AREVA

Kiggavik Project
Final Environmental Impact Statement

Tier 2 Volume 6: Terrestrial Environment

September 2014

History of Revisions

Revision Number	Date	Details of Revisions
01	December 2011	Initial release Draft Environmental Impact Statement (DEIS)
02	April 2012	Revised DEIS – to address comments received from the Nunavut Impact Review Board as part of their conformity determination released on January 18, 2012
03	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

Authorship

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Executive Summary

As per the guidelines issued by the Nunavut Impact Review Board (NIRB 2011), AREVA Resources Canada Ltd. (AREVA) prepared this volume of the Environmental Impact Statement (EIS) to assess the potential environmental effects of the Kiggavik Project (the Project) on the terrestrial environment. Volume 6 focuses on the potential Project environmental effects on terrain, soil, vegetation, and wildlife and wildlife habitat.

The primary Project components considered in the terrestrial assessment include all land-based construction, operation, final closure and post closure infrastructure and activities. Two access road options were considered in the assessment; a Winter Road and an All-Season Road. Three siting options for the Baker Lake dock and storage facility were also included in the assessment.

Scope of the Assessment for the Terrestrial Environment

The NIRB developed the scope of the terrestrial assessment for the Project based on input from Inuit, government, and other interested stakeholders. Inuit stakeholders have played a fundamental role in raising awareness of potential Project interactions with the terrestrial environment.

Through Inuit Qaujimajatuqangit (IQ) interviews and engagement activities, AREVA has learned about the importance of the terrestrial environment to Kivalliq community members. This includes the value of terrestrial resources to the Inuit way of life (IQ-BLH 2009[1], IQ-CIHT 2009[2]), concerns and questions about potential contamination of the plants and animals (EN-BL HS Nov 2010[3], IQ-BLE 2009[4], EN-BL EL Oct 2012[5]), and the importance of protecting the terrestrial environment (EN-BL NIRB April 2010[6], EN-BL OH Oct 2012[7], EN-CH OH Nov 2010[8]). The value of the terrestrial

[1] IQ-BLH 2009: *Hunters emphasized that most people in Baker Lake still depend on caribou for food.*

[2] IQ-CIHT 2009: *The people of Chesterfield continue to primarily depend on caribou, fish and seal. Consuming country food is not considered 'ritual food' but the daily way of life.*

[3] EN-BL HS Nov 2010: *What effect will mining have on the land?*

[4] IQ-BLE 2009: *Elders are concerned that uranium may escape and contaminate the ground*

[5] EN-BL EL Oct 2012: *There will be lots of dust and animals like rabbits and wolves will be affected.*

[6] EN-BL NIRB April 2010: *Important that the company respect and protect the land, water and animals.*

[7] EN-BL OH Oct 2012: *Will the berries and animals be protected if your mine goes ahead?*

environment and the scope of this assessment exemplify the IQ guiding principle of Avatimik Kamattiarni (the concept of environmental stewardship).

Terrain, soils, vegetation, and wildlife were selected as valued environmental components (VECs) for the terrestrial assessment because they have the potential to be affected by Project activities and are of cultural and ecological importance in the Kivalliq region.

For wildlife, key indicators were selected to focus the assessment on key species or species groups that represent components of the broader resource. Wildlife species selected as indicators were:

- ungulates — caribou (*Rangifer tarandus*) and muskox (*Ovibos moschatus*)
- predators — wolf (*Canis lupus*)
- migratory birds — lapland longspur (*Calcarius lapponicus*), long-tailed duck (*Clangula hyemalis*), and shorebirds
- raptors — peregrine falcon (*Falco peregrinus*)
- species at risk — short-eared owl (*Asio flammeus*), grizzly bear (*Ursus arctos horribilis)*, and wolverine (*Gulo gulo*)

No key indicators were selected for assessing Project effects on terrain, soils and vegetation.

Regulatory considerations pertaining to the terrestrial assessment include the *Nunavut Land Claims Agreement Act*, Keewatin Regional Land Use Plan, *Nunavut Wildlife Act*, *Species at Risk Act* (SARA), *Migratory Birds Convention Act*, and the Federal Policy on Wetland Conservation.

The terrestrial environment assessment is spatially bound by three assessment areas: the Project footprint, the local assessment area (LAA), and the regional assessment area (RAA). The Project footprint is the area of direct physical disturbance by the Project. The LAA is the maximum area within which Project effects can be predicted or measured with reasonable accuracy and confidence. The LAA consists of two different areas, the mine LAA and the road LAAs. The mine LAA was represented by a 5 km buffer that encompassed the proposed facilities and the access road between the mine sites. The LAAs for the two different road options are represented by a 5 km wide buffer centered over the proposed road alignments. The RAA is a broader area within which cumulative effects may potentially occur, or a VEC is broader ranging. The dock facility options are included

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[8] EN-CH OH Nov 2010: *I am worried about the wildlife, will you protect it, make sure you don't harm it?*

within the All-Season Road and Winter Road LAA boundaries. The RAA includes all of Judge Sissons Lake and the southern portion of Aberdeen and Schultz lakes. It encompasses a minimum buffer of 22 km around the Project footprint.

The temporal boundaries for the terrestrial assessments are generally based on the timing and duration of effects over all phases of the Project (construction, operation, final closure and post-closure). The total life span of the Project is expected to be 25 years, with post-closure extending beyond the final closure phase.

A residual environmental effect caused by the Project is considered significant if it adversely affects the long-term viability of the VEC. The significance of a residual environmental effect was determined based on thresholds or standards identified for each VEC. In the absence of known thresholds or standards, professional judgment was used to determine significance. A residual effect is considered to be not significant if the effect causes a change in the VEC that is within the range of natural variability, or does not affect the integrity of the VEC in a measurable or meaningful way.

Scope of the Assessment for Terrain

Existing Environment — Terrain

Surficial deposits consist mainly of glacial till and small local deltaic deposits in the RAA. Periglacial geomorphic processes in the RAA are associated with the ground that is permanently affected by the cold climate, consisting of an active layer (also known as thaw depth), excess ground-ice and a layer of perennially frozen ground. Periglacial processes observed within the Mine LAA and RAA include frost wedging and frost shattering, thaw subsidence and solifluction, which shaped various landforms.

A typical top layer of surficial material profile in the Mine LAA consists of a thin organic soil layer underlain by glacial till varying in thickness from less than one meter on ridges to several meters in depressions, overlying moderately jointed bedrock with good rock quality. The surficial materials have been historically grouped into six major deposits: glacial till or morainal, glaciofluvial; glaciolacustrine, glaciomarine deposits, organic, and bedrock.

Major landforms are subdivided into four different types: common depositional, glacial, permafrost sensitive and uncommon landforms. Common landforms are further subdivided into six types within the Mine LAA: undifferentiated alluvial, glaciofluvial, glacial till or morainal, glaciomarine, organic and bedrock landforms. The most common landform within the LAA is morainal. Alluvial, glaciofluvial, morainal (glacial till), glaciomarine and bedrock landforms cover approximately 10.5% (3,786 ha), less than 1% (200 ha), 84% (30,356), 0.3% (108 ha), and 5% (1,790 ha) of the Mine LAA, respectively. Glacial landforms are dominated by hummocky, bouldery glacial till and scattered boulder till moraines with frequent bedrock outcrops and shattered bedrock features in isolated exposures, elevated plateaus and elongated ridges (drumlins, and other glaciofluvial outwash features) within the LAA. Permafrost sensitive landforms may be determined based on potential high water and ground-ice content, high frozen bulk density of soil, fine-grained strata with high silt content, position in the landscape, and slope types. Eskers are considered to be the most prominent uncommon landforms within the LAA. They are isolated topographic features, but three esker-related landforms have been identified within the LAA.

The Project site is located within the zone of continuous permafrost. Thickness of the active layer is highly variable from 1 m in surficial sediments to 5 m in bedrock outcrops. The ground-ice content of permafrost soil and rock is expected to be less than 10%.

Environmental Effects Assessment for Terrain

Issues related to Project effects on terrain identified through AREVA's public engagement activities and IQ interviews included potential changes in permafrost conditions, terrain stability and landforms. Key concerns focused primarily on potential melting of permafrost due to uranium (EN-RI RLC Feb 2009[9]) and Project-related mining activities, and the cultural importance and use of landforms such as hills (IQ-BL01 2008[10], IQ-BL09 2008[11], IQ-BL11 2008[12]).

Terrain was considered as a VEC for the assessment as it has the potential to be affected by Project activities through changes in permafrost conditions, terrain stability and changes in landforms, and has direct and indirect linkages with other VECs.

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[9] EN-RI RLC Feb 2009: *Does uranium melt the permafrost?*

[10] IQ-BL01 2008: *People camped at the Kazan River in the spring, pitching tents on a hill so that they could see all around*

[11] IQ-BL09 2008: *There's a hill that gets very foggy, I heard of it as Kinnga'tuaq. I have heard that you cannot go there or pass through. Thick fog starts to form on it when you go through there, you cannot see anything.*

[12] IQ-BL11 2008: *There's a nice big hill there that you can see way from a distance. The lower part is very smooth, with a lake. That's where my name sake is buried.*

A qualitative and quantitative approach was adopted for the terrain assessment based on the previous experiences with similar projects in Nunavut and other parts of the Canadian Arctic, and best professional judgment. Federal and territorial guidelines, regulations standards and/or thresholds applicable to assess the effects of changes in terrain are not available. The terrain assessment focuses on:

- changes in permafrost conditions and terrain stability due to vegetation clearing, changes in terrain slope, redirection of surface drainage patterns, changes in sub-surface water flow, excavation and blasting
- changes in landforms due to disturbance of eskers and other significant and sensitive landforms

As climate change has the potential to change permafrost conditions, terrain stability, and landforms, effects of climate change on Project effects to terrain has been taken into account in the assessment.

Thresholds are defined using the proportion of lost terrain surface or landform relative to the total area of the Mine LAA and selected based on the general knowledge of the Arctic terrestrial environment, professional judgment and the thresholds chosen for similar projects in Nunavut. A residual environmental effect caused by the Project is considered to be significant if the Project disturbance exceeds the threshold values of 30% loss of the terrain surface, 30% loss of common depositional landforms, 15% loss of permafrost sensitive landforms or 15% loss of uncommon landforms in the LAA.

Change in Permafrost Conditions and Terrain Stability

Two factors that determine change in permafrost are ground temperature and the volume of ground-ice within the permafrost overburden. Ground temperature, in turn, is determined by several factors including: air temperature, type and thickness of vegetation cover, organic soils insulation, rock type, snow cover, and terrain slope. Site and vegetation clearing, potential change in terrain slope, modification of surface water and drainage patterns, changes in subsurface water flow and any destructive activities such as blasting may result in changes in permafrost conditions and terrain stability.

Project activities that cause surface and subsurface disturbance can affect vegetation cover, organic soil insulation and frozen overburden materials, which can change the overall permafrost conditions and its distribution, and terrain stability. In turn, this can lead to a change in the abundance and distribution of various landforms within the Project area.

Surface disturbances from construction and operation related activities will affect about 803 ha (or 2.2%) of the total 36,240 ha within the Mine LAA. This will be caused by the loss of vegetation and organic soil due to removal (645 ha; 1.8% of the LAA) and burial (158 ha; 0.4% of the Mine LAA). Any changes in permafrost conditions and terrain stability as a result of the loss of vegetation cover and organic soil will be confined to the Project footprint and will occur primarily during the construction phase, although effects are expected to continue through the life of the Project until site reclamation is complete.

The proposed All-Season Road alignment, if required, is expected to be 114 km long and approximately 24 m wide and will extend from the Kiggavik mine site to the Baker Lake dock site facility. The road will be built with rock material placed on top of the existing terrain (fill method), which will protect permafrost and prevent terrain stability issues. The proposed road is designed and routed on higher ground as these areas tend to contain less ground-ice, fewer drainage areas to cross, are less prone to snow drifts, and generally contain more bedrock, as well as suitable quarry locations. Routing the proposed road on higher ground will reduce geotechnical issues and road fill required during construction. This will also reduce potential maintenance issues (e.g., snow drifts) throughout the life of the Project.

Overburden materials at the dock site facility will be removed and stored. Following removal of the overburden, a site pad will be constructed to provide thermal protection to the underlying permafrost layer. Construction of the preferred dock site facility is estimated to disturb an area of approximately 25 ha.

Mitigation measures will be implemented in two ways: mitigation by design and discipline-specific mitigation. Project design measures include minimizing the Project disturbance footprint and the number of drainage areas affected by the Project components and activities, and avoiding surface disturbance in high ground-ice areas to reduce potential for deepening the thaw depth and associated thaw settlement and terrain stability. Discipline-specific mitigation include the consideration of scheduling Project activities such as construction in permafrost sensitive areas during the winter time where feasible, controlling vehicular traffic along roads, planning of proper culvert locations, and construction and maintenance of roads susceptible to excessive groundwater seepage. Other mitigation measures include sustaining safe construction and operation practices within and adjacent to the Project footprint, management of drainage system around infrastructure, insulation of infrastructure, and use of coarser materials for road construction.

With implementation of the mitigation measures, residual environmental effects of the Project on permafrost conditions and terrain stability are expected to be low in magnitude, site specific, long term and reversible. The level of confidence in this prediction is considered high as these mitigation measures are widely used and well accepted practices for construction and operation of mining projects in areas of continuous permafrost in the Canadian Arctic. The potential environmental effects of changes in permafrost and terrain stability are predicted to be below the threshold for loss in terrain and, therefore, are predicted to be not significant.

Change in Landforms

Construction and operation activities, including excavation, placement of structural foundations, road construction, airstrip construction, pads and quarrying, will cause surface disturbances that can lead to a change or direct loss of surface materials due to stripping or burial of surficial deposits associated with landforms. This can lead to a change in the quantity of common landforms and the loss or change in uncommon landforms such as eskers. Project activities can also lead to changes in permafrost conditions, which can cause a loss or change in permafrost sensitive landforms.

Mitigation measures to reduce and/or eliminate Project effects on landforms will take place during the Project design and include minimizing the Project disturbance footprint, avoidance of uncommon landforms, and reduction of the use of glaciofluvial landforms. Project design features to prevent landforms susceptible to excessive surface and subsurface water seepage will be implemented, which includes the planning and design of proper culverts, where necessary.

Any changes in landforms as a result of the Project will be confined to the Project footprint within the Mine LAA, and will occur primarily during construction and, to a lesser extent, during operations and closure of the Project. Of the total surface areas covered by alluvial, glaciomarine, bedrock and glacial (till and moraine) landforms within the Mine LAA, about 0.6% (22 ha), 0.4% (less than 1 ha), 3.8% (68 ha) and 2.4% (720 ha) will be lost as a result of surface disturbances, respectively. Approximately 2.2% of the total surface area covered by common depositional landforms within the Mine LAA will be disturbed by Project activities.

Residual effects on landforms will be confined to within the All-Season Road LAA, and will occur primarily during construction. The construction of the road will involve the burial of common landforms. The total surface area of the All-Season Road LAA encompasses approximately 52,032 ha. The estimated surface areas covered by alluvial, glaciofluvial, glaciomarine, bedrock and morainal (glacial till) landforms that are expected to be buried by the proposed road will comprise 6.65 ha (0.01%), 0.35 ha (less than 0.01%), 6.60 ha (0.01%), 65.76 ha (0.13%), and 148.02 ha (0.28%) of the total area of the All-Season Road LAA, respectively.

No changes or loss of permafrost sensitive and uncommon landforms are expected to occur, as glaciofluvial landforms will not be affected by the Project. With implementation of mitigation measures, residual environmental effects on landforms are predicted to be low in magnitude, spatially limited (site specific), permanent, will likely occur once, and are irreversible. The level of confidence in this prediction is high as these predictions are based on experiences with similar projects in the Canadian Arctic, and the mitigation measures are widely used and well accepted practices for the construction and operation of mining projects in areas of continuous permafrost in the Canadian Arctic. Changes in common depositional landforms as a result of the Project are predicted to be below the threshold and, therefore, are expected to be not significant.

Given the limited spatial extent of surface disturbance caused by the Project, residual effects on terrain are expected to be low and considered to be not significant. Effects on terrain stability, permafrost conditions and landforms due to construction and operation activities are not expected to contribute to cumulative effects on terrain in the RAA.

A monitoring system of terrain will be established during all phases of the Project and include thaw-depth monitoring within the mine, mine affected areas and roads, soil sampling and laboratory analysis, and routine visual field inspection of terrain slope conditions and landforms within the mine development and adjacent areas. Slope stability monitoring devices will be installed, if necessary.

Effects of Climate Change on Terrain

Climate change is expected to cause long-term effects on permafrost conditions and the stability of terrain in the Canadian Arctic. However, the magnitude and extent of these effects will depend on the degree and rate of warming. Thermal modeling results for long-term (2000 years) climate scenario for the Project area indicate that if the mean annual ground surface temperature rises, a change in permafrost depth will be evident at the base but not at the surface. Undisturbed ground surfaces (natural ground) will likely retain permafrost after an assumed climate warming trend of 5°C in the mean annual ground surface temperature. With implementation of permafrost design features with due consideration of predicted long-term climate change in the Arctic, changes to terrain are anticipated to be minor relative to the baseline condition and the residual effects are predicted to be not significant.

Scope of the Assessment for Soils and Vegetation

Existing Environment — Soils

Soils near the Project are influenced by continuous permafrost within the top 2 m of the soil surface. Twelve soil types for the Turbic Cryosol, Static Cryosol and Organic Cryosol classification subgroups have been documented in the RAA.

The soils consist predominantly of a shallow organic veneer overlying fine to coarse textured glacial till blankets, which vary in thickness from less than 1 m on bedrock ridges to more than 4 m in depressions. The average depth of topsoil available for reclamation salvage (organic layers plus organic enriched mineral soil, or A horizon) is approximately 11 cm, with a minimum of 3 cm in upland lichen tundra, heath upland and heath tundra areas (Regosolic Turbic Cryosols), and a maximum of 31 cm in low-lying wet graminoid and graminoid tundra areas with thick peats (Organic Cryosols). Approximately 54% of the topsoil depth in any given area is peat organic material. The till-derived mineral fraction of the soils is medium textured, with coarse fragment size typically ranging from gravel to cobble. Coarse fragment content is typically low at the surface, and increases with depth.

Three of the baseline soil samples from the Kiggavik lease area had elevated trace element concentrations per the Canadian Council of Ministers of the Environment (CCME) Industrial soil guidelines (CCME 2009): one soil sample had an elevated arsenic concentration, and two samples had elevated molybdenum concentrations. Four out of the five peat baseline samples collected in the Kiggavik lease area had elevated concentrations of boron relative to the Industrial soil guidelines. No samples from the Sissons lease area had elevated trace element concentrations. No sample locations had elevated radionuclide concentrations.

Environmental Effects Assessment for Soils

Key issues identified for soil were changes in soil quality and changes in soil quantity. Potential changes in soil quality may result from onland construction, mining, and milling activities. Changes in soil quantity may occur during construction activities and on-land decommissioning work during final closure. The importance of soil as part of the whole environment was identified in comments received during IQ interviews and engagement activities (EN-Kiggavik Project Blog 2009[13], IQ-BLE 2009[14]).

Change in Soil Quality

Changes in soil quality were assessed based on air quality modeling to estimate potential acid inputs (PAI) generated by the Project at the proposed mine sites, as well as dust deposition (metals and radionuclides) generated by Project activities. Adverse effects on soil quality due to changes in Constituents of Potential Concern (COPC) concentration were also evaluated based on comparisons to CCME criteria and changes relative to baseline conditions. Potential changes in soil quality due to admixing, compaction, and erosion were assessed qualitatively based on the nature and extent of construction activities during Project development.

Mitigation measures for changes in soil quality will focus on reducing and/or preventing air emissions, soil contamination from radiation, soil admixing due to construction activities, and soil compaction and erosion throughout the duration of the Project. Mitigation measures to suppress dust and reduce the amount of dust created by Project activities will also be implemented.

Air quality modeling predicted that changes in COPC concentrations in soils will be below the CCME (2009) Soil Quality Guidelines. Approximately 81 ha outside of the Kiggavik mine site may be exposed to PAI values above the critical threshold value. Project residual effects on soil quality due

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[13] EN-Kiggavik Project Blog 2009: *all the animals we eat rely on good soil*

[14] IQ-BLE 2009: *Elders are concerned that uranium may escape and contaminate the grounds*

to air emissions and dust deposition are expected to be low in magnitude and localized in geographic extent, and will likely be continuous in frequency and long term in duration but reversible.

Soil compaction will be kept within the confines of the Project footprint, and will be low in magnitude as the majority of soil types identified within the Project footprint are less prone to compaction due to their sandy texture and amount of coarse fragments. With implementation of the mitigation measures, any residual effects caused by soil admixing and soil erosion are predicted to be negligible. Residual effects of soil compaction are predicted to be low in magnitude, site specific in geographic extent, medium term in duration, continuous in frequency, and reversible. Potential residual effects on soil quality due to soil admixing and soil erosion are anticipated to be negligible. Overall, changes in soil quality caused by the Project are predicted to be not significant.

Monitoring of soil quality through chemical analysis of soil samples, air emissions and dust deposition will occur throughout the duration of the Project. Comparisons will be made between chemical analyses results from soil samples to both air emissions and dust deposition results, as well as to baseline values and CCME guidelines to identify and reduce adverse effects on soil quality caused by the Project.

Change in Soil Quantity

Changes in soil quantity were assessed based on the maximum predicted area to be disturbed by the Project. Effect mechanisms that can contribute to changes in soil quantity during Project development include topsoil stripping, soil erosion, soil movement, and soil burial.

Mitigation measures identified to reduce and/or prevent Project-related effects on soil quantity include construction and storage plans, as well as soil movement for preserving stripped topsoil for reclamation purposes. Project design features, erosion control structures, and measures to limit the amount of soil buried during construction will also be incorporated into the Project to reduce soil loss.

Depending on the Project development option selected, the Project will disturb an area ranging between 931 ha and 1,205 ha, which represents less than 1 % of the combined LAAs. Of this area, approximately 645 ha will be lost due to topsoil stripping, and between 286 ha and 560 ha will be lost due to soil burial.

Project residual effects on soil quantity are expected to be low in magnitude, site specific in geographic extent and reversible. The duration of time over which effects on soil quantity will be detectable will vary depending on the effect mechanism, ranging between short term (i.e., soil movement), medium term (i.e., soil erosion, topsoil stripping) and long term (i.e., soil burial). Effects on soil quantity are expected to predominately occur during the construction phase, although soil erosion may occur sporadically throughout the duration of the Project as a result of weather events interacting with the Project. With a high degree of confidence, it is predicted that residual effects of the Project on soil quantity will be not significant.

An environmental monitor will be on-site during the construction phase to assist AREVA personnel and contractors with implementing mitigation strategies to reduce the effects of the Project on soil quantity, such as topsoil stripping and soil storage activities. Dust deposition monitoring will occur throughout the duration of the Project to identify and mitigate potential effects on soils.

Effects of Climate Change on Soils

Climate change will likely have the most pronounced effect on soil quantity as a result of increased soil erosion due to changes in temperature, precipitation, and wind. Soil susceptibility to erosion would likely increase with increases in temperature, increases in precipitation and resulting runoff and erosionand increases in duration and magnitude of wind events. Soils exposed by the Project (e.g., overburden pile) would likely be most susceptible to soil loss.

Existing Environment — Vegetation

The Project region is dominated by tundra vegetation interspersed with lichen-dominated bedrock outcroppings and boulder fields. Tundra vegetation is continuously underlain by permafrost and characterized by short shrubs such as dwarf birch, willows and heath species, as well as sedges and grasses, herbs, mosses and lichens. Fifteen ecological land classifications (ELC) map units have been identified within the LAAs and RAA.

Wetlands (including all water bodies and watercourses) were identified within the RAA. The Wet Graminoid ELC map unit was used to identify areas containing wetland vegetation that was assumed to be waterlogged throughout the year. Approximately 20.5% (9,205 ha) of the mine LAA consists of wetlands, compared to 32.8% (322,287 ha) of the RAA.

Inuit Qaujimajatuqangit (IQ) studies indicated that certain plant species are of particular value to Inuit for food, medicine, shelter and other human uses (IQ-Mannik 1998[15], IQ-RIHT 2009[16], IQ-CIE 2009[17], IQ-Bennett and Rowley 2004[18]). The most commonly mentioned plant species valued by

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[15] IQ-Mannik 1998: *In the past, other plants such as kanguuyat (cotton grass) were used as wicks for lanterns and brown mosses were used in lanterns, as a match to start fires, and to create smoke to ward off mosquitos. Lichen was also collected for fire.*

[16] IQ-RIHT 2009: *Elders depend on cloudberries and other plants for making teas.*

[17] IQ-CIYA 2009: *Tundra moss can be boiled to make a tea, and other plants were used to make medicinal tea.*

Inuit during the public engagement sessions include black berries (*Empetrum nigrum*), cloudberries (*Rubus chamaemorus*), blueberries (*Vaccinium uliginosum*), and cowberries (*Vaccinium vitis-idaea*). Eleven of the 15 ELC map units identified contain these species.

Plant samples were collected and analyzed to determine baseline analyte concentrations that will be used for comparison during environmental monitoring programs.

Environmental Effects Assessment for Vegetation

Key issues identified for terrestrial vegetation were changes in vegetation abundance and community diversity and changes in vegetation quality. Changes in vegetation abundance and community diversity may occur during construction activities and on-land decommissioning work during final closure. Potential changes in vegetation quality may result from onland construction, mining, and milling activities through to final closure.

The importance role of vegetation as part of the whole environment was identified in IQ interviews and engagement activities (IQ-BLH 2009[19], IQ- ARHT 2009[20], IQ-RBH 2011[21], [22]).

Change in Vegetation Abundance and Community Diversity

Vegetation abundance and community diversity could be adversely affected by the Project as a result of site clearing, vegetation burial due to placement of infrastructure, and the introduction of invasive species.

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[18] IQ-Bennett and Rowley 2004: *Dwarf willows were used to make 'avaalaqiat', the waterproof bottom for bedding.*

[19] IQ-BLH 2009: *But even if we don't live traditionally, (because we live in town), and hunt and gather as many different animals and plants as we used to, it is important to protect all wildlife, protect the whole environmental system*.

[20] IQ- ARHT 2009: *Hunters and elders expressed concerns about the potential for airborne contamination settling on vegetation and being consumed by caribou.*

[21] IQ-RBH 2011: *blackberries and blueberries are harvested.*

[22] IQ-RHB 2011: *Broadleaf willow, fireweed, dwarf fireweed (leaves and flowers), and Labrador lousewort (roots) are all eaten,*

Mitigation to reduce and/or prevent Project-related effects on vegetation abundance and community diversity include measures to prevent destruction of sensitive species during Project development, as well as efforts to limit the amount of vegetated areas affected by site clearing and vegetation burial. The preservation of the vegetation seedbank within the stripped topsoil will facilitate natural regeneration of native vegetation to reclaimed areas, with progressive reclamation occurring throughout the life of the Project. The use of waterbodies and watercourses in selecting routing for the winter road routing was an important consideration in limiting the amount of vegetation disturbed by the proposed access roads. Prevention measures for introduction of invasive and/or non-native vegetation will also be employed through the Project.

Depending on the Project development options selected, between 1,449 ha and 1,708 ha of upland area that supports vegetation will be disturbed by the Project. Of this disturbed area, between 168 ha and 175 ha (0.4 % to 0.5 %) of the wetland area within the LAA boundaries that supports vegetation is predicted to be affected by the Project. Heath tundra is the ELC map unit likely to be most affected by the Project, with a total disturbed area ranging between 685 ha and 813 ha (1.9% and 2.8 % of the total area affected).

Regardless of the development options selected, the predicted residual effects of the Project on vegetation abundance and community diversity are anticipated to be low in magnitude, site specific in geographic extent, and occur primarily during the construction phase. Residual effects will be long term in duration but will be reversible with reclamation. As such, the change in vegetation abundance and community diversity is predicted to be not significant.

Monitoring for changes in vegetation abundance and community diversity will occur throughout the duration of the Project. An environmental monitor will be on-site during all phases of the Project to work with AREVA personnel and contractors to meet and comply with environmental regulations associated with vegetation. Permanent sampling plots will be established around the Project Footprint and adjacent to the proposed access roads. These sampling plots will be routinely surveyed and assessed to measure potential changes in vegetation abundance and community diversity. Monitoring for invasive species will be completed throughout the duration of the Project, and, if identified, attempts will be made to remove any invasive species within or adjacent to the Project footprint.

Change in Vegetation Quality

Construction and operation activities of the Project will affect the quality of vegetation within the LAA as a result of air emissions from fossil fuel combustion and dust deposition. Air quality modeling was undertaken to predict the effects of potential acid inputs (PAI), nitrogen oxides (NO_x), and sulphur dioxides (SO_2) on vegetation quality. Dust deposition was also modeled to determine changes in the concentrations of COPC within different classes of vegetation (i.e., berries, browse [e.g., willow, birch], forage [e.g., sedges, grasses], and lichen) to determine whether these changes will be within phytotoxicity limits. People have raised concerns about the potential f or Project activities to contaminate plants, including berries (EN-BL CLC Jul 2010[23]).

To reduce the effects of air emissions on vegetation, all industrial machinery and equipment, and diesel-powered generators will meet the federal air emission standards. Low sulphur diesel fuel will be used to reduce SO_2 fumigation. The acid plant will be the largest producing unit of SO_2 associated with the Project. As such, a scrubber will be installed on the exhaust stack to remove particulates, acid mist and excess SO_2.

During the detailed design of the roads, efforts will be made to use non-calcareous materials from quarry sites to minimize dust-prone aggregate from being used during road construction. During open pit mining, blasting patterns will be used to control the dispersion of materials as well as dust. Where possible, blasting may also be avoided on days where dust dispersion outside of the Project footprint is anticipated to be excessive due to the prevailing winds speeds. Dust suppression will involve spraying water from a tanker truck affixed with either a spray nozzle or spray bar onto dust-prone areas. If water spraying is not effective in preventing dust occurrence, additional dust suppression techniques will be investigated and implemented. Speed limits around the mine site and along all roads will be imposed to reduce airborne dust from vehicular and other equipment traffic.

About 81 ha of vegetation adjacent to the Kiggavik mine site, representing about 0.2% of the total mine LAA, will likely be exposed to PAI above the threshold value of 0.25 keq/ha/year. Dust deposition (measured as Total Suspended Particle [TSP]) above the threshold of 0.25 g/m2/year will affect about 20 ha and 16 ha at the Kiggavik and Sissons mine sites, respectively. The proportion of ELC map units potentially exposed to dust above this threshold value represents about 0.08 % of the mine LAA. No effects on vegetation quality are expected as a result of exposure to NO_2 or SO_2 from the Project, as the incremental annual maximum concentrations are below benchmark guidelines.

Predicted concentrations of COPC in browse and forage are predicted to be below the minimum available phytotoxic concentrations, with the exception of zinc in browse and forage and cobalt and copper in browse. It is important to note that baseline levels of zinc, cobalt, and copper were found to naturally occur at the upper critical level for pytotoxicity concentrations. A change in the COPC concentration relative to baseline is not expected and predicted concentrations do not exceed upper thresholds. Consequently, no adverse effects on vegetation quality are expected to occur. There is the potential for a measureable change in the concentrations of several COPC in lichen at the Kiggavik mine site. The effect that the measurable change in COPC will have on lichen is unknown, as appropriate thresholds for effects on lichen are not known. Concentrations of COPCs in terrestrial vegetation will be monitored periodically during operations and decommissioning to confirm vegetation quality predictions.

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[23] EN-BL CLC Jul 2010: *would the berries and cloudberries have radiation on them?*

Project residual effects on vegetation quality are expected to be low in magnitude, except for dust created during mining operations when effects are likely to be moderate. While changes in vegetation quality due to dust deposition are expected to be local in geographic extent, effects from air emissions will likely be more regional in extent. The residual effects are anticipated to occur continuously throughout the duration of the Project and the effects will be long term in duration but reversible. As such, changes in vegetation quality as a result of the Project are predicted to be not significant.

Effects of Climate Change on Vegetation

Climate change can influence Project effects on vegetation. An earlier snowmelt that extends the growing season due to temperature increases can accelerate any potential changes in vegetation abundance and community diversity caused by the Project. Changes in vegetation composition from a tundra sedge community to either a graminoid or shrub community in areas adjacent to human development have been documented, and climate change has the potential to facilitate and accelerate this change.

Climate change may also provide more favourable growing conditions for non-indigenous species, especially in areas disturbed by the Project. To prevent the introduction of non-indigenous vegetation to the Project area, all equipment and machinery will be cleaned of foreign particles (e.g., soil, thatch) prior to initial transport to the Project (i.e., prior to loading onto the barge, or shipping by air).

Scope of the Assessment for Wildlife

Caribou and muskox were chosen as the indicators for the assessment of effects on terrestrial wildlife and habitat based on comments from engagement activities and IQ interviews describing the importance of these species to Kivalliq community members (IQ- BL02 2008[24], EN-RI KWB Oct 2009[25], EN-CH OH Nov 2010[26], IQ-BL04 2008[27], IQ-ARVJ 2011[28], EN-CH OH Nov 2010[29]).

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[24] IQ- BL02 2008: *Our main food sources were caribou and fish.*

[25] EN-RI KWB Oct 2009: *We rely on country foods and these have to be protected.*

[26] EN-CH OH Nov 2010: *I am worried about the wildlife, will you protect it, make sure you don't harm it?*

[27] IQ-BL04 2008: *We would be camping mostly around [caribou] crossings in the spring when they are shedding and we could have enough meat to dry, and in the fall when the skins are good for clothing*.

[28] IQ-ARVJ 2011: *Muskoxen are hunted for their meat and skins.*

[29] EN-CH OH Nov 2010: *Wildlife is the most important VEC group.*

Other terrestrial wildlife present in the RAA either exist at low densities where a change from baseline condition would be undetectable, or effects would be linked to effects on caribou and muskox (e.g., mortality risk, habitat loss, movement). An assessment of wolf denning habitat was conducted at the request of the Government of Nunavut Department of Environment (GN DoE). Lapland longspur and long-tailed duck were the indicators for Project effects on migratory bird habitat and health because they represent an upland songbird and a waterbird. Shorebird habitat was also included at the request of the GN DoE. Peregrine falcon was the indicator for raptors because they habitually return to nest within the same territories for many generations. Short-eared owl, grizzly bear and wolverine were included in the effects assessment because they are wildlife species at risk.

Caribou and Muskox

Key issues related to effects on caribou and muskox include

1. direct effects of increased mortality risk from potential vehicle collisions and indirect effects from increased harvester access from the all-season access road (EN-BL NIRB April 2010[30]);
2. reduced habitat availability from the Project footprint that results in a direct loss of foraging habitat, and sensory disturbances that result in an indirect loss of functional habitat (EN-RB NIRB April 2010[31], EN-AR NIRB May 2010[32]);
3. change to seasonal movements from physical structures (e.g., road embankment, open pits, buildings) and sensory disturbances that could directly affect seasonal movement (EN-CH NIRB May 2010[33], EN-BL NIRB April 2010[34]); and
4. change in health as a result of ingestion of contaminants (e.g., consumption of forage mixed with dust) (EN-CI KIA Apr 2007[35], IQ-ARHT 2009[36]).

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[30] EN-BL NIRB April 2010: *Concerned about wildlife and disruptions by environmental changes.*

[31] EN-RB NIRB April 2010: *Concerned with wildlife habitat*

[32] EN-AR NIRB May 2010: *Concerns over potential effects of noise on migrating animals and the need to put in place mitigation measures.*

[33] EN-CH NIRB May 2010: *Have any studies been done in regards to the caribou migrating through the area and on the caribou calving grounds?*

[34] EN-BL NIRB April 2010: *Caribou migration routes are very important in the region.*

[35] EN-CI KIA Apr 2007: *Caribou eat off the ground and then we eat the caribou. If they get sick, we get sick. We'll get diseases.*

Only caribou are assessed for effects on movement because muskox do not make traditional seasonal migrations from wintering to calving areas (IQ-CI03 2009[37]); consequently, changes to muskox movement are covered in the assessment of habitat use.

Key Project components related to these potential effects include site clearing (habitat loss), mine operation (reduced habitat effectiveness), road construction (habitat loss) and operation (mortality and reduced habitat effectiveness), and milling (noise and dust and influence on habitat effectiveness and dust effects on forage and ultimately wildlife health).

Increased mortality risk is considered significant if herd-specific mortality is increased beyond a level of sustainable harvest. There is no known existing standard or threshold for determining a significant loss of habitat for caribou or muskox. Based on professional opinion, experience from other northern projects, and knowledge of caribou and muskox ecology, Project effects on habitat availability are considered significant if greater than 5% of caribou growing or winter range becomes unsuitable for use by caribou, or muskox wildlife management unit MX/21 becomes unsuitable for use by muskox. In absence of published thresholds, effects on movement are considered significant if greater than 10% of the animals in a herd are diverted by Project activities such that the animals do not arrive at calving grounds or wintering areas. For health, the estimated exposure to both non-radioactive contaminants and radioactivity received by the biota, considering both baseline and Project emissions, is compared to levels that are protective of mammals.

Mortality Risk — Increased mortality risk was quantified by determining the caribou and muskox herds that are most likely going to be exposed to increased Project-related collisions (direct effect) and hunter harvest (indirect effect) west of the Thelon River during the snow-free season (EN-BL OH Oct 2012[38]). Information used to assess these effects included population status of trends of herds, current harvest levels, and identification of Total Allowable Harvest (TAH) limits. The all-weather road option was the focus for assessing potential increased mortality risk on caribou because it was the

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[36] IQ-ARHT 2009: *Hunters and Elders expressed concerns about the potential for airborne contamination settling on vegetation and being consumed by caribou.*

[37] IQ-CI03 2009: *Musk ox do not migrate and travel very slowly. If old tracks are seen in an area, they will still be in the area. Musk ox stay in an area where there is vegetation, and only move when it is gone*

[38] EN-BL OH Oct 2012: *There are at least 40 ATVs some days on the Meadowbank road. Likely more (caribou) are taken because of the ease.*

option that would allow hunters access to a previously inaccessible area during the ice-free season, and caribou harvest currently does not have a TAH.

The Qamanirjuaq herd is expected to interact with the Project during the post-calving aggregation and summer dispersal periods, and the Baker Lake (Resident) herd is expected to interact with the Project during the winter. Muskox within wildlife management unit MX21 are expected to be found in the RAA year round. The RAA has been traditionally used for hunting year round. Based on harvest location statistics collected as part of the Nunavut Wildlife Management Board Harvest Study, relatively few caribou have been harvested recently in the RAA. There is no available information on trends or proportions of mortality from natural causes such as disease or predation.

Mitigation for mortality is the combined responsibility of AREVA, other parties, and regulatory agencies. AREVA can implement a number of control measures to limit harvest along the road. These include controlled public access, no-hunting buffers, temporary shut downs, and reduced speed limits. Other agencies may be interested in monitoring harvest and populations, and establishing TAH limits. Ultimately, the potential cumulative additional harvest of caribou could require mitigation and management intervention by management authorities.

Following mitigation, it is predicted that residual effects on caribou mortality risk from the mine and access road options will be not significant. Effects of the mine and winter access road options on Qamanirjuaq caribou are expected to be not significant because these caribou should be mostly absent from the RAA during the winter season. The all-weather road has the potential to provide access to the RAA during the snow-free season when Qamanirjuaq caribou are in the area, which could increase the proportion of Qamanirjuaq animals taken only in the late July/August season. However, application of mitigation measures (i.e. access control) will help to manage the potential for increased mortality risk from harvest. There is a low potential for direct mortality risk from collisions with caribou along the access roads. Collisions with vehicles along the winter road will be unlikely, as reduced speed limits should allow vehicles to stop quickly if caribou are on the road. The all-weather road has faster speed limits, but vehicles should still be able to avoid collisions with caribou, particularly with communication among vehicles travelling the road.

The contribution of the Project to cumulative effects on mortality risk to caribou, and ultimately to the sustainability of the Qamanirjuaq and Baker Lake caribou herd populations will be not significant. While access options could have an indirect effect on caribou harvest, it is not clear if that harvest will be additive or compensatory to what is already harvested by Baker Lake Hunters. The Qamanirjuaq herd seems to be the herd at greatest risk of increased harvest as a result of harvester access during the ice-free season. However, it appears that only a small portion of the herd is found in the RAA when the road provides access, and they are only in the area for a brief time. It is possible that tens of additional caribou could be harvested in the brief time that they are in the RAA. However, the determination of this possible effect is based on broad estimates of both current harvest rates and current caribou population numbers. Better knowledge of both is necessary for all parties to make a more informed decision.

Compliance and environmental monitoring for change in mortality to caribou and muskox can include AREVA's 1) support of a Hunter Harvest Study to help determine total harvest by herd; 2) participation in the Government of Nunavut (GN)-led caribou collaring program to determine seasonal distribution by herd; 3) support of a GN-led population estimate survey to determine regional herd population trends; and 4) Project-specific caribou monitoring programs (ground-based observations; EN-BL OH Oct 2012[39]).

AREVA considers it a high priority to work with interested parties on implementing effective and consistent mitigation to manage the potential increased mortality risk as a result of the all-season road access.

***Habitat* —** A habitat unit index was developed to assess the overall loss of caribou and muskox habitat availability within the RAA. The index is based on assigning a ranked value to each habitat class (i.e. high=3, moderate=2, low=1, nil=0). The quality of all ELC units within the Project footprint will be "nil" once the Project is constructed. The winter road option will remove habitat in winter, but the majority of the habitat (minus the amount that is damaged from the footprint) will be available again each summer when the road is decommissioned. Indirect loss of habitat was assessed by reducing habitat quality for growing and winter seasons within the mine site and access road options. Habitat quality within the mine site Zone of Influence (ZOI) was reduced by 2 classes to a minimum of low within <7 km of the mine footprint, and by 1 class to a minimum of low between 7 and 14 km of the mine footprint. Habitat quality within each access road option ZOI was reduced by 2 classes to a minimum of low within <1 km of the access road footprints, and by 1 class to a minimum of low between 1 and 4 km of the access road footprints.

AREVA will mitigate potential adverse effects on caribou and muskox habitat by: 1) minimizing the Project footprint, 2) minimizing Project activities outside of the footprint; 3) reducing road activity during important migratory seasons and during post-calving; 4) progressively reclaiming disturbed areas; 5) providing dust suppression along roads during dry summer periods (EN-BL OH Nov 2013[40]); and 6) eliminating dust dispersal from the tailings management facility through subaqueous deposition of tailings.

Following mitigation, the effect of the Project on caribou and muskox growing and winter season habitat will be not significant. Habitat effects will be substantially less than the 5% in the seasonal

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[39] EN-BL OH Oct 2012: *Will you hire someone to ensure wildlife is not disturbed on the road?*

[40] EN-BL OH Nov 2013: *Dust from road. What will AREVA do to suppress dust?*

ranges. For caribou, the mine and all road options will reduced habitat effectiveness in less than 1% within the range of the focal caribou herd. For muskox, the mine and all road options will reduce habitat effectiveness in less than 5% within muskox management unit MX/21.

Currently, there are few human activities in the region that affect wildlife. The Meadowbank mine and regional communities are the greatest sources of wildlife habitat effects. The addition of the Kiggavik Project to these disturbances is not expected to measurably reduce the amount of caribou and muskox habitat within their ranges or management unit. Mineral exploration is currently not causing substantive loss of habitat. Although there is the potential for future mine development in the region, given the history of such developments, the likelihood of multiple future mines existing at the same time as the Project is low. The cumulative change to habitat availability for caribou and muskox as a result of the Project is therefore assessed as not significant.

AREVA will monitor the Project footprint on an annual basis to assess the footprint area for changes in habitat availability. AREVA will continue to support the GN-led caribou collaring program; this program will provide future information on the response of caribou to habitat disturbance in the Kivalliq region.

Movement — Caribou migration between calving grounds and winter range was the focus of the assessment of Project effects on animal movement. Minimizing effects on caribou migration is an important component for reducing Project effects on wildlife movement (IQ-BLHT 2011[41]). Muskox move at relatively small scales (i.e., no long distance migration) between available habitats within their range and their movements are less directional and predictable than those of caribou.

The Project could affect caribou migration and localized movements through construction of infrastructure and human activities that change, restrict or block caribou movement across the landscape.

Information used to assess Project effects on caribou movement comes from caribou collar data, IQ studies, and baseline wildlife studies. The potential effect of the Project on caribou movement was assessed by examining possible interactions with the Project during spring and fall migrations. Three assumptions were made in the assessment regarding collar data: 1) the collar data are representative of the entire herd; 2) caribou movement between collar relocations is a straight line; and 3) caribou movement during the collaring period reflects movement in the future. Analyses completed included: analyses of encounter and residency rates with the Project ZOI to estimate potential caribou interactions with the Project; and identification of all water crossings within 10 km of the Project footprint.

[41] IQ-BLHT 2011: C*aribou is a huge part of our diet. Caribou migration is very important.*

AREVA will mitigate effects on caribou movement by: 1) minimizing road embankment height of the all-weather road; 2) snow management that avoids long continuous cuts or piles of snow that could restrict spring migration across roadways; 3) reducing leg entrapment risk to caribou during fall migration by constructing roads from finer material; 4) avoiding construction activities within 10 km of designated water crossings from 15 May to 1 September, in accordance with the DIAND Caribou Protection Measures (EN-BL NIRB April 2010[42]); 5) minimizing the use of fencing and, where required, minimize the lengths of fencing unless required for safety; and 6) implementing temporary road shutdowns if large numbers of caribou are observed migrating through the area (IQ-BLHT 2011[43], EN-BL HTO Mar 2009[44]).

Project residual effects on caribou movement will be not significant. Only small portions of the Qamanirjuaq. Ahiak, Lorillard and Wager Bay herds are expected to interact with the Project during various seasons. Water crossings are within 10 km of the road options, so disturbance at those sites are readily mitigated by reducing or stopping traffic near those areas if they are being used in any given year. Residual effects on movement are expected to be not detectable and therefore will not contribute substantially to cumulative effects.

AREVA will conduct the following monitoring for change in movement of caribou and muskox: 1) ongoing contributions by AREVA to a government-led caribou collaring program; 2) monitoring caribou use of water crossing that are within 10 km of Project activities; and 3) seasonal monitoring of caribou movement prior to caribou entering the RAA as a proactive way of providing information that will advise temporary shutdown of traffic on roads.

Health — Emissions from the Project can affect the concentrations of COPC in the environment (e.g. water, soil, vegetation) which, in turn, could affect the exposure of caribou and muskox as they consume these items. The potential for these emissions to cause adverse effects in the populations of caribou and muskox was evaluated (IQ-Nunavut Tunngavik Inc. 2005[45]). The COPC used in the

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[42] EN-BL NIRB April 2010: *Importance of water crossings, annual migration routes (summer as well as winter ranges) needs to be considered especially regarding the road option.*

[43] IQ-BLHT 2011: *According to traditional caribou hunting practices, the first group of themigrating herd must be allowed to pass through an area undisturbed. After a few days, the hunting can commence.*

[44] EN-BL HTO Mar 2009: W*hen there is a herd, the leader of the heard is followed quite closely by the rest of the heard, and nobody tries to disturb the heard to not disrupt the migratory route.*

[45] IQ-Nunavut Tunngavik Inc. 2005: *The contamination of wildlife is a concern in itself, not just because of the potential repercussions on country foods; the focus of contaminants research should therefore not focus exclusively on human health*

assessment include uranium and the uranium-238 decay series (thorium-230, lead-210, radium-226, and polonium-210), arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, selenium, and zinc. The exposure to COPC were estimated using the predicted environmental concentrations and assumptions about how much the caribou and muskox consume. The amount of time that the wildlife spend in the area is also an important factor. The results show that exposure to caribou or muskox is not expected to exceed exposure levels associated with adverse health effects; therefore no adverse effects on caribou or muskox health are expected.

Combined and Cumulative Effects - A conservative assessment based on the Qamanirjuaq herd of combined effects (i.e, disturbances to mortality, habitat, movement and health are considered), indicated that overall, the Project will have little effect on caribou energetics, and no measurable effect on population projections through to 2040. The number of Qamanirjuaq caribou is predicted to increase through that time period with or without the presence of the Project. The confidence in this prediction is moderate because all data used in the modelling were not specific to the caribou herd, because of possible errors in assumptions, and because predictive population models are subject to errors that may be due to changing environmental features that may be beyond the capability of the model to address.

The Project removes a very small amount of habitat (0.001%) from within the combined caribou ranges. Within individual ranges, the loss ranges from 0.004% to 0.007%. The loss is so small within each herd's range as to be not significant. Total cumulative loss due to all disturbances within the cumulative effects assessment area amounts to, at most, 0.4%, and is consider not significant. The maximum loss of muskox habitat, using an assessment process that errs on the side of precaution, is ~3% of MX/21. These numbers likely represent an over-estimate of loss of habitat to footprints. Mitigating cumulative loss of habitat, should it increase to be of concern, requires management beyond the capabilities or responsibilities of AREVA. Mitigation of cumulative loss of habitat, and cumulative effects in general lies in collaboration with government, management partners, and the land use planning process.

Climate Change — Climate and ultimately, weather, directly influences the body condition of caribou which, in turn, affects survival and mortality rates. Caribou survival is influenced by a number of climate-related parameters at different times throughout the year. Climate variability can influence factors that affect caribou mortality directly, such as summer insect harassment, or indirectly, such as winter severity and spring snow free date. If a suite of negative climate conditions for caribou occurs (i.e., deep winter snow, hard snow crust, late spring snow free date, and extreme summer insect harassment), survival rates will undoubtedly decrease from baseline conditions. However, these effects will likely not be detectable within the 20 to 30 year life of the Project.

Effects of climate change on caribou and muskox populations may occur gradually throughout the life of the Project. Due to the relatively short life of the Project and the predicted changes in climate conditions during this period, it is unlikely that climate change will increase Project effects on terrestrial wildlife or habitat.

Wolf

The Arctic wolf is listed as 'Secure' and has not been identified as a species at risk or of concern by COSEWIC or SARA. Wolves are important to Kivalliq community members and are particularly valued for their pelts (IQ-RBJ 2011[46], IQ-RBYA 2009[47]). Based on available information, wolves appear to be widespread and range across the entire RSA. No particular area, other than possible den sites, appears to be of critical importance. Wolf populations are likely stable or increasing within their Nunavut range, but regional population trends remain poorly understood. Very little demographic information is available for wolf, although they are more common and generally seen singly or in small packs ranging from three to seven animals.

Habitat — Ground disturbance and sensory disturbances can affect wolf den sites. The magnitude of the Project effects is predicted to be moderate during construction, operation, and final closure phases. While the size of the Project footprint is very small at the scale of the affected wolves' ranges, mine associated activities will reduce the suitability of habitat up to 2 km from the Project footprint resulting in a moderate loss of habitat. After final closure, the Project footprint may become useable as denning habitat, consequently the magnitude of the predicted effect remains low beyond the life of the Project. There is general consensus that human disturbance causes large wildlife to avoid areas at the scale of kilometres. The extent of avoidance can vary according to local environmental and topographic conditions, consequently, the confidence in the predicted effect of the Kiggavik Project on wolves is moderate.

The All-Season Road will have the largest footprint and disturbance of the two road options. This will cause the greatest reduction in denning habitat compared to the other road option because of the larger footprint and greater time (eight months) of disturbance. The winter road will be active roughly three winter months each year.

Raptors

Peregrine falcon was the focus for the effects assessment on raptors. Other raptors that occur in the RAA either exist at low densities and a change from baseline condition would be undetectable, or effects would be similar to effects on the indicator species. Activities during construction, operation and closure have the potential to affect the habitat, nest productivity and health of raptors in the RAA.

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[46] IQ-RBJ 2011: *Wolves are hunted and wildlife hunter bought the skins and some sold to Arctic college for clothmaking*

[47] IQ-RBYA 2009: *people continue to hunt wolf deliberately, not for food, but to sell the pelts.*

Key issues related to effects on peregrine falcons include: 1) reduced habitat availability from the Project infrastructure footprint that results in a direct loss of foraging habitat, and sensory disturbances that result in an indirect loss of functional habitat; 2) indirect effects of reduced nest site productivity from sensory disturbances from mine operations and road traffic at nests close to these activities; and 3) change in health due to radionuclide and metal content transfer through the food chain.

Based on professional opinion, experience from other northern projects, and knowledge of raptor ecology, Project effects on habitat availability are considered significant if greater than 10% of the habitat units in the RAA are directly affected by Project activities. A Project effect on productivity is considered significant if average productivity for the nests located to date in the RAA drops below 1.25 chicks/territorial pair/year. For health, the estimated exposure to both non-radioactive contaminants and radioactivity received by the biota, considering both baseline and Project emissions, is compared to levels that are protective of birds.

Habitat — The Project footprint will result in a direct loss of raptor foraging habitat. The footprint is expected to provide no usable habitat for raptors once the Project is constructed. The Project will also result in an indirect loss of raptor forage habitat because of human disturbance (presence, noise, and movement) in proximal habitats. No nest sites are known to occur within the Project footprint; hence development of the site will not result in loss of nests (IQ-BL05 2008[48]).

To assess the overall loss of peregrine falcon habitat availability within the RAA, habitat types were ranked as nil, low, moderate and high quality habitat. Most of the RAA is considered high to moderate quality foraging habitat. Nine peregrine falcon nest sites were found, all located on the rocky cliffs within or adjacent to the All-Season Road access route.

AREVA will mitigate potential adverse effects on raptor habitat through: 1) minimizing the Project footprint; 2) minimizing Project activities outside of the footprint; 3) progressively reclaiming disturbed areas; 4) providing dust suppression along roads during dry summer periods; and 5) eliminating dust dispersal from the tailings management facility through subaqueous deposition of tailings. The Project footprint is reduced with the winter road option, thus habitat loss and the likelihood of the Project acting cumulatively with other projects in the Kivalliq region is reduced.

After mitigation, the mine site and all-weather road will result in a direct loss of 1,780 ha of previously usable foraging habitat. The Project is anticipated to reduce the availability of foraging habitat by 5.8% of the habitat units within the RAA. Given the size of the expected ZOI, all effects are expected to be confined within the LAA. The loss of habitat is reversible as prey species will use previously

[48] IQ-BL05 2008: *Because the Kiggavik area is mostly tundra, I don't know if it would be a place for nesting because birds mostly have their nests along a river or where there is an island.*

disturbed areas as the mine site is reclaimed actively and naturally. The road option that will have the greatest effect on raptor habitat is the all-weather road because of the larger footprint and larger ZOI. The extent of the Project footprint will be monitored on an annual basis to confirm habitat loss predictions.

The Project is not anticipated to act cumulatively with other projects to cause a biologically relevant reduction of habitat availability in the region. The losses of habitat are minor and will not add substantially to cumulative losses of habitat in the region. Other projects have not had a substantial effect on raptor habitat. Therefore the existing cumulative effect (base case) is not significant and the project contribution to existing cumulative effects is not significant.

***Nest Productivity* —** Nest productivity is considered stable if productivity remains at an average of 1.25 chicks/territory/year. The mine site (Project footprint) and the winter road option do not interact with breeding peregrine falcons. All known nesting sites are within or proximal to the All-Season Road LAA. Because falcons annually return to cliff nest sites over many generations, the limited number of sites (9) proximal to the All-Season Road, and the relative ease of follow-up monitoring, effects are assessed on a territory by territory basis for the All-Season Road option.

Continued exploration activities, construction, and operations have the potential to interact negatively with peregrine falcons. Continued aircraft use at the site has the potential to disturb peregrine falcons. The degree of response to disturbance is associated with the stage of the breeding season. Key mitigation for ensuring continued productive nesting in the RAA includes no-disturbance around nest sites when activities must occur during the breeding season, construction outside of the breeding season when disturbance must occur near nest sites, and a no-fly zone around active nest sites for regularly occurring ferrying flights.

The effect of the Project on raptor nest productivity will be not significant. The footprint of the mine and the winter road option do not interact with known raptor nest sites. Mitigation measures for nest sites near the all-weather road during the breeding season are expected to reduce the potential for adverse effects on raptor nest productivity. During operation, no or very few raptors will be exposed to disturbance sufficient to affect the productivity of their nest.

Monitoring for change in raptor nest productivity will include individual nest site monitoring during construction to determine when territorial pairs are attempting to establish a territory and begin nesting (and thus establish a no disturbance buffer), and annual monitoring of territory occupancy, egg laying, egg hatching, and chick fledging (i.e., productivity) of the nests identified in the baseline study.

***Health* —** Emissions from the Project can affect the concentrations of COPC in the environment (e.g., water, soil, small mammals) which, in turn, will affect the exposure of raptors as they consume these items. The potential for these emissions to cause adverse effects in the populations of peregrine falcon was evaluated. The COPC included in the assessment were uranium and the uranium-238 decay series (thorium-230, lead-210, radium-226, and polonium-210), arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, selenium, and zinc. The exposure to COPC can be estimated using the predicted environmental concentrations and assumptions about how much the peregrine falcon consume. The amount of time that falcon spend in the area is also an important factor. The results indicate that exposure of peregrine falcons to COPC will not exceed exposure levels associated with adverse health effects in birds; therefore no adverse health effects on raptors are expected to occur.

Climate Change — Cumulative effects of climate change on raptors and habitat are expected to be negligible over the 20 to 30 year life of the mine. If peregrine falcons are affected by climate change, it will occur via indirect effects. A study in nearby Rankin Inlet, Nunavut, found a strong correlation between the highly variable breeding success of peregrine falcons and weather, especially summer rainfall and spring snowstorms. With increased variability in seasonal weather conditions, the long-term reproductive success of peregrine falcons could be compromised. However, this mechanism is expected to occur independently of effects associated with developments and human activities in the region. Given the measures committed to by AREVA, Project-specific effects on raptor abundance and health are not expected to exacerbate changes in reproductive success associated with climate change.

Migratory Birds

Lapland longspur and long-tailed duck were the focus of the assessment. Other migratory birds occur in the RAA and the expected Project effects will be similar to effects on lapland longspur and long-tailed duck. Key concerns include Project-related effects on habitat availability and health. Migratory birds are hunted and their eggs are collected by Kivalliq community members (IQ-CHW 2009[49], IQ-RBH 2011[50]). Migratory birds are also valued as important animals within the local environment (IQ-RBE 2009[51]). Key Project activities related to these effects include site clearing (habitat loss), mine operation (reduced habitat effectiveness), road construction (habitat loss) and operation (reduced habitat effectiveness), milling (noise affecting habitat effectiveness and dust affecting forage and ultimately bird health).

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[49] IQ-CHW 2009: *The women's focus group discussions indicated that each of the women hunt goose. In mid June goose, duck, and gull eggs are collected*

[50] IQ-RBH 2011: *Several types of birds and eggs continue to be harvested in the Coral Harbour and repulse Bay area.*

[51] IQ-RBE 2009: *Everyone is concerned about birds that migrate past Baker Lake.*

Based on professional opinion, experience from other northern projects, and knowledge of migratory bird ecology, Project effects on habitat availability are considered significant if greater than 10% of the habitat units in the RAA are affected. For health, the estimated exposure to both non-radioactive contaminants and radioactivity received by the biota, considering both baseline and Project emissions, is compared to levels that are protective of birds.

***Habitat* —** The Project will result in a loss of migratory bird growing season habitat (e.g. nesting and post-fledging habitat). The Project footprint will make some habitat unavailable for migratory birds, while human activity associated with the Project could cause a functional loss of adjacent habitat. Effects on habitat from the Project could act cumulatively with similar effects from other human activity in the area.

A habitat unit index was developed to assess the overall loss of lapland longspur and long-tailed duck habitat availability within the RAA. The index is based on assigning a ranked value to each habitat class (i.e. high=3, moderate=2, low=1, nil=0). The quality of all ELC units within the Project footprint will be "nil" once the Project is constructed. The winter road option will not affect breeding bird habitat because most of the habitat will be available again each summer when the road is decommissioned. Habitat quality within the mine site and road ZOIs were reduced by two classes to a minimum of low within 2 km of the mine footprint, and by one class to a minimum of low within 3 km of the mine footprint.

AREVA will mitigate potential adverse effects on migratory bird habitat by 1) minimizing the Project footprint, 2) minimizing Project activities outside of the footprint, 3) progressively reclaiming disturbed areas, 4) providing dust suppression along roads during dry periods, and 5) eliminating dust dispersal from the tailings management facility through subaqueous deposition of tailings.

The effect of the Project on migratory bird habitat within the RAA is assessed as not significant. Predicted loss of available habitat for migratory birds due to the Project is less than 5% of the habitat units for both indicators and all road options. The magnitude of adverse effects of the Project on migratory bird habitat availability is rated as low during all Project phases and for all road options. The Project is expected to result in a detectable loss of habitat within the LAA. The loss of habitat will be not significant as all migratory birds in the RAA will continue to have abundant suitable habitat available for foraging. The extent of the Project footprint will be monitored on an annual basis to confirm habitat loss predictions.

The Project is not anticipated to result in significant adverse effects on migratory bird habitat within the RAA. Although the residual effects of the Project on changes in habitat availability are not significant, the effects could act cumulatively with similar effects from other human activity in the region that affects migratory bird habitat..

Health — Emissions from the Project can affect the concentrations of COPC in the environment (e.g., water, soil, aquatic vegetation, insects) which, in turn, will affect the exposure of migratory birds as they consume these items. The potential for these emissions to cause adverse effects in the populations of migratory birds, represented by the lapland longspur and the long-tailed duck, was evaluated. The COPC included in the assessment were uranium and the uranium-238 decay series (thorium-230, lead-210, radium-226, and polonium-210), arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, selenium, and zinc. The exposure to COPC can be estimated using the predicted environmental concentrations and assumptions about how much the lapland longspur and the long-tailed duck consume. The amount of time that birds spend in the area is also an important factor. The results indicate that exposure of lapland longspur or the long-tailed duck to COPC is not expected to exceed exposure levels associated with adverse health effects in birds; therefore no adverse health effects on migratory birds are expected to occur.

Climate Change — Determining the effects of climate change is complicated due to seasonal habitat use. Winter ranges are often in southern North America to South America, introducing an entirely different suite of climate-related effects that are beyond the scope of this assessment. Effects of climate change on migratory birds that seasonally occur within the RAA would likely be related to the occurrence of local weather conditions above or below normal (e.g., extreme frost or snow events in spring or summer). Indirectly, temporal deviations in environmental conditions (e.g., late snowmelt) could result in increased mortality due to a lack of available forage food. An example of this is the diet of the lapland longspur, which consists of the previous season's berries and catkins when they first arrive in the early spring, and arthropods during summer. Climate change may alter the tundra vegetation from low-lying shrubs (e.g., berries) to taller deciduous shrubs, benefiting arthropod production and resulting in abundant summer forage, but decreasing the production of berries and catkins that are needed when the birds first arrive in the spring. These mechanisms are expected to occur independently of developments and human activities in the region. Given the mitigation measures committed to by AREVA, project effects are not expected to exacerbate effects of climate change on the health and reproductive success of migratory birds.

Species at Risk

The species at risk effects assessment focuses on short-eared owl habitat and the health of short-eared owl, grizzly bear and wolverine. Key Project components related to these potential effects include site clearing (habitat loss), mine operation (reduced habitat effectiveness), road construction (habitat loss), operation (reduced habitat effectiveness), and milling (noise and dust and influence on habitat effectiveness and dust effects on forage and ultimately health). Although no nest or dens sites have been observed in the RAA, all three species are expected to occur infrequently and at low numbers in the area.

Based on professional opinion, experience from other northern projects, knowledge of short-eared Owl ecology in arctic Canada, and the relatively low number of occurrences of the species in the region, Project effects on habitat availability are considered significant if greater than 10% of habitat units in the RAA are affected. For the assessment of health of the three special status species, the estimated exposure to both non-radioactive contaminants and radioactivity received by the biota, considering both baseline and Project emissions, is compared to levels that are protective of mammals and birds.

***Habitat* —** The Project will result in a loss of short-eared owl habitat. A habitat unit index was developed to assess the overall loss of habitat availability within the RAA. The index is based on assigning a ranked value to each habitat class (i.e. high=3, moderate=2, low=1, nil=0).

Mitigation measures that will be implemented to minimize effects on habitat availability for short-eared owl include: 1) all areas within the clearing footprint will be searched for nests prior to clearing activities that occur during the breeding bird season, active nests will be identified and for short-eared owl, and an 800 m radius no-disturbance buffer will be applied until nesting is complete and chicks have fledged; 2) all on-site observations of short-eared owl will be investigated to determine presence of nests sites, and active nests will be marked as described above with an 800 m radius no-disturbance buffer; and 3) reclamation will include the establishment of shrub cover, which will provide small mammal (prey) habitat and potential nesting habitat.

The Project will result in the long-term loss of some nesting and foraging habitat for short-eared Owls. The change in habitat will be measureable, but will be limited to the footprint (complete loss) and within the LAA (indirect loss). Reduced habitat effectiveness is reversible once operations cease. Overall, Project effects on short-eared owl nesting and foraging habitat will be not significant.

Health — Emissions from the Project can affect the concentrations of COPC in the environment (e.g.,. water, soil, fish, berries) which, in turn, will affect the exposure of Species At Risk as they consume these items. The potential for these emissions to cause adverse effects in the populations of grizzly bear and wolverine was evaluated; the assessment of raptors was conducted in a manner that encompasses the potential exposure of the short-eared owl. The COPC included in the assessment include uranium and the uranium-238 decay series (thorium-230, lead-210, radium-226, and polonium-210), arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, selenium, and zinc. The exposure to COPC can be estimated using the predicted environmental concentrations and assumptions about how much the grizzly bear and wolverine consume. The amount of time that the wildlife will spend in the area is also an important factor. The results show that it is not expected that the exposure of grizzly bear and wolverine to COPC will not exceed exposure levels associated with adverse health effects in mammals. In addition, no adverse effects are expected on the short-eared owl. Therefore, no adverse health effects are expected on Species at Risk.

***Climate Change* —** Climate change occurs continuously at a global scale, and will likely have long-term effects on wildlife and habitats. Climate change could exacerbate effects on Species at Risk, especially if they are already subject to current environmental pressures. Effects of climate change on Project and cumulative effects on Species at Risk are expected to occur independently and are not expected to act in combination with any other Project-specific effects.

ᓇᐃᓅᖅᓯᒪᔪᖅ ᑎᑎᖅᑲᖅ 6-ᒧᑦ

ᒪᓕᒃᑕᐅᓯᓇᐊᓕᒃᑎᒍᑦ ᓴᖅᑭᑕᐅᔪᑦ ᓄᓇᕗᒻᒥ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᕿᒥᕐᕈᔨᓄᑦ (NIRB 2011), ᐊᓖᕙᒃᑯᑦ ᑲᓇᑕᒥᑦ (AREVA) ᐋᕿᒃᓯᐃᓚᐅᖅᑐᑦ ᑖᕝᓯᒥᙵᑦ ᑎᑎᖅᑲᒥᒃ ᐊᕙᑎᒥᒃ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᑎᑎᖅᑲᒥᑦ (EIS) ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᕙᑎᒥᒃ ᐊᒃᑐᖅᑕᐅᓂᑦ ᑭᒡᒐᖓᒃ ᐱᓕᕆᐊᒧᑦ (ᐱᓕᕆᐊᖅ) ᓄᓇᐅᑉ ᐊᕙᑎᖓᓄᑦ. ᑎᑎᖅᑲᖅ 6 ᑕᐅᑐᒐᖅᑲᖅᑐᖅ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᐅᔪᓐᓇᖅᑐᓂᒃ ᐊᕙᑎᒥᒃ ᐱᓕᕆᐊᒧᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᒪᔪᓄᑦ ᒪᓂᕆᒧᑦ, ᐃᑉᔪᒧᑦ, ᐱᕈᖅᑐᓄᑦ, ᐊᒪᓗ ᓂᕐᔪᑎᓄᑦ ᐃᓂᒋᔭᖕᒋᓐᓄᑦᓗ.

ᐱᓕᕆᐊᒧᑦ ᐃᓚᒋᔭᐅᖃᑕᐅᓗᐊᖅᑐᑦ ᐱᓕᕆᐊᖑᔪᑦ ᓄᓇᒥᒃ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐃᓚᐅᔪᑦ ᑕᒪᐃᓂᒃ ᓄᓇᒦᑐᑦ ᓴᓇᔭᐅᔪᑦ, ᐊᐅᓛᕐᓂᖅ, ᑭᖑᓪᓕᖅᐹᒃᑯᑦ ᐅᒃᑯᐊᕐᓂᖅ ᐊᒪᓗ ᐅᒃᑯᐊᖅᓯᒪᓕᖅᑎᑦᓗᒍᒥᑦ ᐊᑐᖅᑕᐅᔪᑦ ᐊᒪᓗ ᖃᓄᐃᓕᐅᕐᓂᕐᔪᑦ. ᒪᕐᕉᒃ ᐊᑉᕐᑯᑏᖕᓄᑦ ᖃᓄᐃᓕᐅᓇᓂᕐᒧᑦ ᐃᓱᒪᒋᔭᐅᓚᐅᖅᑐᖅ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ; ᐅᑭᐅᑯᑦ ᐊᑉᕐᑯᑎ ᐊᒪᓗ ᐅᑭᐅᓗᒃᑖᕐᒥᑦ ᐊᑉᕐᑯᑎ ᐊᑐᖅᑕᐅᔪᓐᓇᖅᑐᖅ. ᐱᖕᒐᓯᐃᑦ ᐃᓱᒪᒋᔭᐅᔪᑦ ᖃᒪᓂᑦᑐᐊᕐᒥᑦ ᐃᒃᓴᕐᕕᖕᒧᑦ ᑐᖅᑯᖅᓯᓯᒪᕝᕙᖕᒧᑦᓗ ᐃᓚᐅᖃᑕᐅᓚᐅᕐᒥᔪᑦ ᖃᐅᔨᓴᐃᓂᐅᔪᒥᑦ.

ᑕᐅᑐᒃᓱᒍ ᖃᐅᔨᓴᐃᓂᖅ ᓄᓇᒥᒃ

NIRB-ᑯᑦ ᓴᖅᑭᑎᓚᐅᖅᑐᑦ ᓇᓈᓐᓂᓇᔭᖕᒐᓂᒃ ᓄᓇᒥᒃ ᖃᐅᔨᓴᐃᓂᖅ ᐱᓕᕆᐊᒧᑦ ᐊᑐᖅᓱᒋᑦ ᐅᖃᐅᓯᐅᔪᑦ ᐃᓄᖕᓄᑦ, ᐅᕙᒪᒃᑯᓐᓄᑦ ᐊᒪᓗ ᐊᓯᖕᒋᓐᓄᑦ ᐱᖃᖅᑕᐅᔪᓄᑦ. ᐃᓄᐃᑦ ᐱᖃᖅᑕᐅᔪᑦ ᐅᔾᔨᕈᓯᓕᕐᓂᖃᑦᑎᐊᓚᐅᖅᑐᑦ ᐱᓕᕆᐊᒧᑦ ᐊᒃᑑᑎᖃᑦᑕᕐᓂᐅᔪᓐᓇᖅᑐᓂᒃ ᓄᓇᒥᐅᑕᕐᓂᒃ.

ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖕᒋᑦᑎᒍᑦ (IQ) ᐊᐱᖅᓱᐃᓂᖅ ᐃᓚᐅᖃᑕᐅᓂᒃᑯᑦᓗ, ᐊᓖᕙᒃᑯᑦ ᐃᓕᑦᑎᓚᐅᖅᑐᑦ ᐱᓪᓚᕆᒋᔭᐅᓂᖕᒋᓐᓄᑦ ᓄᓇᒥᐅᑕᐃᑦ ᑭᕙᓪᓕᕐᒥᐅᓄᑦ. ᐃᓚᐅᔪᑦ ᐱᓪᓚᕆᐅᓂᖕᒋᑦ ᓄᓇᒥᐅᑕᐃᑦ ᐱᔭᐅᖃᑦᑕᖅᑐᑦ ᐃᓄᐃᑦ ᐃᓅᓯᖕᒋᓐᓄᑦ (IQ-BLH 2009[1], IQ-CIHT 2009[2]), ᐃᓱᓖᓘᑏᑦ ᐊᒪᓗ ᐊᐱᖅᑯᑕᐅᔪᑦ ᐱᐅᖕᒋᑦᑐᓂᒃ ᑎᑭᑕᐅᑐᐃᓐᓇᓇᐊᖅᑲᕐᓂᖕᒋᓐᓄᑦ ᐱᕈᖅᓯᐊᑦ ᐊᒪᓗ ᓂᕐᔪᑏᑦ (EN-BL HS ᓄᕕᐱᓇ 2010[3], IQ-BLE 2009[4], EN-BL EL ᐅᒃᑑᐱᓇ 2012[5]), ᐊᒪᓗ ᐱᓪᓚᕆᐅᓂᖅ ᒥᐊᓂᖅᓯᓂᕐᒧᑦ ᓄᓇᒥᐅᑕᕐᓂᒃ (EN-BL NIRB ᐄᐳᓇ 2010[6], EN-BL OH ᐅᒃᑑᐱᓇ 2012[7], EN-CH OH ᓄᕕᐱᓇ 2010[8]). ᐱᓪᓚᕆᐅᓂᖕᒋᑦ ᓄᓇᒥᐅᑕᐃᑦ ᐊᒪᓗ ᑕᐅᑐᒐᐅᔪᖅ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᒃᑲᓐᓂᖅᑐᖅ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖕᒋᑦᑕ ᒪᓕᒃᑕᐅᔫᒃᓴᖕᒋᓐᓄᑦ ᒪᓕᒐᖕᒐᓂᒃ 'ᐊᕙᑎᒥᒃ ᑲᒪᑦᑎᐊᕐᓂᖅ' (ᑕᐅᒃᑕᐅᓂᖕᒐᓄᑦ ᐊᕙᑎᒥᒃ ᒥᐊᓂᖅᓯᓂᖅ).

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[1] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖕᒋᑦ-BLH 2009: *ᒪᖃᐃᑏᑦ ᖃᐅᔨᒪᖁᔨᓚᐅᖅᑐᑦ ᖃᒪᓂᑦᑐᐊᕐᒥᐅᑕᐃᑦ ᑐᒃᑐᓂᒃ ᓱᓕ ᓂᕿᖃᕐᒪᑕ.*

[2] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖕᒋᑦ-CIHT 2009: *The ᐃᒡᓗᓕᒫᕐᔪᖕᒥᐅᑕᐃᑦ ᐅᑉᓗᒥ ᓱᓕ ᓂᕿᖃᖅᑐᑦ ᑐᒃᑐᓂᒃ, ᐃᖃᓗᖕᓂᒃ ᐊᒪᓗ ᓇᕐᑎᓂᒃ. ᓂᓇᑉᓗᓂ ᐃᓄᐃᑦ ᓂᕿᖕᒋᓐᓂᒃ ᐃᓱᒪᒋᔭᐅᖕᒋᑦᑐᖅ 'ᐅᒃᐱᕈᓱᖕᓂᖃᕐᓂᕐᒧᑦ ᑭᓯᐊᓂ ᖃᐅᑕᒫᑦ ᐃᓅᓯᒥᑦ ᐊᑐᖅᑕᐅᔪᖅ.*

[3] EN-BL HS ᓄᕕᐱᓇ 2010: *ᓱᓇᒥᒃ ᐊᒃᑐᖅᓯᓂᖃᕐᓂᐊᖅᐸ ᐅᔭᕋᖕᓂᐊᕐᓂᖅ ᓄᓇᒥᑦ?*

[4] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖕᒋᑦ-BLE 2009: *ᐃᓐᓇᑐᖃᐃᑦ ᐃᓱᓖᓘᑎᖃᖅᑐᑦ ᓄᖕᒍᓯᐃᑐᖅ ᓄᓇᒥᒃ ᓴᕋᐃᓂᐊᕐᓂᖕᒐᓄᑦ*

[5] EN-BL EL ᐅᒃᑑᐱᓇ 2012: *ᐳᔪᖅᑖᓕᓪᓚᓇᐊᓘᓂᐊᕐᒪᑦ ᓂᕐᔪᑏᑦᓗ ᓲᕐᓗ ᐅᑲᓕᐊᕐᔪᐃᑦ ᐊᒪᓗ ᐊᒪᖅᑯᐃᑦ ᐊᒃᑐᖅᑕᐅᓂᖃᕐᓂᐊᖅᑐᑦ.*

[6] EN-BL NIRB ᐄᐳᓇ 2010: *ᐱᓪᓚᕆᐅᔪᖅ ᑲᓪᐸᓂᐅᔪᖅ ᐃᒃᐱᒍᓱᖕᓂᖃᕐᓗᓂ ᒥᐊᓂᕆᓗᒍᓗ ᓄᓇ, ᐃᒪᖅ ᐊᒪᓗ ᓂᕐᔪᑏᑦ.*

[7] EN-BL OH ᐅᒃᑑᐱᓇ 2012: *ᐸᐅᕐᖓᐃᑦ ᓂᕐᔪᑏᑦᓗ ᒥᐊᓂᓇᔭᐅᓂᐊᖅᐸᑦ ᐅᔭᕋᖕᓂᐊᕐᓂᖅ ᑲᔪᓯᒃᐸᑦ?*

[8] EN-CH OH ᓄᕕᐱᓇ 2010: *ᐅᐱᖕᕆᕆᔭᒃᑲ ᓂᕐᔪᑏᑦ, ᒥᐊᓂᓇᓂᐊᖅᐱᑦ, ᐋᓐᓂᖅᑎᙱᑦᓗᒋᑦᓗ?*

ᒪᓂᕋᖅ, ᐃᐸᔦᐃᑦ, ᐱᕈᖅᑐᐃᑦ, ᐊᒻᒪ ᓂᕐᔪᑏᑦ ᓂᕈᐊᖅᑕᐅᓚᐅᖅᑐᑦ ᐱᒻᒪᕆᐅᑉᐳᑎᒃ ᐃᓚᒋᔭᐅᓂᖏᓐᓄᑦ (VECs) ᓄᓇᒥᐅᑕᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐊᒃᑐᖅᓯᓂᖃᑐᐃᓐᓇᕆᐊᖃᕐᓂᖏᓐᓄᑦ ᐱᓕᕆᐊᒥᒃ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓄᑦ ᐊᒻᒪ ᐱᖅᑯᓯᒃᑯᑦ ᐆᒻᒪᓂᒃᑯᓪᓗ ᐱᒻᒪᕆᐅᒋᔭᐅᖕᒪᑕ ᑭᖑᓪᓕᕐᒥᑦ.

ᓂᕐᔪᑎᓄᑦ, ᓇᓗᓇᐃᖅᓯᓗᐊᖅᑐᑦ ᓂᕈᐊᖅᑕᐅᓚᐅᖅᑐᑦ ᑕᐅᑐᒐᕆᔭᐅᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᒃ ᐆᒪᔫᓂᖏᓐᓄᑦ ᐅᖓᓗᓃᑦ ᐆᒪᔪᑦ ᑲᑎᕐᒪᑉᐳᑎᒃ ᐃᓚᒋᔭᐅᑉᐳᑎᒃ ᐊᕐᒌᓂᖅᓴᒥᒃ ᐱᕝᕕᐅᖓᒃᑐᓂᒃ. ᓂᕐᔪᑏᑦ ᓂᕈᐊᖅᑕᐅᔪᑦ ᓇᓗᓇᐃᖅᓯᓂᕐᒧᑦ ᐅᑯᐊᖑᔪᑦ:

- ᑐᒃᑐᐃᑦ ᐊᒻᒪ ᐅᒥᖕᒪᐃᑦ
- ᐊᒪᕈᐃᑦ
- ᑎᖕᒥᐊᑦ ᐅᑭᐅᖅᑕᖅᑐᒧᑦ ᐅᑎᖅᑕᖅᑐᑦ
- ᑭᒡᒐᕗᐊᕐᔪᐃᑦ
- ᓂᕐᔪᑏᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑐᑦ – ᐅᒃᐱᒡᔪᐊᑦ, ᐊᒃᕆᐃᑦ, ᐊᒻᒪ ᖃᕝᕚᑦ

ᓇᓗᓇᐃᖅᓯᔪᓂᒃ ᓂᕈᐊᖅᑕᐅᔪᖃᓚᐅᖏᑦᑐᖅ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐱᓕᕆᐊᒧᑦ ᐊᒃᑐᖅᑕᐅᓂᖃᖅᑐᓂᒃ ᓄᓇᒧᑦ, ᐃᐸᔪᑦ ᐊᒻᒪ ᐱᕈᖅᑐᓄᑦ.

ᒪᓕᒐᓕᐅᕆᓂᕐᒧᑦ ᐃᓱᒪᒋᔭᐅᔪᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᓄᓇᒥᐅᑕᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐃᓚᐅᔪᑦ *ᓄᓇᕗᒻᒥᑦ ᓄᓇᑖᕐᓂᕐᒧᑦ ᐊᖏᖃᑎᒌᒍᑎᒧᑦ ᐱᕐᑯᓯᖅ, ᑭᕙᓪᓕᕐᒥᑦ ᓄᓇᒥᒃ ᐊᑐᕐᓂᕐᒧᑦ ᐸᕐᓇᐅᑎ, ᓄᓇᕗᒻ ᓂᕐᔪᑎᓄᑦ ᐱᕐᑯᓯᖅ, ᐆᒪᔪᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑐᓄᑦ ᐱᕐᑯᓯᖅ* (SARA), *ᐅᑭᐅᖅᑕᖅᑐᒧᑦ ᐅᑎᖅᑕᖅᑐᑦ ᑎᖕᒥᐊᓄᑦ ᐱᕐᑯᓯᖅ*, ᐊᒻᒪ ᑲᓇᑕᐅᑉ ᐊᑐᐊᒐᖕᒑᑦ ᓄᓇᒥᑦ ᐃᒪᖃᕐᓂᐅᔪᒥᑦ-ᒧᑦ.

ᓄᓇᒥᐅᑕᓂᒃ ᖃᐅᔨᓴᐃᓂᖅ ᑭᒡᒐᓕᐅᖅᓯᒪᔪᖅ ᐱᖓᓱᔪᓂᑦ ᖃᐅᔨᓴᐃᓂᖅᖃᕝᕕᐅᔪᓄᑦ: ᐱᓕᕆᐊᑉ ᐃᓂᖓᓂᑦ, ᖃᓂᑦᑐᒥᒃ ᖃᐅᔨᓴᐃᓂᖅ (LAA), ᐊᒻᒪ ᐅᖓᓯᖕᓂᖅᓯᒪᒥᒃ ᖃᐅᔨᓴᐃᓂᖅ (RAA). ᐱᓕᕆᐊᑉ ᐃᓂᖓ ᐱᓕᕆᐊᑉ ᐱᓕᕆᕝᕕᒋᔭᖓ. LAA ᐊᖏᓖᒃᑯᖓᔪᖅ ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᑕᐅᓂᖃᕐᓂᕐᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᔭᖕᓇᖅᑐᖅ ᐆᒃᑐᕋᖅᑕᐅᓗᓂᓘᓃᑦ ᓈᒻᒪᓈᕈᕐᓗᑎᒃ ᓇᓗᖕᒋᑦᑎᐊᕐᓗᑎᒡᓘᓃᑦ. LAA ᐃᓗᓕᖅᑲᖅᑐᖅ ᒪᕐᕉᖕᓂᒃ ᐊᔾᔨᒌᖕᒋᑦᑐᓂᒃ ᐃᓂᐅᔪᓂᒃ, ᐅᔭᕋᖕᓂᐊᕐᕕᒃ LAA-ᒥᑦ ᐊᒻᒪ ᐊᑉᕐᑯᑎ LAA-ᒥᑦ. ᐅᔭᕋᖕᓂᐊᕐᕕᒃ LAA-ᒥᑦ ᑭᒡᓕᖅᑲᖅᑐᖅ 5 ᑮᓗᒥᑕᒥᒃ ᐊᕙᑖᒍᑦ ᐃᓗᐊᓃᑦᑐᑎᒃ ᐱᕐᑯᑎᖏᑦ ᐊᒻᒪ ᐊᑉᕐᑯᑎ ᐊᑯᓐᓂᖏᓐᓂᒃ ᐅᔭᕋᖕᓂᐊᕐᓂᕐᒧᑦ ᐃᓂᐅᔪᑦ. LAA-ᖑᔪᑦ ᒪᕐᕈᖕᓄᑦ ᐊᔾᔨᒌᖕᒋᑦᑐᓄᑦ ᐊᑉᕐᑯᑎᒧᑦ ᖃᓄᐃᓕᐅᕈᑕᐅᓂᕐᒧᑦ 5 ᑮᓗᒥᑕᒥᒃ ᓯᓚᒃᑎᒋᔪᒥᒃ ᑭᒡᓕᖅᑲᖅᑐᖅ ᕿᑎᐊᓄᐊᖅᑕᐅᓯᒪᔪᖅ ᐊᑉᕐᑰᑎᐅᑉ ᓇᒧᙵᐅᓂᖓᓄᑦ. RAA ᐊᖏᓂᖅᓴᐅᔪᖅ ᐃᓂ ᑲᑎᑉᐸᓪᓚᐊᓂᕐᒧᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᖃᕈᖕᓇᖅᑐᑦ, ᐅᕙᓃᙵᑦ VEC ᐊᖏᓂᖅᓴᐅᔪᖅ. ᐃᒡᓴᕝᕕᖕᒧᑦ ᐊᑐᖅᑐᓄᑦ ᖃᓄᐃᓕᐅᕈᑏᑦ ᐃᓚᐅᔪᑦ ᐅᑭᐅᓗᒃᑖᑦ ᐊᑐᖅᑕᐅᔪᖕᓇᖅᑐᖅ ᐊᑉᕐᑯᑎ ᐊᒻᒪ ᐅᑭᐅᑯᑦ ᐊᑉᕐᑯᑎ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᖅ LAA-ᒧᑦ ᑭᒡᓕᐅᔪᓄᑦ. RAA-ᒥᑦ ᐃᓚᐅᔪᑦ ᑕᒪᐃᓂᒃ Judge Sissons Lake ᐊᒻᒪ ᓂᕆᖅᐸᓯᐊᓃᑐᖅ ᐃᓚᖓ Aberdeen ᐊᒻᒪ Shultz ᑕᓱᑦ. ᐃᓗᓕᖅᑲᖅᑐᖅ ᒥᑮᑰᖓᔪᖅ ᑭᒡᓕᓕᐅᖅᓯᒪᔪᖅ 22 ᑮᓗᒥᑕᒥᒃ ᐱᓕᕆᐊᑉ ᐃᓂᖓᑕ ᐊᕙᓗᐊᓂᑦ.

ᑭᒡᓕᐅᔪᑦ ᓄᓇᒥᐅᑕᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᑐᖅᓱᑎᐅᓚᔪᒃᑐᖅ ᖃᖓᒃᑯᑦ ᐊᒻᒪ ᖃᑯᒍᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᑕᒪᐃᓄᑦ ᓇᓃᓐᓂᖅᓯᓗᒃᑖᖕᒋᓐᓄᑦ ᐱᓕᕆᐊᑉ (ᓴᓇᔭᐅᑎᓪᓗᒍ, ᑭᖑᓪᓕᖅᐹᒃᑯᑦ ᐅᒃᑯᐊᖅᑎᓪᓗᒍ ᐊᒻᒪ ᐅᒃᑯᐋᕐᓂᒃᑎᓪᓗᒍ-ᒧᑦ). ᑲᑎᕐᓗᒍ ᐊᐅᓛᕐᓂᐊᕐᓂᖅᓴᖕᒐᑕ ᐱᓕᕆᐊᑉ ᓂᖅᐅᕆᔭᐅᔪᖅ 25 ᐅᑭᐅᓄᑦ, ᐅᒃᑯᐋᕐᓂᒃᓯᒪᓕᖅᑎᓪᓗ ᐅᐃᒍᕆᐊᖅᑕᐅᓗᓂ ᐊᕗᖕᒑᒃᑲᓐᓂᕐᓂᒃ ᑭᖑᓪᓕᖅᐹᒃᑯᑦ ᐅᒃᑯᐊᕐᓂᕐᒥᐅᓕᖅᑐᒥᑦ.

ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᒃᑐᖅᑕᐅᓂᖅ ᐱᓕᕆᐊᒥᑦ ᐃᓱᒪᒋᔭᐅᔪᖅ ᐊᖏᔫᓂᖓᓂᒃ ᐊᒃᑐᖅᓯᓂᖅᑲᓂᐊᖅᐸᑉ ᑕᑭᔪᒥᒃ-ᐊᑯᓂᐅᓂᖓᓂᒃ ᐊᔪᙱᓐᓂᐊᕐᓂᖓ VEC. ᐅᔾᔨᕐᓇᕐᓂᖓ ᕿᒪᒃᑎᑦᑐᓄᑦ ᖃᓄᐃᙱᓕᖅᑎᑦᑎᓂᖅ ᖃᐅᔨᔭᐅᓚᐅᖅᑐᖅ ᐊᑐᖅᓱᒋᑦ ᑲᑎᓯᒪᔪᑦ ᐅᑯᓇᓂᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᑦ ᐃᓕᑕᕆᔭᐅᔪᑦ ᐊᑐᓂ VEC-ᓂᑦ. ᐱᑕᖃᙱᑎᓪᓗᒋᑦ ᖃᐅᔨᓴᒪᔭᐅᔪᑦ ᑲᑎᓯᒪᔪᑦ ᐅᑯᓇᓂᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᑦ, ᖃᐅᔨᒪᓂᖅᑲᖅᑐᓄᑦ ᖃᐅᔨᔭᐅᔪᑎᒍᑦ ᐊᑐᖅᑕᐅᓚᐅᖅᑐᖅ ᖃᐅᔨᓂᕐᒧᑦ ᐅᔾᔨᕐᓇᕐᓂᖅ. ᕿᒪᒃᑎᑦᑐᓄᑦ ᖃᓄᐃᙱᓕᖅᑎᑦᑎᓂᖅ ᐃᓱᒪᒋᔭᐅᔪᖅ ᐅᔾᔨᕐᓇᔾᔭᙱᓐᓂᒃᙱᓚᓂᒃ ᖃᓄᐃᙱᓕᕐᓂᐅᔪᖅ ᐊᓯᐊᕗᖅᑎᑦᑎᒃᐸᑦ VEC-ᒥᒃ ᐊᔪᙱᓐᓂᖅᑲᕐᓂᐊᖅᑐᓅᓐᓂᐊᖅᐸᑦ, ᐅᑯᓇᓂᑦ ᖃᓄᐃᙱᓕᖅᑎᑦᑎᓂᖅᑲᙱᑉᐸᑦ ᐃᓗᐃᑑᑎᐊᕐᓂᖓᓂᒃ VEC ᐆᒃᑐᕋᖅᑕᐅᓂᒃᑯᑦ ᐅᑯᓇᓂᑦ ᑐᑭᖅᑐᒃᑯᑦ.

ᑕᐅᑦᑐᖑ ᖃᐅᔨᓴᐃᓂᖅ ᒪᓂᕋᒥᑦ

ᒫᓐᓇᐅᔪᖅ ᐊᕙᑎ - ᒪᓂᕋᖅ

ᓄᓇᐅᑉ ᖄᖓᓃᑐᓂᑦ ᐃᓚᐅᔪᑦ glacial till ᐊᒻᒪ ᒥᑭᑦᑐᑦ local deltic RAA-ᒥᑦ. Periglacial geomorphic ᐱᕙᓪᓕᐊᔪᑦ RAA-ᒥᑦ ᐊᒃᑐᐊᓂᖅᑲᖅᑐᑦ ᒪᓂᕋᒥᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᐃᓐᓇᐅᔭᖅᑐᖅ ᓂᒡᓕᓇᖅᑐᒧᑦ, ᐃᓗᓕᖅᑲᖅᑐᖅ ᐊᐅᓚᓂᖅᑲᐃᓐᓇᐅᔭᖅᑐᒥᒃ (ᖃᐅᔨᒪᔭᐅᕐᒥᔪᖅ ᐊᐅᒃᐸᓪᓕᐊᓂᖅᑲᖅᐱᒃ), ᒪᓂᕋᒥᒃ ᓯᑯᐃᑦ ᐊᒻᒪ ᖁᐊᖅᓯᒪᐃᓐᓇᐅᔭᖅᑐᖅ ᓄᓇ. Periglacial ᐱᕙᓪᓕᐊᔪᖅ ᖃᐅᔨᔭᐅᔪᖅ ᐅᔭᕋᕐᓂᐊᖅᐱᐅᑉ LAA-ᖓᓂᑦ ᐊᒻᒪ RAA-ᒥᑦ ᐃᓚᐅᔪᑦ frost wedging ᐊᒻᒪ frost shattering, [ᐸᑐᓕᕆᔪᑦ] ᐊᐅᒃᐸᓪᓕᐊᓂᖅ ᐊᒻᒪ thaw subsidence ᐊᒻᒪ solifluction, ᖃᓄᐃᖓᓕᖅᑎᑦᑎᔪᑦ ᒪᓂᕋᐅᑉ ᖃᓄᐃᖓᓂᓇᔭᖓᓂᒃ.

ᒪᓂᕋᐅᑉ ᖄᖓᓃᑦ ᐅᔭᕋᕐᓂᐊᖅᐱᐅᑉ LAA-ᖓᓂᑦ ᐃᓗᓕᖅᑲᖅᑐᖅ ᓵᑐᒥᒃ ᐃᐸᔪ ᐊᑖᓂᖑᓂ glacial till ᐃᐸᔪᓂᖏᑦ ᐊᔾᔨᒌᙱᓐᓂᖅᑲᖅᓱᑎᒃ ᐊᑕᐅᓯᖅ ᒦᑕ ᑐᖕᒫᓂᑦ ᐳᖅᑐᓂᖅᓂᑦ ᖃᑉᓯᐊᖅᔪᖕᓄᑦ ᒦᑕᓄᑦ ᐃᓗᑐᓂᕐᓄᑦ, ᐅᔭᖅᑲᐃᑦ ᑕᐃᒪᐅᑉᓗᑎᒃ ᐃᓚᖅᑲᖅᓱᑎᒃ ᐅᔭᕋᑎᐊᕙᐅᔪᓂᒃ. ᖄᖓᓃᑐᑦ ᑲᑎᕐᒪᔩᖅᑲᑦᑕᖅᓯᒪᔪᖅ ᐊᕿᓂᓕᐅᑉᓗᑎᒃ: glacial till ᐅᑯᓇᓂᑦ morainal, glaciofluvial; glaciolacustrine, glaciomarine deposits, organic, ᐊᒻᒪ bedrock.

ᐊᖏᓂᐅᔪᑦ ᓄᓇᐃᑦ ᖃᓄᐃᖓᓕᖓᓕᕐᓂᑦ ᐊᕕᒃᑕᐅᓯᒪᔪᑦ ᓯᑕᒪᐅᓕᖓᑉᓗᑎᒃ: ᓯᖀᑦ, ᐊᐅᓱᐃᑐᑦ ᐊᒻᒪ ᖃᓄᐃᖓᓕᖅᑐᑦ ᓄᓇ. ᖃᓄᐃᖓᓕᖅᑐᑦ ᓄᓇ ᐊᕕᒃᑕᐅᑲᓐᓂᖅᓱᑎᒃ ᐊᕿᓂᓕᖕᓅᖓᑉᓗᒍ ᐅᔭᕋᕐᓂᐊᖅᐱᐅᑉ LAA-ᖓᓂᑦ: undifferentiated alluvial, glaciofluvial, glacial till ᐅᑯᓇᓂᑦ morainal, glaciomarine, organic ᐊᒻᒪ bedrock landforms. ᖃᓄᐃᖓᓕᖅᑐᑦ ᓄᓇ LAA-ᒥᑦ ᐅᑯᐊᖑᔪᑦ morainal. Alluvial, glaciofluvial, morainal (glacial till), glaciomarine ᐊᒻᒪ bedrock landforms ᐃᒪᓐᓇᐃᓗᐊᖅᑐᖅ 10.5% (3,786 ha), ᒥᑭᓂᖅᓴᖅ 1% (200 ha), 84% (30,356), 0.3% (108 ha), ᐊᒻᒪ 5% (1,790 ha) ᐅᔭᕋᕐᓂᐊᖅᐱᐅᑉ LAA-ᖓᓂᑦ: ᓯᖅᒥᓄᑦ ᓄᓇᒥᒃ ᖃᓄᐃᖓᓕᕐᓂᐅᔪᑦ ᐊᐅᓚᑕᐅᔪᖅ hummocky, bouldery glacial till ᐊᒻᒪ ᓯᐊᒪᒃᓯᒪᔪᓄᑦ boulder till moraines-ᓄᑦ bedrock outcrops-ᑕᖅᑲᐅᕋᔪᒃᓱᓂ ᐊᒻᒪ shattered bedrock features ᐃᑖᑰᖕᒐᔪᓂᒃ ᑕᑯᒃᓴᐅᔪᓂᑦ, ᖁᑦᑎᒃᑐᓂᑦ ᐊᒻᒪ ᑕᑭᔪᓂᑦ ᐳᖅᑐᓂᖅᓂᑦ (drumlins, ᐊᓯᖏᓪᓗ glaciofluvial ᐊᓂᐊᓂᑯᐃᑦ) LAA-ᒥᑦ. ᐊᐅᓱᐃᑐᑕᖅᑲᖅᑐᑦ ᓄᓇᐃᑦ ᖃᐅᔨᔭᐅᔪᖕᓇᖅᑐᑦ ᐊᑐᖅᓗᓂ ᐃᒪᖅᑕᓕᖕᓂᑦ ᐊᒻᒪ ᒪᓂᕋᒥᑦ ᓯᑯᖃᖅᑐᖅᑕᓕᖕᓂᑦ, ᓯᑯᓯᒪᔪᓂᑦ ᐃᐸᔪᓂᑦ, ᓯᐅᕋᓂᑦ, ᐊᒻᒪ ᓯᑐᖅᑲᖓᔪᑦ. ᖁᑦᑎᖕᓂᐅᔪᑦ ᑕᐃᒪᐅᓚᔪᒃᑐᑦ ᐊᔾᔨᐅᖏᑦᑐᓂᒃ ᓄᓇᐅᑉ ᖃᓄᐃᖓᓂᓇᔾᖏᓐᓂᒃ LAA-ᒥᑦ.

ᐱᓕᕆᐊᑉ ᐃᓂᖓ ᐊᐅᓯᐃᑐᒥᖃᕐᓂᐅᔪᖅ. ᐃᑉᐸᓂᖓ ᐊᐅᓚᓂᖃᖅᑑᔪᖅ ᐊᔾᔨᒌᖕᒋᑦᑐᓂᒃ 1m-ᒥᒃ ᖄᖓᓃᑐᖃᖅᑐᓂ ᓇᑎᐊᓂᑦ ᐊᒻᒪ 5m-ᒥᒃ ᐅᕋᕋᐅᓂᖅ. ᒪᓂᕋᒥᑦ ᓯᑰᑉ ᐊᐅᓯᐃᑐᖅ ᐃᑉᐱ ᐊᒻᒪ ᐅᔭᕋᐃᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ 10% ᑐᖓᓃᑐᑦ.

ᐊᕙᑎᒧᑦ ᐊᒃᑐᖅᑕᐅᓂᐅᔪᓂᒃ ᖃᐅᔨᓴᐃᓂᖅ ᓄᓇᒧᑦ

ᐅᖃᐅᓯᐅᔪᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᓄᓇᒥᑦ ᐃᓕᑕᕆᔭᐅᔪᑦ ᐊᕿᕙᒃᑯᑦ ᐃᓄᖕᓂᒃ ᐱᓕᕆᖃᑎᖃᖅᑎᓪᓗᒋᑦ ᐊᒻᒪ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖅᑲᐅᓂᒃ ᐊᐱᖅᓱᐃᓂᕐᒥᑦ ᐃᓚᐅᔪᑦ ᐊᓯᐊᕗᖅᓯᓂᐅᔪᖕᓇᖅᑐᑦ ᐊᐅᓯᐃᑑᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ, ᓄᓇᐅᑉ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖓᓄᑦ. ᐃᓱᒫᓘᑕᐅᔪᑦ ᐊᐅᒃᑉᐸᓪᓕᐊᓂᖅ ᐊᐅᓯᐃᑐᖅ ᓄᖑᓯᐃᑐᒧᑦ (EN-RI RLC ᕙᕗᐊᖅ 2009[9]) ᐊᒻᒪ ᐱᓕᕆᐊᒎᖓᔪᓄᑦ ᐅᔭᕋᖕᓂᐊᖅᑐᓕᕆᓃᑦ, ᐊᒻᒪ ᐱᖅᑯᓯᐅᓂᕐᒧᑦ ᐱᓪᒪᕆᒋᔭᐅᔪᑦ ᐊᑐᖅᑕᐅᓂᖏᓪᓗ ᓄᓇᐅᑉ ᖃᓄᐃᖓᓂᖏᑦ ᓵᕐᓗ ᖃᖅᑲᐃᑦ (IQ-BL01 2008[10], IQ-BL09 2008[11], IQ-BL11 2008[12]).

ᒪᓂᕋᖅ ᐃᓱᒪᒋᔭᐅᓚᐅᕐᒥᔪᖅ VEC-ᖑᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᓂᖃᑐᐃᓐᓇᕆᐊᖃᕐᒪᑦ ᐱᓕᕆᐊᒥᒃ ᐊᒃᑐᖅᑕᐅᓂᖃᖅᑐᓄᑦ ᐊᓯᐊᖑᖅᐸᓪᓕᐊᓂᒃᑯᑦ ᐊᐅᓯᐃᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᑦ, ᒪᓂᕋᐅᑉ ᖃᓄᐃᑐᖓᕐᓂᖓ ᐊᒻᒪ ᐊᓯᐊᖑᕐᓂᐅᔪᓄᑦ ᓄᓇᒧᑦ, ᐊᒻᒪ ᑕᐃᑲᙵᑦ ᐊᓯᐊᔾᔪ ᐊᒃᑐᐊᓂᖃᖅᑐᓂ ᐊᓯᖏᓐᓄᑦ VEC-ᓄᑦ.

ᖃᓄᐃᓐᓂᕆᔭᖏᑦᑎᒍᑦ ᖃᑉᓯᐅᓂᖏᑦᑎᒍᓪᓗ ᐊᑐᕐᓗᓂ ᐊᑐᖅᑕᐅᓚᐅᖅᑐᖅ ᒪᓂᕋᕐᒥᒃ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐊᑐᖅᓗᓂ ᐊᑐᖅᑕᐅᓂᑯᓂᒃ ᐊᔾᔨᐸᓗᖏᓐᓄᑦ ᐱᓕᕆᐊᓄᑦ ᓄᓇᕗᒻᒥᑦ ᐊᓯᖏᓐᓂᓪᓗ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᖓᓂᑦ, ᐊᒻᒪ ᖃᐅᔨᒪᓂᖃᖅᑐᓄᑦ ᐃᓱᒪᒋᔭᐅᔪᑎᒍᑦ. ᑲᓇᑕᒥᑦ ᐊᒻᒪ ᓄᓇᕗᒻᒥᑦ ᒪᓕᒃᑕᐅᔪᒃᓴᐃᑦ, ᒪᓕᒐᐃᑦ ᐊᑐᖅᑕᐅᔪᑦ ᐊᒻᒪ/ᐅᕙᓘᓃᑦ ᖃᑉᓯᐅᓂᖏᑦ ᐊᑐᖅᑐᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᒃᑐᖅᑕᐅᓂᖃᖅᑎᑦᑎᓂᐅᔪᓂᒃ ᐊᓯᐅᖑᕐᓂᐅᔪᓄᑦ ᓄᓇᒥᒃ ᒪᓂᒪᔪᖃᙱᑦᑐᑦ. ᓄᓇᒥᒃ ᖃᐅᔨᓴᐃᓂᖅ ᑕᐅᑐᒐᖃᖅᑐᖅ ᐅᑯᓂᙵᑦ:

- ᐊᓯᐊᖑᕐᓂᖓ ᐊᐅᓯᐊᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᑦ ᐊᒻᒪ ᓄᓇᐅᑉ ᖃᓄᐃᑦᑐᖓᕐᓂᖓ ᐱᕈᖅᑐᐃᑦ ᐲᔭᖅᑕᐅᓂᖏᓐᓄᑦ, ᓄᓇᐅᑉ ᐅᕝᕙᖓᓂᖓ, ᑰᒃᑐᑦ ᐊᓯᐊᒎᓕᖅᑎᑕᐅᓂᖏᓐᓄᑦ, ᓄᓇᐅᑉ ᖄᖓᓃᑐᑦ ᑰᖕᓂᖏᑦ ᐊᓯᐊᖑᕐᓂᖏᓐᓄᑦ, ᓄᓇᒥᒃ ᐃᓗᑦᑐᖅᑎᕆᓂᕐᒧᑦ ᐊᒻᒪ ᖄᖅᑎᕆᖃᑦᑕᕐᓂᕐᒧᑦ
- ᐊᓯᐊᖑᕐᓂᖏᑦ ᓄᓇᐅᑉ ᐊᒃᑐᖅᑕᐅᓂᖏᓐᓄᑦ ᖁᑦᑎᖓᓃᑦ ᐊᓯᖏᓪᓗ ᐅᔾᔨᕐᓇᖅᑐᑦ ᓄᓇᐃᑦ

ᓯᓚ ᐊᓯᐊᖑᖅᐸᓪᓕᐊᓂᖓ ᐊᓯᐊᖑᖅᑎᑦᑎᔪᓐᓇᖅᑎᓪᓗᒍ ᐊᐅᓯᐃᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ, ᓄᓇᐅᑉ ᖃᓄᐃᑦᑐᖓᕐᓂᖓᓂᒃ, ᐊᒻᒪ ᓄᓇᐅᑉ ᖃᓄᐃᖓᓂᖓᓂᒃ, ᐊᒃᑐᖅᑕᐅᓂᐅᔪᑦ ᓯᓚᐅᑉ ᐊᓯᐊᖑᕐᓂᖓᓄᑦ ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᓄᓇᒥᒃ ᐃᓱᒪᒋᔭᐅᖃᑕᐅᓯᒪᔪᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ.

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[9] EN-RI RLC ᕙᕗᐊᖅ 2009: ᓄᖑᓯᐃᑐᖅ ᐊᐅᒃᑎᑦᑎᖃᑦᑕᖅᐸ ᐊᐅᓯᐃᑐᒥᒃ?

[10] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-BL01 2008: ᐃᓄᐃᑦ ᑕᖖᖅᑐᑦ Kazan ᑰᖕᒥᑦ ᐅᐱᕐᖔᒃᑯᑦ, ᑐᐱᖅᑐᖅᓱᑎᒃ ᑭᙵᕐᒥᑦ ᐅᖓᓯᒃᑐᒧᑦ ᑕᐅᑐᖑᓇᕐᓂᐊᕐᒪᑕ

[11] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-BL09 2008: ᕿᙵᖅᑕᖃᖅᑐᖅ ᑕᒃᓯᓕᒃᑲᓪᒪᕆᐊᓗᖕᒥᑦ, ᕿᙵᑦᑐᐊᖅ-ᒥᑦ ᑕᐃᔭᐅᔪᖅ. ᑐᓴᓚᐅᖅᑐᖓ ᑕᐃᑯᙵᐅᓂᖅ ᐊᔪᖅᑐᒍᑦ ᐃᑳᕐᕕᒋᓗᒍᓘᓂᑦ. ᑕᒃᓯᓕᖅᐸᓪᓕᐊᕐᔪᐊᖅᑲᑦᑕᖅᑐᖅ ᑕᐃᑰᓇᕈᕕᑦ, ᑕᑯᓂᖅ ᓱᓇᑐᐃᓐᓇᒥᒃ ᐊᔪᓕᕐᓗᑎᑦ.

[12] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-BL11 2008: ᐊᖏᔪᑦᑎᐊᕙᖕᒥᒃ ᕿᙵᖅᑕᖃᖅᑐᖅ ᐊᕙᓂ ᑕᑯᒃᓴᐅᔪᖅ ᑖᒪᓂ. ᐊᑦᑎᖕᓂᖓ ᒪᓂᕋᓪᒪᕆᐊᓗ, ᑕᓯᖃᖅᑐᓂ. ᑕᐃᑲᓂ ᐊᑎᕋ ᐃᓗᕕᖅᑕᐅᓯᒪᔪᖅ.

ᖃᑉᓯᐅᓂᖕᒋᑦ ᓇᓗᓇᐃᖅᑕᐅᔪᑦ ᐊᑐᖅᓱᑎᒃ ᐃᓚᖕᒋᑦ ᐊᓯᐅᔨᕐᔭᐅᔪᑦ ᓄᓇᐅᑉ ᖃᖓᖕᒐ ᖃᓂᖕᒐᓂᖕᒐᓘᓃᑦ ᐊᒃᑐᐊᓂᖃᖅᑐᖅ ᑕᒪᐃᓄᑦ ᐅᔭᕋᖕᓂᐊᕐᓂᐅᑉ LAA-ᖕᒐᓃᑦ ᐊᒻᒪ ᓂᕈᐊᖅᑕᐅᔪᑦ ᐊᑐᖅᓱᒍ ᖃᐅᔨᒪᔭᐅᓂᐅᔪᖅ ᐅᑭᐅᖅᑕᖅᑑᑉ ᓄᓇᖕᒐᑕ ᐊᕙᑎᖕᒐᓂᒃ, ᖃᐅᔨᒪᓂᖃᖅᑐᑦ ᐃᓱᒪᒋᔭᖕᒋᓐᓄᑦ ᐊᒻᒪ ᖃᑉᓯᐅᓂᖕᒋᑦ ᓂᕈᐊᖅᑕᐅᔪᑦ ᐊᔾᔨᐸᓗᖕᒋᑦ ᐱᓕᕆᐊᖑᔪᑦ ᓄᓇᖁᒻᒥᑦ. ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᒃᑐᖅᑕᐅᓂᖅ ᐱᓕᕆᐊᒥᑦ ᐱᔪᑦ ᐃᓱᒪᒋᔭᐅᔪᖅ ᐊᖕᒋᔫᓂᖕᒐᓂᒃ ᐱᓕᕆᐊᖅ ᐅᖕᒐᑕᐅᑎᓂᐊᖅᐸᑦ ᖃᑉᓯᐅᓂᖕᒐᓄᕐ ᐊᑭᐅᔪᓂᒃ 30%-ᒥᒃ ᐊᓯᐅᔨᓂᖅ ᓄᓇᐅᑉ ᖃᖓᖕᒐᓃᑦ, 30%-ᒥᒃ ᐊᓯᐅᔨᓂᖅ ᓄᓇᐅᑉ ᐋᕿᒃᓯᒪᓂᖕᒐᓂᒃ, 15%-ᒥᒃ ᐊᓯᐅᔨᓂᖅ ᐊᐅᓱᐃᑐᕐᒧᑦ ᖃᓄᐃᖕᒐᓕᖅᑐᓄᑦ ᐅᕙᓃᓃᑦ 5%-ᒥᒃ ᐊᓯᐅᔨᓂᖅ ᐊᐅᓱᐃᑐᕐᒧᑦ ᖃᓄᐃᖕᒐᓕᖅᑐᓄᑦ LAA-ᒥᑦ.

ᐊᓯᐊᖖᕐᓂᖅ ᐊᐅᓱᐃᑐᐃᑦ ᖃᓄᐃᖕᒐᓂᖕᒋᓐᓄᑦ ᓄᓇᐅᑉᓗ

ᒪᕐᑖᒃ ᐱᔾᔪᑕᐅᔪᑦ ᖃᐅᔨᓂᕐᒧᑦ ᐊᓯᐊᖖᕐᓂᖕᒐᓄᑦ ᐊᐅᓱᐃᑐᖅ ᒪᓂᕋᐅᑉ ᓂᒡᓚᓇᕐᓂᑲᔭᖕᒐ ᐊᒻᒪ ᖃᓄᑎᒋᐅᓂᖕᒐ ᒪᓂᕋᕐᒥ ᓱᑰᑉ ᐊᐅᓱᐃᑐᒦᑐᖅ. ᓄᓇᐅᑉ ᓂᒡᓚᓇᕐᓂᖕᒐ, ᖃᐅᔨᔭᐅᓚᑉᓗᓂ ᖃᑉᓯᐊᕐᔪᖕᓄᑦ ᐱᔾᔪᑕᐅᔪᓄᑦ ᐃᓚᐅᑉᓗᑎᒃ: ᐊᓂᖅᗁᖅᑐᖅᑕᑉᑕ ᐆᓐᓇᕐᓂᖕᒐ, ᖃᓄᐃᑑᓂᖕᒐ ᐊᒻᒪ ᐃᑉᔪᓂᖕᒐ ᐱᕈᖅᑐᐃᑦ ᖃᖓᓃᑦ, ᐃᑉᔪᐃᑦ, ᖃᓄᐃᑑᓂᖕᒋᑦ ᐅᔭᕋᐃᑦ, ᐊᐳᑎ ᖃᖓᓃᑦ, ᐊᒻᒪ ᒪᓂᕋᐅᑉ ᓯᑐᖅᑲᖕᒐᓂᖕᒐᓄᑦ. ᐃᓂᐅᔪᒥᒃ ᐱᕈᖅᑐᓂᒡᓗ ᐂᔭᐃᓂᖅ, ᐊᓯᐊᖖᕐᓂᐅᔪᖕᓇᖅᑐᖅ ᒪᓂᕋᐅᑉ ᓯᑐᖅᑲᖕᒐᓂᖕᒐ, ᐋᕿᒋᐊᖅᓯᓂᖅ ᐃᒪᐅᑉ ᖃᖓᓃᑦ ᐊᒻᒪ ᑰᒃᑐᐃᑦ ᖃᓄᐃᓕᐅᕐᓂᖕᒋᓐᓂᒃ, ᐊᓯᐊᖖᕐᓂᐅᔪᑦ ᑰᖕᓂᖕᒐᓄᑦ ᐃᒪᐅᑉ ᐊᒻᒪ ᓱᓇᑐᐃᓐᓇᐃᑦ ᓱᕋᐃᔪᖕᓇᖅᑐᑦ ᓲᕐᓗ ᖄᖅᑎᑦᓂᖅ ᐊᓯᐊᖖᖅᓯᓂᖅᐸᖕᓇᖅᑐᑦ ᐊᐅᓱᐃᑑᑉ ᖃᓄᐃᓐᓂᑲᔭᖕᒋᓐᓂᒃ ᓄᓇᐅᑉᓗ.

ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᓄᓇᐅᑉ ᖃᖓᓃᑦ ᐸᒃᕙᓴᐃᖅᑳᖅᑐᑦ ᐊᒃᑐᖅᑕᐅᓂᖅᑲᕈᖕᓇᖅᑐᑦ ᐱᕈᖅᑐᓂᒃ, ᐃᑉᔪᓂᒃ ᐊᒻᒪ ᖁᐊᖅᓯᒪᔪᓂᒃ, ᐊᓯᐊᖖᖅᓯᔪᖕᓇᖅᑐᑦ ᐊᐅᓯᐅᑎᑉ ᖃᓄᐃᓐᓂᑲᔭᖕᒐᓂᒃ ᓇᒨᖕᒐᐅᖅᑳᖅᑕᕐᓂᖕᒐᓂᓪᓗ, ᓄᓇᒥᓪᓗ. ᐊᓯᐊᖖᖅᓯᔪᖕᓇᖅᑐᖅ ᐱᑕᖅᑲᕐᓂᖕᒋᓐᓂᒃ ᓇᒨᖕᒐᐅᖅᑳᖅᑕᕐᓂᖕᒋᓐᓂᓪᓗ ᐊᔾᔨᒌᖕᒋᑦᑐᑦ ᖃᓄᖕᒐᓂᐅᔪᑦ ᓄᓇᒥᒃ ᐱᓕᕆᐊᒦᑐᓂᒃ.

ᖄᒥᒃ ᐸᒃᕙᓴᐃᓂᖅ ᓴᓇᔭᐅᓂᖕᒐᓄᑦ ᐊᐅᖀᕐᓂᖕᒐᓄᒡᓗ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓄᑦ ᐱᔾᔪᑎᓕᖕᓄᑦ ᐊᒃᑐᖅᓯᓂᖅᑲᕐᓂᐊᖅᑐᖅ 803 ha (ᐅᕙᓃᓃᑦ 2.2%)-ᓗᐊᓂᑦ ᑲᑎᒍᒥᑦ 36,240 ha ᐅᔭᕋᖕᓂᐊᕐᓂᐅᑉ LAA-ᖕᒐᓃᑦ. ᑕᐃᒪᓐᓇᐃᓐᓂᐊᖅᑐᖅ ᐊᓯᐅᔨᓂᕐᒧᑦ ᐱᕈᖅᑐᓂᒃ ᐃᑉᔪᓂᓪᓗ ᐂᖅᑕᐅᓂᖕᒋᓐᓄᑦ (645 ha; 1.8% LAA-ᒥᑦ) ᐊᒻᒪ ᐱᕈᐃᓂᖅ (158 ha; 0.4% ᐅᔭᕋᖕᓂᐊᕐᓂᐅᑉ LAA-ᖕᒐᓃᑦ). ᐊᓯᐊᖖᕐᓂᐅᔪᑦ ᐊᐅᓱᐃᑐᐃᑦ ᖃᓄᐃᓐᓂᑲᔭᖕᒋᓐᓄᑦ ᓄᓇᐅᑉᓗ ᐊᓯᐅᔨᓂᕐᒧᑦ ᐱᕈᖅᑐᑦ ᖃᖓᓃᑦ ᐃᑉᔪᐃᓪᓗ ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖕᒐᓂᐅᓂᐊᖅᑐᖅ ᐊᒻᒪ ᑕᐃᒪᐅᖃᑦᑕᕐᓗᓂ ᑭᓯᐊᓂ ᓴᓇᔭᐅᑎᓪᓗᒍᑐᐃᓐᓇᖅ, ᐊᒃᑐᖅᑕᐅᓃᑦ ᓂᕆᐅᒋᔭᐅᒐᓗᐊᖅᑎᓪᓗᒋᑦ ᑕᐃᒪᐅᓂᐊᕐᓂᖕᒋᓐᓄᑦ ᐊᐅᓛᕐᓂᕆᔭᓗᒃᑖᖕᒐᓃᑦ ᐱᓕᕆᐊᑉ ᐅᑎᖅᑎᑦᑎᕙᓪᓕᐊᓂᖅ ᐱᐊᓂᒃᐸᒧᑦ.

ᐅᑭᐅᓗᒃᑖᖅ ᐊᑉᕿᑎᒧᑦ ᐱᓕᕆᐊᖕᒍᔪᒪᔪᖅ, ᐱᔭᕆᐊᖅᖃᖅᐸᑦ, ᓂᕆᐅᒋᔭᐅᔪᖅ 114 ᑭᓛᒥᑕᒥᒃ ᑕᑭᓂᖅᑲᕐᓂᐊᕐᓂᖕᒐᓄᑦ ᐊᒻᒪ 24m-ᓗᐊᒥᒃ ᓯᓚᖕᓂᖅᑲᕐᓗᓂ ᑎᑭᐅᑎᓗᓂᓗ ᑭᒡᒐᕙᒃ ᐅᔭᕋᖕᓂᐊᕐᓂᐅᑉ ᐃᓂᖕᒐᓄᑦ ᖃᒪᓂᑦᑐᐊᑉ ᐃᒃᓴᕝᕙᖕᒐᓄᑦ ᐃᓂᐅᔪᒧᑦ. ᐊᑉᕿᑎ ᓴᓇᔭᐅᓂᐊᖅᑐᖅ ᐅᔭᖅᑲᓂᒃ ᐃᓕᐅᖃᐃᕝᕙᐅᓗᓂ ᖃᖕᒐᓄᑦ ᓄᓇᐅᑉ (ᐃᓗᓪᓕᖅᑎᓇᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᔪᖅ), ᒥᐊᓂᖅᓯᓂᐊᖅᑐᖅ ᐊᐅᓱᐃᑐᒥᒃ ᐊᒻᒪ ᓄᓇᒥᒃ ᖃᓄᐃᓕᐅᕆᑎᑦᑎᓗᓂ. ᐊᑉᕿᓱᐅᖅᑕᐅᔪᒪᔪᖅ ᐋᕿᒃᑕᐅᓯᒪᔪᖅ ᐊᒻᒪ ᐃᓕᔭᐅᓯᒪᑉᓗᓂ ᖁᑎᖕᓂᖅᓴᒥᑦ ᓄᓇᒥᑦ ᑕᒪᒃᑯᐊ ᓄᓇᒥᑦ ᓯᑯᖃᖖᒋᓐᓂᖅᓴᐅᖃᑦᑕᕐᒪᑕ, ᑰᒃᑐᖅᑕᖃᖖᒋᓐᓂᖅᓴᐅᑉᓗᑎᒃ, ᐊᐱᕙᓪᓕᐊᖕᒋᓐᓂᖅᓴᐅᑉᓗᑎᒃ, ᐅᔭᕋᒃᑕᖃᕐᓂᖅᓴᐅᑉᓗᑎᓪᓗ, ᐊᒻᒪ ᐃᓗᐊᖅᑐᓂᒃ ᐃᓕᐅᖃᕕᐅᕝᕕᒃᓴᖅᑕᖃᖅᓱᑎᒃ. ᐊᑉᕿᓱᐅᖅᑕᐅᔪᒪᔪᖅ ᖁᑎᖕᓂᖅᓴᒧᐊᕐᓂᐊᕐᓗᒍ ᓄᓇᒧᑦ ᓄᓇᒥᒃ ᐱᔪᑎᓕᖕᓂᒃ ᒥᒃᓵᓂᐊᖅᑎᑦᑎᓂᐊᖅᑐᖅ ᐊᒻᒪ ᐊᑉᕿᑎ

ᓴᓇᔭᐅᑎᓪᓗᒍ. ᒥᒃᓵᒋᐊᖅᑎᑦᑎᓂᐊᕐᒥᔪᖅ ᐱᓕᕆᐊᕆᖑᔭᕆᐊᖃᕐᓂᐅᔪᓂᒃ (ᓲᕐᓗ ᐊᐱᔪᓄᑦ) ᐊᐅᓛᕐᓂᕆᔭᖕᒐᓂᒃ ᐱᓕᕆᐊᑉ.

ᐅᖓᑕᐅᑎᓯᒪᔪᑦ ᐃᒃᓵᕙᐅᑉ ᐃᓂᖓᓂᑦ ᐲᖅᑕᐅᓂᐊᖅᑐᑦ ᑐᖅᑯᖅᑕᐅᓗᑎᒡᓗ. ᐲᖅᑕᐅᒃᐸᑕ, ᐃᓂᐅᔪᒥᒃ ᑐᙵᕙᖕᒥᑦ ᓴᓇᓂᐊᖅᑐᑦ ᓂᒡᓕᓇᖅᑐᖅ ᒥᐊᓂᕆᔭᐅᓂᕐᒧᑦ ᐊᐅᓯᐃᑑᑉ ᖁᓛᓂᑦ. ᓴᓇᔭᐅᓂᖓ ᐃᒃᓵᕙᐅᑉ ᐃᓂᒃᓴᖓ ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᐸᒡᕙᓴᐃᓂᐊᕐᓂᖓᓄᑦ ᐃᓂᐅᔪᒥᒃ 25 ha-ᓗᐊᕐᒥᒃ.

ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᒨᖓᔪᑦ ᐊᑐᓕᖅᑎᑕᐅᓂᐊᖅᑐᑦ ᒪᕐᕈᐃᓕᖓᔪᒥᒃ: ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓗᓂ ᖃᓄᐃᖓᓂᐊᕐᓂᖓᓄᑦ ᐊᒪᓗ ᑐᕌᖓᔪᓄᑦ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᓐᓂᐅᑉ. ᐱᓕᕆᐊᑉ ᖃᓄᐃᑑᓂᐊᕐᓂᖓᓅᖓᔪᑦ ᐃᓚᐅᔪᑦ ᒥᑭᓛᒃᑎᑦᑎᓂᕐᒥ ᐱᓕᕆᐊᒥᒃ ᐸᒡᕙᓴᐃᓂᖅ ᐊᒪᓗ ᖃᒡᓯᐅᓂᖏᑦ ᑰᒃᑎᑕᐅᔪᑦ ᐊᒃᑐᖅᓯᓂᖅᑲᕐᓂᐅᔪᑦ ᐱᓕᕆᐊᑉ ᐃᓚᒋᔭᖏᓐᓄᑦ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖏᓐᓄᓪᓗ, ᐊᒪᓗ ᐸᒡᕙᓴᐃᑕᐃᓕᒪᓂᖅ ᓄᓇᐅᑉ ᖄᖓᓂᑦ ᖁᑎᖕᓂᖅᓴᓂᑦ ᐃᓂᐅᔪᓂᑦ ᒥᑭᓪᓕᒋᐊᖅᑎᓐᓂᕐᒧᑦ ᐃᑎᒡᓕᑎᑦᑎᓂᖅ ᐊᐅᖕᓂᐅᔪᒥᒃ ᐊᒪᓗ ᑕᒪᒃᑯᓄᙵ ᐊᒃᑐᐊᔪᓂᒃ ᓄᓇᒥᑦ. ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᒋᐊᕐᓂᕐᒥᑦ ᐃᓚᐅᔪᖅ ᐃᓯᒪᒋᔭᐅᔪᖅ ᖃᖓᐅᓂᐊᕐᓂᖓ ᐱᓕᕆᐊᒥᒃ ᖃᓄᐃᓕᐅᖅᐸᓪᓕᐊᓃᑦ ᓲᕐᓗ ᓴᓇᔭᐅᓂᖓ ᐊᐅᓯᐃᑐᖅᑕᓕᖕᓂᑦ ᐅᑭᐅᖁᑦ ᐃᓗᐊᕿᖓᑦ, ᐊᐅᓚᑦᑎᓂᖅ ᐊᑉᖁᑎᓂᒃ ᐃᖏᕐᕋᔭᒃᑐᓂᒃ, ᐸᕐᓇᐃᓂᖅ ᑯᒻᕖᑦ ᐃᓂᖏᓐᓂᒃ, ᐊᒪᓗ ᓴᓇᔭᐅᓂᖏᑦ ᐱᓕᕆᐊᕆᖃᑦᑕᕐᓂᕐᓗ ᐊᑉᖁᑏᑦ ᐃᒪᕐᒧᑦ ᑎᑭᑕᐅᑕᖅᑐᑦ. ᐊᓯᖏᑦ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᐅᔪᓂᒃ ᐃᓚᐅᔪᑦ ᐅᓗᕆᐊᓇᙱᑦᑐᒥᑦ ᓴᓇᓂᕐᒧᑦ ᐊᐅᓛᕐᓂᕐᒧᓪᓗ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᑦ ᐱᓕᕆᐊᑉ ᐃᓂᐊᑕ ᓴᓂᐊᓂᑦ, ᐊᐅᓚᑦᑎᓂᖅ ᑰᒃᑎᑦᑎᓂᕐᓅᖓᔪᓄᑦ ᐱᖁᑎᒋᔭᐅᔪᓂᒃ, ᓂᒡᓕᓇᖅᑎᑦᑎᖏᓐᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᔪᑦ, ᐊᒪᓗ ᐅᔭᕐᒃᔪᐊᖑᓂᖅᓴᓄᑦ ᐊᑉᖁᓯᐅᕐᓂᕐᒧᑦ.

ᐊᑐᓕᖅᑎᑦᑎᓂᖅ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᒨᖓᔪᓂᒃ, ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᐱᓕᕆᐊᒥᑦ ᐊᐅᓯᐃᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᓄᓇᐅᑉᓗ ᓂᕆᐅᒋᔭᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᐊᕐᓂᖓᓄᑦ ᐊᖏᓂᖓ, ᐱᓕᕆᐊᒦᓪᓗᓂ, ᑕᑭᔪᒥᒃ ᐊᑯᓂᐅᑎᒋᓂᖓ ᐊᒪᓗ ᐅᑎᖅᑎᑦᑐᖕᓇᖅᓗᓂ. ᓇᓗᓇᙱᓐᓂᐅᔪᖅ ᓇᓚᐅᑖᖅᑕᐅᔪᒥᑦ ᐃᓯᒪᒋᔭᐅᔪᖅ ᖁᑎᒃᑑᓂᖓᓂᒃ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᐅᔪᑦ ᐊᑐᖅᑕᐅᒐᔪᖕᒪᑕ ᐊᒪᓗ ᓈᒻᒪᒋᔭᐅᑉᓗᑎᒃ ᐊᑐᖅᑕᐅᖃᑦᑕᕐᓂᖏᑦ ᓴᓇᕙᓪᓕᐊᑎᓪᓗᒋᑦ ᐊᐅᓚᓕᖅᑎᓪᓗᒋᓪᓗ ᐅᔭᕋᖕᓂᐊᖅᑐᓕᕆᓂᖏᑦ ᐱᓕᕆᐊᑦ ᐊᐅᓯᐃᑐᖅᑕᖃᐅᓂᐅᔪᓂᑦ ᑲᓇᑕᐅ ᐅᑭᐅᖅᑕᖅᑐᖓᓂᑦ. ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᑦ ᐊᓯᐊᖑᕐᓂᖏᑦ ᐊᐅᓯᐅᑐᓄᑦ ᓄᓇᒥᒡᓗ ᓂᕆᐅᒋᔭᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᐊᕐᓂᖓ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ ᐊᓯᐅᔨᓂᖅ ᓄᓇᒥᒃ ᐊᒪᓗ, ᑕᐃᒪᓐᓇᓗᑦ, ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᐊᖏᔫᖏᓐᓂᖓᓂᒃ.

ᐊᓯᐊᖑᕐᓂᖅ ᓄᓇᐅᑉ ᖃᓄᐃᖓᓕᖓᓂᖏᓐᓂᑦ

ᓴᓇᕗᓪᓕᐊᑎᓪᓗᒋᑦ ᐊᐅᓛᓕᖅᑎᓪᓗᒋᓪᓗ, ᐃᓚᐅᑉᓗᑎᒃ ᐃᓗᑦᑐᖅᑎᓇᓂᖅ, ᐃᓕᐅᖅᑲᐃᓂᖅ ᑐᙵᕙᒃᓴᓂᒃ, ᐊᑉᖁᓯᐅᕐᓂᖅ, ᒥᕝᕙᓕᐅᕐᓂᖅ, ᑐᙵᕚᑦ ᐊᒪᓗ ᐃᓗᑦᑐᖅᓯᒪᔪᑦ, ᖄᒥᒃ ᐊᒃᑐᖅᓯᓂᖅᑲᕐᓂᐊᖅᑐᑦ ᐊᓯᐊᖑᖅᑎᑦᑎᔪᖕᓇᖅᑐᑦ ᐊᓯᐅᔨᓂᖅᑲᖅᑎᑦᑎᓗᑎᒡᓘᓐᓂᑦ ᐲᔭᐃᓂᖓᓄᑦ ᐅᕙᓘᓐᓂᑦ ᓴᐅᑎᓇᓂᖓᓄᑦ ᓄᓇᒥᑦ. ᑕᒪᓐᓇ ᐊᓯᐊᖑᖅᓯᓂᖅᑲᕈᖕᓇᖅᑐᖅ ᓄᓇᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ ᐊᒪᓗ ᐊᓯᐅᔨᓂᕐᒥᒃ ᐊᓯᐊᖑᖅᓯᓂᕐᒥᒡᓘᓐᓂᑦ ᓄᓇᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ ᓲᕐᓗ ᖃᑦᑎᒃᑐᐃᑦ. ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᐅᕐᓃᑦ ᐊᓯᐊᖑᖅᑎᑦᑎᔪᖕᓇᕐᒥᔪᑦ ᐊᐅᓯᐃᑑᑉ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ, ᐊᓯᐅᓂᖅᑲᖅᑎᑦᑎᔪᖕᓇᖅᑐᖅ ᐊᓯᐊᖑᖅᑎᑦᑎᓗᓂᓪᓘᓐᓂᑦ ᐊᐅᓯᒧᑦ ᓄᓇᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ.

ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᒨᖓᔪᑦ ᒥᒃᓵᒋᐊᖅᑎᑦᑎᓂᕐᒥᒃ ᐊᒪᓗ/ᐅᕙᓘᓐᓃᑦ ᐲᖅᑎᑦᑎᓂᕐᒥᒃ ᐱᑕᖃᕐᓃᖅᑎᑦᑎᓂᕐᒥᒃ ᐊᒃᑐᖅᑕᐅᓂᑦ ᓄᓇᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᐱᓕᕆᐊᖑᓂᐊᖅᑐᑦ ᐱᓕᕆᐊᑉ ᕐᑯᓄᐃᓐᓂᐊᕐᓂᕆᔭᖓᓂᑦ ᐱᓕᕆᓕᖅᐸᑕ ᐊᒪᓗ ᐃᓚᐅᑎᓪᓗᒍ ᒥᑭᓛᒐᓕᖅᑎᓐᓂᖅ ᐱᓕᕆᐊᑉ ᐃᓂᐊᓂᑦ

ᐸᒡᕕᓴᐃᓂᖅ, ᓄᓇᒥᒃ ᐊᒃᑐᖅᓯᑦᑕᐃᓕᓂᖅ, ᐊᒻᒪ ᒥᒃᓴᕆᐊᕐᓗᒍ ᐊᑐᕐᓂᖅ glaciofluvial-ᖃᖅᑐᓂᒃ ᓄᓇᓂᒃ. ᐱᓕᕆᐊᑉ ᖃᓄᐃᖓᓂᐊᕐᓂᖓ ᓄᓇᒥᒃ ᖃᓄᐃᖓᓕᕐᓂᖃᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᓄᓇᐅᑉᓗ ᐃᒪᐅᑉᓗ ᖄᖏᓐᓂᑦ ᐊᑐᓕᖅᑎᑕᐅᓂᖃᖅᑐᖅ, ᐃᓚᐅᔪᖃᖅᓱᓂ ᐸᕐᓇᐃᓂᖅ ᖃᓄᐅᑑᓂᐊᕐᓂᖏᓪᓗ ᑰᕙᓕᐊᑦ, ᐱᔭᕆᐊᖃᕆᙱᑦ.

ᐊᓯᐊᖑᕐᓂᖅᑕᖃᖅᐸᑦ ᓄᓇᐃᑦ ᖃᓄᐃᖓᓂᕆᔭᖏᓐᓄᑦ ᐱᓕᕆᐊᖅ ᐱᔾᔪᑎᒋᐸᓗᒍ ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖓᓃᓐᓂᐊᖅᑐᑦ ᐅᔾᔨᖕᓂᐊᕐᓂᐅᑉ LAA-ᖓᓂᑦ, ᐊᒻᒪ ᓴᓇᔭᐅᑎᓪᓗᒍᑐᐃᓐᓇᐅᓂᐊᖅᓱᓂ ᐊᒻᒪ, ᒥᑭᓂᖅᓴᐅᓂᐊᖅᓱᓂ, ᐊᐅᓚᖅᑎᓪᓗᒍ ᐅᒃᑯᐊᖅᑎᓪᓗᒍᓗ ᐱᓕᕆᐊᖅ. ᑲᑎᖦᖢᒋᑦ ᖄᖏᑦ ᖃᓪᓕᖅᑕᐅᓯᒪᔪᑦ alluvial, glaciomarine, ᐊᒻᒪ ᐅᔭᖅᑲᓂᒃ ᓯᕐᒥᓂᒡᓗ (till and moraine) ᓄᓇᐅᑉ ᖃᓄᐃᖓᓂᕆᔭᖏᑦ ᐅᔾᔨᖕᓂᐊᕐᓂᐅᑉ LAA-ᖓᓂᑦ, 0.6% (22 ha), 0.4% (ᒥᑭᓂᖅᓴᖅ 1 ha-ᒥᑦ), 3.8% (68 ha) ᐊᒻᒪ 2.4% (720 ha)-ᓗᐊᕐᒥᑦ ᐊᓯᐅᔨᓂᐊᖅᑐᑦ ᐱᓕᕆᐊᖑᓂᕐᒧᑦ ᖃᖏᑦ. 2.2%-ᓗᐊᑦ ᑲᑎᖦᖢᒋᑦ ᖄᖏᑦ ᖃᓪᓕᖅᑕᐅᓯᒪᔪᑦ ᐃᓕᔭᐅᑉᓗᑎᒃ ᓄᓇᐅᑉ ᖃᓄᐃᖓᓂᕆᔭᖓᓕᐅᖅᑐᑦ ᐅᔾᔨᖕᓂᐊᕐᓂᐅᑉ LAA-ᖓᓂᑦ ᐸᒡᕕᓭᑕᐅᓂᐊᖅᑐᑦ ᐱᓕᕆᐊᑉ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖏᓐᓄᑦ.

ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᓄᓇᐅᑉ ᖃᓄᐃᖓᓂᕆᔭᖏᓐᓄᑦ ᐅᑭᐅᓗᒃᑖᖅ ᐊᑉᕐᑯᑎᒦᓐᓂᐊᖅᑐᑦ RAA-ᒥᑦ, ᐊᒻᒪ ᓴᓇᔭᐅᑎᓪᓗᒍᑐᐃᓐᓇᐅᓗᓂ. ᓴᓇᔭᐅᓂᖓ ᐊᑉᕐᑯᑎ ᓴᐅᓯᓂᖅᑕᕐᑲᕐᓂᐊᖅᑐᖅ ᓄᓇᓂᑦ. ᑲᑎᖦᖢᒋᑦ ᖄᖏᑦ ᖃᓪᓕᖅᑕᐅᓯᒪᔪᑦ ᐃᓕᔭᐅᑉᓗᑎᒃ ᓄᓇᐅᑉ ᐅᑭᐅᓗᒃᑖᖅ ᐊᑉᕐᑯᑎᒧᑦ LAA-ᒥᑦ ᐃᓗᓕᖃᖅᑐᖅ 52,032 ha-ᓗᐊᓂᒃ. ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᖄᒧᑦ ᖃᓪᓕᖅᑕᐅᓯᒪᔪᑦ alluvial, glaciomarine, ᐊᒻᒪ ᐅᔭᖅᑲᓂᒃ ᓯᕐᒥᓂᒡᓗ ᓄᓇᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᔪᓂᒃ ᓂᕆᐊᕆᔭᐅᔪᑦ ᓴᐅᓯᒪᓂᐊᕐᓂᖏᓐᓄᑦ ᐊᑉᕐᑯᓯᐅᖅᑕᐅᔪᒪᔪᒥᑦ ᐅᓂᖕᖓᕐᑲᕐᓂᐊᖅᑐᖅ 6.65 ha (0.01%), 0.35 ha (ᒥᑭᓂᖅᓴᖅ 0.01%), 6.60 ha (0.01%), 65.76 ha (0.13%), ᐊᒻᒪ 148.02 ha (0.28%) ᑲᑎᓗᒃᑖᖅᖢᒋᑦ ᐃᓂᐅᔪᖅ ᐅᑭᐅᓗᒃᑖᖅ ᐊᑉᕐᑯᑎᒧᑦ LAA-ᒥᑦ.

ᐊᓯᐊᖑᕐᓂᐅᔪᓂᒃ ᐊᓯᐅᔨᓂᐅᔪᓂᒡᔫᓃᑦ ᐊᐅᓯᐃᑐᖅᑕᓕᖓᓂᒃ ᓄᓇᒥᑦ ᓂᕆᐅᕆᔭᐅᔪᑦ ᐱᑕᕐᑲᔾᔮᖏᓐᓂᖏᓐᓄᑦ, glaciofluvial-ᒥᑦ ᓄᓇᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᔪᑦ ᐊᒃᑐᖅᑕᐅᓂᖃᔾᔮᖏᒻᒪᑦ ᐱᓕᕆᐊᒧᑦ. ᐊᑐᓕᖅᑎᑦᑎᓂᖅ ᐊᖏᓗᐊᖏᕆᐊᖅᑎᑦᑎᓂᕐᔫᖓᔪᒥᒃ, ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᓄᓇᒥᒃ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᐊᕐᓂᖓᓄᑦ ᐊᖏᓂᐅᔪᒥᑦ, ᐃᓂᐅᔪᒥᒃ ᐊᖏᓗᐊᖏᓪᓗᓂ (ᐃᓂᐅᔪᒥᑐᐃᓐᓇᖅ), ᑕᐃᒪᐅᖏᓐᓇᕐᓗᓂ, ᐊᑕᐅᓰᕐᓗᓂᐅᔫᒃᓴᐅᔪᖅ, ᐊᒻᒪ ᐅᑎᖅᑎᓐᓂᖅ ᐊᔪᕐᓂᐊᖅᓱᓂ. ᓇᓗᓇᙱᓐᓂᐅᔪᖅ ᓇᓚᐅᑖᖅᑕᐅᔪᒥᑦ ᖁᑎᒃᑑᔪᖅ ᓇᓚᐅᑖᖅᑕᐅᓯᒪᖕᒪᑕ ᐊᑐᖅᓱᓂ ᐱᓕᕆᓂᑯᕆᔭᐅᔪᓂᒃ ᐊᔾᔮᐸᓗᖏᓐᓄᑦ ᐱᓕᕆᐊᓄᑦ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᖓᓂᑦ, ᐊᒻᒪ ᐊᖏᓗᐊᖏᕆᐊᖅᑎᑦᑎᓂᐅᔪᑦ ᐊᑐᖅᑕᐅᒐᔪᒪᑕ ᐊᒻᒪ ᓈᒻᒪᒋᔭᐅᑉᓗᑎᒃ ᐊᑐᖅᑕᐅᖃᑦᑕᕐᓂᕐᒧᑦ ᓴᓇᕗᓕᐊᑎᓪᓗᑦ ᐊᐅᓛᓕᖅᑎᓪᓗᑎᓪᓗ ᐅᔾᔨᖕᓂᐊᖅᑐᓕᕆᓂᕐᒧᑦ ᐱᓕᕆᐊᑦ ᐊᐅᓯᐃᑐᖅᑕᖃᐅᕐᓂᐅᔪᓃ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᖓᓂᑦ. ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᐃᓕᔭᐅᓂᕐᒧᑦ ᓄᓇᐅᑉ ᖃᓄᐃᖓᓕᕐᓂᖓᓄᑦ ᐱᓕᕆᐊᖅ ᐱᔾᔪᑎᒋᐸᓗᒍ ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᐊᑦᑎᒃᑑᓂᖓᓂᒃ ᖃᐸᓯᐅᓂᖏᑦ ᐊᒻᒪ, ᑕᐃᒪᓐᓇᒧᑦ, ᓂᕆᐊᕆᔭᐅᖏᑦᑐᑦ ᐊᖏᔩᖏᓐᓂᖓᓂᒃ.

ᐃᓂᐅᓂᐊᖅᑐᖅ ᐊᖏᓗᐊᖏᑦᑑᑎᓪᓗᒍ ᖄᒥᒃ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᐱᓕᕆᐊᖅ ᐱᔾᔪᑎᒋᐸᓗᒍ, ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᓄᓇᒧᑦ ᓂᕆᐅᕆᔭᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᐊᕐᓂᖓᓄᑦ ᐊᒻᒪ ᐃᓱᒪᕆᔭᐅᑉᓗᓂ ᐊᖏᔫᔾᔮᖏᓐᓂᖓᓄᑦ. ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᓄᓇᒧᑦ, ᐊᐅᓯᐃᑐᒧᑦ ᐊᒻᒪ ᓄᓇᐅᑉ ᖃᓄᐃᖓᓂᕆᔭᖓᓄᑦ ᓴᓇᔭᐅᕙᓪᓕᐊᓂᖅ ᐊᐅᓚᖅᑎᓪᓗᒍᒧᓪᓘᖓᔪᓄᑦ ᓂᕆᐅᕆᔭᐅᔪᑦ ᐃᑲᔪᐃᓂᖃᕐᓂᐊᕐᓂᖏᓐᓄᑦ ᑲᑎᑉᐸᓪᓕᐊᓂᕐᒧᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓄᑦ ᓄᓇᒧᑦ RAA-ᒥᑦ.

ᓄᓇᒥᒃ ᖃᐅᔨᓯᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᐊᑐᕐᓂᐊᖅᑐᓂᒃ ᓴᖅᑭᑎᓂᐊᖅᑐᑦ ᐱᓕᕆᐊᖅ ᓇᐅᑰᖅᑎᓪᓗᒍᓗᒃᑖᖅ ᐃᓚᐅᑎᓪᓗᒍᓗ ᐊᐅᒃᐸᓪᓕᐊᔪᒥᒃ ᐃᑎᔪᒥᒃ ᖃᐅᔨᓯᐊᖃᑦᑕᐅᑎᒥᒃ ᐅᔾᔨᖕᓂᐊᕐᕕᖕᒥᑦ, ᐅᔾᔨᖕᓂᐊᕐᕕᖕᒧᑦ

ᐊᒃᑐᖅᑕᐅᓯᒪᔪᑦ ᐊᑉᖁᑏᓪᓗ, ᐃᐸᔨᑦ ᐆᒃᑐᕋᖅᑕᐅᓂᖏᑦ ᐊᒻᒪ ᖃᐅᔨᓴᖅᑕᐅᓂᖏᑦ, ᐊᒻᒪ ᓄᓇᒥᒃ ᖃᐅᔨᓴᕆᐊᖃᑦᑕᕐᓂᖅ ᖃᓄᐃᙶᓂᕆᔾᔪᙶᓄᑦ ᐅᔾᔪᕈᓂᐊᕐᕕᒃ ᐱᕙᓪᓕᐊᑎᓪᓗᒍ ᐊᒻᒪ ᓴᓂᐊᓃᑐᓂᒃ. ᓱᑐᖅᑲᐃᑦ ᖃᓄᐃᓐᓂᕆᔾᔪᑎᖓᓄᑦ ᖃᐅᔨᕆᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᐊᑐᕐᓂᐊᖅᑐᑦ ᐃᓕᔭᐅᓂᐊᖅᑐᑦ, ᐱᔭᕇᐊᖃᖅᐸᑦ.

ᐊᒃᑐᖅᑕᐅᓃᑦ ᓯᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᙶᓄᑦ ᓄᓇᒥᒃ

ᓄᓇᐅᑉ ᐊᓯᐊᙳᕐᓂᖓ ᓂᕆᐊᕆᔭᐅᔪᖅ ᑕᑯᓂᖓ-ᐊᑯᓂᐅᔪᒥᒃ ᐊᒃᑐᖅᑕᐅᓂᖃᕐᓂᐊᕐᓂᙶᓂᒃ ᐊᐅᓯᐃᑐᐃᑦ ᓄᓇᐅᑉᑐ ᖃᓄᐃᓐᓂᕆᔾᔪᑎᖓᓄᑦ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᙶᓂᑦ. ᑭᓯᐊᓂ, ᐊᖏᓂᕆᔾᔪᙶ ᖃᓄᑎᕆᐅᓂᙶᓗ ᑕᒪᒃᑯᐊ ᖃᓄᐃᙶᓕᕈᑕᐅᔪᑦ ᖃᓄᐃᙶᓕᖅᑎᑦᑎᓂᐅᔪᓂᒃ ᖃᓄᑎᕆᐅᓂᙶᓄᑦ ᐊᒻᒪ ᐆᓐᓇᖅᓯᕙᓪᓕᐊᓂᕐᒧᑦ ᐊᑐᕐᓂᐊᖅᑐᑦ. ᐆᓐᓇᕐᓂᕐᒥᒃ ᐆᒃᑐᕋᐃᓂᕐᒧᑦ ᖃᓄᐃᙶᓂᐅᔪᑦ ᑕᑭᔪᒥᒃ-ᐊᑯᓂᐅᑎᕆᔪᒧᑦ (2000 ᐅᑭᐅᑦ) ᓯᓚᐅᑉ ᖃᓄᐃᓐᓂᐊᕐᓂᙶᓄᑦ ᐱᓕᕆᐊᑉ ᐃᓂᙶᓄᑦ ᓇᓗᓇᐃᖅᓯᔪᖅ ᐊᕿᒍᑕᓛᑦ ᓄᓇᐅᑉ ᖄᙶᑕ ᐆᓇᕐᓂᙶ ᖁᑦᑎᒃᓯᒃᐸᑦ, ᐊᓯᐊᙳᕐᓃᖅ ᐊᐅᓯᐃᑑᑉ ᐃᑎᓂᙶᓄᑦ ᓇᓗᓇᔾᔮᖏᑦᑐᖅ ᑭᒡᓕᐅᔪᒥᑦ ᑭᓯᐊᓂ ᖄᙶᓂᐅᖏᑦᑐᖅ. ᐊᒃᑐᖅᑕᐅᓯᒫᖏᑦᑐᖅ ᓄᓇᐅᑉ ᖄᙶ (ᓄᓇᑐᖅᑲᖅ) ᐊᐅᓯᐃᑐᖅᑕᖅᑲᐃᓐᓇᕐᓂᐊᖅᑐᒃᓴᐅᔪᖅ ᓯᓚᐅᑉ ᐆᓇᖅᓯᕙᓪᓕᐊᓂᙶ ᐊᐅᓚᓂᖅᑲᖅᐸᑦ 5°C-ᒥᑦ ᐊᕿᒍᑕᓛᑦ ᓄᓇᐅᑉ ᖄᙶᑕ ᐆᓇᕐᓂᙶᓂᑦ. ᐊᑐᓕᖅᑎᐸᑦ ᐊᐅᓯᐃᑐᓄᑦ ᑐᕋᙶᔪᑦ ᐃᓱᒪᒃᓴᖅᓯᐅᕐᓂᒃᑯᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᓂᒃ ᑕᑯᓂᖓ-ᐊᑯᓂᐅᓂᖓ ᓯᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᙶᓄᑦ ᐅᑭᐅᖅᑕᖅᑐᒥᑦ, ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᓄᓇᒧᑦ ᓂᕆᐅᕆᔭᐅᔪᑦ ᒥᑭᑦᑐᓂᙶᓂᒃ ᑭᒡᓕᕆᔭᐅᔾᔪᑉ ᖃᓄᐃᓐᓂᕆᔾᔪᙶᓄᑦ ᐊᒻᒪ ᕿᒪᒃᑎᑦᑐᓄᑦ ᖃᓄᐃᙶᓕᕈᑏᑦ ᓂᕆᐊᕆᔭᐅᖏᑦᑐᑦ ᐊᖏᔫᖏᓐᓂᙶᓄᑦ.

ᑕᐅᑦᑲᑐᒍ ᖃᐅᔨᓴᐃᓂᖅ ᐃᐳᓄᑦ ᐊᒻᒪ ᐱᕈᖅᑐᓄᑦ

ᒫᓇᐅᔪᖅ ᐊᕙᑎᐅᔪᖅ - ᐃᐸᔨᑦ

ᐃᐸᔨᑦ ᐱᓕᕆᐊᑉ ᖃᓂᑕᙶᓂᑦ ᑕᐅᒪᐅᔪᑦ ᑲᔪᓯᔪᒥᒃ ᐊᐅᓯᐃᑐᖅᑕᖃᕐᓂᕐᒧᑦ 2m-ᒥᒃ ᖃᓪᓕᐅᔪᑦ ᐃᐸᔩᑉ ᖄᙶᓂᑦ. 12-ᙳᔪᓂᒃ ᐃᐸᔨᑦ ᖃᓄᐃᑑᓂᖏᑦ Turbic Cryolol-ᒧᑦ, Static Cryosol ᐊᒻᒪ Organic Cryosol ᓇᓗᓇᐃᖅᑕᐅᓯᒪᓂᖏᑦ ᑲᑎᕐᒪᖃᑕᐅᔪᓂᑦ ᑎᑎᕋᐅᓯᐅᓚᐅᖅᑐᑦ RAA-ᒥᑦ.

ᐃᐸᔨᑦ ᐃᓗᓕᖃᖅᑐᑦ ᐱᕈᖅᑐᓂᒃ ᖄᖃᖅᓱᑎᒃ ᓵᑐᒥᒃ ᐱᕈᖅᑐᓂᒃ ᓯᑯᓯᒪᔩᑉ ᖄᙶᓂᑦ, ᐊᔾᔨᕌᖏᑦᑐᑦ ᐃᐸᔨᓂᖏᑦ 1m-ᒥᒃ ᐅᔭᖅᑲᐃᑦ ᖄᖏᓐᓂᑦ 4m ᐅᖓᑖᓄᑦ ᐃᓗᑐᓂᕐᓂᑦ. ᐃᑎᓂᐅᔪᑦ ᖃᓪᓕᖅᐹᓄᑦ ᐃᐸᔪᓄᑦ ᑕᐃᒪᐅᔪᑦ ᐅᑎᖅᑎᑎᓇᓂᕐᒧᑦ (ᐱᕈᖅᑐᑦ ᖃᓪᓕᐅᔪᑦ ᐃᓚᖃᖅᓱᑎᒃ ᐊᑯᓪᓕᓪᓕᖓᓂᒃ ᐃᐸᔪᓂᒃ, ᐅᕙᓘᓃᑦ A horizon) 11cm-ᓗᐊᖅ, ᒥᑭᓖᑯᖓᐸᓗᓂ 3cm-ᒥᒃ ᓄᓇᖅᐸᓯᖕᒥᑦ ᐱᕈᖅᑐᓂᑦ, (Regosolic Turbic Cryosols), ᐊᒻᒪ ᐊᖏᓖᒃᑯᑦ 31 cm-ᙳᔪᖅ ᐊᑦᑎᒃᑐᒥᑦ ᑭᓂᐸᔪᒥᑦ ᓄᓇᐅᔪᓂᑦ ᐃᐸᔪᔪᓂᒃ peats (Organic Cryosols)-ᖃᖅᓱᑎᒃ. 54%-ᓗᐊᑦ ᖄᖓᑕ ᐃᐸᔪᓂᖓ ᓇᓂᑐᐃᓐᓇᖅ peat organic-ᙳᔪᖅ. Till ᐲᖅᑕᐅᔪᖅ ᐃᐸᔪᓂᑦ ᕿᑎᕈᔪᐊᓃᑐᖅ, ᓯᐅᕋᖅᑕᖃᐅᖅᓱᑎᒃ. ᑕᐃᒪᓐᓇᐃᑐᑦ ᐊᑦᑎᒃᑑᔪᑦ ᖄᒥᑦ, ᐊᖏᒡᓕᕙᓪᓕᐊᐸᓗᑎᒃ ᐃᑎᓂᖅᓴᒧᐊᖅᐸᓪᓕᐊᓂᖅ ᒪᓕᒃᓱᒍ.

ᐱᖓᓯᐃᑦ ᑭᒡᓕᐅᔪᑦ ᐃᐸᔪᓄᑦ ᐆᒃᑐᕋᐃᓃᑦ ᑭᒡᒐᕕᖕᒥᑦ ᖁᑦᑎᒃᓯᓯᒪᓂᖃᓚᐅᖅᑐᑦ ᒥᑭᑦᑐᓂᒃ Canadian Council of Ministers of the Environment (CCME) Industrial ᐃᐸᔪᓄᑦ ᒪᓕᒃᑕᐅᔪᒃᓴᖏᑦᑎᒍᑦ (CCME 2009): ᐊᑕᐅᓯᖅ ᐆᒃᑑᑎ ᖁᑦᑎᒃᑐᒥᒃ arsenic-ᒥᒃ ᑲᑎᓯᒪᔪᓂᒃ ᐱᖃᓚᐅᖅᑐᖅ, ᐊᒻᒪ ᒪᕐᕉᒃ ᐆᒃᑑᑏᒃ ᖁᑦᑎᒃᓯᓯᒪᔪᒥᒃ ᑲᑎᓯᒪᔪᓂᒃ molybdenum-ᖃᖅᓱᑎᒃ. ᓯᑕᒪᐃᑦ ᑖᓪᓚᒪᐅᔪᓂᒃ ᑭᒡᓕᒧᑦ ᐆᒃᑐᕋᐅᑏᑦ ᑲᑎᑕᐅᔪᑦ ᑭᒡᒐᕕᖕᒥᑦ ᖁᑦᑎᒃᓯᓯᒪᔪᒥᒃ boron-ᖃᓚᐅᖅᑐᑦ ᐃᐸᔪᓄᑦ ᒪᓕᒃᑕᐅᔫᒃᓴᓂᑦ. ᐆᒃᑑᑎᓂᒃ Sissons-ᒥᑦ ᖁᑦᑎᒃᓯᓯᒪᓂᖅᑕᖃᓚᐅᖏᑦᑐᖅ ᑲᑎᓯᒪᔪᓂᑦ. ᐆᒃᑑᑎᓂᒃ ᐃᓂᐅᔪᓂᒃ ᖁᑦᑎᒃᓯᓯᒪᓂᖅᑕᖃᓚᐅᖏᑦᑐᖅ radionuclide ᑲᑎᓯᒪᔪᓂᑦ.

ᐊᕙᑎᒧᑦ ᐊᑦᑐᖅᑕᐅᓃᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐃᐸᔪᓄᑦ

ᐃᓕᑕᕆᔭᐅᔪᑦ ᐃᐸᔪᓄᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᐃᐸᔪᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᖃᓄᑎᒋᐅᓂᖏᓐᓄᓪᓗ. ᐊᓯᐊᙳᕐᓂᐅᔭᖕᓇᖅᑐᑦ ᐃᐸᔪᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᓄᓇᒥᑦ ᓴᓇᕗᓪᓚᐊᓂᕐᔫᑐᐃᓐᓇᓇᐊᖃᖅᑐᖅ, ᐅᓴᕋᖕᓂᐊᖅᑐᓚᓇᓂᕐᒥᑦ, ᐊᒻᒪ ᓯᕐᑲᓪᓚᑎᓇᓂᕐᒥᑦ. ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᐃᐸᔪᐃᑦ ᖃᐸᓯᐅᓂᕆᔭᖏᓐᓄᑦ ᓴᓇᕗᓪᓚᐊᓂᕐᔫᑐᐃᓐᓇᓇᐊᖃᖅᑐᖅ ᐊᒻᒪ ᓄᓇᒥᑦ ᓄᖅᑲᖅᐸᓪᓚᐊᓂᕐᒧᑦ ᑭᖑᓪᓚᖅᐹᒃᑯᑦ ᐅᒃᑯᐊᕐᓂᕐᒧᑦ. ᐱᒪᕆᐅᓂᖓ ᐃᐹᔾ ᐃᓚᒋᔭᐅᓂᖓ ᐃᓗᐅᑐᕐᒥᑦ ᐊᕙᑎᒥᑦ ᐃᓕᑕᕆᔭᐅᓚᐅᖅᑐᖅ ᐅᖃᐅᓯᐅᔭᓂᒃ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓄᑦ ᐊᐱᖅᓱᐃᓂᕐᓂᑦ ᐊᒻᒪ ᐃᓚᐅᖃᑕᐅᕈᓘᔭᕐᓂᐅᔭᓂᒃ (EN-ᑮᓇᐅᔮᒃ ᐱᓕᕆᐊᒧᑦ ᐅᖃᐅᓯᐅᔪᑦ 2009[13], IQ-BLE 2009[14]).

ᐊᓯᐊᙳᕐᓂᖅ ᐃᐸᔪᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ

ᐊᓯᐊᙳᕐᓅᑦ ᐃᐸᔪᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᑦ ᐊᑐᖅᓱᑎᒃ ᐊᓂᖅᓵᖅᑐᖅᑕᑉᐸ ᖃᓄᐃᓐᓂᕆᔭᕆᓐᓄᑦ ᐊᑐᖅᑕᐅᔪᒃᓴᖅ ᓇᓚᐅᑖᕐᓂᕐᒧᑦ acid ᐋᓯᑖᖅᐸᓪᓚᐊᓅᑦ (PAI) ᐱᓕᕆᐊᒥᑦ ᐅᓴᕋᖕᓂᐊᕐᓂᕐᒧᑦ ᐃᓂᓕᐅᖅᑕᐅᔪᒪᔪᓂᑦ, ᐊᒻᒪ ᐳᔪᖃᑖᓄᑦ (ᓴᕖᑦ ᐊᒻᒪ radionuclides) ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓂᑦ. ᐊᑦᑐᖅᓯᓂᑲᓪᓚᐅᔪᑦ ᐃᐸᔪᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᐊᓯᐊᙳᕐᓂᕆᓐᓄᑦ ᐃᓚᒋᔭᐅᔪᓄᑦ ᐃᓱᒫᓘᑕᐅᔪᓂᒃ (COPC) ᑲᑎᓯᒪᔪᑦ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᕐᒥᔪᑦ ᐊᑐᖅᓱᑎᒃ ᖃᓄᐃᓐᓂᖅᓴᐅᓂᕐᒥᒃ CCME-ᒧᑦ ᐊᒻᒪ ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᑭᒡᓕᐅᔪᒧᑦ ᖃᓄᐃᙵᓂᐅᔪᑦ. ᐊᓯᐊᙳᕐᓂᐅᔭᖕᓇᖅᑐᑦ ᐃᐸᔪᐃᑦ ᖃᓂᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᐊᒃᐸᓪᓕᖅᑎᓇᓂᕐᒧᑦ, ᓯᑎᒃᑎᓇᓂᕐᒧᑦ, ᐊᒻᒪ ᓱᕋᒃᑐᑦ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᕆᑦ ᐊᑐᖅᓱᑎᒃ ᓯᓚᒥᑦ ᐊᒻᒪ ᓴᓇᔭᐅᔪᓕᓇᓂᕐᒧᑦ ᐱᓕᕆᐊᖅ ᐱᕙᓪᓕᐊᑎᓪᓗᒍ.

ᐊᕐᕌᒍᕐᕿᑎᕐᖁᑎᓂᖁᒻᒪᔪᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᓄᑦ ᐃᐸᔪᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄ ᑕᐅᑐᒐᖃᕐᓂᐊᖅᑐᑦ ᒥᒃᓵᕆᐊᖅᑎᑦᑎᓂᕐᒥᒃ ᐊᒻᒪ/ᐅᕙᓘᓅᑦ ᓯᓚᒧᐊᖅᐸᓪᓚᐊᑎᑦᑎᑕᐃᓕᒪᓂᕐᒧᑦ ᐳᔪᕐᓗᕐᓂᑦ, ᐃᐸᔪᐃᑦ ᐱᐅᕆᑦᑐᓂᒃ radiation-ᒥᑦ, ᐃᐸᔪᒥᒃ ᐊᒃᐸᓪᓕᖅᑎᓇᓂᕐᒥᒃ ᓴᓇᕗᓪᓚᐊᓂᖅ ᐱᔮᔪᑎᕆᐸᓗᒍ, ᐊᒻᒪ ᐃᐸᔪᓂᒃ ᓯᑎᒃᑎᓇᓂᕐᒧᑦ ᓱᕈᖅᑐᓄᓪᓗ ᐱᓕᕆᐊᐸ ᐊᐅᓛᕐᓂᖓᓂᑦ. ᐊᕐᕌᒍᕐᕿᑎᕐᖁᑎᓂᖁᒻᒪᔪᑦ ᐳᔪᖄᓗᐊᕐᕿᑎᑎᔪᑦ ᐊᒻᒪ ᒥᒃᓵᑎᑦᑎᐸᓗᑎᒃ ᐳᔪᕐᒥᑦ ᐱᓕᕆᐊᒧᑦ ᐊᑐᓕᖅᑎᑕᐅᓂᐊᖅᑐᖅ.

ᐊᓂᖅᓵᖅᑐᖅᑕᑉᐸ ᖃᓄᐃᓐᓂᕆᔭᖓ ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᐊᓯᐊᙳᖅᑎᑦᑎᔪᖅ COPC-ᓂᒃ ᑲᑎᓯᒪᔪᓂᒃ ᐃᐸᔪᓂᑦ ᐊᑦᑎᖕᓂᖅᓴᐅᓂᐊᖅᑐᑦ CCME (2009)-ᒥᑦ ᐃᐸᔪᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᒪᓕᒃᑕᐅᔪᒃᓴᓂᒃ. 81 ha-ᓗᐊᑦ ᑭᒡᒐᕗᐅᑉ ᐅᓴᕋᖕᓂᐊᕐᕗᐅᑉ ᓯᓚᑖᓂᑦ ᐊᑦᑐᖅᓯᑐᐃᓐᓇᓇᐊᖃᖅᑐᖅ PAI-ᓂᒃ ᖁᑦᑎᖕᓂᖅᓴᖅ ᓈᓴᐅᑎᐅᔪᓂᒃ. ᐱᓕᕆᐊᒥᒃ ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᑦᑐᖅᑕᐅᓃᑦ ᐃᐸᔪᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᓯᓚᒧᑦ ᐳᔪᕐᓗᐃᑦ ᐊᓂᐊᓂᕆᓐᓄᑦ ᐊᒻᒪ ᐳᔪᖃᑖᓂᒃ ᓂᕆᐊᕆᔭᐅᔪᑦ ᐊᑦᑎᖕᓂᐊᕐᓂᕆᓐᓄᑦ ᐊᕆᓂᐅᔪᒥᑦ ᐊᒻᒪ ᖃᓂᑦᑐᒥᐅᓂᐊᖅᓘᓂ ᓄᓇᐅᑉ ᑭᒡᓕᖓ ᑕᐅᑐᒃᓗᒍ, ᐊᒻᒪ ᑲᔪᓯᓂᐅᓂᐊᖅᑐᒃᓴᐅᑉᓗᓂ ᖃᐹᔾᖅᑕᖃᑦᑕᕐᓂᖓ ᑕᑭᓂᖓᓗ ᐊᑭᓂᐅᓗᓂ ᑭᓯᐊᓂ ᐅᑎᖅᑎᑐᕐᓇᖅᓗᓂ.

ᐃᐸᔪᓂᒃ ᓯᑎᒃᑎᓇᓂᖅ ᐱᓕᕆᐊᐸ ᐃᓂᖓᑕ ᐃᓗᐊᓃᓐᓂᐊᖅᑐᖅ, ᐊᒻᒪ ᐊᑦᑎᒃᑑᓗᓂ ᐊᕐᕿᓂᐅᔭᒥᒃ ᑕᒪᕐᒥᒃᓴᐃᑦ ᐃᐸᔪᐃᑦ ᖃᓄᐃᑑᓂᕆᑦ ᐃᓕᑕᕆᔭᐅᔪᑦ ᐱᓕᕆᐊᐸ ᐃᓂᖓᓂᑦ ᓯᑎᒃᑎᒐᒃᓴᐅᖃᑦᑕᙳᕆᒻᒪᑕ ᓯᐅᕋᔾᔪᒍᓂᕆᓐᓄᑦ ᐊᒻᒪ ᓯᐅᕋᕆᑦᑐᖃᐅᕐᓂᖓᓄᑦ. ᐊᑐᓕᖅᑎᑦᑎᓂᖅ ᐊᕐᕌᒍᕐᕿᑎᕐᖁᑎᓂᖁᒻᒪᔪᓂᒃ, ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᑦᑐᖅᑕᐅᓃᑦ ᐃᐸᔪᐃᑦ ᐊᒃᐸᓪᓕᖅᑐᖅᑕᐅᓂᕆᓐᓄᑦ ᓱᕋᕐᓂᕐᒧᑦ ᓂᕆᐊᕆᔭᐅᔪᑦ ᒥᑭᑦᑑᓂᖓᓄᑦ. ᕿᒪᒃᑎᑦᑐᓄᑦ

ᐅᖃᐅᓯᐅᔪᑦ 2009: ᑕᒪᐃᓂᒃ ᓂᕐᔪᑏᑦ ᓂᕆᖃᑦᑕᖅᑕᕗᑦ ᐱᐅᔪᒥᑦ ᐃᐸᔪᒥᑦ ᐊᑐᖃᑦᑕᖅᑐᑦ.

[13] EN-ᑮᓇᐅᔮᒃ ᐱᓕᕆᐊᒧᑦ ᐊᖃᓪᓚᐅᓰᑦ 2009: ᑕᒪᐃᓂᒃ ᓂᕐᔪᑏᑦ ᓂᕆᖃᑦᑕᖅᑕᕗᑦ ᐱᐅᔪᒥᑦ ᐃᐸᔪᒥᑦ ᐊᑐᖃᑦᑕᖅᑐᑦ.
[14] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-BLE 2009: ᐃᓐᓇᑐᖃᐃᑦ ᐃᓱᒫᓘᑎᖃᖅᑐᑦ ᓄᖑᓯᐃᑐᖅ ᒪᓂᕋᒧᐊᖑᐊᒃᓴᖓᓂᒃ ᓯᕋᐃᓗᓂᓗ.

ᖃᓄᐃᓐᖓᓕᕈᑏᑦ ᐃᐸᔪᓂᒃ ᓯᑎᒃᑎᑎᑦᑎᓂᕐᒧᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᖕᖏᓐᓂᒃ ᐊᕐᕌᓂᖓ, ᐱᓕᕆᐊᒦᓐᓂᐊᖅᑰᓂ, ᕿᑎᐊᓂᑦ ᐊᑯᓂᐅᓂᖓ, ᑲᔪᓯᓗᓂ ᖃᐸᔫᖅᑕᖃᑦᑕᕐᓂᖓ, ᐊᒻᒪ ᐅᑎᖅᑎᑦᑐᙳᕐᓂᐊᖅᑰᓂ. ᕿᒪᒃᑎᑦᑐᓄᑦ ᖃᓄᐃᓐᖓᓕᕈᑏᑦ ᐃᐸᔪᑦ ᖃᓄᐃᓐᖓᓂᓇᓱᖕᖏᓐᓄᑦ ᐃᐸᔪᑦ ᐊᑯᐸᓕᖅᑐᖅᑕᐅᖃᑦᑕᕐᓂᖕᖏᓐᓄᑦ ᓯᕋᖕᓂᕐᒧᑦᑐ ᓂᓇᐅᕆᔭᐅᔪᑦ ᒥᑭᑑᓂᐊᕐᓂᖓᓄᑦ. ᑕᒪᐃᓄᑦ, ᐊᓯᐊᕗᕐᓂᐅᔪᑦ ᐃᐸᔪᑦ ᖃᓄᐃᓐᓂᓇᓱᖕᖏᓐᓄᑦ ᐱᓕᕆᐊᒥᑦ ᐱᔪᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᐊᕐᕿᔫᕐᖏᓐᓂᖓᓄᑦ.

ᖃᐅᔨᕆᐊᖃᑦᑕᕐᓂᖅ ᐃᐸᔪᑦ ᖃᓄᐃᓐᓂᓇᓱᖕᖏᓐᓂᒃ ᖃᐅᔨᓴᐃᓂᒃᑯᑦ ᐃᐸᔪᓂᒃ ᐆᒃᑐᕋᐅᑎᓂᒃ, ᓯᓚᒧᑦ ᐳᔪᕐᒧᐃᑦ ᐊᓂᐊᓂᖕᖏᓐᓄᑦ ᐊᒻᒪ ᐳᔪᖃᑖᖅ ᑕᐃᒪᐅᖃᑦᑕᕐᓂᐊᖅᑐᖅ ᐱᓕᕆᐊᖅ ᐊᐅᓛᕐᓂᓇᓱᖓᓂᑦ. ᖃᓄᐃᓂᖅᓴᐅᓂᐅᔪᑦ ᖃᐅᔨᓴᐃᓂᐅᔪᓂᒃ ᖃᓄᐃᖓᓂᐅᔪᓂᐅᓂᐊᖅᑐᖅ ᐃᐸᔪᓂᒃ ᐆᒃᑐᕋᐅᑎᓂᒃ ᑕᒪᐃᓄᑦ ᓯᓚᒧᑦ ᐳᔪᕐᒧᐃᑦ ᐊᓂᐊᔪᓄᑦ ᐳᔪᖃᑖᓄᑉᒧ ᖃᓄᐃᖓᓂᐅᔪᓄᑦ, ᐊᒻᒪ ᑭᒡᓕᐅᔪᓄᑦ CCME ᒪᓕᒃᑕᐅᔫᖅᓴᖕᖏᓐᓄᑦ ᐃᓕᑕᖅᓯᓂᕐᒧᑦ ᐊᒻᒪ ᒥᒃᓵᕆᐊᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᒃᑐᖅᓯᓂᑲᓪᓚᐅᔪᒥᑦ ᐃᐸᔪᑦ ᖃᓄᐃᓐᓂᓇᓱᖕᖏᓐᓄᑦ ᐱᓕᕆᐊᒥᑦ ᐱᔪᓄᑦ.

ᐊᓯᐊᕗᕐᓂᖅ ᐃᐸᔪᑦ ᖃᓄᑎᕆᐅᓂᖓᓄᑦ

ᐊᓯᐊᕗᕐᓂᐅᔪᑦ ᐃᐸᔪᑦ ᖃᓄᑎᕆᐅᓂᖓᓄᑦ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᑦ ᐊᑐᖅᑰᑎᒃ ᐊᕐᕆᓚᖁᖓᔪᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᒃᑐᖅᑕᐅᓂᖕᖏᓐᓄᑦ ᐱᓕᕆᐊᒥᑦ. ᐊᒃᑐᖅᑕᐅᓂᕐᒧᑦ ᐊᑐᖅᑐᑦ ᐃᑲᔪᐃᓂᖃᕈᖕᓇᖅᑐᑦ ᐊᓯᐊᕗᖅᑐᓄᑦ ᐃᐸᔪᑦ ᖃᓄᑎᕆᐅᓂᖓᓄᑦ ᐱᓕᕆᐊᖅ ᐱᕙᓪᓚᐊᑎᓪᓗᒍ ᐃᓚᐅᔪᑦ ᐃᐸᔪᓂᒃ ᖄᒥᑐᓂᒃ ᐋᔭᐃᓂᖅ, ᐃᐸᔪᑦ ᓱᑯᖅᑐᑦ, ᐃᐸᔪᑦ ᓅᑕᐅᓂᖕᖏᑦ, ᐊᒻᒪ ᐃᐸᔪᑦ ᓴᐅᔭᐅᔪᑦ.

ᐊᕐᕿᓗᐊᕐᕿᕆᐊᖅᑎᑦᑎᓂᕐᒨᕐᖓᔪᑦ ᐃᓕᑕᓇᔭᐅᔪᑦ ᒥᒃᓵᕆᐊᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᒻᒪ/ᐅᕙᓘᓐᓃᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᐱᓕᕆᐊᒥᑦ ᐃᐸᔪᑦ ᖃᓄᑎᕆᐅᓂᖓᓄᑦ ᐃᓚᐅᔪᑦ ᓴᓇᔭᐅᓂᖓᓄᑦ ᐊᒻᒪ ᑐᖅᑯᖅᓯᒪᕗᕕᖕᒧᑦ ᐸᕐᓇᐅᑏᑦ, ᐊᒻᒪ ᐃᐸᔪᑦ ᓅᑕᐅᓂᖕᖏᑦ ᐸᐸᑐᖕᓂᕐᒧᑦ ᐋᖅᑕᐅᔪᑦ ᖄᖕᖓᓂᑦ ᐅᑎᖅᑎᑦᑎᓇᓂᕐᒧᑦ. ᐱᓕᕆᐊᐸ ᖃᓄᐃᑑᓂᐊᕐᓂᖕᖓᓅᖕᖓᔪᑦ, ᓱᕈᖅᑐᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᖅᑐᑦ, ᐊᒻᒪ ᐃᐸᔪᑦ ᓴᐅᔭᐅᔪᓂᒃ ᐊᕐᕿᓗᐊᕐᕿᑎᑦᑎᕆᐊᕐᓂᐅᔪᑦ ᓴᓇᔭᐅᑎᓪᓗᒍ ᐃᓚᐅᓕᖅᑎᑕᐅᓂᐊᕐᒥᔪᑦ ᐱᓕᕆᐊᒧᑦ ᒥᒃᓵᕆᐊᖅᑎᓐᓂᕐᒧᑦ ᐊᓯᐅᔨᓂᖅ.

ᐱᓕᕆᐊᐸ ᐱᕙᓪᓕᐊᓂᖓ ᐊᑐᕐᓗᒍ ᓂᕈᐊᖅᑕᐅᔪᖅ, ᐱᓕᕆᐊᖅ ᐊᒃᑐᖅᓯᓂᐊᖅᑐᖅ ᒧᓇᒥᒃ 931 ha ᐊᒻᒪ 1,205 ha ᐊᑯᓐᓂᖓᓐᓂᑦ, ᒥᑭᓂᖅᓴᐅᔪᖅ 1 %-ᒥᒃ ᑲᑎᓯᒪᔪᓂᒃ LAA-ᓂᑦ. ᑕᒡᕙᓂ ᒧᓇᐅᔪᒥᑦ 645 ha-ᒧᐊᑦ ᐊᓯᐊᔨᔭᐅᓂᐊᖅᑐᖅ ᖄᒥᑦ ᐋᔭᐃᓂᕐᒧᑦ, ᐊᒻᒪ 286 ha ᐊᒻᒪ 560 ha ᐊᑯᓐᓂᖕᖏᓐᓂᒃ ᐊᓯᐅᔨᓂᐊᖅᑐᑦ ᓴᐅᔭᐅᓂᖓᓄᑦ ᐃᐸᔪ.

ᐱᓕᕆᐊᒥᑦ ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᐃᐸᔪᑦ ᖃᓄᑎᕆᐅᓂᖓᓄᑦ ᓂᕆᐅᕐᔭᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᐊᕐᓂᐊᖓᓄᑦ ᐊᕐᕆᓂᖓ, ᐃᓂᐅᔪᒦᑦᑐᓂ ᐊᒻᒪ ᐅᑎᖅᑎᑦᑐᙳᕐᑐᓂ. ᖃᓄᖅ ᐊᑯᓂᐅᑎᕆᓂᖓ ᖃᓄᐃᓐᖓᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᐃᐸᔪᑦ ᖃᓄᑎᕆᐅᓂᖓᓄᑦ ᖃᐅᔨᔭᐅᔪᙳᕐᓂᐊᖅᑐᑦ ᐊᔾᔨᑉᕆᑦᑑᓂᐊᖅᑐᖅ ᖃᓄᐃᓐᖓᓕᖅᑎᑦᑎᓂᕐᒨᕐᖓᔪᑎᒍᑦ, ᓇᐃᑐᒥᑦ ᖃᓄᑎᕆᐅᓂᖓᓂᑦ (ᓲᕐᓗ ᐃᐸᔪ ᓅᑕᐅᓂᖓ), ᕿᑎᐊᓄᑦ ᖃᓄᑎᕆᐅᓂᖓᓄᑦ (ᓲᕐᓗ ᐃᐸᔪ ᓱᑯᒃᑐᖅ, ᖄᒥᒃ ᐋᔭᐃᓂᖅ) ᐊᒻᒪ ᑕᑭᓗᓂ ᖃᓄᑎᕆᐅᓂᖓ (ᓲᕐᓗ ᐃᐸᔪ ᓴᐅᔭᐅᔪᖅ). ᖃᓄᐃᓐᖓᓕᖅᑎᑦᑎᓂᖅ ᐃᐸᔪᑦ ᖃᓄᑎᕆᐅᓂᖓᓄᑦ ᓂᕆᐅᕐᔭᐅᔪᖅ ᑕᒪᐅᓂᐊᕐᓂᖓᓄᑦ ᓴᓇᔭᐅᑎᓪᓗᒍ, ᐃᐸ ᓱᑯᖅᑐᖅ ᑕᒪᖃᑦᑕᕐᓂᐊᕐᓗᓂ ᖃᑯᑎᒃᑯᑦ ᐊᐅᓛᕐᓂᓇᓱᖓᓂᒃ ᐱᓕᕆᐊᐸ ᓯᓚ ᐱᔾᔪᑎᒋᓗᒍ. ᖁᑦᑎᒃᑐᒥᒃ ᓇᓗᓇᙱᓐᓂᖃᖅᑰᓂ, ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᕿᒪᒃᑎᑦᑐᓄᑦ ᖃᓄᐃᓐᖓᓕᕈᑕᐅᔪᑦ ᐱᓕᕆᐊᒥᑦ ᐃᐸᔪᑦ ᖃᓄᑎᕆᐅᓂᖓᓄᑦ ᐊᕐᕿᔫᔾᔭᕐᖏᓐᓂᖓᓄᑦ.

ᐊᕙᑎᒥᒃ ᖃᐅᔨᓴᐃᓂᖅ ᐃᓂᐅᔪᒦᓐᓂᐊᖅᑐᖅ ᓴᓇᔭᐅᑎᓪᓗᒍ ᐃᑲᔪᐃᓂᕐᒧᑦ ᐊᓅᕙᒃᑯᑦ ᐱᓕᕆᔾᔪᑎᖓᓂᒃ ᐊᒻᒪ ᑳᓐᑐᕌᖅᑐᓂᒃ ᐊᑐᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᖏᕈᐊᖏᑎᐊᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᓄᖅᑑᕈᑎᓂᒃ ᒥᒃᓵᑎᐊᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᓂᒃ ᐱᓕᕆᐊᒥᑦ ᐃᑉᔪᐃᑦ ᖃᓄᑎᒋᐅᓂᖓᓄᑦ, ᓱᕐᓗ ᖄᖓᓂᑦ ᐲᔭᐃᓂᖅ ᐊᒻᒪ ᐃᑉᔪᐃᑦ ᑐᖅᑯᖅᑕᐅᓂᖏᓐᓅᖓᔪᑦ. ᐳᔪᖃᑦᑖᓂᒃ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᑕᐃᒪᐅᖃᑦᑕᕐᓂᐊᖅᑐᖅ ᐱᓕᕆᐊᖅ ᐊᐅᓛᕐᓂᕆᔭᖓᓂᑦ ᐃᓕᑕᖅᓯᓂᕐᒧᑦ ᐊᒻᒪ ᐊᖏᕈᐊᖏᑎᐊᖅᑎᑦᑎᓂᕐᒧᑦ ᐃᑉᔪᓄᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᓂᒃ.

ᐊᒃᑐᖅᑕᐅᓃᑦ ᓯᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᖓᓂᒃ ᐃᑉᔪᓄᑦ

ᓯᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᖓ ᐊᒃᑐᖅᑕᐅᓂᖃᓛᙳᓂᐊᖅᑐᒃᓴᐅᔪᖅ ᐃᑉᔪᐃᑦ ᖃᓄᑎᒋᐅᓂᖓᓄᑦ ᑕᐃᒪᓐᓇᒧᑦ ᐊᖏᓪᓕᓗᓂ ᐃᑉᔪᐃᑦ ᓱᕋᒃᑐᑦ ᐊᓯᐊᙳᕐᓂᖏᓐᓄᑦ ᐆᓇᕐᓂᐅᔪᖅ, ᖃᐅᓯᖅᑐᖃᕐᓂᖅ, ᐊᒻᒪ ᐊᓄᓇᒧᑦ. ᐃᑉᔪᐃᑦ ᓱᕈᖅᐸᓪᓕᐊᓂᖃᕈᖕᓇᖅᑐᑦ ᐊᖏᓪᓕᒋᐊᕐᓂᐊᖅᑐᒃᓴᐅᔪᑦ ᐆᓐᓇᕐᓂᕐᒧᑦ, ᒥᒃᓵᔪᓄᑦ ᖃᐅᓯᕐᓃᑦ, ᐊᒻᒪ ᐊᖏᓪᓕᒋᐊᕐᓂᖏᑦ ᖃᓄᑎᒋᐅᓂᖅ ᐊᒻᒪ ᐊᖏᓂᓴᖏᑦ ᐊᓄᓈᑦ. ᐃᑉᔪᐃᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᔪᑦ ᐱᓕᕆᐊᒧᑦ (ᓲᕐᓗ ᑲᑎᑕᐅᓯᒪᔪᑦ) ᐊᓯᐅᔨᓂᐅᓛᙳᔪᖕᓇᕋᔭᖅᑐᑦ ᐃᑉᔪᓄᑦ.

ᒫᓇᐅᔪᖅ ᐊᕙᑎ - ᐱᕈᖅᑐᑦ

ᐱᓕᕆᐊᖅ ᐃᓂᖓ ᓄᓇᐅᔪᒦᑐᖅ ᐱᕈᖅᑐᖅᑕᓕᖕᒥᑦ ᐅᔭᕋᖅᑕᖃᐅᖅᓗᓂ. ᐱᕈᖅᑐᑦ ᐊᑖᓂ ᐊᐅᓯᐃᑑᑉᓗᑎᒃ ᐱᕈᖅᑐᖅᑕᖄᖅᔪᒃᓗᑎᒃ, ᐅᒃᐱᒐᐃᑦ ᐆᒪᓂᖃᖅᑐᐃᓪᓗ, ᐊᒻᒪ ᐃᕖᑦ. 15-ᖑᔪᑦ ᓄᓇᒥᑦ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᔪᑦ (ELC) ᐃᓕᑕᕆᔭᐅᓚᐅᖅᑐᑦ LAA-ᒥᑦ ᐊᒻᒪ RAA-ᒥᑦ.

ᖃᐅᓯᖅᑐᑦ (ᐃᓚᐅᔪᑦ ᐃᒪᓗᒃᑖᑦ ᐊᒻᒪ ᑰᒐᓛ) ᐃᓕᑕᕆᔭᐅᓚᐅᖅᑐᑦ RAA-ᒥᑦ. Wet Graminoid ELC ᐊᑐᖅᑕᐅᑉᓗᓂ ᐃᓕᑕᖅᓯᓂᕐᒧᑦ ᓄᓇᓂᒃ ᖃᐅᓯᖅᑐᒦᑐᓂᒃ ᐱᕈᖅᑐᕐᑲᖅᑐᓂᒃ ᐃᒪᕐᒦᓗᐊᕋᓱᒋᔭᐅᑉᓗᑎᒃ ᐅᑭᐅᓗᒃᑖᖅ. 20.5%-ᓗᐊᑦ (9,205 ha) ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒧᑦ LAA-ᒥᑦ ᐃᓗᓕᖅᑲᖅᑐᑦ ᖃᐅᓯᖅᑐᓂᒃ, RAA-ᒥᓪᓕ ᐃᒪᓐᓇᐃᑎᓪᓗᒍ 32.8% (322,287 ha).

ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓄᑦ ᖃᐅᔨᓴᐃᓃᑦ ᓇᓗᓇᐃᖅᓯᓚᐅᖅᑐᑦ ᐃᓚᖏᑦ ᐱᕈᖅᑐᐃᑦ ᐱᓪᒪᕆᐅᒋᔭᐅᓗᐊᕐᓂᖏᓐᓄᑦ ᐃᓄᖕᓄᑦ ᓂᕿᒋᔭᐅᓂᖏᓐᓄᑦ, ᐃᓗᐊᖅᓴᐅᑎᒋᔭᐅᔪᑦ, ᐅᖅᑯᐊᓕᐅᕈᑎᒋᔭᐅᔪᑦ ᐊᒻᒪ ᐊᓯᖏᓐᓄᑦ ᐃᓄᖕᓄᑦ ᐊᑐᖅᑕᐅᕐᑲᖅᑐᑦ (IQ-ᒪᓐᓂᒃ 1998[15], IQ-RIHT 2009[16], IQ-CIE 2009[17], IQ-Bennett ᐊᒻᒪ Rowley 2004[18]). ᐅᖃᐅᓯᐅᕙᔪᓗᐊᖅᑐᖅ ᐱᕈᖅᑐᓂᑦ ᐱᓪᒪᕆᐅᒋᔭᐅᔪᖅ ᐃᓄᖕᓄ ᐃᓄᐃᑦ ᑲᑎᒪᑎᑕᐅᑎᓪᓗᒋᑦ ᐃᓚᐅᔪᑦ ᐸᐅᕐᖓᐃᑦ, ᐊᖅᐲᑦ, ᑭᖕᒥᖕᓇᐃᑦ, ᐊᒻᒪ ᑭᒍᑕᖏᕐᓇᐃᑦ. 11-ᖑᔪᑦ 15-ᖑᔪᓂᒃ ELC-ᓂᑦ ᐃᓕᑕᕆᔭᐅᓚᐅᖅᑐᑦ ᑕᒪᒃᑯᓂᙵᑲᕐᓂᖏᓐᓄᑦ.

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15 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-ᒪᓐᓂᒃ 1998: *ᑕᐃᕝᓯᒪᓂ, ᐊᓯᖏᑦ ᐱᕈᖅᑐᐃᑦ ᓲᕐᓗ ᑲᖑᔫᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᓚᐅᖅᑐᑦ ᐃᑯᒪᖅᑯᑎᒋᓂᕐᒧᑦ ᐊᒻᒪ ᑎᕋᐅᔮᑦ ᐃᑯᒪᖅᑯᑎᒋᐸᓗᒋᑦ, ᐃᑭᑎᑐᑦ ᐃᑯᐊᓛᖅᑐᓕᐅᕐᓂᕐᒧᑦ, ᐳᔪᖅᑎᑦᑎᓂᕐᒧᓪᓗ ᕿᒃᑐᓇᐊᖅᑕᖃᓗᐊᖅᑎᑦᑎᖏᓐᓂᕐᒧᑦ. Lichen ᑲᑎᑕᐅᕙᓚᐅᕐᒥᔪᑦ ᐃᑯᐊᓛᖅᑐᓕᐅᕐᓂᕐᒧᑦ.*
16 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-RIHT 2009: *ᐃᓐᓇᑐᖃᐃᑦ ᐊᑐᖃᖅᑕᖅᑐᑦ ᐊᖅᐲᑦ ᐊᓯᖏᓪᓗ ᐱᕈᖅᑐᐃᑦ ᐲᓕᐅᕐᓂᕐᒧᑦ.*
17 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-CIYA 2009: *ᑎᕋᐅᔮᑦ ᖃᓛᖅᑎᑕᐅᔪᓐᓇᖅᑐᑦ ᐲᑐᕐᓂᐊᕐᓗᒍ, ᐊᒻᒪ ᐊᓯᖏᑦ ᐱᕈᖅᑐᐃᑦ ᐃᓗᐊᖅᓴᐅᑎᒧᑦ.*
18 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-Bennett ᐊᒻᒪ Rowley 2004: *ᐊᕚᓚᕿᐊᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᓚᐅᖅᑐᑦ 'ᐊᕚᓚᕿᐊᑦ', ᖃᐅᓰᔅᔫᖏᑦᑐᑦ ᐊᒃᕙᓕᐅᑎᓗᒍ.*

ᐱᕈᖅᑐᓄᑦ ᐆᒃᑐᕋᐅᑏᑦ ᑲᑎᑕᐅᓚᐅᖅᑐᑦ ᐊᒻᒪ ᖃᐅᔨᓴᖅᑕᐅᕝᕙᑎᒃ ᖃᐅᔨᓂᕐᒧᑦ ᑭᒡᓕᐅᔪᓂᒃ analyte-ᓂᒃ ᑲᑎᓯᒪᔪᓂᒃ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᑦ ᖃᓄᐃᓂᖅᓴᐅᓂᖏᓐᓄᑦ ᖃᐅᔨᔪᒪᓂᕐᒧᑦ ᐊᕙᑎᒥᒃ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒥᒃ ᑐᕌᖓᔪᓂᒃ.

ᐊᕙᑎᒥᒃ ᐊᒃᑐᖅᑕᐅᓂᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐱᕈᖅᑐᓂᒃ

ᐃᓕᑕᕆᔭᐅᔪᑦ ᓄᓇᒥᑦ ᐱᕈᖅᑐᓄᑦ ᐊᓯᐊᕐᒍᕐᓂᐅᔪᑦ ᐱᕈᖅᑐᐃᑦ ᖃᓄᑎᒋᐅᓂᖏᑦ ᐊᒻᒪ ᓯᐊᒻᒪᒃᓯᒪᓂᖏᑦ ᐊᓯᐊᕐᒍᕐᓂᐅᔪᓪᓗ ᐱᕈᖅᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ. ᐊᓯᐊᕐᒍᕐᓂᐅᔪᑦ ᐱᕈᖅᑐᑦ ᖃᓄᑎᒋᐅᓂᖏᓐᓄᑦ ᓯᐊᒻᒪᒃᓯᒪᓂᖏᓪᓗ ᑕᐃᒪᐅᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᓴᓇᔭᐅᑎᓪᓗᒍ ᐊᒻᒪ ᓄᓇᒥᑦ ᐊᑐᕈᓐᓂᖅᐸᓪᓕᐊᓂᕐᒥᑦ ᑭᖑᓪᓕᖅᐹᒃᑯᑦ ᐅᒃᑯᐊᖅᓴᓂᕐᒥᑦ. ᐊᓯᐊᕐᒍᕐᓂᐅᔪᙳᖅᑐᑦ ᐱᕈᖅᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ ᓄᓇᒥᑦ ᓴᓇᕙᓪᓕᐊᓂᕐᒥᑦ, ᐅᔾᕋᕐᓂᐊᖅᑐᓕᕆᓂᕐᒥᑦ, ᐊᒻᒪ ᓯᖄᓪᓕᑎᕆᓂᖅᑲᖅᑎᓪᓗᒋᑦ ᑕᐃᑯᖓ ᑭᖑᓪᓕᖅᐹᒃᑯᑦ ᐅᒃᑯᐊᖅᓴᓂᕐᒧᑦ.

ᐱᒻᒪᕆᐅᔪᓂᖏᑦ ᐱᕈᖅᑐᐃᑦ ᐃᓚᒋᔭᐅᓂᖏᓐᓄᑦ ᐃᓗᐃᑦᑐᔪᒥᑦ ᐃᓕᑕᕆᔭᐅᓚᐅᖅᑐᖅ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓄᑦ ᐊᐱᖅᓱᐃᓂᕐᓂᑦ ᐊᒻᒪ ᐃᓚᐅᖃᑕᐅᕉᔾᔭᕐᓂᐅᔪᓂᒃ (IQ-BLH 2009[19], IQ- ARHT 2009[20], IQ-RBH 2011[21],[22]).

ᐊᓯᐊᕐᒎᕐᓂᖅ ᐱᕈᖅᑐᐃᑦ ᖃᓄᑎᒋᐅᓂᖏᑦ ᓯᐊᒻᒪᒃᓯᒪᓂᖏᓪᓗ

ᐱᕈᖅᑐᐃᑦ ᖃᓄᑎᒋᐅᓂᖏᑦ ᓯᐊᒻᒪᒃᓯᒪᓂᖏᓪᓗ ᐊᒃᑐᖅᑕᐅᓂᖃᕝᕙᑐᐃᓐᓇᕆᐊᖃᖅᑐᑦ ᐱᓕᕆᐊᒥᑦ ᐃᓂᐅᔪᖅ ᐂᔭᖅᑕᐅᓕᖅᐸᑦ, ᐱᕈᖅᑐᐃᑦ ᓴᐅᔭᐅᓂᖏᓐᓄᑦ ᐃᓕᓯᖖᕐᓂᕐᒧᑦ ᐱᖁᑎᓄᑦ, ᐊᒻᒪ ᐃᓕᑕᕐᓇᖖᒋᑦᑐᓂᒃ ᐃᓕᓯᓂᕐᒧᑦ.

ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖅ ᒥᒃᓵᒋᐊᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᒻᒪ/ᐅᕙᓘᓃᑦ ᐊᒃᑐᖅᑕᐅᓂᖅᖃᐃᓕᒪᓂᖅ ᐱᓕᕆᐊᒥᑦ ᐱᕈᖅᑐᓄᑦ ᐃᓚᐅᔪᑦ ᖃᓄᐃᓕᐅᕈᑏᑦ ᓱᕋᐃᑕᐃᓕᒪᓂᕐᒧᑦ ᐆᒪᔪᓂᒃ ᐱᓕᕆᐊᖅ ᐱᕙᓪᓕᐊᑎᓪᓗᒍ, ᐊᒻᒪ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖅ ᖃᓄᑎᒋᐅᓂᖏᓐᓄᑦ ᐱᕈᖅᑐᐃᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᔪᑦ ᐃᓂᐅᔪᖅ ᐂᔭᖅᑕᐅᑎᓪᓗᒍ ᐊᒻᒪ ᐱᕈᖅᑐᑦ ᓴᐅᔭᐅᑎᓪᓗᒋᑦ. ᐸᐸᑐᕐᓂᖅ ᐱᕈᖅᑐᐃᑦ ᐱᕈᖅᓯᐊᕐᒋᓐᓂᒃ ᖃᕐᒪᓂᑦ ᐂᔭᐃᓂᕐᒥᑦ ᐃᕐᒥᕐᓂᒃ ᐱᒃᑲᓐᓂᕈᕐᓇᕐᓂᕐᒥᒃ ᐱᕈᖅᑐᓂᒃ ᐅᑎᖅᑎᑦᑎᓂᕐᒧᑦ ᐃᓂᐅᔪᓂᒃ, ᐅᑎᖅᑎᑦᑎᕙᓪᓕᐊᓂᖅᑕᖅᑎᓪᓗᒍ ᐱᓕᕆᐊᑉ ᐊᐅᓚᕐᓂᓗᒃᑖᕐᒪᓂᑦ. ᐊᑐᖅᑕᐅᓂᕐᒥᑦ ᐃᒪᐃᑦ ᐊᑦᑯᑎᒋᔭᐅᔪᓂᑦ ᐅᑭᐅᑯᑦ ᐊᑦᑯᑎᒥᑦ ᐱᒻᒪᕆᐅᒋᔭᐅᓚᐅᖅᑐᖅ ᐊᖏᓗᐊᖏᑎᑦᑎᓂᕐᒥᒃ ᐱᕈᖅᑐᐃᑦ ᐊᒃᑐᖅᑕᐅᓂᖏᓐᓄᑦ ᐊᑦᑯᑎᓕᐊᕐᒎᔪᒪᔪᓄᑦ. ᐱᑎᑦᑕᐃᓕᒪᓂᕐᒨᕐᒪᔪᑦ ᓄᑖᓂᒃ ᑎᑭᑎᑦᑎᓂᕐᒥᒃ ᐊᒻᒪ/ᐅᕙᓘᓃᑦ ᑕᒫᓂᕐᒥᐅᑕᑐᖃᐅᖏᑦᑐᓂᒃ ᐱᕈᖅᑐᓂᒃ ᑕᐃᒪᐅᓂᐊᕐᒥᔪᑦ ᐱᓕᕆᐊᖅ ᐱᓕᕆᐊᕈᑎᓪᓗᒍ.

19 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-BLH 2009: *ᑕᐃᕀᓯᒪᓂᑎᑐᑦ ᐃᓅᖏᓕᕋᓗᐊᕐᓗᑕ (ᓄᓇᓕᖕᒥᐅᑕᐅᓕᕋᕀᑕ), ᐊᒻᒪ ᒪᖃᐃᖀᓗᖃᑦᑕᖏᓕᖅᓗᑕ ᓂᕆᑎᓂᒃ ᐱᕈᖅᑐᓂᓪᓗ ᐊᑐᐊᓗᒃᐸᒍᖕᓃᖅᓗᑕ, ᐱᒻᒪᕆᐅᔪᖅ ᒥᐊᓂᖅᓯᓂᕐᒥᒃ ᓂᕆᑎᓗᒃᑖᓂᒃ, ᒥᐊᓂᕆᓗᒍ ᐊᕙᑎᓗᒃᑖᖅ.*
20 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ- ARHT 2009: *ᒪᖃᐃᑏᑦ ᐃᓐᓇᕆᔭᐅᔪᓪᓗ ᐃᓯᒫᓘᑎᖃᖅᑐᑦ ᐊᓂᖅᖄᖅᑐᖅᑕᕀᑎᖕᓂᑦ ᐱᐅᖏᑦᑐᑦ ᐱᕈᖅᑐᓄᐊᕆᐊᒃᓴᖏᓐᓂᒃ ᑐᒃᑐᓄᓪᓗ ᓂᕆᔭᐅᓗᑎᒃ.*
21 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-RBH 2011: *ᐸᐅᕐᖓᐃᓪᓗ ᑭᖕᒥᖕᓇᐃᓪᓗ ᑲᑎᑕᐅᖃᑦᑕᖅᑐᑦ.*
22 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-RHB 2011: *Broadleaf willow, fireweed, dwarf fireweed (leaves ᐊᒻᒪ ᓄᓇᕋᐃᕐ), ᐊᒻᒪ Labrador lousewort (roots) ᓂᕆᔭᐅᖃᑦᑕᖅᑐᒃᑖᕐ,*

ᐱᓕᕆᐊᖅ ᐱᕙᓪᓕᐊᓂᖓᑎᒍᑦ ᓂᕈᐊᖅᑕᐅᔪᑦ, ᐊᑯᓐᓂᖏᓐᓂᑦ 1,449 ha ᐊᒻᒪ 1,708 ha ᓄᓇᖅᐸᓯᖏᑦ ᐃᑲᔪᐃᔪᑦ ᐱᕈᖅᑐᓂᒃ ᐊᒃᑐᖅᑕᐅᓂᖃᕐᓂᐊᖅᑐᑦ ᐱᓕᕆᐊᒧᑦ. ᐊᒃᑐᖅᑕᐅᔪᓂᑦ, ᐊᑯᓐᓂᖏᓐᓂᑦ 168 ha ᐊᒻᒪ 175 ha (0.4 % to 0.5 %) ᖃᐅᓯᕐᓂᓕᖕᒦᑦ LAA-ᒥᑦ ᑭᒡᓕᐅᔪᓂᑦ ᐃᑲᔪᐃᔪᑦ ᐱᕈᖅᑐᐃᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᐊᒃᑐᖅᑕᐅᓯᒪᓂᐊᕐᓂᖓᓄᑦ ᐱᓕᕆᐊᒧᑦ. ᓄᓇᐅᔪᖅ ELC-ᒥᑦ ᐊᒃᑐᖅᑕᐅᓂᖅᐹᖑᓂᐊᖅᑐᒃᓴᐅᔪᖅ ᐱᓕᕆᐊᒧᑦ, ᑲᑎᖮᒋᑦ ᐊᒃᑐᖅᑕᐅᔪᑦ ᐊᑯᓐᓂᖏᓐᓂᑦ 685 ha ᐊᒻᒪ 813 ha (1.9% ᐊᒻᒪ 2.8 % ᑲᑎᒍᒃᑖᖅᖢᒍ ᓄᓇ ᐊᒃᑐᖅᑕᐅᔪᖅ).

ᐱᕙᓪᓕᐊᓂᕐᒧᑦ ᓂᕈᐊᖅᑕᐅᔫᒐᒍᐊᖅᑎᓪᒍᒍ, ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᒃᑐᖅᑕᐅᓂᑦ ᐱᓕᕆᐊᒥᑦ ᐱᕈᖅᑐᐃᑦ ᖃᓄᑎᒋᐅᓂᖏᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᐊᑦᑎᒃᑑᓂᐊᕐᓂᖓ ᐊᖏᓂᐅᔫᔅ, ᐃᓂᐅᔫᒥᒍᓂ, ᐊᒻᒪ ᑕᐃᒪᐅᖃᑦᑕᕐᒍᓂ ᓴᓇᔭᐅᑎᓪᒍᒍ. ᕿᒪᒃᑎᑦᑐᓄᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᑕᑯᓂᖓ ᐊᑯᓂᐅᒍᓂ ᑭᓯᐊᓂ ᐅᑎᕈᖕᓇᖅᖢᓂ ᐅᑎᖅᑎᑦᑎᓇᓂᒃᑯᑦ. ᑕᐃᒪᓐᓇᒧᑦ, ᐊᓯᐊᖑᕐᓂᖅ ᐱᕈᖅᑐᑦ ᖃᓄᑎᒋᐅᓂᖏᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᐊᖏᔫᔾᔭᖏᓐᓂᖓᓄᑦ.

ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᐊᓯᐊᖑᕐᓂᐅᔪᓄᑦ ᐱᕈᖅᑐᓄᑦ ᑕᐃᒪᐅᖃᑦᑕᕐᓂᐊᖅᑐᖅ ᐊᐅᓛᕐᓂᖓᓂᑦ ᐱᓕᕆᐊᖅ. ᐊᕙᑎᒧᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᐃᓂᐅᔫᒥᓐᓂᐊᖅᑐᖅ ᐊᐅᓛᕐᓂᒍᒃᑖᓇᔭᖓᓂᒃ ᐱᓕᕆᐊᑉ ᐱᓕᕆᖃᑎᖃᕐᒍᑎᒃ ᐊᑮᕙᒃᑯᑦ ᐱᓕᕆᔨᖏᓐᓂᒃ ᐊᒻᒪ ᑳᓐᑐᕌᖃᑦᑕᖅᑐᓂᒃ ᑎᑭᐅᑎᓂᕐᒧᑦ ᐊᒻᒪ ᒪᓕᖕᓂᕐᒧᑦ ᐊᕙᑎᓕᕆᓂᕐᒧᑦ ᒪᓕᒐᓂᒃ ᐱᔾᔪᑎᖃᖅᑐᓂᒃ ᐱᕈᖅᑐᓂᒃ. ᐆᒃᑐᕋᐃᖃᑦᑕᕐᓂᕐᒨᔭᒪᔪᑦ ᓴᖅᑭᑕᐅᓂᐊᖅᑐᑦ ᐱᓕᕆᐊᑉ ᐃᓂᖓᓄᑦ ᐊᒻᒪ ᓴᓂᐅᓂᑦ ᐊᑉᖁᓯᐅᖅᑕᐅᔪᒪᔪᒥᑦ. ᑕᒪᒃᑯᐊ ᐆᒃᑐᕋᐃᓃᑦ ᖃᐅᔾᔮᖅᑕᐅᖏᓐᓇᖅᑲᖅᑕᕐᓂᐊᖅᑐᑦ ᖃᓄᑎᒋᐅᓂᖏᓐᓄᑦ ᐊᓯᐊᖑᖅᓯᓂᐅᔪᖕᓇᖅᑐᑦ ᐱᕈᖅᑐᐃᑦ ᖃᓄᑎᒋᐅᓂᖏᓐᓄᑦ. ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᓄᓖᓄᑦ ᐆᒪᔪᓄᑦ ᐱᐊᓂᒃᑕᐅᓂᐊᖅᑐᖅ ᐊᐅᓛᕐᓂᕆᔭᖓᓂᑦ ᐱᓕᕆᐊᖅ, ᐊᒻᒪ, ᐃᓕᑕᕆᔭᐅᒃᐸᑦ, ᐋᔭᐃᓇᓯᒋᐊᕐᓂᐊᖅᑐᑎᑦ ᓄᓖᓂᒃ ᐆᒪᔪᓂᒃ ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖓᓂᑦ ᐅᕙᓃᓃᑦ ᓴᓂᐊᓂᑦ.

ᐊᓯᐊᖑᕐᓂᖅ ᐱᕈᖅᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ

ᓴᓇᔭᐅᓂᖅ ᐊᒻᒪ ᐊᐅᓛᕐᓂᕐᒨᖓᔪᑦ ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᓯᓂᐊᖅᑐᑦ ᖃᓄᐃᓐᓂᕆᔭᖓᓂᒃ ᐱᕈᖅᑐᐃᑦ LAA-ᒥᑦ ᐳᔪᕐᒧᖕᓂᒃ ᐊᓂᐊᔪᓄᑦ ᐊᒻᒪ ᐳᔪᖅᑳᓂᑦ. ᐊᓂᖅᓵᖅᑐᖅᑕᐸᑕ ᖃᓄᐃᓐᓂᕆᔭᖓ ᐱᓕᕆᐊᖑᓚᐅᖅᑐᖅ ᓇᓚᐅᑖᕈᒪᓂᕐᒧᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ acid ᐋᓯᑦᓂᑦ (PAI), nitrogen oxides (NOx), ᐊᒻᒪ sulphur dioxides (SO_2) ᐱᕈᖅᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ. ᐳᔪᖃᑖᑦ ᐋᕿᒃᑕᐅᓂᖃᓚᐅᕐᒥᔪᑦ ᖃᐅᔨᔪᒪᓂᕐᒧᑦ ᐊᓯᐊᖑᕐᓂᐅᔪᓂᒃ ᑲᑎᓯᒪᔪᓂᒃ COPC-ᓂᒃ ᐊᔾᔨᒌᖏᑦᑐᓂᑦ ᐱᕈᖅᑐᓂᑦ (ᓲᕐᒪ ᐸᐅᖕᒐᐃᑦ ᐅᒃᐱᒐᐃᑦ, ᐃᕼᐊᑦ) ᖃᐅᔨᔪᒪᓂᕐᒧᑦ ᑕᒪᒃᑯᐊ ᐊᓯᐊᖑᕐᓂᐅᔪᑦ phytotoxicity ᑭᒡᓕᕐᔭᐅᔫᓂᒪᖖᒫᑕ. ᐃᓄᐃᑦ ᐃᓱᒫᓗᑎᕆᔭᕐᒥᖕᓂᒃ ᐅᖃᓚᐅᖅᑐᑦ ᐱᓕᕆᐊᑉ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖏᓐᓄᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᔪᓄᑦ ᐱᐅᖏᑦᑐᓄᑦ ᐱᕈᖅᑐᑦ, ᐃᓚᐅᑉᐳᑎᒃ ᐸᐅᖕᒐᐃ (EN-BL CLC ᔪᓚᐃ 2010[23]).

ᒥᒃᓕᑭᐊᖅᑎᓐᓂᕐᒧᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᓯᓚᒧᑦ ᐳᔪᕐᒍᐃᑦ ᐊᓂᐊᔪᓄᑦ ᐱᕈᖅᑐᓄᑦ, ᐃᑯᒪᓅᖅᑐᒍᒃᑖᖅ ᐊᑐᖅᑕᐅᔪᓪᒍ, ᐊᒻᒪ ᐅᖅᓱᐊᒍᖕᒧᑦ ᐊᐅᓛᖅᑐᑦ ᑎᑭᐅᑎᓯᒪᓂᐊᖅᑐᑦ ᑲᓇᑕᐸ ᓯᓚᒧᐊᖅᑐᑦ ᐳᔪᕐᒍᐃᑦ ᒥᒃᓵᓄᑦ ᐊᑐᖅᑕᖏᓐᓇᓄᑦ. ᐊᑦᑎᒃᑐᑦ ᐅᖅᓱᐊᒍᖕᒥᑦ ᐊᓂᐊᔪᑦ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᑦ ᒥᒃᓕᑭᐊᖅᑎᑦᑎᓂᕐᒧᑦ SO_2 fumigation-ᒥᒃ. ᐋᓯᑦᓕᑎᕝᕕᒃ ᐊᖏᓛᖑᓂᐊᖅᑐᖅ SO_2 -ᒥᒃ ᓴᓇᕙᓪᓕᐊᓂᕐᒧᑦ ᐱᓕᕆᐊᒧᑦ ᐊᒃᑐᐊᓂᖅᑲᖅᑐᖅ. ᑕᐃᒪᓐᓇᒧᑦ, ᓴᒍᒻᒪᖅᓴᐃᔭᔪᑎᒥᒃ ᐃᓕᓯᓂᐊᖅᑐᑦ ᐊᓂᐊᕗᕕᐅᔪᒧᑦ ᐋᔭᐃᓂᕐᒧᑦ ᐱᐅᕆᑦᑐᓂᒃ, ᐋᓯᑦᒥᒃ ᒥᓂᔪᑦ ᐊᒻᒪ ᐊᖏᔪᑦ SO_2.

[23] EN-BL CLC ᔪᓚᐃ 2010: *ᐸᐅᖕᒐᐃᓪᓗ ᐊᖅᐱᓪᓗ radiation -ᖃᕐᓂᐊᖅᐸᑦ?*

ᖃᓄᐃᑑᓂᐊᕐᓂᖕᒋᓐᓂᒃ ᐊᑉᕐᑯᑏᑦ ᐱᓕᕆᐊᖑᑎᓪᓗᒋᑦ, calcareous -ᖃᙱᑦᑐᓂᒃ ᐊᑐᕋᓱᖕᓂᐊᖅᑐᑦ ᐃᓗᑦᑐᖅᑎᓯᒪᔪᓂᑦ ᒥᑭᓛᑰᖅᑎᑦᑎᓂᕐᒧᑦ ᐳᔪᖃᑖᖃᓕᕈᖕᓇᖅᑐᓂᑦ ᐊᑐᖅᑕᐅᓂᖓᓄᑦ ᐊᑉᕐᑯᓯᐅᖅᑎᓪᓗᒋᑦ. ᐅᑭᐅᖑᔪᒥᑦ ᐅᔭᕋᖕᓂᐊᖅᑐᓕᕆᑎᓪᓗᒋᑦ, ᖀᖅᑎᕆᓃᑦ ᖃᓄᐃᖓᓂᕆᔭᖕᒋᑦ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᑦ ᐊᐅᓚᕐᑎᓂᕐᒧᑦ ᓯᐊᒪᒃᑎᕆᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᔪᓂᒃ ᐳᔪᖃᑖᑦ ᐃᓚᐅᓗᑎᒃ. ᐊᔪᓐᓇᙱᑦᑕᕌᖓᑦ, ᖀᖅᑎᕆᓂᖅ ᐊᑐᖅᑕᐅᑕᐃᓕᓂᐊᖅᑐᖅ ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖓᓂᑦ ᐊᓄᕆᑐᓂᖅᑕᖃᓗᐊᖅᐸᑦ. ᐳᔪᖃᑖᖃᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᑦ ᐃᒪᕐᒥᒃ ᐊᑐᕐᓗᑎᒃ ᓄᓇᒃᑰᕈᑎᓂᑦ ᐳᔪᖃᑖᖃᓗᐊᖅᑎᑦᑎᔪᓂᑦ. ᑕᐃᒪᓐᓇ ᐊᔪᖅᐸᑦ, ᐊᓯᖕᒋᓐᓂᒃ ᐊᑐᖅᑕᐅᔪᖕᓇᖅᑐᓂᒃ ᖃᐅᔨᓴᐃᓂᐊᖅᑐᑦ ᐊᑐᖅᑕᐅᓗᑎᒡᓗ. ᓇᑭᖅᓴᕐᓃᑦ ᓄᓇᒃᑰᕈᑎᓄᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥᑦ ᐊᑉᕐᑯᑎᓂᒡᓗ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᑦ ᒥᒃᓱᑎᑦᑎᓯᒪᓂᕐᒧᑦ ᐳᔪᖃᑖᓂᒃ ᓄᓇᒃᑰᕈᑎᓂᒃ ᐊᓯᖕᒋᓐᓂᒡᓗ ᐊᑐᖅᑕᐅᔪᓂᒃ ᐃᖕᒋᕐᕋᔾᔪᑎᓂᒃ.

81 ha-ᓗᐊᓂᒃ ᐱᕈᖅᑐᓂᒃ ᓴᓂᐊᓂᑦ ᑭᒡᒐᕙᐅᑉ ᐅᔭᕋᖕᓂᐊᕐᓂᕐᒧᑦ ᐃᓂᐅᔪᒥᑦ, ᐱᑕᖃᖅᑐᖅ 0.2%-ᓗᐊᒥᒃ ᑲᑎᕞᒋᑦ ᐅᔭᕋᖕᓂᐊᕐᓂᐅᑉ LAA-ᖕᒐᓂᑦ, ᐊᒃᑐᐊᓂᖃᕐᓂᐊᖅᑐᒃᓴᐅᔪᖅ PAI-ᒧᑦ ᓈᓴᐅᑎᐅᔪᑦ ᖁᓛᓂᑦ ᖃᑉᓯᐅᓂᖕᒋᓐᓄᑦ ᓈᓴᐅᑎᒋᔭᐅᔪᓄᑦ 0.25 keg/ha/ᐅᑭᐅᑕᒦᑦ. ᐳᔪᖃᑖᒃ (ᐆᒃᑐᕋᖅᑕᐅᔪᖅ ᑲᑎᓪᓗᒋᑦ ᐳᔪᖃᑖᑦ [TSP]) ᖁᓛᓃᑐᖅ ᖃᑉᓯᐅᓂᖕᒋᓐᓄᑦ ᓈᓴᐅᑎᐅᔪᓂᒃ 0.25 g/m2/ᐅᑭᐅᖅ ᐊᒃᑐᖅᓯᓂᖃᕐᓂᐊᖅᑐᖅ 20 ha ᐊᒻᒪᓗ 16 ha ᑭᒡᒐᕙᖕᒥᑦ ᐊᒻᒪᓗ Sissons-ᒥᑦ. ᐃᓚᒋᔭᐅᔪᖅ ELC-ᒧᑦ ᐊᒃᑐᐅᓂᖃᑐᐃᓐᓇᕆᐊᖃᖅᑐᖅ ᐳᔪᖃᑖᒧᑦ ᖃᑉᓯᐅᓂᖕᒋᓐᓄᑦ ᓈᓴᐅᑎᒋᔭᐅᔫᑉ ᖁᓛᓂᑦ ᐱᑕᖃᖅᑐᖅ 0.08%-ᓗᐊᓂᒃ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ LAA-ᖕᒐᓂᑦ. ᐊᒃᑐᖅᑕᐅᓂᕐᒥᒃ ᐱᕈᖅᑐᓄᑦ ᓂᕆᐊᒋᔭᐅᖕᒋᑦᑐᖅ ᐊᒃᑐᖅᓯᓯᒪᓂᕐᒧᑦ NO2 ᐅᕙᓘᓃᑦ SO_2-ᒧᑦ ᐱᓕᕆᐊᒥᑦ, ᐃᒥᓱᙳᖅᐸᓪᓚᐊᓂᖅ ᐊᕿᒍᑕᒫᑦ ᐊᖕᒋᓛᒃᑯᑦ ᑲᑎᓯᒪᔪᑦ ᐊᑦᑎᖕᓂᖅᓴᐅᖕᒪᑕ ᑭᒡᓕᐅᔪᒧᑦ ᒪᓕᒃᑕᐅᔭᕆᐊᓕᖕᓄᑦ.

ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᑲᑎᓯᒪᔪᑦ COPC-ᒥᑦ browse ᐊᒻᒪᓗ forage ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᐊᖅᑐᑦ ᒥᑭᓛᑰᖕᒐᔪᒥᑦ ᑕᐃᒪᐅᔪᓂᒃ phytotoxic ᑲᑎᓯᒪᔪᓂᒃ, ᐃᓚᐅᖕᒋᕗᓂ zinc browse-ᒥᑦ ᐊᒻᒪᓗ forage-ᒥᑦ ᐊᒻᒪᓗ cobalt ᐊᒻᒪᓗ copper browse-ᒥᑦ. ᐱᒻᒪᕆᐅᔪᖅ ᖃᐅᔨᒪᔭᐅᓂᖕᒐ ᑭᒡᓕᒋᔭᐅᔪᑦ ᓇᓃᓐᓂᖕᒋᑦ zinc-ᒧᑦ, cobalt-ᒧᑦ, ᐊᒻᒪᓗ copper-ᒧᑦ ᐃᖕᒥᖕᓂᒃ ᓴᖅᑭᖃᑦᑕᕐᒪᑕ ᖁᑦᑎᖕᓂᖅᓵᖕᒐᔪᒥᑦ pytotoxicity ᑲᑎᓯᒪᔪᓂᑦ. ᐊᓯᐊᖑᕐᓂᖅᑕᖃᕐᓂᐊᕋᓱᒋᔭᐅᖕᒋᑦᑐᖅ COPC ᑲᑎᓯᒪᔪᑦ ᑭᒡᓕᐅᔪᒧᑦ ᐊᒻᒪᓗ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᑲᑎᓯᒪᔪᑦ ᐅᖕᒐᑕᐅᑎᙱᕞᑎᒃ ᖁᑦᑎᖕᓂᖅᓴᓄᑦ ᖃᑉᓯᐅᔪᓄᑦ. ᑕᐃᒪᓐᓇᒧᑦ, ᐊᒃᑐᖅᓯᓂᑲᓪᓚᐅᔪᓂᒃ ᐱᕈᖅᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖕᒋᓐᓄᑦ ᐱᑕᖃᕐᓂᐊᕐᓂᖕᒋᓐᓄᑦ ᓂᕆᐅᒋᔭᐅᖕᒋᑦᑐᖅ. ᐊᓯᐊᖑᖅᑐᖃᑐᐃᓐᓇᕆᐊᖃᖅᑐᖅ ᑲᑎᓯᒪᔪᓂᑦ ᖃᑉᓯᐊᕐᔫᔪᓂᒃ COPC-ᓄᑦ lichen-ᒧᑦ ᑭᒡᒐᕙᖕᒥᑦ. ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᖅ ᐊᓯᐊᖑᕈᖕᓇᕐᓂᕐᒧᑦ COPC-ᒥᑦ lichen-ᒧᑦ ᖃᐅᔨᒪᔭᐅᖕᒋᑦᑐᖅ, ᖃᑉᓯᐅᓂᖕᒋᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᓄᑦ lichen-ᒧᑦ ᖃᐅᔨᒪᔭᐅᖕᒋᒻᒪᑕ. ᑲᑎᓯᒪᔪᑦ COPC-ᓄᑦ ᓄᓇᒥᑦ ᐱᕈᖅᑐᓂᑦ ᖃᐅᔨᕆᐊᖅᑕᐅᖃᑦᑕᕐᓂᐊᖅᑐᖅ ᖃᑯᑎᒃᑯᑦ ᐊᐅᓛᖅᑎᓪᓗᒍ ᐊᒻᒪᓗ ᓄᖅᑲᖅᐸᓪᓕᐊᑎᓪᓗᒍ ᓇᓗᓇᐃᖅᓯᓂᕐᒧᑦ ᐱᕈᖅᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖕᒋᓐᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ.

ᐱᓕᕆᐊᒥᑦ ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᒃᑐᖅᑕᐅᓂᐅᔪᑦ ᐱᕈᖅᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖕᒋᓐᓄᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᖕᒐᓂᒃ ᐊᖕᒋᓂᕆᔭᖕᒐ, ᑭᓯᐊᓂ ᐳᔪᖃᑖᖑᖅᑐᖅ ᐅᔭᕋᖕᓂᐊᕐᓂᖅ ᐊᐅᓛᖅᑎᓪᓗᒍ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᖁᑦᑎᒃᓯᓯᒫᕐᔪᑐᐃᓐᓇᕆᐊᖃᖅᑐᑦ. ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᐱᕈᖅᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖕᒋᓐᓄᑦ ᐳᔪᖃᑖᒧᑦ ᖃᓂᑦᑐᒥᐅᓂᐊᖅᑎᓪᓗᒋᑦ, ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᓯᓚᒧᐊᖅᑐᓂᒃ ᐳᔪᕐᓗᖕᓂᒃ ᐅᖕᒐᓯᖕᓂᖅᓴᒧᐊᕐᓂᐊᖅᑐᒃᓴᐅᔪᑦ. ᕿᒪᒃᑎᑦᑐᓄᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᑕᐃᒪᐅᖕᒋᓇᖅᑲᑦᑕᕐᓂᐊᕐᓂᖕᒋᓐᓄᑦ ᐊᐅᓛᕐᓂᕆᔭᖕᒐᓂᑦ ᐱᓕᕆᐊᑉ ᐊᒻᒪᓗ ᐊᑯᓂᐅᓗᓂ ᖃᓄᑎᒋᐅᓂᖕᒐ ᑭᓯᐊᓂ ᐅᑎᖅᑎᑦᑐᖕᓇᖅᑐᖅ. ᑕᐃᒪᓐᓇᒧᑦ, ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᐱᕈᖅᑐᐃᑦ ᖃᓄᐃᓐᓂᕆᔭᖕᒋᓐᓄᑦ ᐱᓕᕆᐊᒥᑦ ᐱᔪᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᖕᒋᔫᔮᖕᒋᓐᓂᖕᒋᓐᓄᑦ.

ᐊᒃᑐᖅᑕᐅᓃᑦ ᓯᓚᐅᑉ ᐊᓯᐊᖑᕐᓂᖓᓄᑦ ᐱᕈᖅᑐᓄᑦ

ᓯᓚᐅᑉ ᐊᓯᐊᖑᕐᓂᖓ ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᑕᐅᔪᓐᓇᖅᑐᖅ ᐱᕈᖅᑐᓄᑦ. ᐊᐅᒃᓵᓕᓂᖅ ᐊᑯᓂᐅᑎᑦᑎᒃᑲᓂᖅᑦᑕᕐᒪᑦ ᐱᕈᖅᐸᓪᓕᐊᓂᕐᒥᒃ ᐆᓇᕐᓂᖅᓴᐅᓕᕐᓂᐅᔪᖅ ᐱᕆᐊᖅᑎᑦᑎᔪᓐᓇᕐᒪᑦ ᐊᓯᐊᖑᕐᓂᐅᔪᓐᓇᖅᑐᓂᒃ ᐱᕈᖅᑐᐃᑦ ᖃᓄᑎᒋᐅᓂᖕᒋᓐᓄᑦ ᐱᓕᕆᐊᒥᑦ ᐱᔪᓄᑦ. ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᐱᕈᖅᑐᓄᑦ ᓄᓇᒥᑦ ᓇᓕᑐᐃᓐᓇᖏᓐᓄᑦ graminoid ᐅᕙᓂᓃᑦ shrub ᓴᓂᐊᓂᑦ ᐃᓄᐃᑦ ᐱᕙᓪᓕᐊᑎᑕᖓᓂᑦ ᑎᑎᕋᐅᓯᐅᓯᒪᔪᖅ, ᐊᒻᒪ ᓯᓚᐅᑉ ᐊᓯᐊᖑᕐᓂᖓ ᐱᕆᐊᖅᑎᑦᑎᒃᑲᓐᓂᕈᓐᓇᖅᑐᖅ ᑕᒪᑐᒨᖓ ᐊᓯᐊᖑᕐᓂᐅᔫᑦ.

ᓯᓚᐅᑉ ᐊᓯᐊᖑᕐᓂᖓ ᐃᑲᔪᐃᓂᖅᑲᕈᓐᓇᕐᒥᔪᖅ ᑖᒪᓂᕐᒥᐅᑕᑐᖅᑲᐅᖏᑦᑐᓂᒃ ᐱᕈᖅᑎᑦᑎᕙᓪᓕᐊᓂᕐᒥᒃ, ᐱᔪᐊᖅᑐᒥᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᔪᓂᒃ ᐱᓕᕆᐊᒨᑦ. ᑖᒪᓂᕐᒥᐅᑕᑐᖅᑲᐅᖏᑦᑐᓂᒃ ᑕᒪᐅᖓᖅᑎᑦᑎᑕᐃᓕᒪᓂᕐᒨᑦ ᐱᓕᕆᐊᑉ ᐃᓂᖓᓄᑦ, ᑕᒪᐃᓂᒃ ᐊᑐᖅᑕᐅᔫᒃᑖᑦ ᐃᑯᒪᕐᒃᖅᑐᓪᓗ ᓴᑐᒻᒪᖅᓴᖅᑕᐅᖅᑲᑦᑕᕐᓂᐊᖅᑐᑦ ᑖᒪᓂᕐᒥᐅᑕᐅᖏᑦᑐᓂᒃ ᐋᔭᐃᓂᕐᒨᑦ (ᓲᕐᓗ ᐃᐸᔦᑦ, ᐃᕝᕐᓚᐃᑦ) ᑎᑭᑎᑦᑎᓂᐊᕌᕐᓗᑎᒃ ᐱᓕᕆᐊᒨᑦ (ᓲᕐᓗ, ᐅᓯᓕᖅᑐᖅᑳᕐᓇᒋᑦ ᓯᑲᐅᒧᑦ, ᑎᖕᒥᓲᑯᓪᓗᓃᑦ).

ᑕᐅᑐᒃᑯᒍ ᖃᐅᔨᓴᐃᓂᖅ ᓂᕐᔪᑎᓄᑦ

ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᓂᕈᐊᖅᑕᐅᓚᐅᖅᑐᑦ ᓇᓗᓇᐃᖁᑕᐅᓂᕐᒨᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᒃ ᐊᒃᑐᖅᑕᐅᓂᐅᔪᓄᑦ ᓄᓇᒥᐅᑕᓄᑦ ᓂᕐᔪᑎᓄᑦ ᐃᓂᕆᔭᕆᓐᓄᓪᓗ ᐊᑐᖅᑯᓂ ᐅᖃᐅᓯᐅᔪᑦ ᐃᓚᐅᖃᑕᐅᓂᒃᑯᑦ ᐊᒻᒪ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑎᒍᑦ (IQ) ᐊᐱᖅᓱᐃᓂᒃᑯᑦ ᐅᖃᐅᓯᖃᖅᑐᑦ ᐱᒪᓇᐅᓂᖏᓐᓄᑦ ᑕᒪᒃᑯᐊ ᐆᒪᔪᑦ ᑭᕙᓪᓕᕐᒥᐅᓄᑦ (IQ- BL02 2008[24], EN-RI KWB ᐅᒃᑰᐱᓐ 2009[25], EN-CH OH ᓄᑲᐱᓐ 2010[26], IQ-BL04 2008[27], IQ-ARVJ 2011[28], EN-CH OH ᓄᑲᐱᓐ 2010[29]).

ᐊᓯᖏᑦ ᓄᓇᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ ᑕᐃᒪᐅᔪᑦ RAA-ᒥᑦ ᑕᐃᒪᐅᔪᑦ ᐊᑎᒃᑑᐸᓗᑎᒃ ᖃᕝᓯᐅᓂᖏᑦ ᐊᓯᐊᖑᕐᓂᖅ ᑭᒡᓕᕆᔭᐅᔪᒥᑦ ᖃᓄᐃᓐᓂᖓᓄᑦ ᖃᐅᔨᓐᓇᕋᔭᙱᑦᑐᖅ, ᐅᕙᓂᓃᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᐊᒃᑐᐊᓂᖅᑲᕋᔭᖅᑐᑦ ᐊᒃᑐᖅᑕᐅᓂᐅᔪᓄᑦ ᑐᒃᑐᓄᑦ ᐅᒥᖕᒪᓄᓪᓗ (ᓲᕐᓗ, ᑐᕐᑯᑎᑦᑎᑐᐃᓐᓇᓇᐊᖅᑲᕐᓂᒃᑯᑦ, ᐃᓂᕆᔭᐅᔪᓂᒃ ᐊᓯᐅᔨᓂᖅ, ᐊᐅᓚᓐᓂᖏᑦ). ᖃᐅᔨᓴᐃᓂᖅᑕᖅᑲᓚᐅᖅᑐᖅ ᐊᒪᖅᑯᑦ ᓯᑎᖏᑦᑕ ᐃᓂᖏᓐᓂᒃ ᓄᓇᕗᑦ ᒐᕙᒪᒃᑯᖏᑦᑕ ᐊᕙᑎᓕᕆᔨᒃᑯᖏᑦ ᐱᕐᑯᔨᓂᖓᒍᑦ. ᕿᕐᓂᖅᑖᑦ ᐊᒻᒪ ᑕᕆᐅᕐᒥᐅᑕᐃᑦ ᐸᒥᐅᕐᑯᖅᑐᔪᑦ ᑎᖕᒥᐊᑦ ᓇᓗᓇᐃᖁᑕᓚᐅᖅᑐᑦ ᐱᓕᕆᐊᑉ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᖕᒐᓂᒃ ᓅᖅᑲᖅᑐᓄᑦ ᑎᖕᒥᐊᑦ ᐃᓂᖏᓐᓄᑦ ᐋᓐᓂᐊᖅᑲᖅᑕᐃᓕᒪᓂᖏᓐᓄᓪᓗ ᑭᒡᒐᖅᑐᐃᖕᒪᑕ ᖁᐸᓄᐊᓂᒃ ᐊᒻᒪ ᐃᒪᕐᒥᐅᑕᓂᒃ. ᓯᕗᒥᐅᑕᐃᑦ ᑎᖕᒥᐊᑦ ᐃᓂᖏᑦ ᐃᓚᐅᑎᑕᐅᓚᐅᖅᑐᑦ ᐱᖁᔨᓂᖕᒐᑦᑎᒍᑦ ᐊᕙᑎᓕᕆᔨᒃᑯᑦ. ᑭᒡᒐᐊᕐᔪᐃᑦ ᓇᓗᓇᐃᖁᑕᓚᐅᖅᑐᑦ ᑕᒪᒃᑯᓄᙵ ᐃᓂᑐᖅᑲᖏᓐᓄᑦ ᐅᐸᓗᖅᑲᕿᓕᓚᐅᖅᑕᖏᓐᓄᑦ ᐅᑎᖅᑦᑕᐃᓇᐅᔭᖅᑦᑕᕐᓂᖏᓐᓄᑦ. ᐅᒃᐱᕐᔪᐊᑦ, ᐊᒃᓴᐃᑦ ᐊᒻᒪ ᖃᖁᕝᕕᑦ ᐃᓚᐅᑎᑕᐅᓚᐅᖅᑐᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᐅᔪᓄᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᓂᕐᔪᑎᐅᕙᑕ ᐅᓗᓇᐊᓇᖅᑐᒦᓗᑎᒃ.

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24 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ- BL02 2008: *ᓂᕿᓗᐊᓐ ᖃᑦᑕᖅᑕᕗᑦ ᑐᒃᑐᐃᑦ ᐃᖃᓗᐃᑦᓗ.*
25 EN-RI KWB ᐅᒃᑰᐱᓐ 2009: *ᐃᓄᐃᑦ ᓂᕿᖏᓐᓂᒃ ᐊᑐᑎᐊᖅᑐᒍᑦ ᑕᒪᒃᑯᐊᓗ ᒥᐊᓂᓐᔭᐅᔭᓐᐊᖃᖅᑐᑦ.*
26 EN-CH OH ᓄᑲᐱᓐ 2010: *ᐱᖏᕆᔭᒃᑲ ᓂᕐᔪᑏᑦ, ᒥᐊᓂᓐᓂᐊᖅᐱᕆᑦ, ᐋᓐᓂᖅᑎᙱᑦᑐᕆᑦᑐ?*
27 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-BL04 2008: *ᑕᖕᒫᖅᓯᒪᒐᔪᒃᑐᒍᑦ ᑐᒃᑐᐃᑦ ᐃᑳᖅᑕᕝᕙᖏᑦᑕ ᖃᓂᕆᔭᖏᓐᓂᑦ ᐅᐱᕐᖔᑯᑦ ᒥᖅᑯᐃᔭᖅᑎᑦᑐᕆᑦ ᓂᕿᖃᕐᑎᐊᕐᑐᑕᑐ ᒥᑉᑯᓕᐅᕐᓂᕐᒎᑦ, ᐅᑭᐊᒃᓵᑯᑦᑐ ᐊᒥᕐᑎᐊᓐᒃᓯᔭᕌᖓᑕ ᐊᓄᕌᓕᐅᕐᓂᕐᒎᑦ.*
28 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-ARVJ 2011: *ᐅᒥᖕᒪᐃᑦ ᒪᖃᐃᑕᐅᖅᑲᖅᑕᖅᑐᑦ ᓂᕿᖏᓐᓄᑦ ᐊᒥᖏᓐᓄᑦᑐ.*
29 EN-CH OH ᓄᑲᐱᓐ 2010: *ᓂᕐᔪᑏᑦ ᐱᒻᒪᓐᐅᓂᖅᐹᑦ VEC-ᓂᑦ ᑲᑎᕐᒪᔪᓂᑦ.*

ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ

ᐱᔾᔪᑕᐅᓗᐊᖅᑐᑦ ᐊᒃᑐᖅᑕᐅᓂᕐᒧᑦ ᑐᒃᑐᓄᑦ ᐅᒥᖕᒪᓄᓪᓗ ᐃᓚᐅᔪᑦ

1) ᐊᒃᑐᖅᑕᐅᓂᓐ ᐊᖏᒡᓕᒋᐊᕐᓂᖓ ᑐᕐᑯᕋᕐᓂᕐᒧᑦ ᐅᓗᑎᐊᓇᖅᑐᒦᓐᓂᖅ ᓄᓇᒃᑰᕈᑎᓄᑦ ᑐᓱᖅᑕᐅᓗᑎᒃ ᐊᒻᒪᓗ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐊᖏᒡᓕᒋᐊᕐᓂᖕᒋᓐᓄᑦ ᒪᕐᑲᐃᕐᑲᑦᑕᖅᑐᑦ ᑎᑭᖅᑲᐅᒪᓂᕆᔾᔪᖕᒋᓐᓄᑦ ᐅᑭᐅᓗᒃᑖᖅ ᐊᑐᖅᑕᐅᔪᖕᓇᖅᑐᒃᑯᑦ ᐊᕐᕿᑎᒃᑯᑦ (EN-BL NIRB ᐃᐳᓇ 2010[30]);

2) ᐊᒥᓲᔪᖕᓅᕐᓂᖕᒋᑦ ᐃᓂᒃᓴᖅᑲᕐᓂᕐᒧᑦ ᐱᓕᕆᐊᒃ ᐃᓂᒋᔅᖕᒐᓂᑦ ᐊᓯᐊᔭᓂᐅᔪᖅ ᓂᕆᔾᔭᒃᓴᖅᓯᐅᕐᕕᖕᒧᑦ, ᐊᒻᒪᓗ ᐃᒃᐱᒋᓂᕐᒧᑦ ᐸᒡᕕᓴᐃᓂᖅ ᑕᐃᑲᖖᒐᐅᖕᒋᑦᑐᖅ ᐊᓯᐅᔨᓂᕐᒧᑦ ᑕᐃᒪᐅᔪᓂᒃ ᐃᓂᒋᔭᐅᔪᓂᒃ (EN-RB NIRB ᐃᐳᓇ 2010[31], EN-AR NIRB ᒪᐃ 2010[32]);

3) ᐊᓯᐊᖑᕐᓂᖅ ᐅᑭᐅᒃ ᐃᓚᖕᒐᓂᒃ ᐊᐅᓚᓐᓂᖅ ᓴᓇᓯᒪᔪᓄᑦ ᐱᑉᐳᑎᒃ (ᐊᑉᕐᑯᑎᒥᑦ ᐊᕙᓗ, ᐅᒃᑯᐃᖕᒐᔪᑦ ᒪᓂᕋᒥᑦ, ᐃᒡᓗᕐᔪᐊᑦ) ᐊᒻᒪᓗ ᐃᒃᐱᒋᓂᕐᒧᑦ ᐸᒡᕕᓴᐃᓂᐅᔪᑦ ᑕᐃᑲᖖᒐᑦ ᐊᒃᑐᖅᓯᓂᖅᑲᕈᖕᓇᖅᑐᑦ ᐅᑭᐅᒃ ᐃᓚᖕᒐᓂᒃ ᐊᐅᓚᓐᓂᕐᒧᑦ (EN-CH NIRB ᒪᐃ 2010[33], EN-BL NIRB ᐃᐳᓇ 2010[34]); ᐊᒻᒪᓗ

4) ᐊᓯᐊᖑᕐᓂᖅ ᐋᓐᓂᐊᖅᑲᖅᑕᐃᓚᒪᓂᖕᒋᓐᓄᑦ ᓂᕆᔭᖕᒋᓐᓄᑦ ᐱᐅᖕᒋᑦᑐᖅᑕᖅᑲᖅᑐᓂᒃ (ᓲᕐᓗ, ᓂᕆᓗᑎᒃ ᐳᔪᖅᑖᖅᑲᖅᑐᒥᒃ) (EN-CH NIRB ᒪᐃ 2010[35], EN-BL NIRB ᐃᐳᓇ 2010[36]);

ᑐᒃᑐᐃᑦ ᑭᓯᒥ ᖃᐅᔨᓴᖅᑕᐅᔪᑦ ᐊᒃᑐᖅᑕᐅᓂᓐ ᐊᐅᓚᓐᓂᕐᒥᑦ ᐅᒥᖕᒪᐃᑦ ᓅᖅᑲᑦᑕᕆᒻᒪᑕ ᐅᑭᐅᑯᑦ ᐃᓂᒋᔭᖕᒋᓐᓂᑦ ᓄᕐᓇᐅᕝᕕᖕᓄᑦ (IQ-CI03 2009[37]); ᑕᐃᒪᓐᓇᒎᑦ, ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᐅᒥᖕᒪᐃᑦ ᐊᐅᓚᓐᓂᖕᒋᓐᓄᑦ ᐅᖃᐅᓯᐅᔪᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐃᓂᒋᔭᐅᖃᑦᑕᖅᑐᒥᒃ ᐊᑐᕐᓂᕐᒧᑦ.

ᐱᓕᕆᐊᒎᑦ ᐃᓚᒋᔭᐅᔪᑦ ᐊᒃᑐᐊᓂᖃᖅᑐᑦ ᑕᒪᒃᑯᓄᖕᒐ ᐊᒃᑐᖅᑕᐅᓂᓐ ᐃᓚᐅᔪᑦ ᐃᓂᐅᔪᒥᒃ ᐃᔭᐃᓂᖅ (ᐃᓂᒋᔭᐅᔪᒥᒃ ᐊᓯᐅᔨᓂᖅ), ᐅᔭᕋᖕᓂᐊᕐᓂᐅᑉ ᐊᐅᓚᕐᓂᖓ (ᒥᑭᒡᓕᒋᐊᖅᑐᖅ ᐃᓂᒋᔭᐅᔪᖅ ᐋᑎᖅᑦᑎᐊᕐᓂᖕᒐᓂᒃ), ᐊᑉᕐᑯᑎ ᓴᓇᔭᐅᓂᖓ (ᐃᓂᐅᔪᒥᒃ ᐊᓯᐅᔨᓂᖅ) ᐊᒻᒪᓗ ᐊᐅᓚᕐᓂᖓ (ᑐᕐᑯᑎᑦᑎᓂᖅ ᐊᒻᒪᓗ ᒥᑭᒡᓕᒋᐊᕐᓂᖓ ᐃᓂᐅᔫᒃ ᐋᑎᖅᑦᑎᐊᕈᖕᓇᕐᓂᖓ), ᓯᖅᑲᓪᓕᑎᓇᓂᖅ (ᓂᐱᖅᑲᕐᓂᖅ ᐳᔪᖅᑖᒡᓗ

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[30] EN-BL NIRB ᐃᐳᓇ 2010: *ᐃᓯᒫᓘᑎᑦ ᓂᕐᔪᐃᑦ ᒥᒃᓵᓄᑦ ᐊᒃᑐᖅᑕᐅᓂᖕᒋᓪᓗ ᐊᕙᑎᒧᑦ ᐊᓯᐊᖑᕐᓂᐅᔪᓄᑦ.*
[31] EN-RB NIRB ᐃᐳᓇ 2010: *ᐃᓯᒫᓘᑎᖃᖅᑐᑦ ᓂᕐᔪᐃᑦ ᐃᓂᒋᔭᖕᒋᑦᑕ ᒥᒃᓵᓄᑦ*
[32] EN-AR NIRB ᒪᐃ 2010: *ᐃᓯᒫᓘᐃᑦ ᐊᒃᑐᖅᓯᓂᐅᑐᐃᓐᓇᓇᐊᓕᖕᓄᑦ ᓂᐱᖃᕐᓂᕐᒧᑦ ᓅᐸᓪᓚᐊᑎᓪᓗᒋᑦ ᓂᕐᔪᐃᑦ ᐊᒻᒪᓗ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖅᑕᖅᑲᓇᐊᖅᑲᖅᑐᖅ.*
[33] EN-CH NIRB ᒪᐃ 2010: *ᖃᐅᔨᓴᐃᓂᖅᑕᖅᑲᓚᐅᖅᐸ ᑐᒃᑐᐃᑦ ᑕᒪᐅᓇ ᓅᖅᑲᑦᑕᕐᓂᖕᒋᑦᑕ ᒥᒃᓵᓄᑦ ᓄᕐᓇᐅᕝᕕᒋᕙᒃᑕᖕᒋᓐᓄᓪᓗ?*
[34] EN-BL NIRB ᐃᐳᓇ 2010: *ᑐᒃᑐᐃᑦ ᐊᑉᕐᑯᑎᖕᒋᑦ ᓅᑎᓪᓗᒋᑦ ᐱᒻᒪᕆᐅᔪᑦ ᑭᕙᓪᓕᕐᒥᑦ.*
[35] EN-CI KIA ᐃᐳᓇ 2007: *ᑐᒃᑐᐃᑦ ᒪᓂᕋᕐᒥᑦ ᓂᕆᖃᑦᑕᖅᑐᑦ. ᐋᓐᓂᐊᓕᖅᐸᑕ, ᐅᕙᖑᑦᑕᐅᖅ ᐋᓐᓂᐊᓕᕐᓂᐊᖅᑐᒍᑦ. ᐋᓐᓂᐊᕐᓂᖅᑖᕐᓗᑕ.*
[36] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖕᒋᑦ-ARHT 2009: *ᒪᖃᐃᑏᑦ ᐃᓐᓇᑐᖃᐃᓪᓗ ᐃᓯᒫᓘᑎᖃᖅᑐᑦ ᐱᐅᖕᒋᑦᑐᓂᒃ ᐊᓂᖅᓵᖅᑐᖅᑕᐸᑎᖕᓄᐊᖅᑐᖃᓇᐊᒃᓴᖕᒐᓂᒃ ᐱᕈᖅᑐᓄᐊᕐᓗᑎᒡᓗ ᑐᒃᑐᑦ ᓂᕆᖃᑦᑕᖅᑕᕐᒋᓐᓄᑦ.*
[37] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖕᒋᑦ-CI03 2009: *ᐅᒥᖕᒪᐃᑦ ᓅᖅᑲᖖᒋᑦᑐᑦ ᐊᒻᒪᓗ ᐃᖕᒋᕋᕙᒃᓗᑎᒃ ᓯᑲᐃᑐᒥᒃ. ᓄᑕᐅᖕᒋᑦᑐᑦ ᑐᒦᑦ ᑕᑯᔭᐅᒃᐸᑕ, ᑕᐃᑲᓃᓐᓂᐊᖅᑐᑦ ᓯᓚ. ᐅᒥᖕᒪᐃᑦ ᐱᕈᖅᑐᖅᑕᖅᑲᖅᑐᒦᖅᑲᑦᑕᖅᑐᑦ, ᓅᓕᖅᑲᓗᑎᒃ ᑭᓯᐊᓂ ᐱᕈᖅᑐᑦ ᓄᖑᑦᑕᕌᖓᑦ.*

ᐊᑦᑐᖅᓯᐊᖅ ᐃᓂᐅᐊᒥᒃ ᐋᑐᑦᑎᖃᑦᑎᐊᕈᓐᓇᕐᓂᐅᐊᒥᒃ ᐊᒻᒪ ᐳᐊᖅᑲᑖᒃ ᐊᑦᑐᖅᑕᐅᓂᖓ ᓂᕆᓐᕓᐅᓐᕓᙵᓂᑦ ᐊᒻᒪ ᓂᕐᔪᑏᑦ ᐋᓐᓂᐊᕐᑲᖅᑕᐃᓕᒪᓂᖏᓐᓇᑦ).

ᐊᖏᒡᓕᒋᐊᕐᓂᖓ ᑐᕐᑯᕋᕐᓂᕐᒧᑦ ᐅᑐᕆᐊᓇᖅᑐᒥ̇ᓐᓂᖅ ᐃᓱᒪᒋᔭᐅᐊᖅ ᐊᖏᔫᓂᖓᓂᒃ ᑐᕐᑯᕋᐃᓂᖅ ᐅᖓᑕᐅᑎᒃᐸᑦ ᒪᕐᑲᐃᑕᐅᕐᑲᑦᑕᕆᐊᕐᑲᕐᓂᐅᐊᓂᒃ. ᖃᐅᔨᒪᔭᐅᐊᒥᒃ ᐊᑐᖅᑕᐅᔭᕆᐊᕐᑲᖅᑐᒥᒃ ᐱᑕᕐᑲᙳᕆᑦᑐᖅ ᐅᕙᓃᓐᓃᑦ ᖄᓯᐅᓂᕐᒧᑦ ᖃᐅᔮᓂᐊᕐᓗᓂ ᐊᓯᐅᔮᓂᐅᐊᒥᒃ ᐃᓂᕆᔭᐅᐊᓂᒃ ᑐᒃᑐᓄᑦ ᐅᒥᖕᒪᓄᓪᓘᓃᑦ. ᐊᑐᖅᓗᓂ ᐃᓕᓐᓂᐊᖅᓯᒪᔦᐃᑦ ᐅᖃᐅᓯᖏᓐᓂᒃ, ᐱᓕᕆᓂᑰᖅᑲᖅᑐᓂᒃ ᐅᑭᐅᖅᑕᖅᑐᒦᑐᓂᒃ ᐱᓕᕆᐊᓂᑦ, ᐊᒻᒪ ᖃᐅᔨᒪᓂᖅᑲᕐᓂᖅ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᐆᒪᓂᕐᒧᑦ ᐊᑐᖅᐸᒃᑕᖏᓐᓂᒃ. ᐱᓕᕆᐊᒥᒃ ᐊᑦᑐᖅᑕᐅᓃᑦ ᐃᓂᒋᔭᐅᔦᑦ ᑕᐃᒪᐅᓂᖏᓐᓄᑦ ᐃᓱᒪᒋᔭᐅᐊᖅ ᐊᖏᓂᖓᓂᒃ ᐊᖏᓂᖅᓴᐅᒃᐸᑦ 5%-ᒥᒃ ᑐᒃᑐᐃᑦ ᐱᑖᖅᐸᓪᓕᐊᓂᕆᔭᖏᓐᓂᒃ ᐅᕙᓃᓐᓃᑦ ᐅᑭᐅᑯᑦ ᐃᓂᒋᔭᖏᑦ ᐊᑐᖅᑕᐅᓂᖅ ᐊᔦᓕᖅᐸᑦ ᑐᒃᑐᓄᑦ, ᐅᕙᓃᓐᓃᑦ ᐅᒥᖕᒪᓄᑦ ᐊᐅᓚᑦᑎᓂᖅ MX/21 ᐊᑐᖅᑕᐅᓂᖅ ᐊᔦᓕᖅᐸᑦ ᐅᒥᖕᒪᓄᑦ. ᐱᑕᕐᑲᙳᕆᑦᑐᓂᒃ ᖃᐸᓯᐅᓂᖏᓐᓇᑦ ᑎᑎᕋᐅᓰᑦ, ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᐊᑦ ᐊᐅᓚᓐᓂᐅᐊᓂᒃ ᐃᓱᒪᒋᔭᐅᐊᖅ ᐊᖏᓂᖓᓂᒃ ᐊᖏᓂᖅᓴᐅᒃᐸᑦ 10%-ᒥᒃ ᐊᒥᕐᑯᐃᑦ ᓴᖑᑎᑕᐅᒃᐸᑕ ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᐊᓄᑦ ᓂᕐᔪᑏᑦ ᓄᕐᖃᐅᕝᕕᕆᐅᒃᑕᖏᓐᓇᑦ ᑎᑭᐅᑎᙳᕆᓪᓗᑎᒃ ᐅᕙᓃᓐᓃᑦ ᐅᑭᐅᑯᑦ ᐃᓂᕆᐅᒃᑕᖏᓐᓇᑦ. ᐋᓐᓂᐊᕐᑲᖅᑕᐃᓕᒪᓂᕐᒧᑦ, ᓇᓚᐅᑖᖅᑕᐅᔦᑦ ᐊᑦᑐᖅᑕᐅᓂᕐᑲᖅᑐᑦ ᑕᒪᐃᓄᑦ ᐅᑐᕆᐊᓇᖅᑐᕐᑲᙳᕆᑦᑐᓄᑦ ᐅᑐᕆᐊᓇᖅᑐᓄᓪᓗ ᐱᔭᐅᔦᑦ ᐆᒪᓂᕐᒧᑦ, ᐃᓱᒪᒋᐸᓗᒋᑦ ᑕᒪᕐᒥᒃ ᑭᒡᓕᒋᔭᐅᔦᑦ ᐱᓕᕆᐊᒥᑦ ᐳᐊᕐᓗᐃᑦ ᐊᓂᐊᔦᑦ, ᖃᓄᐃᓐᓂᖅᓴᐅᓂᖏᑦ ᖃᐅᔨᒋᐊᕈᑕᐅᔦᑦ ᖃᓄᑎᒋᐅᓂᖏᓐᓇᑦ ᒥᐊᓂᖅᓯᐊᑦ ᓂᕐᔪᑎᓂᒃ.

ᑐᕐᑯᕋᕐᓂᕐᒧᑦ ᐅᑐᕆᐊᓇᖅᑐᒥ̇ᓐᓂᖅ – ᐊᖏᒡᓕᒋᐊᕐᓂᖅ ᑐᕐᑯᕋᕐᓂᕐᒧᑦ ᐅᑐᕆᐊᓇᖅᑐᒥ̇ᓐᓂᖅ ᐊᒥᓯᓕᐅᖅᑕᐅᓚᐅᖅᑐᖅ ᖃᐅᔮᐸᓗᒍ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᐊᒥᕐᑯᐃᑦ ᑎᑭᐅᑎᓯᒪᓂᐊᕐᓂᖏᓐᓇᑦ ᐱᓕᕆᐊᒨᖓᔪᒃᑯᑦ ᑐᓗᖅᑕᐅᓂᕐᒧᑦ (ᑕᐃᒃᑲᙵᑦ ᐊᑦᑐᖅᑕᐅᓂᖅ) ᐊᒻᒪ ᒪᕐᑲᐃᑕᐅᕐᑲᑦᑕᕐᓂᕐᒧᑦ (ᑕᐃᒃᑲᙵᐅᖏᑦᑐᖅ ᐊᑦᑐᖅᑕᐅᓂᖅ) ᐱᖓᖕᓇᖓᓂᑦ Thelon ᑰᑉ ᐊᐅᔭᐅᑎᓪᓗᒍ (EN-BL OH ᐅᑦᑑᐱᓇ 2012[38]). ᑐᑭᓯᐅᒪᔾᔪᑏᑦ ᐊᑐᖅᑕᐅᔪᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᑖᑉᑯᓂᙶᖓᑦ ᐊᑦᑐᖅᓯᓂᐅᔪᓂᒃ ᐃᓚᐅᔪᑦ ᖃᐸᓯᐅᓂᖏᑦ ᓇᓅᓐᓂᖏᓐᓇᑦ ᐊᒥᕐᑯᐃᑦ, ᒦᓐᓇᐅᔪᖅ ᐱᑕᕆᔭᐅᕐᑲᑦᑕᖅᑐᑦ ᓇᓅᓐᓂᖏᑦ, ᐊᒻᒪ ᐃᓕᑕᖅᓯᓂᖅ ᑲᑎᕆᒃ ᐱᔭᐅᔪᖕᓇᖅᑐᑦ ᒪᕐᑲᐃᑕᐅᓗᑎᒃ (TAH) ᑭᒡᓕᐅᔪᑦ. ᐅᑭᐅᓗᒃᑖᖅ ᐊᑐᖅᑕᐅᔪᖕᓇᖅᑐᖅ ᐊᑉᑯᑎ ᑕᐅᑐᒐᐅᓚᐅᖅᑐᖅ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᖏᒡᓕᒋᐊᕈᖕᓇᕐᓂᖅ ᑐᕐᑯᕋᕐᓂᕐᒧᑦ ᐅᑐᕆᐊᓇᖅᑐᒥ̇ᓐᓂᖅ ᑐᑦᑐᓄᑦ ᐊᑐᖅᑕᐅᔪᖕᓇᓚᐅᕐᒪᑦ ᐱᔪᖕᓇᖅᑎᑦᑎᓂᕐᒧᑦ ᒪᕐᑲᐃᑏᑦ ᐊᑐᕈᖕᓇᕐᓂᖏᓐᓇᑦ ᐊᔪᕐᓇᓚᐅᖅᑑᓗᐊᒥᒃ ᓯᕗᓂᕐᒥᑦ ᓯᑯᓯᒪᙳᕆᑎᓪᓗᒍ, ᐊᒻᒪ ᑐᑦᑐᑕᐅᔪᑦ ᒦᓐᓇᐅᔪᖅ (TAH)-ᒥᒃ ᐱᖃᙳᕆᒻᒪᑕ.

ᖃᒪᓂᕐᔪᐊᖅ ᐊᒥᕐᑯᐃᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᐊᑦᑎᑎᖃᑦᑕᕐᓂᐊᕐᓂᖏᓐᓇᑦ ᐱᓕᕆᐊᒧᑦ ᓄᕐᖃᐅᕌᓂᒃᑎᓪᓗᒋᑦ ᑲᑎᑉᐸᓪᓕᐊᓂᕐᒥᑦ ᐊᒻᒪ ᐊᐅᔭᒃᑯᑦ ᓅᑎᖅᑎᓪᓗᒋᑦ, ᐊᒻᒪ ᖃᒪᓂᑦᑐᐊᖅ ᐊᒥᕐᑯᐃᑦ ᓂᕆᐊᒋᔭᐅᔪᑦ ᐊᑦᑎᑎᖃᑦᑕᕐᓂᐊᕐᓂᖏᓐᓇᑦ ᐱᓕᕆᐊᒧᑦ ᐅᑭᐅᑯᑦ. ᐅᒥᖕᒪᐃᑦ ᓂᕐᔪᑎᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒥᑦ MX21-ᒥᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ RAA-ᒥ̇ᓐᓂᐊᕐᓂᖏᓐᓇᓂᒃ ᐅᑭᐅᓗᒃᑖᖅ. RAA ᐊᑐᖅᑕᐅᕐᑲᑦᑕᖅᑐᑦ ᐃᓕᖅᑯᓯᑐᕐᑲᒃᑯᑦ ᒪᕐᑲᐃᓂᕐᒧᑦ ᐅᑭᐅᓗᒃᑖᖅ. ᐊᑐᖅᓗᓂ ᒪᕐᑲᐃᕙᐅᔦᓄᑦ ᓈᓴᐅᑎᓂᒃ ᑲᑎᑕᐅᔪᑦ ᐃᓚᒋᔭᐅᓂᕐᒧᑦ ᓄᓇᕗᒻᒥᑦ ᓂᕐᔪᑎᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᑲᑎᒪᔨᖏᑦ ᐱᑕᖅᑕᐅᔦᓄᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ, ᐊᒥᓲᖏᑦᑐᑦ ᑐᑦᑐᐃᑦ ᐱᑕᕆᔭᐅᓯᒪᔪᑦ ᒦᓐᓇᓈᓴ RAA-ᒥᑦ. ᑐᑭᓯᐅᒪᔾᔪᑎᓂᒃ ᒪᓂᒪᔪᖅᑲᙳᕆᑦᑐᖅ ᖃᓄᐃᓕᐅᕐᓂᐅᐊᓂᒃ ᐃᓚᒋᔭᐅᔪᓂᒡᓗᓃᑦ ᑐᕐᑯᕋᕐᓂᕐᒧᑦ ᐃᖏᖕᓂᒃ ᐱᔦᓄᑦ ᓱᕐᓗ ᐋᓐᓂᐊᕐᑲᕐᓂᕐᒧᑦ ᐊᓯᖏᓐᓄᑦ ᓂᕐᔪᑎᓄᑦ ᐱᔭᐅᓂᖏᓐᓄᑦᓗᓃᑦ.

38 EN-BL OH ᐅᑦᑑᐱᓇ 2012: *40 -ᓗᐊᓂᒃ Hᐋᓐᑕᑕᕐᑲᕐᑲᑦᑕᖅᑐᖅ ᐃᓚᖏᑦᑎᒍᑦ ᐅᐸᓗᐃᑦ ᐊᐳᖅᑎᓈᖅᑑᑉ ᐊᑉᑯᑎᖓᓂᕐ. ᐊᒥᓲᓂᖅᓴᐅᔪᒃᓴᐅᔪᑦ (ᑐᑦᑐᐃᕐ) ᐱᔭᐅᕐᑲᑦᑕᖅᑐᒃᓴᐅᓕᖅᑐᕐ.*

ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖅ ᑐᕐᑯᕋᕐᓂᕐᒧᑦ ᐃᓚᒋᔭᐅᔪᖅ ᐱᔭᒃᓴᐅᑎᖏᓐᓄᑦ ᐊᕇᕙᒃᑯᑦ, ᐊᓯᖏᓐᓄᑦ, ᐊᒪᓗ ᒪᓕᒐᓂᒃ ᒪᓕᒃᑕᐅᔪᒃᓴᓕᐅᖅᑎᓄᑦ. ᐊᕇᕙᒃᑯᑦ ᐊᑐᓕᖅᑎᑦᑎᔪᓐᓇᖅᑐᑦ ᖃᐸᖓᐅᓂᕐᒧᑦ ᐊᐅᓚᑦᑎᓂᕐᒨᕐᒐᔪᓄᑦ ᑭᒡᓕᖅᑲᖅᑎᑦᑎᓂᕐᒧᑦ ᐱᑕᕆᔭᐅᔪᓐᓇᖅᑐᓂᒃ ᐊᑦᕋᑎᐅᑉ ᖃᓂᖕᒐᓂᑦ. ᑕᒪᒃᑯᓇᓂ ᐃᓚᐅᔪᑦ ᐊᐅᓚᑦᑎᓂᖃᕐᕕᐅᔪᑦ ᐃᓄᖕᓄᑦ ᑎᑭᑕᐅᔪᓐᓇᖅᑐᑦ, ᑭᒡᓕᓕᐅᖅᓯᒪᔪᑦ ᒪᖃᐃᕙᐅᓂᖅ ᐅᔪᕐᓂᕐᒧᑦ, ᐅᒃᑯᐊᓚᐅᐱᓪᓚᖓᓃᑦ, ᐊᒪᓗ ᒥᑭᒡᓕᒋᐊᖅᓯᓗᓂ ᓇᑭᖅᓴᕐᓂᐅᔪᓄᑦ ᑭᒡᓕᐅᔪᓂᒃ. ᐊᓯᖏᑦ ᐱᔾᔪᔾᔨᔾᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒥᒃ ᐱᓕᕆᐊᖃᕈᒪᓇᔭᖅᑐᒃᓴᐅᔪᑦ ᐱᑕᖅᑕᐅᔪᓂᒃ ᐊᒪᓗ ᖃᐳᔨᐅᓂᖏᓐᓂᒃ, ᓴᖅᑭᑦᑎᓗᓂᓗ TAH-ᒧᑦ ᑭᒡᓕᐅᔪᓂᒃ. ᑲᑎᑉᐸᓪᓕᐊᔪᓐᓇᖅᑐᑦ ᒪᖃᐃᑕᐅᑲᓐᓂᖅᑐᓄᑦ ᑐᒃᑐᓂᒃ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖃᑐᐃᓐᓇᓇᐊᖃᖅᑐᑦ ᐊᐅᓚᑦᑎᓂᕐᒥᒡᓗ ᐊᐅᓚᑦᑎᓂᖃᖅᑐᓄᑦ.

ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖅᑕᖃᖅᑳᖅᑎᓪᓗᒍ, ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᖄᒪᒃᑎᑦᑐᓄᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᑐᒃᑐᐃᑦ ᑐᕐᑯᕋᕐᓂᕐᒧᑦ ᐅᓗᓇᐊᓇᖅᑐᒥᓐᓂᖏᑦ ᐅᔭᕋᖕᓂᐊᕐᕙᖕᒥ ᐊᑉᕿᑎᒥᓪᓗ ᐊᖏᔫᔮᖏᑦᑐᖅ. ᐊᒃᑐᖅᓯᓃᑦ ᐅᔭᕋᖕᓂᐊᕐᕙᖕᒥᑦ ᐅᑭᐅᑯᓪᓗ ᐊᑉᕿᑎᒥᑦ ᖃᒪᓂᕐᔪᐊᖅ ᑐᒃᑐᓄᑦ ᓂᕈᐅᒋᔭᐅᔪᑦ ᐅᔮᕐᓇᔾᔮᖏᓐᓂᖏᓐᓄᑦ ᑖᑉᑯᐊ ᑐᒃᑐᐃᑦ ᑕᐃᒪᐅᔪᕐᒃᔾᔮᖏᒻᒪᑕ RAA-ᒥᑦ ᐅᑭᐅᑯᑦ. ᐅᑭᐅᓗᒃᑖᖅ ᐊᑐᖅᑕᐅᔪᓐᓇᖅᑐᖅ ᐊᑉᕿᑎ ᑎᑭᖅᑲᐅᒪᑎᑦᑎᔪᓐᓇᖅᑐᖅ RAA-ᒥᑦ ᐊᐳᑎᕐᑲᖖᒋᑎᓪᓗᒍ ᖃᒪᓂᕐᔪᐊᖅ ᑐᒃᑐᐃᑦ ᑖᒫᓃᑎᓪᓗᒋᑦ, ᐊᖏᒡᓕᒋᐊᕈᖅᓇᖅᑐᖅ ᐃᓚᖏᓐᓂᒃ ᖃᒪᓂᕐᔪᐊᖅ ᓂᕐᔪᑎᖏᓐᓂᒃ ᐱᔭᐅᔪᑐᐃᓐᓇᐃᑦ ᔪᓚᐃ ᓄᖑᐊᓂᑦ/ᐋᒋᓯᒥᑦ. ᑭᓯᐊᓂ, ᐊᑐᓕᖅᑎᑦᑎᓂᖅ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᒨᕐᒐᔪᑦ (ᓛᕐᓗ ᑎᑭᖅᑲᐅᒪᓂᕐᒧᑦ ᐊᐅᓚᑦᑎᓂᖅ) ᐃᑲᔪᐃᓂᐊᖅᑐᖅ ᐊᐅᓚᑦᑎᓂᕐᒥᒃ ᐊᖏᒡᓕᒋᐊᕈᖅᓇᖅᑐᓂᒃ ᑐᕐᑯᕋᕐᓂᕐᒧᑦ ᐅᓗᓇᐊᓇᖅᑐᒥᓐᓂᖅ ᒪᖃᐃᑕᐅᓂᕐᒧᑦ. ᐊᑦᑎᒃᑐᒥᑦ ᑕᐃᑲᖖᒐᑦ ᑐᕐᑯᕋᕐᓂᕐᒧᑦ ᐅᓗᓇᐊᓇᖅᑐᒥᓐᓂᖅᑕᖅᑐᐃᓐᓇᓇᐊᖃᖅᑐᖅ ᑐᓗᖅᑕᐅᓂᖏᓐᓄᑦ ᑐᒃᑐᐃᑦ ᐊᑉᕿᑎᓃᑐᓄᑦ. ᑐᓗᖅᑕᐅᔪᑦ ᓄᓇᒃᑰᕈᑎᓄᑦ ᐊᑉᕿᑎᒥᑦ ᑕᐅᒪᔾᔮᖏᑦᑐᒃᓴᐅᔪᑦ, ᓇᕿᒃᓴᕐᓂᐅᔪᓄᑦ ᑭᒡᓕᐅᔪᑦ ᒥᒃᓵᒋᐊᖅᑕᐅᓂᖅ ᓄᓇᒃᑰᕈᑎᓂᒃ ᓄᖅᑲᕈᖅᓇᖅᓵᓕᑎᑦᑎᖕᒪᑦ ᑐᒃᑐᐃᑦ ᐊᑉᕿᑏᑉᐸ. ᐅᑭᐅᓗᒃᑖᖅ ᐊᑐᖅᑕᐅᔪᖅᓇᖅᑐᖅ ᐊᑉᕿᑎ ᓇᕿᕐᓂᖅᓴᒥᒃ ᑭᒡᓕᕐᑲᖅᑐᖅ ᓇᕿᖅᓴᕈᖅᓇᕐᓂᕐᒥᒃ, ᑭᓯᐊᓂ ᓄᓇᒃᑰᕈᑏᑦ ᑐᓇᖅᓯᑦᑕᐃᓕᓂᖅ ᑐᒃᑐᓂᒃ ᐊᔪᙱᓇᔭᖅᑐᑦ, ᓄᓇᒃᑰᕈᑏᑦ ᐅᖅᑲᖅᑕᐅᑎᓂᖅ ᐱᑦᑲᕐᒪᑕ.

ᐃᑲᔪᐃᓂᐅᔪᖅ ᐱᓕᕆᐊᒥᑦ ᑲᑎᑉᐸᓪᓕᐊᓂᕐᒧᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᓄᑦ ᑐᕐᑯᕋᕐᓂᕐᒧᑦ ᐅᓗᓇᐊᓇᖅᑐᒥᓐᓂᖅ ᑐᒃᑐᓄᑦ, ᐊᒪᓗ ᑕᐃᒪᐅᑎᑦᑐᖕᓇᕐᓂᖅ ᖃᒪᓂᕐᔪᐊᖅ ᐊᒪᓗ ᖃᒪᓂᑦᑐᐊᖅ ᐊᒥᕐᕋᖏᑦ ᖃᐳᔨᐅᓂᖏᑦ ᐊᖏᔫᔮᖏᑦᑐᖅ. ᑎᑭᖅᑲᐅᒪᓂᖅᑕᕐᓂᖅ ᐊᓯᐊᒍᑦ ᐊᒃᑐᖅᓯᓂᖅᑭᖕᓇᖅᑎᓪᓗᒍ ᑐᒃᑐᐃᑦ ᐱᑕᖅᑕᐅᔪᓄᑦ, ᓇᓗᓇᖅᑐᖅ ᐱᑕᖅᑕᐅᔪᑦ ᐃᓚᓯᓂᐅᓂᐊᕐᒪᖕᓕᑦ ᒥᑭᔾᒋᐊᖅᑎᑦᑎᓂᕐᓘᓃᑦ ᐱᑕᖅᑕᐅᕋᓂᒃᑐᓄᑦ ᖃᒪᓂᑦᑐᐊᑉ ᒪᖃᐃᑎᖏᓐᓄᑦ. ᖃᒪᓂᕐᔪᐊᖅ ᐊᒥᕋᐃᑦ ᐅᓗᓇᐊᓇᖅᑐᒦᓛᖑᔾᔭᖅᑐᑦ ᐊᖏᒡᓕᒋᐊᕐᓂᕐᒧᑦ ᒪᖃᐃᑕᐅᖃᑦᑕᕐᓂᖏᓐᓄᑦ ᒪᖃᐃᑏᑦ ᑎᑭᖅᑲᐅᒪᓂᖅᓴᐅᓂᖏᓐᓄᑦ ᓯᑯᖃᙱᑎᓪᓗᒍ. ᑭᓯᐊᓂ, ᒥᑭᑦᑐᑐᐃᓐᓇᕐᒥᒃ ᐊᒥᕋᓂᒃ ᓇᓂᓯᓯᒪᔪᑦ RAA-ᒥᑦ ᐊᑉᕿᑎ ᐊᑐᖅᑕᐅᔪᓐᓇᕋᖓᑦ, ᐊᒪᓗ ᑕᐅᕙᓃᒃᑲᕐᒪᑕ ᐊᑯᓂᐅᖏᑦᑐᖅ. ᐊᔪᕐᓇᙱᑦᑐᖅ ᖃᐳᔭᓐᓂᐊᕐᔪᐃᑦ ᑐᒃᑐᐃᑦ ᒪᖃᐃᑕᐅᑲᓂᕈᓐᓇᖅᑐᑦ ᓇᐃᑐᒥᑦ RAA-ᒦᑎᓪᓗᒋᑦ. ᑭᓯᐊᓂ, ᖃᐅᔨᓂᐊᕐᓗᒍ ᐊᒃᑐᖅᓯᓂᐅᔭᖅᓇᖅᑐᖅ ᐊᑐᕐᓗᓂ ᐊᖏᔪᒥᒃ ᓇᓚᐅᑖᖅᑕᐅᔪᓂᒃ ᑕᒪᐃᓄᑦ ᒫᓇᐅᔪᕐᓗ ᒪᖃᐃᑕᐅᔪᓄᑦ ᓈᓴᐅᑏᑦ ᐊᒪᓗ ᒫᓇᐅᔪᖅ ᑐᒃᑐᐃᑦ ᖃᐳᔨᐅᓂᖏᑦ. ᖃᐅᔨᒪᓂᒃᑲᓂᖅ ᑕᒪᐃᓂᒃ ᐱᔭᕇᐊᖅᑐᖅ ᑕᒪᐃᓄᑦ ᐃᓚᐅᖃᑕᐅᔪᓄᑦ ᑐᑭᓯᓇᖅᑐᓂᒃ ᐃᓱᒪᓕᐅᕆᓂᖃᕐᓂᐊᕐᓗᓂ.

ᒪᓕᖕᓂᖅ ᐊᒪᓗ ᐊᕙᑎᒥᒃ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᐊᓯᐊᙳᕐᓂᕐᒧᑦ ᑐᕐᑯᕋᕐᓂᖏᑦ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᐃᓚᐅᔪᓐᓇᖅᑐᑦ ᐊᕇᕙᒃᑯᓐᓄᑦ 1) ᐃᑲᔪᐃᓂᖕᒐᑦ ᒪᖃᐃᑎᒥᒃ ᐱᑕᖅᑕᖏᓐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐃᑲᔪᐃᓂᕐᒧᑦ ᖃᐅᔨᓂᖅ ᑲᑎᓗᒋᑦ ᐱᑕᖅᑕᐅᔪᑦ ᐊᒥᕋᓂᑦ; 2) ᐃᓚᐅᖃᑕᐅᓗᓂ ᓄᓇᕗᑦ ᒐᕙᒪᒃᑯᖏᑦᑕ ᖁᖓᓯᕈᓯᖅᑐᐃᓂᕐᒧᑦ ᑐᕌᖓᔪᓄᑦ ᖃᐅᔨᔪᒪᓂᕐᒧᑦ ᖃᖓᒃᑯᑦ ᐊᒥᕋᐃᑦ ᓇᒨᖓᐅᖃᑦᑕᕐᓂᖏᑦ; 3) ᐃᑲᔪᐃᓗᓂ ᓄᓇᕗᑦ ᒐᕙᒪᒃᑯᖏᑦᑕ ᖃᐳᔨᐅᓂᖏᓐᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᒥᒃ ᖃᐅᔨᔪᒪᓂᕐᒧᑦ ᓇᓂ ᐊᒥᕋᐃᑦ ᖃᐳᔨᐅᓂᖏᑦ

ᖃᓄᐃᖓᓂᐅᔪᑦ; ᐊᒻᒪ 4) ᐱᓕᕆᐊᒨᖓᔪᑦ ᑐᒃᑐᓂᒃ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᑐᕌᖓᔪᑦ (ᓄᓇᒥᑦ ᖃᐅᔨᓴᐅᔪᑦ; EN-BL OH ᐅᒃᑑᐱᕆ 2012[39]).

ᐊᕼᓇᒃᑯᑦ ᐃᓱᒪᔪᑦ ᕿᑦᑎᓛᒃᑯᑦ ᐱᓕᕆᐊᖑᖅᑲᐅᑕᐅᓴᕆᐊᖃᕐᓂᖓ ᐱᓕᕆᖃᑎᖃᕐᓂᖅ ᐃᓚᐅᔪᓂᒃ ᐊᑐᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᐃᓗᐊᖅᑐᒥᒃ ᐊᔾᔨᕉᖕᓂᖃᖅᑐᒥᒡᓗ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖅ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᖏᒡᓕᓂᐅᔪᙳᖅᑐᑦ ᑐᕐᑯᕋᕐᓂᕐᒧᑦ ᐅᓗᕆᐊᙳᖅᑐᒦᓐᓂᖅ ᐅᑭᐅᓗᒃᑖᖅ ᐊᑉᕿᑎ ᐊᑐᖅᑕᐅᔪᙳᖅᑐᖅ ᐱᔾᔪᑎᒋᐸᓗᒍ.

ᐃᓂᒋᓴᐅᔪᖅ – ᐃᓂᒋᓴᐅᔪᒧᑦ ᓇᓗᓇᐃᖁᑕᖅ ᓴᖅᑭᑕᐅᓚᐅᖅᑐᖅ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᑕᒪᐃᓂᑦ ᐊᓱᐃᕆᓂᐅᔪᑦ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᑦᑐ ᐃᓂᒋᓴᖕᒋᓐᓂᒃ RAA-ᒥᑦ. ᓇᓗᓇᐃᖁᑕᖅ ᐊᑐᖅᑐᓂ ᐃᓕᓯᐸᑐᓂ ᓇᓂᓐᓂᐅᔪᒧᑦ ᓈᓴᐅᑎᒥᒃ ᐊᑐᓂ ᐃᓂᒋᓴᐅᔪᓄᑦ (ᓱᕐᓗ, ᕿᑦᑎᒃᑐᖅ=3, ᕿᑎᐊᓃᑐᖅ=2, ᐊᑦᑎᒃᑐᖅ=1, ᐱᑕᖃᙱᑦᑐᖅ=0). ᖃᓄᐃᓐᓂᕆᓴᕆᑦ ᑕᒪᕐᒥᒃ ELC ᐱᓕᕆᐊᑉ ᐃᓂᒋᓴᖓᓂᑦ “ᐱᑕᖃᙱᑦᑐᖅ”-ᖑᓂᐊᖅᑐᖅ ᐱᓕᕆᐊᖅ ᓴᓇᔭᐅᕙᓂᒃᐸᑦ. ᐅᑭᐅᑯᑦ ᐊᑉᕿᑎ ᐋᖅᓯᓂᐊᖅᑐᖅ ᐃᓂᐅᔪᒥᒃ ᐅᑭᐅᑯᑦ, ᑭᓯᐊᓂ ᐊᒥᓲᓂᖅᓴᐃᑦ ᐃᓂᐅᔪᑦ (ᐃᓚᐅᖏᓪᓗᓂ ᖃᓄᑎᒋᐅᓂᖓ ᓱᕐᒃᑐᖅ ᐱᓕᕆᐊᑉ ᐃᓂᒋᓴᖓᓄᑦ) ᒪᓂᒪᓂᐊᖅᑐᑦ ᐊᑐᓂ ᐊᐅᓯᒃᑯᑕᒫᑦ ᐊᑉᕿᑎ ᓄᖅᑲᖅᑎᑕᐅᒃᐸᑦ. ᑖᒃᑯᙵᐅᖏᑦᑐᖅ ᐊᓱᐃᕆᓂᖅ ᐃᓂᒋᓴᐅᔪᒥᒃ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᖅ ᒥᒃᓵᒋᐊᖅᑐᒍ ᐃᓂᐅᔫᑉ ᖃᓄᐃᓐᓂᕆᓴᖓ ᐱᕈᐃᓂᕐᒧᑦ ᐊᒻᒪ ᐅᑭᐅᑯᑦ ᐅᓴᕋᖕᓂᐊᕐᓂᐅᑉ ᐃᓂᖓᓂᑦ ᐊᒃᑐᖅᑎᑦᑎᓂᐅᑉ (ZOI) ᒥᒃᓵᒋᐊᖅᑕᐅᓚᐅᖅᑐᖅ ᒪᕈᐃᓕᖓᔫᖓᓄᑦ ᒥᑭᓛᖑᖅᑐᒍ ᐊᑦᑎᒃᑐᒥᑦ <7 ᑭᓛᒥᑕᒥᒃ ᐅᓴᕋᖕᓂᐊᕐᕕᐅᑉ ᐃᓂᖓᓂᑦ, ᐊᒻᒪ ᐊᑕᐅᓯᕐᒥᒃ ᒥᑭᓛᖑᖅᑐᒍ ᐊᑦᑎᒃᑐᒥᑦ <7 ᑭᓛᒥᑕᒥᒃ ᐊᒻᒪ 14 ᑭᓛᒥᑕᒥᒃ ᐅᓴᕋᖕᓂᐊᕐᕕᐅᑉ ᐃᓂᖓᓂᑦ. ᐃᓂᒋᓴᐅᔪᐃᑦ ᖃᓄᐃᓐᓂᕆᓴᕆᑦ ᐊᑉᕿᑎᓂᑦ (ZOI)-ᒥᑦ ᒥᒃᓵᒋᐊᖅᑕᐅᓚᐅᖅᑐᖅ ᒪᕐᕉᖕᓅᖓᔪᓄᑦ ᒥᑭᓛᖑᖅᑐᒍ ᐊᑦᑎᒃᑐᒥᑦ <1 ᑭᓛᒥᑕᒥᒃ ᐊᑉᕿᑎᐅᑉ ᐃᓂᖏᓐᓂᑦ, ᐊᒻᒪ ᒥᑭᓛᖑᖅᑐᒍ ᐊᑦᑎᒃᑐᒥᑦ <1 ᐊᒻᒪ <4 ᑭᓛᒥᑕᒥᒃ ᐊᑉᕿᑎᐅᑉ ᐃᓂᖏᓐᓂᑦ.

ᐊᕼᓇᒃᑯᑦ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᐊᖅᑐᑦ ᐊᒃᑐᖅᓯᓂᒃᑲᓚᐅᔪᓂᒃ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᑦᑐ ᐃᓂᖏᓐᓂᒃ ᐃᒪᓐᓇ: 1) ᒥᑭᒡᓕᒋᐊᕐᓗᒍ ᐱᓕᕆᐊᑉ ᐃᓂᖓ, 2) ᒥᑭᒡᓕᒋᐊᕐᓗᒍ ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᓯᓚᑖᓂᑦ ᐃᓂᐅᔫᑉ; 3) ᒥᑭᒡᓕᒋᐊᕐᓗᒍ ᐊᑉᕿᑎᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᖅ ᓅᑉᐸᓪᓕᐊᓂᖃᖅᑎᓪᓗᒍ ᐊᒻᒪ ᓄᕐᕆᐅᕙᓂᒃᑎᓪᓗᒋᑦ; 4) ᐅᑎᖅᑎᑎᕆᓂᖅᑕᖃᐃᓐᓇᕐᓗᓂ ᐸᒡᕕᓴᖅᑕᐅᔪᓂᒃ 5) ᐳᔪᖃᓗᐊᖅᑕᐃᓕᒪᑎᑦᑎᓂᕐᒥᒃ ᐱᑎᑦᑎᓗᓂ ᐊᑉᕿᑎᓂᑦ ᐊᐅᓯᒃᑯᑦ (EN-BL OH ᓄᕕᐱᕆ 2013[40]); ᐊᒻᒪ 6) ᐋᕐᓗᕆᑦ ᐳᔪᓕᐅᕆᓂᖅ ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᐅᓚᑦᑎᕝᕕᖕᒥᑦ.

ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖅᑕᖃᖅᑳᖅᑎᓪᓗᒍ, ᐊᒃᑐᖅᑕᐅᓂᖅ ᐱᓕᕆᐊᒧᑦ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᐱᕈᕐᓂᖕᒋᓐᓄᑦ ᐊᒻᒪ ᐅᑭᐅᑯᑦ ᐃᓂᒋᓴᖕᒋᑦ ᐊᖏᔫᔭᖕᒋᑦᑐᖅ. ᐃᓂᐅᔪᓄᑦ ᐊᒃᑐᖅᓯᓃᑦ ᒥᑭᓂᖅᓴᑲᓪᓚᐅᓂᐊᖅᑐᑦ 5%-ᒥᑦ ᐅᑭᐅᑉ ᐃᓚᖓᒍᑦ. ᑐᒃᑐᓄᑦ, ᐅᓴᕋᖕᓂᐊᕐᕕᒃ ᐊᑉᕿᑎᓗ ᒥᒃᓵᒋᐊᖅᑎᑦᑎᓂᐊᖅᑐᖅ ᐃᓂᐅᔪᓂ ᒥᑭᓂᖅᓴᒥᒃ 1%-ᒥᑦ ᐃᓂᒋᓴᐅᔪᓂᒃ ᑐᒃᑐᓄᑦ. ᐅᒥᖕᒪᖕᓄᑦ, ᐅᓴᕋᖕᓂᐊᕐᕕᒃ ᐊᑉᕿᑎᓗ ᒥᒃᓵᒋᐊᖅᑎᑦᑎᓂᐊᖅᑐᖅ ᐃᓂᐅᔪᓂ ᒥᑭᓂᖅᓴᒥᒃ 5%-ᒥᑦ ᐅᒥᖕᒪᖕᓄᑦ ᐊᐅᓚᑦᑎᓂᕐᒥᑦ MX/21.

ᒫᓐᓇᐅᔪᖅ, ᐊᒥᓱᕆᖕᑐᓂᒃ ᐃᓄᐃᑦ ᖃᓄᐃᓕᐅᕐᓂᖃᖅᑐᑦ ᓂᕐᔪᑎᓂᒃ ᐊᒃᑐᖅᓯᓂᖃᕐᓂᐅᔪᓂᒃ. ᐊᐳᖅᑎᓐᓈᖅᑐᒥᑦ ᐅᓴᕋᖕᓂᐊᕐᕕᒃ ᓄᓇᓖᑦᑕ ᐊᖏᓂᖅᐸᙳᔪᑦ ᓂᕐᔪᑏᑦ ᐃᓂᒋᓴᖕᒋᓐᓄᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᓄᑦ. ᐃᓚᓯᓂᖅ ᑭᒡᓕᕕᒃ ᐱᓕᕆᐊᒧᑦ ᐸᒡᕕᓴᐃᓂᐅᔪᓄᑦ ᓂᕆᐅᒋᓴᐅᖕᒋᑦᑐᖅ ᒥᒃᓵᑎᑦᑐᐊᕐᓂᐊᕐᓂᖕᒋᓐᓄᑦ ᖃᓄᑎᒋᐅᓂᖕᒋᓐᓄᑦ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᑦᑐ ᐃᓂᖕᒋᓐᓂᒃ. ᐅᓴᖅᑲᓂᒃ ᕿᓂᖅᓴᐃᓂᖅ ᒫᓐᓇᐅᔪᖅ ᐊᓱᐃᕆᓂᖅᑕᖅᑲᖅᑎᑦᑎᖕᒋᑦᑐᖅ ᐃᓂᒋᓴᐅᔪᒥᒃ.

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[39] EN-BL OH ᐅᒃᑑᐱᕆ 2012: *ᐱᓕᕆᔾᑖᕐᓂᐊᖅᐱᑦ ᐊᑉᕿᑎᒦᑐᒃᓴᒥᒃ ᓂᕐᔪᑏᑦ ᐸᒡᕕᓴᖅᑕᐅᔭᕆᖓᑕ?*

[40] EN-BL OH ᓄᕕᐱᕆ 2013: *ᐳᔪᖃᑖᖅ ᐊᑉᕿᑎᒥᑦ. ᖃᓄᐃᓕᐅᕐᓂᐊᖅᐸᑦ ᐊᕼᓇᒃᑯᑦ ᐳᔪᖃᑖᖅᑲᖅᑎᑦᑎᐃᓕᒪᓂᕐᒧᑦ?*

ᓯᕗᓂᕐᒥᒃ ᐅᔾᕋᖕᓂᐊᕐᕕᓕᐅᕐᓂᖅᑕᕐᑲᕐᓂᐊᖅᑐᒃᓴᐅᑎᓪᓗᒍ ᑕᒫᓂ, ᑕᐃᒪᓐᓇᐃᑐᓂᒃ ᐱᕙᓪᓕᐊᓂᖅᑕᕐᑲᕐᑲᑦᑕᓚᐅᖅᑎᓪᓗᒍ, ᐊᑕᐅᓯᐅᖕᒋᑦᑐᒥᒃ ᐊᑕᐅᑎᒃᑰᖅᑐᓂᒃ ᐅᔾᕋᖕᓂᐊᖅᑐᓕᕆᔪᑦ ᑕᐃᒪᐅᓂᐊᕐᓂᖕᒋᑦ ᐊᑦᑎᒃᑑᔪᖅ. ᑲᑎᑉᐸᓪᓕᐊᔪᓄᑦ ᐊᓯᐊᖑᕐᓂᖅ ᐃᓂᐅᔪᑦ ᑕᐃᒪᐅᓂᖕᒋᓐᓄᑦ ᑐᒃᑐᓄᑦ ᐅᒥᖕᒪᖕᓄᓪᓗ ᐱᓕᕆᐊᒥᑦ ᐱᔪᓂᒃ ᖃᐅᔨᓴᖅᑕᐅᔪᒥᑦ ᐊᖏᓂᐊᙱᑦᑑᔪᖅ.

ᐊᕐᓇᕙᒃᑯᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᐊᖅᑐᑦ ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖕᒐᓂᑦ ᐊᕿᒍᑕᓖᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐃᓂᐅᔪᖅ ᐊᓯᐊᖑᖅᑎᑦᑎᓂᖃᕐᒪᖕᒐᑦ ᓂᕐᔪᑏᑦ ᐃᓂᒋᔭᖕᒋᑦ ᒪᓂᒪᓂᖕᒋᓐᓄᑦ. ᐊᕐᓇᕙᒃᑯᑦ ᑲᔪᓯᓂᖃᕐᓂᐊᖅᑐᑦ ᐃᑲᔪᐃᓂᕐᒥᒃ ᓄᓇᕗᑦ ᒐᕙᒪᒃᑯᖕᒋᑦᑕ ᑐᒃᑐᓂᒃ ᖁᖓᓯᕈᓯᖅᑐᐃᓂᕐᒧᑦ ᑐᕌᖓᔪᖅ; ᑐᕌᖓᔪᖅ ᑐᓂᓯᓂᐊᖅᑐᖅ ᓯᕗᓂᕐᒧᑦ ᑐᑭᓯᐅᒪᔾᔪᑎᓂᒃ ᑐᒃᑐᐃᑦ ᖃᓄᐃᓕᐅᕐᓂᖕᒋᑦ ᐃᓂᖕᒋᑦ ᐸᖁᓴᖅᑕᐅᓂᖕᒋᓐᓄᑦ ᑭᕙᓪᓕᕐᒥᑦ.

ᓅᑦᑕᕐᓂᖅ – ᑐᒃᑐᐃᑦ ᓅᓐᓂᖕᒋᑦ ᐊᑯᓐᓂᖕᒋᓐᓂᒃ ᓄᕐᖃᐅᕐᕕᖕᓂᑦ ᐊᒻᒪ ᐅᑭᐅᑯᑦ ᐃᓂᖕᒋᓐᓄᑦ ᑕᐅᑐᒃᑕᐅᓚᐅᖅᑐᖅ ᖃᐅᔨᓴᕐᓂᕐᒥᑦ ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᓯᓂᕐᓄᑦ ᓂᕐᔪᑏᑦ ᓅᕐᑲᑦᑕᕐᓂᖕᒋᓐᓄᑦ. ᒥᑭᓪᓕᕆᐊᖅᑎᑦᑎᓂᖅ ᐊᒃᑐᖅᓯᓂᐅᔪᓂᒃ ᑐᒃᑐᐃᑦ ᓅᕐᑲᑦᑕᕐᓂᖕᒋᓐᓄᑦ ᐱᒻᒪᕆᐅᔪᖅ ᐃᓚᒋᔭᐅᔪᓂᑦ ᒥᒃᓵᕆᐊᖅᑎᑦᑎᓂᕐᒧᑦ ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᓄᑦ ᓂᕐᔪᑏᑦ ᓅᕐᑲᑦᑕᕐᓂᖕᒋᓐᓄᑦ (IQ-BLHT 2011[41]). ᐅᒥᖕᒪᐃᑦ ᓅᕐᑲᑦᑕᖅᑐᑦ ᒥᑭᑦᑑᔪᒥᒃ (ᓱ̇ᕐᓗ, ᐊᕗᖕᒐᒃᑲᓪᓚᒃ ᓅᕐᑲᑦᑕᙱᑦᑐᑦ) ᐊᑯᓐᓂᖕᒋᓐᓂᒃ ᒪᓂᒪᔪᑦ ᐃᓂᐅᔪᓄᑦ ᐊᐅᓚᓐᓂᕆᔭᖕᒐᓐᓂᑦ ᐊᒻᒪ ᓅᕐᑲᑦᑕᕐᓂᖕᒋᑦ ᓇᒨᖕᒐᐅᓂᖕᑲᙱᑦᑐᑦ ᐊᒻᒪ ᓇᓗᓇᖅᓱᑎᓪᓕ ᑐᒃᑐᑎᑑᖕᒋᑦᑐᖅ.

ᐱᓕᕆᐊᖅ ᐊᒃᑐᖅᓯᓂᖅᑲᕈᖕᓇᖅᑐᖅ ᑐᒃᑐᐃᑦ ᓅᕐᑲᑦᑕᕐᓂᖕᒋᓐᓂᒃ ᖃᓂᑦᑐᒥᒡᓗ ᐊᐅᓚᓐᓂᕆᔭᖕᒋᓐᓄᑦ ᓴᓇᔭᐅᓂᖕᒋᓐᓄᑦ ᐱᕐᑯᑎᕆᔭᐅᔪᑦ ᐊᒻᒪ ᐃᓄᐃᑦ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖕᒋᓐᓄᑦ ᐊᓯᐊᖑᕐᓂᖅ, ᐊᔪᖅᑎᑦᑎᓗᓂ ᑐᒃᑐᐃᑦ ᓅᓐᓂᕆᔭᖕᒋᓐᓂᒃ ᓄᓇᒥᑦ.

ᑐᑭᓯᐅᒪᔾᔪᑏᑦ ᐊᑐᖅᑕᐅᔪᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐱᓕᕆᐊᑉ ᐊᒃᑐᖅᓯᓂᖕᒋᓐᓄᑦ ᑐᒃᑐᐃᑦ ᐊᐅᓚᓐᓂᖕᒋᓐᓂᒃ ᑐᒃᑐᐃᑦ ᖁᖓᓯᕈᑎᖕᒋᓐᓂᙱᖅᑐᑦ ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ, ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖕᒋᓐᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᓂᑦ, ᐊᒻᒪ ᑭᓪᓕᐅᔪᑦ ᓂᕐᔪᑎᓄᑦ ᖃᐅᔨᓴᐃᓂᕐᓂᑦ. ᐊᒃᑐᖅᓯᓂᐅᔪᖕᓇᖅᑐᖅ ᐱᓕᕆᐊᒥᑦ ᑐᒃᑐᐃᑦ ᐊᐅᓚᓐᓂᖕᒋᓐᓄᑦ ᖃᐅᔨᓴᖅᑕᓚᐅᖅᑐᖅ ᕿᒥᕐᕈᐸᓗᒋᑦ ᑎᑭᑦᑕᐅᑎᓂᖕᒋᑦ ᐱᓕᕆᐊᒧᑦ ᐅᐱᕐᖠᑯᑦ ᐅᑭᐊᒃᓵᑯᓪᓗ ᓅᑎᓪᓗᒋᑦ. ᐱᖑᓯᐃᑦ ᐃᓱᒪᒋᔭᐅᓚᐅᖅᑐᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᖁᖓᓯᕈᑎᓄᑦ ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ ᒥᒃᓵᓄᑦ: 1) ᖁᖓᓯᕈᑎᓄᑦ ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᑕᒪᐃᓐᓄᑦ ᐊᒥᕐᕋᓄᑦ; 2) ᑐᒃᑐᐃᑦ ᓅᓐᓂᖕᒋᑦ ᐊᑯᓐᓂᖕᒋᓐᓂᑦ ᖁᖓᓯᕈᑏᑦ ᐊᓯᐊᓄᐊᕐᓂᖕᒋᑦ ᑐᑭᓕᐊᖅᑑᖕᒪᑦ; ᐊᒻᒪ 3) ᑐᒃᑐᐃᑦ ᓅᓐᓂᖕᒋᑦ ᖁᖓᓯᕈᓯᖅᓯᒪᑎᓪᓗᒋᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᔪᑦ ᓅᓐᓂᕆᓂᐊᖅᑕᖕᒋᓐᓂᒃ ᓯᕗᓂᕐᒥᑦ. ᖃᐅᔨᓴᐃᓃᑦ ᐱᐊᓂᒃᑐᓂᒃ ᐃᓚᐅᔪᑦ: ᖃᐅᔨᓴᐃᓃᑦ ᑎᑭᑕᐅᓂᖕᒋᑦ ᐊᒻᒪ ᐃᓂᒋᔭᖕᒋᓐᓄᑦ ᓈᓴᐅᑏᑦ ᐱᓕᕆᐊᑉ ZOI-ᖕᒐᓄᑦ ᓇᓚᐅᑖᕐᓂᕐᒧᑦ ᑐᒃᑐᐃᑦ ᑎᑭᐅᑎᖃᑦᑕᕐᓂᖕᒋᓐᓄᑦ ᐱᓕᕆᐊᒧᑦ: ᐊᒻᒪ ᐃᓚᑕᖅᓯᓂᖅ ᑕᒪᐃᓂᒃ ᐃᒪᒃᑯᑦ ᐃᑳᕐᓂᖕᒋᓐᓂᒃ 10 ᑭᖠᒥᑕᒥᒃ ᐅᖕᒐᓯᒃᑎᕆᔪᑦ ᐱᓕᕆᐊᑉ ᐃᓂᖕᒐᓂᑦ.

ᐊᕐᓇᕙᒃᑯᑦ ᐊᖏᕈᐊᖏᕆᐊᖅᑎᑦᑎᓂᐊᖅᑐᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᒥᒃ ᑐᒃᑐᐃᑦ ᓅᓐᓂᕆᔭᖕᒋᓐᓄᑦ ᐃᒪᓐᓇ: 1) ᒥᑭᓪᓕᕆᐊᕐᓗᒋᑦ ᐊᐸᕐᑯᑎᒥᒃ ᐊᕙᓗᐃᑦ ᖁᑦᑎᖕᓂᖕᒋᑦ ᐅᑭᐅᓗᒃᑖᖅ ᐊᑐᖅᑕᐅᔪᖅ ᐊᐸᕐᑯᑎᒥᑦ; 2) ᐊᐳᓯᕆᓂᕐᒧᑦ ᐊᐅᓚᑦᑎᓂᖅ ᑕᑭᔪᓂᒃ ᑭᐱᓯᓂᖅᑲᖅᑐᑦ ᑲᑎᖅᓱᖅᓯᒪᔪᓂᒡᓘᓃᑦ ᐊᔪᖅᑎᑦᑐᐃᓐᓇᕆᐊᖅᑲᖅᑐᑦ ᐅᐱᕐᖠᒃᑯᑦ ᓅᓂᐅᔪᓂᒃ ᐊᐸᕐᑯᑎᑎᒎᑦ; 3) ᒥᒃᓵᕆᐊᕐᓗᒍ ᑐᒃᑐᐃᑦ ᓂᐅᖕᒋᓐᓂᒃ ᐊᔪᓕᖅᑎᑦᑎᔪᖕᓇᖅᑐᑦ ᐅᑭᐊᒃᓵᑯᑦ ᓅᑎᓪᓗᒋᑦ ᓴᓇᔭᐅᔪᓂᒃ ᐊᐸᕐᑯᑎᓂᒃ ᓯᐅᕋᐅᓂᖅᓴᓂᑦ; 4) ᓴᓇᓂᖅᑕᕐᑲᖅᑕᐃᓕᓗᓂ 10 ᑭᖠᒥᑕᒥᒃ ᐅᖕᒐᓯᒃᑎᕆᔪᒥᑦ ᐃᒪᕐᒥᑦ ᐃᑳᕐᕕᐅᖅᑲᑦᑕᖅᑐᒥᑦ ᒪᐃ 15-ᒥᑦ ᓯᑎᐱᕆ 1-ᒧᑦ, ᒪᓕᒡᓗᒋᑦ ᒐᕙᒪᑐᖅᑲᐃᑦ ᐃᓄᓕᕆᔨᖕᒋᑦᑕ ᑐᒃᑐᓂᒃ

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41 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖅᑲᖕᒋᑦ-BLHT 2011: *ᑐᒃᑐᐃᑦ ᐊᖕᒋᔪᒥᒃ ᐃᓚᒋᔭᐅᖅᑲᑕᐅᔪᑦ ᓂᕿᒋᔭᑉᑎᖕᓄᑦ. ᑐᒃᑐᐃᑦ ᓅᖅᑲᑦᑕᕐᓂᖕᒋᑦ ᐱᒻᒪᕆᐊᓘᔪᖅ.*

ᒥᐊᓂᖅᓯᓂᕐᒨᖓᔪᖏᑦ (EN-BL NIRB ᐋᐳᕆ 2010[42]); 5) ᒥᒃᓵᒋᐊᕐᓗᒍ ᐊᕙᓗᓂᒃ ᐊᑐᖃᑦᑕᕐᓂᖅ ᐊᒻᒪ, ᐱᔭᕆᐊᖃᖅᐸᑦ, ᒥᒃᓵᒋᐊᕐᓗᒋᑦ ᑕᑯᓂᖏᑦ ᐊᕙᓗᐃᑦ ᑭᓯᐊᓂ ᐊᑐᖅᑕᐅᔭᕆᐊᖃᖅᐸᑕ ᐋᓐᓂᖅᑕᐃᓕᒪᓂᕐᒧᑦ; ᐊᒻᒪ 6) ᐊᑐᓕᖅᑎᑦᑎᓗᓂ ᐊᑦᑐᑎᓂᒃ ᐅᒃᑯᐊᓚᐅᐱᓪᓚᖕᓂᕐᒥᑦ ᐊᖏᔪᑦ ᐊᒥᕐᕋᐃᑦ ᑐᒃᑐᐃᑦ ᓅᑐᑦ ᑕᑯᔭᐅᒃᐸᑕ ᐃᓂᒋᔭᐅᔪᑎᒍᑦ (IQ-BLHT 2011[43], EN-BL HTO ᒫᕐᓯ 2009[44]).

ᐱᓕᕆᐊᒥᑦ ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᒃᑐᖅᓯᓃᑦ ᑐᒃᑐᐃᑦ ᓅᓐᓂᖏᓐᓄᑦ ᐊᖏᔫᔾᔭᖏᑦᑐᖅ. ᐃᓚᐃᓇᖏᑦ ᖃᒪᓂᕐᔪᐊᖅ. ᐊHᐃᐊᒃ, Lorillard ᐊᒻᒪ ᐅᒃᑯᓯᒃᓴᓕᒃ ᐊᒥᕐᕋᐃᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᑎᑭᐅᑎᖃᑦᑕᕐᓂᐊᕐᓂᖏᓐᓄᑦ ᐱᓕᕆᐊᒧᑦ ᐊᔾᔮᒌᖏᑦᑐᒃᑯᑦ ᐅᑭᐅᑉ ᐃᓚᖓᒍᑦ. ᐃᒪᒃᑯᑦ ᐃᑳᕐᓃᑦ 10 ᑭᓛᒥᑕᒥᒃ ᐅᖓᓯᒃᑎᒋᓗᒍ ᐊᑉᕐᑯᑎᒥᒃ, ᐸᒡᕕᓴᐃᓂᖅ ᑕᐃᑯᓇᓂ ᐃᓂᐅᔪᓃᑦ ᒪᓂᒪᓂᐊᕐᒪᑕ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᓐᓂᕐᒧᑦ ᒥᒃᓵᒋᐊᖅᑎᓐᓂᒃᑯᑦ ᐅᕙᓘᓃᑦ ᓄᖅᑲᖅᑎᓐᓂᒃᑯᑦ ᐃᖏᕐᕋᔪᑦ ᖃᓂᑦᑐᓄᑦ ᑖᑉᑯᓄᙵ ᖃᖓᒃᑯᑐᐃᓐᓇᖅ ᐅᑭᐅᑉ ᐃᓗᐊᓂ ᐊᑐᖅᑕᐅᒃᐸᑕ.

ᐊᕼᕙᒃᑯᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖃᕐᓂᐊᖅᑐᑦ ᐊᓯᐊᕗᕐᓂᐅᔪᓂᒃ ᓅᓐᓂᕆᔭᖏᓐᓂᒃ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ: 1) ᑐᓂᕐᕈᑎᖃᐃᓐᓇᕐᓗᑎᒃ ᐊᕼᕙᒃᑯᑦ ᓄᓇᕗᑦ ᒐᕙᒪᒃᑯᖏᑦᑕ ᑐᒃᑐᓂᒃ ᖁᖓᓱᕈᓯᖅᑐᐃᓂᕐᒧᑦ ᑐᕋᖓᔪᖏᓐᓄᑦ; 2) ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓗᓂ ᐃᒪᒃᑯᑦ ᐃᑳᖅᑕᕐᓂᕆᔭᖏᑦ 10 ᑭᓛᒥᑕᒥᒃ ᐅᖓᓯᒃᑎᒋᔪᑦ ᐱᓕᕆᐊᑉ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖏᓐᓄᑦ; ᐊᒻᒪ 3) ᐅᑭᐅᑉ ᐃᓚᖓᒍᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᑐᒃᑐᐃᑦ ᓅᓐᓂᖏᓐᓂᒃ ᑐᒃᑐᐃᑦ RAA-ᒧᐊᖄᖅᑎᓐᓇᒋᑦ ᑲᒪᓂᖃᕐᓂᒃᑯᑦ ᑐᓂᓯᓂᕐᒥᒃ ᑐᑭᓯᐅᒪᔾᔪᑎᓂᒃ ᖃᐅᔨᑎᑦᑎᓂᐊᖅᑐᓂᒃ ᐅᒃᑯᐊᓚᐅᐱᓪᓚᒋᐊᖃᕐᓂᕐᒧᑦ ᐊᑉᕐᑯᑎᒥᒃ ᐃᖏᕐᕋᔭᖕᓂᕐᒧᑦ.

ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖅ – ᐳᔪᕐᓗᐃᑦ ᐊᓂᐊᔪᑦ ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᓯᓂᖃᕈᖕᓇᖅᑐᑦ ᑲᑎᓯᒪᔪᓂᒃ COPC-ᓂᒃ ᐊᕙᑎᒥᑦ (ᓖᕐᓗ ᐃᒪᖅ, ᐃᐸᔪ, ᐱᕈᖅᑐᑦ) ᐊᒃᑐᖅᓯᓂᖃᕈᖕᓇᕐᓗᑎᒃ ᑎᑭᐅᑎᔪᖕᓇᕐᓂᖏᑦ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᓂᕆᒍᓂᔾᔪᒃ ᑕᒪᒃᑯᐅ. ᐳᔪᕐᓗᐃᑦ ᐊᓂᐊᔪᑦ ᐊᒃᑐᖅᓯᓂᑲᓪᓚᐅᔪᓂᒃ ᖃᐸᓯᐅᓂᖏᓐᓂᒃ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᖅ (ᐃᓄᐃᑦ ᖃᐅᔨᒪᔪᖅᑲᖏᑦ-ᑐᙵᕕᒃᑯᑦ. 2005[45]). COPC ᐊᑐᖅᑕᐅᔪᖅ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐃᓚᐅᔪᑦ ᓄᖑᓯᐃᑐᖅ ᐊᒻᒪ ᓄᖑᓯᐃᑐᖅ-238 ᐃᒍᓇᖅᑐᓅᖓᔪᑦ (thorium-230, lead-210, radium-226, ᐊᒻᒪ polonium-210), arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, selenium, ᐊᒻᒪ zinc. ᑎᑭᐅᑎᓂᖅ COPC-ᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᓚᐅᖅᑐᖅ ᐊᑐᖅᓱᑎᒃ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᕙᑎᒥᑦ ᑲᑎᓯᒪᔪᑦ ᐊᒻᒪ ᐃᓱᒪᒋᔭᐅᔪᑦ ᖃᓄᑎᒋ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᓂᕆᓂᖏᑦ. ᖃᓄᐃᖓᓂᐅᔪᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᔪᑦ ᑎᑭᐅᑎᓯᒪᓂᒃ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓘᓃᑦ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᖅ ᐅᖓᑕᐅᑎᓂᐊᕐᓂᖏᓐᓄᑦ ᑭᒡᓕᐅᔪᑦ ᐊᒃᑐᐊᓂᖅᖃᖅᑐᑦ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᐊᒃᑐᖅᓯᓂᕐᓄᑦ; ᑕᐃᒪᓐᓇᒧᑦ ᐊᒃᑐᖅᓯᓃᑦ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᑦ.

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[42] EN-BL NIRB ᐋᐳᕆ 2010: *ᐱᖁᑎᐅᔪᑦ ᐃᒪᒃᑯᑦ ᐃᑳᖃᑦᑕᕐᓂᐅᑐᕐ, ᐅᑭᐅᑕᒫᑦ ᓅᑦᑐᓄᑦ ᐊᑉᕐᑯᑎᒋᔭᐅᔪᑦ (ᐊᐅᔭᒃᑯᑦ ᐅᑭᐅᑯᓪᓗ ᐃᓂᒋᔭᖏᕐ) ᐃᓱᒪᒋᔭᐅᔭᕆᐊᖃᖅᑐᑦ ᐱᓗᐊᖅᑐᒥᒃ ᐊᑉᕐᑯᑎᓕᐊᖑᔪᒪᔪᒧᑦ.*
[43] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-BLHT 2011: *ᒪᖃᐃᑕᐅᖃᑦᑕᕐᓂᖏᓐᓄᑦ ᑐᒃᑐᐃᑦ ᐃᓕᖅᑯᓯᕆᔭᐅᔪᑎᒍᑦ ᐊᑐᖅᓗᑎᒃ, ᓯᕗᓪᓕᐅᔪᑦ ᐊᒥᕐᕋᐃᑦ ᐊᓂᒍᖅᑎᑕᐅᔭᕆᐊᖃᖅᑐᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᙱᑦᑐᒃᑯᑦ. ᐅᐸᓗᐃᑦ ᖃᔦᐊᕐᔪᐃᑦ ᐊᓂᒍᖅᐸᑕ, ᑐᒃᑐᓯᐅᕆᐊᕈᓇᖅᓗᑎᒃ.*
[44] EN-BL HTO ᒫᕐᓯ 2009: *ᐊᒥᕐᕋᖅᑕᖃᕋᖕᖓᕐ, ᓯᕗᓪᓕᐅᑎᔪᖅ ᖃᓂᒋᐸᓗᒍ ᒪᓕᒃᑕᐅᖃᑦᑕᖅᑐᖅ ᐊᓯᖏᓐᓄᑦ, ᐃᓱᒪᒋᔭᐅᑕᐃᓕᖅᑲᑦᑕᖅᑐᑦ ᓅᐸᓪᓕᐊᓂᖓᕐ.*
[45] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-ᑐᙵᕕᒃᑯᑦ. 2005: *ᐱᐅᖏᑦᑐᓂᒃ ᐊᒃᑐᖅᑕᐅᓂᖏᑦ ᓂᕐᔪᑏᑦ ᐃᓱᒫᓘᑎᒋᔭᐅᔪᖅ, ᖃᓄᐃᓕᖓᓕᕐᓂᐊᕐᓂᖏᓐᓄᑦ ᐃᓄᐃᑦ ᓂᕿᖏᑦᑐᐃᓐᓇᐅᖏᑦᑐᖅ; ᑕᐅᑐᖓᖅ ᐱᐅᖏᑦᑐᓂᒃ ᖃᐅᔨᓴᐃᓂᖅ ᑕᐅᑐᖓᖃᖅᑐᑑᔭᕆᐊᖃᙱᑦᑐᖅ ᐃᓄᐃᑦ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᕆᔭᖏᓐᓂᒃ.*

ᑲᑎᓪᓕᑦ ᐊᒻᒪ ᑲᑎᑉᐸᓪᓚᐊᔪᓄᑦ ᖃᓄᐃᓪᓚᕐᑎᑦᑎᓂᐅᔪᑦ (ᐊᐅᓚᓐᓂᕐᒋᑦ) – ᐊᑐᖅᑕᐅᕙᒃᑐᑎᒍᑦ ᖃᐅᔨᓴᐃᓂᖅ ᖃᒪᓂᕐᔪᐊᖅ ᑐᒃᑐᕐᒋᑦᑕ ᑲᑎᓪᓕᑦ ᖃᓄᐃᓪᓚᕐᑎᑦᑎᓂᐅᔪᑦ (ᓱᕐᓗ, ᐸᒡᕕᓴᐃᓂᖅ ᑐᕐᑯᖅᐸᓪᓚᐊᔪᓂᒃ, ᐃᓂᐅᔪᕆᔭᐅᔪᓄᑦ, ᓈᓐᓂᕆᓐᓂᒃ ᐊᒻᒪ ᐋᓐᓂᐊᖅᑲᖅᑕᐃᓚᒪᕆᓐᓄᑦ ᐃᓱᒪᒋᔭᐅᓯᒪᔪᑦ), ᓇᓗᓇᐃᖅᓯᓚᐅᖅᑐᑦ ᑕᒪᐃᓅᕐᒐᔪᒃᑖᒃᑯᑦ, ᐱᓕᕆᐊᖅ ᒥᑭᑐᒥᒃ ᖃᓄᐃᓪᓚᕐᑎᑦᑎᓂᖅᑲᓂᐊᕐᓂᕐᒐᓂᒃ ᑐᒃᑐᐃᑦ ᐊᐅᓚᓐᓂᕆᔪᕐᒋᓐᓄᑦ, ᐊᒻᒪ ᐆᒃᑐᖅᑕᐅᔪᕐᓇᖅᑐᓂᒃ ᖃᑉᓯᐅᓂᕐᒋᓐᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᓄᑦ ᑕᐃᑯᕐᒪ 2040–ᒧᑦ. ᓈᓴᐅᑏᑦ ᖃᒪᓂᕐᔪᐊᖅ ᑐᒃᑐᕐᒋᓐᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᐊᕐᒋᓪᓚᓂᐊᕐᓂᕐᒐᓄᑦ ᐅᑉᓗᐃᑦ ᖄᕐᒋᐅᑎᕙᓪᓚᐊᑎᓪᓗᒋᑦ ᐅᕙᓘᓃᑦ ᐱᓕᕆᐊᖅ ᐱᑕᖅᑫᒋᑎᓪᓗᒍ. ᓇᓗᓇᖏᕐᔪᑎ ᓇᓚᐅᑖᖅᑕᐅᔪᒥᑦ ᕿᑎᐊᓃᑐᖅ ᑕᒪᓗᒃᑖᖅ ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ ᐊᑐᖅᑕᐅᔪᒥᑦ ᑐᒃᑐᓄᑦ ᑲᑎᕐᒪᔪᓄᓪᓚᑦᑖᖅ ᑐᕋᕐᒐᓚᐅᕐᒋᒻᒪᑦ, ᑕᒻᒪᖅᓯᒪᓂᖅᑕᖅᑲᑐᐃᓐᓇᕆᐊᖅᑲᕐᓂᕐᒐᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᓂᑦ, ᐊᒻᒪ ᓇᓚᐅᑖᖅᑕᐅᔪᕐᓇᖅᑐᑦ ᖃᑉᓯᐅᓂᕐᒋᓐᓄᑦ ᐊᑐᖅᑕᐅᔪᑦ ᑕᓖᔭᕐᓂᖃᑐᐃᓐᓇᕆᐊᖃᕐᓚᑕ ᐱᔾᔪᑎᖃᖅᑐᓄᑦ ᐊᓯᐊᕗᖅᐸᓪᓚᐊᓂᖅ ᐊᕙᑎᒨᕐᒐᔪᓄᑦ ᑕᒪᓐᓇ ᐅᕐᒐᑕᐅᑎᓯᒪᑐᐃᓐᓇᕆᐊᖃᖅᑐᖅ ᐃᓂᖃᕐᓂᕆᔾᔪᕐᒐᑕ ᐊᑐᖅᑕᐅᔪᖅ ᐱᓕᕆᐊᕝᕕᓂᐊᕐᓗᓂ.

ᐱᓕᕆᐊᖅ ᒥᑭᒃᑐᒻᒪᕆᕐᒥᑦ ᐲᖅᓯᔪᖅ ᐃᓂᒋᔭᐅᔪᒥᒃ (0.001%–ᒥᒃ) ᑕᕝᕙᓐᖓᑦ ᑲᑎᓪᓕᑦ ᑐᒃᑐᓄᑦ ᑎᑭᖅᑲᐅᒪᔭᐅᔪᓂᑦ. ᐃᕐᒥᒃᑰᕐᒐᔪᓂᑦ ᑎᑭᖅᑲᐅᒪᔭᐅᔪᓂᑦ, ᐊᓱᐊᔾᔨᓂᖅ 0.004%–ᒥᑦ 0.007%–ᒧᑦ–ᖑᔪᖅ. ᐊᓱᐊᔾᔨᓂᖅ ᒥᑭᓗᐊᕐᓂᕐᒐᓄᑦ ᐊᑐᓂ ᑐᒃᑐᑦ ᑲᑎᕐᒪᔪᑦ ᑎᑭᖅᑲᐅᒪᔭᕐᒋᓐᓄᑦ ᐊᕐᒋᓗᐊᕐᒋᓐᓂᐊᖅᑐᖅ. ᑲᑎᓪᓗᒃᑖᖅᓪᓕᑦ ᑲᑎᑉᐸᓪᓚᐊᔪᓄᑦ ᐊᓯᐅᔾᔨᓂᖅ ᐱᔾᔪᑎᒋᐸᓗᒍ ᐸᒡᕕᓴᐃᓂᐅᔪᓂᓗᒃᑖᖅ ᑲᑎᑉᐸᓪᓚᐊᔪᓄᑦ ᖃᓄᐃᓪᓚᕐᑎᑦᑎᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓂᐅᔪᖅ ᑎᑭᐅᑎᔪᖅ, ᐊᕐᒋᓛᒃᑯᑦ 0.4%–ᒥᒃ, ᐃᓱᒪᒋᔭᐅᔪᐸᓗᓂᓗ ᐊᕐᒋᔫᔮᕐᒋᓐᓂᕐᒐᓄᑦ. ᐊᕐᒋᓛᒃᑰᕐᒐᔪᒃᑯᑦ ᐊᓯᐅᔾᔨᓂᖅ ᐅᒥᕐᒪᐃᑦ ᐃᓂᕐᒋᓐᓂᒃ, ᐊᑐᖅᓪᓗᓂ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐱᕙᓪᓚᐊᓂᖅ ᐅᔾᔨᖅᑐᕐᑯᔨᓂᖅᑕᖅᑲᖅᑐᖅ, ~3%–ᖑᐸᓗᓂᑦ MX/21–ᒥᑦ. ᑕᒪᒃᑯᐊ ᓈᓴᐅᑏᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᑐᐃᓐᓇᕆᐊᖃᖅᑐᑦ ᐅᕐᒐᑖᓄᓗᐊᖅ–ᓇᓚᐅᑖᖅᑕᐅᔪᓂᒃ ᐊᓱᐊᔾᔨᓂᕐᒧᑦ ᐃᒋᔭᐅᔪᓂᒃ. ᐊᕐᒋᓗᐊᕐᒋᒋᐊᖅᑎᑦᑎᓂᖅ ᑲᑎᑉᐸᓪᓚᐊᔪᓂᒃ ᐊᓯᐅᔾᔨᓂᕐᒧᑦ ᐃᓂᒋᔭᐅᔪᓂᒃ, ᐊᕐᒋᓪᓚᒋᐊᕋᔭᖅᐸᑦ ᐃᓱᓖᓗᑕᐅᔭᓇᐊᖅᑲᓪᓗᓂ, ᐊᐅᓚᑦᑎᓂᖅᑕᖅᑲᓇᐊᖅᑲᖅᑐᖅ ᐱᔪᕐᓇᕐᓂᓇᔭᐅᔪᑦ ᐅᕐᒐᑖᓄᑦ ᐅᕙᓘᓃᑦ ᐱᔭᒃᓴᐅᑎᕐᒋᑦᑕ ᐊᓅᕙᒃᑯᑦ. ᐊᕐᒋᓗᐊᕐᒋᒋᐊᖅᑎᑦᑎᓂᖅ ᑲᑎᑉᐸᓪᓚᐊᔪᓂᒃ ᐊᓯᐅᔾᔨᓂᕐᒧᑦ ᐃᓂᒋᔭᐅᔪᓂᒃ, ᐊᒻᒪ ᑲᑎᑉᐸᓪᓚᐊᔪᓄᑦ ᖃᓄᐃᓪᓚᕐᑎᑦᑎᓂᐅᔪᑦ ᐱᓕᕆᖃᑎᕈᕐᓂᕐᑏᑐᖅ ᓚᕙᒃᑯᓐᓂᑦ, ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐱᓕᕆᖃᑎᒋᔭᐅᔪᓂᑦ, ᐊᒻᒪ ᓄᓇᒥᒃ ᐊᑐᕐᓂᕐᒧᑦ ᐸᕐᓇᒃᐸᓪᓚᐊᓕᕆᓂᐅᔪᓂᑦ.

ᓯᓚᐅᑉ ᐊᓯᐊᕗᕐᓂᕐᒐ – ᓯᓚ ᐊᒻᒪ ᓯᓚᐅᑉ ᖃᓄᐃᓐᓂᕐᒐ, ᑕᐃᑲᙵᑦ ᐱᑎᑕᐅᐸᓗᓂ ᑐᒃᑑᑉ ᑎᒥᕐᒐᑕ ᖃᓄᐃᓐᓂᕆᔭᕐᒐ ᐊᒃᑐᖅᓯᓂᖅᑕᖅᑐᖅ ᐆᒪᔭᕆᐊᖅᑲᕐᓂᕐᒧᑦ ᑐᕐᑯᕐᓂᕐᒧᓪᓗ ᓈᓴᐅᑏᑦ. ᑐᒃᑐᐃᑦ ᐆᒪᓂᕐᒐᑦ ᐱᑎᑕᐅᔪᖅ ᖃᐱᐊᕐᔪᕐᓄᑦ ᓯᓚᒥᒃ-ᐱᔾᔪᑎᓚᕐᓄᑦ ᐊᔾᔨᐅᕐᒋᑦᑐᒃᑯᑦ ᐅᑭᐅᑉ ᐃᓗᐊᓂᑦ. ᓯᓚᐅᑉ ᐊᔾᔨᐅᕐᒋᓐᓂᕐᒐ ᐱᑎᑦᑎᔪᕐᓇᖅᑐᖅ ᐱᔾᔪᑕᐅᔪᓂᒃ ᐊᒃᑐᖅᓯᓂᖅᑲᖅᑐᑦ ᑐᒃᑐᐃᑦ ᑐᕐᑯᕐᓂᕐᒋᓐᓄᑦ, ᓱᕐᓗ ᐊᐅᔭᒃᑯᑦ ᖁᐱᕐᕈᓄᑦ, ᐅᕙᓘᓂᑦ ᐊᓱᐊᒍᑦ, ᓱᕐᓗ ᐅᑭᐅᑯᑦ ᐃᑉᐱᕐᓇᓗᐊᖅᑐᒧᑦ ᐊᒻᒪ ᐅᐱᕐᖑᒃᑯᑦ ᐊᐳᑎᖃᕈᓐᓃᕐᓂᐅᑉ ᐅᐸᓗᕐᒐ. ᖃᐸᓯᐊᕐᔪᐃᑦ ᓯᓚᓗᕐᓂᕐᒧᑦ ᑐᒃᑐᓄᑦ ᑕᐃᒪᐅᔪᖅᑲᖅᐸᑦ (ᓱᕐᓗ, ᐊᐳᑎᓚᓗᐊᕿᓗᒃ, ᐊᐳᑎ ᓯᑎᓗᐊᖅᑐᖅ, ᐅᐱᕐᖓᕐᓇᕕᖅᑐᖅ ᐊᐳᑎᖃᕈᓐᓃᕐᓇᕕᖅᑐᖅ, ᐊᐅᔭᒃᑯᓪᓗ ᖁᐱᕐᕈᖅᑕᖃᓗᐊᖅᑐᖅ) ᐆᒪᓂᕐᒧᑦ ᓈᓴᐅᑏᑦ ᓇᓗᓇᙱᑦᑐᖅ ᒥᒃᓵᓂᐊᖅᑐᑦ ᑭᒡᓕᒋᔭᐅᔪᑦ ᖃᓄᐃᓐᓂᕐᒋᓐᓂᕐᓂᑦ. ᑭᓱᐊᓂ, ᑕᒪᒃᑯᐊ ᐊᒃᑐᖅᓯᓃᑦ ᖃᐅᔨᓇᔾᔭᕐᒋᑦᑐᒃᓴᐅᔪᑦ 20-ᓗ 30-ᓗ ᐅᑭᐅᑦ ᐊᐅᓛᕐᓂᕐᒐᔭᕐᒪᓂᑦ ᐱᓕᕆᐊᖅ.

ᐊᒃᑐᖅᑕᐅᓃᑦ ᓯᓚᐅᑉ ᐊᓯᐊᕗᕐᓂᕐᒪᓄᑦ ᑐᒃᑐᐃᑦ ᐅᒥᕐᒪᐃᓪᓗ ᖃᑉᓯᐅᓂᕐᒋᓐᓄᑦ ᑕᐃᒪᐅᖅᑲᑦᑕᕐᓂᐊᖅᑐᒃᓴᐅᔪᑦ ᓱᑲᐃᑐᒥᒃ ᐊᐅᓛᕐᓂᕐᒐᔭᕐᒪᓂᑦ ᐱᓕᕆᐊᑉ. ᓇᐃᑐᒥᒃ ᐊᐅᓚᓂᖅᑲᕐᓂᐊᖅᑎᓪᓗᒍ ᐱᓕᕆᐊᖅ ᐊᒻᒪ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᓯᐊᕗᕐᓂᕐᒧᑦ ᓴᓚᐅᑉ ᖃᓄᐃᓐᓂᕐᒐᔭᕐᒪᓄᑦ ᑕᒪᓐᓇ ᐊᑐᖅᑎᓪᓗᒍ, ᓯᓚᐅᑉ ᐊᓯᐊᕗᕐᓂᕐᒐ ᐊᕐᒋᓪᓚᒋᐊᖅᑎᑦᑎᓂᖅᑲᕐᒋᑦᑐᒃᓴᐅᔪᑦ ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᓂᒃ ᓄᓇᒥᐅᑕᓂᒃ ᓂᕐᔪᑎᓄᑦ ᐃᓂᒋᔭᐅᔪᓄᓪᓘᓃᑦ.

ᐊᒪᕈᖅ

ᐅᑭᐅᖅᑕᖅᑐᒥᑦ ᐊᒪᕈᖅ ᑎᑎᕋᖅᑕᐅᓯᒪᔪᖅ 'ᓈᒻᒪᒃᑐᖅ'-ᒥᑦ ᐊᒻᒪ ᐃᓕᑕᕆᔭᐅᓚᐅᖏᓗᓂ ᐆᒪᔪᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑐᓂᑦ ᐃᓱᒫᓘᑕᐅᓂᕐᒧᑦ ᓘᓃᑦ COSEWIC-ᑯᓐᓄᑦ SARA-ᑯᓐᓄᑦᓘ. ᐊᒪᕈᐃᑦ ᐱᒻᒪᕆᐅᔪᑦ ᑭᕙᓪᓕᕐᒥᐅᓄᑦ ᐊᒻᒪ ᐱᔭᐅᔪᒪᓗᐊᖅᑐᑦ ᒥᖅᑯᖏᓐᓄᑦ (IQ-RBJ 2011[46], IQ-RBYA 2009[47]). ᐊᑐᖅᓯᓂ ᒪᓂᒪᔪᓂᒃ ᑐᑭᓯᐅᒪᔾᔪᑎᓂᒃ, ᐊᒪᕈᐃᑦ ᓯᐊᒪᒃᓯᒪᔫᔮᖅᑐᑦ ᑕᐃᒪᐅᑉᓗᑎᒡᓗ ᑕᒪᓗᒃᑖᒥᑦ RSA-ᒥᑦ. ᐃᓂᐅᔪᒥᑦ, ᐊᓯᖏᑦᑕ ᓯᑎᖏᓐᓄᑦ ᐃᓂᐅᔪᑦ, ᐱᒻᒪᕆᐅᓂᖅᐹᖑᔭᖅᑐᖅ. ᐊᒪᕈᐃᑦ ᖃᑉᓯᐅᓂᖏᑦ ᖃᓄᐃᖏᑦᑐᒥᓇᖅᑐᑦ ᐅᕙᓘᓃᑦ ᐊᒥᓲᖑᖅᐸᓪᓕᐊᔪᑦ ᓄᓇᕗᒻᒥᑦ, ᑭᓯᐊᓂ ᐅᖓᓯᒃᑐᒥᑦ ᖃᐸᓯᐅᓂᖏᑦ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖏᑦ ᒥᑭᑦᑐᒥᒃ ᑐᑭᓯᐅᒪᔭᐅᓂᖃᐃᓐᓇᖅᑐᑦ. ᒥᑭᑦᑐᒻᒪᕆᖏᑦ ᓄᓇᒥᑦ ᑐᑭᓯᐅᒪᔾᔪᑎᑕᖃᖅᑐᖅ ᐊᒪᕈᐃᑦ ᒥᒃᓴᓄᑦ, ᐊᑕᐅᓯᐅᑲᔪᓂᖅᓴᐅᑲᓗᐊᖅᑎᓪᓗᒋᑦ ᐊᖏᖕᒋᑦᑑᐸᓗᑎᒡᓘᓃᑦ ᐱᖓᓱᓂᑦ 7-ᓄᑦ ᑲᑎᕐᒪᒍᑎᒃ.

ᐃᓂᒋᔭᐅᔪᖅ – ᐸᕝᕙᐃᓂᖅ ᓄᓇᒥᑦ ᐃᒃᐱᒋᓂᐅᔪᓂᒡᓗ ᐊᒃᑐᖅᓯᓂᖃᕈᓇᖅᑐᖅ ᐊᒪᕈᐃᑦ ᓯᑎᖏᑦᑕ ᐃᓂᖏᓐᓂᒃ. ᐊᖏᓂᖓ ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᓰᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᕿᑎᐊᓃᓐᓂᖓᓂᒃ ᓴᓇᔭᐅᑎᓪᓗᒍ,ᐊᐅᓚᖅᑎᓪᓗᒍ, ᐊᒻᒪ ᑭᖑᓪᓕᖅᐹᑯᑦ ᐅᒃᑯᐊᖅᐸᓪᓕᐊᑎᓪᓗᒍ. ᐊᖏᓂᖓᑕ ᐱᓕᕆᐊᐸ ᐃᓂᒋᔾᔭᓄᑦ ᒥᑭᑦᑐᒻᒪᕆᐅᒐᓗᐊᖅᑎᓪᓗᒍ ᖃᓄᑎᒋᐅᓂᖓ ᐊᒃᑐᖅᓯᓂᐅᐸ ᐊᒪᖅᑯᐃᑦ ᐃᓂᖏᓐᓄᑦ, ᐅᔭᕋᖕᓂᐊᕐᕕᐅᐸ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖏᓐᓅᖓᔪᑦ ᒥᒃᓯᒋᐊᖅᑎᑦᑎᓂᐊᖅᑐᑦ ᐃᓂᖅᑲᕐᕕᒋᔭᖏᓐᓂᒃ 2 ᑭᓛᒥᑕᒥᒃ ᐅᖓᓯᒃᑎᒋᓂᖅᖅᑐᒥᒃ ᐱᓕᕆᐊᐸ ᐃᓂᖓᓂᑦ ᐊᖏᓂᐅᔪᖅ ᕿᑎᐊᓃᖓᔪᒥᒃ ᐊᓯᐅᕌᓂᖅᑯᓂ ᐃᓂᒋᔭᐅᔪᒥᑦ. ᑭᖑᓪᓕᖅᐹᑯᒃ ᐅᒃᑯᐊᖅᓯᒪᓕᖅᑎᓪᓗᒍ, ᐱᓕᕆᐊᐸ ᐃᓂᖓ ᐊᑐᓕᖅᑕᐅᑲᓂᕈᖕᓇᕐᓂᐊᖅᑐᒃᓴᐅᔪᖅ ᐊᒪᖅᑯᑦ ᓯᑎᖏᓐᓄᑦ, ᐊᖏᓂᖓ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᓃᑦ ᐊᑦᑎᒃᑑᔪᖅ ᐊᐅᓛᕐᓂᕆᔭᖓᑕ ᐱᓕᕆᐊᐸ ᐅᖓᑖᓄᑦ. ᐊᖏᖃᑎᒌᒃᓯᒪᔪᑦ ᐃᓄᐃᑦ ᐸᕝᕙᐃᓂᖏᑦ ᐊᖏᔪᒥᒃ ᓂᕐᔪᑎᓂᒃ ᑎᑭᐅᑎᑦᑕᐃᓕᒪᓂᖏᑦ ᖃᓄᑎᒋᐅᓂᖓ ᑭᓛᒥᑕᐅᐸ. ᑎᑭᐅᑎᓂᖓ ᑎᑭᐅᑎᑦᑕᐃᓕᒪᓂᕐᒧᑦ ᐊᔾᔩᖏᑦᑐᑦ ᒪᓕᒃᓱᒋᑦ ᖃᓂᑦᑐᒥᑦ ᐊᕙᑎᒧᑦ ᓄᓇᐅᐸ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ, ᓇᓗᓇᖖᒋᓐᓂᖅ ᓇᓚᐅᑖᖅᑕᐅᔪᒥᑦ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᑭᒡᓕᕝ ᐱᓕᕆᐊᒧᑦ ᐊᒪᕈᕐᓄᑦ ᕿᑎᐊᓃᑐᖅ.

ᐅᑭᐅᓗᒃᑕᖅ ᐊᑐᖅᑕᐅᔪᖕᓇᖅᑐᖅ ᐊᐸᕐᑯᑎ ᐊᖏᓛᒥᒃ ᐃᓂᖅᑲᕐᓂᐊᖅᑐᖅ ᐊᒻᒪ ᐸᕝᕙᐃᓂᖅᑲᕐᓗᓂ ᒪᕿᖕᓄᑦ ᐊᐸᕐᑯᑎᓄᑦ. ᒥᒃᓵᒋᐊᖅᑎᑦᑎᓂᖅᑳᖑᓂᐊᖅᑐᖅ ᓯᑎᓄᑦ ᐃᓂᒋᔭᐅᔪᓂᒃ ᑕᐅᑐᖑᖅᓱᒍ ᐊᓯᖏᑦ ᐊᐸᕐᑯᑏᑦ ᐊᖏᓂᖅᓴᐅᓂᖓᓄᑦ ᐃᓂᐅᔪᖅ ᐊᒻᒪ ᖃᓄᑎᒋᐅᓂᐊᕐᓂᖓ (8 ᑕᖅᑮᑦ) ᐸᕝᕙᐃᓂᐅᑉ. ᐅᑭᐅᑯᑦ ᐊᐸᕐᑯᑎ ᐊᑐᖅᑕᐅᓂᖅᖃᑦᑕᕐᓂᐊᖅᑐᖅ ᑕᖅᑭᓄᑦ ᐱᖓᓱᓄᑦ ᐊᑐᓂ ᐅᑭᐅᒥᑦ.

ᑭᒡᓕᕝᐊᕐᔪᐃᑦ ᐅᒃᐱᖕᔪᐊᑦ ᑕᒪᒃᑯᐊᕋᓗᐃᑦ

ᑭᒡᓕᕝᐊᕐᔪᐃᑦ ᑐᕌᖅᑕᐅᓯᒪᓚᐅᖅᑐᑦ ᐊᒃᑐᖅᓯᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᑕᒪᒃᑯᓄᙵ. ᐊᓯᖏᑦ ᑕᐃᒪᓐᓇᐃᑐᑦ ᓴᑭᕐᑲᑦᑕᖅᑐᑦ RAA-ᒥᑦ ᑕᐃᒪᐅᔪᑦ ᐊᒥᓲᖏᑦᑑᑉᓗᑎᒃ ᑭᓪᓕᐅᑉᓗ ᐊᓯᐊᖑᕐᓂᖓ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ ᖃᐅᔨᓐᓇᔾᔮᖏᑦᑐᖅ, ᐅᕙᓘᓃᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᐊᔾᔨᐸᓗᕆᓇᔭᖅᑕᖓ ᓇᓗᓇᐃᑯᑕᐅᑉ ᐆᒪᔪᓄᑦ. ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᓴᓇᔭᐅᑎᓪᓗᒍ, ᐊᐅᓚᖅᑎᓪᓗᒍ ᐅᒃᑯᐊᖅᑎᓪᓗᒍᓗ ᐊᒃᑐᖅᓯᓂᖃᕈᓇᖅᑐᖅ ᐃᓂᐅᔪᓂᒃ, ᐅᐸᓗᖅᑲᕝᕕᐅᔪᓂᒃ ᐋᓐᓂᐊᖅᑲᖅᑕᐃᓕᒪᓂᖏᓐᓂᒡᓗ RAA-ᒥᑦ.

[46] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-RBJ 2011: *ᐊᒪᖅᑯᐃᑦ ᒪᖃᐃᑕᐅᖃᑦᑕᖅᑐᑦ ᒪᖃᐃᑎᐅᐸ ᐊᒥᖏᑦ ᓂᐅᕝᕙᖅᓱᒋᑦ ᐃᓚᖏᑦᓗ ᓂᐅᕝᕙᖅᑕᐅᐸᓗᑎᒃ ᓯᓚᑦᑐᖅᓴᖅᕝᕕᖑᑦ ᐊᓐᓄᕌᓕᐅᕐᓂᖑᑦ*
[47] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-RBYA 2009: *ᐃᓄᐃᑦ ᒪᖃᐃᓂᖅ ᐊᒪᖅᑯᓂᒃ ᑲᔪᓯᔪᑦ, ᓂᖏᕆᓂᐊᕐᓗᒍᖕᒋᑦᑐᖅ, ᑭᓯᐊᓂ ᐊᒥᖏᓐᓂᒃ ᓂᐅᕝᕙᒃᓴᖅᑲᕐᓂᕐᒧᑦ.*

ᐱᔾᔪᑕᐅᔪᑦ ᐊᒃᑐᕐᓯᓂᐅᔪᓄᑦ ᑭᒡᒐᕙᐊᕐᔪᖕᓄᑦ ᐃᓚᐅᔪᑦ: 1) ᒥᒃᓵᒋᐊᕐᓂᖕᒋᑦ ᐃᓂᒋᔭᖕᒋᑦ ᒪᓂᒪᔪᑦ ᐱᓕᕆᐊᑉ ᐱᕐᑯᑎᖕᒋᑦᑕ ᐃᓂᖕᒋᓐᓄᑦ ᐊᓯᐅᔨᓂᐅᔪᕐᒃ ᓂᕐᕆᕝᕙᖕᒋᓐᓂᒃ, ᐊᒻᒪ ᐃᒃᐱᖕᓂᐊᓂᖕᒋᓐᓄᑦ ᐊᓯᐊᒍᑦ ᐊᓯᐅᔨᓂᐅᔪᑦ ᐃᓂᒋᔭᖕᒋᓐᓄᑦ; 2) ᐊᓯᐊᒍᑦ ᐊᒃᑐᕐᓰᓐᑦ ᐅᑉᐳᐃᑦ ᐊᒥᓲᔪᖕᓅᕐᓂᖕᒋᓐᓄᑦ ᐃᒃᐱᒋᓂᕐᒧᑦ ᐸᒡᕙᓴᐃᓂᕐᒥᑦ ᐅᔭᖅᑕᕆᐊᑉ ᐊᐅᓛᕐᓂᖕᒐᓄᑦ ᐊᒻᒪ ᐊᑉᕐᑯᑎᒥᑦ ᐃᖕᒋᖅᖄᖕᓂᕐᒧᑦ ᐅᑉᐳᖕᒋᑦ ᖃᓂᑦᑐᓄᑦ ᖃᓄᐃᓕᐅᕐᕙᐅᔪᓂᑦ; ᐊᒻᒪ 3) ᐊᓯᐊᖖᒎᕐᓂᕐᒃ ᐋᓐᓂᐊᕐᑲᕐᑕᐃᓕᒪᓂᖕᒋᓐᓄᑦ radionuclide-ᒧᑦ ᐊᒻᒪ ᓴᕙᕐᑲᕐᑐᓄᑦ ᓂᕆᔭᖕᒋᑦᑎᒨᕐᑐᑦ.

ᖃᐅᔨᒪᓂᕐᑲᕐᑐᑦ ᐅᖃᐅᓯᖕᒋᑦᑎᒍᑦ, ᐱᓕᕆᓂᑯᒃᑯᑦ ᐊᓯᖕᒋᓐᓂᒃ ᐅᑭᐅᕐᑕᕐᑐᒥᑦ ᐱᓕᕆᐊᓂᑦ, ᐊᒻᒪ ᖃᐅᔨᒪᓂᕐᒃ ᑕᒪᒃᑯᐊ ᐆᒪᓂᕐᒧᑦ ᐊᑐᕐᐸᒃᑕᖕᒋᓐᓂᒃ, ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᕐᑕᐅᓃᑦ ᐃᓂᒋᔭᐅᔪᑦ ᒪᓂᒪᓂᖕᒋᓐᓄᑦ ᐃᓱᒪᒋᔭᐅᔪᑦ ᐅᔾᔨᕐᓇᕐᓂᖕᒋᓐᓄᑦ ᐊᖕᒋᓂᕐᒃᓴᐅᒃᐸᑦ 10%-ᒥᒃ ᐃᓂᐅᔪᐃᑦ RAA-ᒥᑦ ᑕᐃᒃᙵᑦ ᐊᒃᑐᕐᑕᐅᓂᕐᑲᕐᐸᑕ ᐱᓕᕆᐊᑉ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖕᒋᓐᓄᑦ. ᐱᓕᕆᐊᒧᑦ ᐊᒃᑐᕐᑕᐅᓂᕐᒃ ᐊᓯᓕᐅᑲᓐᓂᕈᖕᓇᕐᓂᐅᔪᒧᑦ ᐃᓱᒪᒋᔭᐅᔪᕐᒃ ᐊᖕᒋᔩᓂᖕᒐᓂᒃ ᐅᑉᐳᓕᐅᕆᓂᕐᓄᑦ ᐃᓂᐅᔪᕐᒃ ᐅᑉᐳᒥᒧᑦ RAA-ᒥᑦ ᑲᑕᒃᐸᑦ ᐊᑦᑎᖕᓂᕐᒃᓴᒧᑦ 1.25 ᐱᐊᗰᑦ/ᐃᓂᒋᔭᖕᒐᓂᑦ ᑲᑎᕐᒪᔩᒃ/ᐅᑭᐅᒥᑦ. ᐋᓐᓂᐊᕐᑲᕐᑕᐃᓕᒪᓂᕐᒧᑦ, ᓇᓚᐅᑖᕐᑕᐅᔪᑦ ᐊᒃᑐᕐᑕᐅᓂᕐᑲᕐᑐᑦ ᑕᒪᐃᓄᑦ ᐅᑐᕆᐊᓇᕐᑐᕐᑲᙱᑦᑐᓄᑦ ᐅᑐᕆᐊᓇᕐᑐᓄᒡᒍ ᐱᔭᐅᔪᑦ ᐆᒪᓂᕐᒧᑦ, ᐃᓱᒪᒋᑉᐳᒋᑦ ᑕᒪᕐᒥᒃ ᑭᒡᓕᐅᔪᑦ ᐊᒻᒪ ᐱᓕᕆᐊᒥᑦ ᐳᔪᕐᒍᐃᑦ ᐊᓂᐊᔪᑦ, ᑕᐅᑐᖕᓖᕐᔫᒍ ᖃᓄᑎᒋᐅᔪᑦ ᒥᐊᓂᕐᓯᓂᕐᑲᕐᑐᑦ ᑎᖕᒥᐊᓂᒃ.

ᐃᓂᒋᔭᐅᔪᕐᒃ – ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖕᒐ ᑕᐃᒃᙵᑦ ᐊᓯᐅᔨᓂᕐᑕᕐᑲᕐᓂᐊᕐᑐᕐᒃ ᑭᒡᒐᕙᐊᕐᔪᒍᕿᑦ ᓂᕆᕝᕙᒋᕗᒃᑕᖕᒋᓐᓄᑦ ᐃᓂᐅᔪᓂᒃ. ᐱᓕᕆᐊᑉ ᐃᓂᖕᒐ ᓂᕆᐅᒋᔭᐅᔪᕐᒃ ᑭᒡᒐᕙᐊᕐᔪᒍᕿᑦ ᐃᓂᒋᔭᖕᒋᓐᓂᒃ ᐊᑐᕐᑕᐅᔪᖕᓇᕐᓂᕐᑲᕐᑎᑦᑎᔾᔭᖕᒋᓐᓂᖕᒐᓂᒃ ᐱᓕᕆᐊᕐᒃ ᓴᓇᔭᐅᒃᐸᑦ. ᐱᓕᕆᐊᕐᒃ ᑕᐃᒃᙵᐅᖕᒋᑦᑐᕐᒃ ᐊᓯᐅᔨᓂᕐᑲᕐᑎᑦᑎᓂᐊᕐᑐᕐᒃ ᑭᒡᒐᕙᐊᕐᔪᒍᕿᑦ ᓂᕆᕝᕙᖕᒋᓐᓄᑦ ᐃᓂᐅᔪᓂᒃ ᐃᓄᖕᓄᑦ ᐸᒡᕙᓴᕐᑕᐅᓂᕐᒧᑦ (ᐃᓄᐃᑦ ᑕᐃᒪᐅᓂᖕᒋᓐᓄᑦ, ᓂᐱᕐᑲᕐᓂᕐᒃ, ᐊᐅᓚᓂᕐᒍ) ᖃᓂᑦᑐᓂᒃ ᐃᓂᐅᔪᓂᒃ. ᐅᑉᐳᕐᑲᕐᕙᐅᔪᓂᒃ ᖃᐅᔨᒪᓐᓇᕐᑐᕐᑲᙱᑦᑐᕐᒃ ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖕᒐᓂᑦ; ᑕᐃᒪᓐᓇᒧᑦ ᐱᕚᓕᐊᓂᕐᒃ ᐊᓯᐅᔨᓂᕐᑕᕐᑲᕐᑎᑦᑎᔾᔭᖕᒋᑦᑐᕐᒃ ᐅᑉᐳᖕᒋᓐᓂᒃ (IQ-BL05 2008[48]).

ᖃᐅᔨᓴᐃᓂᕐᑲᕐᓂᐊᕐᒍᓂ ᑕᒪᐃᓅᖕᒐᔪᒥᒃ ᐊᓯᐅᔨᓂᕐᒃ ᑭᒡᒐᕙᐊᕐᔪᐃᑦ ᐃᓂᒋᔭᖕᒋᓐᓂᒃ RAA-ᒥᑦ, ᖃᓄᐃᑑᓂᖕᒋᑦ ᐃᓂᐅᔪᑦ ᓇᓐᓂᓂᕆᔭᖕᒋᓐᓄᑦ ᐃᓂᓕᐅᕐᑕᐅᓚᐅᕐᑐᕐᒃ "ᐱᑕᕐᑲᙱᑦᑐᕐᒃ"-ᒥᑦ, ᐊᑦᑎᒃᑐᕐᒃ, ᕿᑎᐊᓂᑦ ᐊᒻᒪ ᖁᑦᑎᒃᑐᕐᒃ ᖃᓄᐃᓐᓂᕆᔭᖕᒐ ᐃᓂᐅᑉ. ᑕᒪᒃᑖᕐᑲᔭᕐᒃ RAA ᐃᓱᒪᒋᔭᐅᔪᕐᒃ ᖁᑦᑎᒃᑐᒥᑦ ᕿᑎᐊᓄᑦ ᖃᓄᐃᓐᓂᐅᑉ ᓂᕆᔭᒃᓴᕐᓯᐅᕐᕙᖕᒐᑦᑕ ᐃᓂᖕᒐᓄᑦ. 9 ᑭᒡᒐᕙᐊᕐᔪᐃᑦ ᐅᑉᐳᕐᑲᕐᕙᖕᒋᑦ ᓇᓂᔭᐅᓚᐅᕐᑐᑦ, ᑕᒪᕐᒥᒃ ᐅᔭᖅᐅᓂᕐᒥᑦ ᖁᑦᑎᒃᑐᒦᕐᒍᑎᒃ ᑕᐃᑲᓂ ᐊᑭᐊᓂᓘᓃᑦ ᐅᑭᐅᒧᒃᑖᕐᒃ ᐊᑐᕐᑕᐅᔪᖕᓇᕐᑐᕐᒃ ᐊᑉᕐᑯᑎᒨᙱᑦᑐᐃᑉ.

ᐊᓈᕗᒃᑯᑦ ᐊᖕᒋᒍᐊᖕᒋᒋᐊᕐᑎᑦᑎᓂᐊᕐᑐᑦ ᐊᒃᑐᕐᓯᓂᑲᓪᓚᐅᔪᓂᒃ ᑭᒡᒐᕙᐊᕐᔪᖅᑯᐃᑦ ᐃᓂᒋᔭᖕᒋᓐᓂᒃ ᐃᒪᓐᓇᐃᓕᐅᕐᑯᑎᒃ: 1) ᒥᑭᒡᓕᒋᐊᕐᑐᒍ ᐱᓕᕆᐊᑉ ᐃᓂᖕᒐ; 2) ᒥᑭᒡᓕᒋᐊᕐᑐᒍ ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᓯᓚᑖᓂᑦ ᐃᓂᐅᔩᑉ; 3) ᐅᑎᕐᑎᑎᕆᓂᕐᑕᕐᑲᐃᓐᓇᕐᑐᓂ ᐸᒡᕙᓴᕐᑕᐅᔪᓂᒃ; 4) ᐳᔪᕐᑲᒍᐊᕐᑕᐃᓕᒪᑎᑦᑎᓂᕐᒥᒃ ᐱᑎᑦᑎᒍᓂ ᐊᑉᕐᑯᑎᓂᑦ ᐊᐅᔭᒃᑯᑦ; ᐊᒻᒪ 5) ᐲᕐᒍᒋᑦ ᐳᔪᓕᐅᕆᓂᕐᒃ ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᐅᓚᑦᑎᕝᕙᖕᒥᑦ. ᐱᓕᕆᐊᑉ ᐃᓂᖕᒐ ᒥᒃᓵᒋᐊᕐᑕᐅᔪᕐᒃ ᐅᑭᐅᑯᑦ ᐊᑉᕐᑯᑎᐅᓂᐊᕐᑐᒧᑦ, ᐃᓂᐅᔪᓂᒃ ᐊᓯᐅᔨᓂᕐᒃ ᐱᓕᕆᐊᕐᒍ ᑲᑎᐸᑉᓕᐊᓂᕐᒥᒃ ᐊᓱᖕᒋᓐᓂᒃ ᐱᓕᕆᐊᓄᑦ ᑭᕗᑉᓕᕐᒥᑦ ᒥᒃᓵᒋᐊᕐᓂᕐᑲᕈᖕᓇᕐᒍᓂ.

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[48] ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᕐᑲᖕᒋᑦ-BL05 2008: *ᑭᒡᒐᕙᐅᑉ ᐃᓂᖕᒐ ᓄᓇᐃᓐᓇᕈᔫᓂᖕᒐᓄᑦ, ᖃᐅᔨᒪᙱᑦᑐᖕᒐ ᐅᑉᐳᕐᑲᕐᕙᐅᖕᒪᖕᒫᑦ ᑎᖕᒥᐊᑦ ᐅᑉᐳᕐᑲᒍᐊᕐᑲᑦᑕᕐᒪᑕ ᑑᑉ ᖃᓂᑕᖕᒐᓂᑦ ᕿᑭᕐᑕᕐᑲᕐᑐᒥᓪᓗᓐᓂᑦ.*

ᐊᖑᔪᐊᖑᒋᒋᐊᖅᑎᑦᑎᓂᖅᑕᕐᑳᓂᖅᑳᖅᑎᓪᓗᒍ, ᐅᔾᕋᖕᓂᐊᕐᓂᐅᑉ ᐃᓂᖓ ᐅᑭᐅᓗᒃᑖᕐᓗ ᐊᑐᖅᑕᐅᔪᖅ ᐊᑉᖁᑎ ᑕᐃᑲᙶᖅᑐᓂᒃ ᐊᓯᐅᔨᓂᖅᑕᕐᑲᕐᓂᐊᖅᑐᖅ 1,780 ha-ᓂᒃ ᐊᑐᖅᑕᐅᕙᓚᐅᖅᑑᒐᓗᐊᒥᒃ ᓂᕆᕝᕕᐅᓂᕐᒧᑦ. ᐱᓕᕆᐊᖅ ᓂᕆᐅᒋᔭᐅᔪᖅ ᒥᒃᓵᑎᑦᑎᓂᐊᕐᓂᖓᓗᓐᑦ ᒪᓂᒪᔪᓂᒃ ᓂᕆᕝᕕᐅᕝᕕᖕᓂᒃ 5.8%-ᒥᒃ ᐃᓂᐅᔪᓂᒃ RAA-ᒥᑦ. ᐊᖏᓂᖓ ᓂᕆᐅᒋᔭᐅᔪᖅ ZOI-ᒥᑦ, ᑕᒪᐃᓂᒃ ᐊᒃᑐᖅᑕᐅᓃᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ LAA-ᒦᓐᓂᐊᕐᓂᖏᓐᓄᑦ. ᐊᓯᐅᔾᔭᓂᖅ ᐃᓂᐅᔪᒥᒃ ᐅᑎᖅᑎᑦᑐᙵᖅᑐᖅ ᓂᕐᔪᑏᑦ ᐊᑐᕐᑲᑦᑕᕐᒪᑕ ᐸᒃᕕᓴᖅᑕᐅᓯᒪᓚᐅᖅᑐᒥᐅᒐᓗᐊᖅ ᐅᔾᕋᖕᓂᐊᕐᕕᒃ ᐅᑎᖅᑎᑎᕆᓂᕐᑲᐃᓐᓇᐅᔾᕐᒪᑕ ᐊᒪᓗ ᐃᖕᒥᓂᒃ ᓄᓇ ᐅᑎᖅᐸᓪᓚᐊᓂᒃᑯᑦ. ᐊᑉᖁᑎ ᐊᖏᓛᒥᒃ ᐊᒃᑐᖅᓯᓂᕐᑲᕐᓂᐊᖅᑐᖅ ᑕᒪᑯᓄᙵ ᐃᓂᒋᔭᐅᔪᓂᒃ ᐅᑭᐅᓗᒃᑖᖅ ᐊᑐᖅᑕᐅᕐᑲᑦᑕᖅᑐᖅ ᐊᑉᖁᑎᒧᑦ ᐊᖏᓂᖅᓴᐅᓂᖓᓐᓄᑦ ᐃᓂᐅᔪᖅ ᐊᒪᓗ ᐊᖏᓂᖅᓴᐅᓂᖓᓐᓄᑦ ZOI. ᑎᑭᐅᑎᓂᖓ ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖓ ᕐᑲᐅᔨᒋᐊᖅᑕᐅᕐᑲᑦᑕᕐᓂᐊᖅᑐᖅ ᐊᕐᕌᒍᑕᒫᑦ ᓇᓗᓇᐃᖅᓯᓂᕐᒧᑦ ᐃᓂᐅᔪᓂᒃ ᐊᓯᐅᔾᔭᓂᕐᒧᑦ ᓇᓚᐅᑖᕐᓂᐊᕐᓗᑎᒃ.

ᐱᓕᕆᐊᖅ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᖅ ᑲᑎᕐᕿᓪᓚᐊᔪᓂᒃ ᐊᓯᖏᓐᓄᑦ ᐱᓕᕆᐊᓅᖓᔪᓂᒃ ᐆᒪᓂᐅᔪᓂᐅᖓᔪᓐᑦ ᒥᒃᓱᒋᐊᖅᑎᑦᑎᓂᐊᕐᓂᖓᓗᓐᑦ ᐃᓂᐅᔪᑦ ᒪᓂᒪᓂᖏᓐᓄᑦ ᑕᒫᓂ. ᐊᓯᐅᔾᔭᓂᖅ ᐃᓂᐅᔪᓂᒃ ᒥᑭᑦᑑᔪᖅ ᐊᒪᓗ ᐃᓚᓯᓂᐊᖏᕈᓂ ᐊᖏᔪᒥᒃ ᑲᑎᕐᕿᓪᓚᐊᔪᓂᒃ ᐊᓯᐅᔾᔭᓂᕐᒧᑦ ᐃᓂᐅᔪᓂᒃ ᑕᒫᓂ. ᐊᓯᖏᑦ ᐱᓕᕆᐊᑦ ᐊᖏᔪᒥᒃ ᐊᒃᑐᖅᓯᕐᑲᖅᓯᒪᙱᑦᑐᑦ ᑭᒡᓚᕕᐊᕐᔪᕋᓗᐃᑦ ᐃᓂᖏᓐᓂᒃ. ᑕᐃᒪᓐᓇᒧᑦ ᒫᓐᓇᐅᔪᖅ ᑲᑎᕐᕿᓪᓚᐊᓂᕐᒧᑦ ᐊᒃᑐᖅᓯᓃᑦ (ᑭᒡᓕᐅᔪᒦᖓᔪᑦ) ᐊᖏᔫᖏᑦᑐᖅ ᐱᓕᕆᐊᕐᓗ ᐃᑲᔪᐃᓂᖓ ᒫᓐᓇᐅᔪᖅ ᑲᑎᕐᕿᓪᓚᐊᔪᓐᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᓐᑦ ᐊᖏᔫᖏᕈᓂ.

ᐅᐸᑐᓕᐅᖅᐸᓪᓚᐊᓂᖅ - ᐅᐸᑐᓕᐅᖅᐸᓪᓚᐊᓂᖅ ᐃᓱᒪᒋᔭᐅᔪᖅ ᖃᓄᐃᖏᓐᓂᖓᓂᒃ ᐅᐸᑐᓕᐅᕆᓂᖅ ᑕᐃᑲᓃᖏᓐᓇᖅᐸᑦ 1.25 ᐱᐊᓛᑦ/ᐃᓂᒋᔭᖓᓂᑦ/ᐅᑭᐅᒥᑦ. ᐅᔾᕋᖕᓂᐊᕐᓂᐅᑉ ᐃᓂᖓ ᐅᑭᐅᑯᓪᓗ ᐊᑐᖅᑕᐅᕐᑲᑦᑕᖅᑐᖅ ᐊᑉᖁᑎ ᐊᒃᑐᐊᓂᕐᑲᙱᑦᑐᑦ ᐱᐊᓛᓕᐅᕐᓂᖏᓐᓄᑦ ᑭᒡᓚᕕᐊᕐᔭᐃᑦ. ᑕᒪᐃᓂᒃ ᖃᐅᔨᒪᔭᐅᔪᑦ ᐅᐸᑐᕐᑲᕐᕖᑦ ᖃᓂᑕᖓᓃᑐᑦ ᐅᑭᐅᓗᒃᑖᖅ ᐊᑐᖅᑕᐅᕐᑲᑦᑕᖅᑑᐸ ᐊᑉᖁᑎᐅᑉ LAA-ᒥᑦ. ᑭᒡᓚᕕᐊᕐᔭᐃᑦ ᐅᑭᐅᑕᓖᑦ ᐅᑎᕐᑲᑦᑕᕐᓂᖏᓐᓄᑦ ᐅᐸᑐᕐᑲᕐᕕᒋᕙᒃᑕᖏᓐᓄᑦ, ᖃᐟᓯᐅᓂᖏᓐᓄᑦ ᐃᓂᐅᔪᑦ (9) ᖃᓂᑦᑐᑦ ᐅᑭᐅᓗᒃᑖᖅ ᐊᑐᖅᑕᐅᕐᑲᑦᑕᖅᑐᒧᑦ ᐊᑉᖁᑎᒧᑦ, ᐊᒪᓗ ᑕᒪᑐᒨᖓ ᖃᐅᔨᒋᐊᕐᑲᑦᑕᕐᓂᖅ, ᐊᒃᑐᖅᓯᓃᑦ ᖃᐅᔮᓴᖅᑕᐅᕐᑲᑦᑕᖅᑐᑦ ᐃᓂᒋᔭᐅᔪᒥᑦ ᐃᓂᒋᔭᐅᔪᔾᔪᖓᐸᓗᒍ ᐅᑭᐅᓗᒃᑖᖅ ᐊᑐᖅᑕᐅᕐᑲᑦᑕᖅᑐᒧᑦ ᐊᑉᖁᑎᒧᑦ.

ᕿᓂᖅᓴᐃᓂᖅᑕᕐᑲᕐᓂᖅ ᑲᔪᓯᔪᒥᒃ, ᓴᓇᔾᔭᐅᕙᓪᓚᐊᓂᖅ, ᐊᒪᓗ ᐊᐅᓛᕐᓃᑦ ᐊᒃᑑᑎᓂᖅᑲᕈᖓᖅᑐᑦ ᐱᐅᖏᑦᑑᔪᒥᒃ ᑭᒡᓚᕕᐊᕐᔪᖕᓄᑦ. ᑎᖕᒥᓱᓂᒃ ᐊᑐᑲᑕᖕᓂᖅ ᑲᔪᓯᔪᒥᒃ ᐅᔾᕋᖕᓂᐊᕐᕕᐅᑉ ᐃᓂᖓᓂᑦ ᐸᒡᕕᓴᐃᓂᕐᑲᕈᖓᖅᑐᑦ ᑭᒡᓚᕕᐊᕐᔪᖕᓄᑦ. ᐊᖏᓂᖓᑕ ᐊᒃᑐᖅᑕᐅᓂᐅᑉ ᐸᒡᕕᓴᖅᑕᐅᓂᕐᒧᑦ ᐊᒃᑐᐊᓂᕐᑲᖅᑐᖅ ᓇᓃᓐᓂᐅᔪᒥᒃ ᐱᐊᓛᓕᐅᖅᑎᓪᓗᒋᑦ. ᐊᖑᔪᐊᖑᒋᒋᐊᖅᑎᑦᑎᓂᖅ ᑲᔪᓯᔪᒥᒃ ᐅᐸᑐᓕᐅᖅᐸᓪᓚᐊᓂᕐᒧᑦ RAA-ᒥᑦ ᐃᓚᐅᔪᑦ ᐸᒡᕕᓴᐃᓂᖅᑕᕐᑲᙱᑦᓗᓂ ᐅᐸᑐᓕᐅᕐᕕᐅᔪᑦ ᖃᓂᑕᖓᓂᑦ ᖃᓄᐃᓕᐅᕐᓂᖅᑕᕐᑲᕖᖓᑦ ᐅᐸᑐᓕᐅᒪᑎᓪᓗᒋᑦ, ᓴᓇᕙᓪᓚᐊᓂᖅ ᓯᓚᑖᓗᓂ ᐅᐸᑐᓕᐅᖅᑐᑦ ᐸᒡᕕᓴᐃᓂᖅᑕᕐᑲᕆᐊᕐᑲᖅᐸᑦ ᐅᐸᑐᓕᐅᖅᑐᑦ ᖃᓂᑕᖓᓂᑦ, ᐊᒪᓗ ᑎᖕᒥᓲᑦ ᖃᖓᑕᔾᔪᓂᖅ ᐊᔪᕐᓇᕐᓗᓂ ᐅᐸᑐᕐᑲᕐᕕᐅᔪᑦ ᖃᓂᑕᖏᓐᓂᑦ.

ᐊᒃᑐᖅᓯᓂᖅ ᐱᓕᕆᐊᖅ ᑕᒪᒃᑯᐊ ᐅᐸᑐᓕᐅᕐᓂᖏᓐᓄᑦ ᐊᖏᔫᔾᔭᖏᑦᑐᖅ. ᐃᓂᖓ ᐅᔾᕋᖕᓂᐊᕐᕕᐅᑉ ᐅᑭᐅᑯᓪᓗ ᐊᑐᖅᑕᐅᕐᑲᑦᑕᖅᑐᖅ ᐊᑉᖁᑎ ᑎᑭᐅᑎᔾᔪᑎᓂᖅᑕᕐᑲᙱᑦᑐᖅ ᖃᐅᔨᒪᔭᐅᔪᓂᒃ ᐅᐸᑐᕐᑲᕐᕖᓐᓄᑦ. ᐊᖑᔪᐊᖑᒋᒋᐊᖅᑎᑦᑎᓂᕐᒨᖓᔪᑦ ᐅᐸᑐᕐᑲᕐᕕᐅᔪᓐᑦ ᐅᑭᐅᓗᒃᑖᖅ ᐊᑐᖅᑕᐅᕐᑲᑦᑕᖅ ᐊᑉᖁᑕᐅᑉ ᖃᓂᑕᖓᓂᑦ ᓂᕆᐅᒋᔭᐅᔪᖅ ᒥᒃᓱᒋᐊᖅᑎᑦᑎᓂᐊᕐᓂᖓᓗᓐᑦ ᐊᒃᑐᖅᓯᓂᒃᓪᓚᐅᔪᓂᒃ ᑕᒪᒃᑯᓐᓇᙱᓐ ᐅᐸᑐᓕᕆᓂᖏᓐᓄᑦ. ᐊᐅᓛᖅᑎᓪᓗᒍ, ᑭᒡᓚᕕᐊᕐᔪᕋᓗᖕᓂᒃ ᐊᒃᑐᖅᑕᐅᓂᕐᑲᖅᑐᕐᑲᔾᔭᖏᑦᑐᖅ ᐸᒡᕕᓴᐃᓂᕐᒧᑦ ᐊᒃᑐᖅᑕᐅᓂᕐᒧᑦ ᐅᐸᑐᓕᕆᓂᖓᑦ.

ᖃᐅᔨᓯᐊᖃᑦᑕᕐᓂᖅ ᐊᓯᐊᙳᕐᓂᕐᒥᒃ ᑭᒡᒐᕕᐊᕐᔪᐊᓗᐃᑦ ᐅᑉᓗᓕᐅᕐᓂᖏᓐᓂᒃ ᐃᓚᐅᓂᐊᖅᑐᑦ ᐊᑕᐅᓯᐅᑉᓗᑎᒃ ᐅᑉᓗᓄᑦ ᐃᓂᐅᔪᑦ ᖃᐅᔨᓯᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᓴᓇᔭᐅᑎᓪᓗᒍ ᖃᐅᔨᓂᐊᕐᓗᓂ ᖃᖓᒃᑯᑦ ᐃᓂᖏᓐᓄᑦ ᑲᑎᕐᒪᔫᒃ ᑕᐃᑯᙵᒐᕋᓱᖕᒪᖕᒐᑕ ᐅᑉᓗᓕᐅᕐᓂᐊᕐᓗᑎᒃ (ᑭᒡᓕᓕᐅᓕᕐᓗᓂ ᐸᕝᕕᓴᐃᓂᖃᖅᑕᐃᓕᓂᕐᒧᑦ), ᐊᒪᓗ ᐅᑭᐅᑕᒫᑦ ᖃᐅᔨᓯᐊᖃᑦᑕᕐᓗᓂ ᐃᓂᒋᔭᖏᓐᓃᓂᖏᓐᓄᑦ, ᒪᓐᓂᓕᐅᕐᓂᖏᓐᓄᑦ, ᐱᐊᓛᑦ ᐊᓂᕆᓪᓕᐊᓂᖏᓐᓄᑦ, ᐊᒪᓗ ᐱᐊᓛᙳᓕᖅᑎᓪᓗᒋᑦ (ᓲᕐᓗ ᐱᕙᓪᓕᐊᓂᖅ) ᐅᑉᓗᐃᑦ ᐃᓕᑕᕆᔭᐅᔪᑦ ᑭᓪᓄᑦ ᖃᐅᔨᓴᐃᓂᒥᑦ.

ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖅ – ᐳᔪᕐᓗᐃᑦ ᐊᓂᐊᔪᑦ ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᓯᔪᖕᓇᖅᑐᑦ ᑲᑎᓯᒪᔪᓂᒃ COPC-ᓂᒃ ᐊᕙᑎᒥᑦ (ᓲᕐᓗ, ᐃᒪᖅ, ᐃᐸᔪ, ᒥᑭᔪᑦ ᓂᕐᔪᑏᑦ) ᑕᐃᒪᓐᓇᓗ ᐊᒃᑐᖅᓯᓂᖅᑲᕐᓂᐊᖅᑐᑦ ᑎᑭᑕᐅᖅᑲᑦᑕᕐᓂᖏᑦ ᑭᒡᒐᕕᐊᕐᔪᐊᓗᐃᑦ ᓂᕆᒍᓂᔾᔪᒃ ᑕᒪᒃᑯᐊ. ᐳᔪᕐᓗᐃᑦ ᐊᒃᑐᖅᓯᓂᑲᓪᓚᐅᔪᓂᒃ ᑭᒡᒐᕕᐊᕐᔪᖕᓄᑦ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᖅ. COPC ᐊᑐᖅᑕᐅᔪᖅ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐃᓚᐅᔪᑦ ᓄᙳᓯᐃᑐᖅ ᐊᒪᓗ ᓄᙳᓯᐃᑐᖅ-238 ᐃᒍᓇᖅᑐᓅᖓᔪᑦ (thorium-230, lead-210, radium-226, ᐊᒪᓗ polonium-210), arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, selenium, ᐊᒪᓗ zinc. ᑎᑭᐅᑎᓂᖅ COPC-ᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᖕᓇᖅᑐᖅ ᐊᑐᖅᖢᓂ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᕙᑎᒥᑦ ᑲᑎᓯᒪᔪᑦ ᐊᒪᓗ ᐃᓯᒪᒋᔭᐅᔪᑦ ᖃᓄᑎᒋ ᑭᒡᒐᕕᐊᕐᔪᐊᐃᑦ ᓂᕆᖃᑦᑕᕐᒪᖔᑕ. ᑭᒡᒐᕕᐊᕐᔪᐊᐃᑦ ᖃᓄᑎᒋ ᐃᓂᐅᔪᒦᖃᑦᑕᕐᓂᖏᑦ ᐱᒻᒪᕆᐅᖕᒥᔪᖅ. ᖃᓄᐃᖕᒪᓂᐅᔪᑦ ᓇᓗᓇᐃᖅᓯᔪᖅ ᐊᒃᑐᖅᑕᐅᓯᒪᓂᖏᑦ ᑭᒡᒐᕕᐊᕐᔪᐊᐃᑦ COPC-ᓄᑦ ᐅᖓᑕᐅᑎᔾᔭᖏᑦᑐᖅ ᐊᒃᑐᖅᑕᐅᓯᒪᓂᕐᒧᑦ ᓇᓃᓐᓂᐅᔪᓄᑦ ᐊᒃᑐᐊᓂᖃᖅᑐᑦ ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᓄᑦ ᑎᖕᒥᐊᓄᑦ; ᑕᐃᒪᓐᓇᓗ ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᑭᒡᒐᕕᐊᕐᔪᐊᓗᐃᑦ ᐊᒃᑐᖅᑕᐅᓂᐊᕐᓂᖏᓐᓄᑦ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᖅ.

ᓯᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᖓ - ᑲᑎᑉᐸᓪᓕᐊᔪᓄᑦ ᐊᒃᑐᖅᓯᓃᑦ ᓯᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᖓᓄᑦ ᑭᒡᒐᕕᐊᕐᔪᐊᓗᖕᓄᑦ ᐃᓂᒋᔭᖏᓐᓄᓪᓗ ᓂᕆᐅᒋᔭᐅᔪᑦ ᒥᑭᑦᑑᓂᐊᕐᓂᖏᓐᓄᑦ ᐅᑭᐅᓄᑦ 20-ᒥᑦ 30-ᒧᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ ᐊᐅᓛᕐᓂᕆᔭᖓᓄᑦ. ᑭᒡᒐᕕᐊᕐᔪᐊᑦ ᐊᒃᑐᖅᑕᐅᓂᖃᖅᐸᑕ ᓯᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᖓᓄᑦ, ᑕᐃᒪᐅᓂᐊᖅᑐᖅ ᑕᐃᑲᙵᐅᖏᑦᑐᖅ ᐊᒃᑐᖅᓯᓂᐅᔪᓂᒃ. ᖃᐅᔨᓴᐃᓂᖅ ᖃᓂᑕᖓᓂᑦ ᑲᖏᖅᖠᓂᖅ, ᓄᓇᕗᑦ, ᓇᓂᓯᓚᐅᖅᑐᑦ ᓴᙱᔪᒥᒃ ᐊᔪᙱᓐᓂᖅᑲᖅᑐᑦ ᐱᐊᓛᓕᐅᕈᓐᓇᕐᓂᖏᑦ ᑭᒡᒐᕕᐊᕐᔪᐊᑦ ᓯᓚ ᖃᓄᐃᑑᓗᐊᖅᑎᓪᓗᒍ, ᐱᓗᐊᖅᑐᒥᑦ ᐊᐅᔭᒃᑯᑦ ᒪᕐᑯᒃᑐᒥᑦ ᐊᒪᓗ ᐅᐱᕐᙵᒃᑯᑦ ᐱᖅᓯᖅᑐᓂᒃ. ᓯᓚ ᐊᓯᐊᙳᖅᐸᓪᓕᐊᖏᓐᓇᖅᑎᓪᓗᒍ, ᑕᑭᓂᖅ-ᐊᑯᓂᐅᔪᒥᒃ ᐱᕙᓪᓕᐊᓂᖅᑲᕈᓐᓇᕐᓂᕐᒪᑦ ᑭᒡᒐᕕᐊᕐᔪᐊᑦ ᐊᒃᑐᖅᑕᐅᔪᓐᓇᖅᑐᑦ. ᑭᓯᐊᓂ, ᑕᒪᓐᓇ ᐊᑐᖅᑕᖕᒪᑦ ᓂᕆᐅᒋᔭᐅᔪᖅ ᑕᐃᒪᐅᖃᑦᑕᕐᓂᐊᕐᓂᖓᓄᑦ ᐃᖕᒥᒃᑰᖕᒪᔫᒃᑯᑦ ᐊᒃᑐᖅᑕᐅᓂᕐᒧᑦ ᐊᒃᑐᐊᓂᖅᑲᖅᑐᑦ ᐱᕙᓪᓕᐊᓂᕐᒥᒃ ᐊᒪᓗ ᐃᓄᐃᑦ ᖃᓄᐃᓕᐅᕐᓂᓇᔭᖏᓐᓄᑦ ᑕᒫᓂ.

ᓅᖃᑦᑕᖅᑐᑦ ᑎᖕᒥᐊᑦ

ᕿᕐᓂᖅᑖᑦ ᐊᒪᓗ ᑕᓇᐅᕐᒥᐅᑕᐃᑦ ᐸᒥᐅᕐᑯᖅᑐᑦ ᑎᖕᒥᐊᑦ ᑕᐅᑐᑦᑕᐅᓚᐅᖅᑐᑦ ᖃᐅᔨᓴᐃᓂᐅᔪᒥᑦ. ᐊᓯᖏᑦ ᓅᖃᑦᑕᖅᑐᑦ ᑎᖕᒥᐊᑦ ᑕᐃᒪᐅᔪᑦ RAA-ᒥᑦ ᓂᕆᐅᒋᔭᐅᐸᓪᓗᑎᒃ ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᐊᔾᔨᐸᓗᒋᓂᐊᕐᒪᒥᑦ ᐊᒃᑐᖅᑕᐅᓂᖏᑦᑕ ᕿᕐᓂᖅᑖᑦ ᐊᒪᓗ ᑕᓇᐅᕐᒥᐅᑕᐃᑦ ᐸᒥᐅᕐᑯᖅᑐᑦ ᑎᖕᒥᐊᑦ. ᐃᓯᒫᓘᑎᑦ ᐱᓕᕆᐊᒨᖓᔪᓄᑦ ᐊᒃᑐᖅᓯᓂᖏᑦᑕ ᐃᓂᐅᔪᒧᑦ ᐋᓂᐊᖃᖅᑕᐃᓕᒪᓂᖏᓪᓗ. ᓅᖃᑦᑕᖅᑐᑦ ᑎᖕᒥᐊᑦ ᒪᒃᐃᑕᐅᖃᑦᑕᖅᑐᑦ ᒪᓐᓂᖏᓪᓗ ᐱᑭᐅᑕᖅᑕᐅᐸᓪᓗᑎᒃ ᑭᕙᓪᓕᕐᒥᐅᑕᓄᑦ (IQ-CHW 2009[49], IQ-RBH 2011[50]). ᓅᖃᑦᑕᖅᑐᑦ ᑎᖕᒥᐊᑦ ᐱᒻᒪᕆᐅᖕᒥᔪᑦ ᖃᓂᑦᑐᒥᑦ ᓄᓇᒥᑦ (IQ-RBE 2009[51]). ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ

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49 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ -CHW 2009: *ᐊᕐᓇᐃᑦ ᑲᑐᔾᔨᖅᑎᒌᑦᑯᖏᑦ ᐅᖃᖅᑎᒌᖕᓂᖓᑦ ᓇᓗᓇᐃᓚᐅᖅᑐᖅ ᐊᑐᓂ ᐊᕐᓇᐃᑦ ᑎᖕᒥᐊᖅᓯᐅᖅᑲᑦᑕᕐᓂᖏᓐᓄᑦ. ᔫᓂ ᕿᑎᐊᓂ ᑎᖕᒥᐊᑦ, ᒥᑏᑦ, ᐊᒪᓗ ᓇᐅᔭᐃᑦ ᒪᓐᓂᖏᓐᓂᒃ ᐱᑭᐅᑕᑦᑕᕐᒪᑕ*

50 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-RBH 2011: *ᑲᓯᐊᕐᔪᐊᐃᑦ ᐊᔾᔨᒌᖏᑦᑐᑦ ᑎᖕᒥᐊᖅᓯᐅᖅᑕᐅᐸᓗᑎᒃ ᐊᒪᓗ ᐱᑭᐅᑕᖅᑕᐅᑲᑕᖅᑐᑦ ᓴᓪᓕᕐᒥ ᐊᒪᓗ ᓇᐅᔮᓂᑦ.*

51 ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ-RBE 2009: *ᑕᒪᕐᒥᒃ ᐃᓯᒫᓘᑎᖅᑲᖅᑐᑦ ᑎᖕᒥᐊᓂᒃ ᓅᖃᑦᑕᖅᑐᓂᒃ ᖃᒪᓂᑦᑐᐊᖅ ᐅᖓᑖᓂᑦ.*

ᐱᔾᔪᑎᖃᖅᑐᑦ ᑕᒪᒃᑯᓄᙵ ᐊᒃᑐᖅᓯᓂᐅᔪᓄᑦ ᐃᓚᐅᔪᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ ᐃᓂᒃᓴᖓᓂᑦ ᐲᔭᐃᓂᖅ (ᐃᓂᒋᔭᐅᔪᓂᒃ ᐊᓯᐅᔨᓂᖅ), ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ ᐊᐅᓛᕐᓂᖓ (ᒥᒃᓵᔪᖅ ᐋᑐᑎᖃᕐᓂᖓ ᐃᓂᒋᔭᐅᔫᑉ), ᐊᑉᖁᓯᐅᕐᓂᖅ (ᐃᓂᐅᔪᒥᒃ ᐊᓯᐅᔨᓂᖅ) ᐊᒻᒪ ᐊᐅᓛᕐᓂᖅ (ᒥᒃᓵᔪᖅ ᐋᑐᑎᖃᕐᓂᖓ ᐃᓂᒋᔭᐅᔫᑉ), ᓯᖃᓪᓕᑎᓇᓂᖅ (ᓂᐱᖃᕐᓂᖅ ᐊᒃᑐᖅᓯᔪᖅ ᐋᑐᑎᖃᕐᓂᐅᔪᒥᒃ ᐊᒻᒪ ᐳᔪᖃᑖᖅ ᐊᒃᑐᖅᓯᓂᖓ ᓂᓇᵖᕕᐅᖃᑦᑕᖅᑐᓂᒃ ᐊᒻᒪ ᑎᖕᒥᐊᑦ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖕᒋᓐᓂᒃ).

ᖃᐅᔨᒪᓂᖃᖅᑐᑦ ᐅᖃᐅᓯᖕᒋᑦᑎᒍᑦ, ᐱᓕᕆᓂᑯᒃᑯᑦ ᐊᓯᖕᒋᓐᓂᒃ ᐅᑭᐅᖅᑕᖅᑐᒥᑦ ᐱᓕᕆᐊᓂᑦ, ᐊᒻᒪ ᖃᐅᔨᒪᓂᖅ ᑕᒪᒃᑯᐊ ᐆᒪᓂᕐᒧᑦ ᐊᑐᖅᐸᒃᑕᖕᒋᓐᓂᒃ, ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᑕᐅᓃᑦ ᐃᓂᒋᔭᐅᔪᑦ ᒪᓂᒪᓂᖕᒋᓐᓄᑦ ᐃᓱᒪᒋᔭᐅᔪᑦ ᐊᖏᔫᖕᒋᓐᓂᖕᒋᓐᓄᑦ ᐊᖏᓂᖅᓴᐅᒃᐸᑦ 10%-ᒥᒃ ᐃᓂᐅᔪᐃᑦ RAA-ᒥᑦ ᑕᐃᑲᙵᑦ ᐊᒃᑐᖅᑕᐅᓂᖃᖅᐸᑕ. ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᕐᒧᑦ, ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᒃᑐᖅᑕᐅᓂᖃᖅᑐᑦ ᑕᒪᐃᓄᑦ ᐅᓗᓇᐊᓇᖅᑐᖃᙱᑦᑐᓄᑦ ᐅᓗᓇᐊᓇᖅᑐᓄᓪᓗ ᐱᔭᐅᔪᑦ ᐆᒪᓂᕐᒧᑦ, ᐃᓱᒪᒋᐸᓗᒋᑦ ᑕᒪᕐᒥᒃ ᑭᒻᓕᐅᔪᑦ ᐊᒻᒪ ᐱᓕᕆᐊᒥᑦ ᐳᔪᕐᓗᐃᑦ ᐊᓂᐊᔪᑦ, ᑕᐅᑐᖕᒑᖅᓗᒍ ᖃᓄᑎᒋᐅᔪᑦ ᒥᐊᓂᖅᓯᓂᖃᖅᑐᑦ ᑎᖕᒥᐊᓂᒃ.

ᐃᓂᒋᔭᐅᔪᖅ – ᐱᓕᕆᐊᖅ ᐊᓯᐅᔨᓂᖃᖅᑎᑦᑎᓂᐊᖅᑐᖅ ᓅᖃᑦᑕᖅᑐᑦ ᑎᖕᒥᐊᑦ ᐱᑭᖅᐸᓪᓕᐊᕕᖕᒋᓐᓂᒃ (ᓱᕐᓗ ᐅᐸᓗᓕᐅᓇᓂᖅ ᐱᑭᐊᓂᒃᐸᑕᓗ ᐱᐊᓛᑦ). ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖓ ᐃᓚᖕᒋᓐᓂᒃ ᐃᓂᒋᔭᐅᔪᓂᒃ ᒪᓂᒪᑎᑦᑎᓂᖅᑕᕐᑯᕈᕆᖅᑎᑦᑎᓂᐊᖅᑐᖅ ᓅᐸᒃᑐᓄᑦ ᑎᖕᒥᐊᓄᑦ, ᐃᓄᐃ ᖃᓄᐃᓕᐅᕐᓂᓇᔭᖕᒋᑦ ᐊᒃᑐᐊᓂᖃᖅᑐᑦ ᐱᓕᕆᐊᒧᑦ ᐊᐅᓚᑦᑐᖕᓇᕐᓂᓇᔭᖕᒋᓐᓂᒃ ᐊᓯᐅᔨᑎᑦᑎᓗᑎᒃ ᐃᓂᐅᔫᑉ ᓴᓂᐊᓃᑐᓂᒃ. ᐊᒃᑐᖅᑕᐅᓃᑦ ᐃᓂᐅᔪᓄᑦ ᐱᓕᕆᐊᒥᑦ ᑲᑎᑉᐸᓪᓕᐊᓂᐅᔪᖕᓇᖅᑐᑦ ᐊᔾᔨᖕᒋᓐᓄᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᓄᑦ ᐃᓄᐃᑦ ᖃᓄᐃᓕᐅᕐᓂᓇᔭᖕᒋᓐᓄᑦ ᑖᒥᓂ.

ᐃᓂᐅᔪᓄᑦ ᓇᓗᓇᐃᑯᑕᐃᑦ ᓴᖅᑭᑕᐅᓚᐅᖅᑐᖅ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᑕᒪᐃᓅᖓᔪᒥᒃ ᐊᓯᐅᔨᓂᕐᓄᑦ ᕿᕐᓂᖅᑖᑦ ᐊᒻᒪ ᑕᓇᐅᕐᒥᐅᑕᐃᑦ ᐸᒥᐅᖁᖅᑐᔪᑦ ᑎᖕᒥᐊᑦ ᐃᓂᖃᕐᕕᖕᒋᓐᓂᒃ RAA-ᒥᑦ. ᓇᓗᓇᐃᑯᑕᖅ ᐱᔭᐅᔪᖅ ᐃᓕᓯᐸᓗᓂ ᓇᓅᓐᓂᐅᔪᓂᒃ ᐊᑐᓂ ᐃᓂᐃᔪᓄᑦ (ᓱᕐᓗ, ᖁᑦᑎᒃᑐᖅ=3, ᕿᑎᐊᓃᑐᖅ=2, ᐊᑦᑎᒃᑐᖅ=1, ᐱᑕᖃᙱᑦᑐᖅ=0). ᖃᓂᐃᓐᓂᓇᔭᖕᒋᑦ ᑕᐃᒪᓂᒃ ELC ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖓᓂᑦ “ᐱᑕᖃᙱᑦᑐᖅ”-ᖑᓂᐊᖅᑐᖅ ᐱᓕᕆᐊᖅ ᓴᓇᔭᐅᕌᓂᒃᐸᑦ. ᐅᑭᐅᑯᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᖅ ᐊᑉᖁᑎ ᐊᒃᑐᖅᓯᓂᖃᔾᔭᖕᒋᑦᑐᖅ ᑎᖕᒥᐊᑦ ᐃᓂᒋᔭᖕᒋᓐᓂᒃ ᑕᒪᐃᓂᖅᑲᔭᖅ ᐃᓂᐅᔪᑦ ᒪᓂᒪᓂᐊᕐᒪᑕ ᐊᐅᔮᒃᑯᑦ ᐊᑉᖁᑎ ᐊᑐᕈᓐᓂᖅᑎᓪᓗᒍ. ᐃᓂᐅᔪᓄᑦ ᖃᓄᐃᓐᓂᐅᔪᖅ ᐅᔭᕋᖕᓂᐊᕐᓂᐅᑉ ᐃᓂᖕᒋᓐᓂᑦ ᐊᑉᖁᑎᒥᒎ ZOI-ᒥᑦ ᒥᒃᓯᒋᐊᖅᑕᐅᓚᐅᖅᑐᑦ ᒪᕿᐃᓕᖕᒐᔫᖕᓄᑦ ᒥᑭᓛᖑᖅᓗᒍ ᐊᑦᑎᒃᑐᒥᑦ 2 ᑭᓛᒥᑕᒥᒃ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ ᐃᓂᖓᓂᑦ, ᐊᒻᒪ ᐊᑕᐅᓯᕐᒥᒃ ᒥᑭᓛᖑᖅᓗᒍ ᐊᑦᑎᒃᑐᒥᑦ 3 ᑭᓛᒥᑕᒥᒃ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ ᐃᓂᖓᓂᑦ.

ᐊᕉᕝᑯᑦ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᐊᖅᑐᑦ ᐊᒃᑐᖅᓯᓂᑲᓪᓚᐅᔪᓂᒃ ᓅᖃᑦᑕᖅᑐᑦ ᑎᖕᒥᐊᑦ ᐃᓂᒋᔭᖕᒋᓐᓂᒃ ᐃᒪᓐᓇᐃᓕᐅᕐᓗᑎᒃ: 1) ᒥᑭᒡᓕᒋᐊᕐᓗᒍ ᐱᓕᕆᐊᑉ ᐃᓂᖓ; 2) ᒥᑭᒡᓕᒋᐊᕐᓗᒍ ᐱᓕᕆᐊᒥᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᓯᓚᑖᓂᑦ ᐃᓂᐅᔫᑉ; 3) ᐅᑎᖅᑎᑎᓇᓂᖅᑕᖃᐃᓐᓇᕐᓗᓂ ᐸᕝᕙᓴᖅᑕᐅᔪᓂᒃ; 4) ᐳᔪᖃᓗᐊᖅᑕᐃᓕᒪᑎᑦᑎᓂᕐᒥᒃ ᐱᑎᑦᑎᓗᓂ ᐊᑉᖁᑎᓂᑦ ᐊᐅᔮᒃᑯᑦ; ᐊᒻᒪ 5) ᐲᕐᓗᒋᑦ ᐳᔪᓕᐅᕆᓂᖅ ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᐅᓚᑦᑎᕝᕕᖕᒥᑦ.

ᐊᒃᑐᖅᓯᓂᖓ ᐱᓕᕆᐊᑉ ᓅᐸᒃᑐᓄᑦ ᑎᖕᒥᐊᑦ ᐃᓂᖕᒋᓐᓄᑦ RAA-ᒥᑦ ᖃᐅᔨᓴᖅᑕᐅᔪᖅ ᐊᖏᔫᖕᒋᓐᓂᖓᓄᑦ. ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᓯᐅᔨᓂᕐᒧᑦ ᐃᓂᐅᔪᓄᑦ ᓅᐸᒃᑐᓄᑦ ᑎᖕᒥᐊᓄᑦ ᐱᓕᕆᐊᖅ ᐱᔾᔪᑎᒋᐸᓗᒍ 5% ᑐᖕᓕᓃᑐᖅ ᐃᓂᐅᔪᓄᑦ ᑕᒪᐃᓄᑦ ᓇᓗᓇᐃᑯᑕᓄᑦ ᐊᒻᒪ ᐊᑉᖁᑎᓗᒃᑖᓄᑦ. ᐊᖏᓂᓇᔭᖓ ᐊᒃᑐᖅᓯᓂᑲᓪᓚᐅᓂᐅᑉ ᐱᓕᕆᐊᒥᑦ ᓅᐸᒃᑐᓄᑦ ᑎᖕᒥᐊᑦ ᐃᓂᖕᒋᓐᓄᑦ ᐊᑦᑎᒍᑦᔪᖅ ᐱᓕᕆᐊᑉ ᐊᐅᓛᕐᓂᓗᒃᑖᖓᓂᑦ ᐅᑉᖁᑎᓄᓪᓗ. ᐱᓕᕆᐊᖅ ᓂᕆᐅᒋᔭᐅᔪᖅ ᖃᐅᔨᔭᐅᔪᖕᓇᖅᑐᓄᑦ ᐊᓯᐅᔨᓂᕐᒧᑦ ᐃᓂᐅᔪᓂᒃ LAA-ᒥᑦ. ᐊᓯᐅᔨᓂᖅ ᐃᓂᐅᔪᓂᒃ ᐊᖏᔫᔮᖕᒋᑦᑐᖅ ᓅᐸᒃᑐᑦ ᑎᖕᒥᐊᑦ RAA-ᒥᑦ ᑲᔪᓯᓂᖃᕐᓂᐊᕐᒪᑕ ᓈᒻᒪᒃᑐᓂᒃ ᐃᓂᐅᔪᓂᒃ ᒪᓂᒪᔪᑦ

ᓂᕆᖕᕕᐅᓂᕐᒧᑦ. ᖃᓄᑎᒋᐅᓂᖓ ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖓᓂᑦ ᖃᐅᔨᒋᐊᖅᑕᐅᖃᑦᑕᕐᓂᐊᖅᑐᖅ ᐊᕐᕌᒍᑕᒫᑦ ᓇᓗᓇᐃᕐᓂᐊᕐᓗᓂ ᐃᓂᐅᔪᓂᒃ ᐊᓯᐅᔨᓂᕐᒧᑦ ᓇᓚᐅᑖᖅᑕᐅᔪᓂᒃ.

ᐱᓕᕆᐊᖅ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᖅ ᐊᖏᔪᒥᒃ ᐊᒃᑐᖅᓯᓂᑲᓪᓚᐅᓂᐅᑉ ᓅᑉᐸᒃᑐᓄᑦ ᑎᖕᒥᐊᑦ ᐃᓂᖏᓐᓂᒃ RAA-ᒥᑦ. ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᐱᓕᕆᐊᒥᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᓄᑦ ᐃᓂᒋᔭᐅᔪᑦ ᒪᓂᒪᓂᖏᓐᓄᑦ ᐊᖏᔫᖏᒃᑲᓗᐊᖅᑎᓪᓗᒍ, ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᑲᑎᑉᐸᓪᓚᐊᓂᖅᑲᐳᓇᖅᑐᑦ ᐊᔾᔨᐸᓗᖏᓐᓂᒃ ᐊᒃᑐᖅᓯᓂᐅᔪᓄᑦ ᐊᓱᖏᓐᓂᑦ ᐃᓄᖕᓄᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓄᑦ ᑖᒪᓂ ᐊᒃᑐᖅᓯᓂᖅᑲᖅᑐᑦ ᓅᐸᒃᑐᑦ ᑎᖕᒥᐊᑦ ᐃᓂᖏᓐᓄᑦ.

ᐋᓂᐊᕐᑲᖅᑕᐃᓕᒪᓂᖅ – ᐳᔪᕐᓗᐃᑦ ᐊᓂᐊᔪᑦ ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᓯᓂᖅᑲᐳᓇᖅᑐᑦ ᑲᑎᓯᒪᔪᓂᒃ COPC-ᓂᒃ ᐊᕙᑎᒥᑦ (ᓱᕐᓗ ᐃᒪᖅ, ᐃᐸᔪ, ᐃᒪᕐᒥᑦ ᐱᕈᖅᑐᑦ, ᖁᐱᕈᐃᑦ) ᐊᒃᑐᖅᓯᓂᖅᕐᓂᐊᖅᑐᑦ ᑎᑭᐅᑎᓯᒪᓂᖏᓐᓄᑦ ᓅᑉᐸᒃᑐᑦ ᑎᖕᒥᐊᑦ ᓂᕆᔾᔪᓂᔾᔪᒃ ᑕᒪᒃᑯᐊ. ᐳᔪᕐᓗᐃᑦ ᐊᒃᑐᖅᓯᓂᑲᓪᓚᖅᑲᐳᓇᕐᓂᖏᑦ ᓅᑉᐸᒃᑐᓄᑦ ᑎᖕᒥᐊᓄᑦ, ᕿᕐᓂᖅᑖᑦ ᐊᒪᓗ ᑕᓇᐅᕐᒥᐅᑕᐃᑦ ᐸᒥᐅᕐᑯᖅᑐᔪᑦ ᑎᖕᒥᐊᑦ, ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᑦ. COPC ᐊᑐᖅᑕᐅᔪᖅ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐃᓚᐅᔪᑦ ᓄᖑᓯᐃᑐᖅ ᐊᒪᓗ ᓄᖑᓯᐃᑐᖅ-238 ᐃᒍᓇᖅᑐᓅᖓᔪᑦ (thorium-230, lead-210, radium-226, ᐊᒪᓗ polonium-210), arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, selenium, ᐊᒪᓗ zinc. ᑎᑭᐅᑎᓂᖅ COPC-ᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᓚᐅᖅᑐᖅ ᐊᑐᖅᓗᑎᒃ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᕙᑎᒥᑦ ᑲᑎᓯᒪᔪᑦ ᐊᒪᓗ ᐃᓱᒪᒋᔭᐅᔪᑦ ᖃᓄᑎᒋ ᑎᖕᒥᐊᓄᑦ, ᕿᕐᓂᖅᑖᑦ ᐊᒪᓗ ᑕᓇᐅᕐᒥᐅᑕᐃᑦ ᐸᒥᐅᕐᑯᖅᑐᔪᑦ ᑎᖕᒥᐊᑦ ᓂᕆᔾᔪᓂᔾᔪᒃ ᑕᒪᒃᑯᐊ. ᑎᖕᒥᐊᑦ ᖃᓄᐃᑎᒋ ᐃᓂᐅᔪᒦᓐᓂᖏᑦ ᐱᒻᒪᕆᐅᖕᒥᔪᖅ. ᖃᓄᐃᖓᓂᐅᔪᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᔪᑦ ᑎᑭᐅᑎᓯᒪᓂᒃ ᓂᕆᔾᔪᓂᔾᔪᒃ ᑕᒪᒃᑯᐊ COPC-ᓄᑦ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᖅ ᐅᖓᑕᐅᑎᓂᐊᕐᓂᖏᓐᓄᑦ ᑭᓪᓚᐅᔪᑦ ᐊᒃᑐᐊᓂᖅᑲᖅᑐᑦ ᐋᓂᐊᕐᑲᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᐊᒃᑐᖅᓯᓂᕐᓄᑦ; ᐊᒃᑐᖅᓰᑦ ᓅᑉᐸᒃᑐᓄᑦ ᑎᖕᒥᐊᓄᑦ ᐋᓂᐊᕐᑲᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᑦ.

ᓯᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᖓ - ᖃᐅᔨᓴᕐᓂᐊᕐᓗᓂ ᐊᒃᑐᖅᓯᓂᐅᔪᒃ ᓯᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᖓᓄᑦ ᐊᔪᕐᓇᖅᑑᔪᖅ ᐅᑭᐅᑉ ᐃᓚᖓᒍᑦ ᐃᓂᐅᔪᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᕐᓂᖏᓐᓄᑦ. ᐅᑭᐅᑯᑦ ᐃᓂᒋᔭᐅᔪᑦ ᓂᒋᖅᐸᓯᐊᓃᒐᔪᒃᑐᑦ ᐅᐊᖕᓇᖓᓂᑦ ᐊᒥᐊᓚᑲᐅᑉ ᓂᒋᐊᓄᑦ, ᓴᖅᑭᑎᑉᐳᑎᒃ ᐊᔾᔨᐅᖏᒻᒪᓇᒃᑐᓂᒃ ᓯᓚᒎᖓᔪᓂᒃ ᐊᒃᑐᖅᓯᓂᕐᓂᒃ ᑖᑉᓯᒪ ᖃᐅᔨᓴᐃᓂᐅᑉ ᐊᓯᐊᒎᖓᑦᑎᐊᖅᑐᖅ. ᐊᒃᑐᖅᓰᓐᑦ ᓯᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᖓᓄᑦ ᓅᑉᐸᒃᑐᓄᑦ ᑎᖕᒥᐊᓄᑦ ᐅᑭᐅᑉ ᐃᓚᖓᒎᕐᑲᑦᑕᖅᑐᓄᑦ RAA-ᒥᑦ ᐊᒃᑐᐊᓂᖅᑲᕋᔭᖅᑐᒃᓴᐅᔪᖅ ᑕᐃᒪᐅᖃᑦᑕᕐᓂᖏᑦ ᖃᓂᑦᑐᒥᑦ ᓯᓚᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ ᖁᓛᓂᑦ ᐊᑖᓂᓗᓃᑦ ᐃᓕᖅᑯᓯᐅᑉ (ᓱᕐᓗ ᐸᑐᒃᔪᐊᕐᓂᖅ ᐊᐱᕐᔪᐊᕐᓃᓗᓃᑦ ᐅᐱᕐᖠᒃᑯᑦ ᐊᐅᔭᒃᑯᓪᓗ). ᑕᐃᑲᙵᐅᖏᑦᑐᖅ, ᓯᓚᒥᑦ ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᐊᕙᑎᐅᑉ ᖃᓄᐃᓐᓂᓕᔨᖏᓐᓄᑦ (ᓱᕐᓗ, ᑭᖑᕙᖅᐳᓂ ᐊᐱᓂᖅ) ᐊᖏᓪᓕᒋᐊᖅᑎᑦᑎᔾᔪᓂᖅᑐᖅ ᑐᕐᑯᕋᐃᓂᕐᒥᒃ ᓂᕿᒃᓴᖃᙱᓐᓂᕐᒧᑦ. ᐆᒃᑑᑎ ᑕᐃᒪᓐᓇᐃᑐᒥᑦ ᕿᕐᓂᖅᑖᑦ ᓂᕆᔭᕆᐊᓄᑦ, ᓂᕆᔭᕆᑦ ᐊᕐᕌᓂᑕᐃᑦ ᐸᐅᕐᖓᐃᑦ ᐊᒪᓗ ᐱᕈᖅᑐᐃᑦ ᐱᕈᓭᕐᖓᑕ ᐅᐱᕐᖓᓭᖅᑎᓪᓗᒍ, ᐊᒪᓗ ᖁᐱᕈᐃᑦ ᐊᐅᔭᒃᑯᑦ. ᓯᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᖓ ᐊᓯᐊᙳᖅᑎᑦᑎᔾᔪᓐᓇᖅᑐᖅ ᓄᓇᒥᑦ ᐱᕈᖅᑐᓂᒃ ᓱᕐᓗ ᐸᐅᕐᖓᓂᑦ ᑕᕿᓂᖅᓴᓄᑦ ᐱᕈᖅᑐᓄᑦ ᐃᑲᔪᐃᓂᖅᑲᖅᑐᑦ ᖁᐱᕐᕈᐃᑦ ᐱᖁᑎᒋᐊᓂᕆᔭᖏᓐᓂᑦ ᐃᑲᔪᐃᓂᖅᑲᖅᓱᑎᒃ ᓈᒻᒪᒃᑐᓂᒃ ᓂᕆᔭᒃᓴᓂᒃ ᐊᐅᔭᒥᑦ, ᑭᓯᐊᓂ ᐱᑦᕐᑲᓗᐊᕐᕆᑎᑦᑎᑉᓗᓂ ᐸᐅᕐᖓᓂᒃ ᐱᕈᖅᑐᓂᓪᓗ ᐱᔭᐅᔭᕆᐊᖅᑲᖅᑐᑦ ᖁᐸᓄᐊᑦ ᑕᒪᐅᖓᓭᕐᖓᑕ ᐅᐱᕐᖠᒃᑯᑦ. ᑕᒪᒃᑯᐊ ᓂᕆᐊᒋᔭᐅᔪᑦ ᑕᐃᒪᐅᖃᑦᑕᕐᓂᐊᕐᓂᖅᑲᖅᑐᓄᑦ ᐃᖕᒥᒃᑯᖓᓗᑎᒃ ᐱᕙᓪᓕᐊᓂᕐᓂᑦ ᐃᓄᖕᓄᑦᓗ ᖃᓄᐃᓕᐅᕐᓂᕆᔭᖏᓐᓄᑦ ᑖᒪᓂ. ᐊᖏᓗᐊᖏᕆᐊᖅᑎᑦᑎᓂᖅᑲᕐᓂᐊᖅᑎᑦᑐᒥᑦ ᐊᕆᕙᒃᑯᑦ, ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᐱᐅᔪᖏᖅᑎᑦᑎᑲᓂᔾᔭᖏᓐᓂᖓᓄᑦ ᓯᓚᐅᑉ ᐊᓯᐊᙳᕐᓂᖓᓄᑦ ᐱᔪᓂᒃ ᐋᓂᐊᕐᑲᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᐱᕙᓪᓕᐊᓂᐅᔪᓄᑦᓗ ᓅᑉᐸᒃᑐᓄᑦ ᑎᖕᒥᐊᓄᑦ.

ᐆᒪᔪᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑐᑦ

ᐆᒪᔪᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑐᓂᒃ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓂᖅ ᑕᐅᑐᒐᖅᑲᖅᑐᖅ ᐅᒃᐱᓪᔪᐊᑦ ᐃᓂᖏᓐᓂᒃ ᐋᓂᐊᕐᑲᖅᑕᐃᓕᒪᓂᖏᓐᓂᓪᓗ ᐅᒃᐱᓪᔪᐊᑦ, ᐊᒃᓭᐃᑦ ᐊᒪᓗ ᖃᖓᑦ. ᐱᓕᕆᐊᒧᑦ ᐃᓚᒋᔭᐅᔪᑦ ᐊᒃᑐᐊᓂᖅᑲᖅᑐᑦ

ᑕᒪᒃᑯᓄᙵ ᐊᒃᑐᖅᑕᐅᓂᑦ ᐃᓚᐅᔪᑦ ᐃᓂᐅᔪᒥᒃ ᐆᔾᔭᐃᓂᖅ (ᐃᓂᒋᔭᐅᔪᒥᒃ ᐊᓯᐅᕚᓂᖅ), ᐅᔭᕋᖕᓂᐊᕐᓂᐅᑉ ᐊᐅᓛᕐᓂᖓ (ᒥᑭᒡᓕᒋᐊᖅᑐᖅ ᐃᓂᒋᔭᐅᔪᖅ ᐊᑑᑎᖃᑦᑎᐊᕐᓂᖓᓂᒃ), ᐊᑉᖁᑎ ᓴᓇᔭᐅᓂᖓ (ᐃᓂᐅᔪᒥᒃ ᐊᓯᐅᕚᓂᖅ) ᐊᒻᒪ ᐊᐅᓛᕐᓂᖓ (ᑐᖁᑎᑦᑎᓂᖅ ᐊᒻᒪ ᒥᑭᒡᓕᒋᐊᕐᓂᖓ ᐃᓂᐅᔫᑉ ᐊᑑᑎᖃᑦᑎᐊᕈᖕᓇᕐᓂᖓ), ᓯᖃᓪᓕᑎᓄᓂᖅ (ᓂᐱᖃᕐᓂᖅ ᐳᔪᖃᑖᒡᒍ ᐊᒃᑐᖅᓯᔪᖅ ᐃᓂᐅᔪᒥᒃ ᐊᑑᑎᖃᑦᑎᐊᕈᖕᓇᕐᓂᐅᔪᒥᒃ ᐊᒻᒪ ᐳᔪᖃᑖᒃ ᐊᒃᑐᖅᑕᐅᓂᖓ ᓂᕆᐋᐅᐋᖕᓂᑦ ᐊᒻᒪ ᐋᓐᓂᐊᖃᕐᑕᐃᓕᒪᓂᖕᒋᓐᓄᑦ). ᖃᐅᔨᓐᓇᓚᐅᖕᒋᒃᑲᓗᐊᖅᑎᓪᓗᒍ ᐅᐸᓗᓂᒃ ᓯᑎᓂᒡᒍ RAA-ᒥᑦ, ᑕᒪᐃᓂᒃ ᐱᖓᓱᐃᑦ ᐆᒪᔪᑦ ᓂᖑᐊᒋᔭᐅᔪᑦ ᑕᐃᒪᐅᖃᑦᑕᕐᓂᐊᕐᓂᖕᒋᓐᓄᑦ ᐊᑎᒃᑑᓗᓂᓗ ᖃᐸᓯᐅᓂᖕᒋᑦ ᑖᒪᓂ.

ᖃᐅᔨᒪᓂᖃᖅᑐᑦ ᐅᖃᐅᓯᖕᒋᑦᑎᒍᑦ, ᐱᓕᕆᓂᑯᒃᑯᑦ ᐊᓯᖕᒋᓐᓂᒃ ᐅᑭᐅᖅᑕᖅᑐᒥᑦ ᐱᓕᕆᐊᓂᑦ, ᖃᐅᔨᒪᓂᖅ ᐅᒃᐱᒡᔪᐊᑦ ᐆᒪᓂᕐᒧᑦ ᐊᑐᖅᐸᒃᑕᖕᒋᓐᓂᒃ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᖓᓂᑦ, ᐊᒻᒪ ᐊᑦᑎᒃᑑᔪᒥᑦ ᖃᐸᓯᐅᓂᖕᒋᑦ ᑕᐃᒪᖃᑦᑕᕐᓂᐊᕐᓂᖕᒋᑦ ᐆᒪᔪᐃᑦ ᑖᒪᓂ, ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᑕᐅᓂᑦ ᐃᓂᒋᔭᐅᔪᑦ ᒪᓂᒪᓂᖕᒋᓐᓄᑦ ᐃᓯᒪᒋᔭᐅᔪᑦ ᐊᖕᒋᔫᓂᐊᓂᖕᒋᓐᓄᑦ ᐊᖕᒋᓂᖅᓴᐅᒃᐸᑦ 10%-ᒥᒃ ᐃᓂᐅᔪᐃᑦ RAA-ᒥᑦ ᐊᒃᑐᖅᑕᐅᔪᑦ. ᖃᐅᔨᓴᐃᓂᖅ ᐋᓐᓂᐊᕐᑲᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᐱᖓᓰᔪᓄᑦ ᐊᔾᔨᐅᖕᒋᑦᑐᓄᑦ ᐆᒪᔪᓄᑦ, ᓇᓚᐅᑖᖅᑕᐅᔪᖅ ᐊᒃᑐᖅᑕᐅᓯᒪᓂᕐᒧᑦ ᑕᒪᐃᓄᑦ ᐅᑐᓇᐊᓇᖅᑐᖅᑲᖕᒋᑦᑐᓄᑦ ᐅᑐᓇᐊᓇᖅᑐᓄᓪᓗ ᐱᔭᐅᔪᑦ ᐆᒪᓂᕐᒧᑦ, ᐃᓯᒪᒋᐸᓗᒋᑦ ᑕᒪᕐᒥᒃ ᑭᒡᓕᐅᔪᑦ ᐊᒻᒪ ᐱᓕᕆᐊᒥᑦ ᐳᔪᕐᓗᐃᑦ ᐊᓂᐊᔪᑦ, ᑕᐅᑐᖓᖅᑲᐅᖏᑦᑐᒍ ᖃᓄᑎᒋᐅᔪᑦ ᒥᐊᓂᖅᓯᓂᖃᖅᑐᑦ ᓂᕈᐊᑎᓂᒃ ᑎᖕᒥᐊᓂᓪᓗ.

ᐃᓂᒋᔭᐅᔪᖅ – ᐱᓕᕆᐊᖅ ᐊᓯᐅᕚᓂᖃᖅᑎᑦᑎᓂᐊᖅᑐᖅ ᐅᒃᐱᒡᔪᐊᑦ ᐃᓂᖕᒋᓐᓂᒃ. ᐃᓂᒋᔭᐅᔪᒧᑦ ᓇᓗᓇᐃᑯᑕᖅ ᓴᖅᑭᑕᐅᓚᐅᖅᑐᖅ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᑕᒪᐃᓂᒃ ᐊᓯᐅᕚᓂᐅᔪᑦ ᐃᓂᒋᔭᐅᔪᑦ ᒪᓂᒪᓂᖕᒋᓐᓄᑦ RAA-ᒥᑦ. ᓇᓗᓇᐃᑯᑕᖅ ᐱᔭᐅᔪᖅ ᐃᓕᓯᐸᓗᓂ ᓇᓅᓐᓂᐅᔪᓂᒃ ᐊᑐᓂ ᐃᓂᐃᔪᓄᑦ (ᓲᕐᓗ, ᖁᑦᑎᒃᑐᖅ=3, ᕿᑎᐊᓃᑐᖅ=2, ᐊᑦᑎᒃᑐᖅ=1, ᐱᑕᖅᑲᙱᑦᑐᖅ=0).

ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᔫᖓᔪᑦ ᐊᑐᓕᖅᑎᑕᐅᓂᐊᖅᑐᑦ ᒥᑭᒡᓕᒋᐊᖅᑎᓐᓂᕐᒧᑦ ᐊᒃᑐᖅᓯᓃᑦ ᐃᓂᒋᔭᐅᔪᑦ ᒪᓂᒪᓂᖕᒋᓐᓄᑦ ᐅᒃᐱᒡᔪᐊᓄᑦ. 1) ᑕᒪᐃᓂᒃ ᐃᓂᐅᔪᓗᒃᑖᑦ ᐆᔾᔭᐃᕙᐅᔪᑦ ᐃᓂᐅᔪᒧᑦ ᕿᓂᖅᓴᕐᕙᐅᓂᐊᖅᑐᑦ ᐅᐸᓗᓂᒃ ᐆᔾᔭᐃᒋᐊᕐᓂᐊᓵᖅᑎᓪᓗᒋᑦ ᐅᐸᓗᑐᕐᓇᐅᑎᓪᓗᒍ, ᐅᒃᐱᒡᔪᐊᑦ ᐅᐸᓗᖕᒋᑦ ᐃᑕᑕᓇᔭᐅᓂᐊᖅᑐᑦ, ᐊᒻᒪ 800m ᑭᒡᓕᖅᑯᒥᒃ ᐸᒡᕕᓴᐃᓂᖅᑕᖅᑲᐃᑎᓂᕐᒧᑦ ᐱᓗᑎᒃ ᐅᐸᓗᐃᑦ ᑭᓯᐊᓂ ᐊᑐᖅᑕᐅᔪᖕᓃᖅᐸᑕ ᐱᐊᓛᓪᓗ ᐊᔪᕈᖕᓃᖅᐸᑕ; 2) ᑕᒪᐃᓂᒃ ᐃᓂᐅᔪᒥᑦ ᖃᐅᔨᔭᐅᔪᑦ ᐅᒃᐱᒡᔪᐊᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᐊᖅᑐᑦ ᖃᐅᔨᔪᒪᓂᕐᒧᑦ ᐅᐸᓗᑕᖃᕐᓚᖓᓛᑕ, ᐊᑐᖅᑕᐅᔪᓪᓗ ᐅᐸᓗᐃᑦ ᓇᓗᓇᐃᖁᑎᖅᑕᐅᓗᑎᒃ 800m ᑭᒡᓕᖅᑯᒥᒃ ᐸᒡᕕᓴᖅᑕᐃᑎᓂᕐᒧᑦ; ᐊᒻᒪ 3) ᐅᑎᖅᑎᑎᓄᓂᕐᒥᑦ ᐃᓚᐅᓂᐊᖅᑐᑦ ᓴᖅᑭᑦᑎᓂᕐᒥᒃ ᓄᓇᕋᓂᒃ ᖃᓕᖅᑐᐃᓂᕐᒧᑦ, ᐃᓂᓕᐅᕐᓂᐊᖅᑐᖅ ᒥᑭᑦᑐᓄᑦ ᓂᕐᔪᑎᓄᑦ ᐊᒻᒪ ᐅᐸᓗᓕᐅᕐᓂᕐᒧᑦ.

ᐱᓕᕆᐊᖅ ᑕᑭᔪᒥᒃ-ᐊᑯᓂᐅᔪᒥᒃ ᐊᓯᐅᕚᓂᖃᖅᑎᑦᑎᕐᓂᐊᖅᑐᖅ ᐃᓚᖕᒋᓐᓂᒃ ᐅᐸᓗᓕᐅᕝᕕᖕᓂᒃ ᓂᕆᐋᐅᕙᒃᑐᓂᓪᓗ ᐅᒃᐱᒡᔪᐊᓄᑦ. ᐊᓯᐊᖑᕐᓂᖅ ᐃᓂᐅᔪᒥᒃ ᐆᒃᑐᒐᒐᒃᓴᐅᓂᐊᖅᑐᖅ, ᑭᓯᐊᓂ ᑭᒡᓕᖅᑲᕐᑐᓂ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ ᐃᓂᖓᓄᑦ (ᐊᓯᐅᕚᑦᑎᐊᕐᓂᖅ) ᐊᒻᒪ LAA-ᒥᑐᓂ (ᐊᓯᐊᒍᑦ ᐊᓯᐅᕚᓂᖅ). ᒥᒃᓵᒋᐊᕐᓂᖅ ᐃᓂᖅᑲᕐᓂᕐᒧᑦ ᐃᓗᐊᕐᓂᕐᒥᒃ ᐅᑎᖅᑎᑕᐅᔪᖕᓇᖅᑐᖅ ᐊᐅᓛᕐᓃᑦ ᓄᖅᑲᖅᐸᑦ. ᑕᒪᐃᓄᑦ, ᐱᓕᕆᐊᒥᑦ ᐊᒃᑐᖅᓯᓃᑦ ᐅᒃᐱᒡᔪᐊᑦ ᐅᐸᓗᓕᐅᕐᓂᕐᒧᑦ ᓂᕆᐅᖕᒋᓐᓄᑦᑐ ᐃᓂᐅᔪᑦ ᐊᖕᒋᔫᔮᖕᒋᑦᑐᖅ.

ᐋᓐᓂᐊᖅᑲᖅᑕᐃᓕᒪᓂᖅ – ᐳᔪᕐᓗᐃᑦ ᐊᓂᐊᔪᑦ ᐱᓕᕆᐊᒥᒃ ᐊᒃᑐᖅᓯᓂᖅᑲᕈᖕᓇᖅᑐᑦ ᑲᑎᓯᒪᔪᓂᒃ COPC-ᓂᒃ ᐊᕙᑎᒥᑦ (ᓲᕐᓗ ᐃᒪᖅ, ᐃᐸᔪ, ᐃᖅᑲᓗᐃᑦ, ᐸᐅᖕᓚᐃᑦ) ᐊᒃᑐᖅᓯᓂᖅᑲᕐᓗᓂ ᐊᒃᑐᐊᓂᖅᑲᖅᑐᑦ ᐆᒪᔪᑦ ᐅᑐᓇᐊᓇᖅᑐᒦᑐᓄᑦ ᓂᕆᒍᑎᒃ ᑕᒪᒃᑯᓂᙵᑦ. ᐊᒃᑐᖅᓯᓂᑲᓪᓚᐅᔪᕐᓇᖅᑐᑦ ᑕᒪᒃᑯᓄᙵ ᐳᔪᕐᓗᖕᓂᒃ ᖃᐸᓯᐅᓂᖕᒋᓐᓄᑦ ᐊᒃᑲᐃᑦ ᖃᕝᕖᓪᓗ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᖅ; ᖃᐅᔨᓴᐃᓂᖅᑕᖅᑲᓚᐅᖅᑐᖅ ᑕᒪᒃᑯᓂᙵᑦ ᐃᓚᐅᖃᑕᐅᑎᒍᑦ ᐊᒃᑐᐊᓂᖅᑐᐃᓐᓇᓂᐊᖅᑲᖅᓂᖕᒋᑦ ᐅᒃᐱᒡᔪᐊᑦ. COPC ᐊᑐᖅᑕᐅᔪᖅ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐃᓚᐅᔪᑦ

ᓄᖓᓯᐃᑐᖅ ᐊᒻᒪ ᓄᖓᓯᐃᑐᖅ-238 ᐃᒍᓇᖅᑐᓅᖕᒐᔪᑦ (thorium-230, lead-210, radium-226, ᐊᒻᒪ polonium-210), arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, selenium, ᐊᒻᒪ zinc. ᑎᑭᐅᑎᓂᖅ COPC-ᓄᑦ ᓇᓚᐅᑖᖅᑕᐅᓚᐅᖅᑐᖅ ᐊᑐᖅᓗᑎᒃ ᓇᓚᐅᑖᖅᑕᐅᔪᑦ ᐊᕙᑎᒥᑦ ᑲᑎᓯᒪᔪᑦ ᐊᒻᒪ ᐃᓱᒪᒋᔭᐅᔪᑦ ᖃᓄᑎᒋ ᐊᒃᑕᐃᑦ ᖃᕝᕕᓪᓗ ᓂᕆᖃᑦᑕᕐᒪᖔᑕ. ᖃᓄᑎᒋᐅᓂᖓ ᖃᖕᒐᒃᑯᑦ ᓂᕐᔪᑏᑦ ᑕᐃᑲᓃᓐᓂᐊᕐᓂᖏᑦ ᐱᒻᒪᕆᐅᖏᔪᖅ. ᖃᓄᐃᖕᒐᓂᐅᔪᑦ ᑕᒃᓴᐅᑎᑦᑎᔪᑦ ᑎᑭᐅᑎᓯᒪᓂᒃ ᐊᒃᑕᓄᑦ ᖃᕝᕕᓄᓪᓗ COPC-ᓄᑦ ᐅᖕᒐᑕᐅᑎᔾᔭᖏᑦᑐᑦ ᓇᓐᓂᐅᔪᓄᑦ ᐱᔾᔪᑎᖅᑲᖅᑐᑦ ᐋᓐᓂᐊᖅᑲᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᐊᒃᑐᖅᓯᓂᕐᓂᒃ ᓂᕐᔪᑎᓄᑦ. ᐊᒻᒪ, ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᑦ ᐅᒃᐱᕐᔪᐊᓄᑦ. ᑕᐃᒪᓐᓇᒧᑦ, ᐊᒃᑐᖅᓯᓂᑲᓪᓚᐅᔪᒥᑦ ᐆᒪᔪᑦ ᐅᓗᕆᐊᓇᖅᑐᓃᑐᓄᑦ ᐋᓐᓂᐊᖅᑲᖅᑕᐃᓕᒪᓂᖏᓐᓄᑦ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᑦ.

ᓯᓚᐅᑉ ᐊᓯᐊᖑᕐᓂᖓ – ᓯᓚᐅᑉ ᐊᓯᐊᖑᕐᓂᖓ ᑕᐃᒪᐅᖃᑦᑕᐃᓐᓇᐅᔭᖅᑐᖅ ᓄᓇᕐᔪᐊᕐᒨᓕᖕᒐᑉᓗᓂ, ᐊᒻᒪ ᑕᑭᓂᖓ-ᐊᑯᓂᐅᔫᑉᓗᓂ ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᓂᕐᔪᑎᓄᑦ ᐃᓂᖏᓐᓄᓪᓗ. ᓯᓚᐅᑉ ᐊᓯᐊᖑᕐᓂᖓ ᐱᐅᔪᖅᓃᖅᑎᑦᑎᔪᖕᓇᖅᑐᖅ ᐆᒪᔪᐃᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑐᓂᒃ, ᐱᓗᐊᖅᑐᒥᑦ ᐊᕙᑎᖏᓐᓂᒃ ᒫᓐᓇᐅᔪᖅ ᑕᐃᒪᓐᓇᐃᑎᑕᐅᔪᖕᓇᖅᓯᒫᓂᒃᑎᓪᓗᒋᑦ. ᐊᒃᑐᖅᓯᓃᑦ ᓯᓚᐅᑉ ᐊᓯᐊᖑᕐᓂᖓᓄᑦ ᐱᓕᕆᐊᒥᑦ ᑲᑎᑉᐸᓪᓕᐊᔪᓄᓪᓗ ᐊᒃᑐᖅᓯᓃᑦ ᐆᒪᔪᐃᑦ ᐅᓗᕆᐊᓇᖅᑐᒦᑐᓂᒃ ᓂᕆᐅᒋᔭᐅᔪᑦ ᑕᐃᒪᐅᖃᑦᑕᕐᓂᐊᕐᓂᖏᓐᓄᑦ ᐃᖕᒥᒃᑯᖕᒐᓗᑎᒃ ᐊᒻᒪ ᓂᕆᐅᒋᔭᐅᖕᒋᓗᑎᒃ ᐃᓚᓕᐅᑎᓂᕐᒧᑦ ᐊᓯᖏᓐᓄᑦ ᐱᓕᕆᐊᓅᖕᒐᔪᓄᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᓄᑦ.

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Glossary

Active Layer	A shallow zone above the permafrost table that thaws in the summer and refreezes each year.
Affinity	A natural liking or attraction.
Albedo	The ratio of the intensity of light reflected from an object to that of the light it receives from the sun.
Alluvial	Unconsolidated accumulation of stream-deposited sediments including sands, silts, clays or gravel.
Analyte	A chemical substance that is the subject of a chemical analysis.
Biomass	The amount of living matter in a given habitat.
Brunisolic	A type of soil that usually formed under forests.
Calcareous	Containing or resembling calcium carbonate; chalky.
Cobble	Coarse soil particles with size range from 75 mm to 300 mm according to the Unified Soil Classification System.
Committee on the Status of Endangered Wildlife in Canada	This committee uses the best available information on wildlife species (including scientific, community, Aboriginal Traditional Knowledge) to assess whether that species is at risk of extinction or extirpation in Canada.
Constituents of Potential Concern (COPC)	Metals and radionuclides that have the potential to adversely affect human health or the environment.
Contouring	To build in conformity with the landscape.
Critical load	A value used to protect ecosystems from acid deposition.

Crustal rebound	A post glacial process of rising of land masses that were depressed by the huge ice sheets during the last glacial period.
Cryosol	A type of soil that has permafrost within one metre of the surface.
Cryoturbation	Movement of surficial materials by heaving or churning as a result of frost action.
Decommissioning	To remove or retire from active service.
Endangered	A wildlife species facing imminent extirpation or extinction.
Equilibrium	A state of rest or balance between opposing influences.
Esker	A well- defined, long, narrow topographic ridge of sandy gravel to gravel material and other sediments deposited resulting from glacial deposition created by streams flowing beneath a glacier.
Felsenmeer	A type of morainal or glacial deposit characterized by low, gentle tomography and very bouldery surface. From the Danish “fjoeld-mark” or rock desert.
Frost wedging	Weathering of soil and rock due to repeated freeze-thaw cycle of water.
Fugitive dust	Particulate matter which becomes airborne and has the potential to adversely affect human health or the environment.
Fumigation	To expose an area to fumes.
Geomorphological process	Natural mechanisms of weathering, erosion and deposition that result in the modification of the surficial materials and landforms at the earth’s surface.
Geotechnical Conditions	Properties, behaviour and use of soil and rock.
Geotextile	A strong synthetic fabric used to retain an embankment.

Glacial till	Unsorted materials that have been deposited directly by the ice (glacier).
Glaciofluvial	Relating to materials moved by glaciers and subsequently sorted and deposited by streams of glacial meltwater.
Glaciolacustrine	Relating to materials released from the glacial ice deposited in layers when flowing glacial meltwater comes to rest, as in lakes and deltas.
Glaciomarine	Relating to materials released from the glacial ice come in contact with marine water and deposits.
Great Groups	Different kinds of soil that are developed under the same soil-forming processes.
Ground-ice	Any body of pure ice that forms in the soil.
Harrowing	Agricultural equipment with spike-like teeth or upright discs that is pulled across the land to loosen compacted soils.
Histic	A type of soil horizon that occurs at shallow depths and consists of poorly aerated organic soil material.
Hummocky	Formed from organic residues, either separate from or intermixed with mineral materials.
Hydrophytic	A plant that grows in water or very moist ground.
Ice-wedge	Ground-ice that forms vertically, tapering down to a point.
Igneous rock	One of the three main rock types according to their origin, which is formed as a result of the cooling and solidification of magma and lava at the depth of the earth's crust or on the Earth's surface.
Intrusive	Pertaining to the process of emplacement of magma in pre-existing rock.

Isopleth	A line drawn on a map through all points having the same numerical value, as of a population figure or geographic measurement.
Isostatic (rebound)	A post glacial process of upward movement of land masses. Post glacial crustal rebound is gradually being replaced by the term isoistatic rebound or isoistatic adjustment.
Kame	Isolated and irregular mounds of stratified ice-contact sediments, generally composed of sand, sometimes with gravel, pebbles and fine clays.
Laurentide Ice Sheet	A massive ice sheet in northern Canada formed due to fall in temperature at the beginning of the last glacial stage. It is one of the main three continental ice sheets, the others being the glacial complex in the High Arctic and the Cordilleran glacial complex.
Metamorphic rock	Rocks formed as a result of transformation of existing rocks (which may be of igneous, sedimentary or metamorphic origin) by partial or complete recrystallization under the action of heat and/or pressure.
Microtopography	The surface features of the Earth on a small scale.
Mitigation	The act of making a condition or consequence less severe; methods employed to reduce, offset, or eliminate adverse effects of an activity on the environment.
Moraine	Glacial till deposited at the end, sides, or beneath the ice (glacier).
Negligible	So small or unimportant that it may safely be neglected or disregarded.
Organic	Composed of material that originates from living organisms.
Outwash	Coarse soil material, mainly sand and gravel, removed or “washed out” from glacier by melt-water streams and deposited near the ground.

Overburden	The amount of soil materials lying above the bedrock in the area of interest.
Particulates	Solid or liquid particles suspended in the atmosphere.
Passerine	A bird of the order Passeriformes, which includes more than half of all bird species; also known as perching birds
Periglacial	Near-glacial in the sense of either location or conditions.
Permafrost	Ground (soil or rock) that stays below 0 degrees Celsius for at least two years (continuous permafrost- a region where over 90% of the ground surface is underlain by permafrost).
Physiology	The branch of science concerned with the functioning of organisms.
Phytotoxicity	Inhibits plant growth or is poisonous to plants.
Plasticity	Ability of a soil to change shape continuously under an applied stress, and retain the new shape on removal of the stress.
Pore pressure	Pressure of water held in pores within a soil or rock.
Potential Acid Input (PAI)	A unit of measurement used to assess the level of acid introduced to a given area by deposition.
Precambrian	Geological time period, the earliest of the geologic ages, that covers the vast bulk of geologic time (approximately 88%), starting from the formation of Earth around 4.5 billion years ago to the beginning of the emergence of life-forms almost 600 million years ago.
Proliferation	Rapid growth or production of cells.
Propagule	Any form of various structures that can act as an agent of reproduction in vegetation (e.g., seeds, spores).

Quartzite	A hard metamorphic rock formed from sandstone under the action of heat and pressure.
Radionuclide	An atomic species in which the atoms all have the same atomic number and mass number, and are radioactive.
Relative biological effectiveness	A relative measure of the effectiveness of different radiation types at inducing a specified health effect. It is expressed as the inverse ratio of the absorbed doses of two different radiation types that would produce the same degree of a defined biological end point.
Riprap	Rock or other materials used to stabilize shorelines, streambanks, and/or streambeds to prevent erosion.
Scarified	To loosen soils using equipment.
Schist	A metamorphic rock formed by metamorphism at high temperature and high pressures.
Shear strength	An engineering term, which is used to describe the strength of the material (soli) against the structural failure or deformation.
Slump	Scoop-like scar slides as result of thaw flows in unconsolidated sediments developed by pereglacial processes in soil-ice mixtures.
Soil admixing	Involves the mixing of materials between soil horizons.
Soil compaction	The process by which a stress applied to a soil causes the soil to become denser as air is displaced from the pores between the soil grains.
Soil erosion	Involves the wearing of exposed soils due to climatic events, such as wind, precipitation, or water flow over a surface.
Solifluction	A type of mass movement whereby a layer of permafrost melts and moves down a slope.

Special Concern	A wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats.
Species at risk	Those species identified by the Committee on the Status of Endangered Wildlife in Canada, or under the Species at Risk Act (SARA) as Special Concern, Threatened, Endangered, or Extirpated. The species are usually considered at risk because of declining populations, loss of habitat, and continued threats to their recovery.
Tailings	Crushed rock, water and chemicals remaining after the removal of the uranium from the rock.
Thaw subsidence	Subsidence resulting from the thaw behaviour of permafrost.
Surficial deposit	Loose deposits covering bedrock.
Tackifier	Chemical compounds used to formulate used to increase the stickiness of a surface.
Thaw settlement	An engineering term, which is used to describe the change in volume of thawing soil from both phase change (ice to water) and flow of excess water out of the soil.
Thermistor	A temperature sensing device used for the measurement of ground temperatures.
Thermokarst	A process of the thawing of subsurface ice confined to the upper part of the permafrost and related to subsidence of the earth's surface with the formation of the negative forms of hummocky, irregular relief.
Threshold	A level of change beyond which unacceptable adverse effects may potentially occur.
Tundra	A treeless landscape with a cold climate that exists in the polar regions and at high altitudes.

Tussock	A tuft or clump of growing grass.
Ungulate	A hoofed mammal. (e.g., caribou, muskox).
Valued environmental component	Attributes that are of cultural or ecological importance that interact with the Project.
Veneer	A thin cover of some material that is more desirable as a surface material that the underlying material.
Zone of Influence (ZOI)	An area surrounding an activity that is indirectly affected by that activity (e.g., noise, dust, visual disturbances).

Acronyms

µg .... microgram
AENV .... Alberta Environment
Agl .... Above Ground Level
BLHTO .... Baker Lake Hunters and Trappers Organization
BQCMB .... Beverly and Qamanirjuaq Caribou Management Board
CASA .... Clean Air Strategic Alliance
CCME .... Canadian Council of Ministers of the Environment
CDA .... Canadian Dam Association
CEAA .... Canadian Environmental Assessment Agency
CESCC .... Canadian Endangered Species Conservation Council
COPC .... Contaminants of Potential Concern
COSEWIC .... Committee on the Status of Endangered Wildlife in Canada
DEIS .... Draft Environmental Impact Statement
e.g. .... Latin abbreviation, for example
EARP .... Environmental Assessment and Review Process
EC .... Environment Canada
Eco-SSL .... Ecological Soil Screening Level
EIS .... environmental impact statement
ELC .... Ecological Land Classification
E-P .... Energy-protein model
FEIS .... Final Environmental Impact Statement
FHCP .... Fish Habitat Compensation Plan
GN .... Government of Nunavut
GN-DoE .... Government of Nunavut, Department of Environment
GNWT .... Government of Northwest Territories
HHS .... Hunter Harvest Study
HTO .... Hunter and Trappers Organization

HU .... Habitat Units
IQ .... Inuit Qaujimajatuqangit
LAA .... local assessment area
LOAEL .... Lowest Observable Adverse Effect Level
m agl .... metres above ground level
mGy/d .... milligray per day
MMER .... Metal Mining Effluent Regulations
Nbe .... non visible ice, well bonded with excess ice
Nbn .... non visible ice, well bonded with no excess ice
Nf .... non visible ice, poorly bonded or friable
NIRB .... Nunavut Impact Review Board
NO_2 .... nitrogen dioxide
NOAEL .... No Observable Adverse Effect Level
NO_x .... nitrogen oxide
NPC .... Nunavut Planning Commission
NRC .... National Research Council
NWMB .... Nunavut Wildlife Management Board
NWT .... Northwest Territories
ORV .... off-road vehicle
PAI .... potential acid input
PDA .... Potential Disturbance/Development Area
PRISM .... Program for Regional and International Shorebird Monitoring
RAA .... regional assessment area
RBE .... Relative Biological Effectiveness
RSA .... Regional Study Area
RSF .... Resource Selection Function
SARA .... *Species at Risk Act*
SI .... screening index

SI .... Suitability Index

SO_2 .... sulphur dioxide

TAH.. Total Allowable Harvest

TMF .... tailings management facility

TSP.. total suspended particle

UHS .... Upland associated shorebirds

Vc .... visible ice, ice coatings on particles

VEC .... Valued Environmental Component

Vr .... visible ice, random or irregularly oriented ice formations

Vs .... visible ice, stratified or distinctly oriented ice formations

WAS.. Wetland associated shorebirds

WHO .... World Health Organization

WTP.. Water Treatment Plant

ZOI.. Zone of Influence

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
Date: 09/01/2011 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 VOLUME 6

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 terrestrial environment and result in a potential environmental effect to the terrain, soil, vegetation and wildlife and their habitat. The overall objective of the terrestrial 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.

The EIS has been prepared in fulfillment of the requirements of the NIRB Guidelines.

1.4 Report Content

This volume is organized to focus on the key Project activities that have the potential to interact with the terrestrial environment that are recognized as a particular interest of regulatory agencies or the public. The terrestrial environment is broken down into four components: terrain, soils, vegetation, and wildlife.

This volume consists of the following sections:

Part 1 – Introduction and Methods

- Section 1: A general introduction to AREVA, the Kiggavik Project, and the terrestrial environment assessment
- Section 2: A description of the Kiggavik Project
- Section 3: A description of the approach and methodology employed in the environmental assessment
- Section 4: A list of references cited in Part 1

Part 2 – Terrain, Soils and Vegetation Assessments

- Section 5: A description of the scope of the terrain, soils and vegetation assessments
- Section 6: A brief description of the existing environment for terrain, soils, vegetation
- Section 7: An assessment of the Project effects and cumulative effects on terrain
- Section 8: An assessment of the Project effects and cumulative effects on soils
- Section 9: An assessment of the Project effects and cumulative effects on vegetation
- Section 10: A list of references cited in Part 2

Part 3 – Wildlife Assessment

- Section 11: A description of the scope of the wildlife assessment
- Section 12: A brief description of the existing environment for wildlife and wildlife habitat
- Sections 13 through 16: An assessment of the Project effects and cumulative effects on the selected wildlife key indicators, specifically:
  - ungulates
  - raptors
  - migratory birds
  - species at risk
- Section 17: A list of references cited in Part 3

Part 4 – Summary of Terrestrial Effects, Mitigation and Monitoring

- Section 18: A summary of the overall Project effects and cumulative effects on the terrestrial environment
- Section 19: A summary of the mitigation measures for the terrestrial environment
- Section 20: A summary of the monitoring programs recommended for the terrestrial environment
- Section 21: A list of references cited in Part 4

Tier 3 documents are appended to this volume to provide further details and supporting information. The Technical Appendices pertaining to this volume are as follows:

- 6A – Surficial Geology, Terrain and Shallow Geotechnical Conditions
- 6B – Vegetation and Soils Baseline
- 6C – Wildlife Baseline
- 6D – Wildlife Mitigation and Monitoring Plan

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.

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

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
- 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 the Inuit, regulators, government agencies and public stakeholders
- 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 in different manners with the Project, 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 or 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 arising 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

3.2.1 Valued Components, Indicators and Measurable Parameters

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

Valued Environmental Components (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 VECs. 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 measure quantitatively or qualitatively 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
- professional judgment of the assessment team, based on experience with similar projects elsewhere and other mining project and activities in Nunavut

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 are likely to 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 interaction is ranked according to the potential for an activity to cause an environmental effect. The interactions are ranked according to the following:

- If there is no interaction or no potential for substantive interaction between a Project activity and the VC to cause a potential environmental effect, an assessment of that environmental effect is not required. These interactions are categorized as 0, and are 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 a potential interaction between a Project activity and a VC but not likely to be substantive in light of planned mitigation, the interaction is categorized as 1. Such interactions are well understood and are subject to prescribed mitigation or codified practices. 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 more substantive environmental effects despite the planned mitigation, if there is less certainty regarding the effectiveness of mitigation, or if there is high concern from regulatory agencies, Inuit or stakeholders, the interaction is categorized as 2. These potential interactions are subject to a 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 to ensure 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 VEC 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 VEC 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.

Three assessment areas are defined for each VC.

The ***Project Footprint*** 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) 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) 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.

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
- operation
- final closure
- post closure

The operation phase includes consideration of maintenance, planned exploration and temporary closure (care and 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.

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.

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 were reviewed for consideration in each discipline-specific assessment, including scoping of baseline data collection, selection of VC and KIs, use of TEK and IQ in the environmental effects assessment, mitigation and monitoring.

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
- Inuit Qaujimajatuqangit
- knowledge gained from the collection of baseline data through 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 compensation (habitat compensation, replacement or financial compensation).

Where mitigation is identified, a brief discussion of how the measure(s) will help to minimize 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 Project Residual Environmental 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 Project Residual Environmental Effects

Significance of a Project residual environmental effect is determined based on standards or thresholds that are specific to the VEC, KI 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
- 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 Project Residual 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
- 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
- how 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?).
- 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 and activities 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 the 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 (Volume 1, Appendix xx).

- ***Base Case***: the current status of the measurable parameters for the environmental effects at baseline (i.e., prior to the Project). Baseline includes all past and present projects and activities in the RAA that may result in similar environmental effects to 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 or commissioning.

- ***Project Case***: 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.
- ***Future Case***: the status of the measurable parameters for the environmental effect because of 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:

  - Meadowbank
  - Doris North 1
  - Doris North 2
  - Meliadine
  - Mary River
  - Hackett River
  - Back River
  - Hackett River
  - 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.

- ***Far Future Case:*** the status of the measurable parameters for the environmental effect because of the Future Case, in combination with possible far future developments in the Kiggavik region.

  It is recognized that exploration activities will continue near 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 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	1 mine within Kiggavik RAA Meadowbank region
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

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 could 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:

- measures that can be implemented solely by AREVA
- measures that can be implemented by AREVA, in cooperation with other project proponents, government, Aboriginal organizations or public stakeholders
- 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
- 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
- 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)
- 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
- 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 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)
- compensation

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
- Follow-up Monitoring Programs

4 References

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ARHT (Arviat Hunters and Trappers Organization). 2009. Excerpt from socio-economic focus group conducted by Linda Havers and Susan Ross. March 30, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment E.BL EL (Baker Lake Elders Society (Qilautimiut)). October 2012. Notes from workshop on Significance. Oct 30, 2012; in Appendix 3A: Public Engagement Documentation, Part 2.

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BLHT (Baker Lake Hunters and Trappers). 2011. Summary of community review meeting conducted by Mitchell Goodjohn with eight representatives of the Baker Lake Hunters and Trappers Organisation. February 16, 2011; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

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BL01 (Baker Lake Interview 01). 2008. Summary of individual Elder IQ interview conducted by Hattie Mannik in Baker Lake, 2008; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BL05 (Baker Lake Interview 05). 2008. Summary of individual Elder IQ interview conducted by Hattie Mannik in Baker Lake, 2008; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BL09 (Baker Lake Interview 09). 2008. Summary of individual Elder IQ interview conducted by Hattie Mannik in Baker Lake, 2008; in Appendix 3B: Inuit Qaujimajatuqangit Documentation , Attachment B.

BL11 (Baker Lake Interview 11). 2008. Summary of individual Elder IQ interview conducted by Hattie Mannik in Baker Lake, 2008; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BL NIRB (Baker Lake - Nunavut Impact Review Board). April 2010. From “Public Scoping Meetings Summary Report, April 25-May 10, 2010, for the NIRB’s Review of AREVA Resources Canada Inc’s Kiggavik Project (NIRB File No. 09MN003)”; in Appendix 3A: Public Engagement Documentation, Part 11.

BL OH (Baker Lake Open House). October 2012. From “Kivalliq Community Information Sessions 2012 Report.” May 2013; in Appendix 3A: Public Engagement Documentation, Part 6.

BL OH (Baker Lake Open House). November 2013. From “Kivalliq Community Information Sessions 2013 Report.” May 2014; in Appendix 3A: Public Engagement Documentation, Part 7.

CIHT (Chesterfield Hunters and Trappers). 2009. Excerpt from socio-economic focus group conducted by Linda Havers and Mitchell Goodjohn. May 7, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment C.

CH OH (Coral Harbour Open House). November 2010. From “Part 5 – Kivalliq Community Information Sessions (Round 2, 2010)” December 2011; in Appendix 3A: Public Engagement Documentation, Part 5.

CHW (Coral Harbour Women). 2009. Excerpt from socio-economic focus group conducted by Linda Havers and Mitchell Goodjohn. May 13, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment H.

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Nunavut Tunngavik Inc. 2005. *Contaminants in Nunavut: Inuit Capacity-Building Workshop-Summary Report February 15-17, 2005.* Prepared by Nunavut Tunngavik Inc. Iqaluit, NU May 2005.

RI RLC (Rankin Inlet - Regional Liaison Committee). February 2009. Regional Liaison Committee Meeting Notes. February 24-26, 2009; in Appendix 3A: Public Engagement Documentation, Part 2.

RBE (Repulse Bay Elders). 2009. Excerpt from socio-economic focus group conducted by Linda Havers and Mitchell Goodjohn. May 11, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment G.

RBH (Repulse Bay Hunters). 2011. Summary of community review meeting conducted by Mitchell Goodjohn with two hunters. February 11, 2011; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment G.

RBJ (Repulse Bay Hunters and Elders). 2011. Summary of community review meeting conducted by Mitchell Goodjohn with five representatives of the Repulse Bay HTO and six Elders; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment G.

RB NIRB (Repulse Bay - Nunavut Impact Review Board). April 2010. From “Public Scoping Meetings Summary Report, April 25-May 10, 2010, for the NIRB’s Review of AREVA Resources Canada Inc’s Kiggavik Project (NIRB File No. 09MN003)”; in Appendix 3A: Public Engagement Documentation, Part 11.

RBYA (Repulse Bay Young Adults). 2009 Excerpt from socio-economic focus group conducted by Linda Havers and Mitchell Goodjohn . May 12, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment G.

5 Scope of Assessment for Terrain, Soils and Vegetation

5.1 Issues and Concerns Identified During 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 terrestrial environment. These issues focused on the effect of the Project on landforms and terrain features, as well as soil quantity and quality (Section 8.1.4). Issues also included Project effects on vegetation abundance and diversity, vegetation quality, and the potential for invasive vegetative species (Section 8.1.11). Specific issues related to routine Project components and activities include:

- the effects on landforms during Project construction and operation
- soil erosion from surface disturbances
- changes in soil quality from compaction, air emissions and dust deposition
- changes to radiation levels to the surrounding environment as a result of the Project
- dewatering of the Andrew Lake Pit
- effects on vegetation abundance and diversity
- effects on vegetation quality from air emissions and dust deposition
- effects of the potential introduction of invasive or exotic species via Project equipment, vehicles, aircraft, and marine vessels

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." 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 terrain, soil and vegetation 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).

Vegetation, including Berries and Lichen

Comments were received about the importance of plants including berries in traditional diets. The following plants were described as being edible in IQ interviews: broadleaf willow seed pods, fireweed, dwarf fireweed leaves and flowers, lousewort roots, bearberries, blackberries or crowberries, blueberries, and purple mountain saxafrage flowers and roots (IQ-RBH 2011[103], IQ-BLE 2009[104], IQ-CIYA 2009[105], EN-CI OH Nov 2010[106]). Plants such as cloudberries and tundra moss were also important because they were used to make teas (IQ-Mannik 1998[107], IQ-RIHT 2009[108], IQ-CIE 2009[109], IQ-BLE 2009[110]). Plants were traditionally used for a variety of purposes around camps

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[103] IQ-RBH 2011: *The following plants and berries are consumed: broadleaf willow (seed pods), fireweed, dwarf fireweed (leaves and flowers), lousewort (roots), bearberries, blackberries (crowberries), blueberries, purple mountain saxafrage (flowers).*

[104] IQ-BLE 2009: *Elders said that traditional cures were no longer used, adding that crowberries, blueberries, blackberries, and 'red' berries were harvested for food.*

[105] IQ CIYA 2009: *People mentioned that certain purple flowers, possibly saxifrage, were edible, and that there were white roots that tasted like carrots.*

[106] EN-CI OH Nov 2010: *Everyone comes to Chesterfield in August to pick cloud berries. Berries are really important to Chesterfield.*

[107] IQ-Mannik 1998: *People started using dried ground plants and leaves such as those from the cloudberry bush, after the introduction of tea by Europeans.*

[108] IQ-RIHT 2009: *Elders depend on cloudberries and other plants for making teas*

[109] IQ-CIE 2009: *Tundra moss can be boiled to make a tea, and other plants were used to make medicinal tea.*

[110] IQ BLE 2009: *Cloudberries were also named as one of the types of berries picked by the people of the Baker Lake area and were used to make tea.*

including bedding (IQ-Bennett and Rowley 2004[111]), fuel (IQ-Bennett and Rowley 2004[112]), wicks and mosquito repellent (IQ-Mannik 1998[113]).

Plants are also important because they provide habitat for wildlife and are a food source for important species such as caribou and muskoxen, as well as for small mammals and birds (IQ-CI03 2009[114], EN-BL OH Nov 2013[115]).

Lichen in particular was identified as an important food source for caribou, which is a valued species for Inuit traditional and cultural ways. Concerns about protecting plants including lichen from potential contamination were receieved, such as *will lichen become contaminated from prevailing winds* (IQ-WCCR 2011)?

Dust

Specific concerns were expressed by participants regarding dust generation as a result of Project activities. Representative comments regarding dust included:

- *If AREVA builds a road, there will be dust from the road in the summer time. This dust will collect on the grass on which the caribou feed, and may impact caribou health. This should be minimized* (BLHT 2011).
- Hunters and Elders expressed concerns about *the potential for airborne contamination settling on vegetation and being consumed by caribou* (IQ-ARHT 2009).
- *Wind travels from Baker Lake towards Rankin Inlet, and that any airborne contaminants, such as dust, would find their way to Rankin Inlet* (IQ-RIHT 2009).
- *There are concerns about air pollutants travelling by way of dust particles. As well, there are dangers associated with the dust to human health and wildlife* (EN-RB NIRB 2010).

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[111] IQ-Bennett and Rowley 2004: *Dwarf willows were used to make 'avaalaqiat', the waterproof bottom for bedding.*

[112] IQ-Bennett and Rowley 2004: *Heather moss and 'urju' (sphagnum moss) were used as fuel and to keep food moist during cooking.*

[113] IQ-Mannik 1998: *In the past, other plants such as kanguuyat (cotton grass) were used as wicks for lanterns and brown mosses were used in lanterns, as a match to start fires, and to create smoke to ward off mosquitos. Lichen was also collected for fire.*

[114] IQ-CI03 2009: *Musk ox stay in an area where there is vegetation, and only move when it is gone.*

[115] 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?*

Participants in the stakeholder engagement sessions wanted to see effective dust control measures implemented to prevent dust-related effects on the environment.

Soil

Issues were raised about Project effects on soilsspecifically, concerns were noted on potential contamination of soil and its effect on food sources (EN-CI KIA Apr 2007[116] EN-Kiggavik Project Blog 2009[117]).

Landforms

A comment posted on the Kiggavik Project Blog website described the importance of landforms for Inuit: *landforms are very important because we use the land everyday* (EN-Kiggavik Project Blog 2009).

Hills were important areas for camping (IQ-BL01 2008[118]) and graves are sometimes located on hills (IQ-BL11 2008[119]). Certain hills are described as being spiritual or mystical place where unusual things happened to people (IQ-BL02 1008[120,121], IQ-BL09 2008[122], IQ-BL13 2008[123]).

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116 EN-CI KIA Apr 2007: *Caribou eat off the ground and then we eat the caribou. If they get sick, we get sick. Will we get diseases?*

117 EN-Kiggavik Project Blog 2009: *all the animals we eat rely on good soil*

118 IQ-BL01 2008: *People camped at the Kazan River in the spring, pitching tents on a hill so that they could see all around*

119 IQ-BL11 2008: *There's a nice big hill there that you can see way from a distance. The lower part is very smooth, with a lake. That's where my name sake is buried. That much I know about his or her grave.*

120 IQ-BL02 2008: *It is said that a thick fog forms as you go on top of that hill, and you start to get really happy, and start playing while you are getting lost. [Someone] was there and started jumping up and down all by himself, and when he realized what was happening, he quickly turned around and started to run as fast as he could. If you go there, you can start playing, even though you are alone*

121 IQ-BL05 2008: *At Kangiluarjuk, there is a house that we call "Ijiraq house" (caribou which turns into a human). My father use to tell us to be very careful about thatarea. The place is a hill and part of it is slanted towards the lake. These Kangiqluarjuk hills, the south side ones, are connected to this hill where this Ijiraq house is. I myself have never seen it, but especially the children were not allowed to get close to it.*

The importance of land in general, concern about the Project contaminating the land, and the need to protect the land were noted (IQ-BLE 2009[124], EN-BL HS Nov 2010[125], EN-CI OH Nov 2012[126]).

Permafrost

During the stakeholder engagement sessions, concerns were expressed regarding the potential for Project-related mining activities to expose permafrost and for uranium to melt the permafrost layer (EN-RB OH Nov 2010[127], EN-RI RLC Feb 2009[128]). People were aware that AREVA has experience operating mines in Saskatchewan and wanted to know that AREVA has considered operating in Nunavut where permafrost is present (EN-WC KIA Jan 2010[129]).

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[122] IQ-BL09 2008: *There's a hill that gets very foggy, I heard of it as Kinnga'tuaq. I have heard that you cannot go there or pass through. Thick fog starts to form on it when you go through there, you cannot see anything*

[123] IQ-BL13 2008: *The area I talked about, where there are caribou that are not real (near Shultz Lake), is a place you cannot go alone. If you climb there on a beautiful clear sunny day, as you walk half way up that hill, you will suddenly be in the middle of a thick fog all around you. There was even an incident that happened to Iglurjuaq. He wounded a caribou there and the caribou climbed that hill. At that moment it got really foggy. He lost his caribou, and almost got lost himself. He turned back and almost didn't make it. And when he died, it got really clear and sunny again. That hill is a big problem in every way.*

[124] IQ-BLE 2009: *Elders are concerned that uranium may escape and contaminate the grounds*

[125] EN-BL HS Nov 2010: *What effect will mining have on the land?*

[126] EN-CI OH Nov 2012: *What are the effects when a barrel breaks, to the land and animals?*

[127] EN-RB OH Nov 2010: *Worried about the underground mine caving in when the permafrost comes.*

[128] EN-RI RLC Feb 2009: *Does uranium melt the permafrost?*

[129] EN-WC KIA Jan 2010: *Saskatchewan doesn't have permafrost and they have fewer storms than we do here. Has this been looked into?*

5.2 Influence of Inuit Qaujimajatuqangit and Stakeholder Engagement on the Terrain, Soils and Vegetation Assessment

Issues and concerns identified during the stakeholder engagement sessions and IQ interviews were incorporated into the terrestrial assessment and informed the associated mitigation and monitoring plans. Many comments relating to vegetation and the land were received including concern about potential effects on traditional use of plants such as berries, effects on vegetation and animals from dust and uranium, and the need for mitigation and monitoring.

AREVA's experience in uranium mining in northern Saskatchewan has been used as a benchmark for Project design and planning. Kivalliq residents expressed uncertainty as to whether or not the comparison to northern Saskatchewan is relevant, since there are some important differences between the boreal and tundra environments. People have expressed the need for assurance that AREVA is designing specifically for the unique environmental conditions at Kiggavik (EN-WC KIA Jan 2010[27], EN-KV OH 09[130]).

The importance of terrain, soil and vegetation is further demonstrated through the selection and validation of Valued Environmental Components (Section 5.4). 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 terrestrial baseline program (Tier 3, Technical Appendices 6A, B and C).

Many of the mitigation, monitoring, and management plans associated with terrain, soil and vegetation 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[131]).

Results of the terrestrial assessment and terrestrial monitoring programs will be communicated to local stakeholders through implementation of the Community Involvement Plan (Tier 3, Appendix 3C). AREVA's commitment to engagement and community involvement is throughout the life of the Project and continues throughout construction, operations, decommissioning and

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[130] EN-KV OH 2009*: No trees up here but the trees stop the wind blowing the ore in Saskatchewan. What will be used to manage dust?*

[131] 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?*

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 the terrestrial assessment.

Vegetation

As outlined in Section 5.1, berry-producing plants were identified as an important traditional food source. Efforts were made to identify the Ecological Land Classification (ELC) map units that contain berry-producing plants, and Project effects to these map units are addressed in Section 9.

Project-related effects associated with constituents of potential concern (COPCs) in vegetation such as berries and lichen 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). Berries and medicinal teas were specifically included in human receptor dietary characteristics for the Kiggavik Project (Tier 3, Technical Appendix 8A) based on community feedback through IQ and engagement activities.

The importance of vegetation, including berries and lichen, in the Arctic foodweb was noted during IQ interviews and engagement feedback. The assessment of potential Project-related effects on vegetation are presented in Section 9. The Ecological and Human Health Risk Assessment (Tier 3, Technical Appendix 8A) examines how potential COPCs may move through the food web to animals and humans. Modelling the uptake of radionuclides and metals by terrestrial biota can be quite involved and requires consideration of several interactions. For example, direct deposition from air to soil and terrestrial vegetation, direct uptake from soil to terrestrial vegetation, and ingestion of diet components by terrestrial animals and birds are considered in the modelling. Potential effects on wildlife that consume vegetation (e.g. browse, forage, lichen, and/or berries) directly or indirectly via the foodweb are presented in Tier 3, Technical Appendix 8A and include the following terrestrial 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)*, 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). The human health risk assessment results are detailed in Tier 2, Volume 8 and Tier 3, Technical Appendix 8A.

People were concerned that vegetation could become contaminated from Project activities. A number of design and management mitigation measures will be employed to reduce potential effects of air emissions on vegetation (Tier 2, Volume 6, Section 9.6.2 and Tier 3, Technical Appendix 4C). In addition, vegetation will be monitored during operations and decommissioning to address community concerns about potential contamination of or changes to vegetation communities resulting from Project activities. This includes sampling and analyzing plants (vegetation quality monitoring) as well as monitoring vegetation communities (e.g. diversity, density). Vegetation quality monitoring results will be compared to baseline values and compared to predictions from this environmental assessment (Section 9). Vegetation quality monitoring results will also be used to update the ecological and human health risk assessment as required (Tier 3, Technical Appendix 8A). Vegetation monitoring results will be considered along with air emissions and dust deposition to verify predictions for vegetation quality.

Dust

People described experiences with dust from existing roads and asked AREVA to minimize dust as much as possible (IQ-BLHT 2011[132], EN-BL EL Oct 2012[133]). Air dispersion modelling was completed to predict the dispersal patterns of dust created at the mine sites (Tier 3, Technical Appendix 4B) and results of modelling were carried forward into Tier 2, Volume 6, Sections 8 and 9 to examine potential changes in soil and vegetation quality, respectively.

Mitigation measures are important for controlling dust from mining activities and infrastructure such as roads. During open pit mining, blasting patterns will be used to control the dispersion of materials as well as dust. Where possible, blasting may also be avoided on days where dust dispersion outside of the Project footprint is anticipated to be excessive due to the prevailing winds speeds. Dust suppression will involve spraying water from a tanker truck affixed with either a spray nozzle or spray bar onto dust-prone mine site areas. If water spraying is not effective in preventing dust occurrence, an adaptive management strategy focussing on addition dust suppression techniques

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[132] IQ-BLHT 2011: *be aware that the road to Meadowbank produces a lot of dust in the summertime. Caribou feed on grass close to the road; this grass is full of dust. If you are going to build a road, try to minimize dust.*

[133] EN-BL EL Oct 2012: *Near my house there is lots of dust on the plants from traffic on the roads.*

will be investigated, such as using a dust suppressant identified in the GN (2002) guidelines. Speed limits around the mine site and along all roads will be strictly adhered to, for safety and to reduce airborne dust from vehicular and other equipment traffic (Tier 3, Technical Appendix 2M). Aspects of these mitigation measures are included in Tier 3, Technical Appendices: 2M Road Management Plan, 2R Preliminary Decommissioning Plan, 4C Air Monitoring and Mitigation Plan, 6D Wildlife Mitigation and Monitoring Plan

Dust monitoring (Tier 3, Technical Appendix 4C) will be undertaken to determine the amount and dispersal of dust generated by the Project and results will be compared to baseline and assessment predictions.

Concerns about COPCs entering the food web through dust (IQ-ARHT 2009[134]) were addressed in the pathways of exposure in the Ecological and Human Health Risk Assessment (Tier 3, Technical Appendix 8A).

Soil

Potential for soil contamination is addressed as part of the assessment of Project effects on soil quality (Section 8). To reduce the potential for soil acidification and changes in COPC concentrations, emissions from all industrial machinery and equipment, including the diesel-powered generators will meet the federal air emission standards. Low sulphur diesel fuel will be used to reduce emissions associated with diesel fuel combustion. In addition, scrubbers will be installed on any mill stacks that emit particulates and contaminants (e.g., acid plant exhaust stack) to remove these items from the air stream before discharge (Tier 3, Technical Appendix 4C).

Soil quality will be monitored during operations and decommissioning (Tier 3, Technical Appendix 4C) to address community concerns about potential contamination of soil resulting from Project activities. This includes sampling and analyzing soil for metals and radionuclides. Soil quality monitoring results will be compared to baseline values and compared to predictions from this environmental assessment (Section 8). Soil quality monitoring results will also be used to update the ecological and human health risk assessment as required (Tier 3, Technical Appendix 8A).

Concerns about potential contamination of soil resulting from spills or accidents are addressed in Accidents and Malfunctions (Tier 2, Volume 10).

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[134] IQ-ARHT 2009: *Hunters and elders expressed concerns about the potential for airborne contamination settling on vegetation and being consumed by caribou.*

The role of soil in the ecosystem and the potential for COPCs to enter the food web is addressed in Tier 3, Technical Appendix 8A. Modelling the uptake of radionuclides and metals by terrestrial biota can be quite involved and requires consideration of several interactions. For example, direct deposition from air to soil and terrestrial vegetation, direct uptake from soil to terrestrial vegetation, and ingestion of diet components by terrestrial animals and birds are considered in the modelling. Soil ingestion is included as a pathway for terrestrial ecological receptors and human receptors (Tier 3, Technical Appendix 8A).

Terrain – Landforms and Permafrost

Landforms and permafrost were identified as key components in the terrain assessment. The importance of hills was discussed by Elders in stories about traditional land use and life on the land (Section 5.1) and questions permafrost were also noted (Section 5.1). Project effects on landforms and permafrost are addressed in Section 7 of this report. Best construction and project management practices coupled with engineering techniques, especially in permafrost engineering, will be implemented to address any issues with changes in permafrost conditions, and terrain stability (e.g. Tier 3, Technical Appendices 2D, 2G,2N). Visual monitoring will be conducted to check for changes to land and ground temperature will be measured at key locations.

Public input and IQ on potential risks to logistical infrastructure and benchmarking against existing projects in Nunavut and the Northwest Territories has been used to provide confidence in logistical and operational plans. Foundations, pads, and road design have been based on existing designs in northern areas of continuous permafrost. Other sections of this environmental assessment examine aspects of Project operations related to permafrost. For instance, the effects assessment for hydrogeology (Tier 2, Volume 5, Section 7 and associated appendices) considers operations such as tailings management in permafrost and non-permafrost conditions. Over the long-term, the tailings management and mine rock facilities have been planned to ensure a robust design for protecting the environment in either the presence or the absence of permafrost. Long-term stability of the tailings and mine rock facilities do not require permafrost encapsulation (Tier 2, Volume 2).

Potential Project-environment interactions with archaeological sites on hills, such as camps and gravesites, are assessed in Tier 2, Volume 9, Part 2 Heritage Resources.

5.3 Regulatory Setting

5.3.1 Terrain

Although there are no federal or territorial guidelines and regulations that are applicable to assess the effect of changes in terrain, precedence for the inclusion of terrain as a valued environmental component (VEC) is found in a number of existing environmental assessments for porjects in the Arctic under the Canadian Environmental Assessment Agency (CEAA). Consequently, the terrain assessment was largely conducted qualitatively. However, a quantitative approach was adopted based on the previous experiences with similar projects in Nunavut and other parts of the Canadian Arctic and best professional judgment to determine the significance of the Project effects on terrain.

Some of existing EARPs in the Arctic were extracted from the CEAA website (CEAA 2009) including:

- Izok Lake EARP where sediments, geomorphology, and permafrost were included in the assessment
- Ekati Diamond Mine EARP where permafrost and eskers were brought forward
- Jericho Diamond Mine where project impacts were considered for permafrost
- Doris North Project where landscape, terrain and regional geology were identified as VECs

5.3.2 Soils

5.3.2.1 Federal Policy on Wetland Conservation

The objective of the 1991 Federal Policy on Wetland Conservation is to “promote the conservation of Canada’s wetlands to sustain their ecological and socio-economic functions, now and in the future” (Government of Canada 1991). One of the goals of this policy is a no net loss of wetland functions on federal lands and waters (Government of Canada 1991). Therefore, any loss of soils associated with wetlands is considered an effect, as soil is a critical component and indicator of wetland function (e.g., a change in soil type due to a change in site hydrology would indicate a change in wetland function). Environment Canada administers this policy. Part of the Project occurs in federal lands, where the policy is directly applicable.

5.3.3 Vegetation

5.3.3.1 Species at Risk Act

The *Species at Risk Act* (SARA) is a key federal government commitment to protect species from becoming extinct, providing legal protection to species at risk on federal lands. Environment Canada (i.e., Canadian Wildlife Service), Fisheries and Oceans Canada, as well as the Parks Canada

Agency, depending on the area of responsibility, administer SARA. SARA aims to secure the actions necessary for the recovery of species identified as at risk. Species are assessed for designation as species at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and given protection through a jurisdictional commitment to action by the appropriate Minister. Schedule 1 of SARA is the official list of species at risk in Canada. Two vegetation species listed on Schedule 1 occur in Nunavut. These include a willow of Special Concern (Felt-leaf willow, *Salix silicicola*), and a moss with Threatened status (Porsild's Bryum, *Mielichhoferia macrocarpa*).

5.3.3.2 Nunavut Wildlife Act

The *Nunavut Wildlife Act* is territorial legislation under the NLCA. Its purpose is the management of wildlife and habitat in Nunavut, including the conservation, protection and recovery of species at risk. It provides legislative responsibility to implement the commitments of SARA on Nunavut lands. The *Nunavut Wildlife Act* is administered by Nunavut's Department of Environment.

5.3.3.3 Nunavut Land Claims Agreement Act

The *Nunavut Land Claims Agreement Act* is the 1993 agreement between the Inuit of the Nunavut Settlement Area and the Government of Canada that allowed for the creation of the territory and the Government of Nunavut (GN). The *Nunavut Land Claims Agreement Act* gave jurisdiction to the GN for wildlife management, land use planning, and natural resource management. The Nunavut Planning Commission (NPC) was established under this Act. The NPC developed the Keewatin Regional Land Use Plan. The study areas for this Project occur within the Keewatin planning region.

5.3.3.4 Keewatin Regional Land Use Plan

The Keewatin Regional Land Use Plan was developed by the NPC. It has the objective that non-renewable resource development should have no significant effects on the environment, wildlife or wildlife habitat.

5.3.3.5 Federal Policy on Wetland Conservation

The Federal Policy on Wetland Conservation (Section 5.3.2.1) applies to vegetation as well as soil..

5.4 Valued Environmental Components, Indicators and Measurable Parameters

5.4.1 Valued Environmental Components

VECs are attributes that are of cultural or ecological importance that interact with the Project. 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.

VECs selected for this assessment include terrain, soils and vegetation. Plant and soil resources provide habitat for wildlife. Geological history, lay of the land, and weather patterns support the development of different soil types, and together all of these physical features create different plant communities. Terrain was selected as a VEC because of its importance as a basic component of the terrestrial environment. Soil was identified as a VEC because they support ecosystems that provide biological and cultural values. Vegetation was selected as a VEC because of their contribution to biodiversity, their role as wildlife habitat, and their importance for traditional Inuit activities such as berry collection. The terrestrial habitat upon which wildlife populations and local communities depend must be well understood and documented because of its important role in the human and environmental setting.

AREVA's efforts to validate VEC selection included use of interactive posters at AREVA's 2010 Open House tour to learn more about *why* these 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 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/all VECs. The two most frequently used values associated with terrestrial components were:

- *Food* and *Beautiful* for berries;
- *Survival* and *Tradition* for lichen;
- *Respect* and *IQ* for soil; and
- *Beautiful* and *Peaceful* for landforms.

As evidenced by these engagement results, these terrestrial VECs are valued for a wide range of reasons, from culture to well being to basic needs. Selection of terrain, soil and vegetation as VECs was further validated by considering feedback received (importance, concern, issues) through public engagement and IQ interviews as described in Sections 5.1 and 5.2 above.

Overall, the issues and concerns raised by Kivalliq community members supported the selection of terrain, soil and vegetation as VECs; the assessment of effects on these VECs is an important component of the Kiggavik Project environmental assessment.

5.4.2 Indicators

Assessment indicators are often used to represent key aspects of a VEC, particularly species of concern to local stakeholders. For the terrestrial assessment, use of key indicators was not necessary for assessing Project effects on terrain, soils and vegetation.

5.4.3 Measurable Parameters

Measurable parameters refer to quantifiable and measurable aspects of the VEC that are used to determine the magnitude and direction of environmental change associated with Project activities. Changes to the measurable parameters will be assessed to determine the significance of Project activities on the VECs. Some environmental effects cannot be quantitatively predicted prior to the environmental effect occurring. As such, predictions based on knowledge and literature from research and monitoring projects can be made to qualitatively characterize the environmental effects. Measurable parameters used to assess environmental effects on terrain, soils and vegetation are discussed in Sections 7, 8 and 9, respectively.

5.5 Project-Environment Interactions

Interactions will occur between Project activities and the terrestrial VECs during all phases (i.e., construction, operation, final closure, and post closure) of the Project. A detailed matrix showing potential interactions between all Project activities and the VECs is provided in Table 5.5-1.

The rationale for ranking Project interactions with the terrain, soils and vegetation VECs as 1 is presented below.

All interactions ranked as 2 are carried forward into the effects assessment for each particular VEC: Section 7 for terrain, Section 8 for soil, and Section 9 for vegetation.

Construct In-water/Shoreline Structures

Site preparation, excavation, contouring and construction of in-water and shoreline structures (i.e., Andrew Lake dewatering structure and dock site) could have potential effects on slope stability, shoreline erosion, slides, rock falls and slumping in surficial deposits and bedrock. These effects could also potentially induce changes in the permafrost regime and terrain instability. Engineering measures have been incorporated to ensure that built structures are geotechnically and hydraulically stable. The following measures will be taken into consideration to mitigate these potential adverse effects during the construction phase of the Project.

- The key design criteria for the Andrew Lake dewatering structure will be based on the Canadian Dam Association Dam Safety Guidelines (CDA 2007), which considers the minimum factor of safety against slope stability failure for static and pseudostatic loading using the Earthquake Design Ground Motion (see Tier 3, Technical Appendix 2F).
- Rockfill and till construction methods will be implemented. Till will be placed as trench backfill through the excavated rockfill under water in the excavation to act as a low hydraulic conductivity core of the structure. Selected crushed rockfills will be placed as a thermal cap over the till to promote consolidation of the till core and to reduce the thermal variation in the till zone.
- Slope stability analyses will further be taken as part of the detailed designed stage.

In the presence of above mitigation measures, the residual effects from in-water and shoreline construction activities on terrain are anticipated to be minor and hence the level of interaction between Project activities and the VEC is ranked as 1 and not carried forward for further assessment.

Table 5.5-1 Project-Environment Interactions: Terrain, Soils and Vegetation

Project Component	Project Activities	Terrain	Soils	Vegetation
Construction				
Economic Activities	Construction workforce management; contracts and taxes; advance training of operation workforce	0	0	0
In-Water Construction	Construct freshwater diversions and site drainage containment systems (dykes, berms, collection ponds)	2	2	2
	Construct in-water/shoreline structures	1	2	2
	Water transfers and discharge	1	0	0
	Freshwater withdrawal	0	0	0
On-Land Construction	Site clearing and pad construction (blasting, earth moving, loading, hauling, dumping, crushing)	2	2	2
	Road and airstrip construction	2	2	2
	Aggregate Sourcing	2	2	2
	Construct foundations	2	0	0
	Construct buildings	0	0	0
	Install equipment	0	0	0
	Install and commission fuel tanks	0	0	0
	Mill dry commissioning (water only)	0	0	0

Table 5.5-1 Project-Environment Interactions: Terrain, Soils and Vegetation

Project Component	Project Activities	Terrain	Soils	Vegetation
Supporting Activities	Transport fuel and construction materials	0	2	2
	Air transport of personnel and supplies	0	0	1
	Hazardous materials storage and use	0	0	0
	Explosives storage and use	0	0	0
	Waste incineration and disposal	0	1	1
	Industrial machinery operation	0	2	2
	Power generation	0	2	2
Operation				
Economic Activities	Workforce management; employment; contracts and taxes	0	0	0
Mining	Mining ore (blasting, loading, hauling)	2	2	2
	Ore stockpiling	1	2	2
	Mining special waste (blasting, loading, hauling)	2	2	2
	Special waste stockpiling	1	2	2
	Mining clean waste (blasting, loading, hauling)	2	2	2
	Clean rock stockpiling	1	2	2
	Mine dewatering	0	0	1
	Underground ventilation	0	0	2
	Backfill production and underground placement	0	0	0
Milling	Transfer ore to mill	0	2	2
	Crushing and grinding	0	2	2
	Leaching and U recovery	0	0	0
	U purification	0	0	0
	Yellowcake drying and packaging	0	0	0
	Tailings neutralization	0	0	0
	Reagents preparation and use	0	0	0
Tailings Management	Pumping and placement of tailings slurry	2	0	0
	Consolidation of tailings	0	0	0
	Pumping of Tailings Management Facility supernatant	0	0	0

Table 5.5-1 Project-Environment Interactions: Terrain, Soils and Vegetation

Project Component	Project Activities	Terrain	Soils	Vegetation
Water Management	Create and maintain water levels	0	0	0
	Freshwater withdrawal	0	0	0
	Potable water treatment	0	0	0
	Collection of site and stockpile drainage	0	0	1
	Water and sewage treatment	0	0	0
	Discharge of treated effluents (including greywater)	0	0	0
Waste Management	Disposal of industrial waste	0	1	1
	Management of hazardous waste	0	1	1
	Management of radiologically contaminated waste	0	1	1
	Disposal of domestic waste	0	0	0
	Incineration and handling of burnables	0	1	1
	Disposal of sewage sludge	0	0	0
General Services	Generation of power	0	2	2
	Operate accommodations complex	0	0	0
	Recreational activities	0	1	1
	Maintain vehicles and equipment	0	0	0
	Maintain infrastructure	0	0	0
	Operate airstrip	0	1	1
	Hazardous materials storage and handling (reagents, fuel and hydrocarbons)	0	0	0
	Explosives storage and handling	0	0	0
Transportation	Marine transportation	0	0	0
	Truck transportation	0	2	2
	General traffic (Project-related)	0	1	1
	Controlled public traffic	0	1	1
	Air transportation of personnel, goods and supplies	0	1	1
	Air transportation of yellowcake	0	1	1
	General air transportation support	0	1	1

Table 5.5-1 Project-Environment Interactions: Terrain, Soils and Vegetation

Project Component	Project Activities	Terrain	Soils	Vegetation
Ongoing exploration	Aerial surveys	0	1	1
	Ground surveys	0	0	0
	Drilling	1	1	1
Final Closure				
Economic Activities	Decommissioning workforce management; employment; contracts and taxes	0	0	0
General	Hazardous materials storage	0	1	1
	Industrial machinery operation	0	2	2
	Ongoing withdrawal, treatment and release of water, including domestic wastewater	0	0	0
In-water Decommissioning	Remove freshwater diversions; re-establish natural drainage	1	1	1
	Remove surface drainage containment	1	1	1
	Remove in-water/shoreline structures	0	1	1
	Water transfers and discharge	2	0	0
	Construct fish habitat as per the Fish Habitat Compensation Plan (FHCP)	0	0	1
On-land Decommissioning	Remove site pads (blasting, earth moving, loading, hauling, dumping)	2	2	2
	Backfilling	2	0	0
	Contouring	2	1	0
	Covering	1	1	0
	Revegetation	1	0	0
	Remove foundations	1	0	0
	Remove buildings	0	0	0
	Remove equipment	0	0	0
	Remove fuel tanks	0	0	0

Table 5.5-1 Project-Environment Interactions: Terrain, Soils and Vegetation

Project Component	Project Activities	Terrain	Soils	Vegetation
Post Closure				
General	Management of restored site	0	0	0

NOTES:

0 = If there is no interaction or no potential for substantive interaction between a Project activity and the VC to cause a potential environmental effect, an assessment of that environmental effect is not required. These interactions are categorized as 0, and are not considered further in the EA. The environmental effects of these activities are thus, by definition, rated not significant.

1 = If there is likely to be a potential interaction between a Project activity and a VC but not likely to be substantive in light of planned mitigation, the interaction is categorized as 1. Such interactions are well understood and are subject to prescribed mitigation or codified practices. These interactions are subject to a less detailed environmental effects assessment and are rated as not significant. Justification is provided and the proposed mitigation is described for such categorizations. Such interactions can be mitigated with a high degree of certainty with proven technology and practices.

2 = If a potential interaction between a Project activity and a VC could result in more substantive environmental effects despite the planned mitigation, if there is less certainty regarding the effectiveness of mitigation, or if there is high concern from regulatory agencies, Inuit or stakeholders, the interaction is categorized as 2. These potential interactions are subject to a more detailed analysis and consideration in the environmental assessment in order to predict, mitigate and evaluate the potential environmental effects

Water Transfers and Discharge

Interaction was ranked as 1 for terrain and 0 for soil and vegetation (Table 5.5-1). For terrain, there is potential for erosion within the constructed diversion channels, and the degree to which this occurs depends on the type of overburden material, channel gradient, channel geometry and flow magnitude. The potential for erosion is greatest where the excavation occurs in overburden till materials and it is much less where the excavation occurs in bedrock. As the channels are constructed in a permafrost environment, there is also potential for deformation in the constructed channel, which may influence erosion potential. The proposed channels will be constructed based on the available geotechnical data and information on shallow permafrost conditions, including thickness of the active layer. General mitigation measures by design for the channel alignments and construction in ice-poor and ice-rich till will be implemented, and the design and channel alignments may be further refined based on the additional information on ground conditions and material types (see Tier 3, Technical Appendix 2E for details). Water transfer and discharge activities are anticipated to have a minor effect on terrain with implementation of the mitigation measures identified; therefore, the interaction was ranked as a 1, and was not carried forward for further assessment.

Ore, Special Waste, Clean Rock and Overburden Stockpiling

Development of ore stockpiles, special waste stockpiles, clean waste stockpiles and overburden stockpiles will result in a net increase in anthropogenic materials in the Mine LAA. In the Kiggavik mine site, approximately 7 ha, 13 ha, 135 ha and 14 ha will be disturbed by ore, special waste, clean waste and overburden stockpiles, respectively. This represents a total of 169 ha (0.47%) of common landforms (till overburden materials) within the Mine LAA (36,240 ha) that will be disturbed due to the Project footprint of the Kiggavik mine. In the Sissons mine site, approximately 1 ha, 12 ha, 132 and 15 ha will be disturbed by ore, special waste, clean waste and overburden stockpiles, respectively. This represents a total of 160 ha (0.44%) of common landforms (till overburden materials) within the Mine LAA that will be disturbed due to the Project footprint of the Sissons mine. A total of 329 ha (i.e., 0.91% of the total Mine LAA) of common landforms will be disturbed by the Project footprint due to the establishment of mine stockpiles within the Mine LAA, which is considered to be not significant. As overburden materials will be salvaged and used for the reclamation purpose, the residual effects from mine stockpiling on terrain are anticipated to be minor and hence the level of interaction is ranked as 1 and not carried forward for further assessment.

Air Emissions

A number of Project activities generate air emissions from fuel combustion; however, the amount of air emissions and their rate of occurrence vary. Project activities expected to generate small amounts or transient sources of air emissions that were subsequently ranked as 1 for potential interactions with soil and vegetation include: waste incineration, incineration of burnables, air transport of personnel and supplies, operation of the airstrip, general traffic (Project-related), controlled public traffic, air transportation of personnel, goods, and supplies, air transportation of yellowcake, general air transportation support, aerial surveys, and drilling.

Truck transportation associated with ore haul traffic, as well as semi-trailer truck traffic from Baker Lake to the Kiggavik and Sissons mine sites along the proposed access roads are anticipated to produce large quantities of air emissions. As well, power generation, the acid plant, and the operation of heavy equipment are anticipated to produce air emissions, and will likely operate for extended periods of time during the operation phase of the Project. Therefore, these Project activities were ranked as 2 and carried forward into the effects assessment.

Mine Dewatering

Mine dewatering involves the removal of water that has seeped into an excavated area. During mine dewatering, the pumping of a well could influence groundwater flow. Changes in groundwater levels may influence soil moisture content, which may then alter the vegetative community in the area. However, the presence of continuous permafrost at the Kiggavik site likely acts as a barrier between groundwater and vegetation. As such, this interaction was ranked as 1 and not carried forward for further assessment.

Collection of Site and Stockpile Drainage

Freshwater diversion channels will be created around the Project footprint area, as well as surrounding the rock stockpiles. Diversion channels created around the Project footprint will transport surface run-off around the site, where it will be released into the natural drainage system downslope of the Project footprint. Diversion channels around the rock stockpiles will transport surface run-off into a sedimentation pond located immediately adjacent to the rock stockpiles. The freshwater diversion channels will likely create new habitat for vegetation, allowing species adapted to mesic environments to establish and proliferate. The vegetation species anticipated to occur will likely be native to the area, as non-native species are likely unable to establish and proliferate due to the harsh climate conditions and nutrient deficient soils. As such, the diversion channels and sedimentation ponds are anticipated to have a minor effect on vegetation; thus, the interaction was ranked as 1 and not carried forward for further assessment.

Waste Management

Waste products (i.e., domestic, industrial, hazardous, radiological, and sewage) will be handled and disposed of in accordance with the GN's environmental guidelines. Recyclable materials will be collected and shipped to appropriate recycling facilities, non-combustible and non-contaminated wastes will be landfilled in a designated area of the clean waste rock piles, hazardous wastes will be collected in designated containers and transported to an appropriate off-site recycling or disposal facility, and radiological waste will be stored on-site for eventual burial in the Kiggavik Tailings Management Facility (TMF). Burnable wastes will be incinerated to meet the GN (2011) environmental guidelines. A sewage treatment plant located on-site will meet Nunavut public health regulations and any requirements stipulated by the Nunavut Water Board and the Canadian Council of Ministers of the Environment (CCME) municipal effluent guidelines for sewage. Treated sewage effluent will be discharged into Judge Sissons Lake.

By following GN's environmental guidelines, waste products will be handled and disposed of properly. As such, the residual effects from these waste management practices on soils and vegetation are anticipated to be negligible. As such, this interaction was ranked as 1 and not carried forward for further assessment.

Recreational Activities

Recreational activities by people working at the mine could disturb soils and vegetation. For example, hiking at a specific location repeatedly can create a trail, thereby causing trampling and destruction of vegetation, as well as soils compaction. However, these types of activities will be localized. As such, the residual effects of recreational activities on soils and vegetation are anticipated to be negligible. The interaction was ranked as 1 and not carried forward for further assessment.

Drilling

Additional exploration drilling will occur over the life of the Project. Monitoring records from current exploration activities identified an area of approximately 8.5 m by 8.5 m (i.e., 72.25 m^2 or 0.007 ha) that may be disturbed by drilling activities. Drilling activities predominately occur from May to September during the spring thaw and snow-free periods on the landscape. Disturbances to terrain may include short-term and localized change in permafrost conditions and aesthetic visual intrusion in landforms within the drill rig set-up and its adjacent areas. Heat generated by generator, drilling and heating system may provisionally warm the active layer and deepening of thaw depth may occur. Heat generated from drilling activities would be temporary and localized. Disturbances to soils include soil compaction where the drill rig is situated, minor scalping of the soil surface during drill placement and removal, as well as digging of a small pit (i.e., usually 0.5 m by 0.5 m) that is used to collect non-radioactive drill cuttings.

Disturbance to vegetation at drill sites is predominately due to trampling. The majority of the soil growth medium, as well as the rooting structure of the vegetation remains intact at drilling sites, allowing for vegetation regeneration.

Best management practices associated with drilling activities, the short duration during which a drill is at a particular location, and the small footprint associated with drilling activities will minimize any residual effects. The residual effects from drilling on soils and vegetation are anticipated to be negligible. As such, this interaction was ranked as 1 and is not carried forward for further assessment.

In-water Decommissioning

Removal of the freshwater diversion channels, surface drainage containment systems, and in-water/shoreline structures during final closure of the Project will likely affect terrain, soils and vegetation. Detailed engineering plans will be developed and include best management practices to conduct in-water decommissioning with minimal effects on permafrost. For terrain, a new shallow permafrost regime and terrain slope may be re-established at these locations. Shallow permafrost condition and the stability of terrain can likely be affected due to disturbances during final closure of the Project. To minimize the effects induced by decommissioning activities, compaction of materials will be allowed under gravity only. However, loose and unstable surficial materials will be reasonably removed to support the stability of adjacent terrain. Natural drainage and surficial materials will be re-established in such way that the residual effects on permafrost and terrain stability are expected to be mitigable as well as stable compared with the baseline condition.

Soil compaction may occur during structure removal, and vegetation that may have re-established at these locations could be lost due to decommissioning-related disturbances. To mitigate soil compaction during decommissioning activities, the disturbed area will be harrowed or scarified to loosen compacted soils. Decommissioning activities will promote re-establishment of native vegetation to these disturbed areas that is suitable for traditional uses. As such, the residual effects from in-water decommissioning activities on terrain, soils, and vegetation are anticipated to be beneficial at these locations; thus, the interaction was ranked as 1 and not carried forward for further assessment.

Contouring

Contouring of the waste rock piles to maintain slope stability may be required during the final closure phase. During this time, the area contoured by the heavy equipment will likely result in soil compaction, which could prevent vegetation establishment and proliferation. Harrowing during decommissioning activities will mitigate soil compaction issues while providing micro-sites for vegetation establishment and proliferation. As such, this interaction was ranked as 1 and not carried forward for further assessment.

Covering

Covering of the mine site footprints will occur during the final closure phase using stored overburden materials during reclamation. Covering is anticipated to occur at the mine pits (following completion of mine pit backfill) as well as the rest of the mine site footprint (excluding the waste rock piles and access roads). For the mine pits used as TMFs, the consolidated tailings materials will be backfilled with waste rock materials. Following placement of waste rock materials, two different scenarios exist for final covering of the pits: 1) the placement of overburden materials on top of waste rock; or 2) the development of a pond on top of the waste rock. Covering of the mine pits via either scenario will cause a change in terrain features prior to baseline conditions. However, covering of the mine pits will re-establish the natural shallow permafrost condition and promote terrain stability. For soils, soil compaction could potentially occur during the placement and spreading of soils over these pits. Harrowing during decommissioning activities will mitigate soil compaction issues while providing micro-sites for vegetation establishment and proliferation. As such, the residual effects that covering will have on terrain and soils are anticipated to be not significant; thus, the interaction was ranked as 1 and not carried forward for further assessment.

Revegetation

Revegetation of the mine pits and mine waste stockpiles will be required during final closure phase of the Project. After covering is placed at the mine pits (following completion of mine pit backfill) as well as the rest of the mine site footprint (excluding the waste rock piles and access roads), a top layer of the dry cover will then be revegetated to establish a vegetation medium. Revegetation will help re-establish the natural shallow permafrost condition and terrain stability. The residual effects that revegetation will have on terrain are anticipated to be not significant the level of interaction and thus the level of interaction between revegetation and the VEC is given as 1 and not carried forward for further assessment.

Remove Foundations

Removal of the foundations during final closure of the Project will likely affect terrain. Compaction of backfill materials can occur during and after the removal of foundation structures and a new shallow permafrost regime and terrain condition may be re-established at these locations. To minimize the effects induced by decommissioning activities, compaction of materials will be allowed under gravity only. However, loose and unstable surficial materials will be reasonably removed in order to support the stability of adjacent terrain. Natural drainage and surficial materials will be re-established in such way that the residual effects on terrain are expected to be mitigated and stable compared with the baseline condition. Hence, the level of interaction between this Project activity and the VEC is given as 1 and not carried forward for further assessment.

5.6 Assessment Boundaries

5.6.1 Spatial Boundaries

5.6.1.1 Project Footprint

The Project footprint is the area of direct physical disturbance by the Project, as described in the Project description. For the purposes of this assessment, the potential for variation in design and alignment of roads was taken into account by using a 12 m buffer on both sides of the proposed road centre line (24 m wide) for the All-Season Road. The Winter Road incorporated a 6 m buffer on both sides of the proposed road centre line (12 m wide). The footprint of other mining facilities used the geographic limits provided by the Project's design team.

5.6.1.2 Local Assessment Area

The LAA is the maximum area within which Project effects can be predicted or measured with reasonable accuracy and confidence. The LAA was broken-down into two different areas consisting of the Mine LAA and the road LAAs.

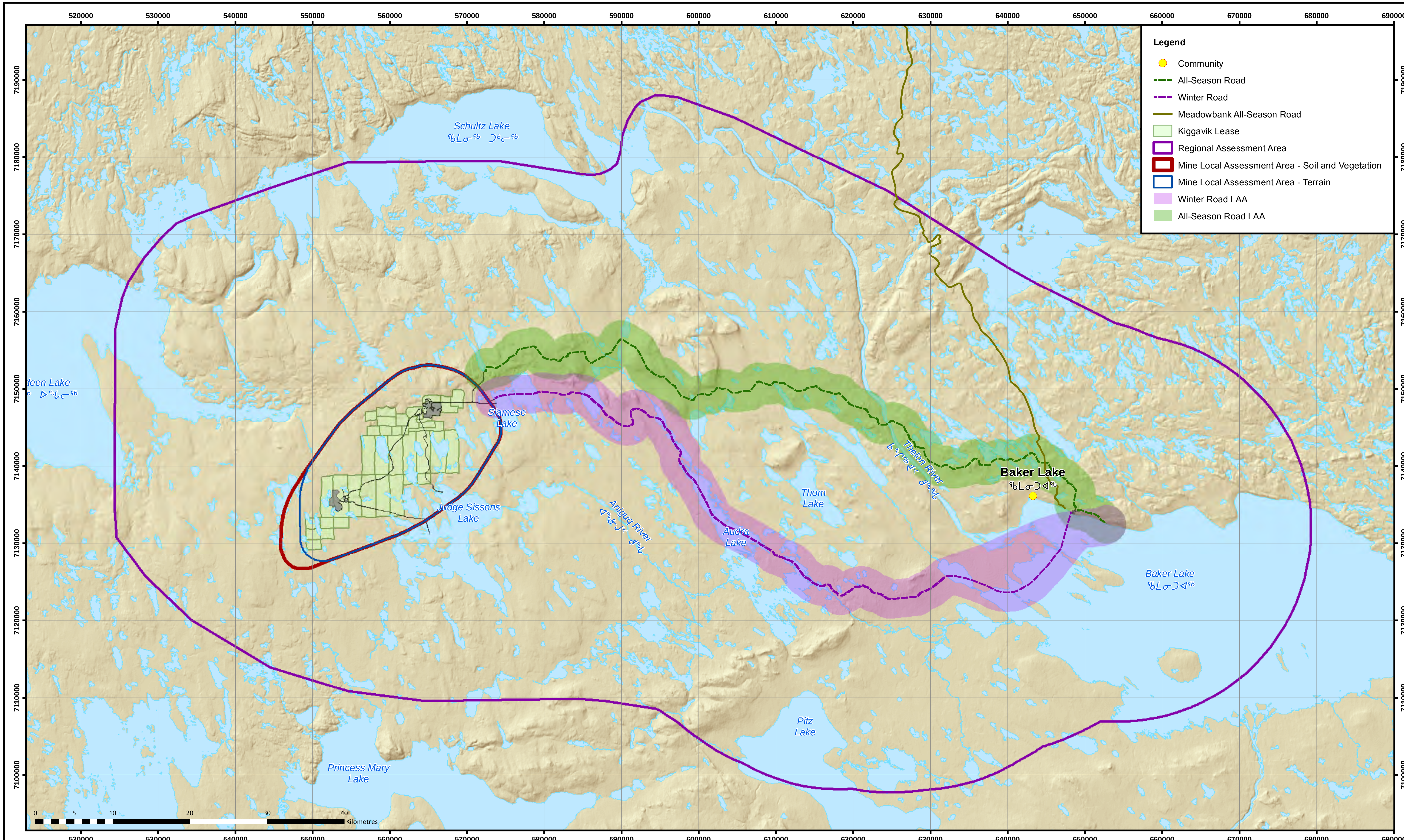
The Mine LAA is centered on the Kiggavik and Sissons deposits with an approximate 5 km buffer around all proposed Project facilities, including the proposed airstrip and access road between the Kiggavik and Sissons mine sites (Figure 5.6-1). The Mine LAA for soils, vegetation, and wildlife is approximately 29 km by 20 km, for a total area of approximately 450.09 km^2 (45,009 ha). Information on surficial geology does not exist for the southwest portion of the Mine LAA. As a result, the Mine LAA boundary for terrain was adjusted to contain only the area where surficial geology information existed. The upland area within the Mine LAA for terrain (excluding water) is 36,240 ha (Figure 5.6-1).

The road LAAs include a 5 km wide buffer centered on the proposed road alignments (Figure 5.6-1). The All-Season Road LAA is approximately 520.32 km^2 (52,032 ha), whereas the Winter Road LAA is approximately 560.9 km^2 (56,090 ha). The dock facility options are included within the All-Season Road and Winter Road LAA boundaries.

5.6.1.3 Regional Assessment Area

The regional assessment area (RAA) is a broader area within which cumulative effects may potentially occur. The terrain, soil and vegetation RAA is consistent with the wildlife RAA (Figure 11.6-1); the consistent use in these RAAs demonstrates the importance of terrain, soil and vegetation in providing wildlife habitat. The RAA covers an area 150 km long and 70 km wide, for a total of 9,828 km^2 (982,800 ha; Figure 5.6-1). The RAA includes all of Judge Sissons Lake and southern portions of Aberdeen and Schultz lakes. The RAA has a minimum buffer of approximately 22 km from the Project footprint.

The RAA incorporates all Project features and associated LAA buffers, as well as areas identified by IQ studies. The RAA also includes areas with similar conditions to those found in the LAA and access road LAAs, which will allow the RAA to be used as a comparable reference area for monitoring potential changes as the Project proceeds.



Projection: NAD 1983 UTM Zone 14N
Creator: CDC Revised:TL
Date: 8/21/2014 Scale: 1:450,000
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Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 5.c-1

LOCATION OF THE TERRAIN, SOILS AND VEGETATION LOCAL AND REGIONAL ASSESSMENT AREAS FOR THE KIGGAVIK PROJECT

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5.6.2 Temporal Boundaries

The temporal boundaries for the terrestrial assessments are based on the timing and duration of effects over all phases of the Project (construction, operation, final closure and post closure). The total life of the Project is expected to be 25 years.

5.6.3 Technical Boundaries

The technical boundaries for the terrain, soil and vegetation assessments are related to significance standards and thresholds. Details on technical boundaries are provided in the terrain (Section 7), soil (Section 8) and vegetation (Section 9) effects assessment sections and examples of technical boundaries are provided here:

Terrain: No federal or territorial regulations or guidelines exist regarding the effect of changes to terrain. As such, previous experiences from other projects in Nunavut and other parts of the Canadian Arctic that have undergone the environmental assessment and review process were referred to, as well as professional judgment to determine threshold values for determining the significance of project effects on terrain. Other projects reviewed included the Ekati Diamond Mine, Jericho Diamond Mine, as well as the Doris North Project and the Izok Lake/High Lake Project. Further details can be found in Sections 5.3.1 *Regulatory Setting - Terr*ain, 7.1.3 *Residual Environmental Effects Criteria for Terrain* and Section 7.1.4 *Standards or Thresholds for Determining Significance*.

Soil: Effects on soil quality are determined by the extent of changes in chemical levels in soil compared to CCME soil quality guidelines (CCME 2009). These values are used to evaluate changes in soil concentrations from emissions of metals; however, no standards exist for radionuclides. To overcome this technical boundary (lack of soil quality guideline for radionuclides), predicted changes in radionuclide concentrations were compared to baseline data. Results indicate there would be no measurable change in soil radionuclide concentrations, relative to baseline, as a result of the Project. Further details can be found in Sections 8.1.3 *Residual Environmental Effects Criteria for Soils* and 8.1.4 *Standards or Thresholds for Determining Significance.*

Vegetation: Although the effects of air emissions on most vegetation types is relatively well understood, and the effectiveness of mitigation measures is well documented, there are no established thresholds exist for determining the effects of dust deposition on vegetation quality. Because of this technical boundary, confidence in assessment predictions will be improved through specific monitoring programs that will occur throughout the Project (dust and air emissions, vegetation sampling for analyte concentrations from permanent sampling plots). Further details can be found in Sections 9.1.3 *Residual Environmental Effects Criteria for Vegetation* and 9.1.4 *Standards or Thresholds for Determining Significance.*

5.7 Residual Environmental Effects Criteria for terrain, soils and vegetation

The NIRB has outlined specific terms to characterize residual environmental effects of the Project. Whenever possible, the magnitude, geographic extent, frequency and duration of an environmental effect were described quantitatively. Where quantitative measures were not available to describe the environmental effect, qualitative terms (e.g., low, moderate, and high) were used. Definitions specific to individual VECs are presented in the effects assessment Sections for terrain, soils and vegetation.

5.8 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.

Potential changes in a measurable parameter or VEC resulting from Project or cumulative effects were evaluated against these standards or thresholds, and were rated as either significant or not significant. Definitions specific to individual VECs are presented in the effects assessment sections for terrain, soils and vegetation.

6 Summary of Existing Environment Terrain, Soils and Vegetation

6.1 Terrain

6.1.1 Introduction

This section summarizes surficial geology, terrain and shallow geotechnical conditions in the Kiggavik Project area. Additional details on the terrain baseline can be found in the Surficial Geology, Terrain and Shallow Geotechnical Conditions (Tier 3, Technical Appendix 6A).

6.1.2 Surficial Geology

Surficial deposits consist mainly of glacial till and small local deltaic deposits. The glacial till varies in texture and composition from well-graded silty sand with some gravel and trace of clay to well-graded gravelly sand with some silt and a trace of clay. The till also contains boulders and cobbles, but only minor amounts of fine particles. The clay fraction of the glacial till exhibits little to no plasticity. Thin deposits of poorly graded sand and gravel, which occur locally on the till surface, are considered to have been produced by glacial melt-water and post-glacial erosion. Fields of large, angular boulders occur where the glacial till is relatively thin or absent, and also where the finer constituents of the till have been removed by erosion. Thin organic layers have been developed on the till surface in poorly drained depressions. Thin soil profiles have been developed on well-drained glacial till.

6.1.3 General Geomorphology

The periglacial geomorphic processes in the RAA are associated with the ground that is permanently affected by the cold climate, consisting of an active layer, excess ground-ice and a layer of perennially frozen ground. Periglacial processes observed within the Mine LAA and RAA include frost wedging and frost shattering, thaw subsidence, and solifluction, which shaped various landforms. The characteristic relief-forming permafrost features are typically subdued in areas of thin overburden and dry conditions. Generally wet conditions exist locally associated with low-lying ground.

The surficial deposits at the proposed mine site and along most of the potential road corridors between the mine/mill site and Baker Lake comprise mainly glacial till overlying Precambrian intrusive igneous and metamorphic rocks that are typically quartzite, schist or granite. The eastern portions of the potential road alignments toward Baker Lake are below the most recent glacial marine transgression; consequently the lower elevations near Baker Lake are partly covered by marine and glaciomarine materials.

6.1.4 Surficial Materials

A typical top layer of surficial material profile in the Mine LAA consists of a thin organic soil layer underlain by glacial till varying in thickness from less than a metre on ridges to several meters in depressions, overlying moderately jointed bedrock with good rock quality. Large areas of boulders (boulder fields) exist on the ground surface where the finer fraction of the glacial till has been removed by erosion or where the boulders have been frost-jacked to surface by the repetitive freeze-thaw action of the active layer.

Surficial materials in the RAA originated as a result of glaciations by the Laurentide ice sheet, and marine offlap following its retreat (EBA 2010). These changes included:

- glacial deposition and erosion, which prevailed during expansion and subsequent retreat of the Laurentide ice sheet, including localized re-advances
- marine submergence, which occurred when much of the terrain near Baker Lake was temporarily inundated by an ancient sea (Tyrrel Sea)
- more recent periglacial conditions established when isostatic rebound of the earth's crust resulted in exposure of the land surface as the margin of the Hudson Bay retreated eastward

The surficial materials in the Project area have been historically grouped into six major deposits (BEAK Consultants Ltd. 1987; Wickware & Associates Inc. 1989): glacial till or morainal; glaciofluvial; glaciolacustrine; glaciomarine deposits; organic and bedrock.

Minor deposits of lacustrine materials occur in the Squiggly Lake area and along shorelines of larger lakes where ice-pushed sandy materials may occur. Their occurrence is of limited areal extent. Immediately to the east of these areas, the landscape is dominated by reworked marine deposits. These deposits mask bedrock and glacial deposits, and mute the lowland topography. The primary materials associated with this marine transgression are foreshore and beach deposits of sand and gravel. Such deposits are found on the flanks of hills and bedrock knobs, often with associated terraces marking the stages of the gradual recession of waters from the area (BEAK 1987). These deposits are characterized by a network of high centred ice-wedge polygons and by patterned peat deposits in the low poorly drained areas.

6.1.5 Landforms

The normal deposition and erosion processes associated with the various preglacial, glacial, marine, and the present day periglacial environments have resulted in the evolution of a variety of common landforms in the Project area. Major landforms are subdivided into four different types: depositional, glacial, permafrost sensitive and uncommon landforms.

6.1.5.1 Depositional Landforms

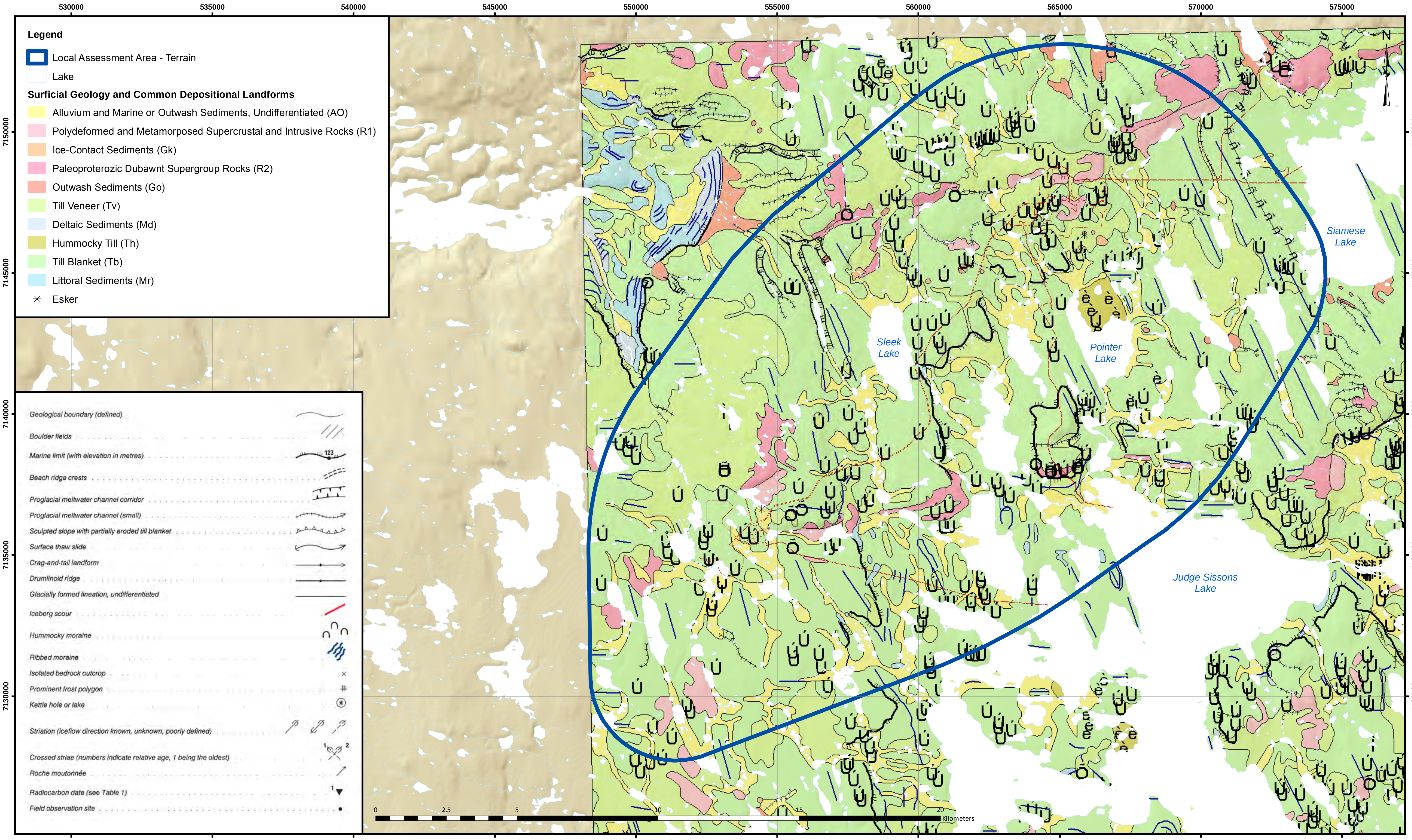
Common depositional landforms are further classified into six different types within the Mine LAA as described below (Figure 6.1-1).

Undifferentiated Alluvium or Outwash Sediments

With the exception of the Kiggavik mine site and its north-northeast areas, undifferentiated alluvium or outwash sediments occur in all directions. However, these sediments occur in the Sissons mine site and adjacent areas. This type of landform covers 3,786 ha of the Mine LAA, which represents 10.45% of this area.

Glaciofluvial

The material typically comprises unsorted and unstratified, moderately to well sorted and stratified gravel and sand. Ground-ice content in glaciofluvial deposits is typically low. Glaciofluvial outwash materials occur randomly throughout the LAA and are generally composed of granular soils. Percentage coverage of glaciofluvial landform is less than 1% of the LAA, or 200 ha.



Projection: NAD 1983 UTM Zone 14N
Creator: CDC
Date: 09/15/2011 Scale: 1:125,000
File:
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc, Geological Survey of Canada Map 2120A*

FIGURE 6.1-1
SURFICIAL GEOLOGY AND COMMON DEPOSITIONAL LANDFORMS WITHIN THE MINE LOCAL ASSESSMENT AREA

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Glacial Till or Moraine

Till ground moraine is the most common and widespread depositional landform in the Kiggavik Project area. The till is generally unsorted, medium brown, silty, sandy and stony, with locally derived volcanic, sedimentary, and lesser granitic clasts. Clast sizes range from granule to boulder with a high proportion in the gravel-sized range. It consists mainly of till blanket, till veneer and hummocky till. The coarse-grained materials common in most of the channels between lakes and ponds are evidence of the finer sediments having been removed by water flow. This type of landform occupies most (approximately 83.76% or 30,356 ha) of the LAA.

Due to the fine texture of the morainal soils and poor drainage conditions, they typically have high ground-ice content. These ice-rich deposits are sensitive to changes in the thermal regime following the removal of surface vegetation, inundation, or tundra fires. These deposits may be susceptible to frost heaving, surface subsidence (consolidation settlement), gullying and drainage network disruption and slope stability. Also, active layer detachment slides and retrogressive thaw flows slides or slumps can occur.

Glaciomarine

Glaciomarine landforms deposited during postglacial emergence due to crustal rebound are minor topographic features in the mine site areas (approximately 0.3% of the Mine LAA or 108 ha), but these landforms are widespread near Baker Lake. Wave action resulted in extensive reworking of the local ground moraine creating subdued raised beach ridges and depositing fine-grained, nearshore marine sediments. The beach ridges comprise granular, sand-sized materials, which are generally well drained. The fine-grained marine sediments are confined to low-lying areas and are often ice rich.

Organic

Organic deposits are composed predominantly of organic materials resulting from accumulation of vegetative matter and contain at least 30% organic matter by weight. Organic deposits form a dominant terrain either as a veneer or blanket overlying the predominantly fine-grained soils of moraine and glaciolacustrine plains. They are highly compressible and have low strength when thawed. When frozen, they may contain up to 100% ice by volume.

Thick organic landforms represent a relatively minor portion of the total Mine LAA, but small localized materials are widespread. Thick peat accumulations occur in low-lying areas. The materials are wet and ice rich.

Bedrock

Bedrock forms prominent ridges, scarps and hills in the LAA. Typically, bedrock is generally freely drained with some poorly drained depressions. There are no records of segregated ice within the bedrock, but the presence of ice is possible in joints and fracture zones. Segregated ice may be present in silt-filled depressions within the region. Outcrops are widespread around the plant/mill site, and are characterized by a jointed or frost shattered upper surface (felsenmeer) resulting in a jagged micro-topography. Bedrock outcrops are also common around the Main Zone Pit, Centre Zone Pit and water storage pit areas. It also occurs north of the proposed overburden and permanent stockpiles. In the Sissons area, outcrops are common in the northeast of Mushroom Lake, east of End Grid Lake and southwest of Lunch Lake. Bedrock outcrop covers approximately 5.0% of the Mine LAA or 1,790 ha.

6.1.5.2 Glacial Landforms

Landforms around the proposed mill site are dominated by hummocky, bouldery glacial till and scattered boulder till moraines with frequent bedrock outcrops and shattered bedrock features in isolated exposures, elevated plateaus and elongated ridges (drumlins, and other glaciofluvial outwash features). The localized north-northwest trending glacial drumlins preserve evidence of regional ice flow. Glaciofluvial kames and eskers form rare, isolated topographic features. The lower elevations near Baker Lake are partly covered by marine, glaciomarine and lacustrine materials.

6.1.5.3 Permafrost Sensitive Landforms

Permafrost sensitive landforms may be determined based on potential high water and ground-ice content, high frozen bulk density of soil, fine-grained strata with high silt content, position in the landscape, and slope types. This type of landform is assessed as sensitive to changes in the thermal regime and surface conditions.

Permafrost is reflected in well-developed patterned ground and periglacial processes. Evidence of active cryoturbation is found in several locations, where boulders and platy stones are thrust upward to the tundra surface. Patterning is primarily sorted circles, sorted stripes, sorted nets, sorted steps and sorted polygons depending on slope and materials. Sorted circles, nets and steps occur on the glacial till material where there is enough fine material. Sorted polygons are confined to glaciofluvial materials likely due to the high proportion of stone and cobble sized material (Geomatics International 1991).

6.1.5.4 Uncommon Landforms

Some of the landforms left behind by glaciation play a significant role in the lives of local communities. Landforms that have a high value in terms of traditional and cultural importance, potential wildlife habitat, rare plant species and human use are considered uncommon landforms. The most prominent uncommon landforms in the Project area are eskers. Three esker-related landforms have been identified within the Mine LAA (Figure 6.1-1). However, they occupy a negligible portion of the area.

6.1.6 Overburden Characteristics

A typical overburden profile comprises a thin, dark brown to black organic topsoil layer, 0.1 m in thickness, underlain by glacial till varying in thickness from approximately one to several metres. The glacial till varies in texture and composition from well-graded silty sand with some gravel and a trace of clay to well-graded gravelly sand with some silt and a trace of clay. Oversize material in the till consists of boulders and cobbles, which tend to be larger and more frequent in proximity to bedrock. In general, the thickness of the till ranges from 0.3 m to 5.0 m. Depth to bedrock generally ranges from 0.3 m to 6.5 m.

6.1.6.1 Water Content and Plasticity

Water content in the permafrost terrain provides information on volumetric ground-ice content. In general, the water content of the glacial till ranges from 7.7% to 50.6%. Sandy gravel till with some silt and trace clay showed maximum water content of 54.2%. The water content of the overburden soils in the proposed mill and End Grid underground mine areas also falls in the same range. The water content of lakebed sediment samples varies from 19.9% to 44.8%.

A glacial till sample, characterized by well-graded silty sand with some gravel and a trace of clay to well graded gravely sand with some silt and a trace of clay, exhibited little to no plasticity (Tier 3, Technical Appendix 6A). Overburden soil in the area north of the Main Zone Pit and Centre Zone Pit exhibit a liquid limit of 18 to 54, plastic limit of 14 to 31, and plasticity index of 3 to 23. In the same area, the glacial till, characterized mainly by sand till with some clay and trace silt exhibit no plasticity. The overburden soil in the proposed mill area and in the area of End Grid underground mine exhibit plasticity index of 6 and 1, respectively. Lakebed sediment samples show no plasticity.

6.1.6.2 Shallow Thermal Conditions

The Kiggavik site is located within the zone of continuous permafrost. The shallow active layer is generally characterized by its limited thickness and continuity. The active layer possesses a seasonal nature as it melts during the summer period (June to September) and is frozen for the rest of the year. Hence, the active layer thickness, also known as the “thaw depth”, increases gradually over the summer months and is believed to reach its maximum depth in August and September. However, the thaw depth depends on various factors including the type and thickness of vegetation cover, organic soils insulation, slope aspect and orientation, the nature of the underlying soil and rock, weather, proximity to waterbodies and human disturbance. The thaw depths in the Kiggavik Project area were estimated from temperature profiles recorded with shallow thermistors and the maximum thaw depths measured with frost depth indicators. In general, the thaw depth ranged from 0.88 m to 3.10 m.

In the area north of the Main Zone Pit, ground-ice depth ranges from 0.60 m to 1.00 m below ground surface. Ground-ice conditions in the glacial till are typically characterized by non-visible ice, well bonded with no excess ice (Nbn) to excess ice (Nbe). In the area north of Centre Zone Pit, ground-ice depth ranges between 0.30 and 0.75 m below ground surface. Ground-ice conditions in the glacial till range from non-visible ice, well bonded with no excess ice (Nbn) to visible ice coatings on soil particles (Vc) and random or irregularly oriented ice formations (Vr) and stratified or distinctly oriented ice formations (Vs). In the south of the Centre Zone Pit, ground-ice occurs at depths of 0.50 and 1.00 m below ground surface. Ground-ice in the silty sand till is non-visible, well bonded with no excess ice (Nbn), whereas ground-ice in the sand and gravel is non-visible, well bonded, excess ice (Nbe).

In the proposed mill area, ground-ice conditions are characterized by non-visible, poorly bonded or friable (Nf) to well bonded with no excess ice (Nbn). However, no ground-ice occurs below a depth of 1.0 m.

The ground-ice content of permafrost soil and rock in the Project area is expected to be between 0% and 10% (dry permafrost) based on regional scale compilation data (Brown et al. 1998). Localized excess ground-ice is expected to be greater in areas such as lowlands that are characterized by poorly drained conditions commonly expressed as patterned ground and other periglacial process features.

The surficial landforms (deposits) along the All-Season Road between the Kiggavik mine site and the north shore of Baker Lake is comprised mainly of glacial till overlying Precambrian intrusive igneous and metamorphic bedrock. The periglacial geomorphic processes in the area are typical of permafrost conditions associated with excess ground-ice. It is estimated that glacial landforms cover approximately 63% of the All-Season Road LAA. Alluvial, Marine, Glaciofluvial and Bedrock landforms cover 3.63%, 2.12%, 0.76% and 30.3% of this area, respectively. Organic deposits compose a small percentage of the materials that will be encountered along the route.

Glacial deposit is the most common and widespread surficial deposits in the proposed dock site area. Till veneer and till blanket appear to be the major glacial depositional units in the area. Marine deposits (primarily littoral sediments or its combination with bedrock) are generally noted occur in the south and southeast part of the proposed dock area. Based on results of the geotechnical investigation results, boreholes located on ice indicated that the overburden surface encountered at depths ranging range from 4.20 m to 5.15 m below ice surface in the vicinity of proposed dock site area. The ice thickness was is approximately 2.0 m. The overburden generally consists of medium brown, very fine to coarse, sub-angular and loose to very loose sand with trace silt and trace fine gravel underlain by sand and gravel with occasional cobble. Boreholes located on land revealed that overburden thicknesses vary from 2.93 m to 8.81 m below ground surface. The overburden generally consists of gravely sand underlain by glacial till. The glacial till is typically silty sand till with some fine to coarse gravel and some non-plastic clay. Oversize material in the glacial till consists of cobbles and boulders. Water content of samples of the till range from 7% to 14%.

6.2 Soils

6.2.1 Soil Classification

Three soil great groups from the Cryosolic Order containing 12 soil subgroups were documented within the Kiggavik RAA during the 2007 to 2010 baseline studies (Table 6.2-1). Cryosols are formed in either mineral or organic materials that have permafrost either within 1 m of the surface or within 2 m if the active layer of the soil profile has been strongly cryoturbated (CSSC 1998). The soil profiles observed within the Kiggavik RAA consisted of a shallow organic soil layer underlain by glacial tills varying in thickness from less than 1 m on ridges to more than 4 m in depressions (AREVA 2008).

The three Cryosolic Great Groups identified were Turbic Cryosols, Static Cryosols, and Organic Cryosols. Turbic Cryosols have the permafrost layer located within 2 m of the mineral surface and have marked cryoturbation (CSSC 1998). Static Cryosols have permafrost within 1 m of the surface, but show little or no evidence of cryoturbation (CSSC 1998). Static Cryosols generally develop on coarse-textured mineral parent material or thin soils over bedrock or in a wide textural range of recently deposited or disturbed sediments where evidence of cryoturbation is still largely absent, and may contain surface organic horizons less than 40 cm thick (CSSC 1998). Organic Cryosols have permafrost within 1 m of the surface and contain an organic layer greater than 40 cm thick. They develop principally from organic materials and have a surface layer composed of at least 30% organic material (CSSC 1998). Details pertaining to the 12 soil subgroups can be found in the Vegetation and Soils Baseline Report (Tier 3, Technical Appendix 6B.)

Table 6.2-1 Soil Classes Observed within the Kiggavik RAA

Soil Order	Soil Class	Abbreviation
Static Cryosols	Orthic Static Cryosol Brunisolic Static Cryosol Gleysolic Static Cryosol Histic Static Cryosol Regosolic Static Cryosol Histic Regosolic Static Cryosol	O.SC BR.SC GL.SC H.SC R.SC HR.SC
Turbic Cryosols	Orthic Turbic Cryosol Brunisolic Turbic Cryosol Gleysolic Turbic Cryosol Regosolic Turbic Cryosol	O.TC BR.TC GL.TC R.TC
Organic Cryosols	Terric Fibric Organic Cryosols Terric Humic Organic Cryosols	TFI.OC THU.OC

6.2.2 Baseline Soil Quality

Soil samples were collected within the Mine LAA. These samples ranged in texture from sandy clay to sandy loam, with the majority of the soils in the sandy clay loam textural class (see Tier 3, Technical Appendix 6B, Attachment G). The coarse fragment size and content of the soils varies widely from only one or two percent gravels in surface horizons to 90% cobble-size materials at the depth of permafrost. The average coarse fragment content (pebbles, gravel and cobbles) of the developed soil layers (A and B horizons) is approximately 30%.

Soil pH was found to be weakly acid to neutral (average 6.1), ranging from moderately acid (4.8) to slightly basic (7.8) (Table 6.2-2). Soils with low pH likely have low base saturation and relatively low nutrient contents, while those with slightly basic pH likely have high base saturation and relatively high nutrient contents. Neutral to basic soils likely occur where soils are frequently saturated and there is lateral movement of soil water, such as in the wet graminoid and graminoid tundra communities (Organic Cryosols).

Chemical analysis of soil samples revealed that, although mean concentrations for all analytes measured were below the CCME industrial soil guidelines (CCME 2009), some samples contained naturally elevated concentrations of some analytes (Table 6.2-2; see Tier 3, Technical Appendix 6B for detailed data). Five soil samples had elevated trace element concentrations. One sample had elevated arsenic concentration, two samples had elevated copper concentration, and one sample had elevated selenium concentration relative to the CCME (2009) guidelines. One sample from the RAA contained nickel concentrations that exceeded the guidelines.

Table 6.2-2 Soil Chemistry Data for the LAA and RAA (2007–2009) Compared with CCME Guideline Levels[1]

Parameter	Units	Mine LSA							RAA					CCME Guidelines (Industrial)
		Sample Number			Mean	SD	Range		Sample Number	Mean	SD	Range		
		2007[(a)]	2008[(b)]	Total			Min	Max	2009[(c)]			Min	Max	
pH	pH	6	50	56	6.1	0.76	4.8	7.8	ND	ND	ND	ND	ND	N/A
Moisture (mineral soil)	%	6	0	6	16	4.8	14	22	10	11	1.8	9.3	14.3	N/A
Moisture (peat)	%	5	0	5	78	3.6	74	84	ND	ND	ND	ND	ND	N/A
Aluminum	µg/g	11	0	11	17,227	11,318	4,400	37,200	10	7,594	3,960	3,500	16,200	N/A
Antimony	µg/g	11	50	61	4.1	2	<0.1	5.0	10	<0.2	N/A	<0.2	N/A	40
Arsenic	µg/g	11	50	61	3.7	2	1.2	13.6	10	3.1	1.4	1.4	5.8	12
Barium	µg/g	11	50	61	156	177	27	910	10	138	202	48	710	2,000
Beryllium	µg/g	11	50	61	0.38	0	<0.5	2.1	10	0.4	0.11	0.3	0.6	8
Boron	µg/g	11	0	11	16	20	<1	54	10	15	19	0.5	48	N/A
Cadmium	µg/g	11	50	61	0.26	0	<0.1	0.89	10	<0.1	N/A	<0.1	N/A	22
Chromium	µg/g	11	50	61	20	7	4.6	44	10	15	14	6.8	54	87
Cobalt	µg/g	11	50	61	4.3	2	1.3	8.9	10	4.0	3.3	1.6	13	300
Copper	µg/g	11	50	61	14	19	2.2	96	10	6.3	6.1	2	23	91
Iron	µg/g	11	0	11	12,391	5,218	5,700	25,000	10	11,810	4,896	7,400	25,100	N/A
Lead	µg/g	11	50	61	15	10	0.74	85	10	11	6.5	4.1	23	600
Manganese	µg/g	11	0	11	150	77	11	280	10	115	53	61	230	N/A
Mercury	µg/g	11	50	61	0.012	0	<0.005	0.12	0	ND	ND	ND	ND	50
Molybdenum	µg/g	11	50	61	2.0	1	0.2	6.9	10	0.2	0.067	0.1	0.3	40
Nickel	µg/g	11	50	61	13	6	<5	34	10	14	17	5.1	61	50
Selenium	µg/g	11	50	61	0.92	0	<0.1	<4.0	10	0.08	0.079	0.05	0.3	2.9
Silver	µg/g	11	50	61	0.84	0	<0.1	1.0	10	<0.1	N/A	<0.1	N/A	40
Strontium	µg/g	11	0	11	73	18	47	110	10	115	102	66	400	N/A
Thallium	µg/g	11	50	61	0.44	0	<0.05	0.50	10	<0.2	N/A	<0.2	N/A	1
Tin	µg/g	11	50	61	2.1	1	<0.05	2.5	10	0.08	0.049	0.05	0.2	300
Titanium	µg/g	11	0	11	303	96	54	410	10	608	419	210	1,600	N/A
Uranium	µg/g	11	0	11	2.5	2	0.65	6.0	10	1.3	0.56	0.8	2.4	300
Vanadium	µg/g	11	50	61	19	7	4.3	47	10	22	13	13	59	130
Zinc	µg/g	11	50	61	19	8	6.2	50	10	20	13	9.1	56	360

Table 6.2-2 Soil Chemistry Data for the LAA and RAA (2007–2009) Compared with CCME Guideline Levels[1]

Parameter	Units	Mine LSA							RAA					CCME Guidelines (Industrial)
		Sample Number			Mean	SD	Range		Sample Number	Mean	SD	Range		
		2007[(a)]	2008[(b)]	Total			Min	Max	2009[(c)]			Min	Max	
Lead-210	Bq/g	11	31[(b)]	42[(b)]	0.020	0.024	<0.006	0.13	10	<0.04	N/A	<0.04	N/A	N/A
Polonium-210	Bq/g	11	31[(b)]	42[(b)]	0.036	0.070	0.004	0.47	10	0.022	0.010	0.005	0.03	N/A
Radium-226	Bq/g	11	31[(b)]	42[(b)]	0.039	0.030	<0.01	0.14	10	0.035	0.020	0.005	0.08	N/A
Thorium-230	Bq/g	11	31[(b)]	42[(b)]	0.037	0.024	0.017	0.13	10	0.020	0.012	0.01	0.04	N/A
Thorium-232	Bq/g	0	31[(b)]	31[(b)]	0.028	0.012	<0.02	0.06	10	0.032	0.014	0.01	0.05	N/A

NOTES:

Shaded value indicates guideline level is exceeded

[1] Based on Table 5.2-3 in Tier 3, Technical Appendix 6B

[(a)] Includes mineral soil samples collected from all six sampling locations and peat samples collected from five of the sampling locations (not SIS3)

[(b)] Includes 20 individual samples (two from each sampling location) and 10 composite samples (one composite from each sampling location), plus an extra sample collected at KIG4

[(c)] Includes 10 samples collected from two sampling locations in 2009

ND = No data

N/A = Not applicable

SD = Standard deviation

CCME = Canadian Council of Ministers of the Environment Soil Quality Guideline (CCME 2009)

The baseline soil trace element and radionuclide data were compared to CCME guidelines (CCME 2009). Radionuclides are frequently elevated in soils above uranium ore deposits, which may also have elevated concentrations of other trace elements. Baseline radionuclide and trace element concentrations are established so that naturally elevated concentrations are not attributed to mining during operational and post closure monitoring. The guidelines are for general guidance only, and site-specific conditions will be considered in the effects assessment for soil quality.

6.2.3 Baseline Soil Quantity

The soils predominantly consist of a shallow organic veneer overlying fine to coarse-textured glacial till blankets, which vary in thickness from less than 1 m on bedrock ridges to more than 4 m in depressions. The growth medium layer (i.e., the organic layers plus organic enriched mineral soil, or topsoil depth) identified during the baseline studies varied from 3 to 31 cm, with an average depth of approximately 11 cm. Vegetation roots were frequently observed in the B horizon. Rooting depth was frequently restricted by frozen or strongly cryoturbated soil (see Tier 3, Technical Appendix 6B, Attachment G). Approximately 54% of the topsoil depth in any given area is peat organic material. The till-derived mineral fraction of the soils is medium textured, with coarse fragment size typically ranging from gravel to cobble. Coarse fragment content is typically low at the surface, and increases with depth.

6.3 Vegetation

6.3.1 Species

Field surveys completed between 1979 and 2009 within the Kiggavik area identified 170 vascular plant species, 21 bryophyte species and 75 lichen species. During the 2008/2009 vegetation baseline surveys, 88 vascular plants and 20 lichen species were identified within the RAA. No vegetation species that have legislative protection (e.g. Species at Risk Act) or identified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), also provide information on vegetation) were observed within the Mine LAA, road LAAs or RAA.

Two vegetation species listed on Schedule 1 of SARA occur in Nunavut: felt-leaf willow (*Salix silicicola)* and Porsild's Bryum (*Mielichhoferia macrocarpa)*. Felt-leaf willow is listed as a species of Special Concern and has been observed near Pelly Lake, Northwest Territories, which is located outside of the RAA (SARPR 2011). Porsild's Bryum is a moss species listed as Threatened. The only recorded location for Porsild's Bryum in Nunavut is on Ellesmere Island (SARPR 2011). Neither of these species were observed during the baseline surveys.

6.3.2 Communities

6.3.2.1 Ecological Land Classification Units

The RAA is dominated by tundra vegetation interspersed with lichen-dominated bedrock outcroppings and boulder fields. Short shrubs such as dwarf birch, willows and heath species, as well as sedges and grasses, herbs, mosses and lichens characterize the tundra vegetation. An ecological classification scheme containing 15 ELC units were identified within the LAAs and RAA, and are summarized in Table 6.3-1.

Table 6.3-1 Ecological Land Classification Units

Category	ELC Unit	Description
Anthropogenic	Disturbance	Anthropogenic disturbance on the landscape, located primarily near the community of Baker Lake
Unclassified	Cloud/ Shadow	Areas of cloud and associated shadows present within the source Landsat image
Non Vegetated	Sand	Areas of exposed sand typically found in dry river or lake beds, or beach ridge uplands
	Gravel	Areas of exposed gravel typically found in dry river or lake beds, eskers or beach ridge uplands
Upland	Rock Association	Areas of bedrock outcrops and boulder fields
	Graminoid Tundra	Sedge communities in mesic areas, including tussock/hummock formations. Usually found on peat substrates. Dominant plant species include mesic sedges (*Carex spp*.), with small amounts of water sedge, tall cottongrass, shrubs and forbs
	Graminoid/ Shrub Tundra	A transition between Graminoid Tundra and Shrub Tundra communities; occurs in mesic areas with 25 to 50% cover of shrubs that are less than 40 cm in height. Graminoids, mosses, and lichens are also present
	Shrub Tundra	Mesic moisture regime communities with at least 50% cover of shrubs such as dwarf birch (*Betula glandulosa*) and diamond leaf willow (*Salix planifolia*); the understory consists of some lichens and herbs; moss may be present
	Shrub/ Heath Tundra	A transitional unit between Shrub Tundra and Heath Tundra; occurs on well to moderately drained soils (mesic-xeric moisture regime) with between 30 and 50% cover of erect shrubs that are less than 40 cm tall; graminoids, mosses, and lichens may be present
	Heath Tundra	Occurs on well to moderately drained soils (mesic-xeric moisture regime) and is dominated by ericaceous shrubs, lichens and some graminoids; vegetative cover typically exceeds 70% with less than 30% exposed rock; erect shrubs are present but to a lesser degree than the shrub/heath tundra unit (less than 30%)

Table 6.3-1 Ecological Land Classification Units

Category	ELC Unit	Description
	Heath Upland	Occurs on rocky substrate with xeric moisture regime; over 70% vegetation cover including ericaceous shrubs, lichens and graminoids; typical species include bog blueberry (*Vaccinium uliginosum*), white arctic mountain heather (*Cassiope tetragona*), northern Labrador tea (*Ledum decumbens*), black crowberry (*Empetrum nigrum*) and the lichen ballroom dervish (*Cetraria nivalis*)
	Heath Upland/ Rock Complex	A transition between Heath Upland and Rock Association, this unit is dominated by ericaceous shrubs and lichens with rock or boulder substrate; closely resembles both parent communities
	Lichen Tundra	Develops on well-drained and poorly developed soils (xeric moisture regime); substrate is typically sand, gravel or cobble; unit is most often associated with esker ridges and ridged moraine landforms; green witch's hair lichen (*Alectoria ochroleuca*), *Bryoria nitidula*, crinkled snow lichen (*Cetraria cucullata*), Iceland moss (*Cetraria islandica*), ballroom dervish, and lesser green reindeer lichen (*Cladina mitis*) are the dominant species
Wetland	Water	Water features identified in the imagery; waterbodies greater than 0.75 ha and rivers wider than 75 m are distinguishable in Landsat imagery
	Wet Graminoid	Occurs in poorly drained areas (hygric moisture regime) and around water features; water sedge (*Carex aquatilis)* and tall cottongrass (*Eriophorum angustifolium*) are dominant species; moss is also present

6.3.2.2 Wetlands

Wetlands are areas saturated with water long enough to promote aquatic processes, as indicated by poorly drained soils, hydrophytic vegetation and other biological activity adapted to a wet environment (NWWG 1997). In the low arctic, wetland definitions have been refined to include only areas waterlogged throughout the year (Zoltai and Pollett 1983; Boch 1974; Tarnocai and Zoltai 1988). Tarnocai and Zoltai (1988) note that, in the low arctic, "large expanses of tundra, covered with tussock forming graminoid species such as *Carex bigelowii* and *Eriophorum vaginatum* are not considered to be wetlands since they are not waterlogged throughout the year." As such, the Graminoid Tundra ELC unit is considered an upland ELC unit. Units with more permanent water were considered wetland (i.e., the Water and Wet Graminoid ELC units).

6.3.3 Species of Value to Inuit

During the IQ studies, interviews with Elders identified vegetation species that were harvested for food. The majority of the responses from the Elders focussed on berry-producing vegetation species such as black berries (*Empetrum nigrum)*, cloudberries (*Rubus chamaemorus)*, blueberries

(*Vaccinium uliginosum)*, and cowberries (*Vaccinium vitis-idaea)*. During the baseline studies, 11 ELC units were found to have moderate to high potential to support these species (Table 6.3-2).

Table 6.3-2 ELC Units Containing Species of Traditional Value to Inuit

ELC Unit	Species of Traditional Value to Inuit			
	Black Berries	**Cloudberries**	**Blueberries**	**Cowberries**
	Empetrum nigrum	***Rubus chamaemorus***	***Vaccinium uliginosum***	***Vaccinium vitis-idaea***
Wet Graminoid			x	
Graminoid Tundra			x	x
Graminoid/ Shrub Tundra			x	
Shrub Tundra			x	x
Shrub/Heath Tundra	x		x	x
Heath Tundra	x		x	x
Heath Upland	x	x	x	x
Heath Upland/Rock Complex	x		x	x
Lichen Tundra	x	x		x
Gravel	x			
Rock Association	x			

NOTE:
x indicates that species occurs with over 10% cover in at least one ELC plot, indicating moderate to high potential to occur within the ELC unit, while no symbol indicates that species occurs with less than 10% cover in all ELC plots, indicating low potential to occur within the ELC unit.

6.3.4 Plant Tissue Chemistry

Analyte concentrations were analyzed from plant tissue samples collected between 2007 and 2009. Sampled tissue included primarily sedge, lichen and berries, as well as some 2007 foliage samples collected from birch, willow and blueberry bush. Mean concentrations for each tissue type are summarized in Tables 6.3-3 to 6.3-6.

Table 6.3-3 Plant Tissue Chemistry Data (Berries) for the Mine LAA and RAA (2007–2009)

Parameter	Unit	Mine LAA (2007/2008)					RAA (2009)				
					Range					Range	
		n	Mean	SD	Min	Max	n	Mean	SD	Min	Max
Aluminum	ug/g	50	7.2	14	<2	75.2	2	5.1	2.1	3.6	6.5
Antimony	ug/g	50	0.010	0.015	<0.010	<0.10	2	0.050	0	<0.1	<0.1
Arsenic	ug/g	50	0.0078	0.0071	<0.010	0.026	2	0.025	0	<0.05	<0.05
Barium	ug/g	50	4.4	6.4	0.813	27	2	10	0.78	9.9	11
Beryllium	ug/g	50	0.045	0.015	<0.01	<0.10	2	0.0050	0	<0.01	<0.01
Boron	ug/g	6	27	17	14	60	2	5.0	0	5	5
Cadmium	ug/g	50	0.037	0.078	<0.005	0.36	2	0.013	0.011	<0.01	0.02
Chromium	ug/g	50	0.46	0.92	<0.10	4.94	2	0.25	0	<0.5	<0.5
Cobalt	ug/g	50	0.017	0.016	<0.02	0.067	2	0.023	0.025	<0.01	0.04
Copper	ug/g	50	1.2	1.4	0.537	7	2	4.4	0.14	4.3	4.5
Iron	ug/g	6	17	6.6	12	30	2	10	0	10	10
Lead	ug/g	50	0.012	0.0077	<0.01	0.05	2	0.030	0	0.03	0.03
Manganese	ug/g	50	50	69	6.07	310	2	75	21	60	90
Mercury	ug/g	50	0.0034	0.0080	<0.0010	<0.05	ND	ND	ND	ND	ND
Molybdenum	ug/g	50	0.092	0.22	<0.010	1.5	2	0.075	0.035	<0.1	0.1
Nickel	ug/g	50	0.51	0.65	<0.1	2.99	2	0.70	0.29	0.49	0.9
Selenium	ug/g	50	0.091	0.025	<0.05	<0.20	2	0.025	0	<0.05	<0.05
Silver	ug/g	6	0.0050	0	<0.01	<0.01	2	0.005	0	<0.1	<0.1
Strontium	ug/g	50	0.92	1.4	0.179	7.2	2	11	7.4	5.6	16
Thallium	ug/g	50	0.0074	0.0066	<0.010	<0.05	2	0.025	0	<0.05	<0.05
Tin	ug/g	50	0.11	0.062	<0.05	0.336	2	0.025	0	<0.05	<0.05
Titanium	ug/g	6	0.25	0.28	0.06	0.79	2	0.19	0.078	0.13	0.24
Uranium	ug/g	50	0.0017	0.0015	<0.002	0.0059	2	0.0050	0	<0.01	<0.01
Vanadium	ug/g	50	0.050	0	<0.1	<0.1	2	0.050	0	<0.1	0.1
Zinc	ug/g	50	17	12	1.31	40.4	2	8.9	1.6	7.8	10
Bismuth	ug/g	44	0.015	0	<0.03	<0.03	ND	ND	ND	ND	ND
Calcium	ug/g	44	273	100	88.6	479	ND	ND	ND	ND	ND
Lithium	ug/g	44	0.050	0	<0.10	<0.10	ND	ND	ND	ND	ND
Magnesium	ug/g	44	84	11	51.2	108	ND	ND	ND	ND	ND

Table 6.3-3 Plant Tissue Chemistry Data (Berries) for the Mine LAA and RAA (2007–2009)

Parameter	Unit	Mine LAA (2007/2008)					RAA (2009)				
					Range					Range	
		n	Mean	SD	Min	Max	n	Mean	SD	Min	Max
Moisture	%	50	87	1.2	84.7	89.8	2	82	2.5	80.65	84.19
Lead-210	Bq/g	16	0.0071	0.0044	<0.002	0.014	2	0.060	0.041	0.031	0.089
Polonium-210	Bq/g	16	0.0068	0.0039	0.002	0.014	2	0.0085	0.0035	0.006	0.011
Radium-226	Bq/g	16	0.0011	0.0009	<0.0005	0.004	2	0.0020	0	0.002	0.002
Thorium-230	Bq/g	16	0.0017	0.0010	<0.0004	<0.005	2	0.0010	0	<0.002	<0.002
Thorium-232	Bq/g	10	0.0025	0.0002	<0.004	<0.005	2	0.0010	0	<0.002	<0.002

NOTE:

Data are for samples collected at locations indicated in Tier 3, Technical Appendix 6B, Section 4.1.2.3, Figure 4.1-2.

All 2007 LSA samples run individually for both metals and radionuclide analysis.

All 2008 LSA samples run individually for metals analysis; 44 LSA berry samples were combined into 10 composite samples for radionuclide analysis; 100 LSA sedge/lichen samples from 2008 were combined into 35 composite samples and 20 discrete samples for radionuclide analysis.

All 2009 RAA samples run individually for metals and radionuclide analysis.

ND = No data

n = Sample size

SD = Standard deviation

Table 6.3-4 Plant Tissue Chemistry Data (Lichen) for the Mine LAA and RAA (2007–2009)

Parameter	Unit	Mine LAA (2007/08)					RAA (2009)				
					Range					Range	
		n	Mean	SD	Min	Max	n	Mean	SD	Min	Max
Aluminum	ug/g	56	178	276	16	1640	10	116	72	66	310
Antimony	ug/g	56	0.021	0.011	<0.020	<0.10	10	0.050	0	<0.1	<0.1
Arsenic	ug/g	56	0.091	0.069	<0.020	0.405	10	0.051	0.028	<0.05	0.09
Barium	ug/g	56	47	33	10.1	243	10	55	34	19	130
Beryllium	ug/g	56	0.16	0.061	<0.01	<0.40	10	0.015	0.015	<0.01	0.05
Boron	ug/g	6	2.5	0.55	2	3	10	0.70	0.26	<1	1
Cadmium	ug/g	56	0.11	0.059	0.019	0.296	10	0.10	0.055	0.03	0.21
Chromium	ug/g	56	1.4	3.0	<0.2	17.9	10	0.25	0	<0.5	<0.5
Cobalt	ug/g	56	0.25	0.55	<0.060	3.84	10	0.15	0.11	0.05	0.37
Copper	ug/g	56	2.1	1.1	0.6	6.19	10	1.2	0.51	0.56	2.4
Iron	ug/g	6	160	97	78	310	10	126	122	50	470
Lead	ug/g	56	0.69	1.0	0.104	6.96	10	0.77	0.80	0.29	3
Manganese	ug/g	56	199	119	27	652	10	202	73	90	350
Mercury	ug/g	56	0.035	0.023	0.0041	0.1	ND	ND	ND	ND	ND
Molybdenum	ug/g	56	0.28	0.52	<0.030	3.41	10	0.055	0.016	<0.1	0.1
Nickel	ug/g	56	1.3	1.6	<0.30	9.09	10	0.49	0.25	0.21	0.94
Selenium	ug/g	56	0.32	0.12	<0.05	<0.80	10	0.025	0	<0.05	<0.05
Silver	ug/g	6	0.034	0.049	<0.01	0.13	10	0.0085	0.0078	<0.01	0.03
Strontium	ug/g	56	13	6.8	4.17	44.5	10	33	32	6.8	100
Thallium	ug/g	56	0.019	0.0078	<0.020	0.069	10	0.025	0	<0.05	<0.05
Tin	ug/g	56	0.083	0.024	<0.05	<0.20	10	0.047	0.058	<0.05	0.21
Titanium	ug/g	6	6.5	3.2	3.2	11	10	4.8	4.4	2.2	17
Uranium	ug/g	56	0.37	2.4	<0.006	18.1	10	0.014	0.011	<0.01	0.04
Vanadium	ug/g	56	0.36	0.66	<0.20	4.67	10	0.20	0.15	<0.1	0.6
Zinc	ug/g	56	28	9.2	10.9	60	10	19	3.6	13	24
Bismuth	ug/g	50	0.067	0.10	<0.060	0.726	ND	ND	ND	ND	ND
Calcium	ug/g	50	3431	1663	933	10700	ND	ND	ND	ND	ND
Lithium	ug/g	50	0.30	0.62	<0.20	4.34	ND	ND	ND	ND	ND
Magnesium	ug/g	50	532	156	212	1080	ND	ND	ND	ND	ND

Table 6.3-4 Plant Tissue Chemistry Data (Lichen) for the Mine LAA and RAA (2007–2009)

Parameter	Unit	Mine LAA (2007/08)					RAA (2009)				
		n	Mean	SD	Range		n	Mean	SD	Range	
					Min	Max				Min	Max
Moisture	%	56	34	20	9.98	68	ND	ND	ND	ND	ND
Lead-210	Bq/g	34	0.45	0.085	0.26	0.64	10	0.58	0.068	0.48	0.71
Polonium-210	Bq/g	34	0.40	0.079	0.15	0.58	10	0.53	0.11	0.36	0.65
Radium-226	Bq/g	34	0.010	0.030	<0.001	0.18	10	0.0045	0.0031	<0.001	0.011
Thorium-230	Bq/g	34	0.0095	0.041	<0.0005	0.24	10	0.0020	0.0014	<0.003	0.006
Thorium-232	Bq/g	28	0.0025	0	<0.005	<0.005	10	0.0015	0	<0.003	<0.003

NOTES:

Data are for samples collected at locations indicated Tier 3, Technical Appendix 6B, Section 4.1.2.3, Figure 4.1-2.

All 2007 LSA samples run individually for both metals and radionuclide analysis.

All 2008 LSA samples run individually for metals analysis; 44 LSA berry samples were combined into 10 composite samples for radionuclide analysis; 100 LSA sedge/lichen samples from 2008 were combined into 35 composite samples and 20 discrete samples for radionuclide analysis.

All 2009 RAA samples run individually for metals and radionuclide analysis.

ND = No data

n = Sample size

SD = Standard deviation

Table 6.3-5 Plant Tissue Chemistry Data (Sedges) for the Mine LAA and RAA (2007–2009)

Parameter	Unit	Mine LAA (2007/08)					RAA (2009)				
					Range					Range	
		n	Mean	SD	Min	Max	n	Mean	SD	Min	Max
Aluminum	ug/g	56	65	116	3.4	839	10	59	40	1.4	140
Antimony	ug/g	56	0.016	0.012	<0.02	<0.10	10	0.050	0	<0.1	<0.1
Arsenic	ug/g	56	0.057	0.091	<0.02	0.51	10	0.034	0.019	<0.05	0.07
Barium	ug/g	56	36	21	8.51	97	10	71	29	8.9	110
Beryllium	ug/g	56	0.10	0.044	<0.01	<0.40	10	0.012	0.014	<0.01	0.05
Boron	ug/g	6	9.0	3.3	5	15	10	3.3	2.2	<1	7
Cadmium	ug/g	56	0.045	0.032	<0.01	0.171	10	0.066	0.050	<0.01	0.18
Chromium	ug/g	56	1.1	3.2	<0.20	22.8	10	0.25	0	<0.5	<0.5
Cobalt	ug/g	56	0.16	0.19	0.02	0.868	10	0.15	0.094	<0.01	0.29
Copper	ug/g	56	2.2	0.91	0.602	4.4	10	2.4	1.1	0.37	4.3
Iron	ug/g	6	112	101	16	300	10	87	53	4.8	220
Lead	ug/g	56	0.19	0.20	0.02	0.947	10	0.41	0.20	0.02	0.71
Manganese	ug/g	56	159	108	39.9	560	10	400	306	50	1100
Mercury	ug/g	56	0.012	0.010	0.002	0.0445	ND	ND	ND	ND	ND
Molybdenum	ug/g	56	0.57	0.89	<0.02	4.8	10	0.58	0.32	0.05	1.1
Nickel	ug/g	56	1.1	1.7	0.24	12.5	10	0.81	0.43	0.06	1.6
Selenium	ug/g	56	0.21	0.085	<0.05	<0.80	10	0.025	0	<0.05	<0.05
Silver	ug/g	6	0.025	0.033	<0.01	0.09	10	0.0050	0	<0.01	<0.01
Strontium	ug/g	56	8.4	5.0	1.99	25.1	10	35	35	1.6	110
Thallium	ug/g	56	0.013	0.0050	<0.02	<0.05	10	0.025	0	<0.05	<0.05
Tin	ug/g	56	0.068	0.10	<0.05	0.82	10	0.025	0	<0.05	<0.05
Titanium	ug/g	6	0.68	1.0	0.11	2.7	10	1.7	1.8	0.06	6
Uranium	ug/g	56	0.44	2.1	<0.004	13.9	10	0.016	0.013	<0.01	0.04
Vanadium	ug/g	56	0.17	0.24	<0.10	1.73	10	0.080	0.079	<0.1	0.3
Zinc	ug/g	56	19	14	6.89	100	10	42	23	3.6	70
Bismuth	ug/g	50	0.035	0.0088	<0.06	<0.12	ND	ND	ND	ND	ND
Calcium	ug/g	50	1767	963	542	5960	ND	ND	ND	ND	ND
Lithium	ug/g	50	0.14	0.12	<0.20	0.89	ND	ND	ND	ND	ND
Magnesium	ug/g	50	413	121	183	740	ND	ND	ND	ND	ND

Table 6.3-5 Plant Tissue Chemistry Data (Sedges) for the Mine LAA and RAA (2007–2009)

Parameter	Unit	Mine LAA (2007/08)					RAA (2009)				
		n	Mean	SD	Range		n	Mean	SD	Range	
					Min	Max				Min	Max
Moisture	%	56	53	13	15.6	70.67	ND	ND	ND	ND	ND
Lead-210	Bq/g	33	0.18	0.12	0.007	0.46	10	0.32	0.092	0.14	0.43
Polonium-210	Bq/g	33	0.14	0.083	0.012	0.29	10	0.26	0.078	0.12	0.38
Radium-226	Bq/g	33	0.014	0.045	0.001	0.26	10	0.0047	0.0025	<0.001	0.008
Thorium-230	Bq/g	33	0.0075	0.021	<0.0005	0.12	10	0.0014	0.0009	<0.002	0.004
Thorium-232	Bq/g	27	0.0034	0.0036	<0.004	0.02	10	0.0011	0.0002	<0.002	<0.003

NOTES:

Data are for samples collected at locations indicated Tier 3, Technical Appendix 6B, Section 4.1.2.3, Figure 4.1-2.

All 2007 LSA samples run individually for both metals and radionuclide analysis.

All 2008 LSA samples run individually for metals analysis; 44 LSA berry samples were combined into 10 composite samples for radionuclide analysis; 100 LSA sedge/lichen samples from 2008 were combined into 35 composite samples and 20 discrete samples for radionuclide analysis.

All 2009 RAA samples run individually for metals and radionuclide analysis.

ND = No data

n = Sample size

SD = Standard deviation

Table 6.3-6 Plant Tissue Chemistry Data (Foliage) for the Mine LSA (2007)

Parameter	Unit	n	Mean	SD	Range	
					Min	Max
Aluminum	ug/g	18	33	25	8.6	100
Antimony	ug/g	18	0.050	0	<0.1	<0.1
Arsenic	ug/g	18	0.031	0.025	<0.05	0.13
Barium	ug/g	18	87	30	55	160
Beryllium	ug/g	18	0.0050	0	<0.01	<0.01
Boron	ug/g	18	12	3.6	9	21
Cadmium	ug/g	18	1.2	1.5	0.08	5
Chromium	ug/g	18	0.27	0.082	<0.5	0.6
Cobalt	ug/g	18	0.42	0.30	0.05	1
Copper	ug/g	18	6.8	2.1	4.3	12
Iron	ug/g	18	28	5.2	22	37
Lead	ug/g	18	0.11	0.058	0.04	0.21
Manganese	ug/g	18	488	302	100	1300
Mercury	ug/g	18	0.025	0	<0.05	<0.05
Molybdenum	ug/g	18	0.12	0.16	<0.1	0.6
Nickel	ug/g	18	1.8	1.0	0.57	4.1
Selenium	ug/g	18	0.025	0	<0.05	<0.05
Silver	ug/g	18	0.011	0.014	<0.01	0.05
Strontium	ug/g	18	18	13	5	47
Thallium	ug/g	18	0.025	0	<0.05	<0.05
Tin	ug/g	18	0.027	0.0082	<0.05	0.06
Titanium	ug/g	18	4.2	12	0.3	49
Uranium	ug/g	18	0.0053	0.0012	<0.01	0.01
Vanadium	ug/g	18	0.16	0.41	<0.1	1.8
Zinc	ug/g	18	132	98	32	380
Bismuth	ug/g	ND	ND	ND	ND	ND
Calcium	ug/g	ND	ND	ND	ND	ND
Lithium	ug/g	ND	ND	ND	ND	ND

Table 6.3-6 Plant Tissue Chemistry Data (Foliage) for the Mine LSA (2007)

Parameter	Unit	n	Mean	SD	Range	
					Min	Max
Magnesium	ug/g	ND	ND	ND	ND	ND
Moisture	%	18	53	3.0	48.25	58.63
Lead-210	Bq/g	18	0.11	0.028	0.057	0.16
Polonium-210	Bq/g	18	0.089	0.025	0.045	0.13
Radium-226	Bq/g	18	0.0043	0.0029	0.0012	0.014
Thorium-230	Bq/g	18	0.00063	0.0004	<0.0004	0.002
Thorium-232	Bq/g	ND	ND	ND	ND	ND

NOTES:
Data are for samples collected at locations indicated in Tier 3, Technical Appendix 6B, Section 4.1.2.3, Figure 4.1-2.
All samples run individually for both metals and radionuclide analysis.
Samples consisted of foliage collected from willow, birch and blueberry bush.
ND = No data ; n = Sample size ; SD = Standard deviation

7 Effects Assessment for Terrain

7.1 Scope of the Assessment for Terrain

7.1.1 Project-Environment Interactions and Environment Effects

The Kiggavik Project has the potential to affect terrain through changes in permafrost conditions and terrain stability, and changes in landforms. Protection of the existing permafrost conditions and thermal regime is closely associated with stability of the terrain and landforms, including the stability of Project elements.

Key issues related to Project effects on terrain include:

- change in terrain and landforms due to disturbance of eskers and other significant and sensitive landforms
- change in permafrost conditions and terrain stability due to vegetation clearing, potential changes in slope, redirection of surface drainage patterns, changes in sub-surface flow and blasting

Refer to Table 5.5-1 for potential interactions between all Project activities and terrain along with rationale for Project–terrain interactions ranked as 1. Interactions ranked as 2 in Table 5.5-1 are examined further here.

Project activities that are the focus of the terrain assessment are summarized in Table 7.1-1.

Table 7.1-1 Project-Environment Interactions and Effects on Terrain

Project Component	Project Activities	Environmental Effect: Change in Permafrost and Terrain Stability	Environmental Effect: Change in Landforms
Construction			
In-Water Construction	Construct freshwater diversions and site drainage containment systems (dykes, berms, collection ponds)	2	1
On-Land Construction	Site clearing and pad construction (blasting, earth-moving, loading, hauling, dumping, crushing)	2	2
	Road and airstrip construction	1	2
	Aggregate sourcing	2	2
	Construct foundations	2	2
Operation			
Mining	Mining ore (blasting, loading, hauling)	2	2
	Special waste (blasting, loading, hauling)	2	2
	Clean waste (blasting, loading, hauling)	2	2
Tailings Management	Placement of tailings slurry, consolidation of tailings and pumping of TMF supernatant	2	0
Final Closure			
In-Water Decommissioning	Water transfers and discharge	2	0
On-Land Decommissioning	Remove site pads (blasting, earth-moving, loading, hauling, dumping)	2	2
	Backfilling	2	0
	Contouring	2	0

Construct Freshwater Diversions and Site Drainage

Site preparation, excavation, and construction of freshwater diversions and site drainage channels (such as dykes, berms and collection ponds) could have potential effects to slope stability, shoreline erosion, slides, rock falls and slumping in surficial deposits and shallow bedrock. These effects could further accelerate changes in landforms. However, the following measures will be taken into consideration to mitigate these potential adverse effects during design and construction phases of the Project (see details in Tier 3, Technical Appendix 2E).

- When a channel is transverse across a slope, natural ground elevation may be used as one channel side and a berm constructed on the opposite side..
- The diversion channels will be constructed maintain the structural integrity of the channel, depending on the terrain and geo-technical conditions.
- Erosion control structures will be incorporated into the design of the freshwater diversion channels to reduce the potential for erosion and sediment transport.
- Freshwater diversion channels will be designed to prevent channel deformation caused by melting of permafrost located adjacent to the channel.
- An ongoing monitoring and maintenance program focussing on the structural integrity of the freshwater diversion channel will occur.

The engineered design of freshwater diversion channels is intended to address potential effects of the Project on terrain. By maintaining terrain stability, Project effects on terrain are minimized. With the implementation of these mitigation measures, the residual effects from the construction of freshwater diversions and site drainage on landforms are anticipated to be minor; hence, the level of interaction between Project activities and the VEC is ranked as 1 and not carried forward for further assessment.

Road and Airstrip Construction

The road and airstrip will be built with granular materials (fill method) placed on top of the existing terrain surface. The total embankment fills for the road construction will range from 0.5 m (exposed rock area) to 1.8 m (wet terrain condition with medium to high ground-ice content). The total embankment fill for the airstrip site will be a minimum of 2 m thick. By placing materials on top of the existing terrain, the surface insulation layer that protects the shallow permafrost regime will not be disturbed; therefore, the potential for thawing of the permafrost layer at the road location is reduced, which also prevents any terrain stability issues. As well, any adverse environmental effect related to erosion (influenced by thawing of the permafrost layer) is also reduced.

The proposed road and airstrip are designed and routed on higher ground as these areas tend to contain less ground-ice, fewer drainage areas to cross, are less prone to snow drifts, and generally contain more bedrock. Routing the proposed road on higher ground will reduce geotechnical issues and road fill required during construction. This will also reduce potential maintenance issues (e.g., snow drifts) throughout the life of the Project. Permafrost conditions and terrain stability are not anticipated to be affected by development of the winter road option. Adding granular fill to create a level travel surface, winter road will be an ice road.

The road construction will likely impede water courses and change the existing drainage pattern. Appropriate culverts will be designed and placed in areas crossed by the road options where surface drainage is apparent.

In the presence of appropriate mitigation measures, the residual effects from road and airstrip construction on permafrost condition and terrain stability are anticipated to be not significant and hence the level of interaction between Project activities and the VEC is ranked as 1 and not carried forward for further assessment

Potential interactions ranked as 2 are subject to a more detailed analysis and carried forward in the assessment in order to predict, mitigate and evaluate the potential environmental effects.

7.1.2 Measurable Parameters

Table 7.1-2 lists the measurable parameters used to assess Project effects on terrain and the rationale for their selection.

Table 7.1-2 Measurable Parameters for Terrain

VEC	Environmental Effect	Measurable Parameters	Rationale
Terrain	Change in Permafrost and Terrain Stability	Thaw depth, ground-ice content	Vegetation clearing, potential change in slope, redirection of surface drainage patterns, changes in sub-surface flow, and blasting may result in changes to permafrost conditions and terrain stability
	Change in Landforms	Direct loss of uncommon landforms from Project footprint	Disturbance to eskers may result in changes to culturally and traditionally significant landforms

7.1.3 Residual Environmental Effects Criteria for Terrain

Project residual environmental effects on terrain are characterized quantitatively and qualitatively using the following attributes: direction, magnitude, geographic extent, duration, frequency, and reversibility. Definitions of these attributes are presented in Table 7.1-3.

Table 7.1-3 Residual Environmental Effects Criteria for Terrain

Attribute	Rating	Definition
Direction	Positive	Improvement in permafrost condition, terrain stability or change in landforms relative to baseline conditions
	Neutral	No change in permafrost condition, terrain stability or change in sensitive landforms relative to baseline conditions
	Adverse	Reduction in permafrost condition, terrain stability or change in sensitive landforms relative to baseline conditions
Magnitude	Negligible	No measurable change from baseline conditions or natural variation on permafrost, terrain stability or landforms
	Low	Effect on one or more of the measurable parameters is detectable, but within the range of natural variation or baseline values; no change in permafrost condition, terrain stability or landforms
	Moderate	Effect on one or more of the measurable parameters is detectable and outside the range of natural variation or baseline values, but unlikely to change in permafrost condition, terrain stability or landforms
	High	Effect on one or more of the measurable parameters is detectable and outside the range of natural variation or baseline values, and hence a change in permafrost condition, terrain stability or landforms is evident
Geographic Extent	Site	Effect confined to specific features within the Project footprint
	Local	Effect confined to the LAA
	Regional	Effect extends beyond the LAA but within the RAA
Frequency	Once	Effect occurs once throughout the Project
	Sporadic	Effect occurs more than once, but at unpredictable intervals throughout the Project
	Regular	Effect occurs repeatedly at regular intervals throughout the Project
	Continuous	Effect occurs continuously throughout the Project
Duration	Short term	Changes in permafrost condition, terrain stability or landforms are no longer detectable at the end of construction
	Medium term	Changes in permafrost condition, terrain stability and landforms are no longer detectable at the end of final closure
	Long term	Changes in permafrost condition, terrain stability or landforms extend beyond the life of the Project
Reversibility	Reversible	Effect on permafrost condition, terrain stability or landforms is reversible over human lifetime
	Irreversible	Effect is not reversible, or will only reverse on geologic time line (i.e., thousands of years for terrain formation)

7.1.4 Standards or Thresholds for Determining Significance

A threshold is the level of change beyond which unacceptable adverse effects occur. In the case of terrain, well defined or accepted thresholds do not exist for the Canadian Arctic. The role of terrain within the terrestrial environment can be assessed either in terms of the area of coverage and its distribution within an area, or in terms of a specific function or value, such as preferred habitat. It is possible to measure the loss of surface and thus the loss of landforms, and its effect on habitat or other VECs.

In the absence of federal or territorial guidelines, a quantitative approach has been adopted to assess Project effects on terrain based on the best available information, previous experience with similar projects in the Canadian Arctic and best professional judgement to determine the significance of Project effects. Project effects on terrain are described quantitatively based on spatial coverage. Thresholds are defined using the proportion of lost surface or landform relative to the total area of the LAA. The following thresholds were selected based on the general knowledge of the Arctic terrestrial environment, professional judgment and the thresholds chosen in similar projects in Nunavut (e.g., High Lake Project). Residual effects are considered to be significant if the Project results in:

- more than 30% loss of the terrain surface
- more than 30% loss of the surface covered by common depositional landforms
- more than15% loss of the surface covered by any permafrost-sensitive landforms
- more than 15% loss of any uncommon landforms

A confidence rating is applied to the significance determination for residual effects on terrain. The rating considers the accuracy of the data used for baseline and application of analytical tools, an understanding of the effectiveness of the mitigation measures, and an understanding of known responses of the measurable parameters to potential Project effects. The confidence ratings are:

- Low – not confident in prediction, could vary considerably
- Moderate – confident in prediction, moderate variability
- High – confident in prediction, low variability

7.1.5 Influence of Inuit Qaujimajatuqangit and Stakeholder Engagement on the Assessment

Inuit Qaujimajatuqangit and engagement activites influenced the assessment of effects for terrain through identification of issues (Section 5.1), selection of VECs (Section 5.4), assessment approach (landforms, terrain stability and permafrost conditions are considered here in Section 7), and scope of mitigation and monitoring plans. Refer to Section 5.2 for additional discussion of the influence of IQ and stakeholder engagement on the terrain assessment.

Landforms and permafrost were identified as key components in the terrain assessment. The importance of hills was discussed by Elders in stories about traditional land use and life on the land (Section 5.1) and questions permafrost were also noted (Section 5.1). The importance of land in general, concern about the Project contaminating the land, and the need to protect the land were noted (IQ-BLE 2009[135], EN-BL HS Nov 2010[136], EN-CI OH Nov 2012[137]). As such, the assessment of potential Project effects on landforms and permafrost, along with associated mitigation and monitoring plans are presented here in Section 7. Best construction and project management practices coupled with engineering techniques, especially in permafrost engineering, will be implemented to address any issues with changes in permafrost conditions, and terrain stability (e.g. Tier 3, Technical Appendices 2D, 2G,2N). Visual monitoring will be conducted to check for changes to land and ground temperature will be measured at key locations.

People were aware that AREVA has experience operating mines in Saskatchewan and wanted to know that AREVA has considered operating in Nunavut where permafrost is present (EN-WC KIA Jan 2010[138]). Public input and IQ on potential risks to logistical infrastructure and benchmarking against existing projects in Nunavut and the Northwest Territories has been used to provide confidence in logistical and operational plans. Foundations, pads, and road design have been based on existing designs in northern areas of continuous permafrost.

During the stakeholder engagement sessions, concerns were expressed regarding the potential for Project-related mining activities to expose permafrost and for uranium to melt the permafrost layer (EN-RB OH Nov 2010[139], EN-RI RLC Feb 2009[140]). Assessment of Project effects on permafrost conditions and terrain stability are presented here in Section 7. Other sections of this environmental assessment examine aspects of Project operations related to permafrost. For instance, the effects assessment for hydrogeology (Tier 2, Volume 5, Section 7 and associated appendices) considers operations such as tailings management in permafrost and non-permafrost conditions. Over the long-term, the tailings management and mine rock facilities have been planned to ensure a robust design for protecting the environment in either the presence or the absence of permafrost. Long-term

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[135] IQ-BLE 2009: *Elders are concerned that uranium may escape and contaminate the grounds*

[136] EN-BL HS Nov 2010: *What effect will mining have on the land?*

[137] EN-CI OH Nov 2012: *What are the effects when a barrel breaks, to the land and animals?*

[138] En-WC KIA Jan 2010: *Saskatchewan doesn't have permafrost and they have fewer storms than we do here. Has this been looked into?*

[139] EN-RB OH Nov 2010: *Worried about the underground mine caving in when the permafrost comes.*

[140] EN-RI RLC Feb 2009: *Does uranium melt the permafrost?*

stability of the tailings and mine rock facilities do not require permafrost encapsulation (Tier 2, Volume 2).

Concerns were raised that archaeological sites not to be disturbed by the mine (EN-CI NIRB May 2010[141]) and that certain archaeological sites are located on terrain features such as hills. Potential Project-environment interactions with archaeological sites on hills, such as camps and gravesites, are assessed in Tier 2, Volume 9, Part 2 Heritage Resources.

7.2 Assessment of Change in Permafrost Conditions and Terrain Stability

7.2.1 Analytical Methods for Change in Permafrost Conditions and Terrain Stability

Two factors that determine change in permafrost are the ground temperature and the volume of ground-ice within the permafrost overburden. The ground temperature is, in turn, determined by several factors including: air temperature, type or thickness of vegetation cover, organic soils insulation, snow cover, and terrain slope. These factors control the thawing and freezing of the active layer. The thickness of the active layer possesses a seasonal nature, which is influenced by additional factors such as the nature of the underlying soil and rock and human disturbance.

Site and vegetation clearing, potential change in terrain slope, modification of surface water and drainage patterns, changes in subsurface groundwater flow and any destructive activities such as blasting will likely result in changes in permafrost conditions and terrain stability. A map of thaw depth was developed in support of the effects assessment for permafrost conditions. This map focussed on the Mine LAA. The map was developed based on thaw depth estimates from ground temperature measurements, as well as measurements taken using frost depth indicators in 19 geotechnical boreholes. The potential area of high ground-ice with thaw depth ranging from 2 to 3 m was delineated north of the Kiggavik mine and infrastructure area. Ground-ice conditions were described in the majority of the boreholes. Approximately 99 tests were performed to determine soil water (moisture) content. Details of the map, thaw depth analysis, grain size distribution analysis, soil density determination, ground-ice descriptions and water content analysis results can be found in Tier 3, Technical Appendix 6A.

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[141] EN-CI NIRB May 2010: *Concerns over potential impacts to archaeological and historical sites in or near the community.*

Road alignments were identified and an assessment was qualitatively completed to determine adverse effects to the permafrost layer as well as terrain stability associated with development of the different road options. An assessment based on the area affected by development of the preferred dock site facility was also completed.

7.2.2 Baseline Conditions for Change in Permafrost Conditions and Terrain Stability

The Kiggavik Project is located within the zone of continuous permafrost (NRCan 2007). Ground-ice content is likely less than 10% over most of the area (Brown et al.1998). This low ground-ice content occurs over most of the terrain, except for marine and localized fine-grained (high silt or clayey silt content) materials, which may contain more than 10% ground-ice. The Mine LAA is characterized by relatively stable terrain conditions as it is dominated by flat lying or gently sloping terrain, and a rolling and hummocky topography with frequent bedrock outcrops.

The majority of the area near the Kiggavik mine site has a thaw depth of 1 to 2 m (see Tier 3, Technical Appendix 6A). An area of potentially greater thaw depth (2 to 3 m) was delineated north of the site. No drilling data exists for the Sissons mine site regarding thaw depth; however, it is anticipated that the thaw depth at this location will be similar to the Kiggavik mine site given the close proximity of these areas.

7.2.3 Effect Mechanism and Linkages for Change in Permafrost Conditions and Terrain Stability

Construction and operation activities can cause surface and subsurface disturbance, which in turn can affect vegetation cover, organic soil insulation and frozen overburden materials. Removal of vegetation cover, organic soil insulation and snow cover generally leads to warming and thawing of the active layer and changes the shallow thermal regime and drainage condition. In thawing, the ice will disappear and, for existing overburden pressures, the soil skeleton must now adapt itself to a new equilibrium void ratio (Andersland and Ladanyi 2004). This further causes the active layer to deepen, and the new thaw zone may cause thaw settlement and eventually terrain instability. Thawing at a slow rate allows generated water to flow from the soil at about the same rate as melting occurs. Excess pore pressures will not be sustained, and settlement proceeds simultaneously with thawing. For faster thawing rates, excess pore pressure will be generated. These excess pore pressures will reduce shear strengths, creating potentially unstable terrain or slope conditions (Andersland and Ladanyi 2004). This will likely change the overall permafrost conditions and its distribution, and terrain stability, which can cause the loss or change in permafrost sensitive landforms and eventually a change in the abundance and distribution of landforms within the Mine LAA.

Terrain instability associated with the disturbance of surficial material is generally confined to the development of shallow depth. This effect is generally associated with the disturbance of the active layer and subsequent thawing of ground-ice, and the over-steepening of existing slopes. Although the majority of the Mine LAA is characterized by gentle slopes, there are localized areas of steeper terrain.

During the construction and operation phases of the Project, there is a high potential for ground disturbance of the permafrost, which may induce terrain instability in the higher relief areas. Terrain stability is serious in terms of safety and effects on normal mine operations. However, in terms of effects on the natural surficial materials and bedrock, only the mine component of the Project footprint will be affected. The proposed mine area is characterized by relatively plain and stable terrain conditions and an effect associated with relatively steep terrain is not expected.

Development of the proposed road options has the potential to impede surface water drainage. This could potentially result in pooling of water in areas adjacent to the road options, which could potentially destroy vegetation, as well as changing the properties of overburden materials which act as the surface insulation layer that protects the permafrost layer. This could potentially result in an increase in thaw depth into the permafrost layer.

7.2.4 Mitigation Measures and Project Design for Change in Permafrost Conditions and Terrain Stability

As the greatest potential effects of the Project on permafrost condition and terrain stability will occur in areas with low ground temperature, mitigation measures will be implemented to comply with regulations and guidelines applicable to permafrost areas in the Canadian Arctic, which provide objectives, principles and design criteria for planning, operation and remediation of projects.

Mitigation measures will be implemented in two ways: mitigation by design and discipline-specific mitigation. Mitigation by design encompasses those aspects of the Project design that will reduce effects to the permafrost and stability of terrain, and particularly to the surface area used by the Project to minimize footprint disturbance and to avoid permafrost sensitive and uncommon landforms. Some of the mitigation measures by design will include padding of surface horizons to maintain existing permafrost conditions, use of platforms for equipment to reduce any heat transfer into frozen ground and use of thermal stabilization methods (such as convection air embankment, heat drains, grass-covered embankments, snow fences, and reflecting surfaces), where feasible.

Discipline-specific mitigation will include the consideration of Project activities such as construction in permafrost-sensitive areas during the winter where feasible, ensuring Project-related vehicular traffic is on designated roads only, maintenance of roads and monitoring of the All-Season Road. Discipline-specific mitigation will minimize the exposure of permafrost to warmer temperatures, maintain the permafrost conditions and ensure the identification of signs of possible permafrost degradation.

Mitigation measures to reduce or eliminate Project effects on permafrost conditions and terrain stability include the following:

Permafrost Conditions:

- limit the Project footprint disturbance area
- sustain safe construction and operation practices within and adjacent to the Project footprint disturbance area
- use coarser materials for road construction to minimize frost effects
- manage drainage around infrastructure to reduce deep pools of water at the surface
- insulate infrastructure, where feasible
- implement proper construction and engineering design to consider the slope stabilization methods; for example, build foundations on bedrock not susceptible to frost heave to minimize thawing effect in permafrost sensitive areas
- avoid surface disturbance in high ground-ice areas to reduce potential for deepening the thaw depth and associated thaw settlement
- conduct additional site-specific field investigations to assess specific poorly drained areas and local variations in permafrost conditions (ground-ice content) prior to construction
- place culverts in areas crossed by the road options where surface drainage is apparent.

Terrain Stability:

- carry out a detailed geotechnical investigation before construction of mine infrastructure to collect data on surficial materials, drainage, slope, and permafrost and ground temperature (to aid in determining road alignment, along with facilitating post-construction monitoring of Project effects on terrain stability)
- avoid or minimize the amount of problematic terrain types (e.g., ground- ice rich, fine- to medium-textured materials on sloping topography) within the mine infrastructure area and along major road alignments
- consider the criteria for the design of roads for varying terrain types based on the findings and recommendations of the previous design work done on similar projects in the Arctic environments (as suggested in Tier 3, Technical Appendix 2L)

The projected rate of climate warming and its effects will be taken into account in the design of all Project elements based on the most up-to-date findings and predictions. Prior to initiation of the construction phase, additional field investigations will be completed to assess specific poorly drained areas and local variations in permafrost and terrain conditions.

7.2.5 Project Residual Environmental Effects for Change in Permafrost Conditions and Terrain Stability

Mine LAA

Residual effects of the Project on permafrost conditions and terrain stability will be confined to the Kiggavik and Sissons mine sites. This effect will occur primarily during the construction phase, although operational activities will continue to change permafrost conditions and terrain stability. Key Project activities during operation include mining and stockpiling of ore, special waste and clean waste that will involve destructive activities such as blasting, loading and hauling. These operational activities can induce ground disturbance as well as cause changes in the shallow and deep thermal regime, which can eventually change permafrost conditions. Residual effects on permafrost conditions are minimized through consideration and implementation of effective engineering design criteria and construction best practices; an example of how engineering designs will consider and account for permafrost is provided in Tier 3, Technical Appendix 2D Technical Appendix Conceptual Design for Ore and Special Waste Pads and Ponds.

Physical loss or change in permafrost from the Project footprint may cause changes to terrain and its stability. Changes to the active layer and consequently the thaw depth can reduce terrain stability through thaw settlement, decrease in shear strengths, frost heave and slope stability. The magnitude of changes in the permafrost thermal regime and potential thaw settlement is directly related to the nature and abundance of ground-ice and the type and severity of disturbance at the surface (Lawson 1986; Pullman et. al. 2007). The depth of the permafrost under climate change condition is expected to decrease from -220 m to -100 m (see Tier 3, Technical Appendix 5J). Undisturbed ground surfaces (natural ground) will likely retain permafrost after a warming of 5°C over 100 years (see Tier 3, Technical Appendix 5G).

Surface disturbance related to the removal of overburden materials will cause a change in permafrost conditions. About 803 ha (2.22%) of the Mine LAA is predicted to be disturbed as a result of Project activities (Table 7.2-1). This includes about 645 ha (or 1.78% of the Mine LAA) due to site clearing and topsoil stripping, and 158 ha (0.44% of the Mine LAA) due to soil and vegetation burial.

With implementation of mitigation, residual effects on changes to permafrost and terrain stability are expected to be low in magnitude, site specific, long term, continuous, and reversible.

Table 7.2-1 Areas Affected by Construction Activities within the Mine LAA

Project Component	Vegetation, Organic Soil and Overburden Stripping	Vegetation and Organic Soil Burial	Area (ha)	Area (%)	Vegetation, Organic Soil and Overburden Stripping in the LAA (ha)	Vegetation and Organic Soil Burial in the LAA (ha)	Vegetation, Organic Soil and Overburden in the LAA (% of Total LAA)
Kiggavik Site							
Site Camp, Mill and Infrastructure	X		103	0.28	103		0.28
Ore stockpile	X		7	0.02	7		0.02
Mine Rock Stockpile Type III	X		13	0.04	13		0.04
Mine Rock Stockpile Type II (2 locations)	X		135	0.37	135		0.37
Overburden Stockpile	X		14	0.04	14		0.04
East Zone Pit	X		8	0.02	8		0.02
Centre Zone Pit	X		15	0.04	15		0.04
Main Zone Pit	X		39	0.11	39		0.11
Purpose Built Pit	X		3	0.01	3		0.01
Explosives and Magazine Area		X	2	0.01		2	0.01
Freshwater Diversion Channels	X		24	0.07	24		0.07
Pointer Lake Airstrip		X	36	0.10		36	0.10
Sissons Site							
Site Buildings and Infrastructure	X		64	0.18	64		0.18
Ore Stockpile	X		1	0.00	1		0.00
Mine Rock Stockpile Type III	X		12	0.03	12		0.03
Mine Rock Stockpile Type II	X		132	0.36	132		0.36
Overburden Stockpile	X		15	0.04	15		0.04
Andrew Lake Pit	X		44	0.12	44		0.12
Freshwater Diversion Channels	X		16	0.04	16		0.04
Roads and Other							
Access Road to Airstrip and Judge Sissons Lake		X	31	0.08		31	0.08
Kiggavik-Sissons Access Road		X	43	0.12		43	0.12
Access Road to Siamese Lake		X	22	0.06		22	0.06
Road/Effluent Pipe from Kiggavik and Sissons Sites to Judge Sissons Lake		X	24	0.07		24	0.07
Total			**803**	**2.22**	**645**	**158**	

Mine LAA (Ha)	*Mine Site (Ha)*	*% Removal*	*% Burial*	*% Total Disturbance*
36240.00	*803.00*	*1.78*	*0.44*	*2.22*

All-Season Road LAA

The proposed All-Season Road is expected to be 114 km and extend from the Kiggavik mine site to the preferred dock site facility on the north shore of Baker Lake. It will be a 24-m-wide gravel road built from rock materials from the quarry sites (fill method) placed on top of the existing terrain. By placing materials on top of the existing terrain, the surface insulation layer that protects the shallow permafrost layer is not disturbed; therefore, the potential for thawing of the permafrost layer at the road location is reduced, which also prevents any terrain stability issues. As well, any adverse environmental effect related to erosion that is influenced by thawing of the permafrost layer is also reduced.

The proposed road is designed and routed on higher ground as these areas tend to contain less ground-ice, fewer drainage areas to cross, are less prone to snow drifts, and generally contain more bedrock, as well as suitable quarry locations. Routing the proposed road on higher ground will reduce geotechnical issues and road fill required during construction. This will also reduce potential maintenance issues (e.g., snow drifts) throughout the life of the Project.

With implementation of mitigation measures, residual effects on changes to permafrost conditions and terrain stability caused by the proposed All-Season Road are predicted to be low in magnitude and site specific in geographic extent. The residual effects will be long term in duration and continuous in frequency; however, all residual effects will be reversible.

Winter Road LAA

Permafrost conditions and terrain stability are not anticipated to be affected by development of the winter road option. Granular fill will be added in localized areas to create a level travel surface over hummocky microtopography. Construction and operation of the winter road will occur during frozen ground conditions; therefore, adverse effects on permafrost conditions and terrain stability are anticipated to be negligible.

Dock Site Options

Construction of the dock site facility at site option #1 (preferred option) was assessed to potentially disturb approximately 25 ha. Alternative dock site option #2 is estimated to disturb approximately 29.4 ha. Another dock option is for AREVA to use the existing Agnico Eagle Meadowbank dock site. This may be a viable alternative if the Meadowbank dock is no longer required by Agnico Eagle when the Kiggavik Project begins operation and appropriate transfer of ownership approvals are maintained. This area is an already disturbed brownfield site, occupying approximately 23.5 ha.

No permafrost conditions were encountered in the boreholes drilled within the vicinity of the proposed dock site facilities, likely due to a thawing effect caused by Baker Lake. However, there is the potential for permafrost to occur at the dock site locations as they are located within the continuous permafrost zone (see Tier 3, Technical Technical Appendix 6A for further details). Overburden materials at the dock site facility will be removed and stored. Following removal of the overburden, a site pad will be constructed with a minimum thickness of 1.7 m to provide thermal protection to the underlying permafrost layer, while providing structural stability to the dock site facility.

The preferred dock site option is located in marine units located along the shorelines, as well as a combination of bedrock and glacial (till veneer) units' farther upland. Development of the dock site location will likely involve removal of the overburden down to bedrock materials to facilitate a stable foundation for the dock site facility.

With implementation of mitigation measures, residual effects on changes to permafrost and terrain stability caused by the proposed dock site facility are expected to be low in magnitude and site specific in geographic extent. The residual effects will be long term in duration and continuous in frequency; however, all residual effects will be reversible.

7.2.6 Determination of Significance for Change in Permafrost Conditions and Terrain Stability

The residual effect of changes in thaw depth and ground-ice conditions on permafrost conditions and terrain stability is predicted to be low in magnitude within the Mine LAA, site specific, long term and continuous. However, these effects are expected to be reversible, and are not anticipated to affect the long-term conditions of permafrost and terrain stability within the Mine LAA. Approximately 2.2% of the Mine LAA will be disturbed, which is below the threshold value. The residual effects due to stripping and/or burial of vegetation, organic soil zone and underlying overburden materials will be confined within the Project footprint and are expected to be not significant. Change in surface drainage patterns and subsurface water flow will be within the Project footprint, and mitigation measures during the detailed design and all phases of the Project will reduce effects on permafrost conditions and terrain stability.

The residual effect of changes in permafrost condition and terrain stability within the road LAAs and the dock site facility is predicted to be low in magnitude, site specific, long term and continuous. However, these effects are expected to be reversible.

The mitigation measures for reducing effects on permafrost conditions and terrain stability are well accepted and practiced for construction and operation of mining projects in areas of continuous permafrost in Canadian Arctic. Total area affected by Project activities is low with respect to the total area of the Mine LAA and Road LAAs, which is based on the available baseline data and the Project description. Hence, the level of confidence in this prediction is rated as high. Confidence will be further improved through monitoring during Project construction and operation.

7.2.7 Compliance and Environmental Monitoring for Change in Permafrost Conditions and Terrain Stability

A monitoring system of permafrost and terrain stability will be established during all phases of the Project based on the historical study results and best professional judgement. The progression of thaw depth will be monitored within the Project activity areas. Potential change in moisture and ground-ice contents will also be monitored during the construction, operation, final closure and post closure phases of the Project. As changes to terrain stability will occur mainly during the construction phase of the Project and the effects will be long term, especially when climate change implications are considered, an environmental monitoring program will be initiated at the start of the construction and will continue until closure and decommissioning of the Project. This program will include:

- establishment of a 'Thaw-Depth Monitoring System' at the Kiggavik and Sissons mine sites, and the All-Season Road
- soil sampling to determine soil moisture and ground-ice contents of the active layer within the permafrost overburden
- routine visual field inspection of terrain slope conditions within the mine development and adjacent areas, and if necessary, installation of slope stability monitoring devices to measure slope movement
- annual monitoring of all roads, particularly areas identified as having a probability of instability

7.3 Assessment of Change in Landforms

Landforms that are influenced by permafrost and are sensitive to disturbance are termed permafrost sensitive landforms. The most common sensitive landforms in the Mine LAA are thaw sensitive soils, which are common to continuous permafrost regions in the Canadian Arctic. Thaw sensitive soils contain at least a small amount of ground-ice, and are typically fine grained in texture with higher silt or clayey silt contents and have significantly low permeability. Effects to permafrost sensitive landforms are mainly related to change in the thermal regime of permafrost. The other types of landforms included in the assessment are common depositional landforms and uncommon landforms, which have ecological, traditional and cultural values (e.g., eskers).

7.3.1 Analytical Methods for Change in Landforms

To assess the effects of surface disturbance on various landforms, the Project footprint was overlain on a baseline map of surficial geology showing common depositional landforms. The area affected by the Project footprint for each landform type was calculated to determine total loss.

Major landforms were subdivided into depositional landform types (alluvium or outwash sediments, glaciofluvial, glacial till or moraine, glaciomarine, organic and bedrock-related landforms) within the Mine LAA, and a map of surficial deposits was developed showing those landforms. The percent coverage of depositional landforms was estimated in relation to the total area of the Mine LAA.

Glacial landforms were identified based on the surficial geological conditions. The localized north-northwest-trending glacial landforms preserve evidence of regional ice flow. Glacial landforms around the proposed mill site in the Mine LAA are dominated by hummocky, bouldery glacial till and scattered boulder till moraines with frequent bedrock outcrops and shattered bedrock features in isolated exposures and elongated.

No evidence of cryoturbation and patterning of ground associated with the development of permafrost sensitive landforms were identified within the Mine LAA.

Three esker-related landforms have been identified within the Mine LAA. However, they occupy a negligible area and are outside of the direct footprint of the Project components of the Mine LAA.

A 500-m buffer centered over the proposed road alignments was used to identify the proportion of depositional landforms in the area to be a conservative assessment of landforms potentially affected by development of the road options.

7.3.2 Baseline Conditions for Change in Landforms

The percent coverage area of each depositional type of landforms with respect to the total area of the Mine LAA was assessed, and is provided below.

Total area of the Mine LAA = 36,240 ha

Alluvial (or outwash sediments) landforms = 3,786 ha (approximately 10% of the LAA)

Glaciofluvial landforms = 200 ha (less than 1% of the LAA)

Morainal (glacial till) landforms = 30,356 ha (approximately 84% of the LAA)

Glaciomarine landforms = 108 ha (less than 1% of the LAA)

Bedrock landforms= 1,790 ha (approximately 5% of the LAA)

Baseline data of landforms located within the 500-m buffered area of the All-Season Road are presented in Table 7.3-1.

Table 7.3-1 Landform Areas Located along the Proposed All-Season Road

Depositional Landforms	Code	All-Season Road Coverage Area	
		(ha)	(%)
Alluvial	Ao	263.66	0.51
Marine	Mr	154.16	0.30
Glaciofluvial	Go	55.47	0.11
Glacial	Tb	4585.89	8.81
	Tv		
Bedrock	R1	2199.28	4.23
	R2		
Total		7258.46	13.95
NOTE: Total area of the All-Season Road LAA is 52,032 ha.			

7.3.3 Effect Mechanisms and Linkages for Change in Landforms

Construction and operation activities including excavation, placement of structural foundations, road construction, airstrip construction, pads and quarrying will cause surface disturbances that can lead to a change or direct loss of surface materials due to stripping or burial of the surficial deposits associated with landforms. This can further lead to a change in the quantity of common landforms and the loss or change in uncommon landforms such as eskers.

Construction and operation activities will also change the shallow thermal regime, surface drainage pattern and subsurface water system due to the disturbance of surface materials and their removal or burial, which will lead to changes in permafrost conditions. Due to changes in permafrost conditions, loss of or change in permafrost sensitive landforms can occur, resulting in a change in abundance and distribution of such landforms. No significant permafrost sensitive and uncommon landforms have been identified within the Project footprint areas and hence the Project is not expected to affect such landforms.

7.3.4 Mitigation Measures and Project Design for Change in Landforms

The most effective mitigation measures for potential Project effects on landforms will take place during the Project design. Construction best practices will also be used to identify and mitigate potential effects on permafrost sensitive and uncommon landforms.

Mitigation measures will include:

- consideration of the local and regional climatic conditions, and the presence and expected changes to permafrost terrain
- avoidance of uncommon landforms like eskers, wetlands and shoreline areas, as well as steep terrain (where possible) during the design phase of Project
- minimizing cut width or disturbance through eskers, wetlands and shoreline areas
- reducing the use of glaciofluvial landforms during mine infrastructure construction
- applying best management practices and best professional judgement (e.g., planning of proper culvert location and construction and maintenance of roads susceptible to excessive groundwater seepage)

Information on mitigation measures are available in Tier 3, Technical Appendix 2N Borrow Pits and Quarry Management Plan, and Tier 3, Technical Appendix 2M Road Management Plan.

7.3.5 Project Residual Environmental Effects for Change in Landforms

7.3.5.1 Mine LAA

Residual effects on landforms will be confined to the Project footprint, and will occur primarily during construction and to a lesser extent during operation and final closure of the Project. Project effects on landforms will likely occur at the local scale, due primarily to surface disturbances that affect the stability, abundance and distribution of various common landforms within the Mine LAA. Project activities such as excavation, the construction of the site camp, mill and infrastructure will involve the stripping or burial of surficial deposits, which will affect various landforms. Surface disturbance may also be required to level the camp and mill sites, infrastructure and roads, storage area, and excavate the proposed mines and quarries. Gravel or fill pads will be needed to build foundations, the airstrip and other Project facilities such as overburden, ore and mine rock stockpiles. Any surface disturbed by stripping, levelling or burial of surficial materials will result in a loss of landforms.

Table 7.3-2 presents the total area of each landform type that will be affected by surface disturbances associated with the Project. It should be noted that the calculated surface covered by each landform type does not include the surface covered by water. The total surface covered by water encompasses 6,154 ha of the Mine LAA.

About 22 ha (0.59%) of the total surface area of the Mine LAA covered by alluvial landforms (3,786 ha) will be lost as a result of the Project, or 0.06% of the total area of the Mine LAA. Consequently, Project effects on alluvial landforms will be negligible.

Glaciofluvial landforms are significant in terms of the soils and vegetation they support, as well as their sensitivity to permafrost conditions and the stability of terrain due to any external disturbance. This type of landform supports warmer soils and valued vegetation communities. Disturbance to this type of landforms may have effects on other glacial features such as glaciofluvial plains and thermokarst plains. However, no glaciofluvial landforms will be disturbed as a result of the Project activities and no effects on this type of landform are predicted.

Less than 1 ha (0.44%) of the total surface area of the Mine LAA covered by glaciomarine landforms (108 ha) will be lost as a result of surface disturbances, or 0.001% of the total area of Mine LAA. Consequently, Project effects on glaciomarine landforms will be negligible.

About 68 ha (3.81%) of the total surface area of the Mine LAA covered by bedrock landforms (1,790 ha) will be lost due to the Project, or 0.19% of the total area of Mine LAA. About 720 ha (2.37%) of the total surface area of the Mine LAA covered by glacial till or morainal landforms (30,356 ha) will be lost as a result surface disturbances, or 1.99% of the total area of Mine LAA. Consequently, Project effects on this type of landforms expected to be low.

It is estimated that the Project footprint will cover 2.24% (811 ha) of the Mine LAA. There will likely be burial of surface landforms by construction materials within the proposed roads (access roads to airstrip, Judge-Sissons Lake, Siamese Lake, Kiggavik-Sissons Access Road, and a small segment of the All-Season Road) and hence all road disturbance footprints on surface landforms within the Mine LAA are included in the calculations.

Table 7.3-2 Project Disturbances to Common Depositional Landforms within the Mine LAA

Common Depositional Landforms	CODE	LAA Baseline Coverage Area*			Project Disturbance Footprint*		
		Area of Landform (ha)		% of Total Mine LAA	Disturbed Area (ha)	Total Mine LAA (%)	Landform Disturbed within the Mine LAA (%)
Alluvial	AO	3,786	3,786	10.45%	22.15	0.061	0.59
Glaciofluvial	Gk	40	200	0.55%	0.00	0.00	0.00
	Go	160					
Glaciomarine (Marine/Littoral)	Mr	108	108	0.30%	0.48	0.001	0.44
Bedrock	R1	758	1,790	4.94%	68.27	0.188	3.81
	R2	1,032					
Morainal (Glacial Till)	Tb	22,918	30,356	83.76%	720.43	1.988	2.37
	Th	205					
	Tv	7,233					
Total		36,240	36,240	100.00%	811.33	2.239	

NOTE:

* The surface covered by water has not been included in the calculations of surface percent coverage of landforms in the Mine LAA.

New landforms will be created by the development of the waste rock piles. Two waste rock piles will be created at each of the Kiggavik and Sissons mine sites, creating new landforms of about 148 ha and 144 ha, respectively. These landforms will be an elevated topographic feature on the landscape.

Physical loss or change in common landforms is expected as a result of surface disturbances within the footprint of the mines and infrastructure. However, it is anticipated that Project activities will likely result in only limited changes to landforms. By implementing effective mitigation measures during the design, construction, operation and final closure and post closure phases of the Project, changes to landforms are anticipated to be low in magnitude, site-specific, long term and will likely occur once, and irreversible.

7.3.5.2 *All-Season Road*

Residual effects on landforms will be confined to the road footprint, and will occur primarily during construction. Construction of the road will involve the burial of common landforms. A summary of the areas covered by common landforms and crossed by the proposed road option as well as the proportion of the total area of the road options anticipated to be buried is provided in Table 7.3-3. The total surface area of the All-Season Road LAA encompasses approximately 273 ha.

Table 7.3-3 Common Depositional Landforms Affected within the All-Season Road LAA

Common Depositional Landforms	Code	Project Disturbance Footprint	
		Disturbed Area (ha)	% of Landform Disturbed within the All-Season Road LAA
Alluvial	AO	6.65	0.01
Glaciofluvial	Gk	0.35	0.00
	Go		
Glaciomarine (Marine/Littoral)	Mr	6.60	0.01
Bedrock	R1	65.76	0.13
	R2		
	R1/Mr*		
Morainal (Glacial Till)	Tb	148.02	0.28
	Th		
	Tv		
Data Gap	No Code**	46.34	0.09
Total		273.72	0.53

NOTES:
Littoral sediments (Mr) in combination with bedrock (R1) are assumed *to be bedrock landforms.*
*** No data exits.*
Total area of the All-Season Road LAA is 52,032 ha.

The estimated surface areas covered by alluvial, glaciofluvial, glaciomarine, bedrock and morainal (glacial till) landforms that are expected to be buried by the proposed road will comprise 6.65 ha (0.01%), 0.35 ha (less than 0.01%), 6.60 ha (0.01%), 65.76 ha (0.13%) and 148.02 ha (0.28%) of the total area of the All-Season Road LAA, respectively. Although 46.34 ha (0.09%) of the All-Season Road LAA lacks data, similar types of common landforms are predicted to exist in those areas with no data.

Physical loss in common landforms is expected as a result of the construction within the footprint of the road. However, it is anticipated that the road construction will likely result in only limited changes to landforms. By implementing effective mitigation measures during the design, construction, operation and final closure and post closure phases of the Project, changes to landforms are anticipated to be low in magnitude, site-specific, long term and will likely occur once, and irreversible.

7.3.5.3 Winter Road

The winter road option is not anticipated to affect landforms as the routes selected focussed on level terrain that will be frozen during road construction and operation. Therefore, any effects to landforms by the winter road will be negligible.

7.3.5.4 Dock Site Options

The preferred dock site option (i.e., option #1) will affect an area of about 25 ha. This area is characterized by gradually slopping gravelly/sandy beach deposits which grade more steeply up a bedrock slope covered by a veneer of terraced marine sand and gravel. No uncommon landforms will be affected by development of the dock site option. With implementation of mitigation measures, residual effects on changes to landforms by the proposed dock site facility are expected to be low in magnitude, site specific, long term, will likely occur once, and irreversible.

7.3.6 Determination of Significance for Change in Landforms

Physical loss or change in common landforms is expected as a result of surface disturbances within the footprint of the mines and infrastructure. However, it is anticipated that Project activities will likely result in only limited changes to landforms. By implementing effective mitigation measures during the design, construction, operation and final closure and post closure phases of the Project, changes to landforms are anticipated to be low in magnitude, site-specific, long term and will likely occur once, and irreversible. It is important to note that no significant permafrost sensitive and uncommon landforms have been identified within the Project footprint areas.

The extent of changes or loss of common landforms due to the Project is predicted to be not significant within the Mine LAA. Approximately 2.2% of the total surface coverage of common depositional landforms within the Mine LAA will be disturbed, which is significantly below the thresholds. No glaciofluvial landforms, permafrost sensitive landforms and uncommon landforms will be disturbed as a result of the Project. Changes to landforms within the road LAAs and the dock site facility are also predicted to be not significant, as areas affected are below threshold values.

The level of confidence in this prediction is considered high, as the mitigation measures are well accepted and practiced and have been shown to be effective for construction and operation of mining projects in areas of continuous permafrost in Canadian Arctic. Changes to landforms due to Project activities are assessed to be low with respect to the total surface coverage within the Mine LAA, which is based on the area affected by the Project. .

7.3.7 Compliance and Environmental Monitoring for Change in Landforms

During the detailed design phase of the Project, disturbance within the mine and infrastructure footprint will be limited by avoiding potentially problematic landforms, where feasible. Prior to the construction phase, additional field investigations will be conducted to visually inspect and assess all types of existing landforms.

Potential change in slope, drainage pattern, subsurface water system or soil will also be monitored during the construction and operation of the Project, which will reduce or eliminate effects to landforms. An environmental monitoring program will include quantifying the Project footprint on an annual basis to ensure effects on landforms are consistent with the assessment (e.g. surface area of disturbance, types of landforms disturbed).

7.4 Cumulative Effects Analysis for Terrain

7.4.1 Screening for Cumulative Environmental Effects

As Project residual effects on terrain are not expected to extend beyond the LAA or overlap with any other existing or future projects or activities, no cumulative effects on terrain are anticipated to occur. As a result, the cumulative effect of changes in terrain is not considered further in this assessment.

7.5 Summary of Residual Environmental Effects on Terrain

7.5.1 Project Residual Environmental Effects

7.5.1.1 Permafrost Conditions and Terrain Stability

The Mine LAA covers a total area of 36,240 ha, which excludes surface area covered by water. Surface disturbance of terrain, as well as vegetation cover, organic soil insulation and permafrost overburden materials is predicted to affect a total of about 803 ha (2.2%) of the LAA. This will be caused by site clearing and soil stripping (1.8% of the LAA) and burial of vegetation and organic soil (0.4% of the LAA).

- The residual effects of stripping and/or burial of vegetation, organic soil zone and underlying overburden materials on permafrost conditions and terrain stability will be confined within the Project footprint, low in magnitude, site specific, long term, continuous over the life of the Project, and reversible. Overall, residual environmental effects of the Project on permafrost conditions and terrain stability are predicted to be not significant.
- A summary of the residual environmental effects for permafrost conditions and terrain stability is provided in Table 7.5-1.

7.5.1.2 Landforms

The estimated surface areas covered by alluvial, glaciomarine, bedrock and morainal (glacial till) landforms that are expected to be disturbed by the Project total 0.06%, 0.001%, 0.19% and 1.99% of the total area of Mine LAA (i.e. 36,240 ha), respectively. Overall, the total area disturbed by stripping and burial of landforms is estimated to be 811 ha (2.2%) of the Mine LAA. It is important to note that no significant permafrost sensitive and uncommon landforms have been identified within the Project footprint areas.

Residual environmental effects of changes in landforms are expected to be low in magnitude, site specific, long term, will likely occur once, and irreversible. Overall, residual effects of the Project on landforms are predicted to be not significant. A summary of the residual environmental effects for landforms is provided in Table 7.5-1.

The residual effects presented considered Project-related effects on an individual basis. Based on professional judgment, the combination of Project-related effects and the subsequent residual effects for terrain are anticipated to be no greater that the residual effects on an individual basis as these effects were assessed on a conservative basis. Therefore, the combined Project-related effects on terrain are predicted to be not significant.

Table 7.5-1 Summary of Project Residual Environmental Effects for Change in Terrain

Project Phase	Mitigation/ Compensation Measures	Residual Environmental Effect (Y/N)	Direction	Residual Environmental Effects Characteristics						Significance	Likelihood	Prediction Confidence	Recommended Follow-up and Monitoring
				Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context				
Change in Permafrost Conditions and Terrain Stability: Stripping and/or burial of vegetation, organic soil zone, and underlying overburden materials; change in slope, change in surface drainage patterns and subsurface flow, and blasting will affect thaw depth and ground-ice content.													
Construction	Minimize the Project footprint disturbance area	Y	A	L	S	LT	C	R	D	N	N/A	H	Establishment of ground temperature and thaw depth monitoring system around the mine and mine affected areas; and along the embankment of roads; routine visual field observation of terrain slopes
	Salvage vegetation, soils and overburden materials												
	Confine activities within the boundaries of Project work area												
Operation	Avoid surface disturbance in ground-ice rich areas												Monitoring of soil moisture and ground-ice content
Final closure													Monitoring of surface and subsurface groundwater system
Post closure	Not required												
Change in Landforms: Stripping and/or burial of surficial materials will affect common depositional landforms and their abundance and distribution													
Construction	Minimize the Project footprint disturbance area	Y	A	L	S	LT	O	I	D	N	N/A	H	Quantify Project footprint on an annual basis
	Avoid or reduce the use of glaciofluvial deposits												
	Salvage surficial materials												
Operation	Avoid surface disturbance in soft and problematic areas												
Final closure													

Table 7.5-1 Summary of Project Residual Environmental Effects for Change in Terrain

KEY ***Direction:*** P Positive: improvement relative to baseline conditions N Neutral: no change relative to baseline A Adverse: reduction relative to baseline ***Magnitude:*** N Negligible: No measurable change from baseline conditions or natural variation on permafrost, terrain stability or landforms. L Low: Effect on one or more of the measurable parameters is detectable, but within the range of natural variation or baseline values; no change in permafrost condition, terrain stability or landforms. M Moderate: Effect on one or more of the measurable parameters is detectable and outside the range of natural variation or baseline values, but unlikely to change in permafrost condition, terrain stability or landforms. H High: Effect on one or more of the measurable parameters is detectable and outside the range of natural variation or baseline values, and hence a change in permafrost condition, terrain stability or landforms is evident. ***Geographic Extent:*** S Site specific: (i.e., within the Project Footprint) L Local (i.e., within the LAA) R Regional (i.e., extends beyond the LAA but within the RAA)	***Duration:*** ST Short term: change no longer detectable at the end of construction. MT Medium term: change no longer detectable at the end of final closure. LT Long term: change extends beyond the life of the Project. ***Frequency:*** O Once: occurs once throughout the Project S Sporadically: occurs more than once, but at unpredictable intervals. R Regularly: occurs repeatedly at regular intervals. C Continuous: occurs continuously throughout the Project. ***Reversibility:*** R Reversible: effect reversible over human lifetime I Irreversible: effect not reversible, but reversible over geologic time scale	***Environmental Context:*** D Disturbed N Not Disturbed ***Significance:*** S Significant N Not Significant ***Prediction Confidence:*** Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation L Low level of confidence M Moderate level of confidence H High level of confidence	***Likelihood:*** Of a significant effect occurring N/A Not Applicable L Low probability of occurrence M Medium probability of occurrence H High probability of occurrence ***Cumulative Effects*** Y Potential for effect to interact with other past, present or foreseeable projects or activities N Effect will not or is not likely to interact with other past, present or foreseeable projects or activities

7.5.2 Cumulative Effects

The Kiggavik Project is not expected to contribute to cumulative effects on terrain in the RAA.

7.5.3 Effects of Climate Change on Project Effects on Terrain

Long-term climate change could have an effect on terrain in the Project area depending on the degree and rate of warming. Increasing mean annual air temperature could lead to warmer weather during the summer months, which could increase the mean annual ground surface temperature. With anticipated warming conditions, the existing thermal regime and permafrost conditions may change, thereby increasing the probability of terrain instabilities due to solifluction, erosion, etc. Warming of permafrost soils and rock may result in greater availability of water within the system, and change the internal physical characteristics and engineering properties of surficial materials.

Thermal modelling results for the long-term climate scenario over 2,000 years in the Kiggavik Project area show that if the mean annual ground surface temperature rises, the change in permafrost depth will be evident at the base but not at the surface (see Tier 3, Technical Appendix 5J). Another model predicted a cooling trend will occur over the next 50 years (see Tier 3, Technical Appendix 4D). Undisturbed ground surfaces (natural ground) will likely retain permafrost after an assumed climate warming trend of 5°C in the mean annual ground surface temperature over the next 100 years, and permafrost will likely develop and be maintained within the waste rock stockpiles and the covered TMF under the current climatic conditions (see Tier 3, Technical Appendix 5G). Natural ground permafrost degradation with climate warming is anticipated to occur over 2000 years for the two assumed warming trends (trend 1: from -7°C to -2°C, and trend 2: from -6°C to -1°C) and the predicted permafrost depths will be -100 m and -45 m relative to the initial permafrost depth of -220 m for the warming trend 1 and trend 2, respectively (see Tier 3, Technical Appendix 5J).

The potential effects of climate change on terrain in the short and long term may include the following:

- permafrost melting
- terrain instability

7.5.3.1 Permafrost Melting

The short-term effect of climate change is anticipated to occur due to surface disturbance activities during the construction and operation and may affect the vegetation cover and organic soil insulation within the Mine LAA, as vegetation cover, organic soils and permafrost overburden material will be stripped or buried. Upon removal or burial of these layers, change in shallow thermal regime may occur. Deepening of thaw depth, ground softening, and thaw settlement in local scale may occur as a result of both Project activities and climate change.

The long-term effect on permafrost may be anticipated due to climate change. It is anticipated that Project activities will result in minor changes to permafrost conditions within the Project footprint of the Mine LAA. By implementing mitigation practices and using permafrost design features with due consideration of climate change in Arctic, changes to permafrost are anticipated to be minor relative to the baseline condition.

7.5.3.2 Terrain Instability

In the absence of mitigation measures, predicted increases in permafrost temperature and thaw depth due to climate warming may result in issues with terrain and slope stability. Changes to thaw depth (active layer thickness) may influence the stability of terrain through thaw settlement, frost heave potential and shear strength.

It is anticipated that Project activities will result in minor changes to terrain stability within the Project footprint of the Mine LAA. By implementing mitigation practices and using permafrost design features with due consideration of climate change in Arctic, changes to terrain stability are anticipated to be minor relative to the baseline condition.

7.6 Summary of Mitigation Measures for Terrain

Effective mitigation strategies for effects on terrain require identification of problematic terrain types that may be susceptible to either terrain instability or thaw settlement or are considered to be significant and sensitive landforms. By identifying specific locations of problematic areas, effective mitigation measures can be tailored to address site-specific conditions.

Detailed mitigation measures will vary depending on local conditions and Project activities. Best construction and project management practices coupled with recent engineering advances, especially in permafrost engineering, will be implemented to address any issues with changes in permafrost conditions, and terrain stability (e.g. Tier 3, Technical Appendices 2D, 2G,2N). Issues related to the surface disturbance to any problematic and challenging landforms will be best addressed by proper citing of Project facilities and associated infrastructure.

Design mitigation measures will include minimizing Project disturbance footprint and the number of drainage areas affected by the Project components and activities, and avoiding surface disturbance in high ground-ice areas and problematic terrain and landforms to reduce potential for deepening the thaw depth and associated thaw settlement and terrain stability. Discipline-specific mitigation will include the consideration of Project activities such as construction in permafrost sensitive areas during the winter time where feasible, controlled vehicular traffic along roads, planning of proper culvert location and construction and maintenance of roads susceptible to excessive groundwater seepage.

Additional mitigation measures will include sustaining safe construction and operation practices within and adjacent to the Project footprint, use of coarser materials for road construction to minimize frost effects, management of drainage around infrastructure to reduce deep pools of water at the surface, insulation of infrastructure where feasible, avoidance or minimization of problematic terrain associated with high ground-ice content and fine- to medium-textured materials on sloping topography within the mine infrastructure area and along major road alignments, avoidance of uncommon landforms like eskers, wetlands and shoreline areas during the design phase of Project, minimization of cut width or disturbance through eskers, wetlands and shoreline areas and reduction in the use of glaciofluvial landforms during mine infrastructure construction. Consideration and implementation of effective engineering design criteria and construction best practices with due consideration of the projected rate of climate warming based on the findings and recommendations of the previous design work done on similar projects in the Arctic environments will be one of the key mitigation measures.

Supplementary engineering field investigations prior to construction of mine infrastructure will help to reduce or eliminate potential Project effects on terrain. Additional site-specific field investigations will be conducted to assess specific poorly drained areas and drainage condition, local variations in permafrost conditions (ground-ice content), terrain slope, and ground temperature prior to construction of mine infrastructure and roads.

7.7 Summary of Compliance and Environmental Monitoring for Terrain

While the implementation of mitigation strategies is critical to reducing any effects on terrain, it is equally as important to complete regular and routine monitoring to ensure that effects on the terrain are minimized and to identify where new mitigation strategies may be required. Monitoring will begin upon construction and will continue through the duration of the Project.

A key consideration in design of the monitoring programs is that the environment is expected to change independent of the Project as a result of climate change. For the most part, visual monitoring will suffice as it will be important to visually observe any changes (e.g., accelerated solifluction, groundwater seepage, erosion, etc.). In some cases, especially on steeper slopes, slope monitoring devices will be used for the duration of the Project. Similarly, thermistors will be installed at key sites to determine and monitor the rate of change in ground temperature. Special devices will also be installed to record maximum thaw penetration and maximum ground-surface movement at thaw depth monitoring sites. While such devices are not required extensively throughout the Project footprint, a number of permanent monitoring plots will be established at the outset of the Project to monitor any effects of climate change and hence the overall change in the natural landscape.

Laboratory analysis of soil samples will be conducted, which will help to determine geotechnical parameters such as total moisture content, frozen bulk density and ground-ice content. These parameters will be used to calculate thaw strains, which are used to determine the thaw settlement resulting from the simulated increase in thaw depth at the each sampling site.

8 Effects Assessment for Soils

8.1 Scope of the Assessment for Soils

8.1.1 Project-Environment Interactions and Effects

Project activities during the construction, operation and final closure phases have the potential to affect the quality and quantity of soils within the RAA. Key issues related to effects on soil include:

- deterioration of soil quality due to air emissions, including dust deposition, during all phases of the Project
- soil loss and deterioration caused by topsoil stripping, soil burial, erosion, admixing, and compaction during construction activities

Refer to Table 5.5-1 for potential interactions between all Project activities and soil along with rationale for Project–soil interactions ranked as 1. Interactions ranked as 2 in Table 5.5-1 are examined further here.

Key Project activities that could affect soil quality and quantity are outlined in Table 8.1-1.

Table 8.1-1 Project–Environment Interactions and Effects on Soils

Project Component	Project Activities	Environmental Effect	
		Change in Soil Quality	**Change in Soil Quantity**
Construction			
In-water Construction	Construct freshwater diversions and site drainage containment systems (dykes, berms, collection ponds)	0	2
	Construct in-water/shoreline structures	0	2
On-land Construction	Site clearing and pad construction (blasting, earth-moving, loading, hauling, dumping, crushing)	2	2
	Road and airstrip construction	2	2
	Aggregate sourcing	0	2

Table 8.1-1 Project–Environment Interactions and Effects on Soils

Project Component	Project Activities	Environmental Effect	
		Change in Soil Quality	Change in Soil Quantity
Supporting Activities	Industrial machinery operation	2	0
	Power generation	2	0
Operation			
Mining	Mining ore (blasting, loading, hauling)	2	0
	Ore stockpiling	2	0
	Mining special waste (blasting, loading, hauling)	2	0
	Special waste stockpiling	2	0
	Mining clean waste (blasting, loading, hauling)	2	0
	Clean rock stockpiling	2	0
Milling	Transfer ore to mill	2	0
	Crushing and grinding	2	0
General Services	Generation of power	2	0
Transportation	Truck transportation	2	0
Final Closure			
General	Industrial machinery operation	2	0
On-land Decommissioning	Remove site pads (blasting, earth-moving, loading, hauling, dumping)	2	2
NOTE: See definitions of rankings in Section 5.6			

8.1.2 Measurable Parameters

Table 8.1-2 lists the measurable parameters used to assess Project effects on soil quality and soil quantity and the rationale for their selection.

Table 8.1-2 Measurable Parameters for Soils

VEC	Environmental Effect	Measurable Parameters	Rationale
Soils	Change in soil quality	Soil chemistry (i.e., soil acidification from air emissions, fugitive dust deposition) Area (km^2) of soil compaction, admixing and erosion	Potential acid input (PAI), as well as changes in pH and metals caused by dust deposition and nutrient transport in soils can influence vegetation occurrence Soil compaction, admixing, erosion could alter soil quality, which in turn could influence vegetation occurrence
	Change in soil quantity	Area (km^2) to have topsoil stripped or soil lost as a result of erosion, movement or burial	Soil removal or burial could alter soil quantity, which in turn could influence vegetation occurrence

8.1.3 Residual Environmental Effects Criteria for Soils

Residual effects on soils are characterized quantitatively and qualitatively using the following attributes: direction, magnitude, geographic extent, duration, frequency, and reversibility. Table 8.1-3 provides definitions for these attributes.

Table 8.1-3 Residual Environmental Effects Criteria for Soils

Attribute	Rating	Definition
Direction	Positive	Improvement in soil quality or soil quantity relative to baseline conditions.
	Neutral	No change in soil quality or soil quantity relative to baseline conditions.
	Adverse	Reduction in soil quality or soil quantity relative to baseline conditions.
Magnitude	Negligible	No affect from baseline conditions or natural variation on soil quality or soil quantity.
	Low	Effect on one or more of the measurable parameters is detectable, but within range of natural variation or baseline values; no change in soil quality or quantity.
	Moderate	Effect on one or more of the measurable parameters is detectable and outside the range of natural variation or baseline values, but is unlikely to change soil quality or quantity and reclamation end land use objectives will still be met.
	High	Effect on one or more of the measurable parameters is detectable, outside the range of natural variation or baseline values, and changes soil quality or quantity will prevent reclaiming the landscape to meet end land use goals.
Geographic Extent	Site	Effect confined to specific features within Project footprint.
	Local	Effect confined to the LAA.
	Regional	Effect extends beyond the LAA but within the RAA.

Table 8.1-3 Residual Environmental Effects Criteria for Soils

Attribute	Rating	Definition
Frequency	Once	Effect occurs once.
	Sporadic	Effect occurs more than once, but at unpredictable intervals.
	Regularly	Effect occurs repeatedly at regular intervals.
	Continuous	Effect occurs continuously throughout the Project.
Duration	Short term	Changes in soil quality or soil quantity are no longer detectable at the end of construction.
	Medium term	Changes in soil quality or soil quantity are no longer detectable at the end of final closure.
	Long term	Changes in soil quality or soil quantity extend beyond the life of the Project.
Reversibility	Reversible	Effect on soils is reversible over human scale lifetime.
	Irreversible	Effect is not reversible, or will only reverse on geologic time line (e.g. thousands of years for soil formation).
Environmental Context	Disturbed	Area has been substantially disturbed previously by human development, or human development is still present.
	Not Disturbed	Area has not been disturbed by human development.

8.1.4 Standards or Thresholds for Determining Significance

8.1.4.1 Soil Quality

The significance of Project residual effects on soil quality is determined by the extent of changes in chemical levels in soil in comparison to CCME soil quality guidelines (CCME 2009). These values are used to evaluate changes in soil concentrations from emissions of metals; no standards exist for radionuclides. To overcome this technical boundary (lack of soil quality guideline for radionuclides), predicted changes in radionuclide concentrations will be compared to baseline data to evaluate the extent of Project effects. Additional information is provided in the Ecological and Human Health Risk Assessment (Tier 3, Technical Appendix 8A).

Threshold values developed by the Clean Air Strategic Alliance (CASA, 1999) and the World Health Organization (2000) for potential acid input (PAI) are used to determine the significance of Project residual effects of acid deposition on soil quality. For sensitive soils, the critical load threshold for PAI (i.e., will not cause long-term ecosystem change) is 0.25 keq/ha/year. Exceedances above the critical load threshold do not mean environmental damage will occur; rather, there is the potential for an effect from PAI on the environment if deposition above the critical load is sustained over many years (CASA 1999).

The significance of changes in soil quality due to admixing, compaction, and erosion is determined during monitoring of construction activities, and mitigation measures to reduce or prevent these environmental effects are continuously evaluated to determine their effectiveness. Therefore, the significance of these environmental effects on soil quality is assessed based on a qualitative description of the Project residual effects.

8.1.4.2 Soil Quantity

Project effects to soil quantity are described quantitatively based on the number of hectares affected, as well as the proportion of the area disturbed within the respective LAAs.

A confidence rating is applied to the significance determination for residual effects on soils. The rating considers the accuracy of the data used for baseline and application of analytical tools, an understanding of the effectiveness of mitigation measures, and an understanding of known responses of the measurable parameters to potential Project effects. The confidence ratings are:

- Low – not confident in prediction, could vary considerably
- Moderate – confident in prediction, moderate variability
- High – confident in prediction, low variability

8.1.5 Influence of Inuit Qaujimajatuqangit and Stakeholder Engagement on the Assessment

Inuit Qaujimajatuqangit interviews and engagement activites influenced the assessment of effects for soil through identification of issues (Section 5.1), selection of VECs (Section 5.4), assessment approach (soil quality and soil quantity examined Section 8), and design of mitigation and monitoring plans. Refer to Section 5.2 for additional discussion of the influence of IQ and stakeholder engagement on the soil assessment.

The importance of soil as part of the whole environment was identified in comments received during IQ interviews and engagement activities (EN-Kiggavik Project Blog 2009[142]), as were concerns about potential contamination of the soil from Project activities (IQ-BLE 2009[143]). Concerns about soil or

[142] EN-Kiggavik Project Blog 2009: *all the animals we eat rely on good soil*

[143] IQ-BLE 2009: *Elders are concerned that uranium may escape and contaminate the grounds*

land contamination influenced the inclusion of soil quality as an environmental effect endpoint in this assessment. The role of soil in the ecosystem (e.g. substrate for plants, habitat for animals) demonstrates the IQ guiding principle (GN 2009) of Avatimik Kamattiarniq which is the concept of environmental stewardship: people are stewards of the environment and must treat all of nature holistically and with respect, because humans, wildlife and habitat are inter-connected (IQ-Nunavut Tunngavik Inc. 2005[144]).

To reduce the potential for soil acidification and changes in COPC concentrations, emissions from all industrial machinery and equipment, including the diesel-powered generators will meet the federal air emission standards. Low sulphur diesel fuel will be used to reduce emissions associated with diesel fuel combustion. In addition, scrubbers will be installed on any mill stacks that emit particulates and contaminants (e.g., acid plant exhaust stack) to remove these items from the air stream before discharge (Tier 3, Technical Appendix 4C).

Soil quality will be monitored during operations and decommissioning (Tier 3, Technical Appendix 4C) to address community concerns about potential contamination of soil resulting from Project activities. This includes sampling and analyzing soil for metals and radionuclides. Soil quality monitoring results will be compared to baseline values and compared to predictions from this environmental assessment. Soil quality monitoring results will also be used to update the ecological and human health risk assessment as required (Tier 3, Technical Appendix 8A).

The role of soil in the ecosystem and the potential for COPCs to enter the food web is addressed in Tier 3, Technical Appendix 8A. Modelling the uptake of radionuclides and metals by terrestrial biota can be quite involved and requires consideration of several interactions. For example, direct deposition from air to soil and terrestrial vegetation, direct uptake from soil to terrestrial vegetation, and ingestion of diet components by terrestrial animals and birds are considered in the modelling. Soil ingestion is included as a pathway for terrestrial ecological receptors and human receptors (Tier 3, Technical Appendix 8A).

Concerns about potential contamination of soil resulting from spills or accidents are addressed in Accidents and Malfunctions (Tier 2, Volume 10).

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[144] IQ-Nunavut Tunngavik Inc. 2005: *the health of Inuit, of wildlife and of the environment are interconnected*

8.2 Assessment of Change in Soil Quality

8.2.1 Analytical Methods for Change in Soil Quality

Changes in soil quality were assessed based on air quality modelling (Tier 3, Technical Appendix 4B) to estimate PAIs generated by the Project at the proposed mine sites, as well as dust deposition (metals and radionuclides) generated by Project activities. Adverse effects on soil quality due to changes in the concentration of the Constituents of Potential Concern (COPC) in soil were evaluated based on comparisons to CCME criteria and changes relative to baseline conditions. The COPC included in this assessment include uranium and the uranium-238 decay series (thorium-230, lead-210, radium-226, and polonium-210), arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, selenium and zinc. Detailed modelling of the concentration of these COPCs in dust is discussed in the Atmospheric Environment Assessment (Tier 2, Volume 4). The results of the air quality assessment are the basis for estimating changes in soil concentrations. A simple deposition model was used for estimating changes in soil concentrations, and the details are discussed in the Ecological and Human Health Risk Assessment (Tier 3, Technical Appendix 8A).

8.2.2 Baseline Conditions for Change in Soil Quality

Soil pH was found to be weakly acid to neutral (average 6.1), and ranges from moderately acid (4.8) to slightly basic (7.8) from the samples taken. A comparison of metal and radionuclide concentrations in soil samples to the CCME (2009) levels for industrial land use areas found one sample to exceed recommended arsenic levels, one sample to exceeded nickel levels, two samples to exceed copper levels, and at least one sample to exceed selenium levels.

Soil texture ranged from silty clay (located in a well-drained area) to loamy sand, with the majority of soil samples exhibiting a sandy clay loam texture. Coarse fragments were found in all soil samples, with the majority of fragments found within the B and C horizons. Roots were commonly observed within most soil samples.

8.2.3 Effect Mechanism and Linkages for Change in Soil Quality

8.2.3.1 Soil Acidification

Soils acidification involves the introduction of acidifying compounds to soils. Soils are considered a primary receptor of acid deposition (CASA 1999). A main pathway for introducing acidifying compounds (i.e., sulphur dioxide [SO_2] and nitrogen dioxide [NO_2]) to soils is through air emissions, where these compounds are transformed and deposited as acids onto soils. The deposited acids are measured as PAI.

Air emissions created by the Project through the burning of fossil fuels have the potential to cause soil acidification. Project activities that will introduce large amounts of air emissions containing acids include the milling process (i.e., acid plant), power generation from diesel generators, and the use of industrial machinery and equipment. Soil acidification resulting from long-term deposition of acidifying substances can result in lower soil pH, a decrease in base saturation and increase in aluminum bioavailability. The results of these changes in soil chemical properties have been shown to negatively affect nutrient cycling and decomposition processes by changing microbial community populations and soil function, and often result in aluminum toxicity to vegetation (Holowaychuk and Fessenden 1987).

8.2.3.2 Dust Deposition

Dust deposition can potentially change the pH and nutrient regime of soils (Auerbach et al. 1997; Myers-Smith et al. 2006; Walker and Everett 1987). Project activities that will generate dust include on-land construction, mining, milling, general services, transportation, and on-land decommissioning. Dust deposition has been shown to cause soil pH to become more basic in a tundra environment (Myers-Smith et al. 2006), which in turn causes a change in the vegetation communities that occur on these soils (Auerbach et al. 1997; Myers-Smith et al. 2006). Changes in the soils' nutrient regimes are also prevalent with the introduction of nitrogen to nutrient-poor soils through dust deposition. An increase in nitrogen to the soils allows plants that have an affinity towards nitrogen to proliferate, such as grasses. Other analytes (e.g., COPC) that become airborne through dust particles can be transported and deposited away from their source.

8.2.3.3 Soil Admixing

Soil admixing involves the mixing of soil horizons. Admixing of the soil layers can affect soil quality by causing changes in soil texture and structure, as well as diluting organic matter and organic carbon, which can negatively influence microbiological activities (Wick et al. 2009). In environments containing continuous permafrost, soil admixing is a naturally occurring phenomenon through cryoturbation (i.e., the mixing of materials among the soil horizons due to freezing and thawing). The presence of patterned ground on the landscape indicates where cryoturbation has occurred. Avoiding further soil admixing from human-caused disturbance is essential for preserving the growth medium layer for reclamation purposes.

8.2.3.4 Soil Compaction

Soil compaction is the process by which a stress applied to a soil causes the soil to become denser as air is displaced from the pores between the soil grains. Soil compaction influences structure, drainage, porosity, and susceptibility to erosion, which affects soil quality. Soil compaction caused by movement of heavy equipment and repeated movement of lighter equipment, as well as placement of heavy materials on top of the soils can break down the soil structure. Compacted soils reduce the ability for vegetation to establish and proliferate.

8.2.3.5 Soil Erosion

Soil erosion involves the wearing of exposed soils due to climatic events, such as wind, precipitation or water flow over a surface. Soil quality can be reduced due to loss of organic materials and soil particles containing valuable nutrients required for vegetation. Soils stored in overburden piles will be susceptible to erosion due to their exposure to climatic events. A loss of soil from erosion events will likely affect revegetation efforts following replacement of soils from the overburden pile over the disturbed areas.

8.2.4 Mitigation Measures and Project Design for Change in Soil Quality

The following mitigation measures and Project design features will be implemented to reduce Project effects on soil quality:

- Industrial machinery and equipment (including the diesel-powered generators) will meet the federal air emission standards.
- Low sulphur diesel fuel will be used to reduce emissions associated with diesel fuel combustion.
- Scrubbers will be installed on exhaust stacks to remove particulates, acid mist and excess SO2 from air emissions prior to discharge.
- Stripped topsoil will be kept separate from subsoils stored at the overburden pile location to prevent soil admixing, as well as loss of the growth medium layer that will be used for reclamation purposes.
- Stripped topsoils will also be well-segregated from the ore piles and the Type 3 mine rock stockpiles to prevent soil contamination.
- Stripped topsoil and subsoil materials stored in the overburden pile location will be scanned to ensure no radiation contamination prior to use during site reclamation.
- Frozen or wet soils removed during site preparation will be stored within dry soil materials of the same nature (i.e., topsoil, subsoil) to prevent potential migration and subsequent admixing with other soil or waste rock piles.
- Freshwater diversion channels will be constructed to divert surface drainage around the Project footprint to prevent on-site erosion, as well as to prevent potential contamination of surface drainage.
- Riprap armouring overlying a geotextile will be placed on the channel bottom and side slopes of the diversion channels to mitigate potential erosion of the channel.
- If required, erosion control structures (e.g., sediment breakers, wattles) may be used within the diversion channels following initial excavation to reduce the amount of soil

erosion by flowing water until vegetation has established or a geotextile liner is placed within the channel.

- Culverts will be installed where the proposed All-Season Road crosses natural drainage patterns to facilitate water movement and minimize potential for soil erosion.
- Site pads will be sloped towards the run-off ponds to prevent any contaminated materials from migrating off-site due to surface drainage. This will minimize the potential for effects on soil quality.
- If required, temporary erosion control structures (e.g., silt fences) will be placed on the downslope side of the Project footprint to capture and filter sediment-laden runoff during construction (Tier 3, Technical Appendix 5O).
- If necessary, a substance such as a soil tackifier may be applied to the overburden piles to prevent erosion of soils.
- During final closure, areas ready for reclamation will be scarified to loosen compacted soils to better facilitate seed germination.
- Soft spots on the winter road will be identified and avoided by vehicular traffic. Rig matting may also be used to prevent rutting and other disturbances to soils where the winter road's integrity is compromised.
- During open pit mining, blasting patterns will be used to control the dispersion of materials as well as dust.
- Where possible, blasting may also be avoided on days where dust dispersion outside of the Project footprint is anticipated to be excessive due to the prevailing winds speeds.
- Dust suppression will occur continuously during the Project in dust-prone mine site areas by spraying water from a tanker truck affixed with either a spray nozzle or spray bar.
- If water spraying is not effective in preventing dust occurrence, an adaptive management strategy focussing on addition dust suppression techniques will be investigated, such as using a dust suppressant identified in the GN (2002) guidelines.
- Speed limits around the mine site and along all roads will be strictly adhered to, for safety reasons and to reduce airborne dust from vehicular and other equipment traffic.

8.2.5 Project Residual Environmental Effects for Change in Soil Quality

No residual effects on soil quality are predicted to occur outside of the LAAs. A description of the predicted residual effects within each LAA is provided below.

8.2.5.1 Mine LAA

Air quality modelling predicted changes in COPC concentrations in soils within the LAA below the CCME (2009) Soil Quality Guidelines (Table 8.2-1; see Tier 3, Technical Appendix 8A for further details), and will be localized in geographic extent. For radionuclides (where no CCME guideline exists), no measurable changes in soil radionuclide concentrations (compared to baseline) are predicted as a result of the Project (Table 8.2-1). There were no residual effects predicted for soil quality related to COPC concentrations. Any change in soil quality due to changes in COPC concentrations are predicted to be low in magnitude, and occur continuous during the construction and operation phases of the Project. Although changes in soil quality are anticipated to be long term; effects of increased concentrations of COPC in soils will be reversible over time following decommissioning of the Project.

It is predicted that approximately 81 ha outside of the Project footprint of the Kiggavik mine site, will likely be exposed to PAI levels in excess of the critical load threshold (i.e., greater than 0.25 keq/ha/year). This represents approximately 0.2% of the Mine LAA. PAI levels at the Sissons mine site are not predicted to exceed the threshold value. There may be a difference in PAI sensitivity among soil classes based on soil quantity, texture and presence of organic matter. However, the scale of the PAI assessment model (1^{o} latitude by 1^{o} longitude cells) found in Alberta Environment (AENV 2008) does not reflect this level of detail. The residual effect from PAI on soils is anticipated to be low in magnitude and localized in geographic extent. Changes to soil quality due to PAI are anticipated to occur continuously during the construction and operation phases of the Project and are anticipated to occur over the medium term, as Project activities contributing to PAI would cease to occur at the end of operation. The effects are anticipated to be reversible.

Soil compaction due to construction activities will be confined to the Project footprint, and will occur predominately in sandy clay loam soils that contain coarse fragments within the B and C horizons. Sandy soils are less prone to compaction than silty or clay soils, and soils with a high content of coarse fragments are less susceptible to compaction than stone-free soils (Archibald et al. 1997). While compaction may occur on soils that have higher clay content, the occurrence of these types of soils appears to be low based on baseline studies (see Tier 3, Technical Appendix 6B, Attachment G). Therefore, the residual effects of soil compaction on soils is predicted to be low, site specific in geographic extent, will likely occur sporadically during the Project, but will be medium term in duration and reversible.

The residual effects from soil admixing and soil erosion will likely be kept within the confines of the Project footprint. With implementation of the mitigation measures described in Section 8.2.4, effects from soil admixing and soil erosion on soil quality are anticipated to be negligible.

Table 8.2-1 Maximum Predicted Mean and 95th Percentile COPC Concentrations in Soils

COPC	Units	SQG		Baseline	Predicted Soil Concentrations							
					Kiggavik Camp		LAA*		RAA*		Baker Lake	
		Ag.	Res/Prk		Mean	95th	Mean	95th	Mean	95th	Mean	95th
U	ug/g	23	23	1.2	1.3	1.4	1.2	1.3	1.2	1.3	1.2	1.3
Th-230	Bq/g	-	-	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Pb-210	Bq/g	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Ra-226	Bq/g	-	-	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Po-210	Bq/g	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
As	ug/g	12	12	3.8	3.8	4.2	3.8	4.2	3.8	4.2	3.8	4.2
Cd	ug/g	1.4	10	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Co	ug/g	40	50	4.0	4.0	4.4	4.0	4.4	4.0	4.4	4.0	4.4
Cu	ug/g	63	63	8.9	9.0	9.9	9.0	9.9	9.0	9.9	9.0	9.9
Pb	ug/g	70	140	13.7	13.7	15.1	13.7	15.1	13.7	15.1	13.7	15.1
Mo	ug/g	5	10	1.8	1.8	2.0	1.8	2.0	1.8	2.0	1.8	2.0
Ni	ug/g	50	50	12.4	12.4	13.7	12.4	13.7	12.4	13.7	12.4	13.7
Se	ug/g	1	1	0.8	0.8	0.9	0.8	0.9	0.8	0.9	0.8	0.9
Zn	ug/g	200	200	14.2	14.2	15.7	14.2	15.7	14.2	15.7	14.2	15.7

NOTES:
Soil Quality Guidelines (SQG) for Agricultural and Residential/Parkland from CCME (1999)
* The LAA and RAA boundaries used in the Ecological and Human Health Risk Assessment report differ from the Terrestrial Assessment boundaries. See Tier 3, Technical Appendix 8A, Figure 3.1-1 for boundary clarification.

8.2.5.2 Road LAAs

Air quality modelling for COPC concentrations in soils was not completed for the road LAAs; however, modelling was completed for the RAA which encompasses the road LAAs. Predictions from this modelling indicate that COPC concentrations within the RAA will be below the CCME (2009) Soil Quality Guidelines (Table 8.2-1; see Tier 3, Technical Appendix 8A for further details). For radionuclides (where no CCME guideline exists), no measurable changes in soil radionuclide concentrations (compared to baseline) are predicted as a result of the Project (Table 8.2-1). There were no residual effects predicted for soil quality. Aany changes in soil quality as a result of an increase in COPCs concentrations within the road LAAs are anticipated to be low in magnitude, and localized in geographic extent. Changes in COPC concentrations are predicted to occur regularly throughout the life of the Project, and the effects on soil quality are anticipated to be long term but reversible.

As vehicle traffic along the winter road will be occurring during frozen ground conditions, soil compaction is not anticipated, except in localized spots where rutting may occur in places where granular material was not used for creating a level travel surface. Soil compaction along the proposed All-Season Road would be restricted to the confines of the road. The residual effects of soil compaction along the All-Season Road is predicted to be low, site specific in geographic extent, occur regularly during the Project, be medium term in duration and reversible.

Soil admixing will not occur during development and operation of the proposed roads, as materials used to develop the roads will be placed on top of the existing and undisturbed tundra. Therefore, no residual effects are anticipated.

Soil erosion is not anticipated at the winter road location as use will occur during frozen ground conditions and climatic events (e.g., precipitation, wind) will not be able to initiate erosion of soil. Proper culvert placement and installation along the proposed All-Season Road will prevent soil erosion from surface drainage.

8.2.5.3 Dock Site Options

Air quality modelling for COPC concentrations in soils was not completed at the proposed dock sites; however, modelling was completed for the community of Baker Lake which is located near the sites. Results of the modelling indicate that COPC concentrations will be below the CCME (2009) Soil Quality Guidelines at the community of Baker Lake (Table 8.2-1; see Tier 3, Technical Appendix 8A for further details). For radionuclides (where no CCME guideline exists), no measurable changes in soil radionuclide concentrations (compared to baseline) are predicted as a result of the Project (Table 8.2-1). There were no residual effects predicted for soil quality. of the effect of COPCs on soil quality is anticipated to be low in magnitude, and localized in geographic extent. Any changes to soil quality due to changes in COPC concentrations are predicted to occur regularly throughout the duration of the Project and the effects are anticipated to be long term and reversible.

Soil compaction caused by vehicular movement during the loading and unloading of the barge at the proposed dock site will likely occur but will be limited to the confines of the site pad located at the dock site location. The residual effects of soil compaction at the dock facility is predicted to be low, site specific in geographic extent, occur regularly during the Project, medium term in duration and reversible.

The residual effects from soil admixing and soil erosion will likely be kept within the confines of the dock site. It is anticipated that with implementation of the mitigation measures effects of soil admixing and soil erosion on soil quality at the dock facility to be negligible.

8.2.6 Determination of Significance for Change in Soil Quality

Given the low predicted levels of COPC concentrations and PAI and the confined nature of effects from soil admixing, compaction and erosion within the Project footprint, changes in soil quality as a result of the Project are predicted to be not significant. Overall, confidence in the predicted changes to soil quality is considered high for the following reasons.

- The effectiveness of mitigation measures related to soil quality is well understood, and the recommended practices are typical for mining operations.
- Project-related effects on soil admixing, compaction, and erosion is well understood, and mitigation measures to reduce or prevent Project-related effects are well known and effective.
- Conservative estimates of emissions sources from Project activities were used to determine the potential effects on soil acidification and changes in the COPCs outside the Project footprint.

Prediction confidence will be further enhanced through a pre-development monitoring program that includes dust and air emission monitoring.

8.2.7 Compliance and Environmental Monitoring for Change in Soil Quality

Compliance and environmental monitoring for potential changes in soil quality will include the following:

- chemical analyses of soil samples from permanent sample plots
- air emissions and dust deposition monitoring

- comparison of chemical analysis results from soils to air emissions and dust deposition results, as well as to baseline values and CCME guidelines
- routine checks of overburden piles for signs of erosion; implementation of mitigation measures if issues are identified
- monitoring of the winter road for structural integrity to avoid rutting or damage to underlying soils, with appropriate mitigation measures implemented in areas of concern
- monitoring of the All-Season Road for structural integrity, effectiveness of dust suppression in the mine site area and near the community of Baker Lake , as well as effectiveness of culverts for allowing surface drainage while preventing soil scouring.

8.3 Assessment of Change in Soil Quantity

8.3.1 Analytical Methods for Change in Soil Quantity

Changes in soil quantity were assessed based on the maximum predicted area to be developed for the Project. The type of change to soil quantity varies based on the effect mechanism. Some of the effect mechanisms were quantitatively assessed based on predicted disturbances to soils, while other effect mechanisms were addressed qualitatively as the predicted disturbances cannot be quantified.

8.3.2 Baseline Conditions for Change in Soil Quantity

Topsoil depths are shallower in areas where bedrock outcrops occur, while topsoil depths are deeper in areas with a lower landscape position that is conducive to accumulating organic matter. Soils classified as either a Brunisolic Turbic Cryosol or Brunisolic Static Cryosol have shallower topsoil depths, while Organic Cryosols and Histic Static Cryosols contain deeper topsoil depths. The topsoil layer, or active growth medium layer used by vegetation, was determined to range from 3 cm to 31 cm in depth.

8.3.3 Effect Mechanism and Linkages for Change in Soil Quantity

A number of different effect mechanisms can contribute to change in soils quantity during Project development. A summary of the effect mechanisms identified, as well as how the Project would influence change in soil quantity are described below.

8.3.3.1 Topsoil Stripping

Topsoil stripping involves the removal of the growth medium layer from a development area. The purpose of topsoil stripping is to conserve the growth medium layer for future reclamation purposes. Topsoil stripping will likely occur at the Kiggavik and Sissons mine sites, but will not occur during construction of the airstrip and the Kiggavik-Sissons access road. Topsoil stripping will also likely occur at the proposed dock site facility. All stripped topsoil will be stored in the overburden pile location, separate from any stored subsoils, to be used for reclamation purposes

8.3.3.2 Soil Erosion

As mentioned in Section 8.2.3.5, soil erosion involves the wearing away of exposed soils due to climatic events, such as wind, precipitation, or water flow over a surface. Soil quantity can be reduced due to loss of finer particles and organic materials from bulk soil. Soils disturbed during construction of the Project footprint and the quarry sites, as well as soils stored in the overburden piles will be susceptible to erosion due to their exposure to climatic events. Loss of soil from erosion would likely affect reclamation activities associated with soil placement and vegetation occurrence.

8.3.3.3 Soil Movement

Soil movement involves the transport of disturbed soils from one location to another. The movement of soils during construction activities can inadvertently cause soil loss, most noticeably with topsoil. This effect mechanism is most evident when stripped soils are transported over a long distance by pushing the soil materials, usually with a grader or bulldozer. When pushing the stripped soils, portions of the stripped materials can inadvertently be lost in small depressions within the construction area. As the soil transfer distance increases, the amount of soil lost during soil movement can increase substantially.

8.3.3.4 Soil Burial

Soil burial is the loss of soil materials due to the placement of other materials on top of the existing soils. The effects of soil burial are most pronounced with topsoil, due to the loss of the active growth layer. Topsoil will not be salvaged for some components of the Project; rather, materials will be deposited on top of the existing soils and vegetation in an effort to prevent thawing of the permafrost layer. As such, the soils and vegetation will be buried. Areas where soil burial is anticipated include the Kiggavik-Sissons access road, the All-Season Road, the airstrip, and any maintenance roads (e.g., road that parallels the effluent pipes to Judge Sissons Lake). Soil burial will also likely occur on the winter road in upland areas where granular material is used to create a level surface.

8.3.4 Mitigation Measures and Project Design for Change in Soil Quantity

The following mitigation measures and Project design features will be implemented to reduce Project effects on soil quantity:

- Construction activities may be postponed during large precipitation events to prevent excessive disturbance to vegetation and soils due to wet working conditions.
- Before commencing construction activities, a construction plan for topsoil stripping will be developed based on the topography and terrain features at the proposed mine sites and dock facility.
- Temporary overburden piles may be required in areas where terrain features or topography prevent pushing stripped materials to the overburden pile without causing substantial loss of stripped materials. In these instances, stripped materials will be transported from the temporary overburden piles in either a buggy scraper or dump truck to the final overburden pile location.
- Stripped topsoil will be kept separate from subsoils stored at the overburden pile location to prevent soil admixing, as well as loss of the growth medium layer that will be used for reclamation purposes.
- Freshwater diversion channels will be constructed to divert surface drainage around the Project footprint to prevent on-site erosion, as well as to prevent potential contamination of surface drainage.
- Riprap armouring overlying a geotextile will be placed on the channel bottom and side slopes of the diversion channels to mitigate potential erosion of the channel.
- If required, erosion control structures (e.g., sediment breakers, wattles) may be used within the diversion channels following initial excavation to reduce the amount of soil erosion by flowing water until vegetation has established or a geotextile liner is placed within the channel.
- Culverts will be installed where the proposed All-Season Road crosses natural drainage patterns to facilitate water movement.
- If required, temporary erosion control structures (e.g., silt fences) will be placed on the downslope side of the Project footprint to capture and filter sediment-laden runoff during construction.
- If necessary, a substance such as a soil tackifier may be applied to the overburden piles to prevent erosion of soils.
- Soil burial during development of the roads and airstrip will be confined to the boundaries established from the detailed design for these components.

8.3.5 Project Residual Effects for Change in Soil Quantity

No residual effects on soil quantity are predicted to occur outside of the LAAs. A description of the predicted residual effects within each LAA is provided below.

8.3.5.1 Mine LAA

A total of approximately 803 ha of area will be disturbed by the Kiggavik and Sissons mine sites, which represents approximately 1.8% of the Mine LAA. Of that area, approximately 645 ha will be affected by topsoil stripping, and approximately 158 ha will be affected by soil burial. The residual effects from soil movement and soil erosion on soil quantity are anticipated to be negligible with implementation of the mitigation measures identified in Section 8.3.4.

Changes in soil quantity are predicted to be low in magnitude and site specific in geographic extent, and will occur once during the construction phase. Residual effects on soil quantity will occur over the medium term at locations where soil stripping occurs, as stripped soils will be replaced during reclamation activities. However, effects of soil quantity due to soil burial will be longer term, as the development of new soil will need to occur on top of materials used to bury existing soils (e.g., airstrip).

8.3.5.2 Road LAAs

The road widths for the road options are expected to be 12 m wide for the winter road, and 24 m wide for the All-Season Road. For the winter road, a conservative estimate of the entire portion of the winter road located within the uplands was used to predict the amount of soil burial, even though it is anticipated that only 50% of the upland portion of the winter road option will require granular fill for creating a level road surface (exact locations of granular material placement will be determined during the detailed design stage). Therefore, the predicted amount of soil burial due to winter road construction is considered conservative. A summary of the areas crossed by the proposed road options in relation to the amount of upland area, as well as the proportion of the total area of the road options anticipated to be buried is provided in Table 8.3-1. The proportion of the road LAAs affected by soil burial will be no greater than 0.2%.

Table 8.3-1 Areas Crossed by Proposed Road Options

	Total Distance	Total Area	Upland (anticipated soil burial)			Water		
Road Option	km	ha	km	ha	Proportion of Total Area (%)	km	ha	Proportion of Total Area (%)
Winter Road	107	128.4	58	69.6	54.2	49	58.8	45.8
All-Season Road[1]	114	273.6	114	273.6	100.0	0	0	0.0

NOTES:

[1] Small portions of the All-Season Road crosses water; however, these areas will contain bridges and will not be affected by granular fill.

Topsoil stripping and soil movement will likely occur at site-specific locations to facilitate vehicular travel over steep terrain along the proposed access roads. Soil erosion due to scouring by surface water at a culvert outflow location may also occur; however, the effects will likely only occur until removal of the culvert during final closure. With implementation of mitigation measures, residual effects from these activities are expected to be negligible.

The overall residual effects of road development on soil quantity are anticipated to be low in magnitude (i.e., 0.2% or less of the road area affected) and site specific in geographic extent (i.e., confined to the road footprint), and will occur once during the construction phase. The duration of residual effects on soil quantity will vary depending on the effect mechanism. Effects from soil movement on soil quantity will cease following completion of construction activities, and therefore will be short term. However, soil erosion due to water flow at culvert outflow locations could potentially occur until culvert removal and the replacement of topsoil from stripped areas during final closure, resulting in more medium term effects on soil quantity. In areas where soil burial occurs, recovery of soil quantity is expected to occur over the long term as natural development of new soil occurs on top of materials used to build the roads and airstrip. Further details regarding final closure of the Project can be found in the Preliminary Decommissioning Plan (i.e., see Tier 3, Technical Appendix 2R).

8.3.5.3 Dock Site Options

Topsoil will be stripped and stored in an overburden pile at the dock facility. Construction of the dock facility at site option #1 (preferred option) is estimated to disturb approximately 25 ha. Alternative dock site option #2 is estimated to disturb approximately 29.4 ha. Another dock option is for AREVA to use the existing Agnico Eagle Meadowbank dock site. This may be a viable alternative if the Meadowbank dock is no longer required by Agnico Eagle when the Kiggavik Project begins operation and appropriate transfer of ownership approvals are maintained. This site is a previously disturbed, brownfield site (23.5 ha) and if used, no topsoil stripping or additional surface disturbance is expected.

The areas disturbed by the dock site options 1 and 2 represent less than 0.1% of the Winter Road and All-Season Road LAAs. Therefore, the residual effects associated with dock facility development on soil quantity are anticipated to be negligible.

8.3.5.4 Project Development Option Combinations

As described in the Project Description (Tier 2, Volume 2), a winter road will be constructed to support both the construction and operation phases of the Project. The All-Season Road with a cable-ferry crossing the Thelon River has also been included as a viable option. As such, a comparison of the changes in soil quantity for the different Project development options was completed. A summary of the residual effects on soil quantity for the preferred Project development option combinations is provided below. The entire portion of the uplands located along the winter road option was used to determine the amount of soil buried, even though it is anticipated that only 50% of the upland portion of the winter road option will require granular fill for creating a level road surface (exact locations of granular material placement will be determined during the detailed design stage). The residual effects on soil quantity for the alternate development option combinations are not anticipated to be substantially different from the preferred development option combinations.

Winter Road and Dock Site Option #1 with the Mine Sites

Approximately 931.4 ha will be disturbed as a result of this development option combination, which represents less than 1% of the combined LAAs. Of the area affected, approximately 645 ha (69%) within the Kiggavik and Sissons mine sites will have the topsoil stripped and stored for reclamation purposes. Approximately 286.4 ha (31%) will be buried along the access roads and airstrip.

Winter Road, All-Season Road, and Dock Site Option #1 with the Mine Sites

The addition of the All-Season Road would result in an additional 273.6 ha of disturbed area for a total area of about 1,205 ha, which represents less than 1% of the combined LAAs. The amount of area disturbed by soil burial would increase to approximately 560 ha (or 47% of the combined area) with the inclusion of the All-Season Road. No additional topsoil stripping would be required for the All-Season Road; therefore, the total area disturbed by topsoil stripping would be 645 ha (or 53% of the combined LAAs).

8.3.6 Determination of Significance for Change in Soil Quantity

Given the small amount of area disturbed under either development option (< 1% of the combined LAAs), any change in soil quantity as a result of construction and operation of the mine sites, access road and dock facility is predicted to be not significant. Overall, the confidence in this prediction is considered high for the following reasons.

- The effectiveness of mitigation measures related to soil quantity are well understood and the recommended practices are typical for construction activities associated with mining operations.
- Assessment of total soil losses (topsoil salvage vs. burial) associated with the Project are based on the Project Description (Tier 2, Volume 2) and are therefore considered to be accurate predictions.

Prediction confidence will be improved through the presence of an on-site environmental monitor during topsoil stripping and storage activities, as well as road construction.

8.3.7 Compliance and Environmental Monitoring for Change in Soil Quantity

Compliance and environmental monitoring for potential changes in soil quantity will include the following:

- An environmental monitor will likely be on-site during the construction phase to assist AREVA personnel and contractors with mitigation strategies to reduce the effects of the Project on soil quantity, such as topsoil stripping, soil storage, and soil erosion on disturbed areas.
- Dust deposition monitoring will occur throughout the duration of the Project to identify and mitigate potential effects.

8.4 Cumulative Effects Analysis for Soils

Project activities could contribute to changes in soil quality and quantity within the Kiggavik area as a result of air emissions, dust generation, site clearing and installation of Project components. Although residual Project effects on soils are expected to be of low magnitude and very localized, they could act cumulatively with that of other projects and activities occurring in the RAA at present and in the foreseeable future.

8.4.1 Screening for Cumulative Environmental Effects

Of the potential future projects and activities identified in the Project Inclusion List (Tier 1, Volume 1), only the Meadowbank dock site facility has the potential to interact with the Project. The Meadowbank dock facility is located approximately 1 km from the preferred dock site (Option #1). Both construction and operation activities at the Project dock facility could overlap temporally with operation of the Meadowbank dock and potentially cause cumulative effects on soil quality as a result of increased air emissions. The likelihood of these projects overlapping is low; however, cumulative effects on soil quality from air emissions are considered as part of a conservative screening.

An air quality assessment was completed as part of the Atmospheric Environmental Assessment (Tier 2, Volume 4) to determine potential cumulative effects from the combined operations of the Meadowbank and Kiggavik dock and storage facilities. Result of the modelling predicted exceedances of the 1-hour and 24-hour threshold values for ambient NO_2 concentrations during periods when both facilities are operating simultaneously. The exceedances are predicted to occur approximately 1% of the time annually and are expected to be localized. Therefore, deposition of NO_2 from the Meadowbank and Kiggavik dock and storage facilities are not expected to result in a detectable change in soil quality. The project contribution to this cumulative effect is minor and not significant.

In addition to the Meadowbank facility, exploration activities are currently occurring near the proposed Project (Tanqueray option, Ukaliq, Schultz Lake, St. Tropez Claims, Judge Sissons, and Kiggavik S. exploration sites). As such, these activities are considered as part of the Base Case, and have been addressed in the context of current baseline conditions for soils. As none of the exploration sites located within the RAA are involved in the regulatory process, or have made a public announcement to seek regulatory approval, details on the programs are lacking. None-the-less, the effects of these exploration activities on soils are likely to be localized to the exploration site, and are not anticipated to overlap with the residual effects from the Kiggavik Project. As well, no other projects or developments are known to occur and no future projects are anticipated within the LAA and RAA boundary. As the Project effects are not expected to extend beyond the LAA or overlap with any other projects, no cumulative effects on soils are anticipated. As a result, the cumulative effect of changes in soil quality and quantity is not considered further in this assessment.

8.5 Summary of Project Residual Environmental Effects on Soils

8.5.1 Project Residual Environmental Effects

The residual effects of changes in soil quantity and soil quality caused by the Project are predicted to be not significant (Table 8.5-1). The residual effects caused by soil admixing, compaction and erosion are anticipated to be negligible with the implementation of effective mitigation measures The estimated total area outside of the Project footprint that has the potential to be exposed to PAI values of greater than 0.25 keq/ha/year is approximately 81 ha, which represents approximately 0.2% of the Mine LAA. Because of the small area predicted to be affected by PAI, the residual effects are anticipated to be negligible. For changes in soil quality associated with dust deposition, no residual effects are anticipated. Changes in concentrations of COPCs in soils within all of the LAAs were predicted to be below the CCME (2009) Soil Quality Guidelines.

Depending on the Project development option selected, changes in soil quantity are predicted to occur within an area of between 953 ha and 1,212 ha, both of which represent less than 1% of the combined LAAs. Of this total, about 645 ha will be disturbed by topsoil stripping and an additional 208 ha to 567 ha will be disturbed from soil burial.

Table 8.5-1 Summary of Project Residual Environmental Effects on Soils

Project Phase	Mitigation/ Compensation Measures	Residual Environmental Effect (Y/N)	Direction	Residual Environmental Effects Characteristics: Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context	Significance	Likelihood	Prediction Confidence	Recommended Follow-up and Monitoring
Change in soil quality: Air emissions from Project components will affect soil quality.													
Construction	• All industrial machinery and equipment (including the diesel-powered generators) will meet federal air emission standards	Y	A	L	L	LT	C	R	ND	N	NA	H	Monitoring of air emissions from static emissions sources associated with the Project (e.g., acid plant).
Operation	• Use of low sulphur diesel fuel.												Monitoring of soil permanent sampling plots located around the mine sites and access roads for changes in soil quality.
Final Closure Post Closure	• Scrubbers installed on mill stacks to remove particulates and contaminants before discharge into the atmosphere.												
Change in soil quality: Dust created by Project activities will affect soil quality.													
Construction Operation	• Avoid blasting on days when winds are excessive.	N	A	L	L	LT	C	R	ND	N	N/A	H	Dust deposition monitoring around the mine sites as well as the access roads.
Final Closure Post Closure	• Dust suppression in the mine site area by spraying water or other approved substance on travel area.												
Change in soil quality: Soil compaction due to vehicular movement will affect soil quality.													
Construction Operation	• Vehicular travel on the winter road will occur during frozen ground conditions, thereby preventing soil compaction.	Y	A	L	S	MT	C	R	ND	N	N/A	H	During reclamation and revegetation, identify areas where soil compaction is evident and implement mitigation measures to de-compact soils, allowing better seed germination conditions.
Operation Final Closure	• Scarification of areas to be reclaimed during final closure will loosen compacted soils.												
Change in soil quantity: Site clearing during Project construction will affect soil quantity.													
Construction	• Activities confined within the work area boundaries. • Topsoil stripping and salvage.	Y	A	L	S	MT	O	R	ND	N	N/A	H	Environmental monitor on-site during construction.
Change in soil quantity: Soil burial due to the placement of materials on undisturbed areas during Project construction will affect soil quantity.													
Construction	• Activities confined within the work area boundaries.	Y	A	L	S	LT	O	R	ND	N	N/A	H	Environmental monitor on-site during construction.
Change in soil quality: Soil compaction due to vehicular movement will affect soil quality.													

Table 8.5-1 Summary of Project Residual Environmental Effects on Soils

Project Phase	Mitigation/ Compensation Measures	Residual Environmental Effect (Y/N)	Direction	Residual Environmental Effects Characteristics: Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context	Significance	Likelihood	Prediction Confidence	Recommended Follow-up and Monitoring
Change in soil quantity: Soil movement during Project construction will affect soil quantity.													
Construction	• Construction plan during topsoil stripping and salvage. • Using equipment to transport soils to overburden pile rather than pushing soils.	Y	A	L	S	ST	O	R	ND	N	N/A	H	Environmental monitor on-site during construction.
Change in soil quantity: Soil erosion until site stabilization, or vegetation establishment and proliferation on disturbed areas will affect soil quantity.													
Construction Operation Final Closure Post Closure	• Erosion control structures to prevent migration of materials off-site.	Y	A	L	S	MT	S	R	ND	N	N/A	H	Monitoring of site, overburden piles, and culverts along access roads for erosion potential and occurrence.

KEY

Direction:
- P Positive
- N Neutral
- A Adverse

Magnitude:
- N Negligible: no measurable change in soil quality or soil quantity
- L Low: effect is detectable but no measurable change in soil quality or soil quantity.
- M Moderate: effect is detectable and outside the range of natural variation, but is unlikely to change soil quality or soil quantity.
- H High: a change in either soil quantity or soil quality will occur, preventing reclaiming the landscape to meet end land use goals.

Geographic Extent:
- S Site specific: (i.e., within Project Footprint)
- L Local (i.e., within the LAA)
- R Regional (i.e., extends beyond the LAA but within the RAA)

Duration:
- ST Short term: change no longer detectable at the end of construction
- MT Medium term: change no longer detectable at the end of final closure
- LT Long term: change extends beyond the life of the Project

Frequency:
- O Once.
- S Sporadically: occurs more than once, but at unpredictable intervals
- R Regularly: occurs repeatedly at regular intervals
- C Continuous: occurs continuously throughout the Project

Reversibility:
- R Reversible
- I Irreversible

Environmental Context:
- D Disturbed: area has been substantially disturbed previously by human development, or human development is still present.
- N Not Disturbed: area has not been disturbed by human activity.
- N/A Not Applicable

Significance:
- S Significant
- N Not Significant

Prediction Confidence:

Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation
- L Low level of confidence
- M Moderate level of confidence
- H High level of confidence

Likelihood:

Of a significant effect occurring
- N/A Not Applicable
- L Low probability of occurrence
- M Medium probability of occurrence
- H High probability of occurrence

Cumulative Effects
- Y Potential for effect to interact with other past, present or foreseeable projects or activities
- N Effect will not or is not likely to interact with other past, present or foreseeable projects or activities

The residual effects presented looked at Project-related effects on an individual basis (e.g., PAI alone, changes in COPC concentrations alone). While these residual effects may be low in magnitude and vary in duration, the combination of the Project-related effects and how they influence the residual effects could have additional effects on soils. These combined interactions and potential changes in residual effects are complex and difficult to understand, and no clear interaction mechanism has been found in the literature. It is also dependant on the each of the COPC, for example in general acidification of soil could increase the leachability and bioavailability of metals that exist as a cation, but not those that are anionic. Availability of nutrients can also be affected by pH. Based on professional judgment, the combination of Project-related effects and the subsequent residual effects for soils are anticipated to be no greater that the residual effects on an individual basis, as these effects were assessed on a conservative basis. Therefore, the combined Project-related effects on soils are predicted to be not significant.

8.5.2 Residual Cumulative Environmental Effects

The Kiggavik Project is not expected to contribute substantially to cumulative effects on soils in the RAA. The Project contribution to cumulative effects is not significant.

8.5.3 Effects of Climate Change on Project Effects on Soils

To estimate the effects of climate change on the Project, twenty three climate change ensembles, which reflect different combinations of models and emission scenarios, were explored, as dicussed in Technical Appendix 5K. Most models predict an increase in temperature throughout the year, however the magnitude of warming in the winter is highest. This is consistent with IQ from the Nunavut Climate Change Centre and the Arctic Climate Impact Assessment report (ACIAR, 2005). Twenty of the twenty three ensembes predict an increase in annual precipitation for the period 2071-2099. The greatest increase in precipitation was 78% greater than historical rates. On average, the models predict a 34% increase in precipitation; this increase is typically distributed throughout the year, however most dramatic increases occur in the autumn. Twenty of the twenty three climate change ensembles predict an increase in runoff at Judge Sisson and Pointer Lake outflows. On average, runoff is estimated to increase 67% and 74% for Pointer Lake and Judge Sissons Lake watersheds, respectively. The maximum increase in runoff is observed at 177% and 200% of historical discharge for the two watersheds. The models also predict an average increase in wind speed of 0.2 m/s with a ll months showing an average increase except May.

Climate change will likely have the most pronounced effect on soil quantity as a result of increased soil erosion due to changes in temperature, precipitation, and wind. Soil susceptibility to erosion would likely increase with increases in temperature, increase in precipitation and resulting runoff and erosion, and increases in duration and magnitude of wind events. Soils exposed by the Project (e.g., overburden pile) would likely be most susceptible to soil loss.

8.6 Summary of Mitigation Measures for Soils

A summary of mitigation measures that will be implemented to reduce or prevent the Project environmental effects on soils are described below. Many of the mitigation measures associated with soil quantity and quality incorporate IQ guiding principles (GN 2009), including Qanuqtuurnunnarniq (being resourceful to solve problems), Avatimik Kamattiarniq (environmental stewardship), and Pilimmaksarniq (skills and knowledge acquisition).

Soil Quality

Air emissions that could cause soil acidification as well as changes in COPC concentrations within soils will occur throughout the duration of the Project. To reduce the potential for soil acidification and changes in COPC concentrations, emissions from all industrial machinery and equipment, including the diesel-powered generators will meet the federal air emission standards. Low sulphur diesel fuel will be used to reduce emissions associated with diesel fuel combustion. In addition, scrubbers will be installed on any mill stacks that emit particulates and contaminants (e.g., acid plant exhaust stack) to remove these items from the air stream before discharge (Tier 3, Technical Appendix 4C).The Air Quality Monitoring and Mitigation Plan (Tier 3, Technical Appendix 4C) outlines mitigation by design and mitigation by management for changes in air quality; these mitigation measures will reduce effects of air emissions on soil quality.Soil admixing has the potential to occur during topsoil stripping and storage of stripped topsoil. Soil admixing will likely occur to varying degrees during topsoil stripping, as topsoil depth varies across the Project development area. To reduce soil admixing, AREVA environmental personnel will be on-site to work with construction crews during the stripping process to help identify areas where the topsoil layer has been adequately stripped to prevent further stripping at these locations. Stripped topsoil will be kept separate from subsoils stored at the overburden pile location to prevent soil admixing, as well as loss of the growth medium layer that will be used for reclamation purposes. Stripped topsoils will also be well-segregated from the ore piles and the Type 3 mine rock stockpiles to prevent soil contamination. Efforts will be made during the storage process to place frozen or wet soils removed during site preparation within drier soil materials of the same nature (i.e., topsoil, subsoil) to prevent potential migration and subsequent admixing with other soil or waste rock piles. The stripped topsoil and subsoil materials stored in the overburden pile location will be scanned to ensure no radiation contamination prior to use during site reclamation.

Soils exposed during construction are susceptible to erosion from surface drainage and wind events. Soil erosion from surface drainage can occur as a result of: 1) natural surface drainage from the surrounding area travelling over the Project footprint; and 2) surface drainage from within the Project footprint caused by rain events. Freshwater diversion channels will be constructed to divert surface drainage around the Project footprint, thereby reducing the potential for on-site erosion. Riprap armouring overlying a geotextile will be placed on the channel bottom and side slopes of the diversion channels to mitigate potential erosion of the channel (see Tier 3, Technical Appendix 2E and Tier 3, Technical Appendix 5O). Other erosion control structures (e.g., sediment breakers, wattles) may also be placed within the diversion channels following initial excavation to reduce the amount of soil erosion by flowing water until vegetation has established or a geotextile liner is placed within the channel. Culverts will be installed where the proposed All-Season Road crosses natural drainage patterns to facilitate water movement, and in a manner that will prevent scouring of the tundra environment at the culvert outflow location (Tier 3, Technical Appendix 5O).

Site containment will involve sloping the site pads towards the runoff ponds. However, during construction and prior to site containment, disturbed soils may be susceptible to erosion from surface drainage within the Project footprint caused by precipitation events and snowmelt. If the disturbed areas are deemed to be susceptible to erosion prior to development of site containment, temporary erosion control structures (e.g., silt fences) will be placed on the downslope side of the Project footprint to capture and filter sediment-laden runoff (Tier 3, Technical Appendix 5O).

Erosion of soils stored in the overburden pile will be monitored throughout the duration of the Project. If climatic events (e.g., precipitation, wind) cause soil erosion from the overburden piles, AREVA will apply mitigation (e.g., the application of a soil tackifier) to the overburden piles to prevent further erosion.

Soil compaction will occur through the duration of the Project due to the movement of vehicles on roads and site pads, as well as placement of infrastructure (e.g., mine plant, accommodations complex). During final closure, areas ready for reclamation will be scarified to loosen compacted soils, allowing for increased success rates of seed germination and sprouting of propagules within the areas being reclaimed (Tier 3, Techncial Appendix 2R). Vehicle travel along the winter road will likely not cause soil compaction as travel will be occurring during frozen ground conditions. However, rutting may occur in localized spots where the integrity of the winter road may be compromised. Efforts to identify and avoid vehicle travel on soft spots along the winter road will be employed. Rig matting may also be used to prevent rutting and other disturbances to soils where the winter road's integrity is compromised.

Dust will be created during mining and movement of materials to either the ore piles or waste rock piles. During open pit mining, blasting patterns will be used to control the dispersion of materials as well as dust. Where possible, blasting may also be avoided on days where dust dispersion outside of the Project footprint is anticipated to be excessive due to the prevailing winds speeds. Dust suppression will involve spraying water from a tanker truck affixed with either a spray nozzle or spray bar onto dust-prone mine site areas. If water spraying is not effective in preventing dust occurrence, an adaptive management strategy focussing on additional dust suppression techniques will be investigated, such as using a dust suppressant identified in the GN (2002) guidelines. Speed limits around the mine site and along all roads will be strictly adhered to, for safety and to reduce airborne dust from vehicular and other equipment traffic (Tier 3, Technical Appendix 2M). Dust suppression on roads was a concern raised through public engagement comments (EN-BL OH Nov 2013[145]).

Aspects of these mitigation measures are included in Tier 3, Technical Appendices: 2M Road Management Plan, 2R Preliminary Decommissioning Plan, 4C Air Quality Monitoring and Mitigation Plan, and 6D Wildlife Mitigation and Monitoring Plan.

Soil Quantity

Best management practices will occur during construction of the Project. Construction activities will likely be postponed during large precipitation events to prevent excessive disturbance to vegetation and soils due to wet working conditions.

During topsoil stripping, efforts will be made to reduce the movement of stripped topsoil when transferring to the overburden pile. For example, topsoil stripped at the far end of the construction area will likely be hauled to the overburden pile using carrying equipment (e.g., buggy scrapers, dump truck) rather than pushing the stripped topsoil to the overburden pile using a bulldozer or grader. This will help prevent soil loss from movement of disturbed soils over the work area.

Preventing soil loss caused by soil movement during the construction phase is important for conserving enough of the growth medium layer for future reclamation purposes. Prior to commencing construction activities, a construction plan for topsoil stripping will be developed based on the topography and terrain features at the proposed mine sites and dock facility. This plan will help determine where stripping will occur, the direction of travel when stripping, taking into consideration terrain features and topography to prevent loss of stripped topsoil as well as where stripped topsoils will be placed. If possible, stripped topsoils will be pushed towards the proposed overburden pile location. Temporary overburden piles may be required in areas where terrain features or topography prevent pushing stripped materials to the overburden pile without causing substantial loss of stripped materials. In these instances, stripped materials will be transported from the temporary overburden piles in either a buggy scraper or dump truck to the final overburden pile location.

Soil burial during development of the roads and airstrip will be confined to the boundaries established from the detailed design for these components. Soil erosion during construction activities has the potential to occur where topsoil stripping or other disturbances to soils have occurred. Mitigation measures for soil erosion are presented above in the soil quality section.

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[145] EN-BL OH Nov 2013: *Dust from road. What will AREVA do to suppress dust?*

8.7 Summary of Compliance and Environmental Monitoring for Soils

A summary of compliance and environmental monitoring pertaining to soils that will occur during the Project are described below. Compliance and environmental monitoring plans associated with soil quality and quantity 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-Kiggavik Project Blog 2009[146], EN-BL OH Nov 2013[147]).

Soil Quality

Soil quality will be monitored throughout the duration of the Project. Air emissions and dust deposition monitoring will occur throughout the duration of the Project to identify and mitigate potential effects. Chemical analyses of soil samples from permanent sample plots located within the Mine LAA (i.e., exposure plots) and within the RAA (i.e., reference plots) will occur, and comparisons will be made to air emission and dust deposition results, as well as to the baseline values and CCME guidelines. The overburden piles will be routinely checked for erosion, and mitigation measures will be implemented if issues are identified. The winter road will be monitored during use for structural integrity to avoid rutting and/or damage to the underlying soils, and mitigation will be applied to areas of concern. The All-Season Road will also be monitored for structural integrity and the effectiveness of dust mitigation measures, as well as the effectiveness of culverts for allowing surface drainage while preventing soil scouring.

Soil Quantity

Soil quantity will be monitored primarily during the construction phase of the Project, as well as when any earthwork involving the removal or placement of topsoil is required. An environmental monitor will likely be on-site during the construction phase to assist AREVA personnel and contractors with mitigation strategies to reduce the effects of the Project on soil quantity, such as topsoil stripping, soil storage, and soil erosion on disturbed areas. Dust deposition monitoring will occur throughout the duration of the Project to identify and mitigate potential effects.

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[146] EN-Kiggavik Project Blog 2009: *all the animals we eat rely on good soil*

[147] 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?*