons Lake during the winter season. Due to winter ice cover, concentrations of COPCs are predicted to increase due to a reduced volume of free-flowing water. Because it is recognized that selenium has the ability to bioaccumulate through aquatic food webs, an assessment of the change to fish tissue concentration was undertaken. It is expected that there would be no measureable change to selenium in fish tissue concentrations.

Fish populations will be monitored throughout the life of the Project to determine whether effluent discharge from the WTPs is having measurable effects on fish health. Under the MMER, AREVA is required to conduct an EEM program to determine if effluent release is having an effect on the receiving environment. The objective of EEM is to evaluate the effects of effluents on fish, fish habitat and the use of fisheries resources by humans. These regulations require monitoring of effluent chemistry, effluent toxicity, and water quality in the receiving environment. Biological monitoring of fish health and bottom dwelling invertebrate communities is also required (Tier 3, Technical Appendix 5M). Effects on the use of fisheries resources are assessed by comparing COPC concentrations in fish tissue against fish health and consumption guidelines. The design of the aquatic receiving environment programs at the Kiggavik and Sissons Mines will be compliant with EEM guidelines while taking into account the special issues in northern Canada.

Summary

Feedback from IQ interviews and engagement activities revealed that stakeholders value the aquatic environment and are concerned about protecting aquatic VECs. Interaction of the Kiggavik Project with the aquatic environment is expected to occur. However, the potential effects on aquatic VECs are minimized through adherence to federal and territorial acts and regulations, careful facility design, and implementation of effective mitigation. In the aquatic effects assessment, it was determined that the Project will not have significantly adverse effects on hydrogeology, hydrology, water quality, sediment quality, aquatic organisms, fish habitat, and fish populations.

Comprehensive monitoring during construction, operation, and decommissioning will be conducted to confirm that Project design features, mitigation measures, and environmental protection measures are being effectively implemented. Monitoring results will be compared to predictions and an adaptive management approach will be used to ensure that predicted environmental performance is achieved. Monitoring program results will be communicated to community members for continued discussion and feedback as part of the Community Involvement Plan (Tier 3, Technical Appendix 3C).

ᓇᐃᓈᖅᓯᒪᔪᖅ ᑎᑎᕋᖅ 5−ᒧᑦ

ᒪᓕᒃᑕᐅᓯᕆᐊᓕᒃᑎᒍᑦ ᓴᖅᑭᑕᐅᔪᑦ ᓄᓇᕗᒻᒥ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᕿᒥᕐᕈᔨᓄᑦ (NIRB 2011), ᐊᕼᕚᒃᑯᑦ ᑲᓇᑕᒥᑦ (AREVA) ᐋᕿᒃᓱᐃᓚᐅᖅᑐᑦ ᑖᑉᓱᒥᙵᑦ ᑎᑎᖅᑲᒥᒃ ᐊᕙᑎᒥᒃ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᑎᑎᖅᑲᒥᑦ (EIS) ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᕙᑎᒥᒃ ᖃᓄᐃᙵᓕᖅᑎᑦᑎᓂᐅᔪᓐᓇᖅᑐᓂᒃ ᑭᒡᒐᕝᒃ ᐱᓕᕆᐊᒧᑦ (ᐱᓕᕆᐊᖅ) ᐃᒪᕐᒥᐅᑕᐃᑦ ᐊᕙᑎᖕᒐᓄᑦ. ᑎᑎᖅᑲᖅ 5 ᑕᐅᑐᒐᖃᖅᑐᖅ ᐊᕙᑎᒥᒃ ᖃᓄᐃᙵᓕᖅᑎᑦᑎᓂᐅᔪᓐᓇᖅᑐᓂᒃ ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᒪᔪᓄᑦ ᐃᒪᐃᑦ ᖃᖠᓂᑦ, ᐃᒪᐅᑉ ᐱᖅᑯᓯᖏᑦ ᖄᖓᓂᑦ ᐊᒪᓗ ᐊᓗᐊᓃᑐᑦ, ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓ, ᐃᒪᐅᑉ ᐊᓗᐊᓃᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖓ, ᐆᒪᔪᕋᓛᑦ, ᐃᖃᓗᐃᑦ ᐃᓂᖏᑦ, ᐊᒪᓗ ᐃᖃᓗᐃᑦ ᖃᑉᓯᐅᓂᖏᑦ.

ᑕᐅᑐᒃᑯᒍ ᖃᐅᔨᓴᐃᓂᖅ ᐃᒪᕐᒥᐅᑕᕐᓂᑦ

NIRB-ᑯᑦ ᓴᖅᑭᑎᓚᐅᖅᑐᑦ ᓇᓃᓂᕆᔭᖓᓂᒃ ᖃᐅᔨᓴᐃᓂᖅ ᐱᓕᕆᐊᒧᑦ ᐊᑐᖅᑯᕕᑦ ᐅᖃᐅᓯᐅᔪᑦ ᐃᓄᖕᓄᑦ, ᒐᕙᒪᒃᑯᓐᓄᑦ ᐊᒪᓗ ᐊᓯᖏᓐᓄᑦ ᐱᖃᖃᑕᐅᔪᓄᑦ. ᐃᒪᕐᒥᐅᑕᓂᒃ ᐱᔾᔪᑎᖃᖅᑐᑦ ᐃᓕᑕᕆᔭᐅᔪᑦ ᐅᖃᖃᑎᖃᑦᑕᐅᑎᓂᒃᑯᑦ ᐱᓕᕆᖃᑎᖃᕐᓂᐅᔪᓕᓗ ᐱᐊᓂᒃᑕᐅᓚᐅᖅᑐᖅ ᐊᕼᕚᒃᑯᓐᓄᑦ ᑲᑎᑕᐅᓚᐅᖅᑐᑦ ᖃᓄᐃᙵᓕᕈᑕᐅᔪᓐᓇᖅᑐᓄᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ.

ᐃᓄᐃᑦ ᐱᖃᖃᑕᐅᔪᑦ ᐅᔾᔨᕈᓯᓕᕐᓂᖃᑦᑎᐊᓚᐅᖅᑐᑦ ᐱᓕᕆᐊᒧᑦ ᐊᒃᑑᑎᖃᑦᑕᕐᓂᐅᔪᓐᓇᖅᑐᓂᒃ ᐃᒪᕐᒥᐅᑕᓄᑦ. ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦᑎᒍᑦ (IQ) ᐊᐱᖅᓱᐃᓂᖅ ᐃᓚᐅᖃᑕᐅᓂᒃᑯᓪᓗ, ᐊᕼᕚᒃᑯᑦ ᐃᓕᑦᑎᓚᐅᖅᑐᑦ ᐱᒻᒪᕆᒋᔭᐅᓂᖏᓐᓄᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᑭᕙᓪᓕᕐᒥᐅᓄᑦ. ᐃᓚᐅᔪᑦ ᐱᒻᒪᕆᐅᓂᖏᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᐱᔭᐅᖃᑦᑕᖅᑐᑦ ᐃᓄᐃᑦ ᐃᓅᓯᖏᓐᓄᑦ (IQ-RB01 2009[21], IQ-BL06 2008[22]), ᐃᓱᒪᓘᑏᑦ ᐊᒪᓗ ᐊᐱᖅᑯᑕᐅᔪᑦ ᐱᐅᖏᑦᑐᓂᒃ ᑎᑭᑕᐅᑐᐃᓐᓇᕆᐊᖃᕐᓂᖏᓐᓄᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ (EN-BL HTO ᒦᑦᓯ 2009[23], EN-BL HS ᓄᕝᐱᕆ 2010[24]), ᐊᒪᓗ ᐱᒻᒪᕆᐅᓂᖅ ᒥᐊᓂᖅᓯᓂᕐᒧᑦ (EN-BL OH ᓄᕝᐱᕆ 2010[25], EN-BL OH ᓄᕝᐱᕆ 2013[26], EN-AR NIRB ᒪᐃ 2010[27]).

ᐱᒻᒪᕆᐅᔪᑦ ᓄᓇᒥᑦ ᐆᒪᓂᕐᒧᑦ ᐃᓚᑭᔭᐅᔪᑦ (VECs) ᐊᖏᕔᔪᑦ ᐆᒪᓂᐅᔪᒧᑦ ᐃᓚᑭᔭᐅᔪᓄᑦ ᐊᕙᑎᒧᑦ, ᐊᒃᑐᖅᑕᐅᓯᒪᓕᖅᐸᑕ ᑭᒡᒐᕝᒃ ᐱᓕᕆᐊᒧᑦ, ᐃᓱᒫᓗᙱᖅᑰᓇᔭᖅᑐᖅ ᒪᓕᒐᖅᑎᑦᑎᔪᓄᑦ, ᐃᓄᖕᓄᑦ, ᓄᓇᓕᖕᒥᐅᓄᑦ ᐊᒪᓗ ᐊᑐᖅᐸᒃᑐᓄᑦ, ᐊᒪᓗ/ᐅᕙᓘᓃᑦ ᖃᓄᐃᑐᑐᐃᓇᓄᑦ ᐃᓄᖕᓄᑦ. ᐃᒪᕐᒥᐅᑕᓄᑦ VECs ᐃᓕᑕᕆᔭᐅᔪᑦ ᑖᑉᓱᒧᙵᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐅᑯᐊᖑᔪᑦ: ᐃᒪᖅ, ᐃᒪᐅᑉ ᖄᖓ, ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓ, ᐃᒪᐅᑉ ᐃᓗᐊᓃᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖓ, ᐃᒪᕐᒥᑦ ᐆᒪᔪᕋᓛᑦ ᐊᒪᓗ ᐃᖃᓗᐃᑦ ᐃᓂᖏᑦ, ᖃᓄᐃᑐᑐᐃᓐᓇᐃᓪᓗ ᐃᖃᓗᐃᑦ.

ᑎᑭᐅᑎᖃᑦᑕᕐᓂᐅᔪᑦ ᐱᓕᕆᐊᒥᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ VECs-ᖏᓐᓄᑦ ᑕᐃᒪᐅᖃᑦᑐᐃᓐᓇᕆᐊᖃᖅᑐᑦ ᐊᔾᔨᖏᑦᑐᒃᑯᑦ ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓄᑦ ᐅᕙᓘᓃᑦ ᐃᓄᐃᑦ ᐱᓕᕆᓂᖃᖅᑎᓪᓗᒋᑦ. ᑎᑭᐅᑎᔾᔪᑎᓂᐅᖃᑦᑕᓗᐊᖅᑐᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ

[21] IQ-RB01 2009: ᐃᓄᐃᑦ ᓯᑯᑕᖃᖅᑕᖅᑐᑦ ᑰᖏᑦ ᐃᒥᒃᓴᓇᐸᓗᒍ. ᐊᒥᓱᑦ ᐃᓄᐃᑦ ᐃᓪᓗᕐᔪᐊᕐᒥᑦ ᑯᕝᔪᒥᑦ ᐃᒥᖃᑦᑕᙱᑦᑐᑦ.
[22] IQ-BL06 2008: ᐊᑕᐅᓯᖅ ᐃᓐᓇᓇᔭᐅᔪᖅ ᓂᕆᔭᑐᐊᕆᔭᕐᓗᑦ ᐃᖃᓗᐃᑦ, ᑐᒃᑐᐃᑦ ᐊᔪᕐᓇᖅᓯᓚᐅᕐᓂᖏᓐᓄᑦ ᖃᒪᓂᑦᑐᐊᕐᒧᑦ ᓅᒪᑕ.
[23] EN-BL HTO ᒦᑦᓯ 2009: ᐊᒃᑕᑯᐃᑦ ᐃᒋᑕᐅᔪᓕ ᐃᒪᕐᓄᐊᖅᐸᑕ ᐅᔭᕆᖕᓂᐊᕐᓂᐅᑉ ᖃᓂᑕᙵᓃᑐᓄᑦ?
[24] EN-BL HS ᓄᕝᐱᕆ 2010: ᓱᓂᐊᖅᐸ ᓱᕈᓯᐃᑐᖅ ᐃᒪᕐᒧᐊᖅᐸᑦ?
[25] EN-BL OH ᓄᕝᐱᕆ 2010: ᐱᓕᕆᐊᖑᓗᒃᑖᕐᓂᐊᖅᐸᑦ ᐃᒪᐃᑦ?
[26] EN-BL OH ᓄᕝᐱᕆ 2013: ᐃᖃᓗᒃᑕᖅᐸᑦ ᑕᓲᑦ? ᐅᓗᕆᐊᓇᖅᑐᒦᖏᓛᑦ?
[27] EN-AR NIRB ᒪᐃ 2010: ᑕᑯᔪᒪᔪᖓ ᐃᒪᕐᒥᐅᑕᐃᑦ ᑕᓯᕐᓂᑦ ᐊᒪᓗ ᑰᖏᑦ ᖃᐅᔨᔭᐅᒋᐊᖃᖅᐸᑕ.

VECs-ᖏᓐᓄᑦ ᐊᒃᑐᐊᓂᖃᕐᑐᑦ ᐅᑯᓄᙵ: ᐃᒪᕐᒥᒃ ᐲᕐᓯᖃᑦᑕᕐᓂᕐ, ᑐᕐᑯᕐᑕᐅᓂᖓ ᑯᕕᑎᑕᐅᓂᖓᓄ; ᐊᓯᐊᖑᕐᑎᓇᓂᕐ ᑰᖕᓂᐅᔪᓂᒃ ᐊᒻᒪ ᓴᓇᔭᐅᓂᖏᑦ ᓴᖑᑎᑦᑎᓂᕐᒧᑦ ᓱᐸᓗᐃᑦ; ᐃᒪᐃᔭᐃᓂᕐ Andrew Lake Pit-ᒥᑦ; ᖄᕐᑎᓇᓂᕐ ᐃᒪᕐᓂᑦ ᐊᒻᒪ ᐃᒪᐃᑦ ᖃᓂᑕᖏᓐᓂᒃ; ᓴᐸᑯᐃᔭᐅᓂᖏᑦ ᐱᓕᕆᐊᖑᓯᒪᔪᑦ ᕐᑯᕝᕙᖕᒥᙲᕐᑐᕋᓗᐃᑦ; ᐊᒻᒪ ᐳᔪᖃᑖᓕᐅᕐᓂᕐ.

ᑭᒻᒪᕝ ᐱᓕᕆᐊᕐ ᖃᐸᐊᕐᔪᖕᓂᒃ ᐱᔭᕌᐅᑎᖃᕐᑐᑦ ᑲᓇᑕᐅᐸ ᐊᒻᒪ ᓄᓇᕘᑦ ᒐᕙᒪᒃᑯᖏᑦᑕ ᐊᕕᒃᑐᕐᓯᒪᔪᕐᑯᑎᖏᓐᓄᑦ, ᐃᓄᐃᑦ ᑲᑐᔾᔨᖃᑎᒌᖏᓐᓄᑦ ᐊᒻᒪ ᐃᓄᖕᓄᑦ ᑐᕌᖓᔪᑦ ᒐᕙᒪᒃᑰᓕᖓᔪᑦ ᐱᔾᔪᑎᖃᕐᓗᑎᒃ ᐃᒪᕐᒥᐅᑕᓂᒃ. ᑲᓇᑕᒧᑦ ᐱᓕᕆᔾᔪᔾᔨᐅᔪᑦ ᐃᒪᓕᕆᓂᖃᕐᑐᑦ ᐃᓚᐅᔪᑦ ᐃᒪᕐᒥᐅᑕᓕᕆᔨᑦ ᑲᓇᑕᒥᑦ (DFO), ᐊᕙᑎᓕᕆᔨᒃᑯᑦ ᑲᓇᑕᒥᑦ, ᓄᓇᒥᙱᕐᑐᓕᕆᔨᑦ ᑲᓇᑕᒥᑦ, ᐋᓂᐊᖃᕐᑕᐃᓕᒪᔪᓕᕆᔩᑦ, ᐊᒻᒪ ᓄᓇᖃᖄᕐᑐᓕᕆᔩᑦ ᑲᓇᑕᒥᑦ. ᐃᒪᐃᑦ ᓄᓇᕗᒻᒥᑦ ᐊᐅᓚᑕᐅᔪᑦ ᓄᓇᕗᑦ *ᓄᓇᕗᒻᒥ ᐃᒪᐃᑦ ᐊᒻᒪ ᓄᓇᕗᑦ ᐱᔪᓐᓇᐅᑎᖓᑦ ᐱᖁᔭᖓᑦ*. ᐱᓕᕆᐊᕐ ᒪᓕᒋᐊᖃᕐᑐᕐ ᐃᒪᕐᒥᐅᑕᓕᕆᔨᒃᑯᑦ ᒥᐊᓂᕐᓯᓂᕐᒧᑦ ᒪᓕᒐᖓᓐᓂᒃ ᐊᓯᖏᓐᓂᓪᓗ ᐊᐅᓚᑦᑎᓂᐅᔪᑦ ᕐᑯᕝᕙᖕᒥᙲᕐᑐᕋᓗᖕᓂᑦ ᓴᐸᑯᐃᓂᕐᒧᑦ, ᐃᖃᓗᐃᑦ ᐃᖏᕐᕋᔾᔨᕙᖏᑦ, ᐃᒪᐃᔭᐃᓂᕐ ᐊᓯᐊᒎᓕᕐᑎᑦᑎᓃᑦ. ᓴᕙᖑᒧᑦ ᐅᔭᕋᖕᓂᐊᕐᑎᐅᐸᓗᓂ, ᐱᓕᕆᐊᕐ ᑐᓂᓯᔭᕆᐊᖃᕐᑎᑕᐅᖕᒥᔪᕐ ᓴᕙᖕᓂᒃ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒧᑦ ᕐᑯᕝᕙᖕᒥᙲᕐᑐᕋᓗᖕᓄᑦ ᒪᓕᒐᓂᒃ (MMER). ᑕᒪᒃᑯᐊ ᒪᓕᒐᐃᑦ ᑎᑎᕋᖃᕐᑐᑦ ᑯᕕᓯᓂᕐᒧᑦ ᑭᒡᓕᒋᔭᐅᔪᓂᒃ ᐅᓄᓇᐊᓇᕐᑐᓂᒃ ᐊᒻᒪ ᖃᐅᔨᒋᐊᕐᑕᐅᓂᖃᖃᑦᑕᓇᐊᖃᕐᕆᑎᒃ ᕐᑯᕝᕙᕋᓗᖕᓂᙲᕐᑐᑦ ᐃᓗᐊᓂᙲᕐᑐᑦ, ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᑲᔾᔪᖓ, ᐊᒻᒪ ᐋᓐᓂᐊᖃᕐᑕᐃᓕᒪᓂᖏᑦ ᐃᒪᕐᒥᑦ ᐆᒻᒪᔪᕋᓛᑦ.

ᖃᐅᔨᓴᐃᓂᕐ ᖃᓄᐃᙶᓕᕈᑎᓄᑦ ᐃᒪᕐᒥᐅᑕᓄᑦ ᐃᓂᖃᕐᑎᑕᐅᔪᕐ ᐱᖓᓱᐃᓄᑦ ᖃᐅᔨᓴᐃᓂᕐᓄᑦ: ᐱᓕᕆᐊᕐ ᐃᓂᒋᔭᖓᓂᑦ, ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ (LAA), ᐊᒻᒪ ᐅᖓᓯᒃᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ (RAA). ᐱᔾᔪᑎᒋᐸᓗᒍ ᖃᐅᔨᓴᐃᓂᕐ, ᐱᓕᕆᐊᐸ ᐃᓂᒋᔭᖓᐅᔪᕐ ᑭᒻᒪᕝ ᐊᒻᒪ Sissons ᐅᔭᕋᖕᓂᐊᕐᕕᒃ, ᐊᒻᒪ ᓱᓇᑐᐃᓐᓇᐃᑦ ᐊᒃᑐᐊᔪᑦ ᐱᓕᕆᐊᐸ ᐱᕐᑯᑎᖏᓐᓄᑦ (ᓲᕐᓗ, ᑯᕕᔪᓄᑦ ᐊᐸᕐᑯᑎᒋᔭᐅᔪᑦ, ᐊᐸᕐᑯᑏᑦ, ᐃᒪᕐᑖᕆᔭᐅᕙᓪᓕᐊᔪᕐ ᐊᒻᒪ ᐱᓕᕆᐊᖑᔪᑦ ᐃᒪᐃᑦ ᑯᕕᑦᑎᓂᕐᒧᑦ ᐊᑐᕐᑐᑦ, ᐊᒻᒪ ᒦᕝ). ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐ ᐱᓕᕆᐊᒧᑦ ᒪᕐᕉᖕᓄᑦ ᐊᕕᒃᓯᒪᔪᕐ: ᐱᖃᑖᓂᑦ ᐃᓚᐅᔪᑦ ᑕᓱᑦ ᐊᒻᒪ ᑰᒃᑐᑦ ᐊᒃᑐᕐᑕᐅᓯᒪᓂᖃᑐᐃᓐᓇᓇᐊᖃᕐᑐᑦ ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓄᑦ ᐱᕐᑯᑎᓄᓪᓘᓃᑦ, ᐊᒻᒪ ᐱᖃᑖᓂᑦ ᐃᓚᐅᔪᑦ ᐃᒪᐃᑦ ᐊᒃᑐᕐᑕᐅᓯᒪᓂᖃᑐᐃᓐᓇᓇᐊᖃᕐᑐᑦ ᐅᑭᐅᑯᑦ ᐊᐸᕐᑯᓯᐅᕐᑕᐅᔪᒪᔪᒧᑦ ᐊᒻᒪ ᐅᑭᐅᓗᒃᑖᕐ ᐊᑐᕐᑕᐅᓇᔭᕐᑐᕐ ᐊᐸᕐᑯᓯᐅᕐᑕᐅᔪᒪᔪᒧᑦ. ᓂᕆᐅᒋᔭᐅᔪᕐ ᐱᓕᕆᐊᒥᒃ ᖃᓄᐃᖓᓕᕈᑕᐅᔪᑦ ᑖᐸᑯᓇᙶᕋᔭᕐᑐᑦ ᐊᒻᒪ ᐆᒃᑐᕋᕐᑕᐅᔪᖕᓇᕐᓗᑎᒃ ᑖᐸᑯᓇᓂ ᑭᒡᓕᐅᔪᓂᑦ. ᐅᖓᓯᒃᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐ ᐃᒪᕐᒥᐅᑕᓄᒃᑖᖃᔭᐃᑦ VECs-ᖏᓐᓄᑦ ᐊᒃᑐᐊᓂᖃᕐᑐᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᖃᓄᐃᙶᓕᕈᑕᐅᔪᓄᒃᑖᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐃᒪᕐᓃᓪᓚᑕ.

ᑭᒡᓕᒋᔭᐅᔪᑦ ᐃᒪᕐᒥᐅᑕᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᑐᕐᓗᓂ ᖃᖓᒃᑯᑦ ᐊᒻᒪ ᖃᓄᕐ ᐊᑯᓂᐅᑎᒋᓂᕐᒥᒃ ᖃᓇᐃᙶᓕᕈᑕᐅᔪᓂᒃ ᓈᓐᓂᑲᔪᒃᑖᖓᓂᑦ ᐱᓕᕆᐊᐸ, ᐃᓚᐅᐸᓗᓂ ᓴᓇᔭᐅᓂᖓ, ᐊᐅᓛᕐᓂᖓ, ᕿᖑᓕᕐᕚᒃᑯᑦ ᐅᒃᑯᐊᕐᑕᐅᓂᖓ ᐊᒻᒪ ᐅᒃᑯᐊᕌᓂᒃᓯᒪᓕᕐᑎᓪᓗᒍ. ᑲᑎᒍᒥᑦ ᐱᓕᕆᐊᐸ ᐊᐅᓛᕐᓂᖓ ᓂᕆᐅᒋᔭᐅᔪᕐ 25-ᓄᑦ ᐅᑭᐅᓅᓂᐊᕐᓂᖓᓂᒃ, ᐅᒃᑯᐊᕌᓂᒃᑎᓪᓗᒍ ᖃᓄᐃᓕᐅᕐᓂᕋᓗᐃᑦ ᐅᖓᑕᐅᑎᓗᑎᒃ ᕿᖑᓕᕐᕚᒃᑯᑦ ᐅᒃᑯᐊᕐᑎᓪᓗᒍᒧᑦ.

ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᕙᑎᒧᑦ ᖃᓄᐃᙶᓕᕈᑎ ᐱᓕᕆᐊᒥᑦ ᐃᓯᒪᒋᔭᐅᔪᕐ ᐊᖏᔫᓂᖓᓂᒃ ᐊᒃᑐᕐᓯᓇᔭᕐᐸᑦ ᐊᑯᓂᐅᔪᒥᒃ ᐱᒻᒪᕆᐅᔪᑦ ᓄᓇᒥᑦ ᐆᒪᓂᕐᒧᑦ ᐃᓚᒋᔭᐅᔪᑦ (VEC)-ᒧᑦ. ᖃᐅᔨᔭᐅᔪᕐ ᐊᖏᓂᑲᔫᖓᓄᑦ ᐊᑐᕐᓱᒋᑦ ᐊᑐᕐᑕᐅᕙᒃᑐᑦ ᓈᓴᐅᑏᓪᓗᓃᑦ ᐃᓚᑕᑲᔭᐅᔪᑦ ᐊᑐᓂ (VEC)-ᓄᑦ; ᖃᐅᔨᒪᔪᒧᑦ ᐊᒻᒪ ᐱᓕᕆᓂᑯᖃᕐᑐᒧᑦ ᐊᔾᔨᖏᓐᓂᒃ ᐱᓕᕆᐊᓂᒃ ᐊᑐᕐᑕᐅᑐᐃᓐᓇᓇᐊᖃᕐᑐᑦ ᖃᐅᔨᓂᒧᑦ ᐊᖏᓂᐅᔪᒥᒃ ᐱᔭᐅᔪᖕᓇᙱᑉᐸᑕ ᐊᑐᕐᑕᐅᔪᑦ ᐊᒻᒪ ᓈᓴᐅᑏᑦ. ᐊᓯᐊᖑᕐᓂᕐ ᐱᒻᒪᕆᐅᔪᑦ ᓄᓇᒥᑦ ᐆᒪᓂᕐᒧᑦ ᐃᓚᒋᔭᐅᔪᑦ (VEC)-ᒧᑦ ᐱᓕᕆᐊᕐ ᐱᔾᔪᑎᒋᐸᓗᒍ ᑎᑭᕐᑲᐅᒪᔭᖏᓐᓄᑦ ᑖᐸᓯᒧᙵ (VEC)-ᒧᑦ, ᐅᕙᔫᓂᑦ ᐊᓯᐊᖑᕐᓂᕐ ᐊᒃᑐᕐᓯᓂᖃᙱᑉᐸᑦ ᐃᓗᐃᑑᑦᑎᐊᕐᓂᖓᓂᒃ (VEC) ᐆᒃᑐᕋᕐᑕᐅᔪᖕᓇᕐᓂᒃᑯᑦ, ᖃᓄᐃᙶᓕᕐᓂᕐ ᐃᓯᒪᒋᔭᐅᔪᕐ ᐊᖏᓗᐊᔾᔮᖏᓐᓂᖓᓄᑦ.

ᑕᐅᑦᑐᒍ ᖃᐅᔨᓴᐃᓂᖅ ᐃᒪᕐᒥᒃ

ᒫᓐᓇᐅᔪᖅ ᐊᕙᑎ - ᐃᒪᖅ

ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖓ ᑲᔪᓯᔪᒥᒃ ᓄᓇᐅᑉ ᐊᑖᓂᑦ ᐊᐅᓱᐃᑐᒥᑦ ᖁᐊᖑᐃᓐᓇᐅᔭᕐᓂᖅᑐᒦᑐᖅ. ᖁᐊᖑᙳᕆᑎᓪᓗᒍ ᒪᓂᕌᖅ (ᓲᕐᓗ 'ᓯᑯᓯᒪᙱᑦᑐᖅ') ᑕᐃᒪᙳᕈᓐᓇᖅᑐᑦ ᐃᑎᔪᓂᑦ ᑕᓲᑦ ᐊᑖᓂᑦ ᖁᐊᕈᑎᔪᓐᓇᙵᑦᑐᑦ ᓇᑎᐊᓄᑦ ᐅᑭᐅᑯᑦ. 2-ᒥᑦ 2.5-ᒧᑦ (m) ᒦᑕᓂᒃ ᐃᐸᔪᑎᕆᔪᒥᒃ ᓯᑯᒧᑦ ᖃᓪᓕᖅᑕᐅᓯᒪᓇᓱᕆᔭᖓᑦ ᐅᑭᐅᑯᑦ ᐱᓕᕆᐊᑉ ᐃᓂᖓᓂᑦ; ᐊᒥᓱᑦ ᑕᓲᑦ ᖁᐊᖃᑦᑕᖅᑐᑦ ᐊᑖᓄᑦᑖᖅ. ᑭᓯᐊᓂ, ᖄᓯᐊᕐᔪᐃᑦ ᑕᓲᑦ ᐱᖃᕐᒪᑕ ᒥᑭᒃᑰᖓᔪᒥᒃ ᖃᓄᑎᕆᐅᔪᒥᒃ ᐊᒪᓗ ᐃᑎᓂᕐᒥᒃ ᐃᑲᔪᐃᔪᒥᒃ ᐅᒃᑯᐃᖓᔪᒥᒃ ᓯᑯᓯᒪᙱᑦᑐᒥᑦ ᑎᑭᐅᑎᔪᒥᒃ ᐃᑎᔪᒥᑦ ᑯᕕᐅᔭᕐᓂᐅᔪᒧᑦ. ᓯᑯᓯᒪᙱᑦᑐᑦ ᐊᖏᓂᖅᓴᐃᑦ ᑕᓲᑦ ᐊᑖᓃᑐᑦ ᑎᑭᐅᑎᖃᑦᑕᖅᑐᑦ ᐃᑎᔪᓄᑦ ᐃᒪᐃᑦ ᖃᓄᐃᓕᐅᖃᑎᒌᙶᓂᓇᔭᕆᓐᓄᑦ.

ᐃᑎᔪᒥᑦ ᐃᒪᐃᑦ ᑯᕕᔪᑦ ᖁᑦᑎᒃᓯᓯᒪᔪᒥᑦ ᐊᑦᑎᒃᑐᒧᙱᓚᐅᔪᑦ. ᐃᒪᖅ ᐃᓂᒋᔭᐅᓗᐊᖅᑐᒥᑦ, ᕿᑎᐊᓂᑦ ᐊᒪᓗ ᑲᓇᙵᙱᓚᓂᑦ ᑰᒃᑐᑦ ᓂᕆᕐᒧᑦ; Andrew Lake ᐊᒪᓗ End Grid ᖃᓂᑕᙱᓚᓂᑦ ᑯᕕᔪᑦ, ᐃᒪᖅ ᑰᓚᔾᔭᒃᑐᖅ ᓂᕆᖅᐸᓯᙵᒧᑦ ᑲᓇᙵᖅᐸᓯᙵᒧᑦ. ᒥᑭᑦᑐᑦ ᑲᑎᕆᓯᑦ ᓄᖑᑎᖅᑐᑦ ᓯᑎᔪᑦ (TDS) ᓂᕈᐅᕆᔭᐅᔪᑦ ᐊᔾᔨᕆᓂᐊᕐᓂᙱᓄᑦ ᐃᑎᔪᒥᑦ ᐃᒪᐅᑉ (Canadian Shield)-ᒥᑦ (Frape ᐊᒪᓗ Fritz 1987).

ᐃᒪᖅ ᓇᑭᙳᕐᓂᙱ ᑕᒪᐃᓄᑦ ᐃᖏᕐᕋᓂᖅᖅᑐᒥᑦ ᐊᒪᓗ ᐃᑎᔪᒥᑦ ᐃᒪᕐᒥᑦ ᐊᐅᓱᐃᑑᑉ ᐊᑖᓂᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᙱᑦᑐᑦ ᒫᓐᓇᐅᔪᖅ ᐃᒥᖅᑕᐅᓂᐊᕐᓗᑎᒃ. ᐃᓱᒪᒋᔭᐅᙱᔪᖅ ᐊᑐᖅᑕᐅᔾᔭᕆᓐᓂᙱᓄᑦ ᐃᒪᖅ ᐃᒥᖅᑕᐅᓂᕐᒧᑦ ᓯᕗᓂᑉᑎᙵᑦ.

ᐊᕙᑎᒥᒃ ᖃᓄᐃᙱᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐃᒪᕐᒥᒃ

ᖃᓄᐃᙱᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐃᒪᕐᒧᑦ ᐃᓚᐅᔪᑦ ᒪᕐᕌᒃ ᐆᒃᑐᕋᖅᑕᐅᔪᙵᖅᑑᒃ. ᓯᕗᓪᓕᖅ ᖁᑦᑎᖕᓂᕆᔭᕆᑦ ᑕᓲᑦ ᐋᑐᖅᑕᐅᓯᒪᑐᐃᓐᓇᕆᐊᖃᖅᑐᑦ ᐃᒪᐃᔭᐃᓂᕐᒧᑦ ᐅᔭᕋᓐᓂᐊᕐᕕᖕᒥᑦ ᑎᑭᐅᑎᔪᑦ ᐊᐅᓱᐃᑑᑉ ᐋᑖᓄᑦ. ᑕᒪᓐᓇ ᐃᓱᒪᒋᔭᐅᔪᖅ ᓇᓗᓇᐃᖁᑕᐅᓂᙱᓄᑦ ᐃᒪᐅᑉ ᖃᓄᑎᕆᐅᓂᙱᓂᒃ ᐱᔾᔪᑎᕐᑦᓗᒍ ᐃᒪᐃᔭᐃᓂᖅ ᒪᓂᕋᒥᑦ ᐅᒃᑯᐃᖓᔪᓂᒃ ᐅᔭᕋᖕᓂᐊᕐᓂᐅᔪᑦ ᑲᑎᑎᑦᑎᓚᔪᙵᒪᑕ ᐃᒪᐃᑦ ᖃᓄᑎᕆᐅᓂᖏᓐᓂᒃ ᐅᔭᕋᖕᓂᐊᕐᕖᑦ ᖃᓂᑕᙱᓂᑦ. ᑕᒪᓐᓇ ᐊᒃᑐᖅᓯᓂᖃᐃᓐᓇᕆᐊᖃᖅᑐᖅ ᑕᓲᑦ ᖃᓄᑎᕆᐅᓂᖕᒋᓐᓂᒃ ᐱᓕᕆᐊᑉ ᐃᓂᕆᔭᖓᓂᑦ. ᑐᒡᓕᖓ ᓇᓗᓇᐃᖁᑕᐅᔪᖅ ᖃᓄᐃᓐᓂᕈᔭᖓᓂᒃ ᐃᒪᐃᑦ ᑎᑭᑕᐅᔪᑦ ᐊᒃᑐᐊᔾᔪᑎᓂᖃᕈᙵᖅᑐᑦ ᐃᑎᔪᓄᑦ ᐃᒪᐃᑦ ᖃᓄᐃᓕᐅᕈᑎᓂᖕᒋᓐᓄᑦ. ᐃᒪᖅ ᐊᑉᖁᑕᐅᔪᙵᖅᑐᖅ ᑎᑭᐅᑎᔾᔪᑎᖃᑦᑕᕐᓂᖕᒋᑦ ᓄᖑᐸᓪᓕᐊᔪᑦ ᐃᓚᒋᔭᐅᔪᑦ ᐃᒪᕐᒥᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥᙶᖅᑐᓂᒃ ᐊᒪᓗ ᐃᒪᐅᑉ ᖅᑳᖓᓂᙶᖅᑐᓂᒃ. ᐃᒪᖅ ᐊᑐᖅᑕᐅᖃᑦᑕᙱᖕᒋᓐᓂᙱᓄᑦ ᑭᒻᒪᕕᒃ ᐱᓕᕆᐊᒥᑦ, ᐃᒪᐅᑉ ᖄᖓᑕ ᖃᓄᐃᓐᓂᕈᔭᖓ ᐃᓱᒪᒋᔭᐅᔪᖅ ᐆᒃᑐᕋᖅᑕᐅᔮᕐᓴᐅᓂᙱᓂᒃ ᖃᓄᖅ ᐊᑯᓂᐅᑎᕆᔪᖅ ᖃᓄᐃᙱᓕᖅᑎᑦᑎᓂᖃᕋᔭᕐᓂᙱᓄᑦ ᐃᒪᕐᒥᐅᑕᓄᑦ ᐱᓕᕆᐊᒥᑦ .

ᖃᓄᐃᙱᓕᕈᑕᐅᔪᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥᑦ ᐃᒪᐃᔭᐃᓂᕐᒧᑦ ᐊᐅᓱᐃᑐᑦ ᐊᑖᓂᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᑲᔪᓯᓂᐊᕐᓂᙱᓂᒃ ᐅᔭᕋᖕᓂᐊᕐᓂᖅᑕᖅᑎᓪᓗᒍ, ᑭᓯᐊᓂ ᐅᑎᖅᑎᑦᑐᙱᖅᑐᑦ ᕿᑎᕈᔪᐊᓂᑦ, ᐊᒪᓗ ᓂᕈᐅᕆᔭᐅᑉᓗᓂ ᒥᑭᑦᑐᒥᒃ ᐊᒃᑐᖅᓯᓂᖃᕐᓂᐊᕐᓂᙱᓄᑦ ᓄᓇᒧᑦ ᐊᒪᓗ ᐃᓄᐃᓪᓗ-ᐱᕙᓪᓕᐊᔪᓄᓪᓗ. ᐊᑦᑎᒃᑐᖅ ᐃᖏᕐᕋᓂᖅ ᐅᔭᕋᒃᑯᑦ ᐊᒪᓗ ᐊᐅᓱᐃᑐᒃᑯᑦ ᖃᓄᐃᙱᓂᐅᔪᑦ ᒥᑭᑦᑐᒥᒃ ᐃᒪᕐᒥᒃ ᑯᕕᓂᐊᖅᑐᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᔪᒪᔪᓄᑦ. ᑕᓲᑦ ᖃᓄᑎᕆᐅᓂᖕᒋᓐᓂᒃ ᐊᓯᐊᙳᖅᑐᖃᕐᓂᐊᕐᓂᖕᒋᓐᓄᑦ ᓂᕈᐅᕆᔭᐅᖕᒋᑦᑐᖅ ᐃᒪᐃᔭᐃᓂᕐᒧᑦ. ᑕᐃᒪᓐᓇᒧᑦ ᕿᒪᒃᑎᑦᑐᓄᑦ ᖃᓄᐃᙱᓕᕈᑏᑦ ᐱᓕᕆᐊᒥᑦ ᐃᒪᐅᑉ ᖃᓄᑎᕆᐅᓂᙱᓄᑦ ᐊᖏᕚᔾᔭᖕᒋᓐᓂᙱᓄᑦ.

ᖃᐅᔨᓴᐃᓂᖅ ᐊᑯᓂᐅᔪᒥᒃ ᖃᓄᐃᙱᓕᕈᑕᐅᔪᙵᖅᑐᓂᒃ ᐃᒪᕐᒧᑦ ᐊᒪᓗ COPC-ᓄᑦ ᐃᒪᐅᑉ ᖄᙱᓄᑦ ᑭᒻᒪᕕᒃ ᐊᒪᓗ Sissons ᖃᓂᑕᙱᓂᑦ ᓇᓗᓇᐃᖅᓯᔪᑦ ᒥᑭᑦᑐᒥᒃ ᐊᓯᐊᙳᕐᓂᐅᔪᓂᒃ ᑲᑎᓯᒪᔪᓂᑦ COPC-ᓄ ᖃᓂᑦᑐᓂᒃ ᑕᓯᕐᓂᑦ; ᓂᕈᐅᕆᔭᐅᔪᑦ

ᑲᑎᓯᒪᔪᑦ ᐊᑦᑎᒃᑐᑳᓪᓚᐅᔪᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᕐᒋᓐᓄᑦ ᒪᓕᒃᑕᐅᔫᒃᓴᓂᑦ ᐅᕙᓘᓃᑦ ᖃᓄᐃᓂᖕᓴᐅᓂᕐᒋᓐᓄᑦ ᖃᐅᔨᓐᓇᖅᑐᑦ ᑭᒡᓕᐅᔪᓄᑦ ᑲᑎᓯᒪᔪᓄᑦ. ᑕᐃᒪᓐᓇᒎᑦ, ᖃᓄᐃᖕᒪᓕᕈᑕᐅᔪᕐᓇᖅᑐᑦ ᐃᒪᐃᑦ ᖄᕐᒋᓐᓄᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᑲᑎᓯᒪᔪᓄᑦ ᑎᑭᐅᑎᑉᓗᓂ (ᓲᕐᓗ, ᐊᑦᑎᒃᑐᖅ ᐊᕐᒋᓂᖕᒪ). ᐊᑐᖅᑕᐅᔪᑦ ᖃᓄᐃᖕᒪᓂᕐᒧᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᔪᑦ ᐃᒪᐅᑉ ᖄᖕᒪᓄᑦ ᐊᑦᑎᒃᑑᓂᐊᕐᓂᖕᒪᓂᒃ ᐊᕐᒋᓂᐅᔪᒥᑦ, ᒫᓐᓇᐅᔫᖅ ᐊᐅᓯᐃᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᕐᒋᑦ ᐊᒻᒪ ᐊᐅᓯᐃᑐᓄᑦ ᖃᓄᐃᖕᒪᓐᓂᐅᔫᖅᑕᖅᑭᑐᐃᓐᓇᕆᐊᖅᑲᕐᓂᖅ ᓯᓚᒥᒃ ᐊᓯᐊᕐᔪᒃᑳᓚᖕᓂᕐᒧᑦ ᐆᓐᓇᕐᓂᐅᔪᒥᑦ.

ᐱᓕᕆᐊᑉ ᖃᓄᐃᖕᒪᓂᖕᒪᓄᑦ ᐊᒻᒪ ᐊᑦᑎᒃᑐᖅ ᐃᒪᐃᑦ ᐊᐅᓚᓐᓂᕐᒋᑦ ᐅᔭᖅᑲᐃᑦ ᖃᓄᑎᒋᐅᓂᖕᒪᓂᑦ, ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᖕᒪᓕᕈᑏᑦ ᐃᒪᕐᒧᑦ ᓂᕆᐅᒋᔭᐅᕐᒋᑦᑐᑦ ᐊᕐᒋᔩᓂᐊᕐᓂᖕᒪᓄᑦ.

ᑕᐅᑐᒃᓱᒍ ᖃᐅᔨᓴᐃᓂᖅ ᐃᒪᐃᑦ ᖄᖕᒪᓃᑐᓂᒃ

ᒫᓐᓇᐅᔪᖅ ᐊᕙᑎ – ᐃᒪᐃᑦ ᖄᕐᒋᑦ

ᑰᒪᑏᑦ ᐱᓕᕆᐊᑉ ᖃᓂᑕᖕᒪᓂᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᔪᑦ ᐅᑭᐅᖅᑕᖅᑐᒥᑦ ᐃᓕᖅᑯᓯᐅᔪᒥᒃ; ᐃᒪᐅᓂᕐᒋᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᔪᑦ ᖁᑦᑎᒃᓯᕙᓪᓕᐊᓂᐅᔪᓂᒃ, ᓄᖅᑲᖅᑲᐅᑎᒃ ᔪᓂ ᕿᑎᐊᓂᑦ ᐅᐱᕐᓛᒃᑯᑦ ᐊᐅᒃᐸᓪᓕᐊᓂᕐᒧᑦ, ᑕᐃᑲᙵᓪᓗ ᒥᒃᓵᕙᓪᓕᐊᓂᖃᓕᖅᑲᐅᑎᒃ ᐊᐅᔭᐅᑎᓪᓗᒍ. ᒪᕐᑯᖃᑦᑕᕐᓂᖅ ᐊᕐᒋᒡᓕᒃᑲᓂᖅᑎᑦᑎᓚᐅᐱᓪᓚᖃᑦᑕᖅᑐᑦ ᓱᑉᐳᓂᒃ ᐊᓯᕐᒋᓐᓂᒡᓗ. ᑰᒃᑐᑦ ᓄᖅᑲᕋᔫᒃᑐᑦ ᐅᑭᐅᑯᑦ.

ᑕᓲᑦ ᐱᓕᕆᐊᑉ ᖃᓂᑕᖕᒪᓂᑦ ᓯᑯᒪᔫᒃᑐᑦ ᐅᒃᑑᐱᓇᒥᑦ ᔫᓂ-ᔫᓚᐃ, ᓯᑰᑉ ᑐᕿᓂᖕᒪ ᐊᕐᒋᖀᒃᑯᑦ 2 ᕓᑕᐅᕙᒃᓱᓂ. ᑕᓲᑦ ᖃᓄᑎᒋᐅᓂᕐᒋᑦ ᑎᑭᐅᑎᖃᖅᑕᖅᑐᑦ ᑭᒡᓕᔫᑦ ᐅᐱᕐᓛᑯᑦ ᐊᐅᒃᐸᓪᓕᐊᓂᕐᒥᑦ ᔫᓂ ᕿᑎᐊᓂᑦ ᖃᓄᑎᒋᐅᓂᕐᒋᑦ ᒥᒃᓵᕙᓪᓕᐊᓕᖅᑲᐅᑎᒃ ᑕᐃᑲᙵᑦ ᐊᐅᔭᐅᓂᖕᒪᓂᑦ.

ᐊᕙᑎᒥᒃ ᖃᓄᐃᖕᒪᓕᖅᑎᑦᑎᓃᐅᔪᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐃᒪᕐᓂᒃ

ᐱᔾᔪᑕᐅᔪᑦ ᐃᒪᐃᑦ ᖄᕐᒋᓐᓂᒃ ᐃᓕᑕᕆᔭᐅᔪᑦ ᐱᖃᖅᑕᐅᔪᑦ ᐃᓚᐅᖃᑕᐅᓂᖅᑲᖅᑎᓪᓗᒋᒥᑦ ᐃᓚᐅᔪᑦ ᐊᓯᐊᕐᔪᕐᓂᐅᔪᑦ ᑰᒪᑏᓂᑦ ᑰᒃᑐᓂᒃ, ᐊᒻᒪ ᑕᓲᑦ ᐊᕐᒋᓂᕐᒋᑦᑕ ᓇᓅᓐᓂᓇᔭᕐᒋᑦ, ᐊᒃᑐᖅᓯᓂᖃᑐᐃᓐᓇᓇᐊᖅᑐᑦ ᐊᓯᕐᒋᓐᓄᑦ ᐃᒪᖃᕐᓂᐅᔪᓄᑦ, ᓄᓇᒨᑦ ᐊᒻᒪ ᐃᓄᐃᑦ-ᐱᕙᓪᓕᐊᔪᑦ ᐊᕙᑎᕐᒋᓐᓄᑦ (EN-CI KIA ᐃᐳᓇ 2007[28], EN-BL OH ᓄᓈᐱᓇ 2010[29]). ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓂᑦ ᐃᓚᐅᔪᑦ ᐃᒪᐃᔭᐃᓅᑦ ᑕᓯᕋᔭᕐᓂᒃ ᐊᒻᒪ ᐃᒪᕐᓂᑦ ᐃᓂᒋᔭᐅᔪᒥᑦ ᐃᓂᓕᐅᓇᑎᓪᓗᕆᑦ ᓴᓇᔭᐅᑎᓪᓗᒍᓗ, ᐃᒪᐃᔭᐃᓂᖅ ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᒥᑦ Andrew Lake-ᒥᑦ, ᑕᓯᕐᓂᑦ ᐃᒪᑦᑎᐊᕙᕐᒥᑦ ᐲᔭᐃᓂᖅ, ᑲᑎᖅᓱᐃᓂᖅ ᐃᓂᒋᔭᐅᔪᒥᑦ ᐊᒻᒪ ᑲᑎᑕᐅᔪᓂᑦ ᑯᕕᔪᓂᒃ, ᐊᒻᒪ ᑯᕕᑎᑕᐅᓂᕐᒋᑦ ᐱᓕᕆᐊᕐᔪᓯᒪᔪᑦ ᖁᕝᕙᕐᓂᙱᖅᑐᕋᓗᐃᑦ.

ᐱᓕᕆᐊᑉ ᖃᓄᐃᖕᒪᓂᕆᔭᕐᒪ ᐊᒻᒪ ᐊᕐᒋᓗᐊᕐᒋᑎᑦᑎᒋᐊᕐᓂᐅᔪᑦ ᓂᕈᐊᖅᑕᐅᓚᐅᖅᑐᑦ ᐃᓚᐊᕇᑯᑦ ᒥᑭᖁᖕᒪᑎᓐᓂᕐᒧᑦ ᖃᓄᐃᖕᒪᓕᕈᑕᐅᔪᑦ ᐃᒪᕐᓄᑦ. ᓲᕐᓗ, ᐃᒪᐃᑦ ᐊᕐᒋᔪᑦ ᓂᕈᐊᖅᑕᐅᓚᐅᖅᑐᑦ ᐃᒪᐃᔭᐃᕙᐅᓂᕐᒧᑦ ᐊᒻᒪ ᖁᕝᕙᕐᓂᙱᖅᑐᕋᓗᐃᑦ ᐃᓂᕐᒋᑦ ᐊᓯᐊᕐᔪᕐᓂᐅᔪᑦ ᐃᒪᕐᓄᑦ ᒥᑭᖁᖕᒪᓂᐊᕐᒪᑕ. ᐃᓂᐅᑉ ᐃᒪᖕᒪᓄᑦ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐋᕿᐅᒪᔪᖅ ᐋᕿᒃᓯᖅᑕᐅᓚᐅᖅᑐᖅ ᐃᒪᕐᒥᒃ ᐊᑐᒃᑲᓂᖅᑕᑦᑕᕐᓂᕐᒧᑦ, ᐊᒻᒪ ᐊᔾᔨᑦᑕᕋᖕᒪᑕ, ᑭᒡᓕᖅᑎᓪᓗᒍ ᐃᒪᐃᔭᐃᓂᕐᒧᑦ ᐱᔭᐅᔭᓇᐊᖅᑐᑦ ᑯᕕᔭᐅᔪᓪᓗ ᖄᓯᐅᓂᕐᒋᑦ. ᖃᓄᐃᓕᐅᕐᓃᑦ ᐃᒪᐃᔭᐃᓂᕐᒥᒃ ᐱᔾᔪᑎᖃᖅᑐᑦ ᒪᓕᖕᓂᐊᖅᑐᑦ ᐃᒪᕐᒥᐅᑕᓕᓇᓐᑦ ᖃᓄᐃᓕᐅᕆᐊᖃᕐᓂᕆᔭᕐᒋᓐᓂᒃ ᓇᓗᓇᐃᖅᓯᔪᑦ 10% ᐅᖕᒪᑖᓂᑦ ᓯᑰᑉ ᐊᑖᓃᑐᒥᒃ ᐲᖅᓯᓂᖅ ᐊᔪᕐᓂᕐᒧᑦ ᑕᓯᕐᒥᑦ ᓯᑯᓯᒪᑎᓪᓗᕆᑦ. ᐃᒪᑦᑎᐊᕙᕐᒥᑦ ᓴᖑᑎᑦᑎᓂᕐᒧᑦ ᓱᑉᐳᐃᑦ ᓴᓇᔭᐅᓂᐊᖅᑐᑦ ᓴᓗᒪᔪᖅ ᐃᒪᖅ ᐅᔭᕋᖕᓂᐊᕐᕗᐅᑉ

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[28] EN-CI KIA ᐃᐳᓇ 2007: *ᖃᓄᖅ ᐊᒃᑎᕆᔪᒥᒃ ᐊᑐᕐᓂᐊᖅᐸᑦ? [ᐊᓃᕙᒃᑯᑦ]*

[29] EN-BL OH ᓄᓈᐱᓇ 2010: *ᐃᒪᕐᒥᒃ ᓴᖑᑎᑦᑎᓂᐊᖅᐸᑦ?*

ᖃᓂᑕᖖᒐᓄᐊᖅᑕᐅᓗᑎᒃ. ᑕᓯᐅᑉ ᓇᑎᐊᓂᖕᖔᖅᑐᓂᒃ ᐱᑕᖃᖅᑐᑦ ᑕᓯᕋᔭᐃᑦ ᑭᒡᓕᖃᖅᑎᑦᑎᓂᐊᖅᑐᑦ ᓇᑎᐊᓂᑦ ᐱᔪᓂᒃ ᐃᒪᐃᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᖕᒋᑦᑐᓂᒃ ᑰᒃᑐᓂᑦ ᑲᑎᑕᐅᔪᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ ᖃᓂᑕᖖᒐᓂᑦ. ᐱᐅᓛᒃᑯᑦ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᑦ (BMP) ᐊᑐᓕᖅᑕᐅᓂᐊᖅᑐᑦ ᓱᑉᖅᑐᓕᕆᓂᕐᒧᑦ ᐊᒻᒪ ᑕᓯᐅᑉ ᓇᑎᐊᓂᖕᖔᖅᑐᓂᒃ ᐅᓯᓂᖅ ᑕᒪᐃᓂᒃ ᐊᒃᑐᖅᑕᐅᓯᒪᔪᓂᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᓂᑦ, ᐃᓚᐅᑉᓗᑎᒃ ᐱᕐᑯᑎᒋᔭᐅᔪᑦ ᐃᓂᖏᑦ ᐊᒻᒪ ᐊᑉᕐᑯᑏᑦ, ᓴᓇᔭᐅᑎᓪᓗᒍ, ᐊᐅᓛᖅᑎᓪᓗᒍ ᐊᒻᒪ ᓄᖅᑲᖅᐸᓪᓕᐊᑎᓪᓗᒍ.

ᐊᖏᓗᐊᖏᑎᑦᑎᓇᓱᖕᓂᐅᔪᑦ ᐊᒻᒪ ᐱᓕᕆᐊᑉ ᖃᓄᐃᖕᒐᓂᖕᒐ ᓂᕆᐅᒋᔭᐅᔪᑦ ᒥᑭᓛᖕᒐᓂᐊᕐᓂᖏᓐᓄᑦ ᖃᓄᐃᖕᒐᓕᕈᑕᐅᔪᓂᒃ ᐃᒪᐅᑉ ᖄᖕᒐᓄᑦ. ᖃᓄᐃᖕᒐᓕᕈᑕᐅᔪᑦ ᑯᕕᔪᓄᑦ ᓈᓴᐅᑏᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᑭᒡᓕᒋᔭᐅᔫᑉ 3% ᐊᑖᓂᓐᓂᐊᕐᓂᖏᓐᓄᑦ ᓱᓕ. ᐊᓯᐊᖑᕐᓃᑦ ᑕᐹᑦ ᐊᖏᓂᖏᓐᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᖁᑦᑎᓛᖑᓂᐊᕐᓂᖕᒐᓄᑦ Andrew Lake-ᒥᑦ, ᓇᐃᑐᒥᒃ–ᑕᑭᓂᖅ ᐊᖏᒡᓕᒋᐊᖅᓲᓂ 24cm–ᓂᒃ ᐃᒪᐃᔭᐃᑎᓪᓗᒋᑦ Andrew Lake–ᒥᑦ. ᑭᓯᐊᓂ, Andrew Lake–ᒥᑦ ᐃᒪᐃᔭᐃᓂᖅᑕᖃᕐᓂᐊᖅᑐᖅ ᐅᐱᖕᖔᖁᑦ ᐊᐅᒃᐸᓪᓕᐊᓂᖅ ᐊᓂᖖᖅᐸᑦ ᐃᒪᐃᑦ ᐊᖏᓂᖏᑦ ᐃᖕᒥᖕᓂᒃ ᒥᒃᓵᕙᓪᓕᐊᓕᖅᐸᑕ. ᐊᖏᓂᖕᒐ ᑕᒪᐃᓂᒃ ᐊᓯᐊᖖᖑᓂᐅᔪᖕᓇᖅᑐᑦ ᑕᐹᑦ ᐊᖏᓂᕆᔭᖏᓐᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ 8cm–ᒥᒃ ᒥᑭᓂᖅᓴᐅᓂᐊᕐᓂᖕᒐᓄᑦ. ᐊᓯᐊᖑᕐᓃᑦ ᓯᑯᐃᑦ ᐊᑖᓂᑦ ᐃᒪᐃᑦ ᒪᓕᖕᓂᐊᖅᑐᑦ ᐃᒪᕐᒥᐅᑕᓕᕆᔨᒃᑯᑦ 10%–ᒥᒃ ᐃᒪᐃᔭᐃᔭᕆᐊᖃᖅᑎᑦᑎᓂᖕᒐᓐᓂᒃ ᓯᑯᓯᒪᑎᓪᓗᒍ. ᑯᕕᔪᑦ Pointer Lake-ᒥᑦ Andrew Lake-ᒧ (ᐱᕚᓪᓕᐊᔪᑦ ᑭᒡᒐᕕᖕᒥᑦ Sissons-ᒥᓪᓗ) ᓂᕆᐅᒋᔭᐅᔪᑦ ᒥᒃᓵᓂᐊᕐᓂᖏᓐᓄᑦ 1% ᐊᒻᒪ 3% ᑐᖕᖔᓂᑦ.

ᓴᓇᔭᐅᑎᓪᓗᒍ, ᐊᒻᒪ ᐊᐅᓛᕐᓂᐅᑎᓪᓗᒍ ᓄᖅᑲᖅᐸᓪᓕᐊᓂᕐᒥᓪᓗ, ᐃᒪᐃᑦ ᐊᖏᓂᖏᑦ, ᑯᕕᓂᕐᒧᑦ ᓈᓴᐅᑏᑦ ᐃᒪᐃᓗ ᐊᖏᓂᖏᑦ ᖃᐅᔨᒋᐊᖅᑕᐅᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐃᓂᐅᔪᓂᒃ ᐊᒃᑐᖅᑕᐅᓯᒪᑐᐃᓐᓇᕆᐊᖃᖅᑐᓂᑦ ᐱᓕᕆᐊᑉ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖏᓐᓄᑦ. ᑖᑉᑯᓇᓂ ᐃᓚᐅᔪᑦ Andrew Lake, Siamese Lake, Mushroom Lake, Judge Sissons Lake, ᐊᒻᒪ ᐊᓂᐊᑎᑦᑎᔪᑦ ᓱᐸᓗᐃᑦ.

ᑕᐅᑐᒃᓲᒍ ᖃᐅᔨᓴᐃᓂᖅ ᐃᒪᐅᑉ ᖃᓄᐃᙱᓂᕆᔭᖕᒐᓂᒃ

ᒫᓇᐅᔪᖅ ᐊᕙᑎ – ᐃᒪᐅᑉ ᖃᓄᐃᙱᓂᕆᔭᖕᒐ

ᑕᓲᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐊᑦᔨᐸᓗᖏᓐᓂᒃ ᐃᒪᐅᑉ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖏᓐᓂᒃ ᐱᑕᖃᖅᑐᑦ (Tier 3, Technical Appendix 5C). ᑕᓲᑦ ᖃᓄᐃᖕᒐᓂᖏᑦ ᐃᒪᙳᐃᑑᖕᒪᑕ "characterized by low ionic strength and neutral to alkaline pH, low to high sensitivity to acidification" ᐊᕿᑦᑐᒻᒪᕆᐊᓗᖕᒥᑦ ᐊᕿᑦᑐᒧᑦ ᐃᒪᐅᑉ ᓯᑎᓂᖕᒐ, ᐊᒻᒪ ᓂᕿᒋᔭᐅᔪᓂᒃ ᐱᑕᖃᓗᐊᖏᓐᓗᑎᒃ (ᓲᕐᓗ., oligotrophic). ᑭᒡᓕᒋᔭᐅᔪᖅ ᐃᒪᐃᑦ ᖃᓄᐃᙱᓂᕆᔭᖏᓐᓄᑦ ᒥᑭᓂᖅᓴᐅᕙᓪᓚᒃᑐᑦ ᒪᓕᒃᑕᐅᔭᕆᐊᓕᖕᓄᑦ.

ᑯᓚᓛᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᕐᒥᑦ ᐋᕿᐅᒪᓂᖃᖅᑐᑦ low ionic ᓴᙱᓂᕐᒧᑦ, neutral to alkaline pH, low to high sensitivity to acidification" ᐊᕿᑦᑐᒻᒪᕆᐊᓗᖕᒥᑦ ᐊᕿᑦᑐᒧᑦ ᐃᒪᐅᑉ ᓯᑎᓂᖕᒐ, ᐊᒻᒪ oligotrophic conditions. ᑭᒡᓕᒋᔭᐅᔪᖅ ᐃᒪᐃᑦ ᖃᓄᐃᙱᓂᕆᔭᖏᓐᓄᑦ ᒥᑭᓂᖅᓴᐅᕙᓪᓚᒃᑐᑦ ᒪᓕᒃᑕᐅᔭᕆᐊᓕᖕᓄᑦ.

ᐊᕙᑎᒧᑦ ᖃᓄᐃᖕᒐᓕᕈᑎᐅᔪᓄᑦ ᖃᐅᔨᓴᐃᓐᓂᑦ ᐃᒪᐅᑉ ᖃᓄᐃᙱᓂᕆᔭᖕᒐᓄᑦ

Key water quality issues identified during stakeholder engagement include changes to surface ᐱᔾᔪᑕᐅᔪᑦ ᐃᒪᐃᑦ ᖃᓄᐃᙱᓂᕆᔭᖏᓐᓄᑦ ᐃᓕᑕᕆᔭᐅᔪᑦ ᐱᖃᖃᑕᐅᔪᑦ ᐃᓚᐅᖃᑕᐅᓂᖃᖅᑎᓪᓗᒋᒥᑦ ᐃᓚᐅᔪᑦ ᐊᓯᐊᖑᕐᓃᑦ ᐃᒪᐅᑉ ᖄᖕᒐᑦᑕ ᖃᓄᐃᓕᐅᕐᓂᖏᑦ ᐱᓕᕆᐊᖑᔪᒧᑦ ᖁᕝᕙᒥᖕᖔᖅᑐᕋᓗᖕᓂᑦ ᑭᒡᒐᕕᖕᒥᑦ ᐊᒻᒪ Sissons ᐃᒪᓕᕆᓂᕐᓂᑦ (WTP); ᐊᖏᒡᓕᒋᐊᕐᓂᖏᑦ ᐳᔪᖃᑖᑦ ᐊᒻᒪ ᓴᕖᑦ ᑕᒪᒃᑯᓂᖕᖔᖅᑐᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᒃ ᓴᓇᔭᐅᕚᓪᓕᐊᑎᓪᓗᒍ ᐊᒻᒪ

ᐊᐅᐸᓕᖅᑎᓪᓗᒍ; ᐋᓯᑦᓗ ᐊᖏᒻᓕᓂᖓᓄᑦ ᓯᓚᒧᑦ ᐊᓂᐊᔪᑦ EN-WC KIA ᐃᐳᓇ 2007[30], EN-KIV OH ᐅᒃᑑᐱᓇ 2009[31], EN-BL EL ᒑᑦᓯ 2009[32]). ᐊᓯᐊᖑᖅᑎᓇᓂᐅᑐᐃᓐᓇᓇᐊᖅᖅᑐᑦ ᐃᒪᐅᑉ ᖀᖓᓂᑕ ᖃᓄᐃᓕᐅᕐᓂᖏᓐᓄᑦ ᑕᒪᒃᑯᓇᙵᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᖃᕈᓐᓇᖅᑐᑦ ᐃᒪᐅᑉ ᐆᒪᔪᕋᓖᖏᓐᓂᒃ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᒃ ᐃᒪᕐᓂᑦ.

ᖃᑉᓯᐊᕐᔪᐃᑦ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᐅᔪᑦ ᐊᒻᒪ ᐱᓕᕆᐊᑉ ᖃᓄᐃᖓᓂᕆᔭᖏᑦ ᐊᑐᓕᖅᑎᑕᐅᓂᐊᖅᑐᑦ ᐊᖏᓗᐊᖏᑎᒋᐊᕐᓂᕐᒧᑦ ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᖓᓕᕈᑕᐅᔪᑦ ᐃᒪᐅᑉ ᖀᖓᑕ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ. ᒥᒃᓵᒋᐊᖅᑎᓐᓂᐊᕐᓗᒋᑦ ᖃᓄᐃᖓᓕᕈᑕᐅᔭᓐᓇᖅᑐᑦ ᕿᕐᕖᓐᓂᙱᓐᖤᓗᒃᑐᓂᑦ, ᐱᓕᕆᐊᖑᓯᒪᔪᖅ ᑯᕚᑎᑕᐅᔪᖅ ᐃᒪᖅ ᐊᑐᖅᑕᐅᑲᓐᓂᖃᑦᑕᕐᓂᐊᖅᑐᖅ ᓯᖃᓪᓕᑎᓇᕝᕙᖏᑦ. ᖃᓄᐃᖓᓂᕆᔭᖓ WTP ᐋᕿᒋᐊᖅᑕᐅᓂᐊᖅᑐᑦ ᒪᓕᖕᓂᕐᒧᑦ ᕿᕐᕖᖕᒥᙱᓐᖤᓗᒃᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ. ᐱᐅᓛᒃᑯᑦ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᑦ (BMP) ᐳᔪᖃᑖᓄᑦ ᐊᑉᖁᑎᓂᑦ ᐊᒻᒪ ᐅᔾᔨᖕᓂᐊᖅᑐᓕᓇᑎᓪᓗᒋᑦ ᐊᑐᓕᖅᑎᑕᐅᓂᐊᖅᑐᑦ ᒥᒃᓵᒋᐊᖅᑎᓐᓂᕐᒧᑦ ᑖᑉᑯᓐᓇᙱᖅᑐᑦ ᐳᔪᕐᓗᐃᑦ ᐊᒻᒪ ᓴᕙᓗᕿᑦ ᑭᒻᒪᕝᕙᒃ ᐱᓕᕆᐊᑉ ᖃᓂᑕᖓᓂᑦ. ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖅ ᐋᓯᑦᓂᒃ ᓯᓚᒧᐊᖅᑐᓄᑦ, ᓴᓗᒻᒪᖅᓴᐃᔾᔪᑏᑦ ᐃᓕᔭᐅᓂᐊᖅᑐᑦ ᐋᓯᑦᑎᓇᕝᕙᖏᑦ, ᐳᔪᕐᓗᖕᓄᑦ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐋᕿᐅᒪᔪᑦ ᐃᓕᔭᐅᓂᐊᖅᑐᑦ ᐅᖅᓯᐊᓗᖏᑦ ᐆᒻᒪᖅᑯᑎᓕᖕᓄᑦ ᐊᒻᒪ/ᐅᕙᓘᓃᑦ ᐸᓂᖅᓲᔾᔪᑎᓄᑦ.

ᐊᑐᖅᑕᐅᔪᓄᑦ ᓈᓴᐅᑏ/ᑎᑎᖅᑲᐃᑦ ᓇᓗᓇᐃᖅᓯᔪᑦ ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ Judge Sissons Lake-ᒥᑦ ᕿᕐᕖᖕᓂᙱᓐᖤᓗᒃᑐᓂᒃ ᑭᒻᒪᕝᕙᒃ-ᒧᑦ ᐊᒻᒪ Sissons-ᒧᑦ WTP-ᖑᔪᑦ ᓂᕈᐅᒋᔭᐅᔪᑦ ᑕᐃᒪᐅᖃᑦᑕᕐᓂᐊᕐᓂᖏᑦ ᐊᐅᐸᖅᑎᓪᓗᒍ ᑭᖑᓪᓕᖅᐸᒃᑯᓪᓗ ᐅᒃᑯᐊᖅᐸᓪᓕᐊᑎᓪᓗᒋᑦ ᐱᓕᕆᐊᒧᑦ, ᑭᓯᐊᓂ ᓈᓴᐅᑏᑦ ᐅᑎᕐᓂᐊᖅᑐᑦ ᑭᒡᓕᐅᔪᓄᑦ ᐅᒃᑯᐊᕌᓂᒃᑎᓪᓗᒍ. ᑲᑎᓯᒪᔪᑦ COPC ᓂᕈᐅᒋᔭᐅᔪᑦ ᐊᑦᑎᖕᓂᖅᓴᐅᓂᐊᕐᓂᖏᓐᓄᑦ ᒪᓕᒃᑕᐅᔭᓇᐊᖃᖅᑐᓂᑦ, ᐃᓚᐅᖏᓪᓗᑎᒃ cadmium, copper, selenium ᐊᒻᒪ zinc. Cadmium-ᒧᑦ, ᓂᕈᐅᒋᔭᐅᔪᖅ ᐊᖏᓂᖅᐹᖑᔪᑦ ᑲᑎᓯᒪᔪᓂᑦ ᐅᑭᐅᑯᑦ ᐅᖓᑕᐅᑎᓂᐊᕌᓱᒋᔭᐅᕐᓗᑎᒃ ᓯᑎᓂᕐᒧᑦ ᐊᑐᖅᑐᓄᑦ ᒪᓕᒃᑕᐅᔭᓇᐊᓕᖕᓄᑦ. Selenium-ᒧᑦ, ᐃᒃᑲᓕᖓᓐᓂᑦ ᑕᓲᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓ ᐃᖕᒥᓂᒃ ᖃᓪᓕᓂᐊᖅᑐᖅ ᒪᓕᒃᑕᐅᔭᓇᐊᓕᖕᒧᑦ ᐅᑭᐅᑯᑦ ᐊᒻᒪ ᐱᓕᕆᐊᒥᙱᖅᑐᖅ ᒪᓕᒃᑕᐅᔭᓇᐊᓕᒃ ᐅᖓᑕᐅᑎᓂᐊᖅᑐᖅ. ᐊᓯᖏᑦ COPC (ᓱᕐᓗ copper ᐊᒻᒪ zinc) ᐊᓯᐊᖑᕐᓂᖃᓗᐊᖏᑦᑐᖅ ᐃᖕᒥᓂᒃ ᐱᕙᓪᓕᐊᔪᑦ ᐱᔾᔪᑎᒋᐸᓗᒋᑦ. ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓃᑦ ᐱᓕᕆᐊᑉᓗ ᖃᓄᐃᖓᓂᕆᔭᖏᑦ ᓂᕈᐅᒋᔭᐅᔪᑦ ᒥᑭᓛᓕᖅᑎᑦᑎᓂᐊᕐᓂᖏᓐᓄᑦ ᖃᓄᐃᖓᓕᕈᑕᐅᔪᓂᒃ ᐃᒪᐅᑉ ᖀᖓᓄᑦ. ᑕᐅᑐᒃᑖᖅᓗᒍ, ᐅᔾᔨᕐᓇᖅᑐᒥᒃ ᖃᓄᐃᖓᓕᕈᑎᑕᕐᓂᐊᕋᓱᒋᔭᐅᖏᑦᑐᖅ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ.

ᐊᓯᐊᖑᕐᓃᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ ᐳᔪᖃᑖᖏᑦ ᓂᕈᐅᒋᔭᐅᔪᑦ ᒥᑭᑦᑑᓂᐊᕐᓂᖓᓄᑦ ᐊᒻᒪ ᑕᐃᒪᐅᓗᐊᖅᑕᕐᓗᓂ ᐅᐱᕐᙵᑯᑦ ᑰᓕᕚᖓᑦ ᐊᐅᒃᐸᓪᓕᐊᓂᕐᒧᑦ. ᒥᑭᑦᑐᑦ ᐅᑭᐅᑕᒫᑦ ᐊᖏᒻᓕᓂᐅᔪᑦ ᓴᕝᖓᓄᑦ, radionuclides ᐊᒻᒪ ᑲᑎᕝᕙᒋᑦ suspended solids (TSS)-ᖑᔪᑦ ᑕᐃᒪᐅᖃᑦᑕᕐᓗᑎᒃ ᐊᐅᐸᕐᓂᖃᖅᑎᓪᓗᒍ ᐅᔭᕋᖕᓂᐊᕐᕝᕙᒃ (25 ᐅᑭᐅᓪᓗᐊᓂᑦ), ᑭᓯᐊᓂ ᑲᑎᓯᒪᔪᑦ ᓂᕈᐅᒋᔭᐅᖏᑦᑐᑦ ᐅᖓᑕᐅᑦᑎᓂᐊᕐᓂᖏᓐᓄᑦ ᓈᒻᒪᒋᔭᐅᔪᓄᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ ᒪᓕᒋᐊᓕᖕᓂᑦ ᐅᕙᓘᓃᑦ ᐱᓕᕆᐊᖑᔪᒪᔪᒧᑦ, ᐅᕙᓘᓃᑦ ᐆᒃᑐᕐᕕᒃᓴᐅᓗᓂ ᐃᖕᒥᓂᒃ ᐊᔾᔨᒌᖏᓐᓂᐅᔪᑦ ᖁᕓᓂᑦ. ᑕᐅᑐᒃᑖᖅᓗᒍ, ᐅᔾᔨᕐᓇᖅᑐᒥᒃ ᖃᓄᐃᖓᓕᕈᑎᑕᕐᓂᐊᕋᓱᒋᔭᐅᖏᑦᑐᖅ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ ᐳᔪᕐᓗᐃᑦ ᐱᔾᔪᑎᒋᐸᓗᒋᑦ.

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[30] EN-WC KIA ᐃᐳᓇ 2007: *ᐊᒥᓱᓂᒃ ᑕᐅᕙᓂ ᑰᒃᑕᖃᐅᖅᑐᖅ. ᐅᓗᓇ ᐊᓇᖅᑐᑦ ᑰᖕᓄᐊᕐᓂᐊᖅᐸᑦ ᑕᓯᕐᓇᓪᓘᓃᑦ?*
[31] EN-KIV OH ᐅᒃᑑᐱᓇ 2009: ᐱᐅᖏᑦᑐᓪᓕ ᐃᒪᕐᒥᑦ?
[32] EN-BL EL ᒑᑦᓯ 2009: *ᐃᓱᓖᓘᑎᖃᕐᒥᔪᖓ ᐊᕙᑎᒥᒃ ᖃᐅᔨᓴᐃᓂᕐᒥᒃ ᐊᒻᒪ ᖃᓄᖅ ᐱᓕᕆᐊᖑᓂᐊᕐᒪᖔᑦ, ᐱᓗᐊᖅᑐᒥᒃ ᐃᒪᕐᒥᒃ ᖃᐅᔨᓴᐃᓂᖅ. ᓂᕐᔪᑎᓄᑦ ᐃᒪᓇᔭᐅᖕᒪᑦ, ᐊᒻᒪ ᐱᐅᓛᖑᔪᖅ ᓱᓇᓗᒃᑖᑦ ᐅᓗᓇ ᐊᓐᓇᖏᓪᓗᒋᑦ ᓂᕐᔪᑎᓄᑦ.*

ᐊᔾᔨᒌᖏᓐᓂᐅᔪᑦ ᑕᓯᖅ pH-ᒥᑦ ᓂᕈᐅᒋᔭᐅᔪᑦ ᑕᐃᒪᐅᖃᑦᑕᕐᓂᐊᕐᓂᖏᓐᓄᑦ ᐃᖏᖕᓂᒃ ᐊᐅᓚᖅᑎᓪᓗᒍ ᐱᓕᕆᐊᖅ (25 ᐅᑭᐅᓪᓗᐊᓂᑦ). ᑕᒪᒃᑯᐊ ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᐋᓯᑦᓂ ᒪᕐᑯᒃᑐᒥᑦ/ᖃᐅᓯᖅᑐᒥᑦ, ᐊᒻᒪ ᖃᓄᐃᖓᓕᕈᑕᐅᔪᑦ ᐅᑭᐅᑉ ᐃᓚᖓᒍᑦ ᖁᐊᖅᑎᓪᓗᒍ-ᐊᐅᒃᑎᓪᓗᒍ-ᒥᑦ ᑕᓯᐅᑉ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖓᓄᑦ. ᐊᓯᐊᙳᕐᓂᐅᑐᐃᓐᓇᕆᐊᖃᖅᑐᑦ ᑕᓯᖅ pH-ᒧᑦ ᐊᖏᓪᓕᓂᖏᓐᓄᑦ ᐋᓯᑦ ᐱᓕᕆᐊᒦᓚᖅᑐᑦ ᓂᕈᐅᒋᔭᐅᔪᖅ ᑕᐃᒪᐅᖃᑦᑕᕐᓂᐊᕐᓂᖏᓐᓄᑦ ᐊᐅᔾᔮᒃᑯᑦ. ᑭᓯᐊᓂ, ᐊᓯᐊᙳᕐᓂᐅᑐᐃᓐᓇᕆᐊᓖᑦ ᒥᑭᑦᑑᓇᔭᖅᑐᑦ (ᓃᕐᓗ, ᐊᑦᑎᖕᓂᖅᓴᐅᓗᓂ ᐊᖏᓛᙳᔪᙳᖅᑐᒥᑦ) ᐊᒻᒪ ᓇᐃᑑᓂᐊᖅᑐᒃᓴᐅᓪᓗᓂ, ᐃᒪᐅᑉ ᐃᖏᕐᕋᓂᖓ ᓇᑭᕐᓂᖓᓄᑦ ᑕᑯᒃᓴᐅᔪᑎᒍᑦ ᑕᓯᖅᑎᒍᑦ. ᐅᔾᔨᕐᓇᖅᑐᒥᒃ ᖃᓄᐃᖓᓕᕈᑎᑕᖃᕐᓂᐊᕋᓱᒋᔭᐅᖏᑦᑐᖅ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ ᐃᒪᖅ ᐋᓯᑦᖃᕐᓂᕐᒧᑦ ᓂᕈᐅᒋᔭᐅᖏᑦᑐᑦ ᐱᓕᕆᐊᒥᙱᖅᑐᒥᑦ.

ᒪᓕᖕᓂᐊᕐᓗᒋᑦ ᓄᓇᕗᑦ ᒪᓕᒐᖏᓐᓂᒃ ᐱᔭᕆᐊᖃᕐᓂᐅᔪᑦ, ᐃᒋᑕᐅᔪᖅ ᐃᒪᖅ ᐊᒻᒪ ᖁᕝᕙᖏᙱᖅᑐᕋᓗᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᐊᖅᑐᑦ ᐊᒻᒪ ᑎᑎᕋᐅᓯᐅᖃᑦᑕᕐᓗᑎᒃ ᐅᔭᕋᖕᓂᐊᕐᓂᐅᑉ ᐊᐅᓚᕐᓂᕆᔭᖓᓂᑦ, ᓄᖅᑲᖅᐸᓪᓕᐊᑎᓪᓗᒍ, ᐊᒻᒪ ᐅᒃᑯᐊᖅᑎᓪᓗᒍ, ᐃᓚᒋᐸᓗᒍ ᒪᓕᖕᓂᖅ ᐊᒻᒪ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ. ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓ ᖁᕝᕙᖏᙱᖅᑐᑦ ᐃᓂᖏᑦ Judge Sissons Lake-ᒥᑦ, ᐊᒻᒪ ᐊᓂᐊᕙᐊᓂᑦ Judge Sissons Lake-ᒥᑦ, ᖃᐅᔨᒋᐊᖅᑕᐅᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐊᐅᓚᖅᑎᓪᓗᒍ, ᐅᒃᑯᐊᖅᐸᓪᓕᐊᑎᓪᓗᒍ ᐊᒻᒪ ᐅᒃᑯᐊᖅᑎᓪᓗᒍ ᐱᓕᕆᐊᖅ. ᐃᒪᐃᔭᐃᓂᖅ ᐊᒻᒪ ᐃᒋᑕᐅᔪᑦ ᐃᒪᐃᑦ/ ᖁᕝᕙᖏᙱᖅᑐᕋᓗᐃᑦ ᓈᓴᐅᑎᖏᑦ ᑎᑎᕋᐅᓯᐅᖏᓐᓇᐅᔭᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᓴᓇᔭᐅᑎᓪᓗᒍ, ᐊᐅᓚᖅᑎᓪᓗᒍ, ᐅᒃᑯᐊᖅᐸᓪᓕᐊᑎᓪᓗᒍ ᐊᒻᒪ ᐅᒃᑯᐊᖅᑎᓪᓗᒍ ᐱᓕᕆᐊᖅ. ᐊᓂᖅᓵᖅᑐᖅᑕᕗᑦ ᐳᔪᕐᓗᐃᓪᓗ ᐊᓂᐊᔪᑦ ᐊᖏᓂᖏᑦ ᐳᔪᖃᑖᓪᓗ ᖃᐅᔨᒋᐊᖅᑕᐅᖃᑦᑕᐃᓐᓇᕐᓂᐊᖅᑐᑦ ᖃᓂᑕᖏᓐᓂᑦ ᑭᒡᒐᕝ ᐊᒻᒪ Sissons-ᒥᑦ ᐅᔭᕋᖕᓂᐊᕐᕚᑦ ᐊᐅᓚᕐᓂᖏᓐᓂᑦ, ᐊᒻᒪ ᐊᑭᐊᓃᑐᖅ ᐅᔭᖅᑲᓂᒃ ᐅᓯᔪᓄᑦ ᐊᑉᕐᑯᑎᐅᑉ ᐊᑯᓐᓂᖏᓐᓂᑦ ᐃᓂᐅᔪᐃᑦ ᖃᐅᔨᔪᒪᓂᕐᒧᑦ ᖃᐅᔨᔭᐅᔪᑦ ᐊᖏᓃᑦ ᐊᔾᔨᒋᖕᒪᖔᕆᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᖏᓂᐅᔪᓄᑦ. ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓ ᑕᓯᕐᓂᑦ ᑰᒪᓛᓂᓪᓗ ᐊᑭᐊᓂᑦ, ᑰᒃᑑᑉ, ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ ᐃᓂᖓᓂᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᖃᐅᔨᒋᐊᖅᑕᐅᖃᑦᑕᕐᓂᐊᖅᑐᖅ ᓇᓗᓇᐃᖅᓯᓂᕐᒧᑦ ᓴᕕᑦ ᐊᒻᒪ radionuclide ᑲᑎᓯᒪᔪᑦ, TSS, ᐋᓯᑦ, ᐊᒻᒪ ᑕᓯᕐᒥᑦ ᐋᓯᑦᙳᔪᐃᑦ ᐅᖓᑕᐅᑎᖏᑦᑐᑦ ᓈᒻᒪᒋᔭᐅᔪᓂᑦ ᐊᖏᓂᐅᔪᓂᒃ. ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᓴᓇᔭᐅᑎᓪᓗᒍ, ᐊᐅᓚᖅᑎᓪᓗᒍ ᐊᒻᒪ ᐅᒃᑯᐊᖅᐸᓪᓕᐊᑎᓪᓗᒍ ᐱᓕᕆᐊᖅ.

ᑕᐅᑐᒃᑯᒍ ᖃᐅᔨᓴᐃᓂᖅ ᐃᒪᐅᑉ ᓇᑎᐊᓃᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ

ᒫᓇᐅᔪᖅ ᐊᕙᑎ – ᐃᒪᐅᑉ ᓇᑎᐊᓃᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ

ᑕᑦᔾᔪᑦ ᐊᓗᖏᑦ ᐊᔾᔨᒌᖃᑦᑕᙱᑦᑐᑦ ᐅᔭᖅᑲᓄᑦ, ᐅᔭᕋᑦᔪᖕᓄᑦ ᐊᒻᒪ ᓯᐅᕋᕐᒧᑦ ᐃᒃᑲᑦᑐᓂᑦ ᑕᓯᐅᑉ ᐊᓗᐊᓃᑐᓄᑦ ᐃᑎᓂᖅᓴᓄᑦ. ᑲᔪᖅᑐᑦ ᕿᕐᓂᕐᓂᖅᓴᐅᓪᓗᑎᒃ ᑕᓯᐅᑉ ᓇᑎᐊᓃᑐᑦ 2cm-ᒥᑦ 10cm-ᒧᑦ ᐃᑎᓂᖃᖃᑦᑕᖅᑐᑦ. ᐊᔾᔨᒌᖏᓐᓂᐅᔪᑦ ᑕᑦᔾᔪᑦ ᐊᓗᐊᓃᑐᑦ ᖃᓄᐃᓂᖏᑦ ᒥᑭᓂᖅᓴᓂᑦ ᑕᓯᕐᓂᑦ ᐊᒻᒪ Judge Sissons Lake-ᒥᑦ ᑕᐃᒪᐅᔪᑦ ᐃᑎᓂᖅᓴᐅᓗᑎᒃ Judge Sissons Lake-ᒥᑦ, ᐊᒻᒪ ᐊᔾᔨᒌᖏᓐᐅᔪᑦ ᑕᐃᒪᐅᔪᑦ ᐃᑎᓂᖅᓴᓂᑦ ᑕᓯᕐᓂᑦ (BEAK 1990).

ᑕᐅᑐᒃᑖᖅᑯᒍ, ᑲᑎᖒᒋᑦ ᓴᕕᑦ ᑲᑎᓯᒪᔪᑦ ᐊᔾᔭᐸᓗᒋᓚᐅᖅᑕᖓ ᑕᓯᕐᓂᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ. Arsenic ᐊᒻᒪ chromium ᑲᑎᓯᒪᔪᑦ ᐅᖓᑕᐅᑎᒐᔾᔪᒃᑐᑦ Canadian Interm Sediment Quality Guideline (ISQG)-ᒥᑦ, ᑭᓯᐊᓂ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔾᔪᓇᖅᑐᒧᑦ ᐊᖏᓂᖅ (PEL)-ᙳᖏᑦᑐᒃᑯᑦ. ᖃᑯᑎᒃᑯᑦ ᐅᖓᑕᐅᑎᓃᑦ cadmium-ᒥᑦ, copper-ᒥᑦ, mercury-ᒥᑦ, ᐊᒻᒪ zinc-ᒥᑦ ISQG-ᙳᔪᑦ, ᐊᒻᒪ mercury ᐊᒻᒪ zinc PEL-ᙳᔪᑦ ᖃᐅᔨᔭᐅᓚᐅᖅᑐᑦ. ᐃᓚᖏᑦ ᐅᖓᑕᐅᑎᔪᑦ arsenic-ᒥᑦ, chromium-ᒥᑦ, copper-ᒥᑦ, molybdenum-ᒥᑦ, nickel-ᒥᑦ selenium-ᒥᑦ, ᐊᒻᒪ vandium-ᒥᑦ ᐊᑦᑎᖠᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᐊᖏᓂᐅᔪᓂᒃ (LEL) ᖃᐅᔨᔭᐅᓚᐅᕐᒥᔪᑦ. Racionuclides ᖃᐅᔨᔭᐅᓚᐅᖅᑐᑦ ᑕᒪᐃᓂᖅᑲᔭᖅ ᑕᑦᔾᔪᑦ ᐊᓗᐊᓂᑦ ᐆᒃᑐᕋᐅᑎᓂᑦ, ᖃᒪᓂᑦᑐᐊᕐᑑᑐᓂᐅᖏᑦᑐᖅ, ᐅᓂᒃᑲᐅᓯᖃᑦᑕᖅᑯᑎᒡᓗ ᑲᑎᓯᒪᓂᖏᑦ 0.3 ᐊᑖᓃᓂᖏᓐᓄᑦ Becquerels per gram dry weight (Bq/g dw). ᑲᑎᓯᒪᔪᑦ hydrocarbons (PAHs)

ᖃᒪᓂᑦᑐᐊᕐᒥᑦ ᑕᓱᑦ ᐊᓗᐊᓂᑦ ᓂᕆᐅᕆᔭᐅᔪᑦ ᐊᑦᑎᒃᑐᑲᓪᓚᐅᓂᖏᓐᓄᑦ ISQG-ᒥᑦ, ᐊᑐᖅᑐᕆᑦ ᒫᓐᓇᓵᐸᓗᒃ (2008)-ᒥᑦ ᐆᒃᑐᕋᐃᓐᑦ (Tier 3, Technical Appendix 5C).

ᐊᕙᑎᒥᒃ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓐᑦ ᑕᓱᑦ ᐊᓗᐊᓐᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ

ᐱᔾᔪᑕᐅᔪᖅ ᖃᐅᔨᔭᐅᓚᐅᖅᑐᖅ ᑕᓱᑦ ᐊᓗᐊᓐᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᐱᓕᕆᐊᒥᑦ ᐊᔪᐊᖑᕐᓂᐅᔪᖕᓇᖅᑐᖅ ᑕᓱᑦ ᐊᓗᐊᓐᑐᑦ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖏᓐᓂᒃ, ᐊᑐᖅᑐᓂ ᑯᕕᑎᑕᐅᓂᖓ ᕿᕐᕕᖕᒥᙱᖅᑐᕋᓗᐃᑦ ᑭᒡᒐᕕᖕᒥᑦ ᐊᒻᒪ Sissons WTP-ᒥᑦ. ᕿᕐᕕᖕᒥᙱᖅᑐᕋᓗᐃᑦ ᑯᕕᔭᐅᔪᑦ ᐊᒃᑐᖅᓯᓂᖃᕈᖕᓇᖅᑐᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖕᒐᓂᒃ ᐊᒻᒪ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓗᑎᒃ ᑕᓯᐅᑉ ᐊᓗᐊᓐᑐᓂᒃ ᐊᓗᐊᓄᑦ ᓄᖅᑲᕐᓂᒃᑯᑦ ᒥᓗᒃᑕᐅᓂᒃᑯᓪᓗ. ᐱᐅᖏᑦᑐᑦ ᐊᖏᓂᖏᑦ ᑕᓱᑦ ᐊᓗᐊᓂᑦ (ᓲᕐᓗ, ᑕᓯᐅᑉ ᐊᓗᐊᓂᕐᒥᐅᑕᐃᑦ ᐆᒪᔪᕋᖦᑦ), ᐃᖃᓗᐃᑦ ᐆᒪᔪᕋᖦᓂᒃ ᓂᕆᖃᑦᑕᖅᑐᑦ, ᐊᒻᒪ ᓂᕐᔪᑏᑦ ᐄᔨᔪᑦ ᑕᓯᐊᑉ ᐊᓗᐊᓐᑐᓂᒃ ᓂᕆᑎᓪᓗᕆᑦ ᐃᒪᕐᒥᐅᑕᓂᒃ. ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᑦ ᑕᓯᐅᑉ ᐊᓗᐊᓐᑐᓂᒃ ᐃᒪᐅᑉ ᖃᓄᐃᓕᐅᕐᓂᖃᑦᑕᖅᑕᖕᒐᓄᑦ, ᐊᖏᓗᐊᖏᕆᐊᖅᑎᑦᑎᓂᖅ ᐊᒻᒪ ᐱᓕᕆᐊᑉ ᖃᓄᐃᖕᒐᓂᕆᔭᖕ ᐊᑐᓕᖅᑎᑦᑎᔪᑦ ᑭᒡᓕᓕᐅᕐᓂᕐᒥᒃ ᐊᒃᑐᖅᓯᓂᐅᑐᐃᓐᓇᕆᐊᓕᖕᓂᒃ ᑕᓯᐅᑉ ᐊᓗᐊᓐᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᑦ ᐊᔾᔨᐸᓗᕆᔭᖕ ᐅᖃᐅᓯᐅᓯᒪᔪᓄᑦ ᖃᓄᐃᑑᓂᖏᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖕᒐᓄᑦ.

ᐊᖏᓗᐊᖏᕆᐊᖅᑎᑦᑎᓐᑦ ᐊᒻᒪ ᐱᓕᕆᐊᑉ ᖃᓄᐃᖕᒐᓂᕆᔭᖏᑦ ᓂᕆᐅᕆᔭᐅᔪᑦ ᒥᑭᓲᖕᒐᑎᑦᑎᓂᕐᒥᒃ ᖃᓄᐃᖕᒐᓕᕈᑕᐅᔪᓂᒃ ᑕᓯᐅᑉ ᐊᓗᐊᓐᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖕᒐᓂᑦ. ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᑦ ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ ᓇᓗᓇᐃᖅᓯᔪᑦ ᑕᓯᐅᑉ ᐊᓗᐊᓐᑐᑦ ᑲᑎᓯᒪᔪᑦ ᑕᒪᐃᓂᑦ COPC-ᓂᑦ ᑕᓯᐅᑉ ᐊᓗᐊᓐᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᓪᓗ ᒪᓕᒃᑕᐅᔾᔮᓴᐃᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᖏᓐᓄᑦ ᑲᑎᑕᐅᐸᓗᑎᒃ ᑲᑎᓯᒪᔪᐃᑦ ᓈᓴᐅᑎᖏᑦ ᑕᒪᐃᓂᑦ Judge Sissons Lake-ᒥᑦ, ᐃᓚᐅᖏᕆᑎᒃ arsenic, copper ᐊᒻᒪ nickel. ᑲᑎᓯᒪᔪᑦ ᑕᒪᒃᑯᓂᙶᑦ COPC-ᓂᑦ ᑕᓯᐅᑉ ᐊᓗᐊᓐᑐᓂᑦ ᓂᕆᐅᕆᔭᐅᔪᑦ ᖁᑦᑎᒃᓯᓯᒫᕐᔪᕆᐊᒃᓴᖏᓐᓂᒃ ᒪᓕᒋᐊᖃᖅᑐᓂᐅᖕᒐᓂᑦ ᓇᓚᐅᑖᖅᑐᑦ ᒥᑭᓲᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᓂᒃ ᐃᒪᕐᒥᐅᑕᐃᑦ ᐆᒪᔪᕋᖦᑦ. ᐅᖕᒐᑕᐅᑎᓂᖅ ᑕᐃᒪᐅᖃᑦᑕᖅᑐᖅ ᑕᒪᐃᓂᓗᒃᑖᖅ ᖃᐅᔨᓴᐃᓂᐅᐸ, ᐃᓚᐅᐸᓗᓂ ᑭᒡᓕᕆᔭᐅᔪᖅ. ᑭᒡᓕᕆᔭᐅᔪᑦ ᐊᖏᓂᖏᑦ ᑕᒪᐃᓄᑦ COPC-ᓄᑦ ᑕᓯᐅᑉ ᐊᓗᐊᓐᑐᑦ ᐊᔾᔨᐸᓗᕆᔭᖕ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᓯᕗᓂᕐᒥᑦ ᕿᕐᕕᖕᒥᙱᖅᑐᕋᓗᖕᓄᑦ ᑯᕕᓯᓂᐅᔪᓄᑦ, ᓂᕆᐅᕆᔭᐅᖏᑦᑐᖅ ᐱᓕᕆᐊᖅ ᐊᖏᔪᒥᒃ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᖃᕆᐊᒃᓴᖕᒐᓂᒃ ᐊᖏᓂᕆᔭᖏᑦ arsenic-ᒥᑦ, copper-ᒥᑦ ᐊᒻᒪ nickel-ᒥᑦ ᑕᓯᐅᑉ ᐊᓗᐊᓐᑐᓄᑦ.

ᑕᓯᐅᑉ ᐊᓗᐊᓐᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᑦ ᖃᐅᔨᕆᐊᖅᑕᐅᖃᑦᑕᕐᓂᐊᑐᖅ ᖃᑯᑎᒃᑯᑦ ᐊᐅᓛᖅᑎᓪᓗᕆᑦ ᐊᒻᒪ ᐅᒃᑯᐊᖅᐸᓪᓕᐊᑎᓪᓗᕆᑦ ᓇᓗᓇᐃᕐᓂᐊᕐᓗᒍ ᑕᓯᐅᑉ ᐊᓗᐊᓐᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ ᓇᓚᐅᑖᕆᓂᕐᒧᑦ (Tier 3, Technical Appendix 5M).

ᑕᐅᑐᒃᑯᒍ ᖃᐅᔨᓴᐃᓂᖅ ᐃᒪᐅᑉ ᐆᒪᔪᕋᖦᖏᓐᓂᒃ ᐊᒻᒪ ᐃᖃᓗᐃᑦ ᐃᓂᖏᓐᓂᒃ

ᒫᓐᓇᐅᔪᖅ ᐊᕙᑎ - ᐃᒪᐅᑉ ᐆᒪᔪᕋᖦᖏᓐᓂᒃ ᐊᒻᒪ ᐃᖃᓗᐃᑦ ᐃᓂᖏᓐᓂᒃ

ᑕᓱᑦ

ᑕᓱᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ ᐃᓂᕆᔭᖕᒐᓂᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐃᒃᑲᑦᑑᒐᔪᒃᑐᑦ (ᐊᒥᓲᑦ ᐊᖏᕈᒃᑯᑦ ᐃᑎᓂᖃᖅᑐᑦ 3m ᑏᑕᒥᒃ ᒥᑭᓂᖅᓴᒥᑦ) ᐊᒻᒪ ᐃᒪᖅ ᐊᑯᐸᓕᖅᓯᒪᑦᑎᐊᖃᑦᑕᖅᑐᓂ. ᐃᒪᐅᑉ ᑕᑯᒃᓴᐅᔪᖕᓇᑦᑎᐊᕐᓂᖓ ᐊᖏᓂᖅᓴᐅᒐᔪᒃᑐᖅ 2m ᐅᖕᒐᑖᓂᑦ ᐊᒻᒪ ᐊᔾᔨᐸᓗᓂᐅᒃ ᑲᑎᑯᕆᑦ ᐃᑎᓂᐅᔪᑦ. ᓯᒡᔭᐃᑦ ᐊᓗᖏᑦ ᑕᓯᕐᓂᑦ ᐅᑯᐊᖑᖃᑦᑕᖅᑐᑦ ᐅᔭᕋᓯᖕᔪᐃᑦ, ᐅᔭᕋᐃᑦ ᐊᖏᓂᖏᑦ ᐊᔾᔩᕈᔪᒃᑐᑦ, ᓯᐅᕋᐃᑦ ᐊᒻᒪ ᒪᕋᖅ. ᓯᒡᒐᒥᑦ ᓯᕙᖕᒐᓂᖃᖅᑐᑦ ᓯᕙᖕᒐᓂᖅᓴᐅᓕᕼᒃᑯᑎᒃ. ᓯᒡᔭᓂᑦ ᐱᕈᖅᑐᐃᑦ ᐃᕕᐅᓗᐊᖃᑦᑕᖅᑐᑦ ᐊᒻᒪ ᐅᒃᐱᒐᐃᑦ. ᑕᓯᕐᓂᑦ ᐃᖃᓗᖕᓄᑦ ᐊᕙᓗᕆᔭᐅᔪᑦ ᐱᕈᖅᑐᐃᑦ ᓯᒡᔭᒥᑦ, ᐊᒻᒪ/ᐅᕙᓘᓐᑦ

ᐊᑉᓯᒪᐅᖅᑐᑦ ᐊᑯᓐᓂᖏᓐᓂᑦ ᒪᓂᕋᐅᖏᑦᑐᑦ ᐊᓘᐊᓂᑦ; ᐃᓚᖏᑦ ᑕᓲᑦ ᐱᑕᖃᐅᖅᑐᑦ ᐃᒪᕐᒥᑦ ᐱᕈᖅᑐᓂᒃ. ᓯᑰᑉ ᐃᑉᔪᓂᖓ ᑎᑭᐅᑎᖃᑦᑕᕐᒪᑦ 2m-ᒨᑦ ᐅᑭᐅᖑᑎᓪᓗᒍ, ᐊᒥᓱᑦ ᐃᒃᑲᑦᑐᑦ ᑕᓲᑦ ᖁᐊᖃᑦᑕᖅᑐᑦ ᑕᓯᐅᑉ ᐊᓘᐊᓄᑦ ᐅᑭᐅᑯᑦ. ᒥᑭᓂᖅᓴᐃᑦ ᑕᓲᑦ ᓯᑯᓯᒪᔪᖕᓃᖅᐸᓪᓚᐊᖃᑦᑕᖅᑐᑦ ᔩᓂ ᐱᒋᐋᓵᕐᓂᖓᓂᑦ, ᐊᖏᓂᖅᓴᐃᑦ ᑕᓲᑦ ᓯᑯᖃᕈᖕᓃᓕᖅᑯᑎᒃ ᔩᓂ ᓄᖖᒍᐊᓂᑦ ᔪᓚᐃ ᐱᒋᐋᓵᕐᓂᖓᓂᒡᔫᓂᑦ. ᑕᒪᕐᒥᖅᑲᔭᐃᑦ ᑕᓲᑦ ᑕᓯᕋᔭᐃᓪᓗ ᐅᔭᕆᖕᓂᐊᕐᕕᐅᑉ ᐃᓘᐊᓂᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐃᒃᑲᑦᑑᓂᖏᓐᓄᑦ, ᑕᒪᕐᒥᖅᑲᔭᐃᑦ ᐅᑭᐅᑉ ᐃᓚᐃᓇᖓᒎᑦ ᓂᕆᔭᒃᓴᖅᓯᐅᕝᕕᐅᖃᑦᑕᖅᑐᑦ ᐃᖃᓗᐃᓪᓗ ᐃᓂᒃᓭᖏᓐᓂᒃ. ᐅᑭᐅᑯᑦ ᐃᓂᒋᔭᐅᔪᑦ ᑕᐃᒪᐅᖃᑦᑕᖅᑐᑦ ᐊᒥᓲᖏᑦᑐᓂᒃ ᐃᑎᓂᖅᓴᓂᑦ (ᓲᕐᓗ, ᐊᖏᓂᖅᓴᖅ [>] 3 m) ᑕᓯᕐᓂᑦ ᑕᒫᓂ.

ᑯᒪᕈᐃᑦ ᑕᓯᕐᓂᑦ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖏᑦ ᐊᑦᑎᒃᑐᒥᑦ ᕿᑎᐊᓄᑦ ᑐᕐᕈᓂᖃᖅᑐᑦ ᐊᒪᓗ ᖃᓄᑎᒋᐅᓂᖏᑦ. ᐊᐟᓱᕆᒃᑐᓂᒃ ᐱᑕᖃᕐᓂᖅ 4-ᒥᑦ 26-ᒨᔪᖕᓇᖅᑐᑦ ᐊᑐᓂ ᑕᓯᐅᔪᒧᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ (ᐃᓚᐅᑉᓗᓂ ᖃᒪᓂᑦᑐᐊᖅ), chironomids ᐊᒥᓲᓂᖅᐹᖑᑉᓗᑎᒃ. ᑕᒪᒃᑯᐊ ᐱᑕᖃᖅᑐᑦ ᑲᓇᑕᒥᑦ ᑎᑎᕋᖅᑕᐅᓯᒪᙱᑦᑐᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᓂᖏᓐᓄᑦ ᓄᖑᑉᐸᓪᓚᐊᓂᕐᒧᑦ. ᑲᑎᓯᒪᔪᓂᒃ ᐊᕿᑦᑐᓂᒃ ᓯᑎᔪᓄᑦ ᑎᒥᓕᖕᓂᒃ ᑯᒪᕈᕐᓂᑦ Judge Sissons Lake-ᒥᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᔪᖅ ᐊᖏᔪᒥᒃ ᐃᓂᖃᕐᓂᕐᒧᑦ (Tier 3, Technical Appendix 5C).

ᒥᑭᔫᑎᑦ ᐱᕈᖅᑐᓄᑦ ᓈᓴᐅᑏᑦ ᓇᓗᓇᐃᖃᑦᑕᓚᐅᖅᑐᑦ ᑕᓲᑦ ᐱᓕᕆᐊᑉ ᐃᓂᖓᓃᑦᑐᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᓚᐅᖅᑐᑦ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖏᓐᓂᒃ ᑲᓇᑕᐅᑉ ᑕᓯᖏᓂᒃ. ᐆᒪᔪᓂᒃ ᐱᑖᓛᑦ ᐊᔾᔨᒋᖏᓕᕇᖃᑦᑕᖅᑐᑦ ᑕᓯᕐᓂᑦ. ᐊᒥᓱᑦ ᒥᑭᔪᑦ ᐱᕈᖅᑐᐃᑦ ᐊᔾᔨᒌᖕᓂᖃᖅᐳᑎᒃ ᑕᐃᒪᐅᔪᑦ; ᑭᓯᐊᓂ, ᑕᒪᕐᒥᒃ ᑲᓇᑕᒥᑦ ᓄᓇᕗᒻᒥᓘᓐᓂᑦ ᑎᑎᕋᖅᑕᐅᓯᒪᙱᑦᑐᑦ.

ᐆᒪᔪᕋᓛᑦ ᒥᑭᓂᖅᓴᐅᓚᔫᑦᑐᑦ ladocerans ᐅᕙᓗᓃᑦ calanoid copepods-ᓂᐅᖕᒪᓂᑦ, rotifers ᑕᐃᒪᐅᖏᓐᓇᖃᑦᑕᖅᑯᑎᒃ ᐊᒥᓲᓚᖑᑉᓗᑎᒃ. ᐊᒥᓱᑦ ᐊᔾᔨᐅᖏᑦᑐᑦ ᐆᒪᔪᕋᓛᑦ ᑲᑎᕐᒪᔪᑦ ᑕᐃᒪᐅᔪᑦ ᖃᓂᑦᑐᒥᒃ ᖃᐅᔨᓴᐃᓂᑦᒥ ᑕᓯᕐᓄᑦ; ᑭᓯᐊᓂ, ᑕᒪᕐᒥᒃ ᑲᓇᑕᒥᑦ ᓄᓇᕗᒻᒥᓘᓐᓂᑦ ᑎᑎᕋᖅᑕᐅᓯᒪᙱᑦᑐᑦ.

<u>ᑰᖓᓛᑦ</u>

ᑰᖓᓛᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᒥᑭᓂᖅᓴᐅᔪᑦ ᑰᒃᑐᓂᒃ ᐊᒪᓗ ᒪᓂᕋᐅᓂᐅᔪᒥᑦ ᐃᓂᒋᔭᐅᔪᓂᑦ, ᐃᒪᖃᕐᓃᑦ, ᐃᒪᖅᓯᐃᑦ, ᐊᒪᓗ ᐃᓂᒋᔭᐅᔪᑦ ᖃᐅᔨᔭᐅᓚᔪᙱᓐᓂᖅᓴᐅᓚᐅᖅᑐᑦ. ᐃᓚᖏᑦ ᑰᓪᓚᕆᖕᓂᖅᓴᐃᑦ, ᐊᒪᓗ ᐃᒪᖃᕈᖕᓃᖅᑲᔭᖅᓯᒪᔪᑦ ᑕᐃᒪᐅᖃᑦᑕᖅᑐᑦ ᐊᐅᔭᒃᑯᑦ. ᑰᖓᓛᑦ 1 ᒦᑕᒥᒃ ᒥᑭᓂᖅᓴᐅᖃᑦᑕᖅᑐᑦ; ᑭᓯᐊᓂ, ᐃᑎᓃᑦ ᐊᔾᔨᕇᖏᓐᓂᖃᕈᖕᓇᖃᑦᑕᖅᑐᑦ ᖃᑉᓯᐊᕐᔪᖕᓂᒃ cm-ᓂᑦ ᐊᖏᓂᖅᓴᐅᔪᒥᒃ 7 ᒦᑕᒨᑦ Thelon River ᑯᖕᒥᑦ. ᐊᓘᖏᑦ ᓯᐅᕋᐅᔪᑦ, ᐊᔾᔨᑐᖓᔪᑦ ᐊᖏᓂᖏᑦ ᐅᔭᖅᑲᐃᑦ, ᐅᔭᕋᓲᔪᐃᑦ ᐊᒪᓗ ᒪᕋᖅ. ᐃᓚᕆᔭᐅᔪᑦ ᑰᖕᓂᐅᔪᖕᓇᖅᑐᑦ, ᐱᕈᖅᑐᐃᑦ ᐊᒪᓗ ᓯᓃᑦ. ᑰᒃᑐᑦ ᑕᓯᕐᒧᑦ ᐃᒪᐅᑉ ᖄᖓᓃᑐᓂᒃ ᐱᕈᖅᑐᖅᑐᖃᕋᔫᒃᑐᑦ ᐊᒪᓗ ᐊᑉᓯᒪᐅᖅᑯᑎᒃ ᒪᓂᕋᐅᖏᑦᑐᓂᒃ ᐊᓘᐊᓂᑦ, ᐃᓚᖏᑦ ᑰᓛᑦ ᑕᑯᒃᓴᐅᔪᓂᒃ ᐃᒪᐅᑉᓘᓃᑦ ᐊᑖᓂᑦ ᐱᕈᖅᑐᖅᑕᖅᑯᑎᒃ. ᐊᒥᓱᑦ ᐊᖏᓂᖅᓴᐃᑦ ᑰᓛᑦ ᐋᕿᐅᒪᔪᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᓱᓗᒃᐸᐅᓚᓛᑦ ᒫᓂᐅᕝᕕᖏᑕᖃᐅᖅᑐᑦ, ᐊᓯᖏᑦ ᐃᖃᓗᐃᑦ ᑰᓛᕐᒧᐊᖃᑦᑕᖅᑯᑎᒃ ᓯᑯᓯᒪᙵᑎᓪᓗᒍ ᓂᕆᔭᒃᓴᖅᓯᐅᖅᑯᑎᒃ, ᐅᕙᓗᓃᑦ ᕿᒫᑉᓗᑎᒃ ᐊᓯᖏᓐᓂᒃ ᓂᕆᔭᐅᕆᐊᒃᓴᒧᑦ ᐅᑭᐅᖑᑎᓪᓗᒍ. ᑰᓛᒥᑦ ᑯᒪᕈᐃᑦ ᐊᖏᓂᖅᓴᒥᑦ ᐊᒥᓲᓂᖅᓴᐅᔪᖕᓇᖅᑐᑦ ᑕᓯᕐᓂᐅᖕᒪᓂᑦ. Chironomids ᐊᒥᓲᓂᖅᓴᐅᖃᑦᑕᕐᓂᕋᖅᑕᐅᔪᑦ ᐅᓂᑉᑳᓂᑦ; ᑭᓯᐊᓂ, ᖃᑉᓯᐊᕐᔪᐃᑦ ᑰᓛᑦ ᐅᓂᑉᑲᐅᓯᖃᖃᑦᑕᖅᑐᑦ ᐊᒥᓲᓂᖅᓴᓂᒃ oligocheate-ᑯᒪᖕᓂᒃ ᐅᕙᓗᓃᑦ hydridae-ᓂᒃ.

ᑰᓛᒥᑦ periphyton ᐊᒥᓲᖏᓐᓂᖅᓴᐅᓚᔫᑦᑐᑦ chlorophytes-ᓂᐅᖕᒪᓂᑦ ᐊᒪᓗ diatoms-ᓂᐅᖕᒪᓂᑦ. Taxonomic-ᖃᐅᖅᑐᑦ periphytic-ᓂᑦ ᐃᓱᒪᕆᔭᐅᔪᖅ ᐊᔾᔨᐸᓗᕆᖕᒪᕆᑦ ᐊᓯᖏᓐᓂᑦ ᐃᒪᕐᓂᑦ, diatoms taxonomic-ᖃᐅᕐᓂᖅᓴᐅᑉᓗᑎᒃ ᑰᓛᓂᑦ ᐱᓕᕆᐊᑉ ᖃᓂᖓᓂᑦ. ᐊᒥᓱᑦ ᐊᔾᔨᐅᖏᑦᑐᑦ periphyton taxa ᑕᐃᒪᐅᔪᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ; ᑭᓯᐊᓂ, ᑕᒪᕐᒥᒃ ᑲᓇᑕᒥᑦ ᓄᓇᕗᒻᒥᓘᓐᓂᑦ ᑎᑎᕋᖅᑕᐅᓯᒪᙱᑦᑐᑦ.

ᐊᕙᑎᒥᒃ ᖃᓄᐃᖓᓕᕈᑎᓄᑦ ᖃᐃᓵᓴᐃᓂᖅ ᐃᒪᕐᒥᑦ ᐆᒪᔪᕋᓛᓂᒃ ᐊᒻᒪ ᐃᖃᓗᐃᑦ ᐃᓂᖏᓐᓄᑦ

ᐱᓕᕆᐊᒧᑦ ᖃᓄᐃᓕᕐᓂᐅᔪᑦ ᐊᓯᐊᙳᖅᓯᓂᖃᑐᐃᓐᓇᕆᐊᖃᖅᑐᑦ ᐊᒥᓲᓂᖏᓐᓄᑦ ᐅᕙᓘᓃᑦ ᓇᒨᕙᐅᓂᖏᓐᓄᑦ ᐃᒪᕐᒥᑦ ᐆᒪᔪᕋᓛᑦ, ᐅᕙᓘᓃᑦ ᖃᓄᐃᖓᓂᕆᔭᖏᓐᓄᑦ ᓇᒨᕙᐅᓂᖏᓐᓅᓘᓃᑦ ᐃᖃᓗᐃᑦ ᐃᓂᒋᔭᖏᑦ. ᐱᓕᕆᐊᙳᐃᓯᒪᔪᑦ ᕿᕐᕕᓐᓂᙱᖅᑐᕋᓗᐃᑦ ᑯᕕᔭᐅᔪᑦ ᑭᒻᒐᕝ ᐊᒻᒪ Sissons WTP-ᒥᑦ ᐊᒃᑐᖅᓯᓂᖃᑐᐃᓐᓇᕆᐊᖃᖅᑐᑦ ᐃᒪᐅᑉ ᖃᖓᑕ ᖃᓄᐃᓐᓂᕆᔭᖓᓂᑦ. ᑕᒪᒃᑯᐊ ᐊᓯᐊᙳᕐᓃᑦ ᐊᒃᑐᖅᓯᓂᖃᕈᓐᓇᖅᑐᑦ ᑲᑎᓯᒪᔪᓂᒃ COPC-ᓂᑦ ᐃᒪᕐᒥᑦ ᐱᕈᖅᑐᓄᑦ (ᓲᕐᓗ, ᐃᒪᕐᒥᑦ ᐱᕈᖅᑐᑦ, ᐆᒪᔪᕋᓛᑦ). ᐱᓕᕆᐊᖅ ᐱᕙᓪᓕᐊᑎᓪᓗᒍ ᐊᒃᑐᖅᓯᓂᖃᖃᑦᑕᑐᐃᓐᓇᕆᐊᖃᖅᑐᑦ ᐊᒻᒪ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓗᓂ ᐃᖃᓗᐃᑦ ᐃᓂᖏᓐᓂᒃ ᑕᒪᓐᓇ ᐃᓱᒪᓘᑕᐅᔪᖅ ᓄᓇᓕᖕᒥᐅᓄᑦ (EN-CH OH Nov 2010[33]).

ᐅᓗᕆᐊᓇᕈᓐᓇᖅᑐᑦ ᐃᒪᕐᒥᑦ ᐆᒪᔪᕋᓛᓄᑦ ᐱᓕᕆᐊᙳᐃᓯᒪᔪᒧᑦ ᕿᕐᕕᖕᒥᙱᖅᑐᕋᓗᓐᓂᑦ ᐊᙳᓗᐊᖕᒋᒋᐊᖅᑎᑕᐅᓂᐊᖅᑐᖅ ᐊᕙᑎᒧᑦ ᐊᐅᓚᑦᑎᓂᕐᔫᖓᔪᑎᒍᑦ ᐃᓚᓕᐅᑎᔭᐅᔪᖅ ᖃᓄᐃᖓᓂᕆᔭᖓᓄᑦ WTP. ᖃᓄᐃᖓᓂᕆᔭᖓ WTP ᑕᐅᑐᖓᖃᕐᓂᐊᖅᑐᖅ ᕿᕐᕕᖕᒥᙱᖅᑐᓄᑦ ᒪᓕᒃᑐᓄᑦ ᐃᒪᐅᑉ ᖃᓂᐃᑦᑕᕆᐊᖃᕐᓂᖓᓄᑦ ᒪᓕᒃᑕᐅᔫᖅᓴᓂᑦ. ᐊᑉᕐᑯᓯᐅᖅᑕᐅᔪᑦ ᐱᓕᕆᐊᒧᑦ ᐋᕿᐅᒪᓂᐊᖅᑐᑦ ᑰᒃᑐᑦ ᐊᒃᑐᐊᓂᖃᖅᑐᑦ ᐊᑉᕐᑯᑎᒋᔭᐅᔪᒧᑦ ᐊᓯᐅᔾᔭᐅᔾᔮᕆᓪᒪᑕ ᐋᕿᒃᓱᖅᑕᐅᓯᒪᔪᑎᒍᑦ ᐃᑳᕐᕕᓕᐊᑎᒍᑦ (ᓲᕐᓗ, ᓱᑉᓗᐃᑦ, ᐃᑳᕈᑏᑦ). ᓵᓇᔭᐅᓂᖏᑦ ᑰᓚᓛᓂᑦ ᐃᑳᕈᑏᑦ ᐱᓕᕆᐊᙳᓂᐊᖅᑐᑦ ᐊᒃᑐᖅᓱᐊᖏᕆᐊᕐᓂᒃᑯᑦ ᐃᖃᓗᙱᒃ ᐃᓂᒋᔭᖏᓐᓂᓪᓗ. ᐱᐅᓛᒃᑯᑦ ᐊᐃᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᔪᑦ (BMP) ᐊᑐᖅᑕᐅᓂᐊᖅᑐᑦ ᓴᓇᕚᓕᐊᑎᓪᓗᕆᑦ Andrew Lake-ᒥᑦ; ᑕᓯᐅᑉ ᐊᓗᐊᓂᑦ (turbidity) ᑕᓗᐃᑦ ᐃᓕᔭᐅᓂᐊᖅᑐᑦ ᓴᓇᔭᐅᓂᐊᓵᖅᑎᓪᓗᒍ ᐊᒻᒪ ᐃᒪᐃᔭᐃᓂᖅᑕᖃᕐᓂᐊᓵᖅᑎᓪᓗᒍ. ᐃᖃᓗᙱᒃ ᐊᓇᒃᑎᕆᓂᖅᑕᖃᕐᓂᐊᖅᑐᖅ ᐃᒪᐃᔭᐃᓂᐊᓵᖅᑎᓪᓗᕆᑦ ᒥᑭᓛᑰᖓᑎᑦᑎᓂᕐᒧᑦ ᐃᖃᓗᙱᒃ ᑐᕐᑯᕋᐃᓂᕐᒧᑦ.

ᖃᐅᔨᓴᐃᓂᖅ ᐊᓯᐊᙳᕐᓂᕐᒧᑦ ᓇᒨᕙᐅᑎᑦᑎᓂᕐᒧᑦ (ᓲᕐᓗ, ᑕᐃᒪᐅᔪᑦ/ᐱᑕᖃᙱᑦᑐᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ) ᐊᒻᒪ ᐱᑕᖃᐅᕐᓂᖏᑦ ᐆᒪᔪᕋᓛᑦ ᐃᓕᑕᕆᔭᐅᔪᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᔫᓇᕐᓂᖏᓐᓄᑦ cadmium-ᒧᑦ ᐊᒃᑐᐊᓂᖏᓐᓄᑦ zooplankton-ᓄᑦ. ᓂᕆᐅᒋᔭᐅᔫᖅ cadmium ᑲᑎᑎᓯᒪᔪᑦ ᓂᕈᐊᖅᑕᐅᔪᓂᒃ Judge Sissons Lake-ᒥᑦ ᕐᑯᑦᑎᒃᓯᒋᐊᖅᑕᐅᓂᐊᖅᑐᑦ ᑕᐅᑐᙴᖅᑯᕆᑦ ᑭᒡᓕᒋᔭᐅᔪᑦ. ᐊᔪᕐᓇᙱᑦᑐᖅ ᐃᓚᖏᓐᓂᒃ ᑕᓯᕐᓂᑦ, ᐃᓚᖏᑦ ᐃᒃᐱᒋᓂᖃᕐᓂᖅᓴᐅᔪᑦ zooplankton ᐊᒃᑐᖅᑕᐅᓯᒪᓂᖃᕐᓂᐊᕐᓂᖏᓐᓄᑦ; ᑭᓯᐊᓂ, ᐃᓱᒪᒋᐸᓗᒍ ᐊᑦᑎᒃᑐᒥᑦ ᕿᑎᐊᓄᑦ ᐊᒃᑐᖅᑕᐅᓂᖏᑦ ᐅᓗᕆᐊᓇᖅᑐᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ zooplankton-ᓄᑦ ᐊᒻᒪ ᓄᓇᐅᔪᒧᑦ ᖃᓄᐃᖓᓕᖃᕐᓂᐅᔪᒥᑦ, zooplankton ᐊᒻᒪ ᕐᑯᑦᑎᒃᓯᓯᒪᔪᑦ ᑲᑎᑎᓯᒪᔪᑦ ᐅᑭᐅᑰᑎᓪᓗᒍ, ᖃᑉᓯᐅᓂᖏᑦ Judge Sissons Lake-ᒥᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᐆᒪᓂᖃᐃᓐᓇᕐᓂᐊᕐᓂᖏᓐᓂᒃ. ᕿᒪᒃᑎᑦᑐᓄᑦ ᖃᓄᐃᖓᓕᕈᑎᖃᕋᓗᐊᖅᑎᓪᓗᒍ, ᖃᓄᐃᖓᓕᕈᑕᐅᔪᓂᒃ ᐊᒥᓲᓂᖏᓐᓄᑦ ᐊᒻᒪ ᓇᒨᕙᐅᓂᖏᓐᓄᑦ ᐆᒪᔪᕋᓛᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᐊᓯᐊᙳᕐᓂᖏᓐᓄᑦ COPC ᑲᑎᓯᒪᔪᑦ ᐃᓂᒋᔭᐅᔪᒥᑦ.

ᐆᒪᔪᕋᓛᑦ ᖃᑉᓯᐅᓂᖏᑦ ᐊᒻᒪ ᖃᓄᑎᒋᐅᓂᖏᑦ ᖃᐅᔨᒋᐊᖅᑕᐅᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐅᔭᕋᓐᓂᐊᕐᕝ ᐊᐅᓛᖅᑎᓪᓗᒍ, ᐅᒃᑯᐊᖅᑎᓪᓗᒍ ᐊᒻᒪ ᐅᒃᑯᐊᖅᓯᒪᓕᖅᑎᓪᓗᒍ ᖃᐅᔨᓂᐊᕐᓗᒍ ᕿᕐᕕᓐᓂᙱᖁᓗᒃᑐᑦ ᑯᕕᔭᐅᔪᑦ WTP-ᒥᑦ ᐆᒃᑐᕋᖅᑕᐅᔫᓐᓇᖅᑐᓂᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᖃᕐᒪᙵᑕ VEC-ᓂᑦ ᓲᕐᓗ ᑯᒪᕈᐃᑦ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ (Tier 3, Technical Appendix 5M).

MMER-ᑯᑎᒎᑦ, ᐊᑏᕙᒃᑯᑦ ᐊᕙᑎᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒥᒃ (EEM) ᐱᔭᕆᐊᖃᖅᑎᑕᐅᔪᑦ ᖃᐅᔨᓂᕐᒧᑦ ᕿᕐᕕᙱᓐᓂᙱᖁᓗᖕᓂᒃ ᑯᕕᑎᑕᐅᔪᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᖃᕐᒪᖔᑦ. ᑕᒪᒃᑯᐊ ᒪᓕᓚᐃᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖃᕆᐊᖃᖅᑎᑦᑎᔪᑦ ᕿᕐᕕᖕᒥᙱᖁᓗᐃᑦ ᖃᓄᐃᓕᐅᕐᓂᖃᕐᒪᖔᑕ, ᕿᕐᕕᖕᒥᙱᖁᓗᒃᑐᑦ ᐅᓗᕆᐊᓇᖅᑐᑦ ᐊᒻᒪ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓂᑦ. ᐆᒻᒪᓂᐅᔪᓂᒃ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᑯᒪᕈᕐᓂᑦ ᕿᕐᕕᖕᒥᙱᖁᓗᒃᑐᓄᑦ

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[33] EN-CH OH ᓄᕕᐱᕆ 2010: *ᐊᑐᕈᓐᓃᖅᑎᑕᐅᔪᖅ ᑕᓯᖅ ᐃᖃᓗᓐᓄᑦ ᐃᓂᒋᔭᐅᔪᖃᖅᐸᑦ?*

ᐱᔭᕆᐊᖃᕐᓂᐅᖏᖦ. ᑕᒪᒃᑯᐊ ᖃᐅᔨᓴᐃᓃᑦ ᐊᑐᓕᖅᑎᑕᐅᓂᐊᖃᖅᑐᑦ ᒪᓕᒡᒍᓯᑦ ᒪᓕᒃᑕᐅᔭᕆᐊᖃᖅᑐᑦ ᐅᖃᐅᓯᐅᔪᑦ MMER-ᒥᑦ ᐊᒻᒪᓗ ᐋᕿᒃᑕᐅᓂᐊᖅᓱᑎᒃ ᐊᑐᕐᓗᑎᒃ ᐊᑐᓕᖅᑎᑦᑎᓂᕐᒨᖓᔪᑎᒍᑦ, ᐋᔩᐅᖏᑦᑐᑦ ᐱᔾᔪᑕᐅᔪᑦ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᖓᓃᑐᑦ ᐃᓱᒪᒋᓗᒋᑦ.

ᐃᓚᖏᑦ ᐱᕚᓪᓕᐊᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᐱᓕᕆᐊᒧᑦ ᐋᓂᖅᓯᓂᖃᖅᑐᑦ ᐃᖃᓗᓐᓄᑦ ᑐᑭᓕᐅᖅᑕᐅᓂᖓᑐᑦ ᐃᖃᓗᓕᕆᓂᕐᒧᑦ ᐱᕐᑯᔭᒥᑦ. ᓴᓇᕚᓪᓕᐊᓕᕆᓂᖅ ᑕᓯᕐᒧᑦ ᑯᒃᑐᓂᑦ ᐋᕿᒃᓯᖅᑕᐅᓂᐊᖅᑐᑦ ᒥᒃᓵᒋᐊᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᓄᐃᖓᓕᕈᑕᐅᔪᓐᓄᑦ ᐃᖃᓗᓐᓄᑦ ᐃᓂᖏᓐᓄᓪᓗ, ᓂᕆᐅᒋᔭᐅᔪᖅ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᐊᓯᐅᔩᓂᖃᖅᑎᑦᑎᓂᐊᖅᑐᑦ ᐅᕙᓘᓃᑦ ᐊᓯᐊᕈᖅᑎᑦᑎᓗᑎᒃ ᐃᖃᓗᐃᑦ ᐃᓂᒋᔭᖏᓐᓂᒃ. ᑕᒪᓐᓇ ᐱᓕᕆᐊᕆᓂᐊᕐᓗᒍ ᐃᖃᓗᐃᑦ ᐃᓂᒋᔭᖏᑦ ᐋᓂᖅᑎᓪᓗᒋᓪᓗ ᐃᖃᓗᐃᑦ, ᑕᐅᑐᒐᐅᔪᖅ ᐃᖃᓗᓕᕆᓂᕐᒧᑦ ᐸᕐᓇᐅᑎ (Tier 3, Technical Appendix 5L) ᐱᙳᖅᑎᑕᐅᓚᐅᖅᑐᖅ. ᐊᖏᖅᑕᐅᓚᐅᖅᑎᓪᓗᒋᑦ ᐸᕐᓇᐅᑎᒧᑦ, ᐊᒻᒪᓗ ᐊᑐᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐅᑎᖅᑎᑦᑎᓂᕐᒨᖓᔪᑦ, ᕿᒪᒃᑎᑦᑐᓄᑦ ᖃᓄᐃᖓᓕᕈᑕᐅᔪᑦ ᐱᓕᕆᐊᒥᑦ ᐃᖃᓗᐃᑦ ᐱᕚᓪᓕᐊᓂᖏᓐᓄᑦ ᐅᑎᖅᑎᑕᐅᓗᒃᑖᕐᓂᐊᖅᑐᑦ.

ᑕᐅᑐᒃᓱᒍ ᖃᐅᔨᓴᐃᓂᖅ ᐃᖃᓗᐃᑦ ᖃᓯᐅᓂᖏᓐᓄᑦ

ᒫᓇᐅᔪᖅ ᐊᕙᑎ – ᐃᖃᓗᐃᑦ ᖃᓯᐅᓂᖏᑦ

ᑐᑭᓯᐅᒪᔾᔨᑏᑦ ᐃᖃᓗᐃᑦ ᓇᒧᙵᐅᓂᖏᓐᓄᑦ ᐊᑐᖅᓱᓂ ᑎᑎᕋᐅᓯᐅᓯᒪᓂᑯᓂᐅᓚᐅᖅᑐᖅ, ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂᒃ ᐊᐱᖅᓱᐃᓂᒃᑯᑦ, ᐃᓚᐅᖃᑕᐅᓂᕐᒧᑦ ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ, ᐊᒻᒪᓗ ᑭᒡᓕᓂᑦ ᐊᐱᖅᓱᐃᓃᑦ ᐱᐊᓂᒃᑕᐅᔪᑦ ᑭᒡᒐᒃ ᐱᓕᕆᐊᒧᑦ. ᐱᖁᓯᕆᔭᐅᔪᑎᒍᑦ ᐊᒻᒪᓗ ᒫᓇᐅᔪᖅ ᐃᖃᓗᒃᓯᐅᕐᕕᐅᔪᑦ ᐃᓕᑕᕆᔭᐊᓚᐅᖅᑐᑦ ᐊᐱᖅᓱᐃᓂᒥᑦ ᐊᒻᒪᓗ ᑕᐅᑐᒐᖃᕐᓂᒧᑦ ᑲᑐᔾᔨᖃᑎᒌᑎᒍᑦ ᐅᖃᓪᓚᖃᑎᒌᖕᓂᒃᑯᑦ; ᑖᓐᓇ ᑐᑭᓯᐅᒪᔾᔨᑎ ᑕᑯᒃᓴᐅᑎᑕᐅᓚᐅᖅᑐᖅ ᑕᐃᒪᓐᓂᒃ ᓄᓇᙳᐊᓂᑦ (Tier 2, Volume 3, Part 2-ᒥᑦ) ᐊᒻᒪᓗ ᑎᑎᕋᖅᑕᐅᓯᒪᔪᑎᒍᑦ ᐅᖃᐅᓯᐅᔪᓂᒃ (ᓱᕐᓗ EN-BL CLC ᕖᕝᐊᕆ 2007[34], IQ-BLE 2009[35]. IQ-RBH 2011[36], IQ- BL17 2008[37]).

ᖃᓄᐃᖕᓂᐅᔪᑦ ᐃᖃᓗᓐᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᓇᓗᓇᐃᖅᓯᔪᑦ ᐃᖃᓗᐃᑦ ᒥᒃᓵᓄᑦ ᑲᑎᖅᓯᐃᓂᖅ ᑕᓯᕐᓂᑦ ᑰᓪᓚᓂᓪᓗ ᐱᓕᕆᐊᑉ ᖃᓂᑕᙵᓂᑦ ᐋᔩᖏᖅᐳᑦ ᐅᖃᐅᓯᐅᔪᑦ ᐅᑭᐅᖅᑕᖅᑑᑉ ᑭᒡᓕᖓᑕ ᓂᒋᐊᓃᑐᓂᑦ. ᓱᓗᒃᐸᐅᓚᓖᑦ ᓇᓂᓗᒃᑖᖅᓯᒪᓕᙶᓚᐅᖅᑐᑦ ᑕᓯᕐᓂᑦ ᐊᒻᒪᓗ ᑰᓪᓚᓂᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ, ᐃᕗᓪᓚᐃᑦ ᑐᒃᓕᐅᑉᓗᑎᒃ.

ᐅᑯᐊ 7-ᙳᔪᑦ ᐃᖃᓗᐃᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒦᓚᐅᖅᑐᑦ: ᓱᓗᒃᐸᐅᓚᐃᑦ, burbot, cisco, ᐃᕗᑫᐃᑦ, ninespine stickleback, round whitefish ᐊᒻᒪᓗ slimy sculpin. ᑕᒪᒃᑯᐊ ᑕᐃᒪᐅᓚᐅᕐᒥᔪᑦ ᖃᒪᓂᑦᑐᐊᕐᒥᑦ, ᓯᑕᒪᒃᑲᓐᓂᕐᓂᒃ ᐃᓚᖃᖅᓱᑎᒃ: ᐃᖃᓗᒃᐲᑦ, fourhorn sculpin, lake whitefish ᐊᒻᒪᓗ longnose sucker. ᓇᓗᓇᐃᔭᖅᓯᒪᔪᑦ ᐃᖃᓗᐃᑦ ᓇᒧᙵᐅᑕᕐᓂᖏᑦᑕ ᑕᓯᕐᓂᑦ ᐊᒻᒪᓗ ᑰᓪᓚᓂᑦ ᑕᑯᒃᓴᐅᔪᑦ Tier 3, Technical Appendix 5C.

ᑕᓯᕐᒥᑦ fourhorn sculpin ᐃᖃᓗᑐᐊᙳᔪᑦ ᐱᓕᕆᐊᑉ ᖃᓂᑕᙵᓂᑦ ᑎᑎᕋᖅᑕᐅᓯᒪᔪᓂᑦ ᑲᓇᑕᒥᑦ ᓂᕈᐊᑦ *ᐅᓗᕆᐊᓇᖅᑐᑏᑐᓄᑦ ᐱᖁᔭᖅ* (SARA)-ᒥᑦ ᐊᒻᒪᓗ ᑲᑎᒪᔨᕋᑖᑦ ᓇᓃᓐᓂᖏᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑐᑦ ᓂᕈᐊᑦ ᑲᓇᑕᒥᑦ

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[34] ᐅᖃᖅᑐᖃᓚᐅᖅᑐᖅ Sissons Lake-ᒥᑦ ᐃᖃᓗᐃᑦ ᓂᕿᖏᑦ/ᑎᒥᖏᑦ ᐋᕿᓗᐊᖅᑑᓕᕐᒪᑕ ᓄᓱᑐᐃᓐᓇᖅᓱᒋᓗᓃᑦ.

[35] IQ-BLE 2009: *ᐃᓐᓇᑐᖃᒃᑖᖅᑲᔭᐃᑦ ᖃᒪᓂᑦᑐᐊᕐᒥᑦ ᑕᐅᑐᒐᖃᕐᓂᕐᒧᑦ ᑲᑎᒪᔩᑦᑎᑕᐅᔪᑦ ᐅᖃᓚᐅᖅᑐᑦ, ᑐᒃᑐᐃᑦ ᐃᖃᓗᐃᓪᓗ ᓂᕿᒋᔭᐅᓗᐊᕐᓂᖏᓐᓄᑦ.*

[36] IQ-RBH 2011: *ᐃᖃᓗᒃᐲᑦ ᐃᕗᑫᐃᓪᓗ ᐃᖃᓗᒃᓯᐅᖅᑕᐅᖃᑦᑕᖅᑐᑦ ᒪᑦᑎᑕᐅᑎᒃᑯᑦ ᐊᐅᔭᒃᑯᑦ.*

[37] IQ- BL17 2008: *ᕼᐊᓪᓕᖅ ᐱᒻᒪᕆᐅᔪᖅ ᐃᖃᓗᒃᓯᐅᕐᕖᑦ ᐅᓂᕐᒧᑦ*

(COSEWIC)-ᒥᑦ. Fourhorn sculpin ᑎᑎᕋᖅᑕᐅᓯᒪᔪᑦ 'ᐃᓱᒫᓗᓐᓇᖅᑐᑦ'-ᑎᑐᑦ ᒪᓕᒃᓗᒍ ᑎᑎᖅᑲᖅ 3 (SARA)-ᒥᑦ, ᐊᒻᒪᓗ "ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ ᐊᒥᒐᖅᑐᑦ" ᓂᕐᔪᑏᑦ (COSEWIC)-ᑯᓐᓄᑦ (COSEWIC 2003).

ᐊᕙᑎᒥᒃ ᖃᓄᐃᖓᓕᕈᑎᓄᑦ ᖃᐃᓐᓴᐃᓂᖅ ᐃᖃᓗᐃᑦ ᖃᖠᐅᓂᖏᓐᓄᑦ

ᐱᔾᔪᑕᐅᔪᑦ ᐃᓕᑕᕆᔭᐅᓚᐅᖅᑐᑦ ᐃᖃᓗᐃᑦ ᖃᖠᐅᓂᖏᓐᓄᑦ ᖃᓄᐃᖓᓕᕈᑕᐅᑐᐃᓐᓇᕆᐊᖃᖅᑐᓄᑦ ᐱᖃᖃᑕᐅᔪᑦ ᐃᓚᐅᖃᑕᐅᓂᖃᖅᑎᓪᓗᒋᑦ ᖄᖅᑕᖅᑎᕆᓂᒃᑯᑦ ᐃᒪᕐᒥᑦ ᖃᓂᑕᖓᓂᒡᓘᓃᑦ ᐊᒻᒪᓗ COPC-ᓄᑦ ᖃᓄᐃᖓᓕᕈᑎᖃᕐᓂᕐᒧᑦ ᐃᖃᓗᐃᑦ ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ (EN-CI KIA ᑲᑉᐸᐊᕆ 2010[38], EN-KIV OH ᐅᒃᑑᐱᕆ 2009[39], EN-CH OH ᐅᒃᑑᐱᕆ 2012[40]). ᖃᓄᐃᖓᓕᕈᑎᖃᑐᐃᓐᓇᕆᐊᓕᒃ ᐃᖃᓗᐃᑦ ᓂᕆᔭᐅᓂᖏᓐᓄᑦ ᐃᓄᖕᓄᑦ ᑎᑎᕋᖅᓯᒪᔪᑦ ᐃᓄᐃᑦ ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓐᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ (Tier 2, Volume 8).

ᖄᖅᑕᖅᑎᕆᓂᖅ ᐊᓯᐊᙳᖅᓯᓂᖃᖅᑎᑦᑎᔾᔪᓐᓇᖅᑐᖅ ᐃᖃᓗᐃᑦ ᐃᓕᖅᑯᓯᖏᓐᓂᒃ ᐅᕙᓗᐊᓂᑦ ᐋᓂᖅᓯᓗᑎᒃ ᐃᖃᓗᖕᓂᒃ, ᒪᓂᖏᓐᓂᒃ, ᐊᒻᒪᓗ ᐃᖃᓗᐊᓛᖑᔪᓂᒃ. ᐃᒪᕐᒥᐅᑕᓕᕆᔾᔪᑯᑦ ᑲᓇᑕᒥᑦ ᒪᓕᒃᑕᐅᔪᒃᓴᕆᑦ ᐅᖃᖅᓯᒪᔪᑦ ᖄᖅᑕᖅᑎᕆᓂᕐᒧᑦ ᑕᒃᑯᖖᒐᑦᑕᐃᓐᓇᖅ ᐃᒪᐅᑉ ᐅᕐᑯᒪᐃᓂᖓ ᐊᓯᐊᙳᒃᑳᓕᖕᓂᖅ (IPC) ᐊᖏᓂᖅᓴᐅᔭᕆᐊᖃᙱᑦᑐᖅ 50 kiloPascals (kPa)-ᒥᑦ ᒥᐊᓂᕆᑦᑎᐊᕐᓂᕐᒧᑦ ᐃᖃᓗᐃᑦ. ᑕᐃᒪᓐᓇᒧᑦ, ᖃᓄᑎᒋ ᐅᖓᓯᒃᑎᒋᓂᖃᕆᐊᖃᖅᑐᑦ ᒪᓕᖓᓂᐊᕐᓗᒍ 50 kPa-ᒧᑦ ᒪᓕᒃᑕᐅᔫᓴᐃᑦ. ᐊᑐᖅᑕᐅᔪᑦ Andrew Lake-ᒥᑦ ᓴᓇᔭᐅᑎᓪᓗᒍ ᓇᓗᓇᐃᖅᓯᓚᐅᖅᑐᖅ ᖄᖅᑎᕆᓃᑦ ᖃᓂᓗᐊᕐᓂᖏᓐᓄᑦ Andrew Lake-ᒧᑦ ᑭᒡᓕᖅᑕᐅᓯᒪᔪᒧᑦ ᐃᒪᕐᒥᐅᑦ ᐅᕐᑯᒪᐃᓐᓂᕐᒧᑦ ᐊᓯᐊᙳᕐᓂᖅ. ᐊᖏᓗᐊᖏᑦᑎᐊᖅᑎᑦᑎᒃᑲᓂᕐᓂᐅᔪᓂᒃ ᐱᑕᖃᕆᐊᖃᖅᑐᖅ. ᐊᒻᒪᓗ ᐃᒪᕐᒥᐅᑕᓕᕆᔾᔪᑯᑦ ᐱᔭᕆᐊᖃᖅᑎᑦᑎᖏᒥᔪᑦ ᓴᔪᖕᓂᐅᔪᑦ ᖄᖅᑎᕆᓂᕐᒥᙵᖅᑐᑦ ᐅᖓᑕᐅᑎᕐᑯᔭᐅᖏᓗᒍ 13 millimetres-ᓂᒃ ᐊᑕᐅᓯᕐᒥᒃ ᓴᒃᑲ-ᑯᓗᐊᓂᑦ ᖃᐅᔨᓴᐅᑎᐅᑉ (mm/s) ᐃᒡᓕᕆᔭᐅᔪᓂᑦ ᒪᓃᔭᐃᑎᓪᓗᒋᑦ. ᓴᔪᒃᑐᓄᑦ ᐊᑐᖅᑕᐅᔪᑦ ᓇᓗᓇᐃᖅᓯᔪᖅ ᓱᓗᒃᐸᐅᒐᐃᑦ ᐃᒡᓕᖏᑦ ᐃᓕᑕᕆᔭᐅᔪᑦ Andrew Lake-ᒥᑦ ᑰᒐᓘᕐᒥᑦ ᖃᓂᓗᐊᕐᓂᙵᓄᑦ ᖄᖅᑎᕆᓂᕐᓂᑦ; ᑕᐃᒪᓕ, ᖄᖅᑎᕆᓂᖅ ᑖᒃᑯᓂ ᐊᖏᓗᐊᖏᑦᑎᐊᖅᑎᑦᑎᓂᖃᕆᐊᖃᖅᑐᖅ. ᐊᖏᓗᐊᖏᑦᑎᐊᖅᑎᑦᑎᓂᐅᔪᓐᓇᖅᑐᑦ ᑕᐃᒪᐅᔪᖅ ᖄᖅᑎᕆᖃᑦᑕᕐᓂᕐᒧᑦ Andrew Lake ᖃᓂᙵᓗᓂᑦ ᐊᒻᒪᓗ ᑰᒑᓂᑦ ᐃᓚᐅᔪᑦ ᒥᑭᓂᖅᓴᒥᒃ ᓵᙵᓂᑖᑦ ᓯᑯᓯᒪᙱᑎᓪᓗᒍᒥᑦ ᐊᒻᒪᓗ/ᐅᕙᓗᐊᓂᑦ ᒪᓂᓂᒃᓯᒪᑎᓪᓗᒋᑦ ᒥᒃᓯᒋᐊᖅᑎᓐᓂᕐᒧᑦ ᖄᖅᑎᕆᓂᖅ ᖃᓂᓐᓂᖏᑦ; ᖄᖅᑎᕆᓂᖅ ᓯᑯᖅᑎᓪᓗᒍ ᒥᐊᓂᖅᓯᓂᕐᒧᑦ Andrew Lake ᐃᖃᓗᖏᓐᓂᒃ; ᐊᒻᒪᓗ ᖄᖅᑎᕆᓂᖅ ᓯᓚᑖᓂ ᒪᓂᓂᒃᑲᐅᔪᐃᑦ ᒥᐊᓂᖅᓯᓂᕐᒧᑦ ᓱᓗᒃᐸᐅᒐᐃᑦ ᒪᓂᓕᐅᖅᑎᓪᓗᒋᑦ Andrew Lake ᑰᒑᖓᓂᑦ.

ᐊᖏᓗᐊᖏᑦᑎᐊᖅᑎᑦᑎᓂᖃᕐᓂᐅᔪᑦ ᐊᑐᓕᖅᑎᑕᐅᔪᑦ, ᐊᒻᒪᓗ IPC 50 kPa-ᖑᔪᒥᑦ, ᐅᕙᓗᐊᓂᑦ ᓴᔪᒃᑎᑦᑎᓂᐅᔪᖅ 13mm/s-ᒥᒃ ᐅᖓᑕᐅᑦᑎᙱᑦᑐᒋᓪᓗᒍ, ᓂᕆᐅᒋᔭᐅᖏᑦᑐᖅ ᕿᒪᒃᑎᑦᑐᓂᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᖅᑕᖃᕐᓂᐊᕐᓂᕐᒥᒃ ᐃᖃᓗᖕᓄᑦ.

ᖃᓄᑎᒋᐅᓂᖅ ᓴᔪᖕᓂᖅ ᐊᒻᒪᓗ IPC-ᒧᑦ ᐊᑐᖅᑐᑦ, ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᑐᕌᖓᔪᑦ ᓴᖅᑭᑕᐅᓂᐊᖅᑐᑦ ᐊᒻᒪᓗ ᐱᐊᓂᒃᑕᐅᓗᑎᒃ ᐃᓂᐅᔪᒥᑦ, ᐃᓂᒋᔭᐅᔪᓂᒃ ᐃᖃᓗᒃᑕᓕᖓᐅᓂᖏᑦᑐᖅ. ᐃᓂᐅᔪᒥᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᖅᑕᖃᕋᔭᖅᑐᖅ ᒪᓂᕋᒥᒃ ᓴᔪᖕᓂᕐᒧᑦ ᐊᒻᒪᓗ IPC-ᒧᑦ ᐅᖓᓯᖕᓂᖅᑎᑦᑎᓂᕐᒧᑦ, ᖄᖅᑎᕆᓂᐊᕌᖅᑎᓪᓗᒋᑦ ᐃᖃᓗᖃᖅᑐᐃᑦ ᖃᓂᑕᕆᓂᑦ.

ᐊᒃᑐᐅᓂᖃᑐᐃᓐᓇᓗᑎᐊᖃᕐᓂᖅ ᐃᖃᓗᐃᑦ COPC–ᓄᑦ ᕿᕐᑲᖕᓂᙵᓘᕋᓗᒃᑐᓂᒃ ᐊᖏᓗᐊᖏᑦᑎᐊᖅᑎᑕᐅᓂᐊᖅᑐᑦ ᐊᕙᑎᒧᑦ ᐊᐅᓚᑦᑎᓂᐅᔪᑎᒍᑦ ᐃᓚᔭᐅᓯᒪᔪᑦ ᖃᓄᐃᖏᑦᑎᐊᖏᓐᓄᑦ WTP. ᖃᓄᐃᖏᑦᑎᐊᖏᓐ WTP ᐱᕚᓕᐊᑎᑦᑎᓂᖅᑕᐅᓂᐊᖅᑐᖅ ᕿᕐᑲᖕᒥᙵᓘᕋᓗᒃᑐᓂᒃ ᐃᒪᐅᑉ ᖃᓄᐃᖓᓂᖏᓐᓄᑦ ᒪᓕᒃᑕᐅᔭᕆᐊᓕᖏᓐᓂᑦ (Tier 3, Technical Appendix 2I).

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38 EN-CI KIA ᑲᑉᐸᐊᕆ 2010: *ᐊᒃᑐᖅᓯᓂᐅᔪᖅ ᑕᓯᕐᓄᑦ ᐃᓱᒪᒋᔭᐅᓚᐅᖅᐸ? ᐃᖃᓗᐃᑦ ᐊᒃᑐᖅᑕᐅᓂᖃᕐᓂᐊᖅᐸᑦ?*
39 EN-KIV OH ᐅᒃᑑᐱᕆ 2009: *ᖃᓄᖅ ᓄᖑᓱᐃᑐᖅ ᐊᒃᑐᖅᓯᓂᖃᕐᓂᐊᖅᐸ ᐃᖃᓗᖕᒋᑎᕐᑎᖕᓄᑦ?*
40 EN-CH OH ᐅᒃᑑᐱᕆ 2012: *ᐃᖃᓗᒃᑕᖃᖅᐸ Andrew Lake-ᒥᑦ?*

ᐊᐅᓵᕐᓂᕐᒨᖓᔪᑦ ᐊᓯᖏᓪᓗ ᐊᖏᓗᐊᖏᑦᑎᐊᖅᑎᑦᑎᓂᐅᔪᑦ ᐃᓚᓕᐅᑎᔭᐅᓚᐅᕐᒥᔪᑦ ᐱᓕᕆᐊᒧᑦ ᐸᕐᓇᐅᑎᐅᔪᓄᑦ ᒥᑭᓵᖕᒐᑎᑦᑎᓂᕐᒧᑦ ᐱᓕᕆᐊᕐᒨᖓᔪᓂᑦ ᐊᓂᐊᔪᓂᒃ ᓯᓚᒧᑦ.

ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ ᒪᓕᒃᑕᐅᔭᕆᐊᖃᖅᑐᑦ selenium–ᒧᑦ ᐅᖓᑕᐅᑎᑐᐃᓐᓇᕆᐊᖃᖅᑐᑦ ᐃᒃᑳᖏᓐᓂᑦ Judge Sissons Lake–ᒥᑦ ᐊᐅᔭᐅᑎᓪᓗᒍ. ᓯᑯᓯᒪᓂᕐᒧᑦ, ᑲᑎᓯᒪᔪᑦ COPC ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᖏᒡᓕᒋᐊᕐᓂᐊᕐᓂᕐᒧᑦ ᒥᒃᓱᓯᒪᓂᖓᓄᑦ ᑰᒃᑐᖅ. ᐃᓕᑕᕆᔭᐅᓯᒪᓂᖓᓄᑦ selenium ᐊᔾᔨᙱᓐᓂᖃᕐᒪᑦ bioaccumilate–ᓂᕐᒥᒃ ᐃᒪᕐᒥᑦ ᓂᕿᒋᔭᐅᔪᑎᒍᑦ, ᖃᐅᔨᓴᐃᓂᖅ ᐊᓯᐊᖑᕐᓂᖏᓐᓄᑦ ᐃᖃᓗᐃᑦ ᓂᕿᖏᑦ (ᑎᒥᖓᓂᑦ, ᓂᕆᖃᑦᑕᖅᑕᖏᐅᖏᑦᑐᖅ) ᑲᑎᓯᒪᔪᖅᓯᐅᓚᐅᖅᑐᑦ. ᓂᕆᐅᒃᑐᑦ ᐊᓯᐊᖑᕐᓂᖃᔮᖏᓐᓂᖓᓄᑦ selenium ᐃᖃᓗᐃᑦ ᓂᕿᖏᓐᓂᑦ ᑲᑎᓯᒪᔪᑦ.

ᐃᖃᓗᐃᑦ ᖃᐅᔨᒋᐊᖅᑕᐅᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐱᓕᕆᐊᑉ ᐊᐅᓵᕐᓂᓗᒃᑖᖓᓂᑦ ᖃᐃᔨᔪᒪᓂᕐᒧᑦ ᖁᕐᕕᖏᙶᖅᑐᕋᓗᐃᑦ WTP–ᓂᑦ ᖃᓄᐃᓕᖓᓕᖅᑎᑦᑎᓂᖃᕐᒪᖔᑕ ᐃᖃᓗᐃᑦ ᐋᓂᐊᖅᑕᐃᓕᒪᓂᕆᔭᖏᓐᓄᑦ. ᒪᓕᒃᓱᒋᑦ MMER, ᐊᓈᓃᒃᑯᑦ ᐱᔭᕆᐊᖃᖅᑎᑕᐅᔪᑦ EEM–ᒥᒃ ᖃᐅᔨᓂᐊᕐᓗᑎᒃ ᖁᕐᕕᖏᙶᖅᑐᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᖃᕐᒪᖔᑕ ᑎᑭᑕᐅᔪᓄᑦ. ᐱᓂᐊᕐᓂᕆᔭᖓᑕ EEM ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓂᒃ ᖁᕐᕕᖏᙶᖅᑐᕋᓗᓐᓂᒃ ᐃᖃᓗᙵᑦ, ᐃᖃᓗᐃᑦ ᐃᓂᒋᔭᖏᓐᓄᑦ ᐊᒻᒪ ᐃᖃᓗᐃᑦ ᓂᕿᒋᔭᐅᓂᖏᓐᓄᑦ ᐃᓄᙵᑦ. ᒪᓕᖓᐃᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᖅᑎᑦᑎᓂᖃᖅᑐᑦ ᖁᕐᕕᖏᙶᖅᑐᕋᓗᐃᑦ ᖃᓄᐃᓕᐅᕐᓂᖃᕐᒪᖔᑕ, ᐅᓗᕆᐊᓇᖅᑐᖏᑦ, ᐊᒻᒪ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ. ᐆᒪᔾᔪᑎᖏᓐᓄᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᐃᖃᓗᐃᑦ ᐋᓂᐊᖅᑕᐃᓕᒪᓂᕆᔭᖏᓐᓄᑦ ᐊᒻᒪ ᑕᓲᑦ ᐊᑖᓃᖃᑦᑕᖅᑐᓄᑦ ᐱᔭᕆᐊᖃᕐᓂᐅᖏᒥᔪᖅ (Tier 3, Technical Appendix 5M). ᖃᓄᐃᖓᓕᕈᑏᑦ ᓂᕆᔭᐅᖃᑦᑕᕐᓂᖏᓐᓄᑦ ᐃᖃᓗᐃᑦ ᖃᐅᔨᓭᖅᑕᐅᖃᑦᑕᖅᑐᑦ COPC–ᖑᔪᓂᑦ ᑲᑎᓯᒪᔪᑦ ᖃᓄᐃᓐᓂᖅᓴᐅᓂᖏᓐᓄᑦ ᐃᖃᓗᐃᑦ ᓂᕿᖏᓐᓄᑦ ᑎᒥᖏᓐᓂᑦ ᐃᖃᓗᐃᑦ ᐋᓂᐊᖅᑕᐃᓕᒪᓂᖏᑦᑎᒍᑦ ᐊᒻᒪ ᓂᕆᔭᐅᓂᖏᓐᓄᑦ ᒪᓕᒃᑕᐅᔭᕆᐊᓕᖓᓄᑦ. ᖃᓄᐃᖓᓂᖓ ᐃᒪᕐᒥᐅᑕᓕᕆᓂᕐᒧᑦ ᑐᕌᖓᔪᑦ ᑭᒡᒐᕙᖏᑦ ᐊᒻᒪ Sissons–ᒥᑦ ᐅᔭᕋᖕᓂᐊᕐᕙᖕᓂᑦ ᒪᓕᖕᓂᐊᖅᑐᑦ EEM–ᒧᑦ ᒪᓕᒋᐊᓕᖕᓂᒃ ᐊᔾᔨᐅᖏᑦᑐᑦ ᓂᕿᑦ ᑎᒥᓃᑐᓂᒃ ᐃᓱᒪᒋᔭᐅᓗᑎᒃ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᖓᓂᑦ.

ᓇᐃᓈ ᖅᓯᒪᔪᖅ

ᑭᐅᔾᔪᑕᐅᔪᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᐅᖃᖏᓐᓂᑦ ᐊᐱᖅᓱᐃᓂᒃᑯᑦ ᐊᒻᒪ ᐃᓚᐅᖃᑕᐅᓂᒃᑯᑦ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᐱᖃᖃᑕᐅᔪᑦ ᐃᒃᐱᒍᓱᙱᓐᖏᓐᓂᒃ ᐃᒪᕐᒥᐅᑕᐃᑦ ᐱᔾᔪᑎᒋᐸᓗᑎᒃ ᐊᒻᒪ ᐃᓱᒫᓗᒍᑎᖃᕐᕈᑎᒃ ᒥᐊᓂᕆᔭᐅᓂᖏᓐᓄᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ VEC–ᖏᑦ. ᑎᑭᐅᑎᔾᔪᑎᖃᑦᑕᕐᓂᖏᑦ ᑭᒻᒐᕝ ᐱᓕᕆᐊᖅ ᐃᒪᕐᒥᐅᑕᓄᑦ ᑕᐃᒪᐅᓂᐊᕐᓂᖓᓄᑦ ᓂᕆᐅᒋᔭᐅᔪᖅ. ᑭᓯᐊᓂ, ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᖅ ᐃᒪᕐᒥᐅᑕᐃᑦ VEC–ᖏᓐᓄᑦ ᒥᑭᓵᒃᑰᖓᓕᖅᑎᑕᐅᔪᖅ ᒪᓕᖕᓂᒃᑯᑦ ᑲᓇᑕᐅᑉ ᓄᓇᕗᓪᓗ ᐱᖁᔭᖏᑦᑎᒍᑦ ᐊᒻᒪ ᒪᓕᖓᖏᑦᑎᒍᑦ, ᐱᖁᑎᒋᔭᐅᔪᑦ ᖃᓄᐃᑑᓂᐊᕐᓂᖏᑦ ᑲᒪᒋᔭᐅᑎᐊᕐᓂᒃᑯᑦ, ᐊᒻᒪ ᐊᑐᓕᖅᑎᑦᑎᓂᒃᑯᑦ ᐊᑑᑎᖃᖅᑐᓂᒃ ᐊᖏᓗᐊᖏᑦᑎᐊᖅᑎᑦᑎᓂᐅᔪᓂᒃ. ᐃᒪᕐᒥᐅᑕᓂᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ, ᖃᐅᔨᓚᐅᖅᑐᑦ ᐱᓕᕆᐊᖅ ᐅᔾᔨᕐᓇᖅᑐᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᖃᕐᓂᐊᖏᓐᓂᖓᓂᒃ ᐃᒪᕐᓄᑦ, ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ, ᑕᓯᐅᑉ ᐊᓗᐊᓃᑐᓄᑦ, ᐆᒪᔪᕋᓛᑦ, ᐃᖃᓗᐃᑦ ᐃᓂᖏᑦ, ᐊᒻᒪ ᐃᖃᓗᐃᑦ ᖃᕝᓯᐅᓂᖏᑦ.

ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅᑕᖃᕐᓂᐊᖅᑐᖅ ᓴᓇᔭᐅᑎᓪᓗᒍ, ᐊᐅᓵᖅᑎᓪᓗᒍ, ᐊᒻᒪ ᐅᒃᑯᐊᖅᐸᓪᓕᐊᑎᓪᓗᒍ ᓇᓗᓇᐃᖅᓯᓂᕐᒧᑦ ᐱᓕᕆᐊᑉ ᖃᓄᐃᖓᓂᕆᔭᖓᓂᑦ, ᐊᖏᓗᐊᖏᑦᑎᐊᖅᑎᑦᑏᑦ, ᐊᒻᒪ ᐊᕙᑎᒥᒃ ᒥᐊᓂᖅᓯᓂᕐᒨᖓᔪᓂᒃ ᐊᑐᓕᖅᑎᑕᐅᔪᓂᒃ. ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᖃᓄᐃᖓᓂᐅᔪᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᓂᒃ ᖃᓄᐃᓂᖅᓴᐅᓂᖏᓐᓄᑦ ᐊᒻᒪ ᐊᑐᓕᖅᑎᑦᑎᓂᖅ ᐊᐅᓚᑦᑎᓂᕐᒨᖓᔪᑦ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᕙᑎᐅᑉ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖓᓄᑦ ᑎᑭᐅᑎᓂᕐᒧᑦ. ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᖃᓄᐃᖓᓂᐅᔪᑦ ᑐᓴᖅᑎᔾᔪᑕᐅᓂᐊᖅᑐᑦ ᓄᓇᓕᖕᒥᐅᓄᑦ ᐅᖃᐅᓯᖃᕐᓂᕐᒧᑦ ᐊᒻᒪ ᓂᐸᓕᐅᑕᐅᔪᓄᑦ ᐃᓚᒋᔭᐅᓗᓂ ᓄᓇᓕᖕᒥᑦ ᐃᓚᐅᖃᑕᐅᓂᕐᒧᑦ ᐸᕐᓇᐅᑎ (Tier 3, Technical Appendix 3C).

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Abbreviations and Units

%	percent
>	greater than
<	less than
°C	degrees Celcius
µg/g	micrograms per gram
µg/L	micrograms per litre
µS/cm	microSiemens per centimetre
AREVA	AREVA Resources Canada Inc.
BC	British Columbia
BLHTO	Baker Lake Hunters and Trappers Organization
BMP	Best Management Practice
Bq/g	Becquerels per gram
Bq/L	Becquerels per litre
$CaCO_3$	calcium carbonate
CCME	Canadian Council of Ministers of the Environment
cm.	centimetre
CNSC	Canadian Nuclear Safety Commission
COPC	Constituent of Potential Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRA	commercial, recreational and Aboriginal
CWQG	Canadian Water Quality Guidelines
DFO	Fisheries and Oceans Canada
DL	detection limit
DO	.dissolved oxygen
Dw	dry weight
e.g.	example
EEM	Environmental Effects Monitoring

EIA .... Environmental Impact Assessment
EIS .... Environmental Impact Statement
ERED .... Environmental Effects Residue Database
FOP .... Fisheries Offsetting Plan
G .... .grams
g/cm^2 .... grams per square centimetre
$g/m^2/y$ .... grams per square metre per year
ha .... hectares
i.e. .... id est, in other words, that is
ICP-AES .... inductively coupled plasma atomic emission spectroscopy
ICP-MS .... inductively coupled plasma mass spectrometry
IPC .... Instantaneous Pressure Change
IQ .... Inuit Qaujimajatuqangit
ISQG .... Interim Sediment Quality Guidelines
FOP .... Fisheries Offsetting Plan
K .... hydraulic conductivity
KB .... Kajak Brinkhurst
Kd ....Distribution Coefficient
KI .... Key Indicator
Kiggavik Project .... Project
Km ....kilometre
km^2 .... square kilometres
kPa .... kiloPascals
LAA .... Local Assessment Area
LEL .... Lowest Effects Level
LiDAR .... Light Detection and Ranging
LSA .... Local Study Area
M .... metre

m/s .... metres per second
m^2 .... square metres
m^3/s .... cubic metres per second
$m^3/s/km^2$ .... cubic metres per second per square kilometre
mbgl .... metres below ground level
mg/kg .... milligrams per kilogram
mg/L .... milligrams per litre
mm .... millimetre
mm/s .... millimetres per second
mm/year .... millimetres per year
MMER .... Metal Mining Effluent Regulations
MoE .... Ministry of Environment
N .... number
NDC .... no defined channel
NIRB .... Nunavut Impact Review Board
NLCA .... Nunavut Land Claims Agreement
NTS .... National Topographic System
PEL .... Probable Effects Level
PAH .... Polycyclic aromatic hydrocarbon
pH .... potential hydrogen
PP .... phytoplankton
RAA .... Regional Assessment Area
SARA .... *Species at Risk Act*
SEL .... serious effects level
SSWQO .... Saskatchewan Surface Water Quality Objectives
TEK .... Traditional Ecological Knowledge
TDS .... Total Dissolved Solids
TMF .... Tailings Management Facility

TOC .... total organic carbon

TSS .... Total Suspended Solids

VC .... Valued Component

VEC .... Valued Environmental Component

Vs .... versus

VSEC .... Valued Socioeconomic Component

WSA .... Water Security Agency

WTP .... Water Treatment Plant

Ww .... wet weight

YOY .... young-of-the-year

ZP .... zooplankton

Glossary

Acidification	A decrease in the acid-neutralizing capacity of water that is exhibited by a reduction in pH.
Active layer	A shallow zone above the permafrost that thaws and re-freezes annually.
Adsorption	Refers to the adhesion of atoms, ions, or molecules to sediment particles in aquatic environments.
Alkalinity	A measurement (expressed in milligrams per litre of calcium carbonate) of the capacity of water to neutralize acids. The concentration is measured based on the presence of naturally available bicarbonate, carbonate, and hydroxide ions.
Aquifer	An underground layer of water-permeable rock from which groundwater can be extracted. Examples of water-permeable rock include sand and gravel.
Artesian	An aquifer containing water that is under positive pressure.
Atretic	Refers to the degeneration and subsequent resorption of an ovarian follicle. In fishes, atresia is most common during the prespawning, spawning, and post-spawning periods.
Backwater	Discrete, localized area of variable size exhibiting reverse flow direction; generally produced by bank irregularities; velocities variable but generally lower than main flow; substrate similar to adjacent channel with higher percentage of fines.
Bankful width (also channel width)	Horizontal distance along a transect line from bank to bank at the bankful stage, measured at right angles to the direction of flow. Multiple channel widths are summed to represent total channel width.
Base case	The assessment case that includes existing environmental conditions, as well as existing, nearby projects, or nearby projects that are in the approval phase.

Bathymetry	The measurement of underwater depth.
Becquerel (Bq)	A unit of measure of radioactive decay, equal to one disintegration per second.
Benefit agreement	A formal contract, usually between a project proponent and one or more Aboriginal groups, that describes the potential impacts of a project, the commitments and roles of each group, and the ways in which Aboriginal communities will share in the benefits of the project (e.g., employment, dividends).
Best management practice (BMP)	A standard management method for maintaining a level of quality that exceeds mandatory legislated standards; best management practices can be based on self-assessment or used as a benchmark.
Biomass	The amount of living material in a given habitat or area.
Cascade	Extremely high gradient and velocity; extremely turbulent with entire water surface broken; may have short vertical sections, but overall is passable to fish; armoured substrate; may be associated with chute. Highly turbulent series of short falls and small scour basins, with very rapid water movement as it passes over a steep channel bottom with gradients exceeding 8%. Most of the water surface is broken by short, irregular plunges creating whitewater, frequently characterized by very large substrates, and a well-defined stepped longitudinal profile that exceeds 50% in supercritical flow.
Chlorophyl a	Primary photosynthetic pigment contained in phytoplankton.
Compliance monitoring	Monitoring completed to confirm that proposed project design features, mitigation measures, environmental protection measures, or benefit agreements are being implemented as proposed and in accordance with regulatory requirements.
Constituent of Potential Concern (COPC)	Metals, radionuclides and organic contaminants that have the potential to adversely affect the health of the environment and/or humans.

Cumulative environmental effects	Effects to the biophysical or socio-economic environment that result from the incremental effect of a project component or activity that is added to that of other past, present, and reasonably foreseeable future projects.
Density	The number of organisms in a given area or volume.
Depositional	Term used to describe sediment types, or areas containing sediment types, that were previously eroded, carried by water and deposited on the bottom of a water body or water course.
Determination of significance	The significance of Project-related and cumulative residual environmental effects is determined using standards or thresholds that are defined for each VC.
Detritus	Decomposing organic material.
Distribution	The occurrence, position or arrangement of organisms within a given area.
Diversity	The number and variety of different organisms found within an area.
Effect linkage	The mechanism by which a Project component or activity could result in an environmental effect to a Valued Component (VC).
Effectiveness monitoring	Monitoring completed to determine if mitigation measures, project design features and offsetting or compensation works are functioning as planned.
Environmental effects	Refers to the array of positive and negative responses of the biophysical or human environments, or a component thereof, to disturbance.
Far Future Case	Represents the status of the measurable parameters for the environmental effect based on the Future Case in combination with possible far future developments in the Kiggavik region.

Flat	Area characterized by low velocity and near-laminar flow; differentiated from pool habitat by high channel uniformity; more depositional than shallow run habitat. Level landform composed of unconsolidated sediments, usually mud or sand, that may be elongated or irregularly shaped and continuous with the shore, that is covered with shallow water or may be periodically exposed.
Follow-up monitoring	Monitoring of the biophysical and socio-economic environment that is completed to verify predictions of environmental effects; determine effectiveness of mitigation and other environmental protection measures; support environmental management systems, and support implementation of adaptive management measures to address unforeseen environmental effects.
Forage fish	Small-bodied fish species, as well as small (i.e., young) large-bodied or sportfish species, that are preyed on by larger predatory fishes.
Freshet	Refers to the increase in stream flows or lake levels that occurs in spring as a result of melting snow and ice.
Future Case	The status of the measurable parameters for the environmental effect, based on the Project Case in combination with all reasonable foreseeable projects, activities and actions.
Gniess	A form of metamorphic rock that has a banded appearance and is made up of diffent layers of rock, usually light and dark silicates.
Hydraulic conductivity (K)	Refers to the ease with which water can move through the pore spaces or fractures in soils and rocks.
Hydrograph	Represents the rate of flow within a stream over a specified time period.
Hydrostratigraphy	Refers to the structure of sub-surface rock as it pertains to the flow of groundwater.
Incubation	Refers to the maintenance of fertilized fish eggs.

Instantaneous Pressure Change (IPC) — Refers to the pressure change that occurs within the water column immediately after detonation of an explosive substance near water; these pressure changes can damage soft tissues of nearby fish or result in fish mortality.

Interaction — Refers to the linkage between the project and some component of the environment by which the project could result in an environmental effect. For an environmental effect to occur there must be an interaction between the project and some component of the environment.

Key Indicators (KIs) — Species, species groups, resources or ecosystem functions that represent components of the broader Valued Components (VCs).

Larvae — A juvenile lifestage in fishes that represents the time between hatching and complete absorption of the yolk sac and the onset of external feeding.

LiDAR — Light Detection and Ranging is a remote-sensing technology that uses a laser of pulsed light to measure distances.

Limnology — The study of open fresh and, more rarely, saline water bodies, specifically lakes and ponds (both natural and man-made), including their physical, chemical, and biological properties. Limnology traditionally is closely related to hydrobiology, which is concerned with the application of the principles and methods of physics, chemistry, geology, and geography to ecological problems.

Littoral — Shallow shore area (less than 6 m deep) of a water body where light can usually penetrate to the bottom and that is often occupied by rooted macrophytes.

Magnitude — The degree of change in a measureable parameter, relative to baseline.

Measureable parameter — A parameter that provides a quantitative or qualitative measure of an environmental effect or cumulative environmental effects from a Project to a Valued Component (VC) or Key Indicator (KI). The degree of change in a measureable parameter is used to evaluate the significance of environmental effects.

Mitigation	Measures, standards and guidelines used to minimize, avoid,or offset Project-induced environmental effects and cumulative environmental effects. These measures include project design features, administrative policies, specialized mitigation, environmental protection measures, protocols, social or community programs, benefit agreements, offsetting (i.e., fisheries offsetting) and financial compensation.
Nival	Of, relating to, growing, or occurring under snow.
Oligotrophic	Trophic state classification for lakes characterized by low productivity (i.e., little aquatic plant or animal life) and low nutrient inputs (particularly total phosphorus).
Opercle	Part of the bony flap that covers and protects the gills of a fish.
Overburden	In the Project area, it is the soil material lying upon the bedrock.
Peak particle velocity	The maximum speed at which a particle (e.g., substrate in a stream) is expected to be displaced when it is subjected to a sound or pressure wave (e.g., blasting).
Permafrost	Refers to soil or rock that remains below zero degrees Celcius (°C) for at least two years at a time; in continuous permafrost regions, over 90 percent (%) of the ground surface is underlain by permafrost.
Periphyton	A term used to describe the algal community that grows attached to the substrate (generally rocks) in streams and lakes.
Phytoplankton	Open-water, algal component (i.e., non-vascular, photosynthetic plants).
Pool	Discrete portion of channel featuring increased depth and reduced velocity relative to riffle/run habitats; formed by channel scour. Aquatic habitat in a stream with a gradient less than 1 percent (%) that is normally deeper and wider that aquatic habitats immediately above and below it.
Probable Effects Level (PEL)	Concentration of a chemical in sediment above which adverse effects on aquatic organisms are likely.

Rapid	Extremely high velocity; deeper than riffle; substrate extremely coarse (i.e., cobble and boulder); instream cover in pocket eddies and associated with substrate.
	Moderately steep stream area (4 to 8 percent [%] gradient) with supercritical flow between 15 and 50%, rapid and turbulent water movement, surface with intermittent whitewater with breaking waves, coarse substrate, with exposed boulders at low flows, and a somewhat planar longitudinal profile.
Residual environmental effect	Project-related environmental effects that are predicted to occur, despite the implementation of mitigation measures.
Reversibility	The ability of a measureable parameter for a Valued Component (VC) to recover from an environmental effect and return to baseline.
Richness	The number of different species represented in an ecological community.
Riffle	An area of fast-flowing water with coarse substrates. The water surface is broken due to the submerged or exposed substrates.
Run	Moderate to high velocity; surface largely unbroken; usually deeper than riffle; substrate size depends on hydraulics. Run habitat can be differentiated into one of four types: deep/slow, deep/fast, shallow/slow, or shallow/fast.
	Swiftly flowing stream reach with a gradient greater than 4 percent (%), little to no surface agitation, waves, or turbulence, no major flow obstructions, approximately uniform flow, substrates of variable particle size, and water surface slope roughly parallel to the overall stream gradient.
Sac-fry	Recently hatched fish larvae that are still in possession of a yolk sac.
Serious harm	Refers to the death of fish or any permanent alteration or destruction of fish habitat.

Setback distance	The physical distance maintained between an explosive detonation and fish or fish habitats. A buffer zone to protect fish, eggs and larvae from injury and mortality.
Significant environmental effect	An environmental effect that causes substantial, irrevocable damage to the environment that cannot be minimized or avoided through implementation of mitigation measures.
Snye	Discrete section of a non-flowing watercourse connected to a flowing channel only at its downstream end; generally formed in a side-channel or behind a peninsula.
Substrate	In underwater environments, it is the surfical layer of material on/in which organisms may live, grow or feed.
Syenite	A type of ingneous rock that is coarse-grained with some quartz and feldspar components.
Talik	Unfrozen ground conditions that may develop underneath northern lakes that do not freeze to the bottom during winter.
Threshold	A level of change beyond which unacceptable adverse environmental effects may occur.
Toxicity	The magnitude of harmful effects observed in organisms related to poisoning from the alteration of natural environmental conditions.
Valued Component (VC)	Collective term for Valued Environmental Components (VECs) and Valued Socio-economic Components (VSECs) that are selected for the Project assessment, based on regulatory standards and guidelines, stakeholder consultation, field studies, and professional judgement of the environmental assessment team.
Valued Environmental Components (VECs)	Major physical and biological components of the environment that, if affected by the Kiggavik Project, would be of concern to regulators, Inuit, local residents and resource users, and/or the general public.

Valued Socio-Economic Components (VSECs)	Aspects of the socio-economic environment considered vital to a particular region or community, including the local economy, health, demographics, traditional way of life, culture, social life, archaeological resources, infrastructure and other services, community organizations, and local governance.
Zooplankton	Microscopic animals that float, drift or swim weakly, and include crustaceans (i.e., Cladocera [cladocerans], Calanoida, and Cyclopoida) and rotifers.

1 Introduction

1.1 Background

The Kiggavik Project (Project) is a proposed uranium ore mining and milling operation located in the Kivalliq region of Nunavut approximately 80 kilometres (km) west of the community of Baker Lake (Figure 1.1-1). The Project is operated by AREVA Resources Canada Inc. (AREVA), in joint venture partnership with Japan-Canada Uranium Company Limited (JCU) and Daewoo International Corporation

Within the Kiggavik Project there are two general site areas referred to herein as the Kiggavik site and the Sissons site. The two sites are located approximately 17 km apart. Three uranium ore deposits will be mined at the Kiggavik site: East Zone, Centre Zone and Main Zone. A uranium mill, related facilities, main accommodations, and landing strip will also be located at the Kiggavik site. The Sissons site has two uranium ore deposits to be mined: Andrew Lake and End Grid. Open pit mining will be used to extract the ore from the three Kiggavik deposits as well as the Andrew Lake deposit. Mining of End Grid ore will require underground methods.

All ore extracted from the mine sites will be processed through the Kiggavik mill. Mined out pits at the Kiggavik site will sequentially be used as tailings management facilities (TMFs) with East Zone being the initial TMF. The uranium product will be packaged and transported via aircraft to southern transportation networks. Initially, mill reagents, fuel and other supplies will be transported by barge to Baker Lake and then by truck to the mine site over a winter access road. An all-season road between Baker Lake and the Kiggavik Site is carried through the assessment as an option proposed as a contingency in case the winter road cannot adequately support the Project over its life-span.

Decommissioning of the Project will include demolition of site facilities, clean up and reclamation of any disturbed areas, closure of the TMFs and reclamation of mine rock piles to promote vegetative growth and to provide wildlife access.

The Kiggavik Project is subject to the environmental review and related licensing and permitting processes established by the Nunavut Land Claims Agreement (NLCA) (NIRB [Nunavut Impact Review Board] 2011), and to the licensing requirements of the Canadian Nuclear Safety Commission (CNSC). The Minister of Indian and Northern Affairs Canada (now Aboriginal Affairs and Northern Development Canada; AANDC) referred the Kiggavik Project to the NIRB for a Review under Part 5 of Article 12 of the NLCA in March of 2010.

Projection: NAD 1983 UTM Zone 14N
Creator: CDC Revised: TL
Date: 9/03/2014 Scale: 1:16,000,000
File:
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, Geological Survey of Canada, AREVA Resources Canada Inc.*

FIGURE 1.1-1
GENERAL LOCATION OF PROPOSED KIGGAVIK PROJECT IN CANADA

ENVIRONMENTAL IMPACT STATEMENT
SECTION 1 INTRODUCTION

Kiggavik Project
AREVA

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

The final NIRB “Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc.’s Kiggavik Project (NIRB File No. 09MN003)” (NIRB 2011) were issued in May of 2011. AREVA submitted the Draft Environmental Impact Statement in December 2011 and again in April 2012 with the NIRB determining that the submission successfully conformed to the EIS guidelines in May 2012. Two review periods followed with the Information Request stage completed in January 2013 and the Technical Review stage completed in May 2013. An in-person technical meeting was hosted in Rankin Inlet, Nunavut by the NIRB in May 2013 with a Community Roundtable and a Pre-Hearing Conference (PHC) hosted in Baker Lake, Nunavut shortly after in June 2013. Following the Pre-Hearing Conference the NIRB issued the “Preliminary Hearing Conference Decision Concerning the Kiggavik Project (NIRB File No. 09MN003)” in July 2013.

1.2 Nunavut Impact Review Board Guidelines for the Environmental Impact Statement and Preliminary Conference Decision

The DEIS, including this volume, was determined by the NIRB on May 4, 2012 to have adequately addressed relevant sections of the NIRB “Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc.’s Kiggavik Project (NIRB File No. 09MN003)” (NIRB 2011).

Greater clarity, consistency and, in some cases, additional design or assessment were provided within AREVA’s responses to information requests in January 2013 and technical comments in May 2013. AREVA commitments for the preparation of the FEIS and regulatory review requirements are listed in the NIRB PHC Decision dated July 2013. Changes from the draft to final EIS including the location of information related to information requests, technical comments, and PHC requirements is noted in the Final Environmental Impact Statement (FEIS) conformity table (Tier 1, Volume 1, Technical Appendix 1A).

1.3 Purpose and Scope

The purpose of this document is to describe the Project components and activities that have the potential to interact with the aquatic environment and result in a potential environmental effect to surface hydrology, hydrogeology, water quality, sediment quality, aquatic organisms, fish habitat and/or fish populations. The overall objective of the environmental effects assessment is to identify the potential residual environmental effects resulting from the Project, inform appropriate mitigation measures and monitoring, and to determine the significance of such effects.

The FEIS has been prepared to fulfil the intent of the NIRB Guidelines and PHC Decision, ultimately providing the information required to confidently proceed with an environmental assessment determination. The assessment has been influenced and reflects input provided from Inuit, Land Claim, Government, community, and other interested stakeholders.

1.4 Report Content

In addition to this introduction (Section 1), this volume consists of the following sections:

- Section 2: An overview of the Project and associated assessment basis
- Section 3: A description of the environmental assessment approach and methodology used to assess potential effects of the Project
- Section 4: A description of the scope of assessment and the methodology used for the Effects Assessment
- Section 5: A summary of the existing aquatic environment
- Section 6: An assessment of Project effects and cumulative effects to surface hydrology
- Section 7: An assessment of Project effects and cumulative effects to hydrogeology
- Section 8: An assessment of Project effects and cumulative effects to water quality
- Section 9: An assessment of Project effects and cumulative effects to sediment quality
- Section 10: An assessment of Project effects and cumulative effects to aquatic organisms and fish habitat
- Section 11: An assessment of Project effects and cumulative effects to fish populations
- Section 12: A summary of residual effects
- Section 13: A summary of mitigation measures
- Section 14: A summary of monitoring for the aquatic environment

Tier 3 documents are appended to this Volume to provide further details. These Technical Appendices are as follows:

- 5A – Hydrology Baseline
- 5B – Geology and Hydrogeology Baseline
- 5C – Aquatics Baseline
- 5D – Groundwater Flow Model
- 5E – Prediction of Water Inflows to Kiggavik Project Mines
- 5F – Mine Rock Characterization and Management
- 5G – Thermal and Water Transport Modelling
- 5H – Waste Rock Water Balance
- 5I - Hydrology of Waste Rock Piles in Cold Climates
- 5J - Tailings Characterization and Management
- 5K – Historical and Climate Change Water Balance
- 5L – Conceptual Fisheries Offsetting Plan
- 5M – Aquatics Effects Monitoring Plan
- 5N – Hydrology Assessments
- 5O – Sediment and Erosion Control Plan
- 5P – Technical assessments of water withdrawl locations and Baker Lake Dock site

2 Project Overview

2.1 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 U3O8) at an average grade of 0.46% uranium.
Life of Mine	• Approximately 12 years of production, based on studies to date. It is anticipated that pre-operational construction will require three years while remaining post-operational decommissioning activities will require ten years. • Date of Project construction will be influenced by favorable market conditions, completion of detailed engineering, and successful completion of licensing and other Project approvals.
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 1, 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 3,200 to 3,800 tonnes uranium (8.3 to 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 a winter road between Baker Lake and Kiggavik. An all-season road is assessed as an option should the winter road be unable to adequately support the Project. 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 to 600 people during operation.
Notes: km = kilometres; lbs = pounds; % = percent; AREVA = AREVA Resources Canada Inc.; $ = dollars.	

The economic feasibility of the Kiggavik Project depends on 1) the production cost for the uranium concentrate including construction, operation and decommissioning costs and 2) the market value of the final product. The latest feasibility study completed for the Kiggavik Project was in November 2011. The study assessed the technical and economic viability of developing and operating a uranium mine and mill site in the Kiggavik area and estimated the capital cost of the Project at $2.1 billion and the operating cost at $240 million per year. This initial feasibility study will be updated and refined prior to a development decision. The market price for uranium concentrate over the last years has been within the range needed for a reasonable return on investment to its owners, however at the time of FEIS preparation was below the threshold needed for Project advancement. AREVA believes future opportunities are strong enough to encourage Project advancement with the intent of development that will coincide with viable future markets.

2.2 Assessment Basis

To ensure that the potential environmental and socioeconomic effects of the Kiggavik Project are adequately considered in this environmental assessment, it was determined that it would be advantageous to develop a clear "assessment basis" for the Project. The purpose of the assessment basis is to clearly and consistently define how the design parameters detailed in Tier 2 Volume 2

Project Description encompass the more conservative values for various design features and options. It is consistent with the precautionary principle to assess potential environmental effects conservatively to improve confidence that the Project can be realized within the predicted effects and approved environmental assessment.

The assessment basis is summarized in Table 2.2-1 and presented with greater detail in Tier 2 Volume 2 Section 20. For biophysical and some socio-economic effects, the range value with the greatest potential to result in an adverse effect is used. In the case of socio-economic benefits, the range value resulting in the lowest benefit is used.

Table 2.2-1 Project Assessment Basis

Project Activities/Physical Works	Parameter	Units	Parameter / Assumption Values	
			Base Case (PD)	Assessment Case
Overall	Production Rate	Tonnes U per year	3,200 – 3,800	3,200 - 4,000
	Mill Feed Rate	Kilotonnes per year	71 - 977	1,000
	Project Operating Life	Years	2 years pre-production 12 years production	25
	Project Footprint	Hectares (ha)	938	1,102
	Access Road Route	Not Applicable	Winter Road	Winter Road All-Season Road
	Dock Site Location	Not Applicable	Site 1	Sites 1,2, Agnico Eagle's Meadowbank Dock Site
Milling	Flowsheet	Not Applicable	Resin in Pulp (RIP)	Resin in Pulp (RIP), possibly solvent extraction (SX) and / or calciner
	Final Product	Not Applicable	Non-calcined uranium concentrate	Non-calcined or calcined uranium concentrate
Tailings Management	Containment volume	Million cubic metres (Mm^3)	28.4	30.0
	Total tailings volume (un-consolidated)	Million cubic metres (Mm^3)	21	30.0
	Design		Natural surround, no drain	Various design contingencies

Table 2.2-1 Project Assessment Basis

Project Activities/Physical Works	Parameter	Units	Parameter / Assumption Values	
			Base Case (PD)	Assessment Case
Water Management	Freshwater requirements – no permeate or site drainage recycle	Cubic metres per day (m^3/day)	7,910	8,000
	Freshwater requirements – permeate and site drainage recycle	Cubic metres per day (m^3/day)	2,000	8,000
	Freshwater requirements - Sissons	Cubic metres per day (m^3/day)	60	60
	Treated effluent discharge at base quality – Kiggavik	Cubic metres per day (m^3/day)	2,707	3,000
	Treated effluent discharge – Sissons	Cubic metres per day (m^3/day)	1,700	1,700
Power Generation	Kiggavik peak load	megaWatt (MW)	13.0	13.0 – 16.8
	Sissons peak load	megaWatt (MW)	3.8	0 – 3.8
Logistics & Transportation	Number of barge trips – 5000t & 250 containers	Barge trips / year	9 - 31	31
	Number of barge trips – 7500t & 370 containers	Barge trips / year	7 - 22	22
	Number of truck trips – 56,000L & 48t	Truck trips / year	328 – 3,233	3,300
	Number of truck trips – 70,000L & 60t	Truck trips / year	243 – 2,405	2,500
	Number of yellowcake flights	Flights / year	310 - 350	355
Decommissioning	Period	Years	10	10

Notes:

ha = hectares; N/A = Not Applicable; SX = solvent extraction; Mm^3 = Million cubic metres; m^3/day = cubic metres per day; MW = megaWatt.

3 Assessment Approach and Methods

3.1 Introduction

This section describes the methods used in the assessment of environmental and socio-economic effects associated with the Kiggavik Project. The methods meet the applicable regulatory requirements while focusing the assessment on the matters of greatest environmental, social, cultural, economic and scientific importance. The methodological approach also recognizes the iterative nature of project-level environmental assessment, considering the integration of engineering design and mitigation and monitoring programs into comprehensive environmental management planning for the life of the Project.

The environmental effects assessment method is based on a structured approach that:

- considers the factors that are required under Nunavut Land Claim Agreement (NLCA);
- focuses on issues of greatest concern;
- affords consideration of all territorial and federal regulatory requirements for the assessment of environmental effects;
- considers issues raised by Inuit, regulators, government agencies and public stakeholders; and
- integrates project design and programs for mitigation and monitoring into a comprehensive environmental planning.

The environmental assessment focuses on specific environmental components called Valued Environmental Components (VECs) or Valued Socio-economic Components (VSECs) that are of particular value or interest to Inuit, regulators, government agencies and stakeholders. The term Valued Components (VCs) refers collectively to VECs and VSECs. Valued Components are selected based on regulatory issues and guidelines; consultation with Inuit, regulators, government agencies and stakeholders; field studies, and professional judgment of the study team. Where a VC has various sub-components that may interact with the Project in different manners, the environmental assessment may consider the environmental effects on individual Key Indicators (KIs).

The term “environmental effect” is used throughout the application and broadly refers to the response of the biophysical or human system, or a component of these systems, to a disturbance from a Project action, activity or other regional actions (i.e., projects and activities).

The environmental assessment methods address Project-related and cumulative environmental effects. Project-related environmental effects are changes to the biophysical or socio-economic environment that are caused by the Project or activity and arise solely because of the proposed principal works and activities, as defined by the scope of the Project. This includes consideration of the environmental effects of malfunctions or accidents that may occur in connection with the Project. Cumulative environmental effects are changes to the biophysical or socio-economic environment that are caused by an action of the Project in combination with other past, present and future projects and activities.

In this assessment, Project-related environmental effects and cumulative environmental effects are assessed sequentially. The mechanisms through which a Project-specific environmental effect may occur are discussed first, taking into account Project design measures and mitigation that help to reduce or avoid environmental effects. The residual environmental effect is then characterized taking into account planned mitigation. At a minimum, all Project environmental effects are characterized using specific criteria (e.g., magnitude, geographic extent, duration) that are defined for each VC.

A cumulative environmental effects screening is then conducted to determine if there is potential for the Project residual environmental effect to act in a cumulative manner with similar environmental effects from other projects and activities. If there is potential for the Kiggavik Project to contribute to cumulative environmental effects, the environmental effect is assessed to determine if it has the potential to shift a component of the natural or socio-economic environment to an unacceptable state.

The environmental effects assessment approach used in this assessment involves the following steps:

- **Scoping:** Scoping of the overall assessment, which includes: issues identification; selection of VCs (and KIs, if required); description of measurable parameters; description of temporal, spatial, administrative and technical boundaries; definition of the parameters that will be used to characterize the Project-related environmental effects and cumulative environmental effects; and identification of the standards or thresholds that will be used to determine the significance of environmental effects.
- **Assessment of Project-related environmental effects:** The assessment of Project-related environmental effects, which includes: description of the mechanism(s) by which an environmental effect will occur; mitigation and environmental protection measures to reduce or eliminate the environmental effect; and evaluation and characterization of the residual environmental effects (i.e., environmental effects remaining after application of mitigation measures) of the Project on the biophysical and socio-economic environment for each development phase.

- **Evaluation of cumulative environmental effects:** The evaluation of cumulative environmental effects, which involves two tasks: screening for potential cumulative environmental effects and, if there is potential for cumulative environmental effects, assessment of cumulative environmental effects. Where an assessment of potential cumulative environmental effects is required, the residual cumulative environmental effects of the Project are evaluated in combination with other past, present and future projects and activities.
- **Determination of significance:** The significance of Project-related and cumulative residual environmental effects is determined using standards or thresholds that are defined for each VC.
- **Monitoring:** Several different types of monitoring may be required to confirm compliance with mitigation measures or Project design features, address uncertainties or verify environmental effects predictions and/or assess the effectiveness of mitigation measures.
- **Summary:** The last step of the assessment of environmental effects on a VC is the development of summaries on Project and cumulative environmental effects (including combined Project environmental effects and combined cumulative environmental effects), mitigation measures and Project design features, and monitoring.

3.2 Scope of the Assessment

Scoping is a widely accepted best management practice (BMP) in environmental assessment, and is used to determine the appropriate content and extent of issues to be addressed in detail in an Environmental Impact Statement (EIS). The approach is also consistent with the Nunavut Impact Review Board (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:

- identifying 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;
- prioritizing each interaction according to the potential for an activity to cause an environmental effect; and
- justifying the rankings for those interactions that will not be assessed in detail in the assessment.

For the Kiggavik Project EIS, the rankings of Project-environment interactions were based on the following considerations to support a precautionary approach during the issues scoping process. The following criteria were considered important 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 an environment component or system is 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 any meaningful 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, and identify where potential interactions could occur based on likely spatial and temporal overlap during each Project phase, the assessor relied on the Project Description and Assessment Basis, as well as available information regarding the VC (published and unpublished information sources, as well as field baseline studies), the effects literature, experience with similar northern mining projects and best professional judgment related to each VC . 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 BMPs 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 best support a detailed analysis of the potential environmental effect.

Through the scoping process, a number of potential interactions, potential effects and VCs were removed from further consideration, either because there is likely to be no interaction under normal operating conditions or no potential for substantive interaction between a Project activity and the VC that would cause a potential environmental effect. For consideration of events outside of normal operations such as spills or accidents, refer to Tier 2, Volume 10 (Accidents, Malfunctions and Effects of the Environment on the Project). In some cases, there is likely to be a potential interaction between a Project activity and a VC, but that interaction 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.

3.2.1 Valued Components, Indicators and Measurable Parameters

Valued Components (VCs) are defined as broad components of the biophysical and socio-economic environments that, if altered by the Project, would be of concern to regulators, Inuit, resource managers, scientists, and public stakeholders.

VECs for the biophysical environment typically represent major components or aspects of the physical and biological environment that might be altered by the Project and are widely recognized as important for ecological reasons.

Criteria for selection of VCs include:

- Do they represent a broad environmental, ecological or human environment component that may be altered by the Project?
- Are they vulnerable to the environmental effects of the Project and other activities in the region?
- Have they been identified as important issues of concerns of Inuit or stakeholders, or in other assessments in the region?
- Were they identified by the NIRB, Inuit organizations or departments within the territorial or federal government?

Key indicators (KIs) are species, species groups, resources or ecosystem functions that represent components of the broader VCs. They are selected using the same criteria as described above for VCs. For practical reasons, KIs are often selected where sufficient information is available to assess the potential Project residual environmental effects and cumulative environmental effects.

For each VC or KI, one or more measurable parameters are selected to quantitatively or qualitatively measure the Project environmental effects and cumulative environmental effects. Measurable parameters provide the means of determining the level or amount of change to a VC or KI. The degree of change in the measurable parameter is used to characterize project-related and cumulative environmental effects, and evaluate the significance of these effects. Thresholds or standards are identified for each measurable parameter, where possible, to assist in determining significance of the residual environmental effect.

3.2.2 Key Issues

Issues identification focuses the assessment on matters of greatest importance related to the Project, and assists in determining which factors and the scope of those factors that will be considered in the assessment.

Issues and concern about the possible biophysical or socio-economic effects of the Project have been identified from a variety of sources, including:

- the regulatory requirements applicable to the Project;
- discussions with technical experts from various territorial and federal government agencies;
- input from Inuit and public stakeholders during engagement activities in relation to the Project;
- existing regional information and documentation regarding environmental components found near the Project;
- baseline and assessment studies conducted in the area of the Project; and
- the professional judgment of the assessment team, based on experience with similar projects and activities in Nunavut and other regions.

Key Project-related issues are summarized in the scoping section for each discipline considered in the assessment.

3.2.3 Project – Environment Interactions and Environmental Effects

Key Project-related activities that could result in environmental effects are considered for each VC. A matrix of Project activities and environmental components is provided in the scoping section for each discipline to identify where interactions are likely to occur based on the spatial and temporal overlap between Project activities and the VC. Each potential interaction is evaluated based on scientific knowledge, logic, experience with similar developments, and the predicted effectiveness of proposed mitigation to focus residual effects analyses on interactions that have potential to lead to residual effects on VCs. For a residual effect to occur, there must be a source (Project activity), an interaction, and a measureable environmental change.

Each Project interaction is ranked according to the potential for a given activity to cause an environmental effect. The interactions are ranked according to the following:

- If the interaction is removed by environmental design features and mitigation so that the Project results in no detectable (i.e., measureable) change and no residual effect on a VC relative to baseline or guideline values, the interaction is given a 0 (zero) classification. Because these interactions are removed through design and mitigation, an assessment of the environmental effect is not required, and the interaction is not considered further in the EA. The environmental effects of these activities are thus, by definition, rated not significant.
- If there is likely to be an interaction between a Project activity and a VC that will result in a minor environmental change, but a negligible residual effect on a VC relative to baseline or guideline values in light of planned mitigation, the interaction is categorized as a 1 (one). Category 1 interactions are not expected to contribute to effects of other existing or reasonably foreseeable projects. These interactions are subject to a less detailed environmental effects assessment and are rated as not significant. Justification is provided and the mitigation is described for such categorizations. Such interactions can be mitigated with a high degree of certainty with proven technology and practices.
- If a potential interaction between a Project activity and a VC could result in a measurable environmental change that could contribute to significant residual effects on a VC relative to baseline or guideline values, despite the planned mitigation, the interaction is categorized as a 2 (two). Interactions may be given a 2 classification if there is less certainty regarding the effectiveness of mitigation, or if there is high concern from regulatory agencies, Inuit or stakeholders. These potential interactions are subject to more detailed analysis and consideration in the environmental assessment in order to predict, mitigate and evaluate the potential environmental effects.

The ranking takes a precautionary approach, whereby interactions with a meaningful degree of uncertainty are assigned a rank of 2 so that a detailed analysis of the potential environmental effect is undertaken.

Justification for ranking the Project-environmental interactions considered for each VC is provided in the scoping section for each discipline.

3.2.4 Assessment Boundaries

Boundaries of the assessment are defined for each VC to allow for a meaningful analysis of the significance of environmental effects. The assessment boundaries are described in terms of temporal, spatial and administrative and technical boundaries.

3.2.4.1 Spatial Boundaries

Spatial boundaries are established for assessing the potential Project-related environmental effects and cumulative environmental effects on each VC. The primary consideration in establishing these boundaries is the probable geographical extent of the environmental effects (i.e., the zone of influence) on the VC.

Spatial boundaries represent the geographic extent of the VC, as they pertain to potential Project-environment interactions. Spatial boundaries are selected for each VC to reflect the geographic extent over which Project activities will or are likely to occur, and as such, they may be different from one VC to another depending on the characteristics of the VC. For this assessment, the spatial boundaries are referred to as 'assessment areas' to differentiate the areas from the local and regional study areas referred to in many baseline studies. Spatial boundaries are also identified in response to specific Inuit Qaujimajatuqangit and engagement (EN-BL HTO 2009[41], EN-AR NIRB 2010[42], EN-OH 2012[43]).

Three assessment areas are defined for each VC. These include:

- The ***Project Footprint.*** This is the most immediate area of the Project. The Project Footprint includes the area of direct physical disturbance associated with the construction or operation of the Project.
- The ***Local Assessment Area (LAA).*** This is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence. The LAA includes the Project Footprint and any adjacent areas where Project-related environmental effects may be reasonably expected to occur.
- The ***Regional Assessment Area (RAA).*** This is a broader area within which cumulative environmental effects on the VC may potentially occur. This will depend on physical and biological conditions (e.g., air sheds, watersheds, seasonal range of movements, population unit), and the type and location of other past, present or reasonably foreseeable projects or activities. For the socio-economic environment, the RAA may be much broader (planning areas, regions, territories etc.) based on the potential geographic extent over which socio-economic effects are likely to occur. It is also the area where, depending on conditions (e.g., seasonal conditions, habitat use, more intermittent and dispersed Project activities), Project environmental effects may be more wide reaching.

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[41] EN-BL HTO 2009: *I'm concerned about how far the buildings and the pits are from each other. I think you should have had a legend. I see a lot of creeks here and we don't know where they run to, how are we going to protect them? There is a slope to the deposits and what if wastes flow into the water surrounding the area*
[42] EN-AR NIRB 2010: *Would like to know what wildlife are in the area and if there are any waterbodies (lakes or rivers) near the mine.*
[43] EN-OH 2012: *Are there lots of lakes near the site?*

3.2.4.2 Temporal Boundaries

The temporal boundaries for the assessment are defined based on the timing and duration of Project activities and the nature of the interactions with each VC. Temporal boundaries encompass those periods during which the VCs and KIs are likely to be affected by Project activities.

For the Kiggavik Project, temporal boundaries include the following Project phases:

- construction;
- operations;
- final closure; and
- post-closure.

The operations phase includes consideration of maintenance, planned exploration and temporary closure (care & maintenance) of the Project. The final closure phase considers decommissioning and reclamation, and post-closure phase includes management of restored sites.

In some cases, temporal boundaries are refined to a specific period of time beyond simply limiting them to a specific phase of the Project. This is carried out as necessary within each environmental effects analysis section. Temporal boundaries for the assessment may reflect seasonal variations or life cycle requirements of biological VCs, long-term population cycles for some biological VECs, or forecasted trends for socio-economic VSECs. McDonald et al. (1997)[44] highlight the need for consideration of long-term effects from developments to fish and lakes.

3.2.4.3 Administrative and Technical Boundaries

Administrative and technical boundaries are identified and justified for each VC or KI, as appropriate. Administrative boundaries include specific aspects of provincial, territorial and federal regulatory requirements, standards, objectives, or guidelines, as well as regional planning initiatives that are relevant to the assessment of the Project's environmental effects on the VC. Administrative boundaries may be selected to establish spatial boundaries.

Technical boundaries reflect technical limitations in evaluating potential environmental effects of the Project, and may include limitations in scientific and social information, data analyses, and data interpretation.

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[44] IQ-McDonald et al. (1997): *In any development the fish and lakes need to be considered for the long-term effects.*

3.2.5 Environmental Effects Criteria

Where possible, the following characteristics are described quantitatively for each VC to assist in the assessment of residual environmental effects. Where these residual environmental effects cannot be defined quantitatively, they are described using qualitative terms. If qualitative descriptions are used, definitions are provided for each VC or KI, as appropriate, in the scoping section of the environmental assessment for that VC or KI.

- ***Direction:*** the ultimate long-term trend of the environmental effect (e.g., positive, neutral or adverse)
- ***Magnitude:*** the amount of change in a measurable parameter or variable relative to the baseline case (i.e., low, moderate, high)
- ***Geographical Extent:*** the geographic area within which an environmental effect of a defined magnitude occurs (site-specific, local, regional, territorial, national, international)
- ***Frequency:*** the number of times during the Project or a specific Project phase that an environmental effect may occur (i.e., once, sporadically, regular, continuous)
- ***Duration:*** this is typically defined in terms of the period of time that is required until the VC returns to its baseline condition or the environmental effect can no longer be measured or otherwise perceived (i.e., short term, medium term, long term, permanent)
- ***Reversibility:*** the likelihood that a measurable parameter for the VC will recover from an environmental effect (i.e., reversible, irreversible)
- ***Ecological or socio-economic context:*** the general characteristics of the area in which the Kiggavik Project is located (i.e., undisturbed, disturbed, urban setting)

3.2.6 Standards or Thresholds for Determining Significance

Where possible, threshold criteria or standards for determining the significance of environmental effects are defined for each VC or KI to represent that limit beyond which a residual environmental effect would be considered significant. In some cases, standards or thresholds are also defined for specific environmental effects on a VC or KI.

Standards are recognized federal and territorial regulatory requirements or industry objectives that are applicable to the VC, and that reflect the limits of an acceptable state for that component. Where standards, guidelines or regulatory requirements do not specifically exist, thresholds are defined for the measurable parameters for an environmental effect on a VC based on resource management objectives, community standards, scientific literature, or ecological processes (e.g., desired states for fish or wildlife habitats or populations).

Potential changes in a measurable parameter or VC resulting from residual Project or cumulative environmental effects are evaluated against these standards or thresholds. Environmental effects are rated as either *significant or not significant*.

3.2.7 Influence of Inuit Qaujimajatuqangit and Engagement on the Assessment

Engagement undertaken to date with regulators, Inuit and public stakeholders in relation to the Project is described in Volume 3. Issues raised during these engagement activities and Inuit Qaujimajatuqangit (IQ) sessions were documented and reviewed for consideration in each discipline-specific assessment, including scoping of baseline data collection, selection of VCs and KIs, describing Project-environment interactions, use of traditional ecological knowledge (TEK) and IQ in the environmental effects assessment, mitigation measures and monitoring plans.

3.3 Assessment of Project Environmental Effects

3.3.1 Existing Conditions

The existing conditions for each VC are described according to the status and characteristics of the VC within its defined spatial and temporal assessment boundaries. This is based on a variety of sources, including:

- information from past research conducted in the region;
- IQ; and
- knowledge gained from baseline data gathered from literature review, qualitative and quantitative analyses, and field programs carried out as part of the environmental assessment.

In general, the description of existing conditions is limited to information directly relevant to the potential VC interactions with the Project to support the environmental effects analysis.

3.3.2 Project Effect Linkages

The mechanisms or linkages through which the Project components and activities could result in an environmental effect on a VC, and the spatial and temporal extent of this interaction is described based on the existing conditions of the VC. Because the assessment focuses on residual environmental effects, effects prior to mitigation are not characterized or quantified and the significance of the effect is not determined.

3.3.3 Mitigation Measures and Project Design

Where Project activities are likely to cause an environmental effect on a VC, mitigation measures are identified to minimize or avoid environmental effects of the Project. This includes measures or strategies that are technically and economically feasible and that would reduce the extent, duration or magnitude of the environmental effect.

Mitigation includes Project design features to change the spatial or temporal aspect of the Project, specialized mitigation, environmental protection measures and protocols and, in some cases, offsetting (i.e., fisheries offsetting).

Where mitigation is identified, a brief discussion of how the measure(s) will help to minimize or avoid the residual environmental effect on the VC is provided. Where possible, this includes a description of how effective the measure is expected to be in minimizing the change in the measurable parameters for the environmental effect.

3.3.4 Residual Project Effects Assessment

Taking into account the mitigation and expected effectiveness of the measure(s), the residual environmental effects of the Project are described according to their probable magnitude, geographic scope, duration, frequency, reversibility and ecological context, where appropriate. The residual effect is characterized in the context of the existing condition for the measureable parameter(s) and how it is likely to change as a result of the Project environmental effect. For some residual environmental effects, the change in the measurable parameter is described relative to each Project phase.

Where possible, the magnitude, geographic extent and duration of the residual environmental effect are quantified. If a residual effect cannot be quantified, qualitative terms are used to describe the attributes of the effect.

3.3.5 Significance of Residual Project Environmental Effects

Significance of a residual Project environmental effect is determined based on standards or thresholds that are specific to the VEC, KI and/or the measurable parameters used to assess the environmental effect. Determination of whether a residual environmental effect is considered to be significant or not significant is based on a comparison of the predicted change in the VC or measurable parameter to the defined threshold or standard. This includes an indication of the likelihood that a residual environmental effect on a VC will occur based on probability of occurrence (i.e., based on past experience) and level of scientific uncertainty.

Determination of significance also includes a discussion of the confidence of the prediction with respect to:

- the characterization of environmental effects; and
- the success of Project design features, mitigation measures, and environmental protection measures in effectively reducing the environmental effect.

Prediction confidence for the environmental effect and the success of mitigation measures is ranked as low, moderate or high.

3.3.6 Monitoring of Residual Project Environmental Effects

Based on analysis of the residual Project environmental effect, it may be necessary to conduct a monitoring program. Monitoring is recommended in cases where there is a need to address Project-related issues of public concern, test the accuracy of the assessment predictions, verify the success of the mitigation measures, or gain additional scientific knowledge related to prediction of the Project environmental effect.

Two types of monitoring are considered: compliance and follow-up environmental monitoring.

Compliance monitoring is undertaken to confirm that Project design features, mitigation measures, environmental protection measures, or benefit agreements are being effectively implemented.

Biophysical and socio-economic monitoring programs are used to:

- verify predictions of environmental effects;
- determine the effectiveness of mitigation measures, environmental protection measures or benefits agreements in order to modify or implement new measures where required;
- support the implementation of adaptive management measures to address previously unanticipated adverse environmental effects; and
- support environmental management systems used to manage the environmental effects of projects.

Where a monitoring program for a specific VC or KI is identified, the following aspects of the program are defined:

- parameters to be measured;
- methods and equipment to be used;
- location and timing of surveys; and
- wow the results of the monitoring will be applied, including consideration of an adaptive management approach.

3.4 Assessment of Cumulative Environmental Effects

3.4.1 Screening for Potential Cumulative Effects

Cumulative environmental effects are only assessed if the following criteria are met for the residual Project effect under consideration:

- the Project will result in a measurable, demonstrable or reasonably-expected residual environmental effect on a component of the biophysical or socio-economic environment;
- the Project-specific residual environmental effect on the component will likely act in a cumulative fashion with the environmental effects of other past or future projects or activities that are likely to occur (i.e., Is there overlap of environmental effects?); and
- there is a reasonable expectation that the Project's contribution to cumulative environmental effects will be substantive, measurable or discernible such as that it will affect the viability or sustainability of the resource.

If, based on these criteria, there is potential for cumulative environmental effects, the effect is assessed further to determine if it is likely to shift the component to an unacceptable state. Where there is no potential for the environmental effect of the Project to spatially or temporally overlap with similar effects of other project and activities, justification for not carrying these environmental effects forward to the assessment of cumulative environmental effects is provided.

3.4.2 Project Inclusion List

The project inclusion list includes all past, present and reasonable foreseeable projects, activities and actions in the region of the Kiggavik Project. Only projects, activities and actions that overlap with the Project residual environmental effects both spatially and temporally are considered in the assessment of potential cumulative environmental effects.

The specific projects, activities and action considered for each environmental effect are described in the assessment for each VC or KI.

3.4.3 Description of Cumulative Environmental Effects

The first step in the assessment of cumulative environmental effects involves describing the environmental effect, the mechanisms by which the Project environmental effect may interact cumulatively with other projects and activities in the RAA (from the Project Inclusion List), and the geographic and temporal scope of the cumulative environmental effect.

For this assessment, cumulative environmental effects are described for four cases. A more detailed description of the assessment cases is provided within the Project Inclusion List (Tier 1, Volume 1, Appendix 2).

3.4.3.1 Base Case

Base Case is the current baseline status (i.e., prior to the Project) of the measurable parameters for the environmental effects. Baseline includes all past and present projects and activities in the RAA that may result in similar environmental effects as the Project environmental effect, including ongoing mineral exploration. Existing projects include projects that have received environmental approval and are in some form of planning, construction and/or commissioning.

3.4.3.2 Project Case

The Project Case represents the status of the measurable parameters for the environmental effect with the Project in place, over and above the Base Case. This is usually assessed using the peak environmental effect of the Project or maximum active footprint for the Project.

3.4.3.3 Future Case

Future Case is the status of the measurable parameters for the environmental effect due to the Project Case, in combination with all reasonable foreseeable projects, activities and actions. Reasonably foreseeable projects are defined as future projects, activities and actions that will occur with certainty, including projects that are in some form of regulatory approval or have made a public announcement to seek regulatory approval.

For this assessment, future projects include proposed mines that are currently under NIRB review. These include the following mines:

- Meadowbank;
- Doris North 1;
- Doris North 2;
- Meliadine;
- Mary River;
- Hackett River;
- Back River; and
- High Lake.

The combination of the Project Case with the Future Case allows determination of the Project's contribution to cumulative effects of all past, present and reasonably-foreseeable projects and activities.

3.4.3.4 Far Future Case

The Far Future Case represents the status of the measurable parameters for the environmental effect resulting from the Future Case, in combination with possible far future developments in the Kiggavik region.

It is recognized that exploration activities will continue in the vicinity of the Kiggavik Project, and that there is the potential for additional resources to be discovered during the life of the Project. To address such a possibility, a potential far future development scenario was developed. This scenario assumes additional deposits within a 200 kilometre (km) radius of the Kiggavik site, and the development of a non-uranium operation located within the Kiggavik RAA. The Meadowbank gold operation is used as the model for this. It assumes additional resources are found in the Meadowbank area, and that operation of Meadowbank continues. The following projects and activities are included in the development scenario.

Component	Locations
Uranium mines	3 mines within 200 km of Kiggavik
Uranium mills	Kiggavik mill
Gold mines	Meadowbank region 1 mine within Kiggavik RAA
Gold mills	Meadowbank region Additional mill within Kiggavik RAA
Access Roads	Meadowbank region Additional mill within Kiggavik RAA
Exploration	Induced exploration near the access road(s) and in the Kiggavik area
Notes: km = kilometres; RAA = Regional Assessment Area.	

Due to the lack of information regarding the specific details of potential future developments (i.e., footprint of projects and activities), the assessment of cumulative environmental effects under this Case is, by definition, qualitative and is limited to a description of how these projects, activities and actions might affect the magnitude, duration and extent of cumulative environmental effects.

3.4.4 Mitigation of Cumulative Environmental Effects

Mitigation measures that would reduce the Project's environmental effects are described for cumulative environmental effects, with emphasis on measures that should limit the interaction of environmental effects of the Project with similar environmental effects from other projects. Three types of mitigation measures are considered, where appropriate. These include:

- measures that can be implemented solely by AREVA Resources Canada Inc. (AREVA);
- measures that can be implemented by AREVA, in cooperation with other project proponents, government, Aboriginal organizations and/or public stakeholders; and
- measures that can be implemented independently by other project proponents, government, Aboriginal Organizations and/or public stakeholders.

For the latter two types of mitigation, the degree to which AREVA can or cannot influence the implementation of these measures is noted.

Mitigation measures that could assist in reducing potential cumulative environmental effects are identified for each environmental effect, including a discussion of how these measures may potentially modify the characteristics of an environmental effect.

3.4.5 Residual Cumulative Environmental Effects Assessment

Residual cumulative environmental effects are described, taking into account how the mitigation will change the environmental effect. Where possible, cumulative environmental effects are characterized quantitatively or qualitatively in terms of the direction, magnitude, duration, geographic extent, frequency and reversibility. This includes characterization of:

- the total residual cumulative environmental effects based on the Future Case (i.e., the environmental effects of all past, present and reasonably foreseeable project and activities), in combination with the environmental effects of the Project; and
- the contribution of the Project to the total residual cumulative effects (i.e., how much of the total residual cumulative effects can be attributed to the Project).

3.4.6 Significance of Residual Cumulative Environmental Effects

The significance of cumulative environmental effects is determined using standards or thresholds that are specific to the VC, KI and/or measurable parameters used to assess the Project environmental effect. Determinations of significance are made for:

- the significance of the total residual cumulative environmental effect, and
- the significance of the contribution of the Project to the total residual cumulative environmental effect.

The determination of residual cumulative environmental effects includes a discussion of the confidence of the prediction based on scientific certainty relative to:

- quantifying or estimating the environmental effect (i.e., quality and/or quantity of data, understanding of the effects mechanisms), and
- the effectiveness of the proposed mitigation measures.

As for residual Project environmental effects, prediction confidence for the cumulative environmental effect and the success of mitigation measures is ranked as low, moderate or high.

3.4.7 Monitoring of Cumulative Environmental Effects

Based on the evaluation of residual cumulative environmental effects, it may be necessary to conduct monitoring programs. Monitoring programs are designed to:

- confirm the effectiveness of a broad range of approved mitigation techniques;
- determine whether different or an increased level of mitigation is required to achieve the mitigation or reclamation goals; and
- identify and address any cumulative effects that occur but were not predicted.

Two types of monitoring are considered:

- **Compliance Monitoring**: to confirm that Project design features, mitigation measures, environmental protection measures, or benefit agreements are being effectively implemented.
- **Biophysical or Socio-economic Monitoring:** to confirm the environmental effect prediction and/or effectiveness of a Project design feature, mitigation measure, environmental protection measure, or benefit agreement.

3.5 Summary of Residual Environmental Effects

Residual Project and cumulative environmental effects are briefly summarized for each VC. This includes a discussion of the overall combined environmental effect of the Project on the VC and its significance, as well as a discussion of the overall combined effect of all cumulative effects on the VC and its significance. For biophysical VECs, this relates to the sustainability of the resource or populations being considered. For socio-economic VSECs, this relates to the ability of the community, the Kivalliq region and/or Nunavut to adapt to or manage the environmental effect. A discussion of the Project's contribution to the combined cumulative effect is also provided.

In addition, this summary section presents an assessment of the effects of climate change on residual Project and cumulative effects. Where possible, the effects are described quantitatively, and include a description of how likely climate changes in the region will likely influence Project and cumulative residual effects.

3.6 Assessment of Transboundary Effects

As required by the NIRB EIS Guidelines, the assessment includes consideration of transboundary effects, where residual environmental effects are likely to extend beyond the Nunavut into federal waters and/or other provincial or territorial jurisdictions. As this is based largely on the cumulative effects assessment, the transboundary effects are characterized qualitatively or semi-quantitatively.

3.7 Summary of Mitigation

A detailed description of the mitigation measures proposed to minimize or avoid Project-related and cumulative effects on VCs is provided based on the scoping and effects analyses. This includes:

- relevant Project design features to reduce environmental effects;
- project policies (e.g., Inuit hiring policy);
- specialized mitigation measures to minimize environmental effects on VECs;
- social or community programs to minimize environmental effects on VSECs;
- Environmental Protection Plans;
- broader agreements (e.g., benefits agreements); and
- compensation or offsetting.

3.8 Summary of Monitoring

Monitoring programs to address uncertainties associated with the environmental effects predictions and environmental design features and mitigation proposed for residual Project effects and cumulative effects are described in detail. This includes all compliance monitoring and environmental monitoring that may be applied during the life of the Project, and that will form the:

- Compliance Monitoring Program Framework;
- Environmental Monitoring Program Framework;
- Socio-Economic Monitoring Program Framework;
- Post-Project Analysis Program Framework; and
- Follow-up Monitoring Programs.

4 Scope of the Assessment

The Kiggavik Project Environmental Impact Assessment (EIA) was developed in accordance with the Nunavut Impact Review Board's (NIRB) "Guidelines for the Preparation of an Environmental Impact Statement (EIS) for AREVA Resources Canada Inc.'s (AREVA) Kiggavik Project" (the Project) (NIRB File No. 09MN003) (NIRB 2011). The Project-specific EIS guidelines from the NIRB were developed based on information contained within the Kiggavik Project Proposal (AREVA 2008), and on the public scoping process carried out by NIRB. Public scoping sessions were conducted in a number of potentially affected Nunavut communities, to solicit input and advice on Valued Environmental Components (VECs) that should be addressed in the development of the EIS.

This Section describes the scope of the assessment for the aquatic environment. Construction, operation, and decommissioning of the Kiggavik mine has the potential to result in environmental effects on the aquatic environment. The environmental effects of routine operations on the aquatic environment are addressed in Sections 6 through 11. The environmental effects of accidents and malfunctions are addressed in Volume 10.

4.1 Issues and Concerns Identified During Inuit Qaujimajatuqangit Interviews and Inuit, Government, and Stakeholder Engagement

The NIRB EIS guidelines for the Kiggavik Project (the Project) (NIRB 2011) incorporated a number of issues and concerns identified during Inuit, government and stakeholder engagement related to Project effects on the aquatic environment.

Issues identified for the aquatic environment by the NIRB were included in NIRB (2011), Sections 8.1.7 through 8.1.10. These issues focused on the effects of the Project to surface and groundwater quantity and quality, and on sediment quality through water extraction, surface runoff and waste disposal. Issues also included Project effects on aquatic organisms, fish, and fish habitat that would be associated with changes to water and sediment quality and waterbody disturbance. Specific issues related to routine project components and activities, as identified by NIRB include:

- the effect of water supply, storage and discharge locations, and water quantities on the downstream environment;
- the alteration of drainage patterns and channels by Project facilities;
- erosion, sedimentation, and runoff during construction and operation;
- effects on navigability of watercourses from proposed water crossings;
- dewatering of the Andrew Lake open pit;
- effects of ice damming;

- effects of permafrost and the active layer on surface water;
- increases in contaminants and radionuclides in groundwater and surface water;
- water quality degradation due to runoff from mine rock stockpiles, ore stockpiles, construction fills, road embankments, and open quarry sites;
- water quality degradation associated with open pit dewatering;
- contaminant transport due to faults in the bedrock;
- effects of discharges from Project wastewater treatment plants;
- effects from other waste management activities, including storage and handling of waste;
- effects of nutrient input from blasting activities;
- effects from the deposition of particulate matter resulting from the incomplete combustion of wastes from incineration;
- effects on riparian environments due to in-water or near-water activities;
- effects on aquatic invertebrates and habitat from planned containment structures (e.g., sediment control structures and fuel containment structures);
- effects on fish from changes to the aquatic or riparian environment;
- effects on fish due to blasting in or near water bodies; and
- fish passage impediments at water crossings along access roads.

As part of AREVA's efforts to gather input and feedback from Kivalliq community members on the Project, a number of public engagement events (Tier 2, Volume 3, Part 1 Public Engagement) and IQ interviews (Tier 2, Volume 3, Part 2 Inuit Qaujimajatuqangit) were conducted. AREVA efforts to engage various groups (e.g. Elders, youth, hunters, women) within communities demonstrates the commitment to IQ guiding principles (GN 2009) of Tunnganarniq (fostering good spirit by being open, welcoming, and inclusive), Aajiiqatigiingniq (consensus decision-making) and Inuuqatigiitsiarniq (respecting others, relationships, and caring for people) and as all groups are recognized as valued contributors. The term Inuit Qaujimajatuqangit is used to describe Inuit epistemology or the Indigenous knowledge of the Inuit (Tagalik 2012). Inuit Qaujimajatuqangit translates into English as "that which Inuit have always known to be true." Throughout the assessment, Inuit Qaujimajatuqangit and engagement comments are differentiated by prefix of either 'IQ' for Inuit Qaujimajatuqangit or 'EN' for engagement.

Many of the issues and concerns raised about the potential effects of the Project on the aquatic environment highlight the understanding that *the health of Inuit, of wildlife and of the environment are interconnected* (IQ-Nunavut Tunngavik Inc. 2005) and the IQ guiding principle of Avatimik Kamattiarniq, the concept of environmental stewardship (GN 2009).

Project-specific issues and concerns identified during engagement and IQ interviews broadly include:

- potential changes in water quality, including drinking water quality (EN-BL CLC 2009[45]; EN-AR NIRB 2010[46]; EN-RB OH 2010[47]; EN-WC KIA 2007[48]);
- fish health and suitability of fish for consumption (EN-BL NIRB 2010[49]; EN-BL OH Nov 2013[50], IQ-BL06 2008[51]);
- changes in the aquatic environment from dust and contaminants in air (EN-RI OH 2009[52]; IQ-RIE 2009[53], EN-RI KWB Oct 2009[54]);
- site water management (EN-BL OH 2010[55], EN-RI OH 2010[56], EN-RB KIA 2007[57], EN-BL OH Nov 2010[58]),
- interaction of site infrastructure (e.g. waste rock piles EN-WC OH 2012[59], tailings EN-CI NIRB 2010[60] and roads EN-CI KIA 2010[61]) with the aquatic environment;
- environmental effects from spills, leaks and accidents (EN-KIV OH 2009[62]; EN-CI OH 2012[63]; EN-CI NIRB2010[64]);
- importance of environmental protection (EN-RI KWB 2008[65]),
- questions about environmental monitoring (EN-BL CLC 2007[66]; EN-BL OH Nov 2013[67]); and
- concern that decommissioning and reclamation needs to be done properly so that the public can use aquatic resources without incidents or concerns (EN-RB NIRB 2010[68]; EN-WC OH 2012[69]; EN-CI OH Nov 2012[70]).

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[45] EN-BL CLC 2009: *What about uranium? This is our drinking water.*
[46] EN-AR NIRB 2010: *Question about the possibility of the uranium/radiation/contaminants travelling downstream to Baker Lake.*
[47] EN-RB OH 2010: *Worried about the area where they get fresh water.*
[48] EN-WC KIA 2007: *The reason I asked there are a lot of rivers in that area. Will contaminants flow in the rivers or lakes?*
[49] EN-BL NIRB 2010: *Concerns regarding the environment and impacts from industrial activities, human activities, and radiation. Impacts already being seen from exploration/drilling already on the fish in the area. They have become very poor, have white spots, are skinny and are not good to eat effects on water.*
[50] EN-BL OH Nov 2013: *Are there fish in the lakes? Will they be safe?*
[51] IQ-BL06 2008: *One Elder said that their diet was fish only, as caribou were scare after moving to Baker Lake.*
[52] EN-RI OH 2009: *When uranium is crushed it is far more radioactive because of the surface area so I am glad to see you have the tailings under water. I am still concerned about very fine particles and the downwind and downstream areas.*
[53] IQ-RIE 2009*: Elders expressed concern about the potential effects of uranium dust travelling and affecting many people*
[54] EN-RI KWB Oct 2009: *How does dust affect the environment?*
[55] EN-BL OH 2010: *Will you divert water? Are you going to treat all of the water and manage all that waste?*
[56] EN-RI OH 2010: *What will you do with all the water during the high spring melt? Rock piles and tailings pit. North is different from south and there will be more snow piling up and spring runoff will create more contamination.*
[57] EN-RB KIA 2007: *Would water flow through the tailings?*
[58] EN-BL OH Nov 2010: *Are you going to treat all of the water?*
[59] EN-WC OH 2012: *Are there lakes under the waste rock?*
[60] EN-CI NIRB 2010: *Concerns over the potential impacts from the tailings (leaching/spills) to Baker Lake and eventually to Chesterfield Inlet.*
[61] EN-CI KIA 2010: *There are calving areas, rivers, migratory birds along the proposed access road. Make sure you understand the Elder's point of view when you get to Baker Lake.*
[62] EN-KIV OH 2009: *What if there is a spill by the river? Do you have plans to fix this and communicate with the people?*
[63] EN-CI OH 2012: *What would happen if you had a spill of uranium in the water? How much damage would be done?*
[64] EN-CI NIRB2010: *Concerns over spillage from fuel transfer.*
[65] EN-RI KWB 2008: *…how do you ensure that waterways are protected from contaminants?*
[6666] EN-BL CLC 2007: *How long will you be monitoring?*
[67] EN-BL OH Nov 2013: *What about the environment? How do you know what is in the air and water and lichen that caribou eat?*
[68] EN-RB NIRB 2010: *Concerns over cleanup and restoration of the land. Cleanups and restoration of the land were suppose to happen at the old DEW line sites but has not happened.*

AREVA has endeavoured to address each of these issues either within this assessment document, or where required, directed the reader to the appropriate document, as outlined in Table 4.1-1.

Table 4.1-1 Stakeholder Concerns Relating to the Aquatic Environment

Issue or Concern	Document
Potential changes in water quality	Volume 5, Sections 7 and 8
Fish health	Volume 5, Sections 10 and 11.
Drinking water quality and suitability of fish for consumption	Volume 5, Sections 8, 10 and 11 plus Volume 8 and Technical Appendix 8A (ecological and human health risk assessments)
Changes in the aquatic environment from dust and contaminants in air	Volume 5, Sections 8 and 9
Site water management	Described in Volume 2 and Technical Appendix 2I and influence of design of site water management on the aquatic environment is assessed in Volume 5, Sections 6, 7, 8, 9, 10, 11
Interaction of site infrastructure with the aquatic environment	Volume 5, Sections 6, 7, 8, 9, 10, 11
Environmental effects from spills, leaks and accidents	Volume 10
Importance of environmental protection	Mitigation measures outlined in Volume 5, Sections 6, 7, 8, 9, 10 and 11 and summarized in Section 13
Questions about environmental monitoring	Environmental monitoring for the aquatic environment is outlined in Volume 5, Sections 6, 7, 8, 9, 10 and 11 and summarized in Section 14 and Technical Appendix 5M
Concern that decommissioning and reclamation needs to be done properly so that the public can use aquatic resources without incidents or concerns	Volume 5, Sections 6, 7, 8, 9, 10, 11 and Technical Appendix 2R

[69] EN-WC OH 2012: *What would happen if a lake goes into the pit?*
[70] EN-CI OH Nov 2012: *Will the uranium go into the water and be dangerous for our kids and grandkids?*

4.1.1 Influence of Inuit Qaujimajatuqangit and Stakeholder Engagement on the Assessment

Issues and concerns identified during the stakeholder engagement sessions and IQ interviews informed the list of Project-environment interactions, were incorporated into the aquatic assessment, and informed the associated mitigation and monitoring plans. Through Inuit Qaujimajatuqangit (IQ) interviews and engagement activities, AREVA has learned about the importance of the aquatic environment to Kivalliq community members. This includes the value of aquatic resources to the Inuit way of life (IQ-RB01 2009[71], IQ-BL06 2008[72]), concerns and questions about potential for contamination of aquatic environment (EN-BL HTO Mar 2009[73], EN-BL HS Nov 2010[74]), and the importance of environmental protection (EN-BL OH Nov 2010[75], EN-BL OH Nov 2013[76], EN-AR NIRB May 2010[77]).

The importance of the aquatic environment and influence of IQ and engagement on the assessment is further demonstrated through the selection and validation of aquatic Valued Environmental Components Refer to Section 4.3 below for a discussion on the selection and validation of VECs.

Baseline data collection was greatly enhanced and informed by local Inuit staff hired to assist with field work (Tier 2, Volume 3, Part 1, Section 3.4.9). Their knowledge of the land and insight into historical and current land use patterns of local Inuit helped define the scope of the aquatic baseline program and demonstrates the IQ principle of Qaujimanilik/Ihumatuyuk (e.g. a person who is recognized by the community as having in-depth knowledge of a subject).

Many of the mitigation, monitoring, and management plans associated with aquatic assessments incorporate IQ guiding principles (GN 2009), including Qanuqtuurnunnarniq (being resourceful to solve problems), Avatimik Kamattiarniq (environmental stewardship), Pilimmaksarniq (skills and knowledge acquisition) and Piliriqatigiingniq (collaborative relationships or working together for a common purpose). The importance of environmental monitoring was highlighted through IQ interviews and engagement feedback (e.g. EN-BL OH Nov 2013[78]).

Results of the aquatic assessment and aquatic effects monitoring programs (Tier 3, Technical Appendix 5M) will be communicated to local stakeholders through implementation of the Community Involvement Plan (Tier 3, Technical Appendix 3C). AREVA's commitment to engagement and

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[71] IQ-RB01 2009: *People drink water and get ice from the rivers. Many people won't drink tap water.*
[72] IQ-BL06 2008: *One Elder said that their diet was fish only, as caribou were scare after moving to Baker Lake.*
[73] EN-BL HTO Mar 2009: *What if wastes flow into the water surrounding the mine?*
[74] EN-BL HS Nov 2010: *What happens if uranium gets into the groundwater?*
[75] EN-BL OH Nov 2010: *Are you going to treat all of the water?*
[76] EN-BL OH Nov 2013: *Are there fish in the lakes? Will they be safe?*
[77] EN-AR NIRB May 2010: *Would like to see aquatic life in the lakes and rivers monitored.*
[78] EN-BL OH Nov 2013: *What about the environment? How do you know what is in the air and water and lichen that caribou eat?*

community involvement is throughout the life of the Project and continues throughout construction, operations, decommissioning and reclamation. Knowledge and understanding of IQ and Inuit culture influences the way in which AREVA conducts business in Nunavut. Many IQ principles are evident in AREVA's efforts to:

- engage various groups (e.g. Elders, youth, hunters, local businesses and others) within communities as all groups are recognized as valued contributors.
  - *Tunnganarniq, Aajiiqatigiingniq, Inuuqatigiitsiarniq*
- remove language barriers through use of translated material and availability of translators at meetings
  - *Pilimmaksarniq, Tunnganarniq*
- prioritize face-to-face meetings to create relationships and use of various other communication mediums to provide information and obtain feedback
  - *Inuuqatigiitsiarniq, Tunnganarniq, Piliriqatigiingniq.*

The following is a summary of how IQ and engagement data influenced specific sections of the aquatic assessment.

4.1.1.1 Groundwater

Inuit and other stakeholder engagement were used to design Project components associated with potential groundwater-related issues. Concerns related to groundwater and surface water quality were raised in the context of mine rock and tailings management. Specifically, the current cold weather conditions, as well as the potential for climate change and its impact on permafrost, were identified as uncertainties associated with the performance of the proposed in-pit disposal of tailings (EN-CI NIRB 2010[79]).

As a result, the thermal behaviour of the tailings and the rock mass surrounding the Tailings Management Facility (TMF) was simulated for several climate change scenarios and the long-term performance of the TMFs was estimated for an ultimate no-permafrost case. This approach was used to confirm that the performance of the tailings management approach during operation will not be impeded by the cold weather conditions, and the long-term performance of the TMFs does not rely upon the current permafrost conditions.

[79] EN-CI NIRB 2010: *Concerns over the safety of storing tailings underground. How do we know the models/technology (southern models) that will be used will work in the arctic and in the permafrost? How do they know the tailings will be safe underground and there will not be any spills? Concerns over the potential impacts from the tailings (leaching/spills) to Baker Lake and eventually to Chesterfield Inlet.*

4.1.1.2 Surface Hydrology

Inuit stakeholders identified concerns relating to potential Project effects on water quantity (hydrology) and subsequent effects to other environmental components such as water quality, sediment quality, aquatic organisms, fish habitat, fish, and species at risk. Specific hydrological concerns referenced water quanitity, (EN-CI KIA 2007[80], EN-RI COC 2013[81]), snow (EN-WC KIA 2007[82]), rain and runoff (EN-RB OH 2013[83], EN-KIV OH 2009[84], rivers and lakes (EN-KIV OH 2009[85], EN-CI KIA 2010[86], EN-RI SEMC 2010[87]), ice (IQ-CI IQ 2011[88]) and general environmental protection (EN-CH NIRB 2010[89], EN-AR OH 2012[90]). Reductions in water quantity (water levels and flows) have been described (IQ-McDonald et al. 1997[91]). Concerns were also raised regarding specific Project activities, such as water withdrawal, wastewater discharge, water crossings, and the Andrew Lake Pit.

Baseline data were collected to support accurate and confident assessments of potential Project effects and address concerns raised during stakeholder consultation. Specifically, hydrological data were collected at each major stream and lake in the Local Assessment Area (LAA) in which Project activities may affect water flows, including Andrew Lake, Siamese Lake, Pointer Lake, Mushroom Lake, Judge Sissons Lake, Jaegar Lake and their respective outflows. Several other lakes and streams were monitored to capture a variety of flow conditions that can be used to better estimate hydrological characteristics at unmonitored locations in the region in the future.

4.1.1.3 Water and Sediment Quality and Aquatic Organisms

Inuit and stakeholder engagement has consistently identified water and sediment quality, as well as aquatic organisms, as indicators of environmental quality. Water quality, sediment quality and aquatic organisms have been identified as VECs based on their direct value, their value as a prerequisite for healthy aquatic ecosystems and healthy fish populations, and because the Project has the potential to affect these components. Refer to Section 4.3 for more information on VEC selection.

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[80] EN-CI KIA 2007: *How much water will they use?*
[81] EN-RI COC 2013: *Will there be affects on water?*
[82] EN-WC KIA 2007: *1) Are they doing studies from now until the future on snow conditions? 2) Snow conditions are important to mining.*
[83] EN-RB OH 2013: *What about spring water. How will water run?*
[84] EN-KIV OH 2009: *Will there be a dam for the settling ponds?*
[85] EN-KIV OH 2009: *1) Mines in Saskatchewan touch a lot of rivers and lakes; if there is a spill what plans do you have to fix the problem? We should start the process of training and community consultations for our youth. Discuss lakes, caribou migration, rivers and dust control. There are other issues not only in uranium mining but other kinds of mines as well.*
[86] EN-CI KIA 2010: *Has the impact on lakes been considered? Will fish populations be affected?*
[87] EN-RI SEMC 2010: *There are some concerns over low water levels and how that might impact the ferry option*
[88] IQ-CI IQ 2011: *I would not like the ice disturbed.*
[89] EN-CH NIRB 2010: *Would like fellow Inuit to be employed and earning a living, as well as the environment should be taken care of at the same time.*
[90] EN-AR OH 2012: *Will the impacts be big on the environment during operation?*
[91] IQ-McDonald et al. 1997: *Changes to rivers (pre-1940-1990s) include seasonal changes in water levels and flow, and a decline in water quality.*

Safety of drinking water for humans and animals was also an issue identified in engagement and IQ comments (EN-AR OH 2010[92,93]; IQ-RIHT 2009[94], EN-BL EL 2009[95]; EN-BL NIRB 2010[96]; EN-BL OH 2013[97]).

Baseline data collection surveys for water and sediment quality, as well as aquatic organisms, were completed over a number of seasons and years to provide information related to the existing environmental quality characteristics in the LAA (IQ-RIYA 2009[98]). With regard to baseline or existing water quality condition, during IQ interviews conducted by AREVA, Elders indicated that water quality in area lakes and streams does not appear to have changed (IQ-BL12 2008[99]). However, declines in water quality (from pre-1940s to 1990s) have also been described (IQ-McDonald et al. 1997)[100]. Baseline data on water and sediment quality and aquatic organisms were collected at all major lakes and streams in the LAA where Project activities might affect these environmental components.

People were concerned that water and sediment could become contaminated from Project activities and that changes in water and sediment quality could affect aquatic organisms and fish populations. A number of design and management mitigation measures will be employed to reduce potential effects of air emissions (e.g. Tier 2, Volume 6, Section 9.6.2 and Tier 3, Technical Appendix 4C), treated effluent discharge (e.g. Tier 2, Volume 2, Section 9 and Tier 3, Technical Appendic 2I), activities in and near water, (Tier 3, Technical Appendix 5O) and blasting (e.g. Tier 3, Technical Appenices 2B and 2C) on the aquatic environment.

Project-related effects associated with constituents of potential concern (COPCs) in water, sediment and aquatic organisms and their potential effects on animals and humans is described in the Ecological and Human Health Risk Assessment report (Tier 3, Technical Technical Appendix 8A). The Ecological and Human Health Risk Assessment process which examines all inputs (e.g. from water, air, soil, plants, animals to humans) shows respect for all living things by acknowledging and embracing the interconnectedness of non-living (soil, water, air) and living things (plants, animals, humans) in a food web or ecosystem.

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[92] EN-AR OH 2010: *If AREVA opens, my concern is that the water released will travel to Baker Lake and the dust in the air will affect the animals and the people.*
[93] EN-AR OH 2010: *There is concern about drinking water. People in Baker Lake not being able to use the water from their usual source because of pollution.*
[94] IQ-RIHT 2009: *Participants in the Rankin Inlet focus groups were also concerned about the potential for contaminants to be spread through the water.*
[95] EN-BL EL 2009: *I support the mine because I am concerned about the young people being unemployed. I am also concerned about the environmental assessment and how it is going to be completed, especially with the water testing. The animals drink the water, and it would be best to have all things safe for the animals.*
[96] EN-BL NIRB 2010: *Need to think of the future well being of our children. Concerns over not being able to hunt caribou or drinking water might be impacted from the project.*
[97] *EN-BL OH 2013: Are there fish in the lakes? Will they be safe? Can you drink the water?*
[98] IQ-RIYA 2009: *Young adults have heard about damage to the environment that has been caused by mines, and believe the impact assessment should consider the potential effects of the Project during all seasons, and that a priority should be given to considering the potential effects of the Project on caribou migration routes.*
[99] IQ-BL12 2008: *Some Elders said that while the quality of the water hasn't changed, the fish are skinnier and are not very good.*
[100] IQ-McDonald et al. 1997: *Changes to rivers (pre-1940-1990s) include seasonal changes in water levels and flow, and a decline in water quality.*

Potential effects on wildlife that consume water (and sediment, depending on ecological characteristics) are evaluated in Tier 3, Technical Appendix 8A and include the following ecological receptors: barren ground caribou (*Rangifer tarandus*), brown lemming (*Lemmus sibiricus*), muskox (*Ovibos moschatus)*, Arctic ground squirrel (*Sper mophilus parryii)*, grizzly bear (*Ursus arctos*), masked shrew (*Sorex cinereus*), Acrtic fox (*Alopex lagopus*), gray wolf (*Canis lupus*), wolverine (*Gulo gulo*), peregrine falcon (*Falco peregrines* ssp. *Tundrius)*, Lapland longspur (*Calcarius lapponicus)*, red-breasted merganser (*Mergus serrator*), long-tailed duck (*Clangula hyemalis*), northern pintail (*Anus acuta*), semipalmated sandpiper (*Calidris pusilla*) and rock ptarmigan (*Lagopus muta*). The health of terrestrial biota is further assessed in Tier 2, Volume 6, Section 13 (caribou and muskox), Section 14 (wolves), Section 15 (raptors), Section 16 (migratory birds) and Section 17 (species at risk).

Potential effects on humans that consume water and aquatic biota, including fish, are presented in the human health risk assessment in Tier 2, Volume 8 and Tier 3, Technical Appendix 8A.

Water and sediment quality and aquatic organisms will be monitored during operations and decommissioning to address community concerns about potential contamination of or changes to the aquatic environment resulting from Project activities. This includes sampling and analyzing water and sediment (water quality and sediment quality monitoring) as well as monitoring aquatic organisms communities (e.g. bethic invertebrate diversity, density). The Aquatic Effects Monitoring Plan is provided in Tier 3, Technical Appendix 5M. Monitoring results will be compared to baseline values and compared to predictions from this environmental assessment (Section 8 for water quality, Section 9 for sediment, Section 10 for aquatic organisms). Water and sediment quality monitoring results will also be used to update the ecological and human health risk assessment as required (Tier 3, Technical Appendix 8A).

4.1.1.4 Fish and Fish Habitat

Numerous Inuit and other stakeholders in all surveyed communities identified healthy fish populations as an important component of environmental quality. The importance of fish is highlighted in an IQ comment from a Baker Lake Elder: *As long as there have been lakes, it has been a tradition to fish* (IQ-BL16 2008). Concerns identified ranged from the general safety of fish in the Project area (EN-BL OH 2013[101]) to the maintenance of healthy fish and fish populations (EN-CI KIA 2010[102]), maintenance of regional and local fish populations for domestic and commercial use by local residents (IQ-WCE 2009[103]), and concerns related to the protection of fish habitat, including

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[101] EN-BL OH 2013: *Are there fish in the lakes? Will they be safe? Can you drink the water?*

[102] EN-CI KIA 2010: *You may not have an answer for this. That's OK. Birds use waterfowl as food. Has the impact on lakes been considered? Will fish populations be affected?*

[103] IQ-WCE 2009: *One of the Elders said there are not many fish anymore, and she hardly gets enough for her own use. Others said that they no longer make much money selling fish to the fish processing plant.*

continued access to spawning areas where Project activities might affect streams and lakes in the mine site or mine access LAA.

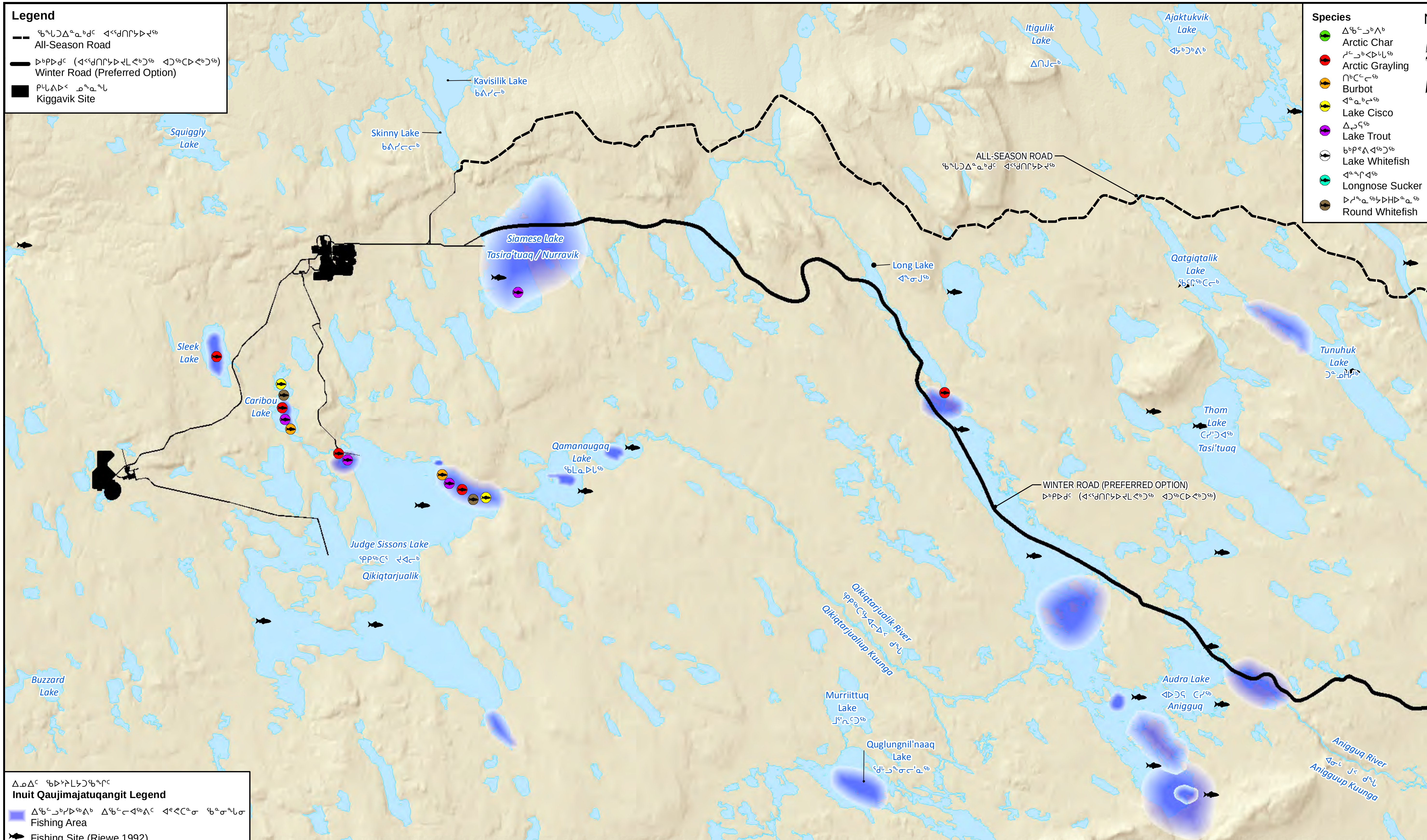
To address these concerns, baseline fish and fish habitat data were collected at all major lakes and streams in the LAA that could be affected by the Project; LAA watercourses and waterbodies identified as traditional fishing areas based on Inuit Qaujimajatuqangit (IQ) surveys were included. Fishing areas identified from IQ are presented in Figure 4.1-1 (A and B). Baseline data and IQ information were used together to describe the existing environment within the LAA; IQ incorporated into the existing environment summary includes information on fish species distributions, timing of spawning and fish movements, and observations related to fish health and tissue quality. Note that not all fishing areas identified from IQ were included in the assessment because some of these areas were outside of the LAA. Inuit Qaujimajatuqangit was also used to help identify VECs to be included in the assessment (Section 4.3). Baseline fish health and fish tissue chemistry data were gathered and examined to address concerns relating to fish health and the quality of fish flesh. Inuit Qaujimajatuqangit (IQ) indicates there is concern that fish condition has declined (IQ-BL02 2008[104]; IQ-BL12 2008[105]).

Fish habitat and fish populations have been identified as VECs based on their direct value, their value as a prerequisite for healthy aquatic ecosystems, the importance of fish in Inuit diets, and because the Project has the potential to affect these environmental components. Refer to Section 4.3 for more information on VEC selection.

People were concerned that fish could become contaminated from Project activities and that the Project could affect fish habitat and fish populations. A number of design and management mitigation measures will be employed to reduce potential effects of air emissions (e.g. Tier 2, Volume 6, Section 9.6.2 and Tier 3, Technical Appendix 4C), treated effluent discharge (e.g. Tier 2, Volume 2, Section 9 and Tier 3, Technical Appendic 2I), activities in and near water, (Tier 3, Technical Appendix 5O), and blasting (e.g. Tier 3, Technical Appenices 2B and 2C) on the aquatic environment.

Potential effects on wildlife that consume fish are evaluated in Tier 3, Technical Appendix 8A and include the following ecological receptors: grizzly bear, red-breasted merganser and long-tailed duck. Potential effects on humans that consume fish as part of their diet are presented in the human health risk assessment in Tier 2, Volume 8 and Tier 3, Technical Appendix 8A.

[104] IQ-BL02 2008: *One of the Elders said that the rivers flowing into Pointer Lake have caused the fish there to die, and that the same will happen to Judge Sissons Lake when mining operations start to get close to the lake.*
[105] IQ-BL12 2008: *Some Elders said that while the quality of the water hasn't changed, the fish are skinnier and are not very good.*



Projection: NAD 1983 UTM Zone 14N
Compiled:TL
Date: 04/08/2014 Scale: 1:200,000
Data Sources: Rick Riewe (Editor). 1992. Nunavut Atlas. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut. Edmonton, AB.Art Design Printing Inc. Baker Lake Elders, AREVA Resources Canada Inc. NRC

FIGURE 4.1-1A

IDENTIFIED FISHING AREAS FROM INUIT QAUJIMAJATUQANGIT (IQ) & LARGE BODIED FISH SPECIES IDENTIFIED DURING BASELINE STUDIES

EVIRONMENTAL IMAPCT STATEMENT
VOLUME 5 - TIER 2

4 0 4
Kilometers

KIGGAVIK PROJECT

AREVA

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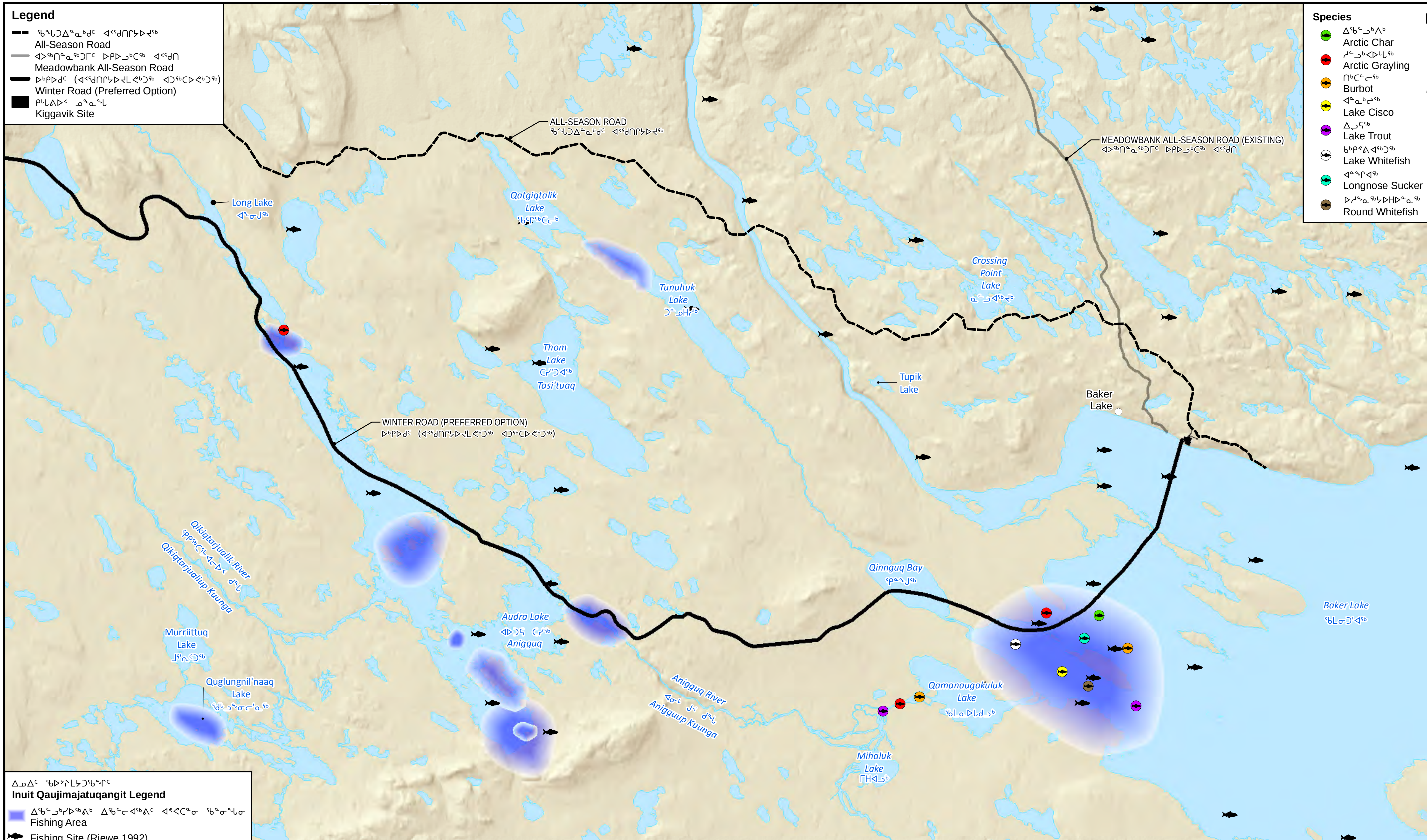
File: Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 5 - Aquatic Environment\Maps\Volume 5 Tier 2\mxd\FIGURE 4.1-1A IDENTIFIED FISHING AREAS FROM INUIT QAUJIMAJATUQANGIT (IQ)_JSL.mxd



Projection: NAD 1983 UTM Zone 14N
Compiled:TL
Date: 04/08/2014 Scale: 1:200,000
Data Sources: *Rick Riewe (Editor). 1992. Nunavut Atlas. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut. Edmonton, AB.Art Design Printing Inc. Baker Lake Elders, AREVA Resources Canada Inc. NRC*

FIGURE 4.1-1B
IDENTIFIED FISHING AREAS FROM INUIT QAUJIMAJATUQANGIT (IQ) & LARGE BODIED FISH SPECIES IDENTIFIED DURING BASELINE STUDIES

EVIRONMENTAL IMPACT STATEMENT
VOLUME 5 - TIER 2

4 0 4
Kilometers

KIGGAVIK PROJECT

AREVA

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File: Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 5 - Aquatic Environment\Maps\Volume 5 Tier 2\mxd\FIGURE 4.1-1B IDENTIFIED FISHING AREAS FROM INUIT QAUJIMAJATUQANGIT (IQ)_BAKER_LAKE.mxd

Fish will be monitored during operations and decommissioning to address community concerns about potential contamination of or changes to the aquatic environment resulting from Project activities. This includes sampling and analyzing fish (fish tissue chemistry monitoring) as well as monitoring fish populations. The Aquatic Effects Monitoring Plan is provided in Tier 3, Technical Appendix 5M. Monitoring results will be compared to baseline values and compared to predictions from this environmental assessment. Fish tissue monitoring results will also be used to update the ecological and human health risk assessment as required (Tier 3, Technical Appendix 8A).

Potential effects of Project activities on fish habitat is assessed in Section 10 (and Tier 3, Technical Appendix 5L) while fish abundance, distribution and health is assessed in Section 11.

4.1.1.5 Climate Change

Information gathered from Inuit Stakeholders has also played a central role in inclusion of climate change issues in the aquatic assessment. Inuit Stakeholders identified the presence of climate change through various observations, suggesting that the rate of change is relevant to the timeframe of the Project and therefore should be incorporated in the assessment. A variety of climatic variables were modeled in detail to quantify the rates and magnitude of the change and the information gathered from Inuit Stakeholders was used to validate results. For example, climate models for the area typically predict warmer and shorter winters over the next several decades; these predictions are supported by Inuit Stakeholders who have observed a warming trend in recent years.

4.2 Regulatory Setting

4.2.1 Metal Mining Effluent Regulations (Canada)

Environment Canada administers the Metal Mining Effluent Regulations (MMER). The MMER were developed under Section 36 of the Canadian, federal *Fisheries Act (2012)* to regulate the depostion of mine tailings and other waste matter produced during mining operations into natural fish bearing water bodies. These regulations apply to both existing and new mines, and are among the most comprehensive and stringent standards for mining effluents in the world. The MMER stipulates discharge limits for deleterious substances in effluent and requires routine monitoring of effluent quality (physio-chemical parameters as well as acute toxicity). The MMER also require metal mines to undertake environmental effects monitoring (EEM) to ensure the adequate protection of all receiving aquatic environments by assessing effects on fish, fish habitat, and the usability of fisheries resources.

4.2.2 Fisheries Act (2012)

Fisheries and Oceans Canada (DFO) administers the federal *Fisheries Act (2012)*, which regulates activities that may affect the sustainability and ongoing productivity of commercial, recreational or Aboriginal (CRA) fisheries. A number of sections of the *Fisheries Act (2012)* apply to activities and developments associated with the proposed Kiggavik Project. Section 35 of the *Act* states that "no person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery" (Government of Canada 2012). The "Applications for Authorization under Paragraph 35(2)(b) of the Fisheries Act Regulations" (Government of Canada 2013) and "Science Advice on Offsetting Techniques for Managing the Productivity of Freshwater Fishes" (DFO 2014) documents also apply to the Project.

Section 36 of the *Fisheries Act (2012)* prohibits the deposit of deleterious substances of any type in waters frequented by fish, or in waters flowing into fish-bearing waters. Sections 20 and 21 of the *Act* provide provisions for sufficient water flow and fish passage. The *Act* requires that fish passage (upstream and downstream) be unobstructed by works, undertakings or activities, and that sufficient water flows be maintained to allow for fish passage. In addition to the Fisheries Protection Provisions in the *Act*, water intakes and outlet pipes should be screened to prevent the entrainment or impingment of fish and to support compliance with DFO's "Measures to Avoid Causing Harm to Fish and Fish Habitat" (DFO 2013; internet site) and Freshwater End-of-Pipe Fish Screen Guidelines (DFO 1995). Water withdrawals must comply with conditions specified by DFO's "Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut" (DFO 2010). This Policy specifies the maximum quantities of water allowed to be withdrawn from individual ice-covered lakes.

4.2.3 Species at Risk Act (Canada)

The *Species at Risk Act* (SARA) provides federal legislation to prevent Canada's wildlife species (including birds, mammals, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens) from becoming extinct, and provide for the recovery of endangered and threatened species. The SARA establishes an official list of wildlife species, sub-species, or populations at risk, and categorizes them as being extirpated, endangered, threatened, or of special concern. Once listed, measures to protect the species at risk and assist with its recovery can be instituted. These measures can include protection of critical habitats. Fisheries and Oceans Canada (DFO) is responsible for the protection of any listed fish species, as well as any listed aquatic arthropods and molluscs.

4.2.4 Groundwater and Surface Water Administration

Federal agencies that are involved in groundwater and surface water related issues include:

- Environment Canada, which is mandated to preserve and enhance the quality of the natural environment;
- Natural Resources Canada, which is mandated todescribe the geological structure of Canada,including the delineation of aquifers and the study of ground and surface water quantity;
- Health Canada; and
- Aboriginal Affairs and Northern Development Canada.

Groundwater and surface water are governed by Nunavut's territorial government under the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*. The Nunavut Department of Environment applies the Nunavut Water Board By-Laws.

Although there are currently no Canadian Environmental Quality Guidelines for groundwater, the following sets of guidelines may be relevant for groundwater and surface water related issues:

- the Guidelines for Canadian Drinking Water Quality (Health Canada, 2012) that apply for potable water sources;
- the Canadian Water Quality Guidelines for the Protection of Aquatic Life that are summarized in the Canadian Environmental Quality Guidelines (Canadian Council of Ministers of the Environment [CCME] 1999c with updates to 2014);
- the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life that are summarized in the Canadian Environmental Quality Guidelines (CCME 1999a with updates to 2001) and may be relevant for sediments in the groundwater-surface water transition zone; and
- The Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses (CCME 1999b with updates to 2006) that may be relevant for groundwater that could be used as a source of irrigation.

4.3 Valued Environmental Components, Indicators and Measurable Parameters

Valued environmental components (VECs) are major physical and biological components of the environment that are of cultural or ecological importance and may interact with the Project. Aquatic VECs are selected based on criteria identified in the NIRB guidelines, scientific input, as well as concerns identified through public engagement activities and IQ interviews. The VECs chosen for the aquatic environment represent major, well recognized divisions that are ecologically distinct, and may be affected by different aspects of the Kiggavik Project development.

The aquatic environment VECs identified for this assessment are:

- groundwater;
- surface hydrology;
- water quality;
- sediment quality,
- aquatic organisms and fish habitat; and
- fish populations.

To better understand the importance and value of VECs to people in the Kivalliq, AREVA undertook specific engagement activites. During AREVA's 2009 Kivalliq open house tour (Tier 2, Volume 3, Part 1 Public Engagement), an interactive display was set up for participants to identify broad ecological and socio-economic areas they valued highly and/or had concerns about in relation to the Kiggavik Project. Each participant was given four stickers that they used to select areas of concern. All four stickers could be used to select a particular area or they could be spread to four separate areas. The eight broad VEC categories and the percent of responses were as follows:

1. Air quality and noise: 7%
2. Fresh water: 31%
3. Freshwater fish and fish habitat: 17%
4. Marine environment: 5%
5. Permafrost and groundwater: 2%
6. Soils, landforms and vegetation: 3%
7. Wildlife: 25%
8. Birds: 10%

These results provide an example of the importance and knowledge of aquatic VECs, such as fresh water and freshwater fish and fish habitat, to Kivalliq community members.

The following year, in 2010, AREVA endeavoured to validate VEC selection by using interactive posters at the open house tour to learn more about *why* VECs, including the aquatic VECs, are important to Kivalliq community members (Tier 2, Volume 3, Part 1 Public Engagement). Interactive posters included a list of 28 VECs and open house attendees were invited to place an unlimited number of stickers with descriptive words (i.e., Beautiful, Comfort, Peaceful, Happy, Money, Food, Clothing, Health, Respect, Spiritual, Tradition, Culture, IQ, Survival, Pride, Fun, Future, Safe/Secure) beside any and all VECs. The two most frequently used values associated with aquatic components were:

- *Beautiful* and *Comfort/Peaceful/Health/Survival* for water flow;
- *Survival* and *Respect* for water quality;
- *Beautiful/Money/Culture/Fun* for sediment quality,
- *Comfort* and *Respect* for aquatic organisms and fish habitat; and
- *Food* and *Fun* for fish populations.

As evidenced by these engagement results, the selected aquatic VECs are valued for a wide range of reasons, from culture to well-being to basic needs. Selection of groundwater, surface hydrology, water quality, sediment quality, aquatic organisms and fish habitat and fish populations as VECs was further validated by considering feedback received (importance, concern, issues, influence) through public engagement events and IQ interviews as described in Sections 4.1 and 4.1.1 above. Overall, the issues and concerns raised by Kivalliq community members supported the selection of aquatic VECs; the assessment of effects on these VECs is an important component of the Kiggavik Project environmental assessment.

Assessment indicators represent the key aspects of the VEC that should be protected to maintain the continued health of all aspects of the aquatic environment and protect its value for use by future generations. Measurable parameters refer to quantifiable and measurable aspects of each assessment indicator that can be used to identify the environmental changes to a VEC that could occur as a result of the Project activities. Changes to the measureable parameters will be assessed to determine the significance of Project activities on assessment indicators and ultimately, on VECs. Indicators and measurable parameters are discussed for each VEC in the individual VEC sections.

4.4 Project-Environment Interactions

Interactions are expected to occur between Project components and the aquatic environment during the construction, operations, and decommissioning phases of the Project. Table 4.4-1 presents a summary table of interactions between the Project and the aquatic VECs. These activities and physical works have been ranked according to their potential to interact with one or more of the aquatic environment VECs. Interactions were assigned a ranking as follows:

- Category 0 activities have no interaction with the aquatic environment; interactions are removed by environmental design features and mitigation so that the Project results in no detectable (i.e., measureable) environmental change and no residual effect on a VEC relative to baseline or guideline values.
- Category 1 activities are likely to interact with the aquatic environment and result in a minor environmental change, but a negligible residual effect relative to baseline or guideline values in light of planned mitigation. These interactions are not expected to contribute to effects of other existing or reasonably foreseeable projects. Because these interactions are considered insignificant, no further assessment is required.
- Category 2 activities are those activities that are likely to interact with the aquatic environment and result in a measureable environmental change that could contribute to significant residual effects relative to baseline or guideline values, despite planned mitigation. Further assessment of the effects of these interactions on the aquatic environment is warranted and is presented in this environmental assessment report.

The Project-environment interactions for each VEC are discussed in more detail in the VEC sections and the rationale for ranking the interactions is presented there.

Table 4.4-1 Identification of Project - Environment Interactions: Aquatic Valued Environmental Components (VECs)

	Project Activities/Physical Works	Groundwater	Surface Hydrology	Water Quality	Sediment Quality	Aquatic Organisms and Fish Habitat	Fish Populations
Construction:							
Economic Activities	Construction workforce management; contracts and taxes; advance training of operations workforce	0	0	0	0	0	0
In-Water Construction	Construct freshwater diversions and site drainage containment systems (dykes, berms, collection ponds)	0	1	1	1	2	1
	Construct/install in-water/shoreline structures (water intake and effluent diffuser structures and lines, spud barge dock, culverts)	0	1	1	1	2	1
	Water transfers and discharge	0	0	1	1	2	1
	Freshwater withdrawal	0	2	0	0	1	0
On-Land Construction	Site clearing and pad construction (blasting, earth moving, loading, hauling, dumping, crushing)	0	2	1	1	2	1
	Construct foundations	1	0	0	0	0	0
	Construct buildings	0	0	0	0	0	0
	Install equipment	0	0	0	0	0	0
	Install and commission fuel tanks	0	0	0	0	0	0
	Mill dry commissioning (water only)	0	0	0	0	0	0
Supporting Activities	Transport fuel and construction materials	0	0	0	0	1	0
	Air transport of personnel and supplies	0	0	0	0	1	0
	Hazardous materials storage and use	0	0	0	0	0	0
	Explosives storage and use	0	0	0	0	0	0
	Waste incineration and disposal	0	0	0	0	0	0
	Industrial machinery operation	0	0	0	0	0	0
	Power generation	0	0	0	0	0	0

Table 4.4-1 Identification of Project - Environment Interactions: Aquatic Valued Environmental Components (VECs)

	Project Activities/Physical Works	Groundwater	Surface Hydrology	Water Quality	Sediment Quality	Aquatic Organisms and Fish Habitat	Fish Populations
Operation:							
Economic Activities	Workforce management; employment; contracts and taxes	0	0	0	0	0	0
Mining	Mining ore (blasting, loading, hauling)	0	0	2	1	0	2
	Ore stockpiling	1	0	0	0	0	0
	Mining special waste (blasting, loading, hauling)	0	0	2	1	0	2
	Special waste stockpiling	2	0	0	0	0	0
	Mining clean waste (blasting, loading, hauling)	0	0	2	1	0	2
	Clean rock stockpiling	2	0	0	0	0	0
	Mine dewatering	2	2	1	0	0	0
	Underground ventilation	0	0	0	0	0	0
	Backfill production and underground placement	0	0	0	0	0	0
Milling	Transfer ore to mill	0	0	0	0	0	0
	Crushing and grinding	0	0	0	0	0	0
	Leaching and U recovery	0	0	0	0	0	0
	U purification	0	0	0	0	0	0
	Yellowcake drying and packaging	0	0	0	0	0	0
	Tailings neutralization	0	0	0	0	0	0
	Reagents preparation and use	0	0	0	0	0	0
Tailings Management	Pumping and placement of tailings slurry	2	0	0	0	0	0
	Consolidation of tailings	2	0	0	0	0	0
	Pumping of TMF supernatant	2	0	0	0	0	0
Water Management	Create and maintain water levels	0	0	0	0	0	0
	Freshwater withdrawal	1	2	0	0	1	0
	Potable water treatment	0	0	0	0	0	0
	Collection of site and stockpile drainage	0	2	1	0	1	0
	Water and sewage treatment	0	0	1	0	1	0
	Discharge of treated effluents (including greywater)	1	2	2	2	2	2

Table 4.4-1 Identification of Project - Environment Interactions: Aquatic Valued Environmental Components (VECs)

	Project Activities/Physical Works	Groundwater	Surface Hydrology	Water Quality	Sediment Quality	Aquatic Organisms and Fish Habitat	Fish Populations
Waste Management	Disposal of industrial waste	0	0	0	0	0	0
	Management of hazardous waste	0	0	0	0	0	0
	Management of radiologically contaminated waste	0	0	0	0	0	0
	Disposal of domestic waste	0	0	0	0	0	0
	Incineration and handling of burnables	0	0	0	0	0	0
	Disposal of sewage sludge	0	0	1	0	0	0
General Services	Generation of power	0	0	0	0	0	0
	Operate accommodations complex	0	0	0	0	0	0
	Recreational activities	0	0	0	0	0	0
	Maintain vehicles and equipment	0	0	0	0	0	0
	Maintain infrastructure	0	0	0	0	0	0
	Operate airstrip	0	0	0	0	0	0
	Hazardous materials storage and handling (reagents, fuel and hydrocarbons)	0	0	0	0	0	0
	Explosives storage and handling	0	0	0	0	0	0
Transportation	Marine transportation	0	0	1	0	1	0
	Truck transportation	0	0	2	1	2	0
	General traffic (Project-related)	0	0	2	1	0	0
	Controlled public traffic	0	0	0	0	0	0
	Air transportation of personnel, goods and supplies	0	0	0	0	1	0
	Air transportation of yellowcake	0	0	0	0	0	0
	General air transportation support	0	0	0	0	0	0
Ongoing exploration	Aerial surveys	0	0	0	0	0	0
	Ground surveys	0	0	0	0	0	0
	Drilling	1	1	0	0	0	0

Table 4.4-1 Identification of Project - Environment Interactions: Aquatic Valued Environmental Components (VECs)

	Project Activities/Physical Works	Groundwater	Surface Hydrology	Water Quality	Sediment Quality	Aquatic Organisms and Fish Habitat	Fish Populations
Final Closure:							
Economic Activities	Decommissioning; workforce management; employment; contracts, and taxes	0	0	0	0	0	0
General	Hazardous materials storage	0	0	0	0	0	0
	Industrial machinery operation	0	0	0	0	0	0
	Ongoing withdrawal, treatment and release of water, including domestic wastewater	0	2	2	2	2	2
In-water Decommissioning	Remove freshwater diversions; re-establish natural drainage	1	1	1	1	2	0
	Remove surface drainage containment	1	0	1	1	2	0
	Remove in-water/shoreline structures	1	1	1	1	2	0
	Water transfers and discharge	1	0	1	1	0	1
	Fisheries Offsetting as per Fisheries Offsetting Plan (FOP)*	0	0	0	0	0	
On-land Decommissioning	Remove site pads (blasting, earth moving, loading, hauling, dumping)	1	0	1	1	2	0
	Backfilling	0	0	0	0	0	0
	Contouring	0	0	0	0	0	0
	Covering	0	0	0	0	0	0
	Revegetation	0	0	0	0	0	0
	Remove foundations	0	0	0	0	0	0
	Remove buildings	0	0	0	0	0	0
	Remove equipment	0	0	0	0	0	0
	Remove fuel tanks	0	0	0	0	0	0
Post Closure:							
	Management of restored site	0	0	0	0	0	0

*Note: This Project activity is ranked as a Category 0 because it is anticipated that no Fisheries Offsetting will be required for the Project (Tier 3, Technical Appendix 5L).

4.5 Assessment Boundaries

4.5.1 Spatial Boundaries

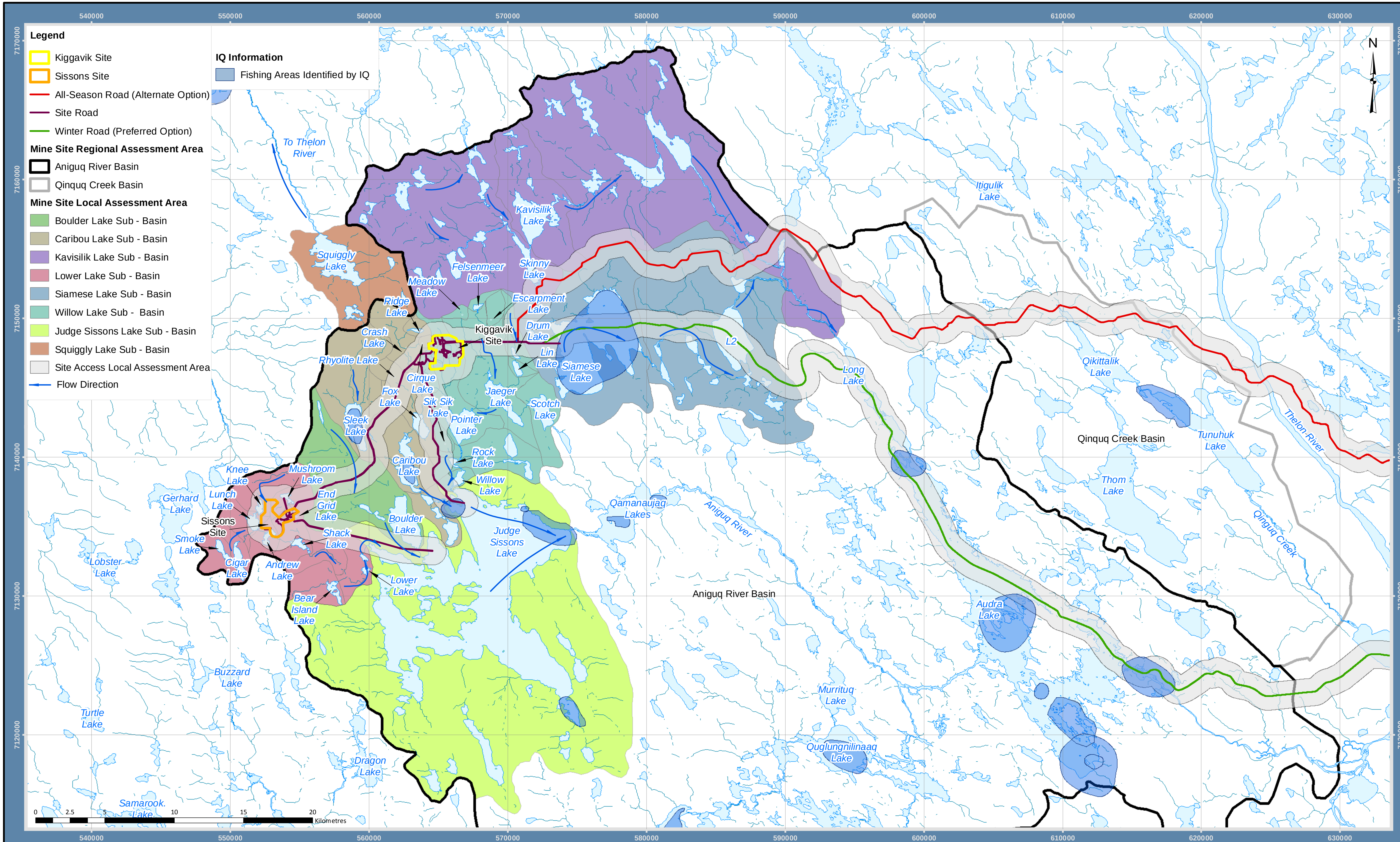
The environmental effects of the Kiggavik Project were assessed for three local assessment areas (LAAs), one that encompasses the surficial environment at the Kiggavik and Sissons areas, one that encompasses the hydrogeological component of the Kiggavik and Sissons areas, and one that includes the proposed winter access road corridor (and alternate all-season access road corridor). The assessment area for all aquatic components, with the exception of hydrogeology, was based on watershed boundaries because fish can access all lakes within a watershed unless a permanent obstacle (e.g., fall or cascade) impedes the fish migration. Figures 4.5-1 and 4.5-2 present the spatial boundaries for the aquatic assessment.

4.5.1.1 Project Footprint

For the purposes of this EIA, the Project footprint is the physical area covered by the Kiggavik mine and mill complex, the Sissons Mine Site, the Kiggavik-Sissons haul road, the airstrip and its associated access road, the water intakes, pipelines, and water intake access roads, and the treated effluent discharge pipeline and diffuser in Judge Sissons Lake and its associated access road.

The majority of the Project footprint (Figure 4.5-3) is located in the Judge Sissons Lake watershed which includes the Willow Lake, Lower Lake, Boulder Lake, and Caribou Lake sub-basins. A smaller portion of the Project footprint affects the Siamese Lake, Skinny Lake, and Kavisilik Lake sub-basins which flow into the Aniguq River, as does the Judge Sissons Lake watershed. The proposed site access road crosses a number of watersheds including the Anigug River, Thelon River, and Baker Lake. Judge Sissons Lake and Siamese Lake are part of the Aniguq River watershed.

The Project footprint for the mine access road consists of the corridor for the proposed winter access road, as well as the alternate all-season access road.



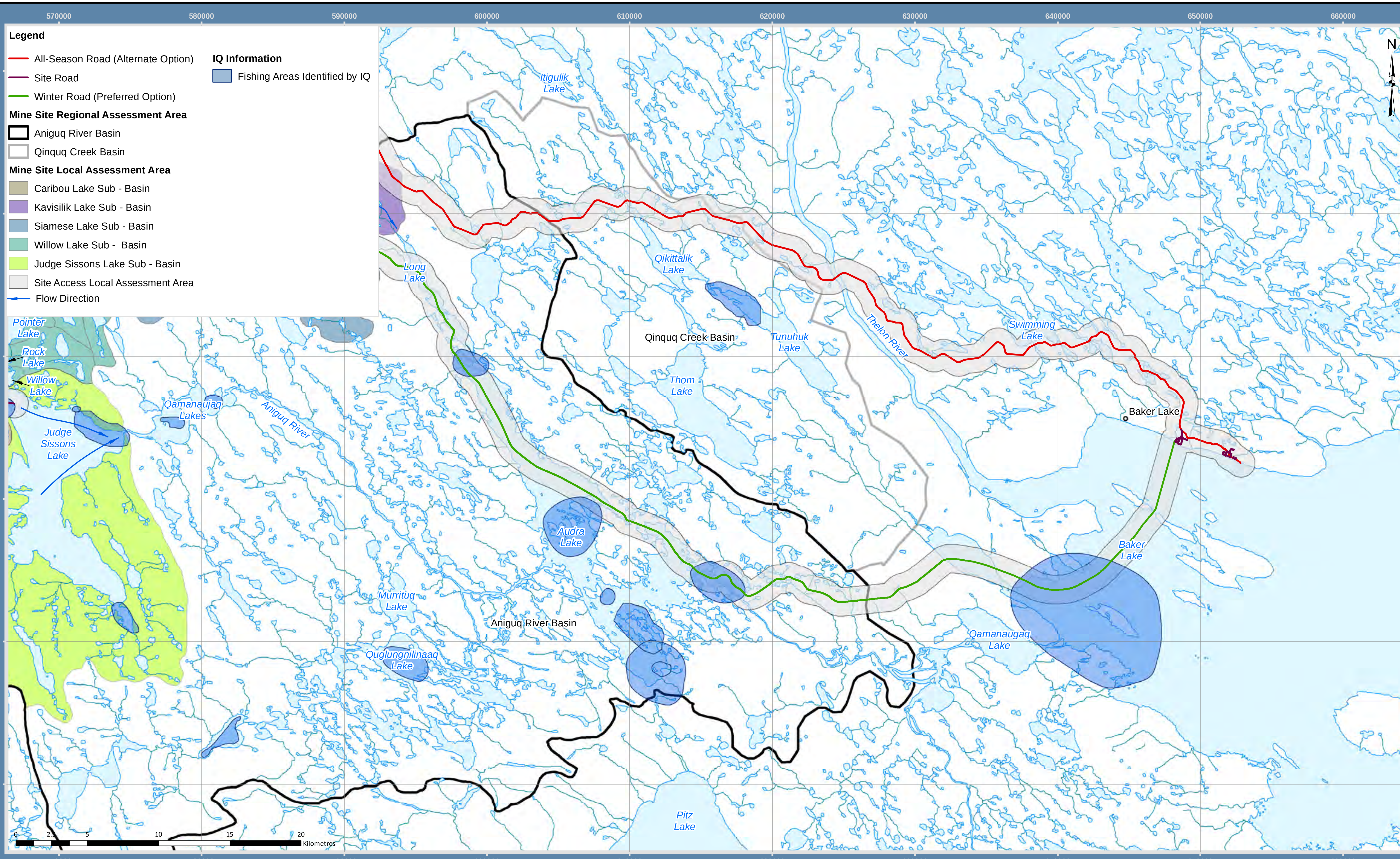
Projection: NAD 1983 UTM Zone 14N
Creator: JRC/LMR
Date: 30/06/2014 Scale: 1:250,000
File: KI08C349
Data Sources: *NTS Mapsheet 56D, 66A, 66B; AREVA Resources Canada Inc. Hattie Mannik and the Baker Lake Elder's Focus Group Baker Lake HTO, Baker Lake Hunter Focus Group*

FIGURE 4.5-1A
SURFACE WATER MINE SITE LOCAL ASSESSMENT AREA

KIGGAVIK PROJECT - EIS

Golder Associates
AREVA

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



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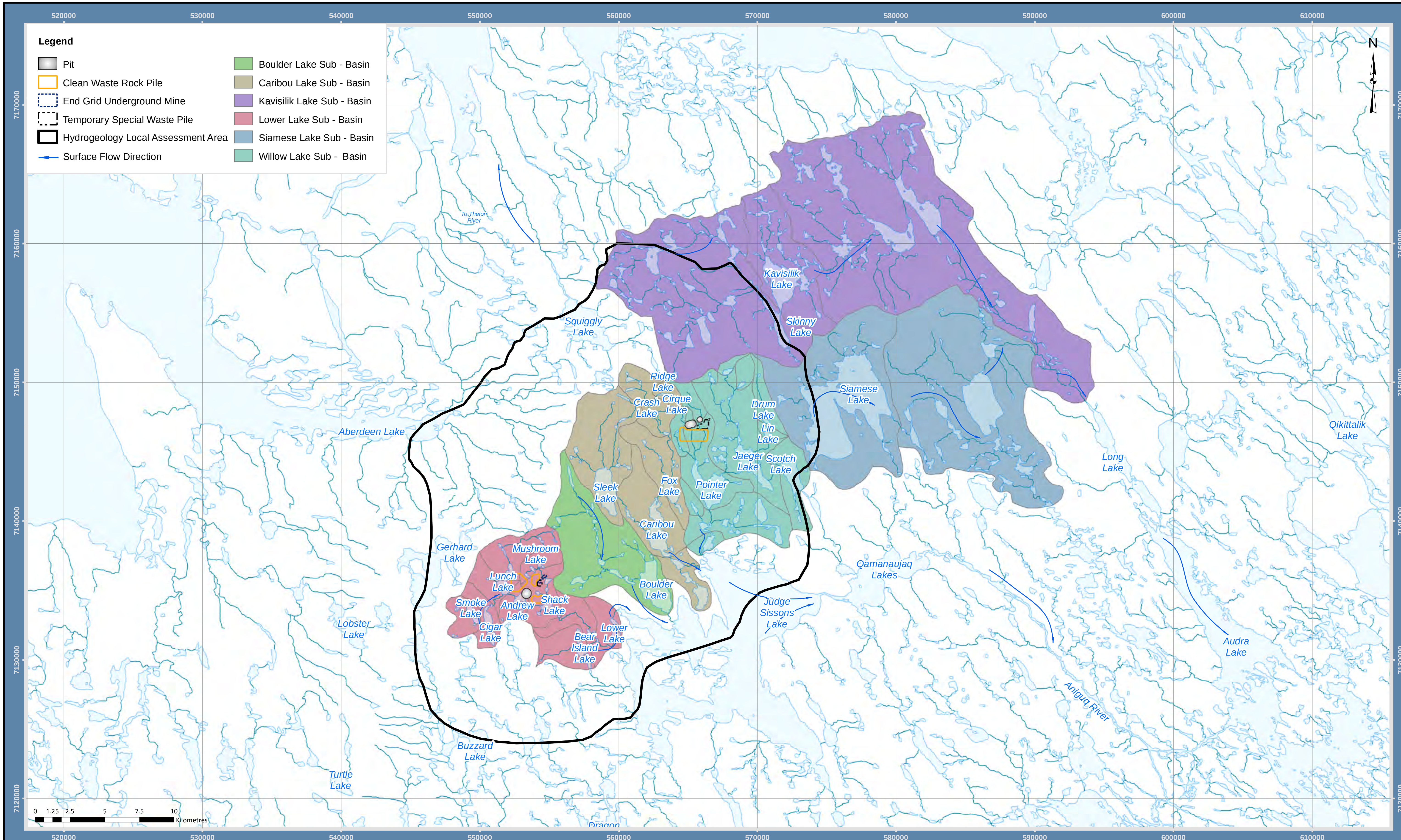
Creator: JRC/LMR
Date: 28/05/2014 Scale: 1:250,000
File: KI08C350
Data Sources: *NTS Mapsheet 56D, 66A, 66B; AREVA Resources Canada Inc.*

FIGURE 4.5-1B
SURFACE WATER SITE ACCESS LOCAL ASSESSMENT AREA

KIGGAVIK PROJECT - EIS

Golder Associates
AREVA

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



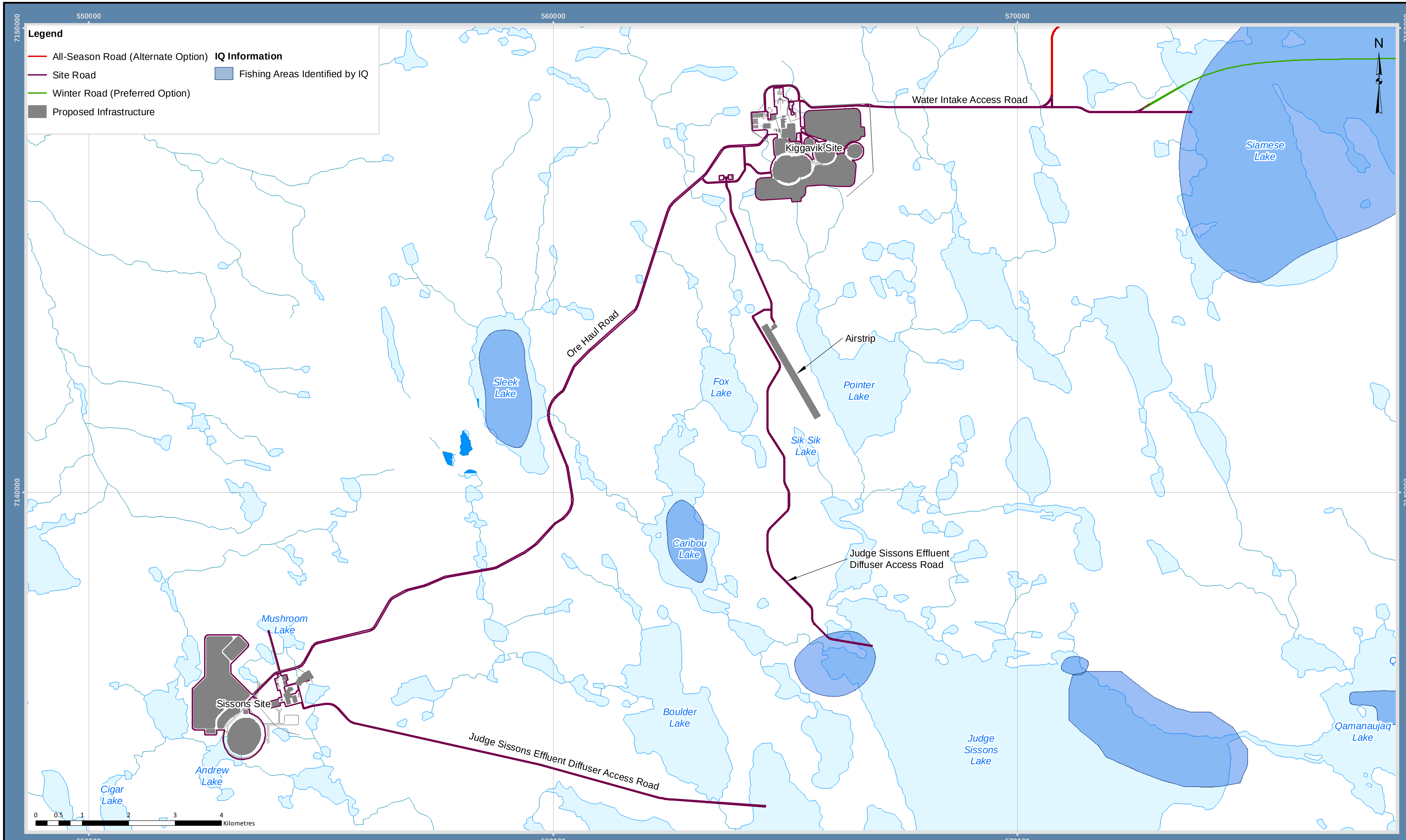
Projection: NAD 1983 UTM Zone 14N
Creator: JRC/LMR
Date: 14/05/2014 Scale: 1:250,000
File: KI08C377
Data Sources: *NTS Mapsheet 56D, 66A, 66B, AREVA Resources Canada Inc.*

FIGURE 4.5-2
HYDROGEOLOGY LOCAL ASSESSMENT AREA

KIGGAVIK PROJECT - EIS

Golder Associates
AREVA

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



Projection: NAD 1983 UTM Zone 14N
Creator: LMR
Date: 24/02/2014 Scale: 1:75,000
File: KI08C392
Data Sources: *NTS Mapsheet 56D, 66A, 66B; AREVA Resources Canada Inc.*
Hattie Mannik and the Baker Lake Elder's Focus Group
Baker Lake HTO, Baker Lake Hunter Focus Group

FIGURE 4.5-3
KIGGAVIK PROJECT FOOTPRINT

KIGGAVIK PROJECT - EIS

Golder Associates

AREVA

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

4.5.1.2 Local Assessment Area

The mine site LAA for the surface water environment includes lakes and their tributary streams that may potentially be directly affected by Project activities or infrastructure. The mine site LAA includes the main basin of Judge Sissons Lake, as well as the Willow Lake, Lower Lake, Boulder Lake, and Caribou Lake sub-basins. The LAA also includes the Siamese Lake watershed sub-basin that flows into the Aniguq River.

The site access LAA includes the corridor for the proposed winter access road from Baker Lake to the Kiggavik mine site, as well as the Baker Lake dock site. The site access LAA overlaps portions of the Baker Lake, Aniguq River and Thelon River watersheds. Additionally, the environmental effects of an optional all-season access road were assessed relative to the winter access road option. The optional all-season access road overlaps portions of the Baker Lake, Thelon River, and Aniguq River watersheds. The extent of the LAA for the various access roads assessed consists of a 200 m wide corridor, extending 100 m on each side of the proposed access road route. It is expected that any Project related effects would originate and be measurable within this corridor.

The LAA and RAA for the hydrogeology component of the aquatic environment are presented in Figure 4.5-2. The LAA covers an area of approximately 740 square kilometres (km^2). The extent of the LAA was selected based on observed topography, location of surface waterbodies, predicted patterns of any potential groundwater flow, and Project activities. The LAA includes the following key features:

- the Lower Lake, Boulder Lake, Caribou Lake and Willow Lake surface drainage basins, where most of the Project development will occur;
- a portion of the Kavisillik Lake and Siamese Lake sub-basins; and
- a portion of the largest lakes (i.e., Aberdeen Lake, Gerhard Lake, and Judge Sissons Lake) in the area of Andrew Lake and End Grid Lake.

The depth of the Hydrogeology LAA is also relevant because of the depth of the proposed mining activities and the depth of the permafrost below which most of the groundwater flow takes place. A maximum LAA depth of 1,000 m below ground surface was selected to account for the maximum depth of the proposed underground mine (approximately 500 m) and the maximum depth to which potential change in groundwater flow conditions are expected to occur.

4.5.1.3 Regional Assessment Area

The Regional Assessment Area (RAA) for most of the aquatic VECs coincides with the LAA because all effects are contained within the LAA watersheds. The Hydrogeology VEC also has a specific RAA that is equivalent to its LAA. This is because deep groundwater migration is limited in spatial and temporal extent as a result of permafrost and low conductivities of the rock mass.

4.5.2 Temporal Boundaries

The temporal boundaries for the assessment of effects on the aquatic environment are related to Project activities associated with the construction, operation, final closure, and post closure phases of the Project. The Project construction period is expected to take three years and the mine is expected to be in operation for up to 25 years. The final closure phase of the Project is expected to require up to ten years. Most Project related effects to the aquatic environment are expected to occur during the construction and operation phases. Water quality, sediment quality, aquatic organisms, and fish habitat are expected to have residual effects in the post-closure period, associated with water treatment plant (WTP) effluent release as the system recovers.

Temporal boundaries for hydrogeological assessments are expected to extend beyond the operations, decommissioning and post-decommissioning phases of the Project (i.e., into post-closure). The potential effects on groundwater quantity are anticipated to last throughout the active mining period, following which dewatering activities will cease, and the groundwater system will recover to conditions similar to the natural pre-mining conditions.

During the post-decommissioning period, groundwater will be the pathway for potential interactions between dissolved constituents of potential concern (COPC) in the water within the pore spaces of the tailings, within the pore spaces of the mine rock, and in the surface water where the groundwater discharges. As a result, the assessment of the long-term effects of the Project focuses on the post-decommissioning groundwater flow regime, the long-term behaviour of the constituents of both the tailings and the mine rock, and the migration of the constituents to the receiving surface water bodies. Because the Project area is located in the zone of continuous permafrost, the assessment of the long-term effects of the Project is dependent on climate change scenarios and their impact on permafrost.

4.6 Residual Environmental Effects Criteria

The NIRB has outlined specific terms to describe environmental effects. Whenever possible, the magnitude, geographic extent, frequency, and duration of an environmental effect were described quantitatively. If quantitative measures were not available to describe an environmental effect, qualitative terms (e.g., low, moderate, and high) were used. When qualitative descriptions were used, specific definitions were provided for the pertinent VEC.

- **Direction:** the ultimate long-term trend of the environmental effect (e.g., positive, neutral, or adverse).
- **Magnitude:** the amount of change in a measureable parameter or variable relative to the baseline case.

- **Geographical Extent:** the geographic area within which an environmental effect of a defined magnitude occurs (e.g. stream segment, lake, local watershed, regional watershed).
- **Frequency:** the number of times during a project or a specific project phase that an environmental effect may occur. Frequency is described as isolated, periodic, or continuous. An environmental effect has an isolated frequency if the effect is confined to a specific discrete period; an environmental effect has a periodic frequency if the effect occurs intermittently or may repeat over the assessment period; an environmental effect is continuous if the effect occurs continually over the assessment period.
- **Duration:** the period of time that is required until the VEC returns to its baseline condition or the environmental effect can no longer be measured or otherwise perceived (construction phase, operations phase, final closure phase, post-closure phase).
- **Reversibility:** the likelihood that a measurable parameter for the VEC will recover from an environmental effect
    - Reversible: the VEC is able to recover from an environmental effect to a state similar to that existing before the VEC was affected. Depending on the effect considered, reversibility may be assessed on both an individual (immediate) and population (long-term) level; or
    - Irreversible: the VEC is unable to recover from the effect).
- **Likelihood:** the probability that a significant effect will occur during the lifetime of the Kiggavik Project (i.e., unlikely, moderately likely, or very likely).

These criteria apply to all the aquatic VECs. Definitions specific to individual VECs are presented in the VEC sections.

4.7 Standards or Thresholds for Determining Significance

Under the NIRB Project Specific Guidelines the environmental assessment must include a determination of the significance of environmental effects. Threshold criteria or standards for determining the significance of environmental effects were identified for each VEC, beyond which a residual environmental effect would be considered significant. Where available, these were selected in consideration of federal and territorial regulatory requirements, standards, objectives, or guidelines applicable to the VEC. Thresholds are discussed for each VEC in the following sections.

Potential changes in a measurable parameter or VC resulting from Project or cumulative effects were evaluated against these standards or thresholds, and were rated as either *significant or not significant.*

5 Summary of Existing Environment

The following sections provide an overview of the existing aquatic environmental conditions of the Kiggavik Project (i.e., the Project) area. This overview sets the basis for the assessment of the Project effects on the aquatic Valued Environmental Components (VECs) that follows. The reader is referred to the following reports for additional information on baseline data:

- Surface Hydrology — Tier 3, Technical Appendix 5A
- Geology and Hydrogeology — Tier 3, Technical Appendix 5B
- Surface Water Aquatic Environment — Tier 3, Technical Appendix 5C

Baseline data collection was greatly enhanced and informed by local Inuit staff hired to assist with field work. Their knowledge of the land and insight into historical and current land use patterns of local Inuit helped define the scope of the aquatic baseline program. Between 2007 and 2013, 11 Inuit were hired to participate in the collection of Aquatics Baseline data carried out by Golder Associates. Some individuals worked more than one season and one worked for parts of 5 years. The Inuit workers are listed in Tier 2, Volume 3, Part 1, Section 3.4.9, Table 3.4-16 along with their activities and years when they worked.

5.1 Surface Hydrology

Surface water provides the link between the atmosphere, soil, and groundwater. Streams, lakes, and wetlands provide habitat for aquatic and terrestrial plants and animals. Surface water systems receive inputs of precipitation from the atmosphere and also inputs of runoff from upstream and upland areas. Losses of surface water typically occur through drainage, evapotranspiration from the watershed (including soils and vegetation), evaporation from waterbodies, the sublimation of snow, and infiltration. Shallow infiltration provides soil moisture and can return to the surface water environment while deep infiltration or percolation recharges groundwater.

Surface hydrology includes the spatial and temporal distribution of surface water, and is typically described as water quantity. Pre-1940 to 1990 changes to water levels and flows in rivers within the Project area are reported by McDonald et al. (1997)[106]. Lakes and streams in the vicinity of the Project were investigated and regional hydrological data were compiled during baseline studies in 2007 through 2010. The hydrological data obtained during the baseline hydrology program describe

[106] IQ-McDonald et al. (1997): Changes to rivers (pre-1940-1990s) include seasonal changes in water levels and flow, and a decline in water quality.

the local and regional hydrological conditions and include streamflow records, lake level and volume measurements, drainage basin boundaries, and flood magnitude and frequency estimates.

Stream discharges were monitored at a total of 16 locations during 2007 to 2010 (Table 5.1-1). At each stream, a continuous water level sensor was installed, and/or instantaneous discharge and water level measurements were taken according to the following methods:

- **Instantaneous stream discharge**: instantaneous stream discharge was determined by measuring velocity at 5 percent (%) intervals along a stream cross section at 60% of the total depth, or 80% and 20% if the total depth was greater than 0.70 metres (m).
- **Water level**: water level was measured using an engineer's rod and level relative to an arbitrary benchmark. Typically, large, stable boulders were selected as benchmarks near each cross section or lake.
- **Continuous water level sensors**: Pressure transducers and datalogger systems were installed at monitoring stations and were set to record water level at 30 minute intervals. These data were compensated using data from a similar transducer that was set to record local barometric pressure.

Table 5.1-1 Stream and Lake Monitoring Locations

Description	Continuous Monitoring	Instantaneous Discharge and/or Level Measurements	Number of Level-Discharge Measurements	Stage – Discharge Equation
Outflow of Skinny Lake	-	2007 to 2009	7	$Q = (3.6219H - 355.4353)^{2.2578}$
Outflow of Unnamed Lake Downstream of Cirque Lake	2007 to 2009	2007 to 2010	13	$Q = (1.7812H - 175.3652)^{6.0864}$
Northeast Inflow of Pointer Lake	2008 to 2009	2007 to 2010	12	$Q = (2.0833H - 207.2244)^{2.3256}$
Outflow of Sik Sik Lake	2007 to 2009	2007 to 2009	10	$Q = (2.5800H - 256.3844)^{2.0517}$
Outflow of Pointer Lake	2007 to 2010	2007 to 2010	9	$Q = (3.8491H - 378.6436)^{2.1128}$
Outflow of Shack Lake	2007 to 2009	2007 to 2009	10	$Q = (1.9091H - 188.9689)^{4.0064}$
Outflow of Judge Sissons Lake	2007 to 2010	2007 to 2010	12	$Q = (5.3706H - 526.8786)^{2.6448}$
Outflow of Siamese Lake	2007 to 2010	2007 to 2010	10	$Q = (3.7908H - 375.2070)^{2.6309}$
Outflow of Squiggly Lake	2007 to 2008	2007 to 2008	5	$Q = 7.2622H - 718.5715$ $Q = \left(\frac{H}{99.1467}\right)^{625}$

Table 5.1-1 Stream and Lake Monitoring Locations

Description	Continuous Monitoring	Instantaneous Discharge and/or Level Measurements	Number of Level-Discharge Measurements	Stage – Discharge Equation
Tributary to the Northeast Inflow of Pointer Lake	-	2007 to 2010	12	$Q = (1.2765H - 357.2286)^{3.5100}$
Northwest Inflow of Pointer Lake	-	2007 to 2009	11	$Q = (3.7383H - 371.7432)^{2.1381}$
Outflow of Jaeger Lake	-	2007 to 2008	3	$Q = 2.8794H - 285.4555$
Aniguq River	2008 to 2010	to		-
Qinguq Creek	2008 to 2010	2009		-
Outflow of Andrew Lake	2009 to 2010	2009 to 2010	5	$Q = (1.7889H - 176.8673)^{3.5486}$
Outflow of Mushroom Lake	-	2009 to 2010	5	$Q = (0.2155H - 20.4858)^{34.965}$
Pointer Lake	-	2007 to 2010	10	$Q = (3.5149H - 344.7986)^{2.1218}$
Unnamed Lake Downstream of Cirque Lake	-	2007 to 2010	14	$Q = (2.5800H - 254.6963)^{2.1496}$
Judge Sissons Lake	-	2007 to 2010	12	$Q = 104.1667H - 10{,}374.0938$
Squiggly Lake	-	2007 to 2008	5	$\mathrm{Q} = (12.9534\mathrm{H} - 1248.5052)$
Skinny Lake	-	2007 to 2009	7	$\mathrm{Q} = (6.9541\mathrm{H} - 689.7928)^{1.8695}$
Kavisilik Lake	-	2007 to 2009	7	-
Siamese Lake	-	2007 to 2010	8	$\mathrm{Q} = (2.5589\mathrm{H} - 247.4094)^{2.9036}$
Andrew Lake	-	2009 to 2010	6	$\mathrm{Q} = (1.6667\mathrm{H} - 164.2823)^{3.6982}$
Mushroom Lake	-	2009 to 2010	5	$\mathrm{Q} = (0.8956\mathrm{H} - 88.3442)^{9.9108}$

At each stream and lake where sufficient data were collected, a stage-discharge rating curve was developed and the continuous water level record was applied to create a continuous discharge record.

Historic data from regional hydrometric stations were analyzed to derive flood flow magnitude and frequency values, flow durations, and the following general basin characteristics:

- Mean annual discharge and drainage area can be described by:
  - $Q = 0.0065A^{0.9852}$ (Where Q = Mean annual discharge in cubic metres per second (m^3/s) and A is the area in square metres (m^2)
- The unit area runoff values for nearby Qinguq Creek and Aniguq River are 0.0060 cubic metres per second per square kilometre ($m^3/s/km^2$) and 0.0062 $m^3/s/km^2$, respectively.
- Qinguq Creek and Aniguq River have annual basin yields of 190 millimetres per year (mm/year) and 197 mm/year, respectively.

The data obtained during baseline studies indicate that streams near the Project display arctic nival characteristics; their hydrographs reflect a steep rising limb, peaking in approximately mid June due to the onset of spring snowmelt, followed by receding flows for the remainder of the open water period. Rainfall events throughout the summer may temporarily reactivate the channels or cause secondary peaks. Streamflow typically ceases during winter months.

Lakes near the Project are typically ice covered from approximately October through June, with mean maximum thickness near 2 m. Lake levels and volumes reflect inflow and outflow characteristics and thus reach their peaks during the spring freshet in mid-June with levels and volumes typically decreasing throughout the remainder of the open-water season.

5.2 Hydrogeology

5.2.1 Introduction

Both the Project site and the community of Baker Lake are located in the zone of continuous permafrost. The uranium ore bodies occur in areas of deep permafrost.

In areas of continuous permafrost, unfrozen ground conditions can develop beneath lakes that do not freeze to the bottom in winter. This unfrozen ground is referred to as “talik”. If a lake is large and deep enough, the talik extends down to the deep sub-permafrost groundwater regime (“open talik”). To support a talik, a lake must be deep enough to maintain an unfrozen bottom throughout the winter. A 2 m thick ice coverage is assumed to develop in lakes at the Project site during the winter months; therefore, lakes must be greater than two metres deep to support a talik.

The depth of the talik formed beneath a lake is dependent on the size of the lake. When the size of a lake is above a critical value, the talik beneath the lake will be an open talik that hydraulically connects to the deep groundwater flow regime beneath the permafrost. Beneath smaller lakes that do not freeze to the bottom during winter, a talik bulb that is not connected to the deep groundwater flow system will form.

Most lakes in the Kiggavik Project area are relatively shallow and many freeze to the bottom in winter. However several lakes near the Project site satisfy both the minimum dimensional and depth requirements to support an open talik extending to the deep groundwater flow system. Figure 5.2-1 identifies lakes that satisfy these requirements. Taliks beneath larger lakes extend down to the deep groundwater regime. The elevations of these lakes provide the principal driving force for deep groundwater flow. Generally, groundwater will flow from higher elevation lakes to lower elevation lakes.

5.2.2 Permafrost

Figure 5.2-2 shows examples of recent ground temperature profiles recorded in the Kiggavik Project area. The data indicate that the depth of permafrost near the Main Zone, Centre Zone, and East Zone deposits is shallower than in the area of the Andrew Lake and End Grid deposits. Permafrost extends to a depth of about 210 m below ground surface in the area of the Main Zone, Centre Zone, and East Zone deposits. Data collected at Sissons Mine Site indicate that permafrost extends to a depth ranging from 240 m to 260 m below ground surface in the area of the Andrew Lake and End Grid deposits. Stakeholder engagement indicates that *even though it may not rain much, tundra seems to have much water* (EN-BL CLC 2007[107]); this is likely attributed to melting of permafrost within the Project area.

[107] EN-BL CLC 2007:*….even though it may not rain much, the tundra seems to have much water, it seems to be that way…..*

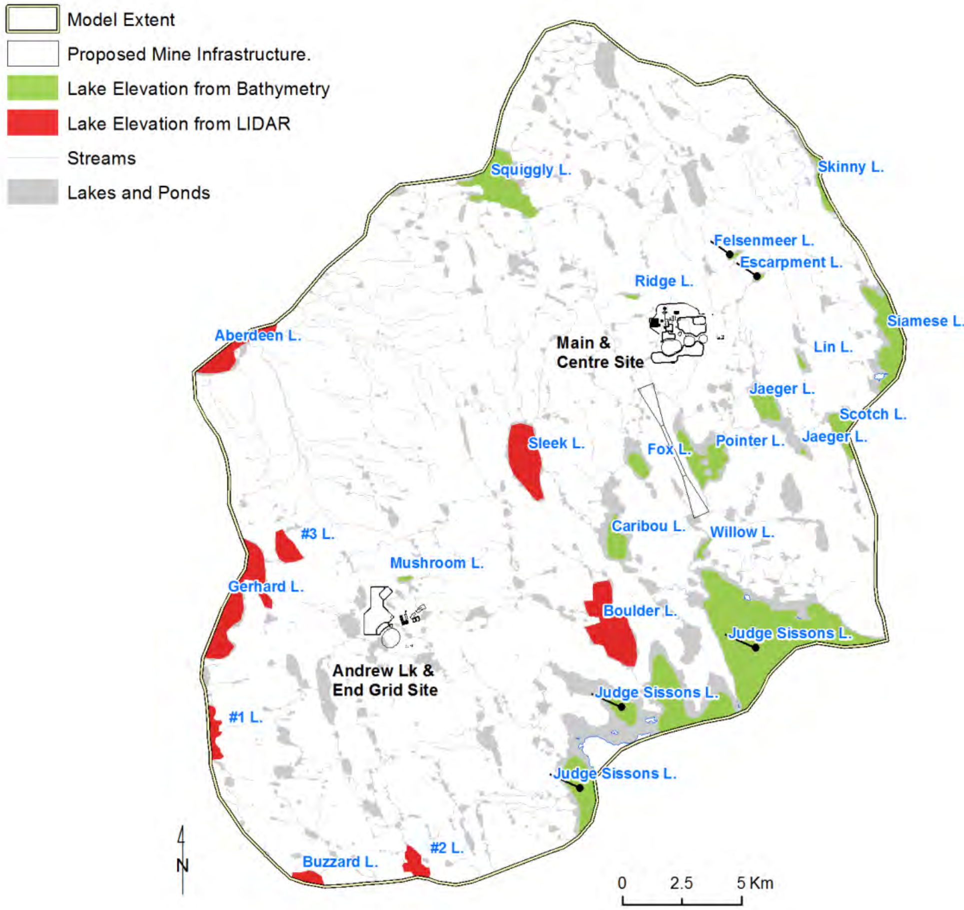


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Figure 5.2-1
Location of lakes supporting taliks within numerical flow model domain

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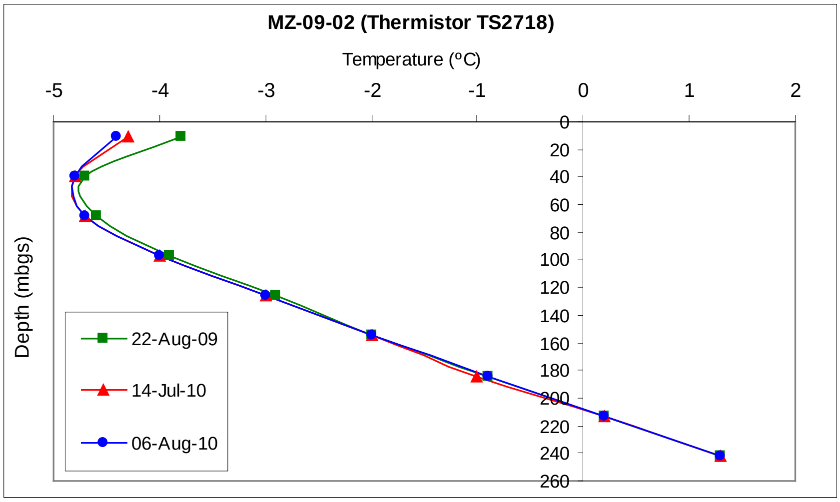

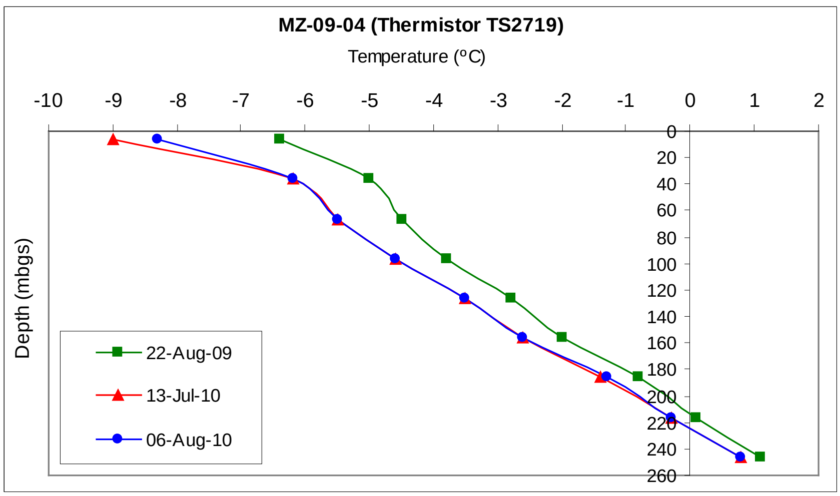

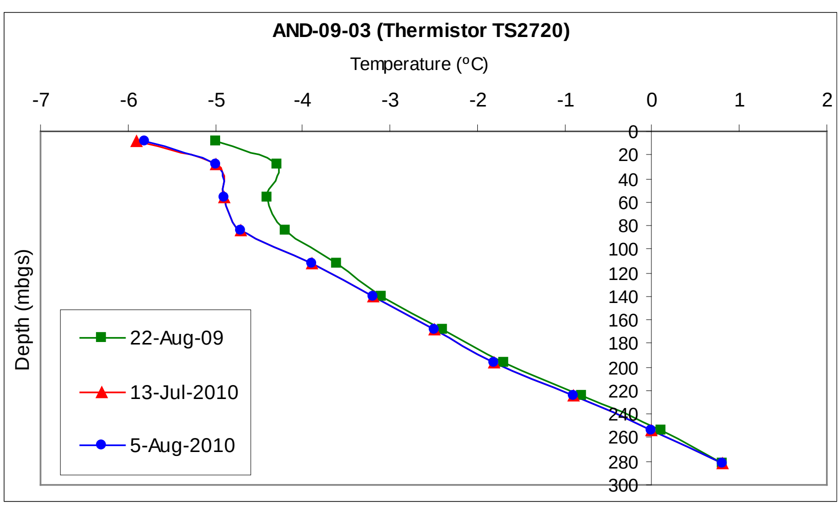

Figure 5.2-2
Example of permafrost temperature profiles with depth

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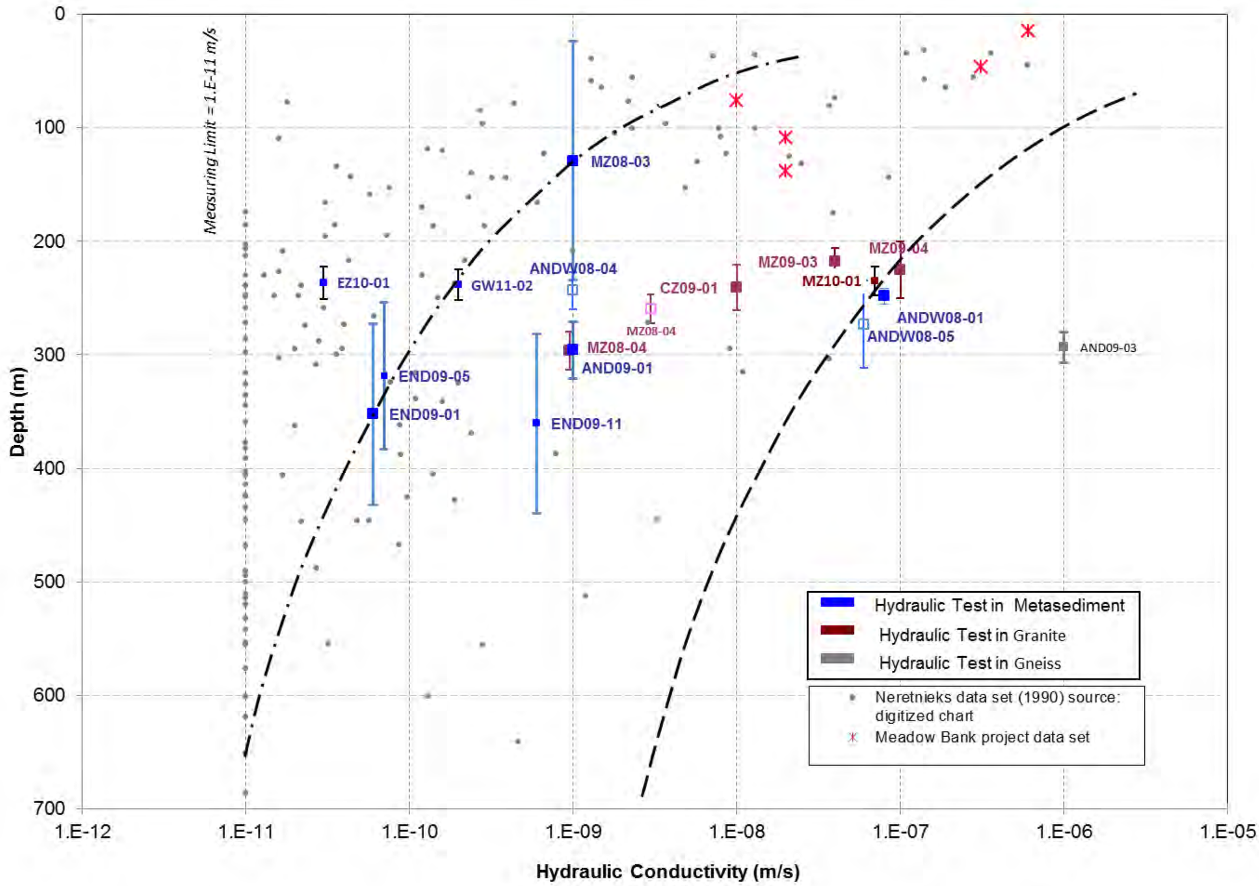
5.2.3 Hydrostratigraphy

The deep groundwater flow regime was characterized during hydrogeological testing undertaken in deep boreholes drilled through permafrost to the unfrozen ground below. A compilation of the hydraulic conductivity values derived from the tests conducted during the 2008 to 2011 field program is presented in Figure 5.2-3. Hydraulic tests conducted to date indicate that the hydraulic conductivity (K) of the rock at the Project site is low.

Figure 5.2-3 also compares the Kiggavik Project results to hydraulic conductivity measurements from the Meadowbank Project (Cumberland Resources Ltd. [Cumberland] 2005) and from a dataset measured in metamorphic rock (Neretnieks 1990). The Neretnieks (1990) and Meadowbank Project (Cumberland 2005) results are both considered to be reasonably representative of the Kiggavik deep rock mass. The Neretnieks and Meadowbank data is not used within this assessment itself, but rather presented for comparison to Kiggavik project data. The dashed line in Figure 5.2-3 indicates a possible upper bound for the K values at depth. Hydraulic conductivities from the Neretnieks (1990) and Meadowbank (Cumberland 2005) datasets range from 1x10-7 to 3x10-10 metres per second (m/s) at 200 m depth and 2x10-8 to 7x10-11 m/s at 300 m depth. The tests at Kiggavik fall within this range, with the exception of one test measurement completed in 2009; AND09-03 was tested at 1x10-6 m/s between 297 and 327 metres below ground level (mbgl). The results show that Kiggavik data fits within other datasets collected in Canadian Shield rock.

Based on the review of site geology, hydraulic test results, and measurements of groundwater table elevation, the following hydrostratigraphic units were identified for the Project area:

- Overburden: this unit does not substantially affect the deep groundwater flow system because it has been shown to be discontinuous, limited to 5 m depth or less, and is only active during the summer when the soil has temporarily thawed. The overburden was modelled with a hydraulic conductivity of 5 x10-5 m/s and specific storage of 1x10-5 m-1.
- Permafrost: the permafrost was considered to be an effective aquitard, laterally continuous, except under lakes that support open taliks. The permafrost was modelled with a very low hydraulic conductivity (1x10-12 m/s). Specific storage was assumed to be zero.
- Sub-permafrost units: the unfrozen rock “aquifers” were subdivided according to the following sub-geological units: Metasediments, Granite, Orthoquartzite, Syenite, Gneiss, and Barrensland Group. Hydraulic properties of each of the hydrostratigraphic units are detailed in Figure 5.2-4.



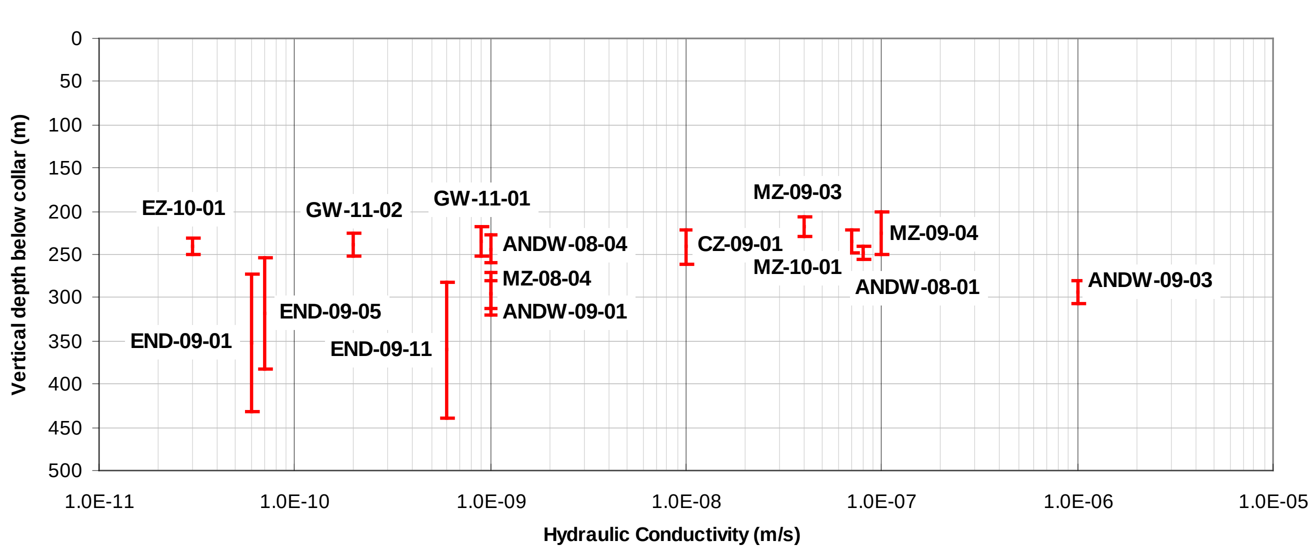
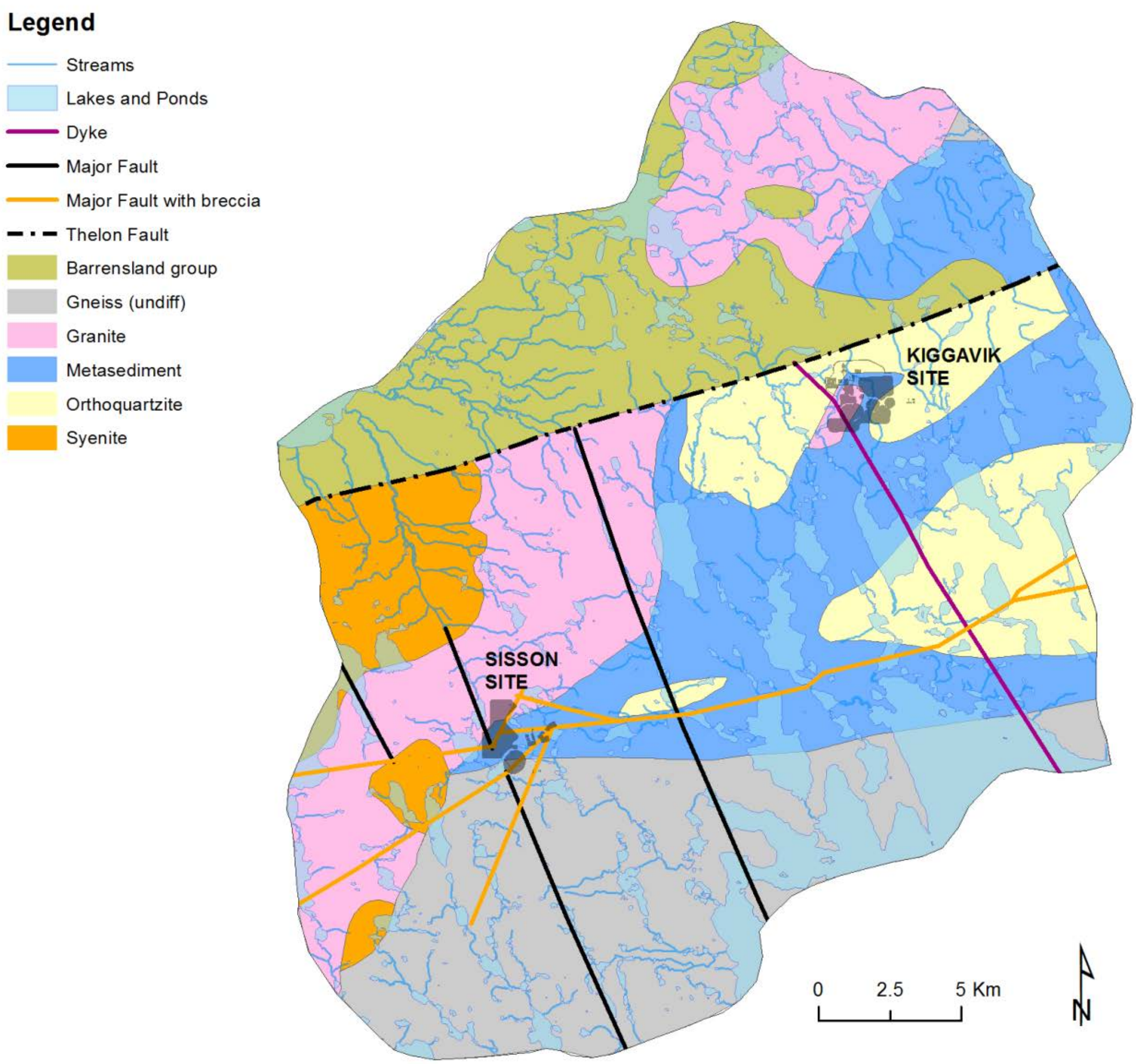


Figure 5.2-3
Compilation of single well pressure response tests results K(m/s) versus Depth (m)



	Depth (m)				
Unit	**0-5m**	**5m-100m**	**100m-215m**	**215m-450m**	**450m-900m**
Permafrost	1x10-12	1x10-12	1x10-12	-	-
Major Fault	1x10-7	1x10-7	1x10-7	1x10-7	1x10-7
Barrensland	5x10-5	3x10-7	3x10-8	8x10-9	8x10-10
Gneiss	5x10-5	5x10-8	5x10-9	1x10-9	1x10-10
Granite	5x10-5	5x10-7	5x10-8	1x10-8	1x10-9
Meta-sediment	5x10-5	5x10-9	5x10-10	1x10-10	1x10-11
Ortho-quartzite	5x10-5	1x10-7	1x10-8	5x10-9	5x10-10
Syenite	5x10-5	8x10-8	8x10-9	3x10-9	3x10-10

Hydraulic conductivity (m/s)

Kx=Ky=10Kz

Figure 5.2-4
Geology units and hydraulic conductivity distribution

5.2.4 Groundwater Flow Regime

Flow directions in the deep groundwater flow regime were first inferred from the elevations of the lakes supporting taliks. The results indicate that the predominant groundwater flow in area of the Main Zone, Centre Zone, and East Zone deposits is south towards Fox Lake, Pointer Lake, Jaeger Lake, and Judge Sissons Lake. Groundwater in this area may also discharge to Sleek Lake, located to the southwest, and Scotch Lake, located to the southeast. In the area of the Andrew Lake and End Grid deposits, the predominant groundwater flow direction is inferred to be southeast towards Boulder Lake and Judge Sissons Lake.

Figures 5.2-5 shows cross section views of the conceptual model of groundwater flow in the Kiggavk and Sissons areas. Figure 5.2-6 shows the simulated steady-state hydraulic head distribution in the sub-permafrost aquifer under pre-mining conditions. The figure also shows the areas where groundwater is predicted to be artesian flowing.

5.2.5 Groundwater Quality

Groundwater sampling in a low hydraulic conductivity environment is challenging because of the longer time required to obtain the volume of water necessary for sampling. In continuous permafrost areas, the difficulties increase due to concerns regarding freezing of the drill hole. Only one hole was successfully sampled for groundwater quality at Main Zone in 2009. Additional groundwater samples were collected in 2010 and 2011 from artesian flowing exploration boreholes in the Bong area, between Kiggavik and Sissons sites.

Cross-plots of major elements chloride versus (vs.) calcium and chloride vs. sodium were used to compare the collected groundwater samples with other samples in the area over the previous 20 years. This analysis shows that there is a distinct chemical signature, indicated from the presence of major ions (i.e., calcium, chloride and sodium), in the groundwater samples, compared to lake samples, a rig circulation tank sample, and historic drill return samples, which all have very low major element concentrations. TDS (total dissolved solids) for the groundwater sample and the historic samples were calculated with the principal major element contributors to TDS (i.e., calcium, magnesium, sodium, alkalinity, potassium, sulphate, and chloride). The TDS resulting from laboratory analysis of the groundwater sample collected at about 250 m below ground surface is 3,500 milligrams per litre (mg/L). This TDS measurement is consistent with the composition of deep groundwater in the Canadian Shield (Frape and Fritz 1987) at the depth that the sample was collected.

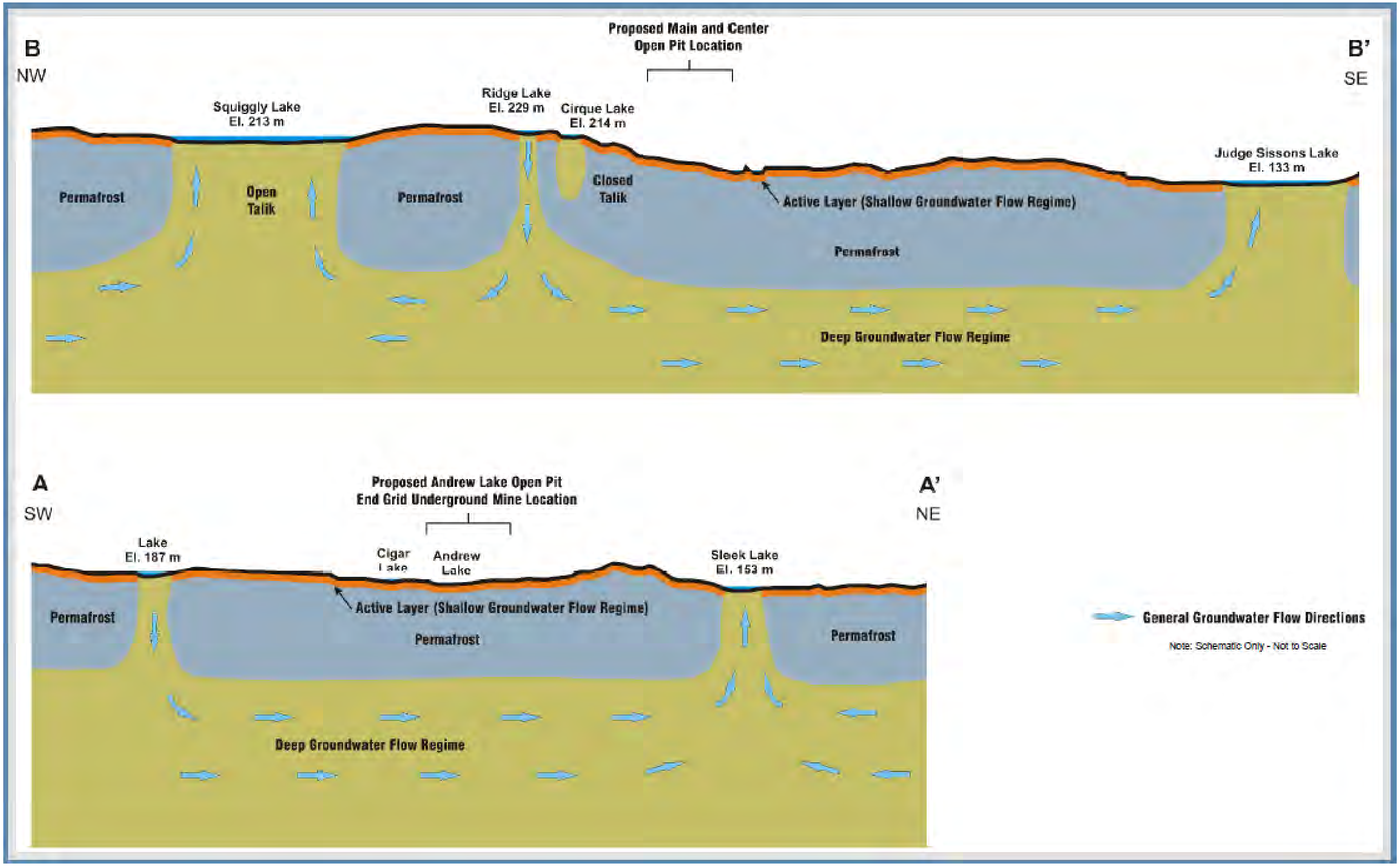


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Figure 5.2-5
Conceptual model of groundwater flow
Cross section view

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