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VOLUME 5 - TERRESTRIAL ENVIRONMENT

Whale Tail Pit Project Meadowbank Division

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Nunavut Water Board

REPORT

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EXECUTIVE SUMMARY – VOLUME 5 TERRESTRIAL ENVIRONMENT

Volume 5 of the Final Environmental Impact Statement for the Whale Tail Pit and Haul Road Project (the Project) addresses Guidelines issues by the Nunavut Impact Review Board, specifically those relating to effects to the Terrestrial Environment, including terrain, permafrost, and soils, vegetation and terrestrial wildlife and wildlife habitat.

Volume 5 includes a discussion on valued components (VCs), incorporation of Inuit Qaujimajatuqangit (IQ), description of the study areas, and an assessment of direct effects to changes to the Terrestrial Environment. The effects assessment evaluates all Project phases, including construction, dewatering, operational, closure, and post-closure.

Public / Inuit Qaujimajatuqangit Concerns

Inuit Qaujimajatuqangit and public concerns were incorporated throughout the evaluation of the potential effects of the Project on the terrestrial environment. Concerns about the Project were obtained through public consultation, focus group meetings, government engagement, and scientific knowledge. Concerns were raised regarding direct and indirect habitat losses as a result of Project activities and construction and are summarized below:

- Eskers found in the Project Regional Study Area (RSA) were identified by Elders as preferred habitat for muskox, denning areas for wolves, fox and Arctic ground squirrels and traditional camp sites.
- Concerns were expressed about Project activities resulting in both quantitative and qualitative losses of vegetation communities, a reduction in quality of wildlife forage through dust deposition, and the capacity of vegetation to regenerate following mine activities. Elders were particularly concerned about the potential loss of lichen which is an important part of the caribou's diet.
- Particular concerns of the effects from the mine on caribou included the potential of caribou to ingest toxic chemicals, the ability of caribou to safely cross the proposed Project haul road and potential effects of the Project haul road on migration and distribution patterns, and concerns related to the potential of reduced caribou availability or a change in the taste of caribou meat.
- Concerns regarding birds and bird habitat were centered on the potential for the destruction or disturbance of nesting bird habitat.

Key Project Elements and Findings of Environmental Impact Statement

Valued components were selected for the Project based on discussions with stakeholders, public meetings, IQ, and experience with other mines in the north. These VCs were then confirmed to be appropriate for the Project through an additional IQ study carried out in 2014. Terrestrial environmental VCs include permafrost, terrain/soils, vegetation (wildlife habitat). Wildlife VCs include ungulates, predatory mammals, raptors, water birds, upland birds and small mammals.

Terrain, Permafrost, and Soils

Project impacts on terrain, permafrost, and soils will result from construction, operations, and closure activities during the life of the Project. Some of these activities will result in physical gain of permafrost through permafrost growth into structural fills as well as to the long-term growth of permafrost beneath the Whale Tail WRSF. Other activities will result in physical loss of terrain, permafrost and soil due to extraction of rock and soil material for use in construction, and due to the physical mining of the open pit. Primary pathways are physical loss or permanent alteration of existing permafrost conditions and terrain and soils features and changes to soil properties.

Permafrost degradation may result from the excavation of the open pit, potential groundwater inflows to the open pit during operations (if depth extends below the base of permafrost). The proposed open pit will likely result in retreat of permafrost into the walls and floor of the pit and creation of an active layer. Minor changes to permafrost will result from flooding during of a number of upstream tributary lakes. The diversion channel that will be constructed as part of the Whale Tail Dike may cause the active layer to increase slightly in thickness.

Site clearing and construction for the Project, particularly through the processes of soil stripping and storage, will result in changes to soil quantity and distribution, and changes to terrain. Changes to the existing terrain and soil conditions will be confined to the Project footprint. Till (moraine) is the dominant surficial material that will experience the greatest change within the Project Footprint. Water is the second largest terrain feature that will experience change as a result of dewatering Whale Tail Lake for the Whale Tail Pit.

Site clearing and construction for the Project may result in changes to soil quality. During decommissioning and reclamation, the soil will be not re-constructed. The footprint of the open pit will primarily be a lake at closure.

Soil disturbance during construction is expected to cause physical changes to soil such as loss of soil structure. The adverse effects on soil ecological characteristics are expected to result in decreased rates of nutrient cycling and reduced availability of macro and micro nutrients in the substrates of the closure landscape for several years or decades after reclamation. Erosion will occur during construction due to removal of the vegetation cover. Without mitigation, most soils in the local study area (LSA) are rated as having moderate erosion potential. Accelerated erosion related to Project activities would be confined mainly to the Project footprint.

Vegetation

Project impacts vegetation habitat quantity and quality will result from construction, operations, and closure activities during the life of the Project.

<u>Changes to Vegetation Habitat Quantity</u>

Effects to vegetation will include the physical removal of vegetation in all Project construction areas. The maximum amount of vegetated and non-vegetated Ecological Land Classification (ELC) units lost due to the Project is predicted to be approximately 2.9% of the LSA. Overall vegetation and consequential wildlife habitat loss as a result of the Project footprint is 2.9% of the LSA and 0.2% of the RSA; the Project is anticipated to decrease vegetated ELC units by 0.1%. During Project construction and operations, Project effects will be localized around the mine site and haul road within the LSA. Losses to vegetation communities are predicted to be long-term for ELC units within the mine footprint that will be naturally revegetated in the long-term post-closure. Reclamation efforts will focus on providing conditions conducive to natural re-colonization of the site by surrounding native vegetation.

Changes to Vegetation Habitat Quality

Potential effects to vegetation associated with non-footprint disturbances may occur during Project operations and include dust deposition. Accumulation of dust produced from the Project may result in direct changes to vegetation and bryophyte and lichens may be particularly vulnerable to the chemical effects of dust. The primary effects of dust are generally confined to the immediate area next to roadways. Effects on vegetation will be directly related to the amount of traffic on the haul road, and is anticipated to be highly seasonal with minimal to no dust being produced in winter months, while the road is covered with snow. Consequently, effects of dust on vegetation are expected to be restricted to the LSA, continuous through operations of the Project.

Dust modelling results along the haul road predicted that the maximum dust deposition values would be within 1 m of the haul road and concentrated within 100 m. Dust deposition is anticipated to be primarily in downwind areas from the haul road and mine site. Dustfall effects on vegetation will be reversible following Project closure. Dustfall studies for the Meadowbank All Weather Access Road (AWAR) support dustfall modelling predictions for the Project; specifically that the majority of dustfall occurs within 100 m of the road, and that impacts to vegetation (wildlife habitat) because of dust will be restricted to this area. Consequently, effects of dust on vegetation are expected to be restricted to the LSA, continuous through operations of the Project and reversible following closure.

Dewatering of the Whale Tail will occur at the end of the construction phase, resulting in the flooding of a number of tributary lakes upstream of the Whale Tail Dike to the Mammoth Lake Watershed, thereby altering flows at Mammoth Lake and downstream lakes. Flooded areas will be dewatered at closure; therefore, effects on vegetation habitat quality are anticipated to be reversible.

The combined evidence concerning vegetation quantity and quality in the LSA and RSA indicates that vegetation would remain self-sustaining and ecologically effective during construction and operations and would continue to function as wildlife habitat. Graminoid and lichen-dominated ELC units that function as high-quality caribou and muskox habitat will continue to be present and well distributed across the landscape. Consequently, incremental effects from the Project on vegetation are not considered to be significant on a local and regional scale

Terrestrial Wildlife and Wildlife Habitat

Project impacts wildlife habitat quantity, quality and survival and reproduction will result from construction, operations, and closure activities during the life of the Project.

Changes to Wildlife Habitat Quantity

Developing the Project will result in the loss of vegetation communities leading to a direct loss of wildlife habitat, affecting all VCs. However, losses of preferred VCs habitats are anticipated to be a low percentage of the available habitat in the LSA and RSA for each VC. The total preferred habitat for caribou that is predicted to be displaced by the Project footprint is 2% of the available habitat in the LSA and less than 0.2% for the RSA. The Project footprint is predicted to displace approximately 3% and 0.2% of the likely number of birds in the LSA and RSA, respectively.

Project construction will require removal of surface material from eskers. While this disturbance to eskers will remove denning habitat, predators are present in low densities and other eskers are available in both the LSA and RSA.

Changes to Wildlife Habitat Quality

While the Project will lead to direct habitat loss for VCs because of the Project footprint, indirect loss will also occur at the local and regional scales. Sensory disturbances (such as noise and movement) that extend beyond the Project footprint will occur during construction and operations. Further, the Project will extend the use of the Meadowbank Mill, camp operations and AWAR by three to four years.

Indirect effects from the Project are likely to reduce the proportion of preferred caribou and upland bird habitat quality in the LSA and RSA. The effect of indirect habitat loss on caribou is anticipated to be limited and diminish with distance from the Project. The noise impact assessment for the Project indicates that the noise created through construction and operations of the Project would be similar to that of the Meadowbank Mine, and that effects would be confined to the RSA.

The Project haul road is expected to be a potential barrier to wildlife (primarily ungulates and wolves), which may affect population connectivity and distribution. Movements of collared caribou near the AWAR indicate that most caribou that approach the road will cross it. The effect of the Project and haul road on caribou migration is expected to be moderate, as some deflections will likely occur as caribou select a crossing point. Upon closure, there will be no remaining traffic and the Project haul road will be scarified. It is anticipated that caribou will cross the road freely following closure (i.e., medium-term) and that the impact will be reversed at this time.

Changes to Wildlife Survival and Reproduction

Some of the flooding will occur during the nesting season and may lead to the loss of nests near the shoreline of the lake. Considering the area to be flooded and the estimated bird nest density, approximately seven nests in 2019 and three nests in 2020 of the shorebirds, gulls and waterfowl groups and approximately 61 upland bird nests in 2019 and 27 nests in 2020 will be displaced by flooding during the nesting season if no mitigation is undertaken. These numbers do not account for possible reduced nesting activity due to sensory disturbance. Flooding will be isolated and will only take place in the first three years of construction and operations. This is a short-term impact because following the construction of the dikes there will no longer be a risk of nest destruction.

Overall, the weight of evidence, and the experience from the Meadowbank Mine, indicates that incremental and cumulative effects from the Project will not have a significant adverse effect on the existing self-sustaining and ecologically effective wildlife populations.

Mitigation Measures

Monitoring programs will be implemented during the life of the Project through a variety of monitoring plans, and may be a combination of environmental monitoring to track conditions and implementing further mitigation as required and follow-up monitoring to verify the accuracy of effect predictions and adaptively manage and implement further mitigation as required. Monitoring programs for permafrost, soils, vegetation and wildlife will include monitoring of permafrost and soil condition, esker surveys to identify dens, dust monitoring on vegetation along the haul road, and wildlife monitoring. Monitoring will be consistent with the current monitoring programs at the existing Meadowbank Mine. Monitoring is included in the following plans to determine if effects are as follows:

- Terrestrial Ecosystem Management Plan.
- Road Management Plan.
- Noise Monitoring Plan.

Mitigation measures are described throughout the environmental impact assessment.

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ᐅᖃᓕᒫᒐᖅ 5 ᑭᖑᓪᓕᖅᐹᖅ ᐊᕙᑎᒥᒃ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᑎᑎᖅᑲᒥᑦ Whale Trail-ᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᒥᑦ ᐊᒻᒪ ᐊᑉᕐᑯᑎᒧᑦ (ᐱᓕᕆᐊᖅ) ᐱᓕᕆᐊᖃᖅᑐᖅ ᒪᓕᒃᑕᐅᔪᒃᓴᓂᒃ ᐱᔾᔪᑎᖃᖅᑐᓂᑦ ᓄᓇᕗᒻᒥ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᕿᒥᕐᕈᔾᔭᒃᑯᓐᓂᑦ, ᐱᓗᐊᖅᑐᒥᒃ ᐱᔾᔪᑎᖃᖅᑐᓂᒃ ᖃᓄᐃᓕᖓᓕᖅᑎᑦᑎᓂᐅᔪᓂᒃ ᓄᓇᒥᑦᑐᑦ ᐊᕙᑎᖏᓐᓂᑦ, ᐃᓚᐅᑉᓗᑎᒃ ᓄᓇ, ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᖅ, ᐊᒻᒪ ᐃᑉᔪᐃᑦ, ᐱᕈᖅᑐᐃᑦ ᐊᒻᒪ ᓄᓇᒥᑦ ᓂᕐᔪᑎᓂᒃ ᐃᓂᒋᔭᖏᓐᓂᓪᓗ.

ᐅᖃᓕᒫᒐᖅ 5-ᒥᑦ ᐃᓚᐅᔪᑦ ᐅᖃᓪᓚᐅᓯᖃᕐᓂᐅᔪᑦ ᐃᑉᐱᒋᓂᖃᕐᕕᐅᔪᓂᑦ ᐃᓚᒋᔭᐅᔪᓂᑦ (VC), ᐃᓚᐅᓕᖅᑎᑕᐅᓂᖏᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ (IQ), ᖃᓄᐃᖓᓂᕆᔭᖏᑦ ᖃᐅᔨᓴᕐᕕᐅᔪᐃᑦ, ᐊᒻᒪ ᖃᐅᔨᓴᐃᓂᖅ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᔪᓂᒃ ᐊᓯᐊᖑᕐᓂᖓᓄᑦ ᓄᓇᐅᑉ ᐊᕙᑎᖓ. ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓂᒃ ᖃᐅᔨᓴᐃᓃᑦ ᐱᓕᕆᐊᑉ ᓇᓃᑉᐸᓪᓕᐊᓂᕆᔭᓗᒃᑖᖓᓂᑦ, ᐃᓚᐅᔪᑦ ᓴᓇᔭᐅᓂᖓ, ᐃᒪᐃᔭᐃᓂᖅ, ᐅᒃᑯᐊᖅᑕᐅᕙᓪᓕᐊᑎᓪᓗᒍ, ᐊᒻᒪ ᐅᒃᑯᐊᖅᓯᒪᓕᖅᑎᓪᓗᒍ.

ᐃᓄᓗᒃᑖᑦ / ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ ᒥᒃᓵᓄᑦ ᐃᓱᒫᓘᑏᑦ

ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᑦ ᐊᒻᒪ ᐃᓄᖕᓄᑦ ᐃᓱᒫᓘᑕᐅᔪᑦ ᐃᓚᓕᐅᑎᔭᐅᓚᐅᖅᑐᑦ ᕿᒥᕐᕈᓂᓗᒃᑖᕐᒥᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᓂᒃ ᐱᓕᕆᐊᕐᒥᑦ ᐱᔪᓂᒃ ᐱᔭᐅᓚᐅᖅᑐᑦ ᐃᓄᖕᓂᑦ ᐅᖃᖃᑎᖃᕐᓂᒃᑯᑦ, ᑲᑎᒪᖃᑎᖃᕐᓂᒃᑯᑦ, ᒐᕙᒪᒃᑯᑦ ᐃᓚᐅᑎᓪᓗᒋᑦ, ᐊᒻᒪ ᓱᓇᑐᐃᓐᓇᓂᒃ ᖃᐅᔨᒪᔭᖃᕐᓂᐅᔪᑦ ᐱᔭᐅᔪᓂᒃ. ᐃᓱᒫᓘᑏᑦ ᓴᖅᑭᑕᐅᓚᐅᖅᑐᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᓂᕈᐃᑏᑦ ᐃᓂᒋᔭᖏᓐᓂᒃ ᐊᓯᐅᔨᓂᕐᒧᑦ ᐱᓕᕆᐊᖅ ᖃᓄᐃᓕᐅᕐᓂᖓᓄᑦ ᐊᒻᒪ ᓴᓇᕙᓪᓕᐊᓂᖓᓄᑦ ᐊᑖᓂ ᓇᐃᓈᖅᓯᒪᔪᑦ:

- ᓄᓇ ᒪᓂᕋᐅᓃᑦ ᐱᓕᕆᐊᑉ ᖃᓂᑕᖓᓂᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ (RSA) ᐃᓕᑕᕆᔭᐅᓚᐅᖅᑐᑦ ᐃᓐᓇᕆᔭᐅᔪᓄᑦ ᓄᓇ ᐊᑐᖅᑕᐅᖃᑦᑕᕐᓂᖓᓄᑦ ᐅᒥᖕᒪᓄᑦ, ᐊᒪᖅᑯᓄᑦ ᓯᑎᖅᑲᕐᕕᐅᓂᖏᓐᓄᑦ, ᑎᑲᒐᓂᐊᕐᓄᑦ ᐊᒻᒪ ᓯᒃᓯᓄᑦ ᐊᒻᒪ ᐱᖅᑯᓯᒃᑯᑦ ᑕᖕᒫᖅᑕᕐᕕᐅᓂᖏᓐᓄᑦ.

- ᐃᓱᒫᓘᑏᑦ ᐅᖃᐅᓯᐅᓚᐅᖅᑐᑦ ᐱᓕᕆᐊᑉ ᖃᓄᐃᓕᐅᕐᓂᖏᓐᓄᑦ ᐱᔪᑦ ᑕᒪᐃᓐᓄᑦ ᐊᒥᓱᙳᕐᓂᕐᒧᑦ ᐊᒻᒪ ᖃᓄᐃᖓᓂᐅᓂᕐᒧᑦ ᐊᓯᐅᔨᓂᕐᒧᑦ ᐱᕈᖅᑐᓂᒃ, ᒥᒃᓯᒋᐊᕐᓂᓪᓚᐅᓐᓄᑦ ᖃᓄᐃᓐᓂᖏᑦᑕ ᓂᕐᔪᑦ ᓂᓇᖕᕕᒋᖅᑲᑦᑕᖅᑲᖅᑕᕐᓂᒃᑯᑦ, ᐊᒻᒪ ᐃᓂᖏᑦᑕ ᐱᕈᖅᑐᐃᑦ ᐱᙳᒃᑲᓂᕈᖅᓇᕐᓂᖏᑦ ᐅᔾᔨᖅᓂᐊᕐᓂᖅᑕᖃᖅᑲᖅᑎᓪᓗᒍ. ᐃᓇᓕᔭᐅᔪᑦ ᐃᓱᒫᓘᑎᖃᓗᐊᓚᐅᖅᑐᑦ ᐊᓯᐅᔾᔨᖅᓇᕐᓂᖏᑦ ᑐᒃᑐᐃᑦ ᓂᖃᖅᑲᑦᑕᖅᑕᖏᓐᓂᒃ.

- ᐃᓱᒫᓘᑕᐅᓗᐊᓚᐅᖅᑐᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓂᒃ ᐅᔾᔨᖅᓂᐊᕐᓂᕐᒥᑦ ᐱᔪᓂᒃ ᑐᒃᑐᓄᑦ ᐃᓚᐅᔪᑦ ᑐᒃᑐᐃᑦ ᐅᓗᓇᐊᓇᖅᑐᓂᒃ ᓂᓇᔪᖅᑲᕐᓂᖏᑦ, ᑐᒃᑐᐃᑦ ᐃᖕᒐᐳᖅᑲᕐᓂᖏᑦ ᐱᓕᕆᐊᖅ-ᖑᔪᒪᔫᑉ ᐊᑉᕐᑯᑎᖓᓄᑦ ᐊᒻᒪ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᑦ ᓅᑉᐸᓪᓕᐊᑎᓪᓗᒋᑦ ᐊᒻᒪ ᓇᒧᙵᐅᖃᑦᑕᕐᓂᖏᑦᑕ ᐃᓕᖅᑯᓯᖏᓐᓄᑦ, ᐊᒻᒪ ᐃᓱᒫᓗᑕᐅᔪᑦ ᒥᒃᓯᒋᐊᕈᖅᓇᕐᓂᖏᑦ ᑐᒃᑐᐃᑦ ᒪᓂᒪᓂᖏᑦ ᐅᕙᓗᓃᑦ ᐊᔪᐊᖑᕐᓗᓂ ᑐᒃᑐᐃᑦ ᓂᕿᖏᑦᑕ ᑎᐱᖏᑦ.

- ᐃᓱᒫᓗᑕᐅᔪᑦ ᑎᖕᒥᐊᑦ ᒥᒃᓵᓄᑦ ᐃᓂᖏᑦᑕᓗ ᐱᔾᔪᑎᖃᓚᐅᖅᑐᑦ ᓱᕐᕋᑕᐅᔪᖕᓇᕐᓂᖏᑦ ᐅᕙᓗᓃᑦ ᐃᓗᐃᓯᖅᑕᐅᓗᑎᒃ ᐅᐸᓗᒃᑲᕝᕕᒋᖃᑦᑕᖅᑕᖏᑦ.

ᐱᓕᕆᐊᕐᒧᑦ ᐃᓚᒋᔭᐅᓗᐊᖅᑐᑦ ᐊᒻᒪ ᓇᓂᔭᐅᔪᑦ ᐊᕙᑎᒥᒃ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᑎᑎᖅᑲᒥᑦ

ᐃᑉᐱᒋᓂᖃᕐᕕᐅᔪᑦ ᐃᓚᒋᔭᐅᔪᑦ ᓂᕈᐊᖅᑕᐅᓚᐅᖅᑐᑦ ᐱᓕᕆᐊᕐᒨᕐᒐᔪᓐᓂᒃ ᐅᖃᐅᓯᕆᔭᐅᓂᕐᒧᑦ ᐱᖃᖃᑕᐅᔪᓂᒃ, ᑲᑎᒪᓂᑦᑎᓂᒃᑯᑦ, ᐊᒻᒪ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂᑦ, ᐊᒻᒪ ᐱᓕᕆᓂᒃᑯᑦ ᐊᔪᕐᓇᖏᓐᓂᒃ ᐅᔾᔨᖅᓂᐊᕐᕕᖕᓂᑦ ᐅᑭᐅᖅᑕᖅᑐᒥᑦ. ᐃᑉᐱᒋᓂᖃᕐᕕᐅᔪᑦ ᓇᓗᓇᐃᖅᑕᐃᖅᓱᒃ ᓈᒻᒪᖕᓂᐊᕐᓂᖏᓐᓂᒃ ᐱᓕᕆᐊᕐᒧᑦ ᖃᐅᔨᓴᐃᓂᒃᑲᓂᕐᓂᒃᑯᑦ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂᒃ ᐱᓕᕆᐊᖑᔪᒥᑦ 2014-ᒥᑦ. ᓄᓇᒥᑦ ᐊᕙᑎᔪᖅ ᐃᑉᐱᒋᓂᖃᕐᕕᐅᔪᓂᑦ ᐃᓚᐅᓚᐅᖅᑐᑦ ᑯᐊᖑᐃᓐᓇᐅᔭᖅᑐᑦ, ᓄᓇ/ᐃᑉᔪᐃᑦ, ᐱᕈᖅᑐᐃᑦ (ᓂᕐᔪᑏᑦ ᐃᓂᖏᑦ). ᓂᕐᔪᑎᓄᑦ ᐃᑉᐱᒋᓂᖃᕐᕕᐅᔪᑦ ᐃᓚᐅᔪᑦ ᑐᒃᑐᕋᓗᐃᑦ, ᓂᕐᔪᑏᑦ ᓂᕐᔪᑎᑐᖃᑦᑕᖅᑐᑦ, ᑎᖕᒥᐊᑦ, ᐃᒪᕐᒥᐅᑕᐃᑦ ᑎᖕᒥᐊᑦ, ᓄᓇᖅ<ᓯᕐᒥᐅᑕᐃᑦ ᑎᖕᒥᐊᑦ ᐊᒻᒪ ᓂᕐᔪᑎᕋᓛᑦ.

ᓄᓇ, ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᖅ, ᐊᒻᒪᓗ ᐃᑉᔪᐃᑦ

ᐱᓕᕆᐊᕐᒥᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᓄᓇᒧᑦ, ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᒧᑦ, ᐊᒻᒪᓗ ᐃᑉᔪᓄᑦ ᑕᐃᒪᙵᕐᓂᐊᖅᑐᑦ ᓴᓇᔭᐅᑎᓪᓗᒍ, ᐊᐅᓚᖅᑎᓪᓗᒍ, ᐊᒻᒪᓗ ᐅᒃᑯᐊᖅᐸᓪᓕᐊᑎᓪᓗᒍ ᐊᐅᓚᕐᓂᕐᓗᒃᑖᖓᓂᑦ ᐅᔾᔨᖕᓂᐊᕐᓂᐅᑉ. ᐃᓚᖏᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᑕᐃᒪᙵᖅᑎᑦᑎᓂᖃᕐᓂᐊᖅᑐᑦ ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᐃᑦ ᐊᖏᒡᓕᕙᓪᓕᐊᓂᖏᓐᓂᑦ ᐃᓗᓪᓕᖅᑕᐅᓯᒪᔪᓄᑦ ᐊᒻᒪᓗ ᐊᑯᓂᐅᔪᒥᒃ-ᑕᑯᑎᒋᓂᖓᓄᑦ ᐱᕈᕐᓂᖓ ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑑᑉ Whale Tail WRSF-ᒥᑦ. ᐊᓯᖏᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᐊᓯᐊᔾᔨᓂᖃᖅᑎᑦᑎᓂᐊᖅᑐᖅ ᓄᓇᒥᒃ, ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᒥᑦ ᐊᒻᒪᓗ ᐃᑉᔪᓂᒃ ᐋᔭᐃᓂᕐᒧᑦ ᐅᔭᖅᑲᓂᒃ ᐊᒻᒪᓗ ᓄᓇᒥᒃ ᐊᑐᖅᑕᐅᓂᕐᒧᑦ ᓴᓇᔭᐅᓂᖓᓄᑦ, ᐊᒻᒪᓗ ᐅᔾᔨᖕᓂᐊᕐᓂᕐᒥᒃ ᐃᓗᑦᑐᖅᑎᖅᑕᐅᓯᒪᔪᒥᑦ. ᐊᑉᖁᑎᒋᔭᐅᓗᐊᖅᑐᑦ ᐊᓯᐅᔨᓂᐅᔪᑦ ᐅᕙᓘᓃᑦ ᐊᓯᐊᖑᖅᑎᑦᑎᓂᖃᖅᑐᑦ ᑕᐃᒪᐅᔪᓂᒃ ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᐃᑦᖃᓄᐃᓐᓂᓴᖏᓐᓂᒃ ᐊᒻᒪᓗ ᓄᓇᒥᒃ ᐃᑉᔪᐃᓪᓗ ᐋᕿᒃᓯᒪᓂᓴᖏᓐᓂᒃ ᐊᒻᒪᓗ ᐊᓯᐊᖑᕐᓂᖏᑦ ᐃᑉᔪᐃᑦ ᐃᓚᒋᔭᖏᑦ.

ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᑦ ᓄᖑᑉᐸᓪᓕᐊᔪᓐᓇᖅᑐᑦ ᐋᔭᐃᓂᕐᒧᑦ ᐅᒃᑯᐃᖓᔪᒥᑦ ᐃᓪᓗᑦᑐᖅᓯᒪᔪᒥᑦ, ᓄᓇᒦᑦ ᐃᒪᕐᒥᑦ ᑰᒍᓐᓇᖅᑐᓂᑦ ᐅᒃᑯᐃᖓᔪᒧᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᒧᑦ ᐊᐅᓚᕐᓂᖅᑎᓪᓗᒋᑦ ᐅᔾᔨᖕᓂᐊᕐᓂᕐᒥᑦ (ᐃᑎᓂᐅᔪᑦ ᑎᑭᐅᑎᑉᐸᑕ ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑑᑉ ᐊᑖᓄᑦ). ᐅᒃᑯᐃᖓᔪᖅ ᐃᓗᑦᑐᖅᓯᒪᔪᖅ ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᒥᑦ ᓴᓂᕋᖓᓐᓂᑦ ᐊᒻᒪᓗ ᓇᑎᖓᓂᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᒧᑦ ᐊᒻᒪᓗ ᐱᑕᖃᓕᖅᑎᑦᑎᓗᓂ ᑕᐃᒪᓐᓇᐃᑦᑐᒥᑦ. ᒥᑭᔪᑦ ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᒧᑦ ᑕᐃᒪᙵᕐᓂᐊᖅᑐᑦ ᐃᒻᒥᖅᑐᖅᑕᐅᑎᓪᓗᒍ ᑕᓯᕐᓄᑦ. ᓴᖑᑎᑦᑎᔪᐃᑦ ᓯᑉᐳᐃᑦ ᓴᓇᔭᐅᓂᐊᖅᑐᑦ ᐃᓚᒋᔭᐅᓗᑎᒃ Whale Tail ᓯᑉᐳᒧᑦ ᑕᐅᒪᐅᔪᓂᒃ ᐊᖏᒡᓕᒋᐊᖅᑎᑦᑐᐃᓐᓇᓇᐊᖃᖅᑐᖅ ᐃᑉᔪᓂᖓᓂᑦ.

ᐃᓂᐅᔪᒥᑦ ᐋᔭᐃᕙᓪᓕᐊᓂᖅ ᐊᒻᒪᓗ ᓴᓇᔭᐅᓂᖓ ᐱᓕᕆᐊᕐᒧᑦ, ᐱᓗᐊᖅᑐᒥᑦ ᓄᓇᐃᔭᐃᓂᕐᒥᑦ ᐊᒻᒪᓗ ᑐᖅᑯᖅᑎᕆᕙᓪᓕᐊᓂᕐᒥᑦ, ᐊᓯᐊᖑᖅᑎᑦᑎᓂᐊᖅᑐᖅ ᐃᑉᔪᐃᑦ ᐊᒥᓲᓂᖏᓐᓂᒃ ᐊᒻᒪᓗ ᓇᒨᖓᐊᓂᖏᓐᓂᒃ, ᐊᒻᒪᓗ ᐊᓯᐊᖑᖅᑎᑦᑎᓗᓂ ᓄᓇᒥᒃ. ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᑕᐃᒪᐅᔪᓂᒃ ᓄᓇᒥᒃ ᐊᒻᒪᓗ ᓄᓇᐅᑉ ᖃᓄᐃᓐᓂᓴᖏᓐᓂᒃ ᐱᓕᕆᐊᑉ ᐃᓗᐊᓃᓐᓂᐊᖅᑐᖅ. ᓄᓇᐅᔪᖅ ᖄᖓᓂᑦ ᐊᓯᐊᖑᕐᓂᖃᕋᓛᖑᓂᐊᖅᑐᖅ ᐱᓕᕆᐊᑉ ᐃᓗᐊᓂᑦ. ᐃᒪᖅ ᑐᓪᓕᐅᓂᐊᖅᑐᖅ ᐊᖏᕈᒥᒃ ᐃᓚᒋᔭᐅᔪᖅ ᓄᓇᒧᑦ ᐊᓯᐊᖑᕐᓂᐊᕐᓗᓂ ᐃᒪᐃᔭᐃᓂᕐᒥᑦ ᐱᔪᒥᑦ Whale Tail ᑕᓯᕐᒥᑦ Whale Tail ᐃᓗᑦᑐᖅᓯᒪᔪᒧᑦ.

ᐃᓂᐅᔪᒥᑦ ᐋᔭᐃᕙᓪᓕᐊᓂᖅ ᐊᒻᒪᓗ ᓴᓇᔭᐅᓂᖓ ᐱᓕᕆᐊᕐᒧᑦ ᐊᓯᐊᖑᖅᓯᑐᐃᓐᓇᓇᐊᖃᖅᑐᖅ ᐃᑉᔫᑉ ᖃᓄᐃᓐᓂᓇᖓᓂᑦ. ᓄᖅᑲᖅᐸᓪᓕᐊᑎᑦᑎᓂᕐᒥᑦ ᐊᒻᒪᓗ ᐅᑎᖅᑎᑎᓇᕙᓪᓕᐊᓂᕐᒥᑦ, ᐃᕙᓕᐅᓇᒃᑲᓂᕐᓂᐊᖏᑦᑐᑦ. ᐃᓂᐅᔫᑉ ᖃᓄᐃᖓᓂᖓ ᐅᒃᑯᐃᖓᔪᖅ ᐃᓕᑦᑐᖅᓯᒪᔪᒥᑦ ᑕᓯᙳᕐᓂᐊᖅᑐᖅ ᐅᒃᑯᐊᖅᑕᐅᑎᓪᓗᒍ.

ᐃᑉᔪᓕᓇᓂᖅ ᓴᓇᔭᐅᑎᓪᓗᒍ ᓂᓇᐅᒋᔭᐅᔪᖅ ᐊᓯᐊᖑᖅᓯᓂᐅᓂᐊᕐᓂᖓᓄᑦ ᐃᑉᔪᓄᑦ ᓃᕐᓗ ᐊᓯᐅᔾᔪᓂ ᖃᓄᐃᖓᓂᕋᔭᖓᓂᒃ ᐃᑉᔫᑉ. ᐊᖏᔪᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᖅ ᐃᑉᔫᑦ ᖃᓄᐃᖓᓂᖏᓐᓄᑦ ᓂᓇᐅᒋᔭᐅᔪᖅ ᒥᒃᓵᒋᐊᖅᑎᑦᑎᓂᐊᕐᓂᖓᓄᑦ ᓂᕿᑦᑎᐊᕙᓕᐅᓇᒃᑦᑖᕐᓂᕐᒧᑦ ᐊᒻᒪᓗ ᒥᒃᓵᒋᐊᖅᑎᑦᑎᑦᑐᓂ ᒪᓂᒪᓂᖓᓂᒃ ᓂᕿᑦᑎᐊᕙᖃᕈᓐᓇᕐᓂᖓᓂᒃ ᖁᐊᖑᓂᖃᖅᑐᓂᑦ ᐅᒃᑯᐊᖅᑕᐅᑎᓪᓗᒧᑦ ᓄᓇ ᖃᑉᓯᐊᕐᔪᙳᓄᑦ ᐅᑭᐅᓄᑦ ᐊᒥᓱᓄᓐᓄᑦ ᐅᑎᖅᑎᑎᓇᐊᓂᒃᑎᓪᓗᒋᑦ. ᓱᐳᖅᐸᓪᓕᐊᓂᖅᑕᑉᕐᓂᐊᖅᑐᖅ ᓴᓇᔭᐅᑎᓪᓗᒍ ᐋᔭᖅᑕᐅᓂᖓᓄᑦ ᐱᕈᖅᑐᐃᑦ. ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖅᑲᙱᓪᓗᒍ, ᐃᑉᔪᒃᑖᖅᑲᔭᐃᑦ ᖃᓂᑦᑐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ (LSA) ᕿᑎᐊᓃᑉᐸᒃᑐᒥᑦ ᓱᐳᖅᐸᓪᓕᐊᓂᖃᕈᖅᓇᕐᓂᖁᖅᑕᐅᔪᖅ. ᓱᐳᖅᐸᓪᓕᐊᖁᓚᓵᓂᖅ ᐲᔭᕇᕐᓗᒍ ᐱᓕᕆᐊᖅ-ᒧᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓂᒃ ᐱᓕᕆᐊᑉ ᐃᓂᖓᓃᖓᓗᐊᓂᕐᐊᖅᑐᖅ.

ᐱᕈᖅᑐᐃᑦ

ᐱᓕᕆᐊᕐᒥᑦ ᐊᒃᑐᖅᓯᓃᑦ ᐱᕈᖅᑐᐃᑦ ᐃᓂᖏᑦᑕ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᖃᓂᐅᓂᖏᓐᓄᑦ ᓴᓇᔭᐅᓂᖓᓃᓂᐊᖅᑐᖅ, ᐊᐅᓚᕐᓂᖓᓄᑦ, ᐊᒻᒪᓗ ᐅᒃᑯᐊᖅᑕᐅᕙᓪᓕᐊᓕᖅᑎᓪᓗᒍ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓄᑦ ᐊᐅᓚᕐᓂᕐᓗᒃᑖᖓᓂᑦ ᐱᓕᕆᐊᑉ.

<u>ᐊᓯᐊᖑᕐᓃᑦ ᐱᕈᖅᑐᐃᑦ ᐃᓂᖏᑦᑕ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ</u>

ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓃᑦ ᐱᕈᖅᑐᓄᑦ ᐃᓚᐅᔪᑦ ᐋᔭᖅᑕᐅᓂᖓᑕ ᐱᕈᖅᑐᐃᑦ ᐱᓕᕆᐊᖅ-ᒧᑦ ᓴᓇᕙᓪᓕᐊᓂᓗᒃᑖᓂᑦ. ᐊᖏᓛᒃᑯᑦ ᐊᖏᑎᒋᓂᖓ ᐱᕈᖅᑐᐃᑦ ᐊᒻᒪᓗ ᓄᓇᐅᔪᖅ (ELC) ᐊᓯᐅᔨᔭᐅᔪᑦ ᐱᓕᕆᐊᖅ ᐲᔭᕇᕐᓗᒍ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᖅ 2.9%-ᓗᐊᖑᓂᐊᕐᓂᖓᓄᑦ LSA-ᒥᑦ. ᑕᒪᐃᓐᓄᑦ ᐱᕈᖅᑐᐃᑦ ᐊᒻᒪᓗ ᖃᓄᐃᖓᓕᕐᓂᐊᕐᓂᖏᑦ ᓂᕐᔩᑦ ᐃᓂᒋᔭᖏᑦ ᐱᓕᕆᐊᑉ ᐃᓂᖓᓄᑦ ᐱᔪᑦ 2.9%-ᖑᓂᐊᖅᑐᑦ LSA-ᒥᑦ ᐊᒻᒪᓗ 0.2%-ᖑᓗᓂ RSA-ᒥᑦ; ᐱᓕᕆᐊᖅ ᓂᕆᐅᒋᔭᐅᔪᖅ ᒥᒃᓵᒋᐊᖅᑎᑦᑎᓂᐊᕐᓂᖓᓄᑦ ᐱᕈᖅᑐᖅᑕᖅᑐᑦ 0.1%-ᒥᑦ. ᓴᓇᕙᓪᓕᐊᓂᕐᒥᑦ ᐊᒻᒪᓗ ᐊᐅᓚᓕᖅᑎᓪᓗᒍ, ᐱᓕᕆᐊᕐᒥᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᖃᓂᑦᑐᒥᐅᓂᐊᖅᑐᖅ ᐅᔾᔨᖕᓂᐊᕐᕕᐅᑉ ᖃᓂᑕᖓᓂᑦ ᐊᒻᒪᓗ ᐊᑉᖁᑎᐅᑉ LSA-ᒦᓪᓗᓂ. ᐊᓯᐅᔨᓂᑦ ᐱᕈᖅᑐᓄᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᑕᑭᓂᖓ ᐊᑯᓂᐅᓂᐊᖅᑐᒥᑦ ELC-ᒧᑦ ᐅᔾᔨᖕᓂᐊᕐᕕᐅᔩᑉ ᐃᓂᖓᓂᑦ ᐃᖕᒥᖕᓂᒃ ᐱᕈᖅᑐᖃᓕᕐᓂᐊᖅᑐᖅ ᐊᑯᓂᐅᔪᒥᑦ ᑕᑯᑎᒋᓂᖓᓄᑦ ᐅᒃᑯᐊᖅᓯᒪᓕᖅᑎᓪᓗᒍ. ᐅᑎᖅᑎᑎᓇᕙᓪᓕᐊᓂᖅ ᑕᐅᑐᙵᖅᑕᐅᓂᐊᖅᑐᖅ ᖃᓄᐃᓐᓂᐅᔪᓂᒃ ᐃᖕᒥᖕᓂᒃ ᐱᙳᖅᐸᓪᓕᐊᓂᕐᒧᑦ ᐃᓂᐅᔪᒥᑦ ᑕᐃᒪᐅᕋᓂᒃᑐᓂᒃ ᐱᕈᖅᑐᓂᑦ.

<u>ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᐱᕈᖅᑐᐃᑦ ᐃᓂᖏᑦᑕ ᖃᓄᐃᓐᓂᕆᓗᖏᓐᓄᑦ</u>

ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᑦ ᐱᕈᖅᑐᓄᑦ ᐃᓂᐅᔫᑉ ᐃᓚᒥᖪᒥᑕᖏᓐᓄᑦ ᐱᔪᓂᒃ ᑕᐃᒪᐅᔪᖕᓇᖅᑐᑦ ᐱᓕᕆᐊᖅ ᐊᐅᓛᖅᑎᓪᓗᒍ ᐊᒻᒪᓗ ᐃᓚᐅᔪᑦ ᐳᔪᖃᑖᑦ. ᑲᑎᑉᐹᓪᓕᐊᔪᑦ ᐳᔪᖃᑖᑦ ᐱᓕᕆᐊᕐᒥᑦ ᐱᔪᑦ ᐊᓯᐊᙳᖅᓯᓂᖃᕈᖕᓇᖅᑐᑦ ᐱᕈᖅᑐᓄᑦ ᐊᒻᒪᓗ bryophyte-ᒧᑦ ᐊᒻᒪᓗ ᑐᒃᑐᐃᑦ ᓂᕿᖏᑦ ᐱᔭᐅᓗᐊᕐᕋᔭᖅᑐᒃᓴᐅᔪᑦ ᐱᐅᖏᑦᑐᓄᑦ ᖃᓄᐃᖓᓕᕐᓂᐅᔪᑦ ᐳᔪᖃᑖᖏᒥᑦ. ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᓗᐊᖅ ᐳᔪᖃᑖᖏᒥᑦ ᐃᓂᐅᔫᒥᓗᐊᕐᓂᐊᖅᑐᖅ ᐊᑉᕿᑏᑦ ᖃᓄᒋᓗᐊᖅᑕᖏᓐᓂᑦ. ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐱᕈᖅᑐᓄᑦ ᐃᖏᕐᕋᔭᖕᓂᕐᒥᑦ ᐅᓯᒃᑕᖏᓂᕐᒧᑦ ᐊᑉᕿᑎᒥᑦ, ᐊᒻᒪᓗ ᓂᕆᐅᒋᔭᐅᔪᖅ ᐅᑭᐅᑉ ᐃᓚᖓᓂᑐᐃᓐᓇᐅᖃᑦᑕᕐᓂᐊᕐᓂᖓᓄᑦ ᒥᑭᔪᒥᑦ ᐱᑕᖄᕆᓪᓗᓂ ᐅᑭᐅᒃᑯᑦ, ᐊᑉᕿᑎ ᐊᐳᑎᑕᖅᑎᓪᓗᒍ. ᑕᐃᒪᓐᓇᒎᑦ, ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐳᔪᖃᑖᖏᒥᑦ ᐱᔪᓂᒃ ᐱᕈᖅᑐᓄᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ LSA-ᒥᐅᓂᐊᕐᓂᖓᓄᑦ, ᑲᔪᓯᓗᓂ ᐊᐅᓚᕐᓂᖃᖅᑎᓪᓗᒍ ᐱᓕᕆᐊᖅ.

ᐳᔪᖃᑖᖑᒧᑦ ᐋᕿᐅᒪᔪᑦ ᖃᓄᐃᖓᓂᕐᒧᑦ ᐊᑉᕿᑎᒥᑦ ᓂᕆᐅᒋᔭᐅᔪᖅ ᐊᖏᕈᒃᑰᖓᔪᖅ ᐳᔪᖃᑖᖑᒧᑦ ᓈᓴᐅᑏᑦ 1 ᒪᐃᓚᒥᐅᓂᐊᕐᓂᖓᓄᑦ ᐊᑉᕿᑎᒥᑦ ᐊᒻᒪᓗ 100-ᒧᑦ ᑎᑭᐅᒪᓗᓂ. ᐳᔪᖃᑖᒃ ᓂᕆᐅᒋᔭᐅᔪᖅ ᐊᓄᓇᒥᑦ ᒪᓕᖕᓂᕐᒧᑦ ᐃᓂᐅᔪᓃᓐᓂᐊᕐᓂᖓᓄᑦ ᐊᑉᕿᑎᒥᑦ ᐊᒻᒪᓗ ᐅᔭᕋᖕᓂᐊᕐᕕᐅᑉ ᐃᓂᖓᓂᑦ. ᐅᔪᖃᑖᖏᒥᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐱᕈᖅᑐᓄᑦ ᐅᑎᖅᑎᑕᐅᔪᖕᓇᓂᖅᓂᑐᑦ ᐱᓕᕆᐊᖅ ᐅᒃᑯᐊᖅᓯᒪᓕᖅᑎᓪᓗᒍ. ᐳᔪᖃᑖᖏᒥᑦ ᖃᐅᔨᓴᐃᓃᑦ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᐅᑭᐅᓗᒃᑖᖅ ᐊᑉᕿᑎᖓᓄᑦ (AWAR) ᐳᔪᖃᑖᖏᒥᒃ ᓇᓚᐅᑖᕐᓂᕐᒧᑦ ᐱᑕᖃᖅᑐᖅ ᐱᓕᕆᐊᕐᒧᑦ; ᐱᓗᐊᖅᑐᒥᑦ ᐊᒥᖁᓂᖅᓴᐃᑦ ᐳᔪᖃᑖᙳᖃᑦᑕᖅᑐᑦ 100-ᒥᑦ ᐊᑉᕿᑎᒥᑦ, ᐊᒻᒪᓗ ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᐱᕈᖅᑐᓄᑦ (ᓂᕐᔪᑏᑦ ᐃᓂᖏᓐᓄᑦ) ᐳᔪᖃᑖᒃ ᐱᔾᔪᑎᒋᐸᓗᒍ ᐃᓂᐅᔫᒥᓐᓂᐊᖅᑐᖅ. ᑕᐃᒪᓐᓇᒎᑦ, ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐳᔪᖃᑖᖏᒥᑦ ᐱᕈᖅᑐᓄᑦ ᓂᕆᐅᒋᔭᐅᔪᖅ LSA-ᒥᐅᓂᐊᕐᓂᖓᓄᑦ, ᑲᔪᓯᓗᓂ ᐊᐅᓚᕐᓂᓗᒃᑖᖓᓂᑦ ᐱᓕᕆᐊᖅ ᐊᒻᒪᓗ ᐅᑎᖅᑎᑦᑐᖕᓇᕐᓗᓂ ᐅᒃᑯᐊᖅᓯᒪᓕᖅᑎᓪᓗᒍ.

ᐃᒪᐃᔭᐃᓂᖅ Whale Tail-ᒥᑦ ᐱᒋᐊᕐᓂᐊᖅᑐᖅ ᓴᓇᔭᐅᕙᓪᓕᐊᓂᖅ ᐱᐊᓂᒃᐸᑦ, ᐃᒻᒥᖅᑐᐃᓗᑎᒃ ᖃᑉᓯᐊᕐᔪᖕᓂᑦ ᑕᓯᕐᓂᑦ Whale Tail ᓱᐸᓗᖓᓂᑦ Mammoth ᑕᓯᕐᒧᑦ, ᑕᐃᒪᓐᓇᒎᑦ ᐊᓯᐊᙳᖅᑎᕐᓗᒋᑦ ᑰᒃᑐᑦ Mammoth ᑕᓯᕐᒥᑦ ᐊᒻᒪᓗ ᑕᐅᓄᖓ ᑰᒃᑐᓄᑦ. ᐃᒻᒥᖅᑐᖅᑕᐅᓯᒪᔪᑦ ᐃᒪᐃᔭᖅᑕᐅᓂᐊᖅᑐᑦ ᐅᒃᑯᐊᖅᐸᓪᓕᐊᓕᖅᑎᓪᓗᒍ; ᑕᐃᒪᓐᓇᒎᑦ, ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐱᕈᖅᑐᑦ ᐃᓂᖏᑦᑕ ᖃᓄᐃᓐᓂᕆᓗᖏᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᐅᑎᖅᑎᑦᑐᖕᓇᕐᓂᐊᕐᓂᖏᓐᓄᑦ.

ᐊᑕᐅᑦᑎᒃᑯᑦ ᖃᐅᔾᒪᓐᓇᖅᑐᑦ ᐱᔾᔪᑎᒋᐸᓗᒋᑦ ᐱᕈᖅᑐᐃᑦ ᖃᑉᓯᐅᓂᖏᑦ ᐊᒻᒪᓗ ᖃᓄᐃᓐᓂᕆᓗᖏᑦ LSA-ᒥᑦ ᐊᒻᒪᓗ RSA-ᒥᑦ ᓇᓗᓇᐃᖅᓯᔪᑦ ᐱᕈᖅᑐᐃᑦ ᐃᖏᖏᓐᓂᒃ ᐱᕈᒃᑲᓐᓂᕈᖕᓇᕐᒪᑕ ᐊᒻᒪᓗ ᐱᕈᕐᓂᕐᒧᑦ ᐊᔪᙱᓐᓂᖃᖅᓱᑎᒃ ᓴᓇᔭᐅᑎᓪᓗᒍ ᐊᒻᒪᓗ ᐊᐅᓛᖅᑎᓪᓗᒍ ᐊᒻᒪᓗ ᐊᔪᙱᓐᓂᖃᐃᓇᕐᓂᐊᖅᑐᑦ ᓂᕐᔪᑎᓄᑦ ᐃᓂᒋᔭᐅᓂᕐᒧᑦ. Graminoid ᐊᒻᒪᓗ ᑐᒃᑐᐃᑦ ᓂᕿᒋᖃᑦᑕᖅᑕᖏᓐᓂᒃ ᐱᑕᖃᐅᖅᑐᑦ ELC-ᓄᑦ ᐊᑐᖅᑕᐅᓪᓚᑦᑐᑦ ᑐᒃᑐᓄᑦ ᐊᒻᒪᓗ ᐅᒥᖕᒪᓄᑦ ᐃᓂᒋᔭᐅᓂᕐᒧᑦ ᑕᐃᒪᐅᖏᓐᓇᕐᓂᐊᖅᑐᑦ ᐊᒻᒪᓗ ᓯᐊᒪᒃᑎᑕᐅᓯᒪᑦᑎᐊᕐᓗᑎᒃ ᓄᓇᒥᑦ. ᑕᐃᒪᓐᓇᒎᑦ, ᖃᓄᐃᖓᓕᖅᑎᑦᑎᕙᓪᓕᐊᓂᐅᔪᑦ ᐱᓕᕆᐊᕐᒥᑦ ᐱᔪᑦ ᐱᕈᖅᑐᓄᑦ ᐊᖏᔫᕐᔭᖏᑦᑐᓇᔭᐅᔪᑦ ᖃᓂᑦᑐᒥᑦ ᐊᒻᒪᓗ ᐅᖓᓯᒃᑐᖅ ᐃᓱᒪᒋᐸᓗᒍ.

ᓄᓇᒥᐅᑕᐃᑦ ᓂᕐᔪᑏᑦ ᐊᒻᒪᓗ ᐃᓂᒋᔭᖏᑦ

ᐱᓕᕆᐊᕐᒥᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᓂᕐᔪᑏᑦ ᐃᓂᒋᔭᖏᑦᑕ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ, ᖃᓄᐃᓐᓂᕆᓗᖏᓐᓄᑦ ᐊᒻᒪᓗ ᐊᓐᓇᒃᑐᕈᖕᓇᕐᓂᕐᒧᑦ ᐊᒻᒪᓗ ᓄᕐᕆᐅᖅᐸᓪᓕᐊᓂᕐᒧᑦ ᐊᒃᑐᖅᑕᐅᓂᖃᕐᓂᐊᖅᑐᑦ ᓴᓇᔭᐅᓂᖓᓄᑦ, ᐊᐅᓛᖅᑎᑦᑎᓂᕐᒧᑦ, ᐊᒻᒪᓗ ᐅᒃᑯᐊᖅᐸᓪᓕᐊᓕᕆᓂᕐᒧᑦ ᐱᓕᕆᐊᑉ ᐊᐅᓛᕐᓂᓗᒃᑖᖓᓂᑦ.

<u>ᐊᓯᐊᙳᕐᓂᐅᔪᑦ ᓂᕐᔪᑏᑦ ᐃᓂᒋᔭᖏᑦᑕ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ</u>

ᐱᕙᓪᓕᐊᑎᓪᓗᒍ ᐱᓕᕆᐊᖅ ᐊᓯᐅᕋᓂᖅᑕᖃᕐᓂᐊᖅᑐᖅ ᐱᕈᖅᑐᓄᑦ ᐊᓯᐅᕋᓂᖃᕐᓗᓂ ᓂᕐᔪᑏᑦ ᐃᓂᒋᖃᑦᑕᖅᑕᖏᓐᓂᒃ, ᐊᒃᑐᖅᓯᓗᓂ VC-ᓗᒃᑖᓂᒃ. ᑭᓯᐊᓂ, ᐊᓯᐅᕋᓃᑦ ᐱᔾᔪᑕᐅᓂᖅᓴᐅᔪᓂᒃ VC-ᓂᑦ ᐃᓂᒋᔭᐅᔪᓂᒃ ᓂᕆᐅᒋᔭᐅᔪᑦ ᐊᑦᑎᒃᑑᓂᐊᕐᓂᖓᓄᑦ ᐳᓵᑎᖏᑦᑎᒍᑦ ᒪᓂᒪᔪᐃᑦ ᐃᓂᐅᔪᑦ LSA-ᒥᑦ ᐊᒻᒪᓗ RSA-ᒥᑦ ᐊᑐᓂ VC-ᓄᑦ. ᑲᑎᓗᒃᑖᖅᓱᒥᑦ ᐱᔾᔪᑕᐅᓂᖅᓴᐅᔪᑦ ᐃᓂᒋᔭᐅᔪᑦ ᑐᒃᑐᓄᑦ ᓂᕆᐅᒋᔭᐅᑉᓗᑎᒃ ᐱᑕᖃᕈᓐᓃᕐᓂᐊᕐᓂᕐᒧᑦ ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖓ ᐱᔾᔪᑎᒋᐸᓗᒍ 2%-ᙳᔪᖅ ᒪᓂᒪᔪᓂᑦ ᐃᓂᐅᔪᓂᑦ LSA-ᒥᑦ ᐊᒻᒪᓗ 0.2% ᑐᖔᓐᓂᕆᓗᓂ RSA-ᒧᑦ. ᐱᓕᕆᐊᑉ ᐃᓂᖓ ᓂᕆᐅᒋᔭᐅᔪᖅ ᐊᓯᐅᕋᓂᐊᕐᓂᖓᓄᑦ 3%-ᓗᐊᓂᑦ ᐊᒻᒪᓗ 0.2%-ᓗᐊᓂᑦ ᑎᖕᒥᐊᑦ ᖃᑉᓯᐅᓂᖏᓐᓄᑦ LSA-ᒥᑦ ᐊᒻᒪᓗ RSA-ᒥᑦ.

ᐱᓕᕆᐊᖅ ᓴᓇᔭᐅᑎᓪᓗᒍ ᐋᔭᐃᓂᖃᕆᐊᖃᕐᓂᐊᖅᑐᑦ ᓄᓇᐅᑉ ᖃᖓᓂᑦ ᒪᓂᕋᐅᓂᐅᔪᓂᑦ. ᐃᓘᐃᓵᕆᓂᖅ ᒪᓂᕋᐅᓂᐅᔪᓂᒃ ᐋᖅᓯᓂᐊᖅᑐᖅ ᓯᑎᖃᕐᕕᐅᖃᑦᑕᖅᑐᓂᒃ, ᓂᕐᔪᑎᐅᖃᑎᒥᖕᓂᑦ ᓂᕆᖃᑦᑕᖅᑐᑦ ᐊᒥᓲᖏᓐᓂᖅᓴᐃᑦ ᐊᒻᒪᓗ ᐊᓯᖏᑦ ᒪᓂᕋᐅᓂᐅᔪᑦ ᒪᓂᒪᔪᑦ ᑕᒪᐃᓂᑦ LSA-ᒥᑦ ᐊᒻᒪᓗ RSA-ᒥᑦ.

<u>ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᓂᕐᔪᐒᑦ ᐃᓂᖏᑦᑕ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓄᑦ</u>

ᐱᓕᕆᐊᖅ ᐊᓯᐅᔾᑎᑦᑎᓂᐊᖅᑎᓪᓗᒍ ᐃᓂᒋᔭᐅᔪᓂᒃ VC-ᓄᑦ ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖓ ᐱᔾᔪᑎᒋᐸᓗᒍ, ᐊᓯᐊᔾᔩᑦ ᑕᐃᑲᙵᐅᖏᑦᑐᖅ ᑕᐃᒪᐅᓂᐊᕐᒥᔪᑦ ᖃᓂᑦᑐᒥᑦ ᐊᒻᒪᓗ ᐅᖓᓯᖕᓂᖅᓴᐅᔪᓂᑦ. ᐃᒃᐱᒋᓴᕋᐃᓐᓂᕐᒧᑦ ᐃᓘᐃᓵᕆᓃᑦ (ᓲᕐᓗ ᓂᐱᖃᕐᓂᕐᒧᑦ ᐊᒻᒪᓗ ᐊᐅᓚᑲᑕᖕᓂᕐᒧᑦ) ᑎᑭᐅᑎᔪᑦ ᐱᓕᕆᐊᑉ ᐃᓂᒋᔭᖓᑕ ᐅᖓᑖᓄᑦ ᑕᐃᒪᐅᓂᐊᖅᑐᑦ ᓴᓇᔭᐅᑎᓪᓗᒍ ᐊᒻᒪᓗ ᐊᐅᓛᖅᑎᓪᓗᒍ. ᐊᒻᒪᓗᒃᑳᓂᖅ, ᐱᓕᕆᐊᖅ ᑎᑭᐅᑎᓂᐊᖅᑐᖅ ᐊᑐᖅᑕᐅᓂᖓᓄᑦ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᓯᖃᓪᓕᑎᕝᕕᒃ, ᓄᓇᓕᐊᓛᖅ ᐊᐅᓛᖅᑎᑕᐅᑎᓪᓗᒍ ᐊᒻᒪᓗ AWAR ᐱᖓᓱᓄᑦ ᓯᑕᒪᓄᑦ ᐅᑭᐅᓄᑦ.

ᑕᐃᑲᙵᐅᖏᑦᑐᖅ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓃᑦ ᐱᓕᕆᐊᕐᒥᑦ ᒥᒃᓵᒋᐊᖅᑎᑦᑎᔪᙶᖅᑐᑦ ᐃᓚᖏᓐᓂᒃ ᐱᔾᔪᑕᐅᓂᖅᓴᐅᔪᑦ ᑐᒃᑐᐃᑦ ᐊᒻᒪᓗ ᓄᓇᒥᐅᑕᐃᑦ ᑎᖏᐊᑦ ᐃᓂᖏᑦᑕ ᖃᓄᐃᓐᓂᕆᔭᖏᓐᓂᒃ LSA-ᒥᑦ ᐊᒻᒪᓗ RSA-ᒥᑦ. ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᑕᐃᑲᙵᐅᖏᑦᑐᖅ ᐊᓯᐅᔾᔨᓂᕐᒧᑦ ᐃᓂᐅᔪᓂᒃ ᑐᒃᑐᓄᑦ ᓂᕆᐅᒋᔭᐅᔪᖅ ᐊᖏᔫᔮᖏᓐᓂᖓᓄᑦ ᐊᒻᒪᓗ ᓄᖑᓪᓗᓂ ᐊᑐᕐᓗᒍ ᐅᖓᓯᖕᓂᖅ ᐱᓕᕆᐊᕐᒥᑦ. ᓂᐱᖃᕐᓂᕐᒧᑦ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᖃᐅᔮᓴᐃᓂᖅ ᐱᓕᕆᐊᕐᒧᑦ ᓇᓗᓇᐃᖅᓯᔪᖅ ᓂᐱᖃᕐᓂᖅ ᐱᔪᖅ ᓴᓇᔭᐅᓂᕐᒧᑦ ᐊᒻᒪᓗ ᐊᐅᓛᕐᓂᕐᒧᑦ ᐱᓕᕆᐊᖅ ᐊᔾᔨᕐᓚᒋᓂᐊᕐᓂᖓᓄᑦ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᐅᔭᕋᖕᓂᐊᕐᓂᕐᒧᑦ, ᐊᒻᒪᓗ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ RSA-ᒦᓐᓇᔭᖅᑯᑎᒃ.

ᐱᓕᕆᐊᕐᒥᑦ ᐊᐸᖅᑯᑎ ᓂᕆᐅᒋᔭᐅᔪᖅ ᑐᓗᖅᑕᕈᑕᐅᔪᙵᕐᓂᖓᓄᑦ ᓂᕐᔪᑎᓄᑦ (ᐱᓗᐊᖅᑐᒥᑦ ᑐᒃᑐᐃᑦ, ᐅᒥᖕᒪᐃᑦ ᐊᒻᒪᓗ ᐊᒪᖅᑯᓄᑦ), ᐊᒃᑐᓯᓂᖃᕈᙵᖅᑐᖅ ᖃᑉᓯᐅᓂᖏᑦᑕ ᐊᒃᑐᐊᖃᑎᒌᖕᓂᕐᒧᑦ ᐊᒻᒪᓗ ᓯᐊᒻᒪᖃᑦᑕᕐᓂᖏᓐᓄᑦ. ᐊᐅᓚᓃᑦ ᖁᖓᓯᕈᓯᖅᓯᒪᔪᑦ ᑐᒃᑐᓄᑦ AWAR ᖃᓂᑕᖓᓂᑦ ᓇᓗᓇᐃᖅᓯᔪᖅ ᑐᒃᑐᒃᑖᖅᑲᔭᐃᑦ ᑎᑭᐅᑎᖃᑦᑕᖅᑐᑦ ᐊᐸᖅᑯᑎᒧᑦ ᐃᑳᕐᓂᐊᖅᑐᑦ. ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᖅ ᐱᓕᕆᐊᕐᒥᑦ ᐊᒻᒪᓗ ᐊᐸᖅᑯᑎᒥᑦ ᐱᔪᓂᒃ ᑐᒃᑐᐃᑦ ᓅᖃᑦᑕᕐᓂᖏᓐᓄᑦ ᓂᕆᐅᒋᔭᐅᔪᖅ ᐊᖏᓂᖓ ᕿᑎᐊᓃᓐᓂᐊᕐᓂᖓᓄᑦ, ᐃᓚᖏᑦ ᐋᕿᐅᒪᔪᙳᕐᓂᐅᔪᑦ ᑕᐃᒪᐅᓂᐊᖅᑐᓴᐅᖕᒪᑕ ᑐᒃᑐᐃᑦ ᐃᑳᕝᕕᒃᓴᖓᓐᓂᒃ ᓇᓂᓯᒍᑎᒃ. ᐅᒃᑯᐊᖅᑎᓪᓗᒍ, ᓄᓇᒃᑰᕈᑎᕋᓗᕐᓂᑦ ᐃᖏᕐᕋᔭᒃᑐᓂᒃ ᐊᒥᐊᒃᑯᖃᔩᖏᑦᑐᖅ ᐊᒻᒪᓗ ᐱᓕᕆᐊᑉ ᐅᐸᖁᑎᖓ ᐱᑕᖃᕈᓐᓂᖅᑎᑕᐅᓗᓂ. ᓂᕆᐅᒋᔭᐅᔪᖅ ᑐᒃᑐᐃᑦ ᐃᑳᖃᑦᑕᕐᓂᐊᕐᓂᖓᓄᓐ ᐊᐸᖅᑯᑎᒥᑦ ᐅᒃᑯᐊᖅᓯᒪᓕᖅᑎᓪᓗᒍ (ᓲᕐᓗ, ᕿᑎᐊ-ᓃᓗᓂ ᑕᑭᑎᒋᓂᖓ) ᐊᒻᒪᓗ ᐊᒃᑐᖅᓯᓂᐅᔪᖅ ᐅᑎᕈᖅᑲᕐᓂᐊᖅᑐᖅ ᐃᓕᖅᑯᓯᑐᖃᕆᓚᐅᖅᑕᖓᓄᑦ.

<u>ᐊᓯᐊᖑᕐᓂᐅᔪᑦ ᓂᕐᔪᐒᑦ ᐊᓇᒃᑐᕈᖅᑲᕐᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ ᓄᕐᕆᐅᕈᖅᑲᕐᓂᖏᓐᓄᑦ</u>

ᐃᒻᒥᖅᑐᐃᓂᖅᑕᖃᕐᓂᐊᖅᑐᖅ ᐅᑉᓗᓕᐅᕆᓂᐅᑎᓪᓗᒍ ᐊᒻᒪᓗ ᐊᓯᐅᔾᔨᓂᖅᑕᖃᕈᓐᓇᖅᐳᓂ ᐅᑉᓗᕆᔭᐅᔪᓂᒃ ᑕᓯᐅᑉ ᓯᒡᔭᖓᓂᑦ. ᐃᓱᒪᒋᑉᓗᒍ ᐃᒻᒥᖅᑐᖅᑕᐅᓂᐊᖅᑐᖅ ᐊᒻᒪᓗ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᖅ ᑎᖕᒥᐊᑦ ᐅᑉᓗᖏᑦ ᖃᑉᓯᐅᓂᖏᑦ, 7-ᓗᐊᑦ ᐅᑉᓗᐃᑦ 2019-ᒥᑦ ᐊᒻᒪᓗ ᐱᖓᓱᐃᑦ ᐅᑉᓗᐃᑦ 2020-ᒥᑦ ᓯᕝᔭᒥᐅᑕᓄᑦ ᑎᖕᒥᐊᓄᑦ, ᓇᐅᔭᔾᔪᐊᑦ ᐊᒻᒪᓗ ᐃᒪᕐᒥᐅᑕᐃᑦ ᐊᒻᒪᓗ 61-ᓗᐊᑦ ᓄᓇᒥᐅᑕᐃᑦ ᑎᖕᒥᐊᑦ ᐅᑉᓗᖏᑦ 2019-ᒥᑦ ᐊᒻᒪᓗ 27 ᐅᑉᓗᐃᑦ 2020-ᒥᑦ ᐱᑕᖃᕈᓐᓂᕐᓂᐊᕐᓂᖏᓐᓄᑦ ᐅᑉᓗᓕᐅᕐᓇᐅᑎᓪᓗᒍ ᐃᒻᒥᖅᑐᐃᓂᖅ ᐱᔾᔪᑎᒋᐸᓗᒍ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᒥᒃ ᐋᕿᒃᓯᙱᑉᐸᑕ. ᑕᒪᒃᑯᐊ ᓈᓴᐅᑏᑦ ᐃᓚᐅᑎᑦᑎᙱᑦᑐᑦ ᒥᒃᓵᒋᐊᖅᑎᑦᑎᔪᙶᕐᓂᐅᔪᓂᒃ ᐅᑉᓗᓕᐅᖅᑐᓂᒃ ᐃᒃᐱᒍᓯᙶᓂᖅ ᐱᔾᔪᑎᒋᐸᓗᒍ. ᐃᒻᒥᖅᑐᐃᓂᖅ ᐃᖕᒥᒃᑰᕐᒐᓂᐊᖅᑐᖅ ᐊᒻᒪᓗ ᓴᓇᔭᐅᑎᓪᓗᒍᓗ ᐊᐅᓛᕐᓂᐅᑎᓪᓗᒍᓗᑐᐃᓐᓇᐅᓗᓂ ᐱᖓᓱᓄᑦ ᐅᑭᐅᓄᑦ. ᑕᒪᓐᓇ ᐊᒃᑐᖅᓯᓂᖅ ᓇᐃᑦᑑᔪᖅ ᑕᑯᓂᖓᓄᑦ ᓴᓇᔭᐅᕚᓂᒃᐸᑦ ᓱᑉᓗᐃᑦ ᐅᓗᕆᐊᓇᖅᑐᖅᑕᖃᕈᓐᓂᕐᓂᐊᖅᑐᖅ ᐅᑉᓗᓕᐅᕝᕙᑦ ᐃᓂᒋᖃᑦᑕᖅᑕᖏᓐᓂᑦ.

ᑕᒪᐃᓐᓅᖓᑉᓗᒍ, ᓇᓗᓇᙱᔾᔪᑎᐅᑉ ᐊᖏᓂᖓ, ᐊᒻᒪᓗ ᐊᑐᖅᑕᐅᖃᑦᑕᕐᓂᑯᖏᑦ ᐊᐳᖅᑎᓈᖅᑐᒥᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᖏᑦ, ᓇᓗᓇᐃᖅᓯᔪᖅ ᐊᒥᓲᙳᖅᐸᓪᓕᐊᔪᑦ ᐊᒻᒪᓗ ᑲᑎᑉᐸᓪᓕᐊᔪᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐱᓕᕆᐊᕐᒥᑦ ᐱᔪᓂᒃ ᐊᖏᔪᒥᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᖃᕈᔾᔭᖏᑦᑐᖅ ᑕᐃᒪᐅᕙᓂᒃᑐᒥᑦ ᐃᖕᒥᓂᒃ ᐱᔪᖕᓇᕐᓂᖃᖅᑐᒥᒃ ᐊᒻᒪᓗ ᐱᕈᕐᓂᕐᒧᑦ ᐊᔪᙱᓐᓂᐅᔪᓂᒃ ᓂᕐᔪᑎᓄᑦ.

ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᒧᑦ ᐱᓕᕆᐊᖑᔪᑦ

ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᑐᕌᖓᔪᓂᒃ ᓴᖅᑭᑦᑎᓂᐊᖅᑐᑦ ᐊᐅᓛᕐᓂᖓᓂᒃ ᐱᓕᕆᐊᖅ ᐊᔾᔨᒌᖏᑦᑐᒃᑯᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᐸᕐᓇᐅᑎᒃᑯᑦ, ᐊᒻᒪᓗ ᐅᑯᐊᖑᔪᖕᓇᖅᓲᑎᒃ ᐊᕙᑎᒧᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᖃᓄᐃᖓᓂᐅᔪᑦ ᐊᒻᒪᓗ ᐊᑐᓕᖅᑎᑦᑎᒃᑳᓂᕐᓗᑎᒃ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᒨᖓᔪᓂᒃ ᐱᔭᕆᐊᖃᕐᓂᖅ ᒪᓕᒃᓗᒍ ᐊᒻᒪᓗ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓗᑎᒃ ᓇᓗᓇᐃᖅᓯᓂᕐᒧᑦ ᓇᓚᐅᑦᑎᖕᒪᖔᑕ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᖕᓇᖅᑐᓂᒃ ᓇᓚᐅᑦᑖᕆᓂᐅᔪᑦ ᐊᒻᒪᓗ ᐊᐅᓚᑦᑎᓂᖃᕐᓗᑎᒃ ᐊᑐᕐᓗᒍ ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᖅ ᐱᔭᕆᐊᖃᕐᓂᖓ ᒪᓕᒃᓗᒍ. ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᑐᕌᖓᔪᑦ ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᓄᑦ, ᐃᑉᔪᓄᑦ, ᐱᕈᖅᑐᓄᑦ ᐊᒻᒪᓗ ᓂᕐᔪᑎᓄᑦ, ᐃᓚᐅᓂᐊᖅᑐᑦ, ᐃᒪᐅᑉ ᖄᖓᑕ ᖃᑉᓯᐅᓂᖓ, ᐃᓚᐅᓗᓂ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑑᑉ ᐊᒻᒪᓗ ᐃᑉᔪᐃᑦ ᖃᓄᐃᓐᓂᖏᑦ, ᓄᓇᒥᒃ ᒪᓂᕋᐅᔪᒥᒃ ᖃᐅᔾᔭᐃᓅᑦ ᓯᑎᒋᔭᐅᔪᓂᒃ ᓇᓂᓯᓂᕐᒧᑦ, ᐳᔪᖃᑖᖏᒥᒃ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓃᑦ ᐱᕈᖅᑐᓄᑦ ᐊᑉᖁᑎᐅᑉ ᖃᓂᖓᓂᑦ, ᐊᒻᒪᓗ ᓂᕐᔪᑎᓂᒃ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ. ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᐊᔾᔨᒋᓂᐊᖅᑕᖓ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᑐᕌᖓᔪᑦ ᐊᐳᖅᑎᓐᓈᖅᑐᒥᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒧᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᑦ. ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᖅ ᐃᓚᒋᔭᐅᔪᖅ ᐅᑯᓇᓂ ᐸᕐᓇᐅᑎᓂᑦ ᖃᐅᔨᓂᕐᒧᑦ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓂᒃ ᐃᒪᓐᓇ:

- ᓄᓇᒥᑦ ᐱᕈᖅᑐᐃᑦ ᐆᒻᒪᓂᖃᑎᒌᖕᓂᖏᓐᓄᑦ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐸᕐᓇᐅᑎ.
- ᐊᑉᖁᑎᒥᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐸᕐᓇᐅᑎ.
- ᓂᐱᖃᕐᓂᐅᑉ ᒥᒃᓵᓄᑦ ᖃᐅᔨᒋᐊᖃᑦᑕᕐᓂᕐᒧᑦ ᐸᕐᓇᐅᑎ.

ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᒨᖓᔪᑦ ᐅᖃᐅᓯᐅᔪᑦ ᐃᓗᐊᓂᑦ ᐊᕙᑎᒥᒃ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓂᖏᑦ.

SOMMAIRE DE GESTION – VOLUME 5 L'ENVIRONNEMENT TERRESTRE

Le Volume 5 de l'Énoncé des incidences environnementales du Projet de gisement Whale Tail et de route de transport (le Projet) traite des directives et lignes directrices émises par la Commission du Nunavut chargée de l'examen des répercussions, plus particulièrement celles relatives aux effets sur l'environnement terrestre, incluant le terrain, le pergélisol et les sols, la végétation et la faune terrestre, ainsi que l'habitat faunique.

Le Volume 5 inclut une discussion sur les composantes valorisées (CV), l'intégration des Inuit Qaujimajatuqangit (IQ), la description des zones d'étude, ainsi qu'une évaluation des effets directs sur les modifications à l'environnement terrestre. L'évaluation des effets s'attarde à évaluer toutes les phases du Projet, incluant la construction, l'assèchement, les opérations, la fermeture et la post-fermeture.

Préoccupations du public / Inuit Qaujimajatuqangit

Les préoccupations du public et l'Inuit Qaujimajatuqangit ont été intégrées tout au long de l'évaluation des effets potentiels du Projet sur l'environnement terrestre. Les préoccupations concernant le Projet ont été obtenues par une consultation publique, des rencontres avec groupes témoins, l'implication du gouvernement et les connaissances scientifiques. Des préoccupations ont été soulevées concernant les pertes directes et indirectes sur l'habitat résultant des activités du Projet et de sa construction. Elles sont résumées ci-dessous :

- Des eskers retrouvés sur la zone d'étude régionale (ZER) du Projet ont été identifiés par les aînés comme un habitat de prédilection pour le bœuf musqué, des aires de mise bas pour le loup, le renard et le spermophile arctique, ainsi que des sites de campement traditionnel.
- Des préoccupations ont été exprimées relativement aux activités du Projet résultant en des pertes en quantité et en qualité des communautés de végétation, une réduction de la qualité du fourrage destiné à la faune en raison du dépôt de poussière, et à la capacité de la végétation de se régénérer à la suite des activités minières. Les aînés ont été particulièrement préoccupés au sujet de la perte potentielle de lichen, lequel constitue un élément important de l'alimentation du caribou.
- Des préoccupations particulières au sujet des effets de la mine sur le caribou incluaient le risque potentiel que les caribous ingèrent des produits chimiques toxiques, l'habilité des caribous à traverser de manière sécuritaire la route de transport proposée du Projet et les effets potentiels de la route de transport du Projet sur les modèles de migration et de répartition, ainsi que des préoccupations relatives au risque potentiel d'une présence réduite du caribou ou d'une altération du goût de la viande de caribou.
- Les préoccupations au sujet des oiseaux et de l'habitat des oiseaux étaient centrées sur le risque potentiel de destruction ou de perturbation de l'habitat des oiseaux nicheurs.

Éléments clés du Projet et résultats de l'Énoncé des incidences environnementales

Les composantes valorisées du Projet ont été sélectionnées en se basant sur les discussions avec les parties prenantes, les rencontres avec le public, l'IQ et l'expérience des autres mines dans le nord. Ces CV ont été alors confirmées comme appropriées pour le Projet grâce à une étude additionnelle sur les IQ effectuée en 2014. Les CV de l'environnement terrestre incluent le pergélisol, le terrain/les sols, la végétation (habitat faunique). Les CV fauniques incluent les ongulés, les mammifères prédateurs, les rapaces, les oiseaux aquatiques, les oiseaux terrestres et les petits mammifères.

Terrain, pergélisol et sols

Des impacts du Projet sur le terrain, le pergélisol et les sols résulteront de la construction, des opérations et des activités de fermeture au cours de la durée de vie du Projet. Certaines de ces activités entraîneront des gains physiques du pergélisol en raison de la croissance du pergélisol en remplissage structural, ainsi qu'une croissance à long terme du pergélisol sous la halde de stériles Whale Tail. D'autres activités occasionneront des pertes physiques de terrain, du pergélisol et du sol en raison de l'extraction de roches et de matériaux du sol pour une utilisation lors de la construction, ainsi qu'en raison de l'extraction minière concrète de la fosse à ciel ouvert. Les liens causals principaux sont des pertes physiques ou des altérations permanentes des conditions actuelles du pergélisol et des caractéristiques du terrain et des sols, de même que des modifications aux propriétés du sol.

La dégradation du pergélisol peut résulter de l'excavation de la fosse à ciel ouvert, alors que des entrées potentielles d'eaux souterraines vers la fosse à ciel ouvert peuvent se produire lors des activités minières (si la profondeur se prolonge au-dessous de la base du pergélisol). La fosse à ciel ouvert proposée occasionnera probablement un retrait du pergélisol dans les parois et le plancher de la fosse, ainsi que la création d'une couche active. Des changements mineurs au pergélisol résulteront de l'inondation en raison d'un certain nombre de lacs tributaires en amont. Le canal de dérivation qui sera construit dans le cadre de la digue Whale Tail peut faire en sorte que la couche active augmente légèrement en épaisseur.

Le déblaiement du site et la construction du Projet, particulièrement par le biais des processus de décapage et de stockage des sols, entraîneront des modifications de la quantité et de la répartition des sols, ainsi que des modifications du terrain. Les modifications aux conditions actuelles du terrain et du sol seront confinées à l'empreinte du Projet. Le till (moraine) est le matériau superficiel dominant qui subira les plus grands changements au sein de l'empreinte du Projet. L'eau constitue la deuxième caractéristique du terrain qui subira le plus de changement résultant de l'assèchement du lac Whale Tail pour les biens de la fosse Whale Tail.

Le déblaiement du site et la construction du Projet pourraient occasionner des modifications de la qualité du sol. Au cours du déclassement et de la remise en état, le sol ne sera pas reconstitué. L'empreinte de la fosse à ciel ouvert deviendra principalement un lac au moment de la fermeture.

La perturbation des sols au cours de la construction devrait occasionner des modifications physiques au sol, telle une perte de la structure du sol. Il est envisagé que des effets négatifs sur les caractéristiques écologiques du sol occasionneront des taux plus bas du cycle des nutriments et une disponibilité réduite des macro et micro nutriments dans les substrats du site après la fermeture, et ce pour plusieurs années ou même décennies après la remise en état. De l'érosion se produira durant la construction en raison du retrait du couvert végétal. Sans atténuation, la majeure partie des sols dans la zone d'étude locale (ZEL) est classée comme ayant un potentiel modéré d'érosion. L'érosion accélérée relative aux activités du Projet serait limitée principalement à l'empreinte du Projet.

La végétation

Des impacts du Projet sur la quantité et la qualité de l'habitat végétal résulteront de la construction, des opérations et des activités de fermeture au cours de la durée de vie du Projet.

Modifications à la quantité des habitats végétaux

Les effets sur la végétation incluront le retrait physique de la végétation dans toutes les zones de construction du Projet. Le montant maximum d'unités de classification écologique des terres (CET) de végétation et de non-végétation perdues en raison du Projet devrait être d'environ 2,9 % de la ZEL. La perte de végétation globale et d'habitat faunique associé en raison de l'empreinte du Projet est de 2,9 % de la ZEL et 0,2 % de la ZER; il est anticipé que le Projet fera diminuer le nombre d'unités CET de végétation de 0,1 %. Au cours de la construction et des activités de la phase opérationnelle, les effets du Projet seront localisés autour du site minier et de la route de transport au sein de la ZEL. Il est prévu que les pertes à la végétation seront à long terme pour les unités CET au sein de l'empreinte de la mine, laquelle sera végétalisée naturellement au cours de la post-fermeture à long terme. Les efforts de remise en état se concentreront à fournir des conditions favorisant la recolonisation naturelle du site par la végétation indigène environnante.

Modifications à la qualité de l'habitat végétal

Des effets potentiels sur la végétation associés aux perturbations en dehors de l'empreinte peuvent se produire durant les opérations du Projet et incluront le dépôt de poussière. L'accumulation de poussière produite par le Projet peut occasionner des changements directs sur la végétation et la bryophyte, et le lichen pourrait être particulièrement vulnérable aux effets chimiques de la poussière. Les premiers effets de la poussière sont généralement limités à la zone immédiate près des routes. Les effets sur la végétation seront directement reliés au niveau de circulation sur la route de transport et il est anticipé que cette circulation sera hautement saisonnière, alors que peu ou pas de poussière du tout ne sera produite en hiver, lorsque la route est recouverte de neige. Par conséquent, les effets de la poussière sur la végétation devraient être confinés strictement à la ZEL, et se poursuivre tout au long des opérations du Projet.

Les résultats de la modélisation de la poussière le long de la route de transport ont prédit que les valeurs maximales de dépôt de poussière se situeraient à moins de 1 m de la route de transport et seraient concentrées à l'intérieur de 100 m. Il est prévu que le dépôt de poussière se produira principalement dans les zones dans le sens du vent par rapport à la route de transport et au site de la mine. Les effets des retombées de poussières sur la végétation seront réversibles, suivant la fermeture du Projet. Les études sur les retombées de poussières de la route d'accès praticable par tous les temps (AWAR) de Meadowbank correspondent aux prévisions modélisées des retombées de poussières pour le Projet; plus particulièrement que la majorité des retombées de poussières se produit à l'intérieur de 100 m de la route et que les impacts sur la végétation (habitat faunique) en raison de la poussière seront restreints à cette zone. Par conséquent, les effets de la poussière sur la végétation devraient être confinés strictement à la ZEL, se poursuivre tout au long des opérations du Projet et être réversibles à la suite de la fermeture.

L'assèchement de Whale Tail se produira à la fin de la phase de construction, résultant en l'inondation d'un certain nombre de lacs tributaires en amont de la digue Whale Tail vers le bassin versant du lac Mammoth, altérant ainsi les débits du lac Mammoth et des lacs en aval. Les zones inondées seront asséchées à la fermeture; donc, les effets sur la qualité de l'habitat végétal seront réversibles.

Les données combinées concernant la quantité et la qualité de la végétation dans la ZEL et la ZER indiquent que la végétation demeurerait autosuffisante et efficace écologiquement au cours de la construction et des opérations et conserverait sa fonction d'habitat faunique. Les unités CET de graminées et de couvertures de lichen qui servent d'habitat de grande qualité pour le caribou et le bœuf musqué continueront d'être présentes et bien réparties à travers le secteur. Par conséquent, les effets incrémentiels du Projet sur la végétation ne sont pas considérés comme importants à l'échelle locale et régionale.

Faune terrestre et habitat faunique

Des impacts du Projet sur la quantité, la qualité de l'habitat faunique, ainsi que sur la survie et la reproduction de la faune résulteront de la construction, des opérations et des activités de fermeture au cours de la durée de vie du Projet.

Modifications à la quantité des habitats fauniques

Le développement du Projet résultera en la perte de communautés de végétation menant à une perte directe des habitats fauniques, affectant toutes les CV. Cependant, les pertes des habitats de prédilection des CV devraient se limiter à un faible pourcentage de l'habitat disponible dans la ZEL et la ZER pour chaque CV. L'habitat de prédilection total pour le caribou qui devrait être déplacé par l'empreinte du Projet est de 2 % de l'habitat disponible dans la ZEL et de moins de 0,2 % pour la ZER. Il est prévu que l'empreinte du Projet déplace environ 3 % et 0,2 % du nombre d'oiseaux habituellement retrouvés dans la ZEL et la ZER, respectivement.

La construction du Projet nécessitera le retrait des matériaux de surface des eskers. Alors que cette perturbation aux eskers éliminera une partie de l'habitat de mise bas, les prédateurs sont présents en faible proportion et d'autres eskers sont disponibles autant dans la ZEL que dans la ZER.

Modifications à la qualité des habitats fauniques

Alors que le Projet engendrera une perte directe de l'habitat pour les CV en raison de l'empreinte du Projet, une perte indirecte se produira également à l'échelle locale et à l'échelle régionale. Des perturbations sensorielles (tels le bruit et le mouvement) qui vont au-delà de l'empreinte du Projet se produiront au cours de la construction et des opérations. De plus, le Projet prolongera l'utilisation de l'usine, des activités du campement et de l'AWAR de Meadowbank de trois à quatre années.

Des effets indirects du Projet devraient mener à la réduction de la proportion de la qualité des habitats de prédilection des oiseaux terrestres et du caribou dans la ZEL et la ZER. L'effet de la perte d'habitat indirect sur le caribou devrait être limité et diminuer en s'éloignant du Projet. L'évaluation des impacts par le bruit du Projet indique que le bruit créé par la construction et les opérations du Projet serait similaire à celui de la mine Meadowbank, et que ces effets seraient confinés à la ZER.

Il est prévu que la route de transport du Projet sera une barrière potentielle pour la faune (principalement les ongulés et les loups), ce qui pourrait avoir un impact sur la connectivité et la répartition des populations. Les mouvements des caribous munis de colliers près de l'AWAR indiquent que la majorité des caribous s'approchant de la route la traverseront. Les effets du Projet et la route de transport sur la migration du caribou devraient être modérés, alors que quelques déviations se produiront certainement lorsque des caribous opteront pour un point de passage. À la fermeture, il n'y aura plus de circulation et la route de transport du Projet sera scarifiée. Il est anticipé que les caribous traverseront la route librement à la suite de la fermeture (c.-à-d. à moyen terme) et que les impacts seront renversés à ce moment.

Modifications à la survie et à la reproduction de la faune

Une portion des inondations se produira durant la saison de nidification et pourrait mener à une perte au niveau des nids près de la rive du lac. Considérant la zone à être inondée et la densité estimé de la nidification des oiseaux, approximativement sept nids en 2019 et trois nids en 2020 des groupes des oiseaux de rivage, des goélands et des sauvagines et environ 61 nids d'oiseaux terrestres en 2019 et 27 nids en 2020, seront déplacés en raison de l'inondation au cours de la saison de nidification si aucune mesure d'atténuation n'est entreprise. Ces chiffres ne prennent pas en compte la possible diminution de l'activité de nidification en raison de la perturbation sensorielle. L'inondation sera isolée et ne se produira qu'au cours des trois premières années de construction et d'opération. Il s'agit d'un impact à court terme puisqu'à la suite de la construction des digues, il n'y aura plus aucun risque de destruction des nids.

De manière générale, les éléments de preuve apportés et l'expérience de la mine Meadowbank indiquent que les effets incrémentiels et cumulatifs du Projet n'auront pas un impact négatif important sur les populations fauniques actuelles autosuffisantes et écologiquement efficaces.

Les mesures d'atténuation

Des programmes de surveillance seront mis en œuvre au cours de la durée de vie du Projet par le biais d'une panoplie de plans de surveillance, et possiblement par une combinaison de surveillance environnementale afin de suivre les conditions et de mettre en œuvre des mesures d'atténuation supplémentaires lorsque nécessaires. Également, il faudra un suivi des activités de surveillance afin de vérifier l'exactitude des prévisions des effets et d'adapter la gestion et la mise en œuvre de mesures d'atténuation supplémentaires, au besoin. Les programmes de surveillance du pergélisol, des sols, de la végétation, de la faune et de la quantité des eaux de surface incluront la surveillance du pergélisol et des conditions du sol, des sondages des eskers afin d'identifier les tanières, la surveillance de la poussière sur la végétation le long de la route de transport, ainsi qu'une surveillance de la faune. La surveillance correspondra aux programmes de surveillance actuels de la mine Meadowbank. La surveillance des impacts est incluse dans les plans suivants :

- Plan de gestion de l'écosystème terrestre;
- Plan de gestion des routes;
- Plan de surveillance du bruit.

Les mesures d'atténuation sont décrites tout au long de l'évaluation des impacts environnementaux.

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LIST OF ACRONYMS

ARD	acidic rock drainage
AWAR	All-weather Access Road
CCME	Canadian Council of Ministers of the Environment
COSEWIC	Committee on Status of Endangered Wildlife in Canada
EC	Environment Canada
EIS	Environmental Impact Statement
ELC	Ecological Land Classification
FEIS	Final Environmental Impact Statement
GNDoE	Government of Nunavut Department of Environment
IPCC	Intergovernmental Panel on Climate Change
IQ	Inuit Qaujimajatuqangit
LSA	Local Study Area
NIRB	Nunavut Impact Review Board
non PAG	not potentially acid generating
PAG	potentially acid generating
PRISM	Program for Regional and International Shorebird Monitoring
RSA	Regional Study Area
TEMP	Terrestrial Ecosystem Management Plan
the Project	Whale Tail Pit and Haul Road Project
VC	Valued Component
WRSF	Waste Rock Storage Facility
ZOI	Zone Of Influence

LIST OF UNITS

%	percent
<	less than
cm	centimetre
ha	hectare
km	kilometre
km^2	square kilometres
m	metre
mg/kg	milligram per kilogram
ºC	degrees Celsius

5.0 TERRESTRIAL ENVIRONMENT

5.1 Introduction

The purpose of this section is to address the Guidelines issued by the Nunavut Impact Review Board (NIRB) for the Meadowbank Mine (Cumberland 2005b), and specifically those relating to the impact of the Whale Tail Pit and Haul Road Project (the Project) on geology and geochemistry, terrain, permafrost, and soils, vegetation, and terrestrial wildlife and birds. Volume 2, Appendix 2-B list the specific requirements set out in the Guidelines, and relating to the baseline and impact assessment of these components.

Volume 5 includes a discussion on valued components (VCs), incorporation of Inuit Qaujimajatuqangit (IQ), description of the study areas, and an assessment of direct effects to changes to geology and geochemistry, terrain, permafrost and soils, vegetation, and terrestrial wildlife and birds in the study area. The effects assessment evaluates all Project phases, including construction, operations, and closure.

5.1.1 Volume Structure

- **Section 5.1:** Introduction
- **Section 5.2:** Geology and Geochemistry
- **Section 5.3:** Terrain, Permafrost, and Soils
- **Section 5.4:** Vegetation
- **Section 5.5:** Terrestrial Wildlife and Wildlife Habitat

5.1.2 Valued Components

A summary of the terrestrial environment VCs and rationale for inclusion in the Final Environmental Impact Statement (FEIS) Addendum are provided in Table 5.1-1.

Table 5.1-1: Summary of Terrestrial Environment Valued Components

Valued Component	Rationale for Inclusion
Permafrost	• Permafrost is a VC. The Project is expected to affect existing permafrost conditions where excavations or landfilling will lead to changes in thermal ground conditions.
Terrain/Soils	• Terrain and Soils not included as a VC. All supporting information is included within this FEIS Amendment to meet the Guidelines (NIRB 2004) for reclamation on poorly developed soils, limited topsoil resources, and low soil moisture.
Vegetation (wildlife habitat)	• The Project is expected to affect existing wildlife habitat conditions (plant populations and communities, including communities with the potential for rare and traditional plants) that may lead to changes in vegetation (wildlife habitat quality and quantity). • Inuit Qaujimajatuqangit highlighted concern about the sensitivity of species, specifically caribou and muskox, losses of vegetation habitat (habitat quantity) and changes in vegetation habitat quality (habitat quality) because of Project activities and dust deposition

FEIS = final environmental impact statement; VC = valued component.

Several wildlife VCs were selected to assess Project-related effects on the terrestrial wildlife and wildlife habitat (Cumberland 2005d; Table 5.1-2). Valued components were selected for the Project based on discussions with stakeholders, public meetings, IQ, and experience with other mines in the north. These VCs were then confirmed to be appropriate for the Project through an additional IQ study carried out in 2014 (Agnico Eagle 2014a). Factors considered when selecting wildlife VCs included the following criteria:

- biophysical components identified by NIRB during Project scoping, Agnico Eagle community and stakeholder consultation, and as outlined in the Project Guidelines (NIRB 2004);
- represent important ecosystem processes;
- territorially and federally listed species (COSEWIC 2016; GC 2016);
- communities or species that reflect the interests of regulatory agencies, traditional use, and communities;
- wildlife that can be measured or described with measurement endpoints and allow cumulative effects to be considered; and
- experience with environmental assessments and effects monitoring programs in Nunavut.

Existing environment information for each VC is provided in Section 5.5.

Table 5.1-2: Valued Components and Rationale

Wildlife VC	Species Included	Rationale for Inclusion
Ungulates	Barren-ground caribou	Important subsistence, cultural, and economic species; migratory species with extensive range requirements; may be affected by disturbance during seasonal movements; primary prey species for large carnivores in northern environments
Ungulates	Muskox	Important subsistence, cultural, and economic species; prey species for large carnivores in northern environments
Predatory Mammals	Grizzly bear Wolverine Arctic wolf	Large home range size linked to caribou migrations; top predator in ecosystem; can be attracted to human disturbance; long generation time means one individual may be affected by disturbance over multiple years resulting in potential regional population effects; important subsistence and cultural species. Polar bear and fox were excluded from the FEIS (Cumberland 2005e) and so were not included here as VCs.
Raptors	Peregrine falcon Gyrfalcon Rough-legged hawk Short-eared owl Snowy owl	Sensitive to noise disturbance and human activity during nesting; includes peregrine falcon and short-eared owl (federal species at risk)
Water Birds	Common loon Red-throated loon Pacific loon Yellow-billed loon	Includes water birds, loons, and swans; water birds may be affected by loss of shoreline habitat for breeding; important staging habitat may also be lost; sensitive to noise disturbance and human activity; some species are important for subsistence; a number of species are listed as sensitive

Table 5.1-2: Valued Components and Rationale (continued)

Wildlife VC	Species Included	Rationale for Inclusion
	Canada goose Snow goose Long-tailed duck	in Nunavut
Upland Birds	Lapland longspur Horned lark Savannah sparrow Rock ptarmigan Red-necked phalarope Semipalmated sandpiper	Includes a range of species that are abundant and sensitive to disturbance
Small Mammals	Arctic hare Arctic ground squirrel (sik sik) Collared lemming Northern red-backed vole	Small mammals are important prey species for raptors and predatory mammals

FEIS = Final Environmental Impact Statement; VC = valued components.

5.1.3 Spatial and Temporal Boundaries

5.1.3.1 Spatial Boundaries

5.1.3.1.1 Terrain, Permafrost, and Soils

The terrain, permafrost, and soils Local Study Area (LSA) covers an area of approximately 10,904 hectares (ha) and is divided into the Whale Tail Pit area (7,722 ha, 71 percent [%] of the LSA) and the haul road area (3,182 ha, 29% of the LSA) (Figure 1.2, Volume 5, Appendix 5-A). The LSA is based on a 1.5 kilometre (km) buffer around the proposed Whale Tail Pit operations, and a 500 metre (m) wide corridor centered on the haul road footprint (Volume 5, Appendix 5-A). The haul road starts at the Vault Pit and travels approximately 63 km north and northwest to the Whale Tail Pit.

A Regional Study Area (RSA) was not identified for the assessment of potential effects to terrain and permafrost; however, a general discussion of regional permafrost conditions is presented to provide context. The RSA for soil was defined as a 50 km buffer centred on the study area (i.e., 25 km radius around Whale Tail Pit site, and 25 km on either side of the road, esker borrow sites and esker borrow site access roads) and encompasses an area of 501,700 ha (5,017 square kilometres [km^2]). This RSA is a similar size to those established along other mine roads (e.g., Meadowbank All-weather Access Road [AWAR]), and is intended to encompass all Project effects.

5.1.3.1.2 Vegetation and Wildlife

The LSA and RSA were established for the purposes of collecting baseline data on, and assessing impacts to vegetation (wildlife habitat) in the proposed Project. Figure 5.1-1 illustrates the extent of the LSA and RSA.

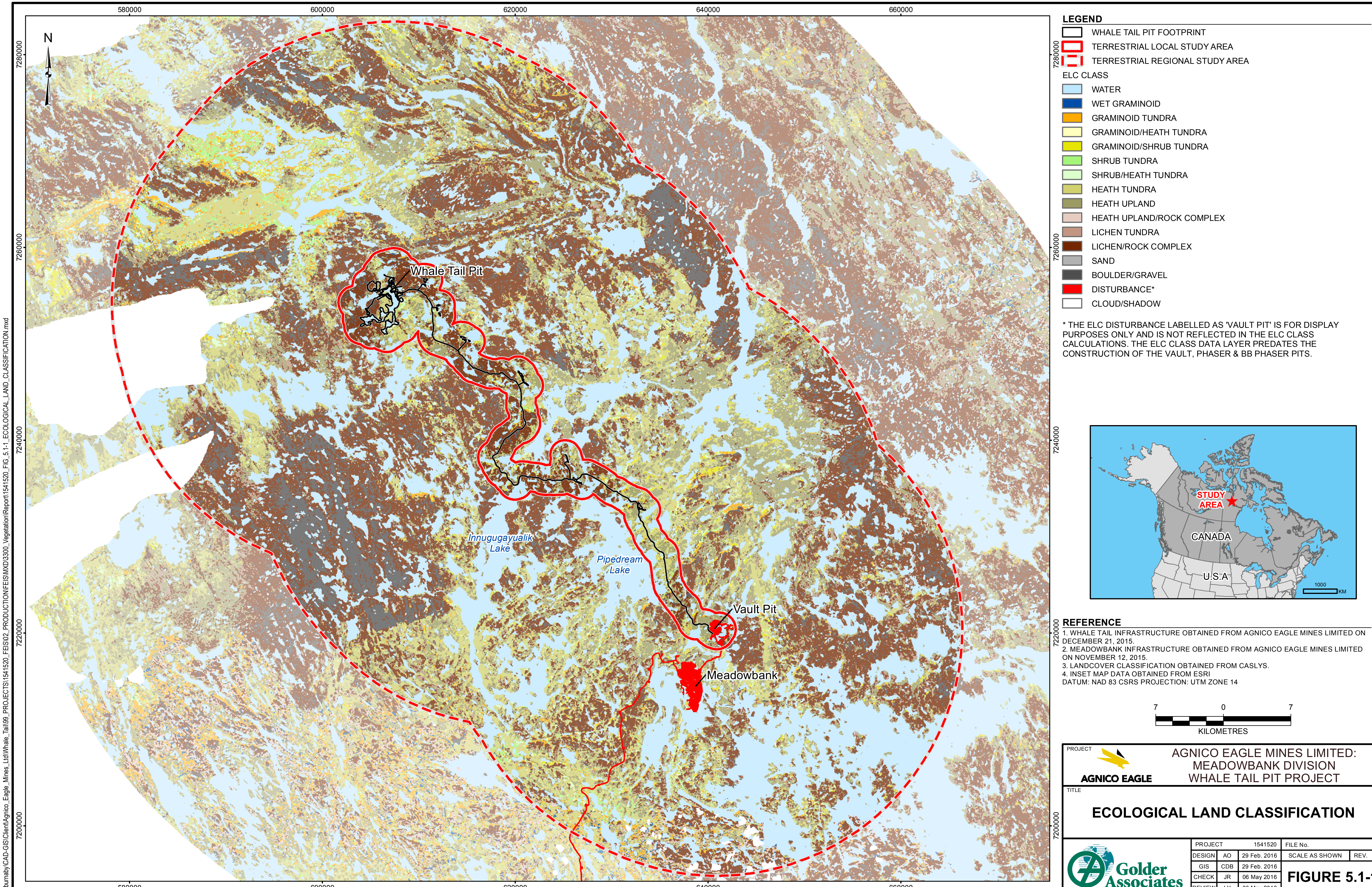
The terrestrial LSA was defined as a 3 kilometre (km) buffer circle around the Project facilities (i.e., 1.5 km from infrastructure) and covers an area of approximately 28,215 hectares (ha) (282 km^2) (Figure 2, Volume 5, Appendix 5-C). The primary sources of impacts (e.g., direct effects) are expected to occur within the LSA. The LSA area does not include baseline disturbance (e.g., Vault Pit area).

The RSA was defined as a 50 km buffer centred on the study area (i.e., 25 km on either side of the road, esker borrow sites and esker borrow site access roads) and encompasses an area of 501,700 ha (5,017 km^2). This

RSA is a similar size to those established along other mine roads (e.g., Meadowbank AWAR), and is intended to encompass all Project effects. The RSA includes both the proposed haul road, and part of the existing Meadowbank AWAR.

5.1.3.2 Temporal Boundaries

For the purposes of the assessment of potential effects of the proposed Project on the terrestrial environment, the temporal boundary for construction, operations, and closure of the Project is about seven years. This includes one year construction, three to four years operations, and two years closure and two years of active closure activities, and passive closure following the breaching of water management infrastructure (Volume 3, Section 3.3.2).


580000
600000
620000
640000
660000
7280000
7260000
7240000
7220000
7200000
N
Whale Tail Pit
Innugugayualik Lake
Pipedream Lake
Vault Pit
Meadowbank
LEGEND
WHALE TAIL PIT FOOTPRINT
TERRESTRIAL LOCAL STUDY AREA
TERRESTRIAL REGIONAL STUDY AREA
ELC CLASS
WATER
WET GRAMINOID
GRAMINOID TUNDRA
GRAMINOID/HEATH TUNDRA
GRAMINOID/SHRUB TUNDRA
SHRUB TUNDRA
SHRUB/HEATH TUNDRA
HEATH TUNDRA
HEATH UPLAND
HEATH UPLAND/ROCK COMPLEX
LICHEN TUNDRA
LICHEN/ROCK COMPLEX
SAND
BOULDER/GRAVEL
DISTURBANCE*
CLOUD/SHADOW
* THE ELC DISTURBANCE LABELLED AS 'VAULT PIT' IS FOR DISPLAY PURPOSES ONLY AND IS NOT REFLECTED IN THE ELC CLASS CALCULATIONS. THE ELC CLASS DATA LAYER PREDATES THE CONSTRUCTION OF THE VAULT, PHASER & BB PHASER PITS.
STUDY AREA
CANADA
U.S.A
1000 KM
REFERENCE
1. WHALE TAIL INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED ON DECEMBER 21, 2015.
2. MEADOWBANK INFRASTRUCTURE OBTAINED FROM AGNICO EAGLE MINES LIMITED ON NOVEMBER 12, 2015.
3. LANDCOVER CLASSIFICATION OBTAINED FROM CASLYS.
4. INSET MAP DATA OBTAINED FROM ESRI
DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14
7 0 7
KILOMETRES
PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED:
MEADOWBANK DIVISION
WHALE TAIL PIT PROJECT
TITLE
ECOLOGICAL LAND CLASSIFICATION
Golder Associates
PROJECT 1541520 FILE No.
DESIGN AO 29 Feb. 2016 SCALE AS SHOWN REV. 0
GIS CDB 29 Feb. 2016
CHECK JR 06 May 2016
REVIEW LY 06 May 2016
FIGURE 5.1-1
Y:\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Whale_Tail\99_PROJECTS\1541520_FEIS\02_PRODUCTION\FEIS\MXD\3300_Vegetation\Report\1541520_FIG_5.1-1_ECOLOGICAL_LAND_CLASSIFICATION.mxd

5.2 Geology and Geochemistry

5.2.1 Geology Baseline Environment

The following summary is adapted from Cumberland (2003) and from the Agnico Eagle lithology summary provided by Agnico Eagle staff.

The Meadowbank Mine and Amaruq property are both underlain by Archean supra crustal rocks of the metamorphosed Woodburn Lake Group. These rocks are believed to have been deposited in a continental rift setting and include mafic to ultramafic and volcaniclastic rocks interlayered with clastic sedimentary units that include greywacke, siltstone, mudstone, banded iron formation, and chert. This rock sequence has been intruded by granitoid rocks and lamprophyres, and underwent multiple deformation events and metamorphism.

The geology of the Whale Tail deposit is described in more detail in the Geochemistry report (Volume 5, Appendix 5-E). There is some consistency between the main lithological units found at Meadowbank Mine (intermediate volcanic, iron formation, ultramafic, and quartzite) and those at the Whale Tail deposit, which include ultramafic komatiites, clastic sedimentary rocks, mafic volcanic rocks and felsic to intermediate intrusive rocks.

Three different mineralization styles are present at the Whale Tail deposit, with gold associated with pyrrhotite or arsenopyrite. Mineralization is hosted in the iron formation (as layers, lenses or disseminations), chert (as silica flooding), and throughout the entire rock sequence (as veins).

Overburden in the Whale Tail Pit area is expected to be similar to that of the Meadowbank Mine. At the Meadowbank Mine, overburden consists of glacial till having an average thickness of 2.75 m, with local deposits over 10 m thick (Cumberland 2003). Where sampled at Whale Tail Pit (in July), the overburden was frozen below 1 m depth, therefore samples were collected in the surficial unfrozen zone.

5.2.2 Geochemistry

Waste Rock, Ore, Overburden, and Lake Sediments

A chemical characterization program investigated the geo-environmental properties of mine wastes that will be disturbed by mining, namely, waste rock, ore, surficial overburden and Whale Tail Lake sediments. Static geochemistry tests, mineralogy, and kinetic leaching tests were carried out to investigate the reactivity of these materials with respect to their potential to generate acidic rock drainage (ARD) and to release metals (metal leaching) to the receiving environment. Leach test results were compared to Portage effluent criteria, which are stricter than the Canadian Metal Mining Effluent Regulations criteria and regulated parameters.

The Whale Tail deposit mineralization is low sulphur but the sulphur carries arsenic, which is enriched in all waste rock types. Arsenic, Sulphur, and carbonate-buffering capacity are the parameters of environmental interest present in mining wastes.

Most of the waste rock lithologies to be disturbed by mining are not potentially acid generating (non PAG), including: the ultramafic, iron formation, mafic volcanic, southern greywacke and intermediate intrusive units. Together, they comprise approximately 73% of the total waste rock (33.6 million tonnes) to be mined. These units will not require means to control ARD. Of these, however, 46% (the ultramafic and iron formation units (46%) and some of the lake sediments leach arsenic in static and kinetic leaching tests at concentrations that exceed the Portage effluent criterion. The mafic volcanic lithology may leach elevated arsenic at the contact with the ultramafic and greywacke units, but the bulk of the samples are low arsenic and release arsenic at concentrations below the Meadowbank Type A Water Licence Part F Item 3 Portage effluent limits. Contact water will be monitored before discharge to the receiving environment.

The southern greywacke, the bulk of the mafic volcanic waste rock units (away from the contacts of greywacke and ultramafic rock), and the intermediate intrusive waste rock units within the open pit are non PAG and have low leachability. These units represent approximately 27% of the waste rock (12.4 million tonnes). They will not require environmental control in the short or long-term and as such, they are targeted for use as construction materials on site, as cover material for the Whale Tail Waste Rock Storage Facility (WRSF) and as reclamation material. The surficial overburden is also non PAG and has low leachability but the fines portion of the material could be amenable to erosion and transport as suspended solids in contact water.

The ore and the central greywacke and chert waste rock are potentially acid generating (PAG). The chert and central greywacke represent 27% of waste rock to be generated by mining (12.4 million tonnes). They are silicified, have a lower buffering capacity and a higher sulphur content than the southern greywacke and other non PAG waste rock. The PAG waste rock also leaches arsenic but at concentrations that are well below the Portage effluent limit. Based on results to date, a sulphur content of 0.1 wt% (percent by weight) is a suitable cut-off criteria below which chert and greywacke waste rock are non PAG. Kinetic leaching tests, mineral depletion calculations and consideration of the scale and site differences between laboratory tests and field conditions suggest a time lag to possible ARD development at site of more than a decade. Upper tier ARD materials (high sulphur/low buffering capacity greywacke or chert waste rock) generated acidic drainage earlier but without the anticipated benefit of additional buffering capacity from mixing with other non PAG rock in the WRSF piles. The delay to onset of ARD from the bulk of PAG waste rock and ore is expected to be longer than the life of mine. Accordingly, ARD control mechanisms for PAG materials can be implemented at the end of mining operations.

The ore is enriched in arsenic, antimony, bismuth, chromium, selenium, silver, and to a lesser extent, nickel. Some of the ore samples leach arsenic at concentrations that exceed the Portage effluent criterion in static tests but exceedances are short-lived in the first cycles of kinetic leaching tests. No other parameter is leached above the Portage effluent criteria in kinetic testing. This material will be placed in temporary stockpiles at Whale Tail for transport to the Meadowbank Mill for processing.

Tailings

A chemical characterization program investigated the geo-environmental properties of mine wastes including one sample of an ore processing residue that represents a composite of future tailings from the Whale Tail mineralization. The process water was also analyzed and compared to Portage effluent criteria.

The Whale Tail mineralization is low sulphur but the sulphur carries arsenic which is enriched in tailings along with antimony, bismuth, copper, selenium and silver. Although arsenic is of interest in waste rock, it is not mobilized from the tailing solid phase at concentrations that exceed the Portage effluent criterion.

The tailing sample tested is PAG for its low carbonate-mineral buffering capacity relative to its sulphide sulphur content (2.8 wt%). The sample subjected to kinetic testing by humidity cell remained neutral for the 44-week test duration and showed little evidence of active sulphide mineral oxidation. Mineral depletion calculations on kinetic test results suggest that the buffering capacity will eventually be consumed, after which the tailings may start to oxidize and develop acidic conditions. Therefore, the tailings require oxidation control in the long-term, which is consistent with the current data and long-term closure strategy for the Meadowbank Mine Tailings Storage Facility.

5.3 Terrain, Permafrost, and Soils

5.3.1 Incorporation of Inuit Qaujimajatuqangit

The effects assessment for terrain, permafrost, and soils was developed to incorporate IQ information, public consultation, focus group meetings, government engagement, and scientific knowledge. To the extent possible, available IQ is incorporated into the evaluation of the potential effects of the Project on the environment. The following reports were reviewed for IQ-specific information related to terrain (landforms), permafrost, and soils:

- Whale Tail IQ Baseline Report (Volume 7, Appendix 7-A);
- Meadowbank Gold Project Baseline Traditional Knowledge Report (Cumberland 2005a);
- Environmental Impact Statement (EIS) Guidelines for the Meadowbank Project (NIRB 2004);
- Proposed All-weather Exploration Road from the Meadowbank Mine to the Project site-Baseline Traditional Knowledge Report (Agnico Eagle 2014a); and
- Community Consultations/Public Information Meeting Summary Reports for 2014 and 2015 (NIRB 2014, 2015).

The following sections summarize the IQ information incorporated into the baseline studies, VC selection, assessment boundaries, and recommendations for mitigation and adaptive management, where applicable.

5.3.1.1 Existing Environment and Baseline Information

Inuit Qaujimajatuqangit refers to the importance of landforms and terrain within the Project area as noted in the Whale Tail IQ Baseline Report (Volume 7, Appendix 7-A) as follows:

- Eskers are recognized as preferred habitats for muskox and also as denning areas for wolves. They are also used as travel routes, and the Elders have suggested that the esker northeast of the haul road (Volume 7, Appendix 7-A, Figure 3-2) may be a potential area for old campsites. During the fall 2015 consultation meeting (Agnico Eagle 2014a), the Elders identified tent rings and camp sites along Esker 3.
- The eskers are also used as travel routes by caribou, and grizzly bears have been seen along the big esker parallel to the haul road (Volume 7, Appendix 7-A).
- Eskers were also noted as important denning areas for arctic foxes and arctic ground squirrels in the Meadowbank Gold Project Baseline Traditional Knowledge Report (Cumberland 2005a).
- Bedrock cliffs are also recognized as important nesting sites for peregrine falcons, gyrfalcons and rough-legged hawks.
- Organic decomposed soil was used in the past on the bottom of dog sleds to slide more easily over the snow.
- During the Baker Lake interviews it was mentioned that due to higher temperatures, as a result of climate change, the caching period which traditionally started in mid-August is delayed by almost a month. Adaptation to the impact of higher temperatures has occurred over the last 3 to 5 years (Volume 7, Appendix 7-A). The meat caches must now be buried closer to the permafrost or somewhere very cool to prevent the meat rotting,

5.3.1.2 Valued Component Selection

Permafrost was not identified as a VC through IQ.

5.3.1.3 Impact Assessment

Particular attention was placed on eskers due to their importance for denning and travel routes.

5.3.1.4 Mitigation and Monitoring

During the consultation meetings in 2014 and 2015, Elders expressed concern for wolf dens located in eskers to be used as borrow sources. The Elders have requested that the esker areas be surveyed for den sites and signs of wolf prior to their being designated as borrow pits (Volume 7, Appendix 7-A). Elders also suggested that a local hunter who is familiar with the area should assist with the survey; therefore, the eskers were surveyed for dens in 2015 and a local hunter was involved with the survey. Results are provided in Volume 5, Appendix 5-C. Mitigation measures applicable to the direct loss of terrestrial habitat due to the excavation of open pits, construction of infrastructure, roads, etc. is discussed in the Meadowbank Gold Project Terrestrial Ecosystem Management Plan (TEMP; Cumberland 2006). Mitigation measures include minimizing the facility footprints and controlling access around facilities. Direct loss of the eskers within the Project footprint is expected to occur. The magnitude of these losses, primarily due to borrow source footprints, will be minimised to conserve eskers and denning habitat to the extent practicable.

5.3.2 Existing Environment and Baseline Information

The Terrain, Permafrost, and Soils Baseline Report (Volume 5, Appendix 5-A) describes the existing terrain, permafrost, and soils conditions in the Project area, including methods used to collect baseline data and to generate terrain and soil data and maps required to support the assessment of Project effects. The baseline report is summarized briefly in this section.

5.3.2.1 Baseline Study Methods

The terrain, permafrost, and soil baseline study methods are described in detail in Section 2.0 of the Volume 5, Appendix 5-A. The following tasks were completed to classify the terrain, permafrost, and soil conditions within the LSA:

- review of publically available data, including maps and reports;
- detailed mapping completed at a scale of 1:5,000 using 50 centimetres (cm) WorldView-2 digital stereo satellite imagery; and
- a terrain and soils field program completed August 13 to 19, 2015. The purpose of the field survey was to ground-truth preliminary mapping and to collect detailed field data on parent materials, surface expression, depth to bedrock, slopes, drainage and geomorphic processes to support the final mapping and the environmental impact assessment.

5.3.2.2 Baseline Terrain

The surficial geology of the LSA shows strong evidence of glacial activity. The area is dominated by veneers and blankets of till overlying undulating bedrock. Bedrock frequently outcrops in isolated exposures, elevated plateaus and elongated ridges. The southern part of the haul road is controlled more by the underlying bedrock than the Whale Tail Pit where thicker till deposits are more common. A large glaciofluvial esker and terrace complex is found in the northeast part of the Whale Tail Pit and extends towards the southeast intersecting at or close to the haul road in several areas. Lakes and ponds are abundant throughout the LSA, occupying approximately 16% of the area. Figure C-2 of Appendix C of the Terrain, Permafrost, and Soils Baseline Report (Volume 5, Appendix 5-A) provides the spatial extent and distribution of primary surficial deposits in the LSA; field site locations are also shown. The polygon labels provide information on primary and any secondary surficial deposits within each polygon as well as any geoprocesses and drainage. A legend describing the sediment and explaining the terrain codes is also included in Appendix C (Volume 5, Appendix 5-A).

Table 5.3-1 provides a summary of surficial materials found within the LSA. Table 5.3-2 provides a summary of surficial materials crossed by the haul road from the Vault Pit to the proposed Whale Tail Pit. The properties of each surficial material are described in detail in the Volume 5, Appendix 5-A.

Table 5.3-1: Summary of Surficial Materials in the Local Study Area

Surficial Material	Whale Tail Pit		Haul Road		Local Study Area	
	Area (ha)	Percent (%)	Area (ha)	Percent (%)	Area (ha)	Percent (%)
Anthropogenic	0.0	0.0	25.0	0.8	25.0	0.2
Bedrock	232.2	3.0	115.1	3.6	347.3	3.2
Colluvium	13.5	0.2	1.8	0.1	15.2	0.1
Fluvial	2.9	<0.1	0.0	0.0	2.9	<0.1
Glaciofluvial	486.7	6.3	112.7	3.5	599.3	5.5
Lacustrine	0.0	0.0	4.7	0.1	4.7	<0.1
Organic	0.4	<0.1	4.7	0.2	5.1	<0.1
Till	5,457.3	70.7	2,703.9	85.0	8,161.2	74.8
Waterbody	1,529.5	19.8	214.0	6.7	1,743.5	16.0
Total	**7,722.4**	**100.0**	**3,181.8**	**100.0**	**10,904.2**	**100.0**

Note: Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.
ha = hectare; % = percent; < = less than.

Table 5.3-2: Summary of Surficial Materials Crossed by the Haul Road from Vault Pit to the Proposed Whale Tail Pit (Including Access Roads to Eskers)

Surficial Material	Haul Road	
	Length (m)	Percent (%)
Anthropogenic	107.7	0.2
Bedrock	1,846.0	2.6
Colluvium	14.5	<0.1
Fluvial	0.0	0.0
Glaciofluvial	2,032.4	2.9
Lacustrine	153.6	0.2
Organic	108.6	0.2
Till	65,027.5	93.2
Waterbody	444.7	0.6
Total	**69,735.1**	**100.0**

Note: Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.
m = metre; % = percent; < = less than.

5.3.2.3 Baseline Permafrost

The Project is found within the zone of continuous permafrost as defined by Heginbottom et al. (1995), meaning that permafrost is found underlying 90 to 100% of the landscape. Heginbottom et al. (1995) suggest that the permafrost in the Canadian Shield extends to depths of more than 500 m in the northern Ungava Peninsula, Somerset Island and Bathurst Inlet, and decreases in thickness to about 60 m in the Churchill, Manitoba area, which lies south of the southern limit of continuous permafrost.

The depth of permafrost in the Project study area is estimated to be 450 to 550 m depending on proximity to lakes, similar to that estimated for the Meadowbank Mine (Cumberland 2005c). Permafrost and hydrogeological characterization work by Knight Piésold (Volume 6, Appendix 6-A, Attachment A) around Whale Tail Lake suggests permafrost is estimated to be approximately 425 m deep. A talik is expected in the central section of Whale Tail Lake and the talik is likely underlain by permafrost in the shallower and narrower parts the lake (Volume 6, Appendix 6-A, Attachment A).

Periglacial processes are evident throughout the landscape in the form of frost shattered bedrock, sorted and non-sorted polygons, mudboils, ice wedge polygons and solifluction. Detailed descriptions of these processes are provided in the Volume 5, Appendix 5-A).

5.3.2.3.1 Baseline Climate Conditions and Projected Climate Change

The Project area is within the Northern Arctic Ecozone; one of the coldest and driest regions of Canada. Climate data has been collected at the Meadowbank camp since 1997. Current climate conditions and projected climate change are discussed in the Meadowbank Gold Project Baseline Physical Ecosystem Report (Cumberland 2005c) and O’Kane (2015); the Meadowbank project is some 63 km south of the proposed Project. Average annual precipitation is 249 mm, and mean annual temperature is -11.3 ºC.

There are numerous lines of evidence that show that climate change is occurring across the planet mainly as a result of human activities. The most compelling evidence comes from observations of the atmosphere, land, oceans and cryosphere (IPCC 2013). According to the Intergovernmental Panel on Climate Change (IPCC 2007), under the worst case scenario it is predicted that there will be an increase of the global mean surface air temperature of 2.4 to 6.4 degrees Celsius (ºC) by 2090 to 2099 relative to 1980 to 1999. O’Kane Consultants (2015) provided a climate change assessment for the Meadowbank Mine. Using historical climate data from Baker Lake O’Kane Consultants modelled climate change scenarios over the next 150 years. The selected modelled scenarios anticipate that temperatures will rise at the same rate (approximately 0.05ºC/year) for the next 60 years, after which temperatures will continue to increase at a reduced rate for 100 years to over 150 years. Climate change scenarios suggest there will be an increase in precipitation with time of between 0.6 mm/year and 0.7 mm/year (O’Kane Consultants 2015). Based on the modelling the temperature at the Meadowbank Mine is anticipated to increase by 3ºC over 60 years.

Permafrost is sensitive to climate change and an increase in air temperature will likely cause natural permafrost degradation. The sensitivity of permafrost to climate warming in Canada has been assessed by Smith and Burgess (1998, 2004) by categorizing the response of ground thermal conditions to climate and the effects of permafrost thaw on terrain stability. The impacts of the warming and thaw of permafrost will be most important in areas of ice-rich permafrost. The Project is within the continuous permafrost zone, and the ground ice content is expected to be between 0 and 10% (i.e., ice-poor) (Heginbottom et al. 1995). Within the Project area, permafrost is regionally predicted to be moderately thermally sensitive to climate change, with a low to moderate physical response resulting from thaw (Smith and Burgess 2004).

5.3.2.4 Baseline Soils

Soils within the LSA are dominated by Cryosols (in particular Turbic Crysols) which develop on till dominated landscapes. This is consistent with the dominant soil type identified for the Meadowbank Mine (Section 4.0, Cumberland 2005d). Saturated soil layers overlying frozen layers were observed in Turbic and Static Cryosols during the 2015 field survey, and were also noted in Cumberland (2005d). Further details on the saturated soil layers can be found in Volume 5, Appendix 5-A. Other soils identified within the LSA include Brunisols which are most prevalent on glaciofluvial material (e.g., eskers), Gleysols which develop on till in transition areas between upland and depressional landscape positions, and Regosols which are poorly developed soils. Organic Cryosolic soils were found in wetlands. Table 5.3-3 provides a summary of soil types identified within the LSA; further details can be found in Volume 5, Appendix 5-A.

Table 5.3-3: Dominant Soil Subgroups within the Local Study Area

Soil Order	Dominant Soil Subgroup	Whale Tail Pit		Haul Road		Local Study Area	
		Area [ha]	Proportion [%]	Area [ha]	Proportion [%]	Area [ha]	Proportion [%]
Cryosolic	Orthic Dystric Turbic Cryosol	5,336.5	69	2,394.1	75	7,730.6	71
	Regosolic Turbic Cryosol	176.3	2	360.9	11	537.2	5
	Terric Fibric Organic Cryosol	0.4	<1	4.7	<1	5.1	<1
Brunisolic	Orthic Dystric Brunisol	431.2	6	91.3	3	522.5	5
Gleysolic	Rego Gleysol	2.9	<1	n/a	n/a	2.9	<1
Bedrock/ Colluvium	n/a	245.7	3	116.9	4	362.5	3
Water	n/a	1,529.5	20	214.0	7	1,743.5	16
Total		**7,722.4**	**100**	**3,181.8**	**100**	**10,904.2**	**100**

Note: Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.
ha = hectare; % = percent; n/a = not applicable; < = less than.

Soil erosion risk is a primary concern for disturbed soils because the sparse vegetation cover exposes soil materials to the elements (e.g., wind and water). Field results suggest that the mineral soils in the LSA are predominantly acidic to neutral, ranging from pH 5.14 to 6.96, with pH tending to increase with soil depth (Volume 5, Appendix 5-A, Appendix E). Due to their mineralogy, the mineral soils in the Project area are increasingly sensitive to adverse effects due to acid deposition with decreasing baseline pH.

The coarse-textured soils commonly found in the LSA, with their higher initial total porosity, are relatively resistant to compaction compared to finer textured soils found in other geographies (Carr et al. 1991). Soil compaction influences the success of reclamation by decreasing plant establishment and plant growth. Soil changes due to compaction causes shifts in the microbial community, impedes root growth and seedling establishment, decreases water, air and nutrient movement, and reduces plant productivity (Blouin et al. 2008; Busse et al. 2006; Corns 1988; Tuttle et al. 1988).

Soil sensitivity ratings can be found in Volume 5, Appendix 5-A.

Reclamation Suitability

Soil reclamation suitability is an indicator of various soil quality parameters that describe a soil's capability to support natural plant communities. In the Arctic the establishment of vegetation is slow due to low soil temperatures, effective rooting depth, moisture and organic matter content. A reclamation suitability assessment is an important step to identify areas where suitable soils exist that can be later used as reclamation material. Based on criteria for undisturbed root zone material (Alberta Agriculture 1987), soils in the LSA have generally Poor to Unsuitable reclamation suitability due to the high coarse fragment content combined with the sandy loam texture of the upper surface horizons. The Organic Cryosols in the area are not given a rating and are classified as an organic category. However, these materials are valuable in reclamation because of higher nutrient content and soil moisture holding capacities and may be used as an amendment during reclamation.

Soil Baseline Metal Chemistry

Sampling for baseline metal chemistry of soils was completed in 2015, and the results can be found in Artinian and Gagnon (2016). The ninety samples collected within the Project footprint are summarized in Volume 5, Appendix 5-B. Of the 90 samples collected, 29 exceeded Arsenic, Chromium, or Nickel Guidelines (CCME 2007) and the results of these samples are presented in Table 5.3-4.

Table 5.3-4: Baseline samples with Total Soil Metal Concentrations (mg/kg) Exceeding CCME (2007) Guidelines within the Project Footprint

	Project Footprint Component	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Thallium (Tl)	Tin (Sn)	Uranium (U)	Vanadium (V)	Zinc (Zn)
Detection Limits		0.2	0.2	5	1	0.5	0.5	1	2	5	0.05	1	2	0.2	1	1	5	2	1	10
2007 CCME Guideline (agricultural)		20	12	750	4	1.4	64	40	63	70	6.6	5	50	1	20	1	5	23	130	200
2015 Soil Sample Plots[a]																				
100057	Road	<0.2	3.7	52	<1	<0.5	94.4	7	9	6	<0.05	<1	34	0.4	<1	<1	<5	<2	21	27
100085	Ore Stockpiles	<0.2	11.2	69	1	<0.5	67.5	9	20	13	0.28	2	32	0.4	<1	<1	<5	4	23	53
100406	Rock Storage Facility	<0.2	35.6	30	<1	<0.5	84.8	8	11	7	<0.05	<1	33	0.3	<1	<1	<5	<2	22	24
100407	Rock Storage Facility	<0.2	16.7	22	<1	<0.5	58.6	5	7	7	<0.05	<1	23	0.2	<1	<1	<5	<2	17	19
100408	Rock Storage Facility	0.2	34.2	29	<1	<0.5	108	12	13	8	<0.05	<1	57	0.3	<1	<1	<5	<2	20	21
100410	Rock Storage Facility	<0.2	14.4	39	<1	<0.5	70.2	9	17	8	0.05	1	32	0.4	<1	<1	<5	2	20	29
100411	Rock Storage Facility	<0.2	65.5	58	<1	<0.5	168	23	28	13	0.08	1	76	0.4	<1	<1	<5	<2	30	35
100412	Road	0.2	196.5	65	1	<0.5	456	33	24	11	0.07	1	164	0.3	1	<1	<5	<2	55	45
100420	Rock Storage Facility	<0.2	56.8	51	<1	<0.5	169.5	15	22	7	<0.05	<1	68	0.4	<1	<1	<5	<2	28	34
100421	Rock Storage Facility	<0.2	15.4	34	<1	<0.5	95.9	10	13	7	<0.05	<1	37	0.4	<1	<1	<5	<2	20	25
100423	Rock Storage Facility	0.2	56.9	51	<1	<0.5	285	14	32	9	0.07	1	123	0.5	<1	<1	<5	2	31	39
100425	Rock Storage Facility	<0.2	38.3	27	<1	<0.5	101	8	15	7	<0.05	<1	35	0.3	<1	<1	<5	<2	19	24
100442	Pond	0.3	176	140	<1	<0.5	549	22	30	8	<0.05	<1	168	0.5	<1	<1	<5	<2	54	36
100444	Dike	0.4	163.5	78	<1	<0.5	406	24	27	6	<0.05	<1	168	0.4	<1	<1	<5	<2	37	34

Table 5.3-4: Baseline Samples with Total Soil Metal Concentrations (mg/kg) Exceeding CCME (2007) Guidelines within the Project Footprint (continued)

	Project Footprint Component	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Thallium (Tl)	Tin (Sn)	Uranium (U)	Vanadium (V)	Zinc (Zn)
Detection Limits		0.2	0.2	5	1	0.5	0.5	1	2	5	0.05	1	2	0.2	1	1	5	2	1	10
2007 CCME Guideline (agricultural)		20	12	750	4	1.4	64	40	63	70	6.6	5	50	1	20	1	5	23	130	200
100446	Pond	<0.2	7.5	46	<1	<0.5	80.3	7	12	6	<0.05	<1	32	0.3	<1	<1	<5	2	17	31
100468	Road	<0.2	25.2	36	<1	<0.5	123	11	12	6	<0.05	<1	48	0.3	<1	<1	<5	<2	23	32
100470	Rock Storage Facility	0.2	40.4	35	<1	<0.5	133.5	16	16	8	<0.05	<1	68	0.4	<1	<1	<5	<2	24	28
100471	Rock Storage Facility	0.2	30.8	32	<1	<0.5	83.3	8	17	7	0.06	<1	39	0.3	<1	<1	<5	<2	20	26
100472	Rock Storage Facility	<0.2	14.8	19	<1	<0.5	47.3	5	10	6	0.12	<1	20	0.4	<1	<1	<5	<2	15	20
100475	Rock Storage Facility	<0.2	28	27	<1	<0.5	74.3	12	11	8	<0.05	1	34	0.3	<1	<1	<5	<2	18	26
100480	Rock Storage Facility	<0.2	35.1	54	<1	<0.5	186	13	22	7	<0.05	1	78	0.4	<1	<1	<5	2	31	37
100481	Rock Storage Facility	<0.2	90.2	74	<1	<0.5	240	25	26	10	<0.05	1	105	0.3	<1	<1	<5	<2	38	45
100703	Rock Storage Facility	<0.2	57.9	43	<1	<0.5	202	17	24	9	<0.05	1	77	0.4	<1	<1	<5	<2	30	34
100703	Rock Storage Facility	<0.2	58.6	43	<1	<0.5	203	17	25	9	<0.05	1	78	0.3	<1	<1	<5	<2	31	35
101008	Rock Storage Facility	<0.2	12.6	24	<1	<0.5	56.7	6	12	5	<0.05	<1	25	0.2	<1	<1	<5	<2	15	27
101009	Rock Storage Facility	<0.2	12.1	21	<1	<0.5	52.1	8	12	6	<0.05	1	25	0.2	<1	<1	<5	<2	16	21
101012	Pond	<0.2	25.6	34	<1	<0.5	109	8	17	7	0.06	1	59	0.3	<1	<1	<5	2	22	38

Table 5.3-4: Baseline Samples with Total Soil Metal Concentrations (mg/kg) Exceeding CCME (2007) Guidelines within the Project Footprint (continued)

	Project Footprint Component	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Thallium (Tl)	Tin (Sn)	Uranium (U)	Vanadium (V)	Zinc (Zn)
Detection Limits		0.2	0.2	5	1	0.5	0.5	1	2	5	0.05	1	2	0.2	1	1	5	2	1	10
2007 CCME Guideline (agricultural)		20	12	750	4	1.4	64	40	63	70	6.6	5	50	1	20	1	5	23	130	200
101013	Pond	<0.2	25.6	50	<1	<0.5	118	11	21	8	0.05	1	56	0.4	<1	<1	<5	<2	25	35
101034	Open Pit	0.3	42.7	28	<1	<0.5	89.7	17	12	5	<0.05	<1	59	0.4	<1	<1	<5	<2	17	22

Note: Shaded cells refer to soil metal concentrations that exceed CCME Guidelines.

[a] Artinian, B., Gagnon, R., 2016. Summer 2015 till survey report, Amaruq property; Explo-Lab / Agnico Eagle

mg/kg = milligram per kilogram; CCME = Canadian Council of Ministers of the Environment.

5.3.3 Potential Project-related Effects Assessment

Pathway analysis is provided in Volume 3, Section 3.4. Primary pathways that require further effects analysis to determine the environmental significance from the Project are provided below. Pathways determined to have no linkage or those that are considered secondary are not predicted to result in environmentally significant effects are provided in Volume 3, Appendix 3-C, Table 3-C-2.

Project impacts on terrain, permafrost, and soils will result from construction, operations, and closure activities during the life of the Project. Some of these activities will result in maintaining existing permafrost conditions or the physical gain of permafrost through permafrost growth into structural fills as well as to the long-term growth of permafrost beneath the Whale Tail WRSF. Other activities will result in physical loss of terrain, permafrost and soil due to extraction of rock and soil material for use in construction, and due to the physical mining of the open pit. Flooding of the open pit at closure will result in the retreat of permafrost away from the flooded pit area. The following provides a list of the primary pathways that require further effects analysis in this assessment to determine the environmental significance from the Project on terrain, permafrost, and soils:

- Physical loss or permanent alteration of existing permafrost conditions within the mined out area. Permafrost degradation may result from the excavation of the open pit, potential groundwater inflows to the open pit during operations (if depth extends below the base of permafrost). In addition, the flooding of the pit at closure may result in the creation of a larger talik beneath the pit lake.
- Physical loss or permanent alteration of terrain and soil features within the Project footprint, including the mined out area, haul road and eskers (borrow sources). Re-sloping, site preparation and other land disturbance activities are expected to result in changes to the distribution of terrain and soils.
- Changes to soil properties - soil disturbance may change physical, chemical, and biological properties of soil and contouring and excavation can cause compaction, and erosion to soils, and changes to soil quality.

5.3.3.1 Effects of the Project on Terrain, Permafrost and Soils

- **Physical loss or permanent alteration of permafrost within the mined out area including (1) permafrost degradation and retreat due to excavation of the open pit, (2) potential groundwater inflows to the open pit during operations if depth extends below the base of permafrost, and (3) flooding of pit may result in the creation of a larger talik zone beneath the pit lake.**

The permafrost and talik conditions below the northern part of Whale Tail Lake have been characterised by Knight Piésold (Volume 6, Appendix 6-A, Attachment A). Permafrost is expected below the land and in the shallowest areas of Whale Tail Lake, but a talik is thought to exist below the central portions of the lake. Knight Piésold (Volume 6, Appendix 6-A, Attachment A) suggests that the talik in the immediate vicinity of the proposed open pit is most likely underlain by permafrost. Where the pit is land based, excavation of the open pit will result in the retreat of permafrost into the walls and floor of the pit. The open pit will expose deeper bedrock to ambient air temperatures, likely resulting in the development of an active layer with an annual freeze/thaw cycle. A talik zone approximately 100 to 200 m in depth currently exists below the proposed open pit that is currently under water (Volume 6, Appendix 6-A, Attachment A). As material is removed from the pit, the talik may reduce in size due to the loss of the thermal heat source maintaining the talik open. This had been observed at the Meadowbank site Second Portage Lake where monitoring has shown an increase in permafrost aggradation (Agnico Eagle 2014c). Subsequent flooding of the pit at the completion of mining may result in an increase in the size of the talik from baseline conditions through increased water depths in areas of the lake that were previously shallow and thereby subject to freezing and permafrost growth.

Water diversion is required for the operations of the open pit mine and it is part of the Project Water Management Plan (Volume 8, Appendix 8-B.2). The diversion plans include the construction of dikes (Whale Tail, Mammoth, and northeast) to divert water away from the north end of Whale Tail Lake and a diversion channel for water to flow by gravity from Whale Tail Lake (South Basin) towards Mammoth Lake.

Construction of the Whale Tail Dike will result in the flooding of a number of upstream tributary lakes; it is anticipated that an additional 157.5 ha of land will be flooded (Volume 6, Appendix 6-F). The active layer in the newly flooded areas may increase in thickness due to the insulating effect of water. However, these areas will be re-exposed at closure when Whale Tail Pit is progressively refilled from Whale Tail Lake (South Basin) and the active layer should revert to the pre-development thickness over time. It is anticipated that there will only be minor changes to permafrost in the flooded areas during the lifetime of the Project.

Thermistors and piezometers within the dewatering dikes at Meadowbank are monitored weekly or biweekly by a qualified engineer or technician. Monitoring of ground conditions at Vault dike indicate that the entire foundation of the dike is frozen and that an active layer exists at the top of the rockfill (Agnico Eagle 2014d). Whale Tail Dike will also be monitored with piezometers and thermistor strings to understand the hydraulic and thermal behavior during reservoir filling.

The diversion channel will be constructed within a block field. Although there is little or no soil within the block field it is still part of the active layer and therefore the active layer may increase in thickness due to excavation of the channel and the increase in water flow through the channel. It is anticipated that there will only be minor changes to permafrost as the channel will only be used during operations and will no longer be used when flows are redirected back through Whale Tail Lake (North Basin).

- **Physical loss or permanent alteration of terrain and soils within the Project footprint, including the mined out area, haul road and eskers (borrow sources). Re-sloping, site preparation and other land disturbance activities can result in changes to the distribution of terrain and soils.**

Site clearing and construction for the Project, particularly through the processes of soil stripping and storage, will result in changes to soil quantity and distribution, and changes to terrain. Soil removal will occur mainly during the construction phase of the Project, and to a much lesser extent during operations. Changes to the existing terrain and soil conditions will be confined to the Project footprint (820.1 ha). The maximum amount of terrain and soil disturbance is 7.5% of the terrain, permafrost and soils LSA (10,904.2 ha.). For the purposes of the assessment, it is assumed that the total Project footprint will be disturbed.

Construction of the Project will aim to minimize impact to existing terrain, permafrost and soil conditions, and will limit potential thaw-settlement of infrastructure due to permafrost degradation. The construction and road fills will be placed directly over existing terrain, including soils and vegetation, without stripping or grubbing to avoid disturbance of the subgrade soils. Construction and road fill thickness will be designed to promote the aggradation of permafrost into thaw-stable fill materials to enhance the stability of the foundations and overlying structural fill materials.

A summary of the surficial materials (terrain types) and soils that are anticipated to be lost or permanently altered within the Project footprint during construction, operations, and closure are presented in Table 5.3-5 and Table 5.3-6, respectively.

Table 5.3-5: Summary of Physical Loss or Permanent Alteration to Terrain Types due to the Construction, Operations, and Closure of the Project

Terrain Type	Terrain Symbol	Project Footprint	
		Area (ha)	Proportion (%)
Fluvial	F	0.1	<1
Glaciofluvial	FG	85.9	10.5
Morainal (Till)	M	370.1	45.1
Anthropogenic	A	0.1	<1
Rock	R	10.6	1.3
Water	N	353.3	43.1
Total		**820.1**	**100**

Note: Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.
ha = hectare; % = percent; n/a = not applicable; < = less than.

Table 5.3-6: Summary of Physical Loss or Permanent Alteration to Soil Types due to the Construction, Operations, and Closure of the Project

Soil Order	Dominant Soil Subgroup	Project Footprint	
		Area (ha)	Proportion (%)
Cryosolic	Orthic Dystric Turbic Cryosol	365.1	44.5
	Regosolic Turbic Cryosol	12.9	1.6
Brunisolic	Orthic Dystric Brunisol	83.2	10.1
Gleysolic	Rego Gleysol	0.1	<1
Bedrock/ Colluvium	n/a	5.4	0.7
Anthropogenic	n/a	0.1	<1
Water	n/a	353.3	43.1
Total		**820.1**	**100**

Note: Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.
ha = hectare; % = percent; n/a = not applicable; < = less than.

Till (moraine) is the dominant surficial material that will experience the greatest change within the Project Footprint; 370 ha or 45% of the Project Footprint. Water is the second largest terrain feature with 353 ha (43%) of the Project Footprint affected; the majority of this will be the result of dewatering Whale Tail Lake for the Whale Tail Pit. Approximately 86 ha or 10% of the Project Footprint that is anticipated to be affected is characterised by glaciofluvial sediments; these sediments are part of the esker complex which will be used for construction of infrastructure. Construction materials for the haul road will be from Vault Pit. One quarry (Esker 3) will only be used if insufficient material is available from existing quarry sites (Volume 1, Section 1.2.14). For the remaining site infrastructure, construction materials will be excavated from the quarries (2.1 M tonnes) and esker 6A-D (0.45 M tonnes).

The soil map unit that would likely experience the greatest change is Orthic Dystric Turbic Cryosol which represents 365 ha or 44.5% of the Project footprint.

- **Soil disturbance can change physical, biological, and chemical properties of soils, and increase erosion potential due to contouring, and excavation can cause compaction and increase erosion potential of soils**

Site clearing and construction for the Project may result in changes to soil quality. Changes to soil quality may influence the ability of soil to support natural plant communities following closure. Soil removal will occur mainly during the construction phase of the Project, and to a lesser extent during operations (i.e., as Open Pit blasting activities are occurring). During decommissioning and reclamation, the soil (i.e., growth media) will be not re-constructed as outlined in the Whale Tail Interim Closure and Reclamation Plan (Volume 8, Appendix 8-F.1). The footprint of the open pit will primarily be a lake at closure landscape and surface that could be reclaimed with topsoil is limited therefore the limited topsoil will not be salvaged.

Soil quality can be altered during construction operations through the following processes:

- physical, biological, and/or chemical changes in the absence of soil stockpiling and replacement on the reclaimed landscape; and
- compaction of soil through site clearing, contouring, excavation, and decommissioning and reclamation

The potential effect on soil quality as a result of the Project is discussed qualitatively and semi-quantitatively by evaluating the potential for soil compaction, erosion, and reclamation suitability rating changes. The effect of Project activities on soil quality was determined through evaluation of changes expected to occur to soil quality indicators through the disturbance of soil materials. These evaluations are based on studies reported in the literature and baseline data collected in the LSA (Volume 5, Appendix 5-A).

Changes to Physical, Chemical, and Biological Soil Properties

Soil disturbance during construction is expected to cause physical changes to soil such as loss of soil structure. Loss of soil structure resulting from physical changes to the soil, and a reduction in the amount of soil organic matter and soil organic carbon present within the soil, influences the bulk density, pore size distribution, microbial community structure, and resistance to erosion (Wick et al. 2009). The direct loss of soil organic matter and soil organic carbon is expected to decrease the ability of soil to support vegetation. The adverse effects on soil ecological characteristics are expected to result in decreased rates of nutrient cycling and reduced availability of macro and micro nutrients in the substrates of the closure landscape for several years or decades after reclamation (Abdul-Kareem and McRae 1984; Stark and Redente 1987; Wick et al. 2009).

Soil Compaction

Soil compaction decreases soil quality and occurs primarily from heavy equipment or repeated passes of equipment across the soil surface during site clearing, contouring and excavation. Soil changes due to compaction causes shifts in the microbial community; impedes root growth and seedling establishment; decreases water, air and nutrient movement; and reduces plant productivity (Blouin et al. 2008; Busse et al. 2006; Corns 1988; Tuttle et al. 1988).

Soil compaction affects the success of reclamation by decreasing plant establishment and plant growth. Compaction of coversoil and subsoil has the potential to lead to a decrease in long-term productivity (Blouin et al. 2008; Heuer et al. 2008). The decrease in long-term productivity is a result of increases in soil bulk density and soil strength, reductions in soil aeration (i.e., less soil oxygen), reduced water infiltration and available soil water, restricted root growth, reductions in soil microbiological activity, and influences on nutrient uptake.

Soils in the Project footprint are predominantly coarse to moderately coarse-textured glacial till and colluvium with high coarse fragment content commonly overlying bedrock at shallow depths (less than 1 m) and generally are not susceptible to compaction. Soils prone to compaction in the LSA are limited to low-lying, imperfectly and poorly drained areas where the clay content of soils is slightly higher.

Most soils in the closure landscape are not expected to be susceptible to compaction. By employing the mitigation actions outlined in Volume 3, Appendix 3-C, Table 3-C-2, soil quality degradation due to compaction is expected to be mitigated.

Soil Erosion

Erosion is a concern within the Project footprint during construction due to removal of the vegetation cover. Soil quality can be affected because erosion can remove finer particles and organic materials from bulk soil. Soils through the operations phase may be susceptible to wind and water erosion due to factors such as absence of vegetation, steep slopes, and desiccation. Soil sensitivity to erosion is dependent upon numerous soil properties, including soil texture, cohesiveness, structure, aggregate stability, moisture content, and infiltration rates (permeability). Other factors that influence erosion susceptibility include topography, slope gradient, slope length, surface roughness, vegetation or residue cover, previous disturbance, weather (e.g., kinetic energy of rainfall events), and natural events (e.g., freeze-thaw) (Campbell et al. 2011; Cruse et al. 2001; Kuhn and Bryan 2004; Li et al. 2007).

Most soils in the LSA are rated as having moderate erosion potential, with the exception of areas with morainal blankets or colluvial deposits on slopes greater than 60%, and areas containing glaciofluvial soils. In areas of gullied or dissected terrain, the erosion potential would increase. The soil erosion ratings represent the maximum erosion that would occur in exposed mineral soils with no mitigation in place. Accelerated erosion related to Project activities would be confined mainly to the Project footprint.

With the addition of the Project, water and wind erosion potential is also rated as moderate for the majority of the Project footprint (Table 5.3-7 and Table 5.3-8).

Table 5.3-7: Predicted Water Erosion Potential within Project Footprint

Water Erosion Risk	Project Disturbance Footprint	
	Area [ha]	**Proportion [%]**
High	0	0
Low	83.3	10.2
Moderate	378.1	46.1
Moderate to High	0	0
Not rated – Water, Anthropogenic and Bedrock/ Colluvium	358.7	43.7
Total	**820.1**	**100**

ha = hectare; % = percent.

Table 5.3-8: Predicted Wind Erosion Potential within Project Footprint

Wind Erosion Risk	Project Disturbance Footprint	
	Area [ha]	**Proportion [%]**
High	83.2	10.1
Low	0.1	<1
Moderate	365.1	44.5
Moderate to High	12.9	1.6
Not rated – Water, Anthropogenic and Bedrock/ Colluvium	358.7	43.7
Total	**820.1**	**100**

Note: Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.
ha = hectare; % = percent; < = less than.

5.3.3.2 Effects of Terrain, Permafrost, and Soils on the Project

The existing terrain conditions found within the Project footprint will to some extent dictate the overall Project footprint. For example, the routing of the haul road has been selected to minimize the number of water crossings and the availability of borrow material along the route (Agnico Eagle 2015a). Where possible, the haul road has been located in areas of higher elevation which tend to have better drainage, minimize the potential for snow drifting and avoid low lying areas with poorer ground conditions (Agnico Eagle 2015a).

The potential for permafrost degradation associated with proposed infrastructure will have an effect on Project design. For example, thaw-stable fill materials (with a minimum fill thickness) will be placed overlying the existing terrain to maintain existing permafrost conditions along the haul road route and minimize the creation of thaw instabilities.

Climate change predictions suggest that for the Arctic air temperatures are expected to increase by 3 to 4°C by 2050, rising to 5 to 7°C across the mainland by 2100 (CCDS 2009). This is similar to the climate change modelling completed by O'Kane (2015) who suggest that scenarios, temperatures at the Meadowbank Mine will increase by 0.05°C per year for the next 60 years; a rise of 3°C. Permafrost is sensitive to climate change and an increase in air temperature will likely cause natural permafrost degradation. The long-term increase in surface temperature and subsequent increase in thickness of the active layer will not occur during the operational lifespan of the project. However, the gradual increase in the active layer due to climate change could impact Project infrastructure remaining after closure and decommissioning e.g. the waste rock pile. The foundations of the waste rock pile are expected to remain frozen under a long-term warming trend however the potential deepening of the active layer will be considered in the design of the waste rock pile and mine infrastructure. The decommissioned haul road will not be significantly impacted by the long-term warming trend as they will no longer be in use.

5.3.4 Residual Impact Classification

Although primary pathways have been identified for permafrost, terrain and soil, no residual impact predictions are made because permafrost, terrain and soil do not have measureable endpoints. Any potential effects associated with the primary pathways for terrain, permafrost and soils are captured in the assessment of the potential effects to, and residual impact classifications for other VCs. Mitigation measures designed to reduce impacts are provided in Volume 3, Appendix 3-C, Table 3-C-2.

5.3.5 Cumulative Effects Assessment

A cumulative effects assessment was not completed for terrain, permafrost, and soil as effects to these components are localized to the Project, and will not interact with other disturbances regionally.

5.3.6 Uncertainty

The following uncertainties apply to the Project and the assessment:

- There is a level of uncertainty with regard to the thickness of the active layer and soil water content (ice content). The active layer at Meadowbank Mine ranges from 1.3 m in areas of shallow overburden and away from the influence of lakes, up to 4 m adjacent to lakes and up to 6.5 m beneath the stream connecting Third Portage and Second Portage Lakes (Cumberland 2005c). It can be expected that the thickness of the active layer within the Whale Tail deposit is likely similar to that at Meadowbank Mine.

- Soil storage effects are not well known for soils in northern climates. Therefore conservatism was applied in assessing the effect and the effect was defined as primary. It is likely that the changes to soil quality will be minor based on the use of best management practices for soil handling during site preparations, and stockpile design, as presented in Volume 3, Appendix 3-C.

- Baseline terrain and soil field surveys and mapping provide an estimation of the distribution of surficial materials and soil resources. Consequently, an amount of uncertainty is always present as maps cannot provide detailed, site-specific information to all areas. However, sufficient terrain and soil field surveys were completed for the purposes of the assessment.

- The baseline mapping provides an estimation of the distribution of soil resources at a given map scale resolution.

Uncertainty was addressed in the assessment by being conservative in defining impacts, incorporating information from available and applicable literature, and using past experience in similar areas including the experience gained from the Meadowbank Mine. In addition, the application of environmental design features and mitigation, the Interim Closure and Reclamation Plan and the Water Management Plan (Volume 8) will mitigate effects to terrain, permafrost, and soils.

5.3.7 Monitoring and Follow-up

Monitoring programs implemented during the life of the Project may be a combination of environmental monitoring to track conditions and follow up monitoring to verify the accuracy of effect predictions and adaptively manage and implement further mitigation as required.

Permafrost conditions will be continuously monitored and inspected during all phases of the Project to verify impact predictions and ensure the effectiveness of the design criteria. Where required adaptive management strategies will be implemented. Full details on management plans and monitoring for the waste rock pile, dewatering of the dikes, and haul road are provided in the Mine Waste Rock and Tailings Management Plan (Volume 8, Appendix 8-A.1), Water Management Plan (Volume 8, Appendix 8-B.2), and Whale Tail Pit Haul Road Management Plan (Volume 8, Appendix 8-C.1), respectively.

Soil conditions will be monitored according to the Meadowbank Mine Project Certificate to estimate reclamation success.

5.4 Vegetation

5.4.1 Incorporation of Inuit Qaujimajatuqangit

The effects assessment relies on the IQ baseline information that came from a variety of sources, including a literature review of publicly available sources, public consultation, focus group meetings, government engagement, and information provided directly by Elders. To the extent possible, available IQ information is incorporated into the evaluation of potential effects of the Project on vegetation. The following reports were reviewed for IQ specific information related to vegetation habitat:

- Project IQ Baseline Report (Volume 7, Appendix 7-A);
- Meadowbank Gold Project Baseline Traditional Knowledge Report (Cumberland 2005a);
- Environmental Impact Statement (EIS) Guidelines for the Meadowbank Project (NIRB 2004);
- Proposed All-weather Exploration Road from the Meadowbank Mine to the Project Site - Baseline Traditional Knowledge Report (Agnico Eagle 2014a);
- Community Consultations/Public Information Meeting Summary Reports for 2014 and 2015 (NIRB 2014, 2015).

5.4.1.1 Existing Environment and Baseline Information

The Inuit's detailed understanding of vegetation, accumulated over generations, encompasses not only knowledge of specific plant species, but also the interconnection between plant communities, wildlife and the environment as a whole (Cumberland 2005a). Traditional plant use by the Inuit was extensive and plants were valued as they served as food, medicine, shelter and tools.

Berries, eaten fresh or used to make jams, were commonly mentioned as a source of sustenance during consultation meetings (Cumberland 2005a). The results of a survey administered in 2006 showed that 87% of Inuit adults in Baker Lake reported gathering wild plants in the previous 12 months (Statistics Canada 2011). While the Elders indicated that plants were no longer used for traditional medicines during interviews in 2009, they reported that berries continued to be harvested for food or to make jam, including crowberry, blueberry, blackberry, and red berry (AREVA 2011; Agnico Eagle 2014a). Vegetation baseline data collected was used to support the assessment on impacts to traditional plants use (Volume 7, Sections 7.3).

During consultation for the Meadowbank Mine, the Elders discussed the importance of certain plants used by wildlife, particularly lichen, which are an important part of the caribou's diet (Cumberland 2005a). Therefore, specific focus was given to vascular plant and non-vascular plant species that are important to wildlife in presenting the existing environment.

Climate change was raised as a concern by the Elders because this has the potential to cause changes to vegetation communities and wildlife habitat; therefore, the current impact of climate change on vegetation (wildlife habitat) was summarized as part of the existing environment.

5.4.1.2 Valued Component Selection

Inuit Qaujimajatuqangit has been integrated in the selection of vegetation as a VC for this assessment and identification of potential Project effects. Inuit Qaujimajatuqangit highlighted concern about the sensitivity of caribou and muskox to losses of vegetation habitat (habitat quantity) and changes in vegetation habitat quality (habitat quality) because of Project activities and dust deposition (Section 5.4.1.1). Elders also expressed concerns regarding the capacity of vegetation to regenerate following Project activities (Cumberland 2005a). Therefore, vegetation was selected as a VC as it provides habitat for wildlife including species that are culturally important (e.g., caribou and muskox) and is also used directly for traditional use (e.g., berry picking). Although not explicitly identified as a VC, the changes to vegetation communities were considered and were assessed in the residual classification analysis and determination of significance.

5.4.1.3 Impact Assessment

Inuit Qaujimajatuqangit was integrated into the pathways analysis through public consultation and other IQ reports (Section 5.4.1.1). Concerns regarding the sensitivity of caribou to vegetation loss were addressed during the pathways analysis. During consultation for the Meadowbank Mine, the Elders discussed the importance of certain plants used by wildlife, particularly lichen, which are an important part of the caribou's diet (Cumberland 2005a).During 2015 consultation meetings, the effects of dust deposition on vegetation was raised as a concern, particularly as it relates to caribou habitat (Volume 7, Appendix 7-A). Dust deposition may also affect vegetation health and therefore change availability for berry picking. Dust deposition was assessed as a primary pathway. Changes to vegetation habitat quality were assessed and carried through residual impact assessment, including changes to lichen.

Elders also expressed concerns regarding the capacity of vegetation to regenerate following Project activities (Cumberland 2005a). Therefore the impact assessment, residual impact classification, and determination of environmental significance considered habitat quantity and habitat quality post-closure.

5.4.1.4 Mitigation and Monitoring

Concerns regarding the potential for the Project to directly affect or degrade vegetation (wildlife habitat) were raised during Inuit Public Information Meetings (Volume 7, Appendix 7-A; NIRB 2014, 2015). These concerns focused on both losses of vegetation communities as well as reduction in quality of wildlife forage through dust deposition. Interviewees also expressed concerns about the capacity of vegetation to regenerate following mining activities: "... but the growth of vegetation is going to be very slow, that's the concern I have" (Cumberland 2005a). Elders have requested an increase in monitoring activities for vegetation communities and wildlife habitat along the road during key caribou migration periods, which will result in road closures.

Mitigation measures and monitoring programs have been proposed to address these concerns around vegetation (wildlife habitat) loss, habitat denigration by contamination (i.e., dust), and reclamation rate and are detailed in the TEMP (Volume 8, Appendix 8-E.7) and Section 5.4.7.

5.4.2 Existing Environment and Baseline Information

Existing conditions were described to provide context for the vegetation assessment in the Terrestrial Baseline Characterization Report (Volume 5, Appendix 5-C). This report describes the methods used to collect baseline data, summarize field data and to generate vegetation maps required to support the vegetation EIS. Baseline information (Cumberland 2005d) was included and analyzed where appropriate. The Terrestrial Baseline Characterization Report is summarized below.

5.4.2.1 Baseline Study Methods

The vegetation baseline study methods are described in detail in Section 3.2 of the Terrestrial Baseline Characterization Report (Volume 5, Appendix 5-C).

Vegetation field programs were completed to classify vegetation communities within the LSA. Field programs were completed from 28 August to 3 September 2014, and 3 to 13 July 2015. Surveys included plot-based vegetation inventories to characterize plant species (including traditional and listed plant species) within the LSA. Ecological Land Classification (ELC) surveys were also completed to verify land cover classification and important wildlife habitat (e.g., graminoid and lichen-dominated vegetation communities) within the LSA.

Baseline phenology studies were completed to record data on vascular plant development during the 2003, 2004, and 2005 growing seasons. These results were used to guide the timing of the 2014 and 2015 vegetation field surveys and are presented in Section 3.3.5 of Appendix 5-C.

The Government of Nunavut Department of Environment (GNDoE) conducted a multi-year program to develop an ELC map for the Kivalliq Region based on classification of Landsat imagery. This mapping facilitated identification of ecological land classes, and ultimately, identification of important vegetation communities, which is critical to the sustainable management of the Kivalliq`s ecological communities and the wildlife species utilizing these habitats (Volume 5, Appendix 5-C, Section 4). Baseline data collected during field programs and the GNDoE's ELC mapping for the LSA and RSA provided by Caslys Consulting were used as the basis for the ELC mapping of the Project. Mapping and accuracy assessment methods are provided in Section 3.2.2.1 of Appendix 5-C.

5.4.2.2 Baseline Vegetation

The 2014 and 2015 vegetation surveys identified 138 vascular plants in the Project area, of which 107 were identified to species level and 31 were identified to genus level. A total of 61 non-vascular plants (20 bryophytes and 41 lichens) were identified from samples collected during 2015 field surveys. Of these, six specimens were identified to genus level. Volume 5, Appendix 5-C, Appendices B and C shows the full list of vascular and non-vascular species recorded within the Project area, including graminoid and lichen species important for wildlife forage. The most common and widespread vascular species found were the northern Labrador-tea (*Rhododendron tomentosum*) and mountain cranberry (*Vaccinium vitis-idea*) which were both observed in 99 of the 128 plots surveyed and present in all ELC types. The overall findings indicate that the majority of the areas surveyed consist of low-diversity vascular plant communities dominated by fewer than 10 species.

Only two federally listed plant species (i.e., the moss species Porsild's bryum [*Haplodontium macrocarpum*] and felt-leaf willow [*Salix silicicola*]) have been identified within Nunavut; these species and suitable habitat were not observed within the LSA during field programs (Volume 5, Appendix 5-C). Of the 107 confirmed vascular species recorded during field programs, six are territorially listed as *Sensitive* (CESCC 2011). A full list of the vascular and non-vascular species recorded during field surveys and their CESCC status is presented in Appendix 5-C.

A total of 15 ELC units were mapped within the RSA and 13 ELC units in LSA. Table 5.4-1 shows the area (ha) and proportion (%) of each ELC community within the RSA and LSA. A detailed description and analysis of the ELC distribution within the study area is provided in Section 3.3.3 of Appendix 5-C.

Table 5.4-1: Total Area and Percent Cover of Ecological Land Classification Units within the Whale Tail Project Regional Study Area and Local Study Area

ELC Unit	RSA		LSA	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Natural				
Boulder/Gravel	46,670	9.3	2,063	7.3
Graminoid Tundra	10,550	2.1	459	1.6
Graminoid/Shrub Tundra	7,573	1.5	403	1.4
Heath Tundra	56,297	11.2	3,440	12.2
Heath Upland	79,061	15.8	5,454	19.3
Heath Upland/Rock Complex	7,725	1.5	359	1.3
Lichen Tundra	21,415	4.3	1,415	5.0
Lichen/Rock Complex	114,902	22.9	7,623	27.0
Sand	2,310	0.5	171	0.6
Shrub/Heath Tundra	8,432	1.7	497	1.8
Shrub Tundra	4,938	1.0	207	0.7
Wet Graminoid	2,618	0.5	127	0.4
subtotal vegetated ELC unit	*362,491*	*72.3*	*22,218*	*78.7*
Non-vegetated				
Cloud/Shadow	12,494	2.49	0	0.0
Water	125,646	25.04	5,998	21.3
subtotal non-vegetated ELC unit	*138,140*	*27.53*	*5,998*	*21.3*
Disturbed				
Existing disturbance	1,069	0.2	0	0.0
Total	**501,700**	**100.0**	**28,216**	**100.0**

Notes: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

The Sand ELC unit includes a non-vegetated sandy substrate and a cover of ericaceous shrubs and lichens (Volume 5, Appendix 5-C).

ELC = Ecological Land Classification; RSA = Regional Study Area; LSA = Local Study Area; ha = hectare; % = percent.

Elders expressed concerns about the loss of caribou habitat, particularly lichen (Cumberland 2005a). Caribou generally feed on lichen during winter, and forbs, shrubs (i.e., leaves and stems) and graminoid species during the growing season (Adamczewski et al. 1988). Lichen-dominated communities were considered to be high quality winter habitat for caribou, and graminoid-dominated communities were considered to be high-quality habitat for caribou in the growing season, and year-round for muskox (Volume 5, Appendix 5-C, Table 4-17a).

There is little disturbance in the RSA with the exception of the Meadowbank Mine. Lakes are the most common ELC Unit; overall lakes contribute one quarter (25%) of the RSA and more than one fifth (21%) of the LSA. High-quality caribou habitat include the Lichen/Rock complex and Heath Upland ELC units, covering 46% of the LSA and 39% of the RSA, respectively. Most of the Lichen/Rock complex patches are located in the southwestern portion of the RSA whereas the Heath Upland patches are mostly localized in the east portion of the RSA.

The Wet Graminoid and Sand ELC units are less common vegetated ELC units in the LSA and RSA representing 1% of each study area. Patches of these ELC units are localized in the southeast portion of the RSA intermixed with the Lichen/Rock Complex patches. The Sand ELC unit includes a non-vegetated sandy substrate and a cover of ericaceous shrubs and lichens (Volume 5, Appendix 5-C). Patches of the Sand ELC unit are scattered in the RSA and mostly localized in the southern portion of the LSA.

Existing disturbance accounts for 0.2% of the RSA and is associated with the Meadowbank Mine footprint. Cloud/Shadow is present randomly in areas where cloud cover obscured the Landsat imagery sourced to create the mapping (i.e., 0% of the LSA and 2% of the RSA).

Within the RSA, the proportion and distribution of vegetation (wildlife habitat) may be different than it was historically. Historical higher spring precipitation increased soil moisture, and vegetation species, which function as caribou forage. However, higher temperatures and a decline in snow and rain in recent years has created drier conditions, which promote growth of birches, willow, and grasses, resulting in a decrease in caribou habitat (Agnico Eagle 2014a; Government of Nunavut 2005; Cumberland 2005a; Thorpe 2000). The earlier spring-melt and later freeze-up has altered the vegetation upon which caribou foraged, thereby influencing caribou migration and foraging behaviour (Thorpe 2000). Similarly, berry producing shrubs have been negatively affected, with decreased growth rates and berry production, as well as delayed berry ripening, resulting in a reduction in feeding areas for wildlife and traditional plant harvesting areas (Government of Nunavut 2005).

5.4.3 Potential Project-related Effects Assessment

A comprehensive analysis of the potential pathways for effects on vegetation (wildlife habitat) during construction, operations, and closure is provided in Volume 3, Appendix 3-C, Table 3-C-2.

Primary pathways are those where effects from the Project will likely result in a measurable change to measurement indicators that could contribute to residual effects on a VC relative to the Baseline Case or guideline values. Pathways determined to have no linkage or those that are considered secondary are not predicted to result in environmentally significant effects on vegetation (wildlife habitat) and are not carried through the effects assessment. Secondary effects pathways and effects pathways with no linkage are summarized in the Pathway Analysis table in Volume 3, Appendix 3-C. The following are the primary pathways that require further effects analysis to determine the environmental significance from the Project on vegetation:

- Physical loss or alteration of vegetation (wildlife habitat) within the Project.
- Loss or alteration of local flows, drainage patterns, and drainage areas from the Project footprint and haul road that can cause changes to vegetation (wildlife habitat).
- Dust deposition on vegetation (wildlife habitat) from haul road and mining activities.

5.4.3.1 Primary Pathways Effect Analysis

The evaluation of Project effects on vegetation (wildlife habitat) considers the changes of vegetation measurement indicators: habitat quantity and habitat quality (Table 5.4-2).

Table 5.4-2: Measurement Indicators and Primary Pathways

Measurement Indicator	Associated Primary Pathway
Changes to Vegetation Habitat Quantity	Direct loss and fragmentation of vegetation habitat from the Project footprint
Changes to Vegetation Habitat Quality	Loss or alteration of local flows, drainage patterns (distribution), and drainage areas from the Project footprint and haul road that can cause changes to vegetation
	Dust deposition on vegetation from roads and mining activities

Vegetation habitat quantity refers to the amount of habitat present for each ELC unit. Habitat quantity is primarily affected by physical changes (e.g., vegetation clearing for the Project footprint), and is represented as the amount of area (i.e., hectares) of each ELC unit.

Vegetation habitat quality refers to the integrity, of each ELC unit on the landscape, and their continued ability to support the community of organisms naturally associated with them and to perform ecological functions. Habitat quality is typically reduced in human-altered ecosystems due to changes in physical (e.g., quality or quantity of soil or water) and biological (e.g., vegetation and wildlife communities) properties.

5.4.3.1.1 Changes to Vegetation Habitat Quantity

Primary effects to vegetation will include the physical removal of vegetation in all construction areas (i.e., the Project). The maximum amount of vegetated and non-vegetated ELC units lost due to the Project is predicted to be approximately 820 ha, or 2.9% of the LSA. In the LSA, there are 22,092 ha (78.7% of the LSA) of vegetated land cover units. Of these about 348 ha (1.6%) are predicted to be lost due to the mine site and 133 ha (0.6%) would be lost due to construction of the haul road (Table 5.4-3). An additional 339 ha (5.7%) of the Water ELC unit will be affected because of the Project. Overall losses of vegetation communities in the construction footprint are shown in Table 5.4-3.

Losses of graminoid ELC units, such as the Graminoid Tundra and the Graminoid/Shrub Tundra, represent a decrease in caribou habitat in the LSA and RSA. A total loss of 17 ha of the Graminoid Tundra ELC unit would occur in the LSA, of which 3.2% (15 ha) of the loss is associated with the mine site and 0.5% (2 ha) to the haul road. In the RSA there will be a total loss of 0.2% (17ha) of the Graminoid Tundra ELC unit and 0.1% (5 ha) Graminoid/Shrub ELC unit. The Wet Graminoid ELC unit also functions as high-quality caribou and muskox habitat and is relatively uncommon in the Wager Bay Plateau ecoregion (Volume 5, Appendix 5-C). Approximately 6.1% (8 ha) of the Wet Graminoid ELC unit is anticipated to be lost due to the mine footprint development, and represents the largest proportional loss of ELC units. Despite losses to this vegetation unit, this vegetation habitat remains well distributed across the LSA, RSA, and the broader Wager Bay Plateau ecoregion in low proportions.

Table 5.4-3: Ecological Land Classification Units Availability in the Project Footprint

ELC Unit	LSA					RSA		
	Baseline Area (ha)	Mine Site		Haul Road[a]		Baseline Area (ha)	Project	
		Area (ha)	Area (%)	Area (ha)	Area (%)		Area (ha)	Area (%)
Vegetated Units								
Boulder/Gravel	2,048	-41	2.0	-10	0.5	46,670	-51	0.1
Graminoid Tundra	457	-15	3.2	-2	0.5	10,550	-17	0.2
Graminoid/Shrub Tundra	402	-4	1.1	-1	0.3	7,573	-5	0.1
Heath Tundra	3,426	-75	2.2	-11	0.3	56,297	-86	0.2
Heath Upland	5,402	-74	1.4	-36	0.7	79,061	-109	0.1
Heath Upland/Rock Complex	357	-3	0.9	-2	0.6	7,725	-5	<0.1
Lichen Tundra	1,400	-21	1.5	-9	0.6	21,415	-30	0.1
Lichen/Rock Complex	7,597	-91	1.2	-51	0.7	114,902	-142	0.1
Sand[b]	171	-1	0.4	-9	5.1	2,310	-9	0.4
Shrub Tundra	207	-7	3.3	<-1	0.2	4,938	-7	0.1
Shrub/Heath Tundra	497	-10	1.9	-1	0.2	8,432	-10	0.1
Wet Graminoid	127	-8	6.1	<-1	0.1	2,618	-8	0.3
Subtotal vegetated units	*22,092*	*-348*	*1.6*	*-133*	*0.6*	*374,986*	*-481*	*0.1*
Non-vegetated Units								
Cloud/Shadow	0.0	0.0	0.0	0.0	0.0	12,494	0	0.0
Water	5,982	-339	5.7	-0.2	<0.01	125,646	-339	0.3
Subtotal non-vegetated units	*5,982*	*-339*	*5.7*	*-0.2*	*<0.01*	*138,140*	*-339*	*0.2*
Disturbed								
Existing disturbance	141	0	0.0	0	0.0	1,069	0	0.0
Total	**28,215**	**-687**	**2.4**	**-133**	**0.5**	**501,701**	**-820**	**0.2**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values. Percent of area is calculated as the percent of baseline area affected by the Project.

[a] Haul road area summaries include the esker borrow sites and esker borrow site access roads.

[b] The sand ELC unit includes a non-vegetated sandy substrate and a cover of ericaceous shrubs and lichens (Volume 5, Appendix 5-C).

ELC = Ecological Land Classification; RSA = Regional Study Area; LSA = Local Study Area; ha = hectare; % = percent; < = less than.

The Project design and construction phases will aim to minimize impacts to existing vegetation habitat quantity. Mitigation measures, such as minimization of the proposed road width and associated borrow areas, will be implemented.

Lichen-dominated communities are high quality winter habitat for caribou and include the Heath Upland and Lichen/Rock Complex. These ELC units are expected to decrease by 0.7% each (36 ha and 51 ha, respectively) in the LSA due to the road footprint. Heath Upland and Lichen/Rock Complex are suitable nesting habitat for upland breeding birds VC (Section 5.5). It is expected that habitat availability for these ELC units are not limited as 5,292 ha and 7,455 ha will remain undisturbed in the LSA, respectively.

Expansion of the haul road is anticipated to be primarily within the Sand ELC unit, with 5.1% (9 ha) of this ELC unit affected. Although the Sand ELC unit is uncommon in the Wager Bay plateau ecoregion, RSA and LSA, this ELC unit will remain well distributed in the LSA and RSA with 161 ha and 2,300 ha, respectively.

The Project will result in a 5.7% (339 ha) loss of the Water ELC unit in the LSA as a result of the mine and haul road footprints, which translates to 0.3% of this ELC unit affected in the RSA. The water ELC unit includes watercourses and waterbodies, which “to the Inuit people, rivers were not just rivers, they were survival” (Local Inuit Field Assistant, 2015, pers. comm. July 5, 2015). Effects of water habitat losses, such as water courses, streams and lakes are assessed in Volume 6.

Overall vegetation and consequential wildlife habitat loss as a result of the Project footprint is small, 2.9% of the LSA and 0.2% of the RSA; the Project is anticipated to decrease vegetated ELC units by 0.1% (481 ha) (Table 5.4-3).

During Project construction and operations, Project effects are localized around the mine site and haul road within the LSA. Losses to vegetation communities are predicted to be long-term for ELC units within the mine footprint that will be naturally revegetated in the long-term post-closure.

Reclamation efforts will focus on providing conditions conducive to natural re-colonization of the site by surrounding native vegetation. Large-scale re-vegetation of the site is not considered feasible at this time as there is no readily-available seed material for native plants. In addition there is a lack of available soils in the Project area which, in conjunction with the harsh climatic conditions (short cold and dry growing season), makes it difficult to establish vegetation over large areas (Volume 8, Appendix 8-F.1). Reclamation activities and natural re-vegetation of disturbed areas during the closure and post-closure phases will improve the loss of vegetation communities and reduce overall residual effects within the LSA.

5.4.3.1.2 Changes to Vegetation Habitat Quality

Potential effects to vegetation associated with non-footprint disturbances may occur during Project operations and include dust deposition (total suspended particulate). These effects were assessed qualitatively and are based on results from Volume 4, Section 4.3.

Dust will be generated as a result of natural conditions in addition to clearing and construction activities, active hauling on the haul road, dumping waste rock, and other operational activities. Dust deposition has the potential to affect Arctic plants and vegetation communities (Auerbach et al. 1997; Myers-Smith et al. 2006, Walker and Everett 1987). The primary effects of dust are generally confined to the immediate area next to roadways (Everett 1980; Walker and Everett 1987).

Dust has the potential to negatively affect plant health (Cumberland 2005e), change vegetation succession and phenology processes, community composition, and the corresponding vegetation communities in proximity to roads. Accumulation of dust produced from the Project may result in direct changes to vegetation. Plant community changes can result if dustfall upsets the competitive balance among plants (Brandt and Rhoades 1973; Farmer 1993). Dust that falls directly on plants can have a physical effect (Farmer 1993) by smothering plant leaves or blocking stomata openings. Dust may also have a chemical effect on plants, either indirectly through the soil or directly on the surface of the plant (Farmer 1993; Rusek and Marshall 2000). Bryophyte and lichens may be particularly vulnerable to the chemical effects of dust as they obtain moisture and nutrients from the atmosphere and immediate surroundings, including substances that are trapped or deposited directly on surface of the bryophyte leaf or lichen thalli (Farmer 1993). Bryophytes and lichens may experience the largest effects close to roads where the greatest amount of deposition frequently occurs.

An air quality modelling assessment was completed to predict the spatial extent of dust deposition and air emissions with the mine site and haul road (Volume 4, Section 4.3). Dust is anticipated to be produced by construction and operations of the haul road and mine site, but effects are anticipated to be relatively limited.

Modelling was completed for the haul road assuming no mitigation measures were applied. Dust modelling results along the haul road predicted that the maximum dust deposition values would be within 1 m of the haul road and concentrated within 100 m (Volume 4, Section 4.3).

Dust deposition is anticipated to be primarily in downwind areas from the haul road and mine site. Because prevailing winds in the region are northwesterly, the major impacts of dust deposition will generally be on plant communities along the haul road connecting the Whale Tail Pit infrastructure and the Meadowbank Mine. Effects on vegetation will be directly related to the amount of traffic on the haul road, and is anticipated to be highly seasonal with minimal to no dust being produced in winter months while the road is covered with snow. The magnitude of the effects along the haul road are mitigated by the low road use volumes, limited traffic speeds, and targeted spraying roads with water, when necessary. Consequently, effects of dust on vegetation are expected to be restricted to the LSA, continuous through operations of the Project.

Dust deposition is expected to continue on the AWAR for the additional years of operation of the Meadowbank Mine. The 2015 Air Quality and Dustfall Monitoring Report for the Meadowbank mine (Agnico Eagle 2015e) has shown a continual decline in dustfall exceedances on an annual basis with only 1 exceedance out of 48 in 2015. In addition, there have been no observed changes in soil/plant metal concentrations from the Wildlife Screening Level Risk Assessment (Cumberland 2006).

Dustfall studies have been completed for Meadowbank AWAR from 2012 to 2014 with sampling stations deployed at 50, 100, and 150 m from both sides of the road. Data from these studies support dustfall modelling predictions for the Project; specifically that the majority of dustfall occurs within 100 m of the road, and that impacts to vegetation (wildlife habitat) because of dust will be restricted to this area (Agnico Eagle 2014e). Additionally, these studies support the efficacy of proposed dust control mitigations.

Effects of dust on vegetation will be reversible during the closure phase and will be reduced relative to effects expected during the construction and operations phases, as use of the haul road will be discontinued and surfaces and shoulders will be rehabilitated to promote natural encroachment of vegetation. Natural succession of vegetation communities, and thus habitat restoration will begin. Therefore, dustfall effects on vegetation are predicted to be reversible. Regular monitoring on the haul road (Volume 8, Appendix 8-E.7) will assess the rate of revegetation along the road. If residual effects are higher than expected, an adaptive management strategy will be taken to ensure that effects are reduced further (Volume 8, Appendix 8-E.7).

Changes to hydrology and drainage patterns are expected to occur during Project construction and operations, and will extend to closure (Golder 2016). Dewatering of the Whale Tail will occur at the end of the construction phase, resulting in the flooding of a number of tributary lakes upstream of the Whale Tail Dike to the Mammoth Lake Watershed, thereby altering flows at Mammoth Lake and downstream lakes. Flooding of terrestrial vegetation is expected to reach a maximum of 165.9 ha in July 2020 and continue to May 2022 (Golder 2016). This change in water regime variations can strongly influence plant species composition, community structure, and biological diversity (Vale et al. 2015). These temporary changes in water levels will affect soil moisture, and may result in localized effects to vegetation habitat quality through decreased species abundance.

Flooded areas will be dewatered at closure; therefore, effects on vegetation habitat quality are anticipated to be reversible because long-term effects on soil are not anticipated. No measurable differences in water flows and water levels are predicted from baseline to post-closure (Volume 6, Section 6.3). It is unlikely that there will be permanent changes in vegetation community composition over the life of the Project (seven years between construction [initial water diversion] and closure).

Mitigation measurements such as directing the pumping discharge directly to the lake environment using natural drainage patterns, when possible to reduce the use of ditches or diversion berms would limit changes in surface water flows to the local level, and therefore minimize effects on vegetation habitat condition. Changes in hydrology because of the Project are not predicted to further reduce vegetation condition in the LSA or RSA beyond the extent of the footprint.

5.4.4 Residual Impact Classification

The effects analysis considers all primary pathways that are likely to result in measurable environmental changes and residual effects on vegetation. Primary pathways were evaluated further through more detailed quantitative and qualitative effects analysis to characterize residual effects of the Project and their potential incremental contribution to cumulative effects. Criteria for evaluating the significance of impacts have been developed for this Project based on best practice, professional judgment, and experience on other impact assessments for similar Projects (Volume 3, Appendix 3-C). The intent of this process is to be transparent and to document decision pathways so that others can review the process used to determine the likelihood of predicted impacts, how mitigation has avoided or reduced an impact, and the significance of impacts.

Residual effects on vegetation from incremental changes to measurement indicators because of the Project were characterized using direction (positive or negative), expected magnitude (i.e., negligible, low, moderate, or high), geographic extent (i.e., site, local, regional, or beyond regional), duration (i.e., short-term, medium term, or long-term), frequency (i.e., isolated, periodic, or continuous), reversibility (e.g., reversible or irreversible) and likelihood (i.e., unlikely, possible, likely, or highly likely) (Table 5.4-4). These criteria were considered together, along with context derived from the existing conditions, to estimate the overall effects from the Project on vegetation using a reasoned narrative. Residual impact classification definitions and the effects criteria and level for determining significance are described in Volume 3, Appendix 3-E.

After mitigation measurements are applied (Volume 3, Appendix 3-C, Table 3.C-2), the effects of the Project footprint are limited to 820 ha, of which 481 ha are limited to vegetated ELC units and 339 ha to water (Table 5.4-3). This loss is predicted to occur mostly in the mine site (Figure 5.1-1). Although high-quality caribou and muskox habitat (i.e., graminoid and lichen dominated ELC units) will be affected by the Project, these ELC units will remain well represented across the LSA and RSA.

Table 5.4-4: Residual Impacts Classification and Determination of Significance on Vegetation

Pathways with Potential to Affect Vegetation (Wildlife Habitat)	Measurement Indicator	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	Significance for Assessment Endpoint[a]
Physical loss of Plants and Vegetation Communities	Changes to Vegetation Habitat Quantity	Negative	Low	Local	Long-term	Continuous	Reversible	Likely	Not Significant
Changes in Hydrology Dust Deposition	Changes to Vegetation Habitat Quality	Negative	Low	Local	Medium-term	Continuous	Reversible	Likely	

[a] Assessment endpoint is defined as self-sustaining and ecologically effective plant populations and communities.

Physical loss of vegetation populations and communities as a result of construction period will remain during the life of the mine. Arctic plant growth rates are limited by harsh growing conditions and a short growing season (Bliss and Wein 1971); therefore, it is anticipated that once vegetation is removed the loss is considered long-term and continuous until functional habitat is reclaimed during the closure and post-closure phases (see Interim Closure and Reclamation Plan and TEMP) (Volume 8, Appendix 8-F.1 and 8-E.7, respectively). Re-vegetation of disturbed Arctic sites is variable and depends on the extent and intensity of the disturbance (i.e., removal of vegetation or removal of vegetation and soil) and the type of vegetation community. Although Arctic ecosystems can take from 20 to 75 years to recover after disturbance (Forbes et al 2001; Walker and Everett 1987), native sedges (*Carex* spp) and cotton grasses (*Eriophorum* spp.) may revegetate in Arctic tundra in as little as five to 10 years (Chapin and Chapin 1980), and viviparous species such as *Poa alpigena* sp. *colpodea*, *Polygonum viviparum*, *Saxifraga rivularis*, and *S. foliolosa* were successful in establishing within 20 years following disturbance. Research on abandoned winter roads on peatlands in the Hudson Bay Lowland also showed that lichen, bryophyte, and vascular plant cover returned to a similar state as the adjacent undisturbed peatlands within five years, though species composition was different (Campbell and Bergeron 2012).

The post-closure vegetation communities will differ from the existing vegetation communities due to the effects of disturbance and recolonization, but revegetated areas of the Project footprint are expected to be productive and function as wildlife habitat, thus the loss is expected to be reversible (Table 5.4-4). Within the LSA and RSA, these changes to vegetation (wildlife habitat) are small enough that there will be no measureable ecological change.

During the construction and operations stage, dust deposition may result in changes to the vegetation quality, particularly to the vegetation adjacent to the haul road. The 2014 and 2015 Air Quality and Dustfall Monitoring report (Agnico Eagle 2014f, Agnico Eagle 2015e) prepared for the Meadowbank Mine indicates that the Alberta Environment recreational/residential area dustfall guidelines were exceeded in 1 out of 48 samples in 2015, 5 out of 44 samples in 2014, 11 out of 44 in 2013, and 10 out of 44 in 2012. The results from the dustfall monitoring program (Agnico Eagle 2014f) show relatively lower dustfall values in May-September (as observed in 2013) compared to previous years. The continual trend of decreasing dust exceedances from 2012 through 2015 is likely a result of increased efforts to manage dust on site roads through use of dust suppressants (calcium chloride application) and water trucks. Similar results are anticipated for this Project.

Progressive reclamation will be used to reclaim areas no longer needed for road construction by stabilizing disturbed land surfaces, which will promote natural re-vegetation. Therefore, dustfall effects on vegetation are considered medium-term and reversible. Monitoring and adaptive management will be implemented to ensure dustfall deposition is controlled over the life of the Project (TEMP, Volume 8, Appendix 8-E.7).

It is unlikely that there will be permanent changes in vegetation community composition due to the Project. The effects on vegetation habitat communities due to changes in hydrology would be localized and limited to the Project LSA. At post-closure, it is expected that hydrology conditions would return to baseline (Volume 6, Section 6.3). Therefore, changes in vegetation communities composition due changes in hydrology are expected to be reversible.

5.4.4.1 Determination of Significance

Residual effects to vegetation (wildlife habitat) were determined to be significant to vegetation if ELC units are expected to no longer be: i) self-sustaining, or ii) ecologically effective.

Incremental changes in the vegetation quantity and quality due to the Project are expected to be small. However, the incremental additions of the Project to existing effects on vegetation, including changes to quantity, are predicted to be within the resilience and adaptability limits of vegetation units for the following reasons:

- decrease of vegetation quantity due to the Project is small and confined to the footprint; and
- changes in vegetation quality are localized and are expected to be small after mitigation.

The combined evidence concerning vegetation quantity and quality in the LSA and RSA indicates that vegetation would remain self-sustaining and ecologically effective during construction and operations and would continue to function as wildlife habitat. Graminoid and lichen-dominated ELC units that function as high-quality caribou and muskox habitat will continue to be present and well distributed across the landscape. Consequently, incremental effects from the Project on vegetation are not considered to be significant on a local and regional scale (Table 5.4-4).

Reclamation activities and natural re-vegetation of disturbed areas during the closure and post-closure phases (see Interim Closure and Reclamation Plan [Volume 8, Appendix 8-F.1] and TEMP [Volume 8, Appendix 8-E.7]) will improve vegetation units lost and reduce overall residual effects within the LSA even further.

5.4.5 Cumulative Effects Assessment

A cumulative effects assessment was not completed for vegetation (wildlife habitat) as effects to this component are localized and will not interact with other disturbances regionally. Cumulative effects to wildlife are considered in Volume 5, Section 5.5).

5.4.6 Uncertainty

The following uncertainties apply to the Project and the assessment:

- Baseline vegetation survey and mapping provide an estimate of the presence and distribution of vegetation ELC units, and vegetation species. Consequentially, an amount of uncertainty is present because maps cannot provide detailed, site-specific information to all areas.
- Dust deposition models, including: differences in actual versus predicted natural mitigation of windblown fugitive dust from unpaved surfaces, drilling and blasting activities, material handling, or wind erosion and/or the effectiveness of proposed dust mitigation measures at the Project.
- Accuracy of the hydrology modelling: differences in actual versus predicted results may vary based on climate conditions and actual filling duration.

Uncertainty was addressed in the assessment by incorporating information from available and applicable literature, and using past experience in similar areas including the experiences at nearby Meadowbank Mine. In addition, the application of environmental design features and mitigation, the Interim Closure and Reclamation Plan (Volume 8, Appendix 8-F.1) and the Water Management Plan (Volume 8, Appendix 8-B.2) will mitigate effects to vegetation.

5.4.7 Monitoring and Follow-up

During Inuit Public Information Meetings, concerns were expressed about Project activities resulting in losses of vegetation communities, a reduction in quality of wildlife forage through dust deposition, and the capacity of vegetation to regenerate following mine activities. A TEMP has been developed for the Project to address these concerns and to manage the interaction between the Project and the terrestrial ecosystem so that residual effects to vegetation, wildlife, and wildlife habitats are acceptable (Volume 8, Appendix 8-E.7).

The objectives of monitoring vegetation will be to ensure that measures to minimize the amount of vegetation (wildlife habitat) lost due to Project construction and operations are effective, and that concentrations of contaminants in vegetation do not exceed acceptable level for wildlife health. Monitoring will also ensure that potentially contaminated vegetation is removed (or isolated from wildlife), and that the site is restored to its natural state (Volume 8, Appendix 8-E.7).

The vegetation monitoring objectives and methods are described in detail in the TEMP (Volume 8, Appendix 8-E.7).

5.5 Terrestrial Wildlife and Wildlife Habitat

5.5.1 Incorporation of Inuit Qaujimajatuqangit

Publicly available IQ sources relevant to the Project and developed primarily by Baker Lake Elders were reviewed. The following documents were reviewed for IQ specific information related to wildlife and wildlife habitat and incorporated into this effects assessment:

- Whale Tail IQ Baseline Report (Volume 7, Appendix 7-A);
- Meadowbank Gold Project Baseline Traditional Knowledge Report (Cumberland 2005a);
- EIS Guidelines for the Meadowbank Project (NIRB 2004);
- Proposed All-weather Exploration Road from the Meadowbank Mine to the Project site-Baseline Traditional Knowledge Report (Agnico Eagle 2014a); and
- Community Consultations/Public Information Meeting Summary Reports for 2014 and 2015 (NIRB 2014, 2015).

The following sections summarize the IQ information incorporated into the baseline studies, VC selection, and recommendations for mitigation and adaptive management, where applicable.

5.5.1.1 Existing Environment and Baseline Information

Inuit Qaujimajatuqangit related to wildlife and wildlife habitat, including caribou and muskox, furbearers/predators, mammals, and birds relevant to the Project area, was incorporated into baseline information. Baseline studies were designed to characterize wildlife as culturally important to Inuit and to characterize important wildlife habitat, including habitat for caribou, muskox, predatory mammals, and water birds. Baseline field programs were guided by IQ, including the assistance of local field assistants. Annual contributions from Inuit to the monitoring programs are presented in the annual wildlife monitoring reports (i.e., Gebauer et al. 2015), and Inuit were involved and consulted with during the baseline studies (Volume 5, Appendix 5-C).

Inuit Qaujimajatuqangit specific to wildlife and wildlife habitat and relevant to the Project that was incorporated into the baseline includes information on abundance and distribution, migration patterns and travel routes, calving grounds, denning and nesting sites, critical habitat features, such as caribou crossing places and predator den locations, harvesting patterns, and the effects of climate change on wildlife populations and on harvesting activities.

5.5.1.2 Valued Component Selection

Inuit Qaujimajatuqangit was incorporated in VC selection by reviewing documented IQ information, discussions with members of the local community, concerns raised through consultation with regulators (GNDoE and NIRB), and a review of VCs identified in other northern mine projects. The Project Guidelines required that special consideration be given to species of particular social, cultural and economic importance, including those for human consumption.

5.5.1.3 Impact Assessment

Inuit Qaujimajatuqangit was incorporated in the FEIS Amendment by considering Project-specific questions related to wildlife and wildlife habitat that were raised by local community members, including Elders, land users, women and youth, into the list of potential effects to be considered.

Particular emphasis was placed on assessing the impacts from the mine on caribou. Specific IQ related to caribou raised through community consultation are as follows:

- potential effects of spills and accidents;
- potential effects of dust and chemicals used in blasting activities;
- potential effects of the road and sharp rocks on road-crossing behaviour;
- potential effects to migration and distribution patterns, and calving grounds; and
- potential effects related to food security due to reduced availability and caribou health, including potential effects on the taste of meat.

Inuit Qaujimajatuqangit specific to furbearers/predators and furbearer/predator habitat was related to effects of the Project on denning habitat, especially along the eskers adjacent to the Project footprint and potential borrow pit locations, and potential disturbance to wolves and their movement patterns due to construction activities.

Inuit Qaujimajatuqangit specific to birds and bird habitat relevant to the Project and incorporated into the impact assessment, are related to the potential effects of the Project on the destruction or disturbance of nesting water bird habitat.

Inuit Qaujimajatuqangit related to wildlife in general were also considered in the impact assessment, including the long-term monitoring of wildlife, the potential effects of dust, and the potential effects of increased shipping traffic.

5.5.1.4 Mitigation and Monitoring

Mitigation measures are developed to reduce impacts and effects to wildlife and wildlife habitat. Mitigation measures to minimize Project effects and proposed monitoring is provided in the TEMP (Volume 8, Appendix 8-E.7).

5.5.2 Existing Environmental and Baseline Information

The existing environment and baseline information summarized here is reported in detail in Appendix 5-C and includes both desktop literature reviews and field studies. In addition to the environmental monitoring information collected at the Meadowbank Mine (Gebauer and Boulanger 2007; Gebauer et al. 2008 to 2015); baseline field studies were completed at the Project during 2014 and 2015 and included the following programs:

- Arctic Program for Regional and International Shorebird Monitoring (PRISM) plot surveys for upland breeding birds and water birds within the RSA;
- transect surveys for breeding birds in six locations along the proposed Project haul road route (prior to construction of the Project haul road);
- shoreline surveys for water birds along waterbodies within 100 m the Project;

- ground reconnaissance surveys for caribou, muskox, predatory mammals, nesting raptors, and other species in the vicinity of eskers;
- height-of-land surveys for caribou, muskox, predatory mammals, and other species in the vicinity of vegetation monitoring plots; and
- raptor nest surveys in the RSA.

5.5.2.1 Species of Concern

The intent of the federal *Species at Risk Act*, is to protect species at risk from becoming extirpated or extinct as a result of human activity. Species with ranges that overlap with the Project, may be considered to be of concern as a result of either their national, territorial or Committee on Status of Endangered Wildlife in Canada (COSEWIC) status. To date, no species have been listed under the Nunavut *Species at Risk Act*.

There are five wildlife species of concern with breeding or wintering ranges that overlap with the Project. The five species are grizzly bear, wolverine, peregrine falcon, red-necked phalarope and short-eared owl and monitoring is proposed for each (Table 5.5-1). Each of the species of concern are represented by a VC, and impacts to these species of concern were considered through the relevant VC (Table 5.5-1).

Table 5.5-1: Wildlife Species of Concern for the Project

Species	COSEWIC Assessment	Federal *Species at Risk Act*	Potential Impacts	Wildlife Value Component
Grizzly bear (western population)	special concern	no status	May be attracted to developments if food is available; direct habitat loss	Predatory mammal
Wolverine (western population)	special concern	no status	May be attracted to developments if food or shelter are available; direct habitat loss	Predatory mammal
Peregrine falcon (anatum-tundrius complex)	special concern	Schedule 1	Direct habitat loss	Raptor
Red-necked phalarope	special concern	no status	Direct habitat loss	Water bird
Short-eared owl	special concern	Schedule 1	Direct habitat loss	Raptor

Source: COSEWIC (2016); GC (2016).
COSEWIC = Committee on the Status of Endangered Wildlife in Canada.

5.5.2.2 Caribou

Caribou are an important part of the Arctic ecosystem, and a key part of the culture and traditional economy of Nunavut. There are five migratory barren-ground caribou herds identified in the Kivalliq including the Beverly, Ahiak, Wager Bay, Lorillard, and Qamanirjuaq herds (Volume 5, Appendix 5-C, Figure 7.1). As a result, Inuit traditionally did not live at or near the calving grounds but rather chose to remain at a distance, and set up camps along the migration routes (Volume 7, Appendix 7-A). Elders have stated that there are no caribou calving grounds identified near the Project area (Volume 7, Appendix 7-A), and according to Nagy et al. (2011), the nearest calving ground to the Project is over 100 km away.

Since 1999, studies on the caribou population status, distribution, seasonal movements, traditional use, and hunting pressures were undertaken (Cumberland 2005e; Gebauer et al. 2008 to 2015, Volume 5, Appendix 5-C). These reports describe existing conditions within the Project LSA and RSA, and provide a regional dataset on the existing conditions for migratory caribou with large home ranges and is summarized herein.

Additional targeted field surveys were also conducted along the proposed Project haul road route in 2014 and 2015 (Volume 5, Appendix 5-C). Information regarding caribou seasonal abundance, movement patterns, water crossings, habitat use, and harvesting patterns is summarized in the following sections.

While mortalities of caribou Meadowbank Mine have been low, the AWAR appears to present a risk as there have been 11 documented caribou mortalities on the road between 2007 and 2015 (Table 5.5-2), although not all of these can be directly attributed to the road. In 2013, all five of the caribou mortalities were the result of a single vehicular incident along the AWAR as a result of human error. This accident led to adaptive management to increase safety awareness amongst Mine staff. Other mitigation implemented to reduce the road-related effects to caribou includes speed limit signs, wildlife activity notices, and road closures. This is a direct result of Elders requesting an increase in wildlife monitoring along the road, a quicker response time, and road closures during key caribou migration periods (Agnico Eagle 2015c). Details of all wildlife mortalities can be found in the annual wildlife monitoring reports (Gebauer et al. 2008 to 2015).

Table 5.5-2: Caribou Road Mortalities at Meadowbank Mine and on All-Weather Access Road, 2007 to 2015

Year	Meadowbank	AWAR
2007	0	2
2008	0	2
2009	0	0
2010	0	1
2011	0	0
2012	0	1
2013	0	5
2014	0	0
2015	0	0

Note: this table includes road related mortalities only and does not include mortalities at the Meadowbank Mine due to other causes.
AWAR = All-Weather Access Road.

Procedures for monitoring caribou movements across the AWAR, including regularly broadcasted wildlife warnings and closing the AWAR when large number of caribou are present, have shown to be effective (Volume 8, Appendix 8-E.7, Appendix A). For example, in October 2014, a large herd of caribou were observed along the AWAR. Notices were sent to all Mine staff reminding them to be mindful of the caribou migration and the caribou in the immediate area. In addition, the environment department and the road operations team closed the road to all vehicles between 23 and 27 October and 25 and 26 November, so that caribou could migrate through the area unobstructed. There have been AWAR closures in most years of AWAR operations, including 10 days of closures in 2015 (Table 5.5-3).

Table 5.5-3: All-Weather Access Road Closures Due to Caribou Presence, 2009 to 2015

Baker Lake to Meadowbank AWAR Data	2009	2010	2011	2012	2013	2014	2015
Road closures for caribou migration (days)	2	0	1	5	0	4	10
Dates of closure or partial closure	mid Oct	10 to 26 Oct	5 to 30 Oct	4 to 25 Nov	28 Nov to 21 Dec	23 Oct to 26 Nov	15 Nov to 10 Dec

AWAR = All-Weather Access Road.

Seasonal Abundance

The region around Baker Lake is a range overlap area for migratory and tundra-wintering caribou, and is used during most seasons. Annual monitoring at Meadowbank Mine and on the AWAR has shown year-round caribou presence, but higher numbers of caribou have been observed during the fall migration, leading to road closures (Table 5.5-3), particularly in early winter (Volume 5, Appendix 5-C, Table 5.5-3).

Inuit Elders (Elders) have expressed concerns that there are fewer caribou in the region than in the past (Agnico Eagle 2014a). Population status of the herds that interact with the Project is unclear, but many mainland Nunavut caribou herds including the Beverly, Ahiak and Qamanirjuaq are believed to be in decline (Vors and Boyce 2009, CARMA 2016).

Collared caribou from all five herds have used the RSA, although at different frequencies and seasons, depending on their herd ranges. The locations of collared caribou from the Ahiak (2002 to 2015), Beverly (1996 to 2015), Lorillard (1998 to 2015), Qamanirjuaq (1993 to 2015), and Wager Bay (1999 to 2015) herds were obtained from Government of the Northwest Territories and Government of Nunavut to describe seasonal presence of these herds within the Project RSA. The data was used to calculate total time spent in the RSA, and the number of individual caribou seasons in which the caribou are present in the RSA (Figure 5.1-1; Table 5-D-1, Appendix 5-D). The date ranges for the seasons follow those used in Gebauer et al. 2015.

Collard caribou from all five herds spent 0.37% of their total time in the RSA (i.e., the ratio of collar time within the RSA versus outside the RSA). The collar data indicates that the Ahiak, Lorillard, and Wager Bay herds have the greatest likelihood of interacting with the Project, as they were the most frequently recorded herds within the RSA. The Ahiak herd had 27 unique individuals recorded interacting with the RSA for a total of 317 days, the Lorillard herd had 25 unique individuals recorded interacting with the RSA for a total of 268 days, and the Wager Bay herd had 12 unique individuals recorded interacting with the RSA for a total of 329 days. This represents a total percent of time recorded of 0.7%, 0.9%, and 2.1% spent in the RSA for the Ahiak, Lorillard, and Wager Bay herds, respectively. Only one unique individual from the Qamanirjuaq herd and six unique individuals from the Beverly herd have been recorded in the Project RSA; therefore, percentage of collar locations is nil or very low in all seasons.

Collared caribou were most commonly recorded in the Project RSA during the late winter (i.e., 8.0% of the collar time) and fall rut (i.e., 5.1% of the collar time). The data do not indicate calving activity in the Project RSA as few collared caribou are present in the Project RSA during the calving period, which is consistent with Elders identifying there that there are no calving grounds near the Project area (Volume 7, Appendix 7-A). Some collared caribou have been recorded traveling through the RSA during the calving and post-calving season, and Elders have reported that cows with calves do frequent the area around the proposed Project haul road route

(Agnico Eagle 2014a). During the calving period, one individual from the Ahiak herd was recorded for a total of two days, and one individual from the Lorillard herd was recorded for approximately one day. No collared individuals from the Beverly herd were recorded in the Project RSA during the calving season, and no collared individuals from the Qamanirjuaq and Wager Bay herds were recorded during the calving or post-calving seasons.

Movement Patterns

Within the Project RSA, caribou movements appear to be diffuse and distributed across the study area, with potential movement corridors north of Tehek Lake (Volume 5, Appendix 5-C, Figure 7.8). Caribou trails identified in the Project RSA during IQ workshops and confirmed by field biologists during the baseline surveys support this observation (Volume 5, Appendix 5-C, Figure 7.9). Elders also noted many caribou frequent the area around Tasirjuaraajuk (Pipedream) Lake (Agnico Eagle 2014a).

The RSA appears to be located within a transit corridor during spring and fall migration, predominantly for the Ahiak and Lorillard herds moving between calving and wintering grounds. For spring migration (April to June), areas of high use by collared caribou are more contained (i.e., less spread out), and these corridors are quite clearly delineated on the way to, and in proximity of, calving grounds outside the RSA (Volume 5, Appendix 5-C, Figure 7.9). For fall migration (September to November), as animals are migrating to wintering grounds, areas of high use by collared caribou are more widely distributed (Volume 5, Appendix 5-C, Figure 7.10). Fall migration corridors are located in closer proximity to the Project RSA than spring corridors. Travel routes along Uiguklik Lake that were identified by Elders, reportedly followed caribou migration routes (Agnico Eagle 2014a). Further description of caribou seasonal movements is provided in Appendix 5-C (Section 4.3.3.9).

The collar data were queried to describe by season the number of collared individuals that entered the LSA (i.e., within 3 km of the road), how many of these individuals went on to cross the AWAR and proposed Project haul road route, and if so, how many times individuals crossed. The query included both actual interactions with the AWAR and expected interactions with the proposed Project haul road route (Table 5-D-2, Appendix 5-D). Ahiak and Lorillard herds were the most likely herds to interact with the AWAR and the proposed Project haul road route. The Ahiak herd had seven unique individuals cross the AWAR and 19 unique individuals cross the proposed Project haul road route. The Lorillard herd had 19 unique individuals cross the AWAR and 13 unique individuals cross the proposed Project haul road route. The Wager Bay herd had three unique individuals cross the AWAR and five unique individuals cross the proposed Project haul road route. The Beverly and Qamanirjuaq herds had no caribou cross the AWAR and two and one unique individuals cross the proposed Project haul road route respectively. Caribou from all herds were most commonly recorded crossing the proposed Project haul road route and the AWAR during the spring season. None of the herds were recorded crossing the proposed Project haul road route during the calving season, and only one caribou was recorded during the post-calving season.

Habitat Use

Habitat selection and behaviour of barren-ground caribou are frequently the result of their response to environmental conditions; therefore, caribou can be found in a variety of habitat types at any one time. Selection of habitat appears to take place over several spatial scales and is related to food availability, ease of travel, relief from insects and predation (Curatolo 1975). Hunters have suggested that weather and snow conditions play a greater role in defining caribou distribution than other factors, and that a range of conditions characterize prime wintering areas (Kendrick and Manseau 2008).

At the scale of the annual range, barren-ground caribou have large ranges and make large seasonal movements across these ranges. The estimated geographic ranges of the herds that may interact with the Project, range from approximately 144,000 to 462,000 km^2 (Table 5.5-4; Nagy et al. 2011; Volume 5, Appendix 5-C, Figure 7.1). At the scale of the seasonal range, caribou select habitats dominated by lichen, heath tundra, and rock vegetation types (Johnson et al. 2005). Caribou generally feed on lichen during winter, and fresh shrubs (leaves and stems) and graminoids during the vegetation growing season (Adamczewski et al. 1988); therefore, habitat that contains these features will be of higher value to caribou in the appropriate season. Habitat suitability rankings were for the Meadowbank Mine (Cumberland 2005e) were updated for the Project (Volume 5, Appendix 5-C, Section 4.3.4).

Table 5.5-4: Annual Range of Kivalliq Caribou Herds

Herd	Annual Home Range Area (km^2)
Ahiak	416,796
Beverly	436,671
Lorillard	144,541
Qamanirjuaq	461,856
Wager Bay	269,209

km^2 = square kilometre.

Water crossings in particular play an important role in many periods of the annual cycle for caribou. During migration, caribou follow natural geographic features, which cause them to concentrate at traditional water crossings (Williams and Gunn 1982). No federal or territory protected water crossings are found in the Project RSA; however, Elders identified narrows along Uiguklik and Nutipilik lakes as known caribou crossing areas (Agnico Eagle 2014a). Caribou were traditionally (and sometimes still are) hunted at such crossing places (Agnico Eagle 2014a).

Harvesting Patterns

Local Elders report that caribou were hunted throughout the Project RSA during both present and historic times (Agnico Eagle 2014a). Annual hunter harvest data for the Meadowbank Mine estimate that approximately 5,000 caribou are currently harvested each year by hunters based in Baker Lake, with many animals hunted north of Baker Lake (Gebauer et al. 2008 to 2015). Historic studies provided lower but similar estimates (NWMB 2005).

August, September, and October have traditionally been the most active harvesting months, likely reflecting higher populations of caribou travelling through the region. Most reported hunting trips have not gone beyond the northern extent of the AWAR, and are focused around Baker Lake and in the Whitehills Lake area. Some successful hunting trips have been reported in the RSA and north of Tehek Lake (Volume 5, Appendix 5-C, Figure 5). Over time, hunter harvest data have suggested an increased hunting pressure; however, the threshold level of 20% change in hunting patterns within the RSA has not been exceeded (67% during baseline compared to 84% in 2015 is equal to a change of 17% ; Gebauer et al. 2016). These hunting patterns are not expected to change in the future as the Project haul road will not be accessible to hunters via Baker Lake by the Meadowbank Mine.

5.5.2.3 Muskox

Current muskox populations in Canada are stable to increasing, representing a rebound from overhunting in the early 1900s (Ferguson and Gauthier 1992). This information is consistent with the IQ findings, which indicated that muskox are becoming more common in the RSA (Agnico Eagle 2014a). In the past, muskox were hunted only when caribou meat was not available, especially during the winter, and today a quota system is in place for muskox and therefore people limit their harvest according to the number of tags available (Agnico Eagle 2014a).

During Project baseline studies, 30 muskox were observed and muskox sign was observed in the form of scat and bones. Data collected during the Meadowbank project baseline and monitoring studies suggest that a relatively stable population of 500 to 1,000 muskox with herd sizes of up to 80 animals reside in the vicinity of the site (Cumberland 2005d). During 2013, muskox were observed seven times. These observations consisted of single animal sightings, except for one sighting of a herd of 30 animals observed on 20 August 2013 (Gebauer et al. 2013). Further details on muskox habitat preferences, reproduction and behaviour are provided in Appendix 5-C (Section 4.3.4.1). No muskox mortalities at the Meadowbank Mine or on the AWAR have been documented to date.

5.5.2.4 Predatory Mammals

Predatory mammals are highly mobile animals that predominantly feed on other vertebrates and occupy the top or near-top terrestrial trophic layer. Within the Project RSA, this group is represented by three VC species; Arctic wolf, grizzly bear, and wolverine. These large terrestrial carnivores occur at low densities in the landscape relative to their prey species (McLoughlin et al. 2004). As a result of this low density, predatory mammals were rarely observed during baseline studies (Cumberland 2005d). Outside of the breeding season, the predatory mammal VCs utilize a wide range of land types within large territories (Naughton 2012). Further details on predatory mammal habitat preferences, reproduction, and behaviour are provided in Appendix 5-C (Section 4.3.4.1).

To date, mortalities of wolf, and wolverine at the Meadowbank Mine have been low. Wolf mortalities have been documented in most years (Table 5.5-5). There have been no grizzly bear mortalities to date, and only two wolverine. Wolf mortalities have been higher, with 14 mortalities to date and in every year except 2007 and 2013. The AWAR presents a lesser risk to wolverine and wolf, with only one and three mortalities to date, respectively (Table 5.5-6). Details of all wildlife mortalities can be found in the annual wildlife monitoring reports (Gebauer et al. 2008 to 2015).

Table 5.5-5: Summary of Meadowbank Mine Site Wildlife Mortalities, 2007 to 2015

Year	Grizzly Bear	Wolverine	Wolf
2007	0	0	0
2008	0	0	2
2009	0	0	4
2010	0	0	1
2011	0	1	4
2012	0	0	1
2013	0	1	0
2014	0	0	1
2015	0	0	1[a]

[a] Naturally injured wolf that was euthanized.

Table 5.5-6: Summary of Meadowbank All-Weather Access Road Wildlife Mortalities, 2007 to 2015

Year	Grizzly Bear	Wolverine	Wolf
2007	0	0	0
2008	0	0	2
2009	0	0	0
2010	0	0	0
2011	0	0	1
2012	0	1	0
2013	0	0	0
2014	0	0	0
2015	0	0	0

5.5.2.4.1 Arctic Wolf

Grey wolves, referred to as Arctic wolves in Nunavut, follow and prey mainly upon migratory barren-ground caribou. The density of wolves in any given area within Kivalliq region may be very low given the immense range size that wolf packs occupy (e.g., up to 75,000 km^2 annually; McLoughlin et al. 2004). The Project LSA encompasses several important areas for wolves (Agnico Eagle 2014a). During IQ workshops, participants noted that the esker is known to be traditional denning habitat and two movement corridors are also known within the study areas; one crosses north of Uiguklik and Tasirjuaraajuk lakes (east/west) and another trends southeast/northwest and passes just south of the Meadowbank Mine (Agnico Eagle 2014a). The presence of wolves and denning sites were confirmed by biologists, as three former den sites and one active den site were found in the RSA during baseline surveys (Volume 5, Appendix 5-C).

Arctic wolves, unlike other wolf populations, migrate seasonally with the caribou herds and wolves can be expected to occur most prominently within the RSA during seasonal peaks of caribou migration (McLoughlin et al. 2004). Elders have expressed the importance and significance of wolves in the food chain, as they help to maintain healthy caribou populations by targeting weaker animals (Agnico Eagle 2014a). The relative abundance of caribou and muskox may directly affect wolves in various ways including changes to patterns of breeding, social structure, dispersal and territoriality, and is essential for the persistence of wolf populations (Carmichael 2007). Further details on Arctic wolf presence in the study area, reproduction, and behaviour are provided in Appendix 5-C (Section 4.3.4.1).

5.5.2.4.2 Grizzly Bear

Grizzly bears are a species of special concern in Canada (COSEWIC 2016). The primary cause of grizzly bear decline has been the fragmentation and destruction of their habitat, as these animals require territories of up to 1,000 km^2 (McLoughlin et al. 2002). Within approximately the last 12 years, local Inuit Elders have noted an increase in the numbers of grizzly bears seen between Baker Lake and the Back River (Agnico Eagle 2014a). Elders have indicated that they will hunt grizzly bears for food and their skin (AREVA 2011), or are taken incidentally while caribou hunting (Cumberland 2005a). Further details on grizzly bear presence in the RSA, reproduction, and behaviour are provided in Appendix 5-C (Section 4.3.4.1).

5.5.2.4.3 Wolverine

Wolverine are a species of special concern in Canada (COSEWIC 2016). Due to its scavenging behaviour, wolverine is susceptible to hunting and trapping and has been largely extirpated from the southern parts of its historic range (Naughton 2012). Wolverines were also noted as a species that was not specifically targeted for harvesting and only taken incidentally while hunting other species (Cumberland 2005a). Elders interviewed in 2008 noted that some people do hunt wolverines, and the best time is during the summer because they are more conspicuous than during the winter when they can disappear in the snow (AREVA 2011). The Elders also indicated that their population appears to be increasing, and they are viewed both as a nuisance animal due to their ability to access and destroy food caches, and as a greatly respected animal due to their intelligence and strength (Agnico Eagle 2014a).

In recent years, local Elders have observed wolverine becoming more common within the RSA (Agnico Eagle 2014a). From January to March 2013, environmental personnel confirmed numerous reports of wolverine sightings near mine operations (Gebauer et al. 2014). Further details on wolverine presence in the RSA, reproduction and behaviour, are provided in Appendix 5-C (Section 4.3.4.1).

5.5.2.5 Raptors

Of the 10 raptor species known to breed in the Kivalliq, five species are expected to occur within the RSA, including: short-eared owl, snowy owl, rough-legged hawk, peregrine falcon, and gryfalcon. Of these species, peregrine falcon and short-eared owl are listed as special concern in Canada (COSEWIC 2016). Elders have noted that there are more raptors in the vicinity of the RSA as compared with 20 years ago; however, owls are believed to be less common (Agnico Eagle 2014). Further detail on raptor presence in the RSA, reproduction, and behaviour are provided in Appendix 5-C (Section 4.3.4.2).

At Meadowbank, peregrine falcons have initiated nests on the cliffs created in the AWAR quarries. This was first observed in 2009 and was followed by the development of a Peregrine Falcon Management and Protection Plan in 2013. Monitoring has found one to five nests annually since 2009 in the 22 quarries, and additional nests in Portage Pit (Table 5.5-7). Monitoring of nest productivity is not undertaken, but chicks have been observed in some of these nests. Agnico Eagle continues to work with Alastair Franke and the Arctic Raptor Group (who assisted with baseline data collection for the Whale Tail Pit; Volume 5, Appendix 5-C). Adaptive management actions taken for raptors nesting in AWAR quarries is documented in Section 5.5.5.1.2. Studies at other mines in northern Canada have indicated that peregrine falcons and gyrfalcon nesting is not affected by mining activity (Coulton et al. 2013), and that nesting on mine infrastructure is not uncommon (ERM 2015).

Table 5.5-7: Presence of Peregrine Falcon Nests within the Local Study Area, 2009 to 2015

Location	2009	2010	2011	2012	2013	2014	2015
Quarry 1	No	No	No	No	No	No	No
Quarry 2	No	Yes	Yes	Yes	Yes	Yes	No
Quarry 3	No	Yes	Yes	Yes	Yes	No	Yes
Quarries 4 to 6	No	No	No	No	No	No	No
Quarry 7	No	No	No	No	No	No	No
Quarry 8	No	No	No	No	No	No	No
Quarry 9	No	No	No	No	No	No	No
Quarries 10 to 11	No	No	No	No	No	No	No
Quarry 12	No	No	No	No	No	No	No
Quarry 13	No	No	No	No	No	No	No
Quarry 14	No	No	No	No	No	No	No
Quarry 15	No	No	No	No	No	No	No
Quarry 16	No	No	No	No	No	No	Yes
Quarry 17	No	No	No	No	No	No	No
Quarry 18	No	Yes	Yes	Yes	Yes	Yes	No
Quarry 19	Yes	No	Yes	Yes	Yes	Yes	Yes
Quarry 20	No	No	No	No	No	No	No
Quarry 21	No	Yes	Yes	Yes	Yes	Yes	Yes
Quarry 22	No	No	No	No	No	No	No
Portage Pit	No	No	No	Yes	Yes	No	No
Vault Pit	N/A	N/A	N/A	N/A	No	No	No
Goose Pit	N/A	N/A	No	No	No	No	No

N/A = not applicable.

5.5.2.6 Water Birds

Water birds encompass waterfowl (ducks, geese, and swans) and loons. There are few water birds in the area, as confirmed during baseline studies and monitoring for the Meadowbank Mine (Cumberland 2005d, Gebauer et al. 2013), and during baseline studies for the Project (Volume 5, Appendix 5-C). Canada goose, snow goose, long-tailed duck and loons were found to be the most abundant water bird species. Details of water bird presence, reproduction, and behaviour are provided in Appendix 5-C (Section 4.3.4.2).

Water bird nest surveys were discontinued at the Meadowbank Mine and AWAR in 2013 because the densities of water bird nests were too low to detect changes in nest abundance or success (Gebauer et al. 2013). For example, surveys of close to 38 km of shoreline within 200 m of the AWAR detected no more than 15 nests in any one year. The most commonly found water bird nests were Canada goose and long-tailed duck.

Sporadic reports of water bird mortalities have been reported over the years, with one report of a Canada goose dying after getting stuck in the tailings storage facility pond in 2015. As a result of this incident, more intensive monitoring of the tailings pond during the migratory period for water birds will be conducted moving forward (e.g., daily monitoring during the migratory season). Deterrents such as driving a boat on the Tailings Storage Facility have been used to reduce water bird use of the Project (Gebauer et al. 2014), following protocols outlined in the Wildlife Protection and Response Plan (Volume 8, Appendix 8-E.7, Appendix A).

5.5.2.7 Upland Breeding Birds

Various upland breeding bird species, including horned lark, American pipit, white-crowned sparrow, savannah sparrow, lapland longspur, snow bunting, willow ptarmigan, rock ptarmigan, semi-palmated sandpiper, and American golden-plover, are present within the study areas. None of the upland birds occurring within the study area are listed federally (COSEWIC 2016). The red-necked phalarope is listed federally as a species of special concern (COSEWIC 2016) but has not been observed in the Project area. Elders consider upland birds to be less common than they were in the past and attribute this to changes in climate (Agnico Eagle 2014a).

Upland breeding birds encompass a wide range of foraging guilds, including seed and insect-feeding birds (e.g., horned lark and American pipit), subterranean invertebrate feeders (e.g., semipalmated sandpiper), and more herbivorous feeders (e.g., rock and willow ptarmigan). Therefore, a wide range of land cover classes are used by upland breeding birds. Some important land classes include heath upland and heath tundra as well as rockier land classes such as lichen/rock complex and the esker.

Upland birds have been surveyed at Meadowbank since 2003 using PRISM protocols. The plots are grouped in areas near the Meadowbank Mine, and in a control area. Analysis of this data up to and including 2012 did not detect any differences in species abundance, richness, or diversity either with proximity to the Mine, or over time (Gebauer et al. 2013). Including all birds identified, an average density of 1.15 birds per hectare were recorded between 2003 and 2015 (SD = 0.13, Table 5.5-8). Baseline studies near the Project in 2015 found a total density of 1.41 birds per hectare representing 13 species (Volume 5, Appendix 5-C, Section 4.3.3.1), results which were comparable to the control area in 2015.

Table 5.5-8: Density of Upland Birds Observed during PRISM Surveys, 2003 to 2015

Year	Male	Female	Unknown	Number of Plots	Male/ha	Female/ha	Unknown/ha	Total Observation/ha
2003	122	66	20	13	0.587	0.317	0.096	1.000
2004	113	53	25	12	0.589	0.276	0.130	0.995
2005	360	216	100	39	0.577	0.346	0.160	1.083
2006	522	247	118	43	0.759	0.359	0.172	1.289
2007	526	270	141	45	0.731	0.375	0.196	1.301
2008	517	214	200	45	0.718	0.297	0.278	1.293
2009	543	245	105	45	0.754	0.340	0.146	1.240
2010	484	297	98	45	0.672	0.413	0.136	1.221
2011	441	244	79	45	0.613	0.339	0.110	1.061
2012	378	190	123	45	0.525	0.264	0.171	0.960
2015	486	240	159	45	0.675	0.333	0.221	1.229

PRISM = Program for Regional and International Shorebird Monitoring; ha = hectare.

5.5.2.8 Small Mammals

In the Arctic, small mammals are a significant food resource for a variety of predatory mammals and birds. Several species, including Arctic hare, Arctic ground squirrel, and northern collared lemming, were observed during 2014 baseline studies. None of the small mammals within the RSA are considered species at risk (COSEWIC 2016). The species presence, reproduction, and behaviour of small mammals are described in Appendix 5-C (Section 4.3.4.1.3).

5.5.3 Project-related Effects Analysis

Analysis of the potential pathways for effects on terrestrial wildlife and birds during construction, operations, and closure is provided in Volume 3, Appendix 3-C, Table 3-C-3.

Primary pathways are those where effects from the Project will likely result in a measurable change to measurement indicators that could contribute to residual effects on a VC relative to the Baseline Case or guideline values. Pathways determined to have no linkage or those that are considered secondary are not predicted to result in environmentally significant effects on terrestrial wildlife and birds and are not carried through the effects assessment. Secondary effects pathways and effects pathways with no linkage are summarized in the Pathway Analysis table in Volume 3, Appendix 3-C, Table 3-C-3. The following are the primary pathways that require further effects analysis to determine the environmental significance from the Project on terrestrial wildlife and birds:

- Changes to wildlife habitat quantity.
- Changes to wildlife habitat quality.
- Changes to Wildlife Survival and Reproduction.

5.5.3.1 Primary Pathways Effects Analysis

The evaluation of Project effects on terrestrial wildlife considers the changes of measurement indicators: and associated primary pathways (Table 5.5-9).

Table 5.5-9: Measurement Indicators and Primary Pathways

Measurement Indicator	Associated Primary Pathway
Changes to Wildlife Habitat Quantity	Direct loss and fragmentation of wildlife habitat from the Project footprint (caribou and upland birds)
Changes to Wildlife Habitat Quality	Sensory disturbance from vehicles, on-site equipment, human presence, and vibrations, can change the amount of different quality habitats, and alter wildlife movement and behaviour (caribou and upland birds) Barriers to migration, which may affect population connectivity and distribution (caribou)
Changes to Wildlife Survival and Reproduction	Destruction of nests and flooding from construction activities including increased flows or water levels can increase risk of mortality to individual birds, which can affect population sizes (upland and water birds)

5.5.3.2 Primary Pathway Direct Habitat Loss

- **Direct loss and fragmentation of wildlife habitat from the Project footprint**

Developing the Project will result in the loss of vegetation communities leading to a direct loss of wildlife habitat, affecting all VCs. Mitigation to prevent direct loss from the Project footprint is outlined in the TEMP and includes the compact arrangement of Project infrastructure to assist with reduction in the overall footprint.

The landscape has been described in terms of ELC units, and ELC loss from the Project is described in Section 5.4.3 (Vegetation). Further to this, habitat suitability rankings were used as a means to quantify the relative value (high, medium and low) of the various ELC units for the VC species and measure the amount of habitat lost to each VC as a result of the Project. These habitat suitability rankings were developed for the FEIS (Cumberland 2005e) and updated for the Project (Volume 5, Appendix 5-C).

Losses of preferred habitats are anticipated for all VCs but as a low percentage of the available habitat in the LSA and RSA for each VC. The maximum amount of vegetated and non-vegetated ELC units lost due to the Project is predicted to be approximately 820 ha, or 2.9% of the LSA (i.e., less than 0.2% of the RSA) (Table 5.4-3, Section 5.4.3). The majority of the Project footprint is comprised of the water (41%) followed by lichen/rock complex (17%), heath upland (13%), and heath tundra (3%). Of these classes, heath upland likely has the greatest value to wildlife.

Habitat suitability rankings for caribou are provided for both the growing and winter seasons (Volume 5, Appendix 5-C, Table 4.7). Ecological land classification units were ranked as high, moderate, low or nil based on expert opinion. For example, wet graminoid is considered high quality habitat in the growing season as there is abundant forage, while lichen/rock complex is considered low quality. For the purpose of this assessment, high and moderate habitats were considered to be preferred habitat (Volume 5, Appendix 5-C, Section 4.2.3.1.1).

While caribou are most abundant in the study area during the fall and winter, they can be present throughout the year and display different habitat preferences between summer and winter. Approximately 55% of the Project footprint is preferred caribou habitat in the growing season, and 50% during the winter season (Table 5.5-10). This is equal to approximately 2% of the preferred habitat in both the growing and winter season in the LSA, and less than 0.2% of the available preferred habitat in the RSA. Further, the RSA is not frequently used by caribou; collared caribou of the Wager Bay herd were most common in the RSA, but this was based on 12 GPS-collared caribou spending 2.1% of their collar time in the RSA (Volume 5, Table 5-D-1, Appendix 5-D).

Table 5.5-10: Habitat Suitability Areas for Caribou in the Local Study Area and Regional Study Area

Habitat Suitability (ha)	LSA		RSA		Project		Project as % of LSA		Project as % of RSA	
	Growing	Winter	Growing	Winter	Growing	Winter	Growing	Winter	Growing	Winter
High	988.63	16,875.49	20,753.90	258,225.06	30.33	342.26	3.1%	2.0%	0.1%	0.1%
Medium	19,813.10	2,900.01	320,594.65	50,619.38	420.51	70.70	2.1%	2.4%	0.1%	0.1%
Low	1,414.73	8,439.45	21,431.59	179,602.01	29.94	407.18	2.1%	4.8%	0.1%	0.2%
water and disturbance	5,998.49	0	126,420.31	754.00	339.37	0	5.7%	-	0.3%	0.0%
not determined	0	0	12,494.14	12,494.14	0	0	-	-	0.0%	0.0%
Total	**28,214.95**	**28,214.95**	**501,694.59**	**501,694.59**	**820.14**	**820.14**	**2.9%**	**2.9%**	**0.2%**	**0.2%**

Note: Areas in hectares, rounded to nearest 100th.

not determined = cloud and shadow; ha = hectare; LSA = local study area; RSA = regional study area; % = percent.

To forecast the displacement of upland breeding birds by the Project, PRISM data from Meadowbank Mine was reviewed. The average number of upland birds observed on PRISM plots at Meadowbank Mine between 2003 and 2015 is 1.15 per ha (Table 5.5-8) and 1.41 birds per ha during the 2014 and 2015 Project baseline studies, respectively (Volume 5, Appendix 5-C, Section 4.3.3.1). Considering the number of upland birds observed at the Meadowbank Mine, and using the higher Project baseline density of 1.41 birds per hectare, the Project footprint is predicted to displace approximately 1,200 birds or approximately 3% and 0.2% of the likely number of birds in the LSA and RSA, respectively. Where possible, vegetation clearing at the Project would take place outside the migratory bird breeding season, to help mitigate the incidental take of bird nests.

Revegetation of disturbed areas during the closure and post-closure phases beginning in 2021 will offset these lost habitats and reduce residual effects within the LSA and RSA. The post-closure vegetation communities will differ from the existing vegetation communities due to the effects of disturbance and recolonization, but revegetated areas of the Project footprint are expected to be productive and upland birds are anticipated to recolonize.

Construction will require removal of surface material from eskers. Prior to quarrying, surveys will be completed at borrow sites to identify and avoid predatory mammal dens. Any dens that are identified during this survey will be given a 1 km buffer. While this disturbance to eskers will remove denning habitat, predators are present in low densities and other eskers are available in both the LSA and RSA.

In addition to direct loss of habitat, the Project may also result in fragmentation of the existing landscape. Mitigation to prevent habitat fragmentation includes designing roads as low and narrow as possible, while maintaining safe construction and operations practices, and meeting legislated requirements, as outlined in the Road Management Plan. Habitat fragmentation is the progressive subdivision of habitat blocks into fragments. Although fragmentation always accompanies habitat loss, it is a different phenomenon (McGarigal and Cushman 2002; Fahrig 2003). Habitat fragmentation effects are lesser in magnitude than direct habitat loss (Andrén 1999; Fahrig 1997, 2003), and species with very specific habitat requirements and low dispersal abilities are more likely to be affected by habitat fragmentation. Reclamation activities and natural re-vegetation of disturbed areas during the closure and post-closure phases will improve the loss of vegetation communities and reduce overall residual effects within the LSA. The post-closure vegetation communities will differ from the existing vegetation communities due to the effects of disturbance and recolonization, but revegetated areas of the Project footprint are expected to be productive and function as wildlife habitat. Thus, direct habitat loss and fragmentation is anticipated to have a limited effect on habitat quantity in the LSA and RSA.

5.5.3.3 Primary Pathway Indirect Habitat Loss

- **Sensory disturbance from vehicles, on-site equipment, human presence and vibrations, can change the amount of different quality habitats, and alter wildlife movement and behaviour**

While the Project will lead to direct habitat loss for VCs because of the Project footprint, indirect loss will also occur at the local and regional scales. Sensory disturbances (such as noise and movement) that extend beyond the Project footprint will occur during construction and operations. Further, the Project will extend the use of the Meadowbank Mill, camp operations and AWAR by three years. Sensory disturbances associated with the Meadowbank Mill, camp operations and AWAR have been considered in combination with Project disturbances. This may result in sensory disturbance and indirect habitat loss for wildlife surrounding the Project, possibly leading to altered movement or avoidance.

Mitigation to address sensory disturbance is addressed in the Noise Monitoring and Abatement Plan, the Whale Tail Pit Haul Road Management Plan, the Air Quality Monitoring Plan, and the TEMP (Agnico Eagle 2014g, Volume 8, Appendices 8-C.1, Appendix 8-E.1, and Appendix 8-E.7, respectively). Mitigation includes managing traffic volumes, enforcing speed limits, providing all employees with wildlife awareness training wildlife, site notifications, and providing wildlife with the right-of-way on all roads.

The effect of indirect habitat loss was considered to be primary pathway for caribou due to their seasonal abundance and cultural importance (Agnico Eagle 2014a), and for upland birds due to their abundance. Other VCs that were present in the Project area during baseline studies tended to be present in low densities or are known to be less affected by sensory disturbance based on monitoring results at Meadowbank and other mines, resulting in negligible effects. For example, monitoring of muskox, water birds, small mammals predatory mammals, and raptors at both the Meadowbank and Ekati mines has shifted to focus on detecting and mitigating direct interactions with the mine, rather than attempting to detect effects of sensory disturbance or a zone of influence (ZOI; Gebauer et al. 2015; ERM Rescan 2014).

Habitat suitability rankings developed for the Meadowbank Mine (Cumberland 2005e) and updated for this Project are described in Appendix 5-C (Section 4.3.4). As described above, habitat suitability ratings were prepared for caribou (Volume 5, Appendix 5-C), with high and moderate rankings pooled to describe preferred habitat. Indirect effects from the Project are likely to reduce the suitability of these habitats, reducing the proportion of preferred habitat in the LSA and RSA.

Avoidance of the Project may also lead to energetic effects. Some studies have shown no responses (e.g., no changes in activity levels from baseline conditions; Telesco and VanManen 2006) or transitory responses (e.g., returning to normal hormone, heart rate, or activity levels within a few minutes; Krausman and Hervert 1983; Weisenberger et al. 1996) of wildlife human disturbance. Previously completed work in the Canadian Arctic suggests that sensory disturbances from development influence wildlife behaviour, movements, and distributions. For example, monitoring at Ekati suggested that caribou groups with calves spend less time feeding within 5 km of the footprint (BHPB 2004), and that mines cause changes to caribou distribution, leading to lower probability of occurrence within 6 to 14 km (Boulanger et al. 2012). The mechanism causing these effects is not yet understood, but is likely a combination of direct effects (e.g., physical footprint) and indirect effects (e.g., noise, smell, dust). As this avoidance does not preclude compensatory foraging to make up for any additional energy costs, or continued foraging during avoidance, the energetic costs of avoidance are likely to be negligible. Regardless, effects to caribou and upland bird habitat quality are anticipated to result from the Project.

The noise impact assessment for the Project (Volume 4, Section 4.4) indicates that the noise created through construction and operations of the Project would be similar to that of the Meadowbank Mine, and that effects would be confined to the RSA.

The air quality impact assessment for the Project (Volume 4, Section 4.3) indicates that the effects of fugitive dust emissions on air quality adjacent to the haul road, and the effects of mining activities at the Whale Tail Pit on regional air quality are both limited in spatial extent. Based on monitoring results at the Meadowbank Mine, an estimated 15 to 20% reduction in Meadowbank Mill throughput using ore from the Whale Tail Pit, the short operations phase of the Project, and the spatial and temporal effects of an extension to the operations of the Meadowbank Mill, camp operations, and AWAR on regional air quality are considered low.

Caribou

Monitoring at other mines suggests that caribou herds change their distribution around diamond mine developments, where probability of occurrence increases with distance from the mine (Boulanger et al. 2012; Johnson et al. 2005; Rescan 2007; Golder 2011a). This area is termed the ZOI. A study using aerial survey and satellite-collar data collected around the Diavik, Ekati, and Snap Lake mines estimated that caribou relative abundance was reduced near the mine, and reached expected levels at up to 14 km away (Boulanger et al. 2012). Golder (2011a) detected ZOI ranging from 12 to 40 km around the Diavik mine and Lac de Gras, although the estimates may be confounded by the presence of Lac de Gras which affects caribou distribution. Ground-based monitoring at Ekati suggested that caribou groups with calves spend less time feeding within 5 km of the footprint (BHPB 2004). At the smaller Snap Lake Mine, a ZOI of 6.5 to 28 km was detected (Golder 2008; Boulanger et al. 2009), which increased with the level of mining activity (Golder 2008). Adding to the uncertainty, interviews with hunters in Kulguktuk familiar with mining reported that caribou are often observed at active mines; appearing undisturbed and staying for days at a time. Caribou are even attracted to mine infrastructure for mosquito relief (Golder 2011b). No such analysis has yet been undertaken for the Meadowbank Mine, although the relatively small size of the mine and the fact that caribou continue to be observed near the Meadowbank Mine and cross the AWAR in large numbers (Table 5.5-3), indicates that any ZOI would be smaller than at Ekati-Diavik. The analysis below considers only the amount of preferred (high and moderate) habitat within the LSA and RSA that has the potential to be degraded due to the Project.

Considering only the winter season, when caribou are more frequently observed in the LSA (Volume 5, Appendix 5-C, Appendix 5-D), there is approximately 16,875 ha of high quality habitat and 2,900 ha of medium quality habitat in the LSA (Table 5.5-10). Combined, this indicates that approximately 70% of the LSA is preferred caribou winter habitat. Approximately 342 ha of high quality and 71 ha of medium quality habitat will be directly disturbed by the Project (Table 5.5-10), or approximately 2% of the preferred habitat in the LSA. Within the RSA, approximately 62% of the landscape is preferred caribou winter season habitat (approximately 258,225 ha of high quality and 50,619 ha of medium quality habitat during the winter season), and direct loss of preferred caribou winter season habitat accounts for less than 0.1% of the available preferred habitat in the RSA. Similarly for the summer season, direct disturbance will lead to a loss of approximately 2% of the preferred habitat in the LSA, and less than 0.1% of the preferred habitat in the RSA.

Sensory disturbance and the resulting indirect habitat loss may cause some of the preferred habitat surrounding the Project to be avoided, in effect reducing preferred habitat to low quality habitat. If the Project were to cause all of the preferred habitat in the LSA to become low quality or avoided habitat, it would reduce the amount of preferred habitat in the RSA by approximately 6% for caribou, for both summer and winter habitat preferences. This change is well below the 40% threshold value identified for habitat loss associated with declines in bird and mammal species (Andrén 1994, 1999; Fahrig 1997; Mönkkönen and Reunanen 1999; Flather and Bevers 2002; Swift and Hannon 2010). This reduction in habitat quality may be accompanied by only a limited loss of habitat connectivity due to barriers to movement. Similarly, the reduction in habitat quality would not be accompanied by a reduction in survival, as harvesting from the Project haul road will be discouraged. Finally, the RSA is not frequently used by caribou, as the most frequently occurring herd (i.e., Wager Bay herd) spend only 2.1% of their time in the RSA, as estimated from collars (Volume 5, Table 5-D-1, Appendix 5-D). In addition, there are very few other disturbances in the RSA that caribou would interact with. During the most sensitive seasons (i.e., calving and post-calving), caribou spend very little time in the RSA during these periods (Volume 5, Appendix 5-D, Table 5-D-1). The Ahiak herd spends the most amount of time in the RSA during the calving (i.e., 0.05%) and post-calving (i.e., 0.22%) seasons, and it is a very low amount. Consequently, an increase in energetics as a result of disturbance-related effects from the Project during these sensitive seasons is likely negligible. The effect of indirect habitat loss on caribou is anticipated to be limited, considering the following:

- this effect would diminish with distance from the Project;
- the LSA and RSA currently contain high proportions of preferred habitat;
- caribou are in the LSA and RSA seasonally;
- direct loss of preferred habitat will be limited;
- caribou are anticipated to continue using and passing through the LSA (based on the results of monitoring at Meadowbank);
- caribou will be free to cross the haul road;
- there are no other barriers to movement; and
- caribou survival within the ZOI is unlikely to be affected.

Upland Birds

Upland birds are a diverse array of species with a range of habitat requirements. Indirect effects from the Project on upland birds were estimated using density from baseline studies (Volume 5, Appendix 5-C, Section 4.3.3.1) and from monitoring at Meadowbank Mine (Table 5.5-8). Studies have documented avoidance effects and reduced bird densities within 1 km of human infrastructure (Reijnen et al. 1996; Benitez-Lopez et al. 2010). Conversely, a study of Lapland longspurs by Male and Nol (2005) showed no difference in nest success between sites with high and low levels of human noise at the Ekati Diamond Mine. In addition, no decrease in upland bird species richness or abundance from mine activity has been observed at the Meadowbank Mine (Gebauer et al. 2012) or at the Ekati Diamond Mine (Smith et al. 2005; Rescan 2010). A 200 m ZOI was applied to estimate possible loss of density and productivity near the Project, as a conservative means of assessing effects. This distance was expanded from the 100 m ZOI used in the Meadowbank environmental assessment (Cumberland 2005e) to reflect potential disturbances related to haul truck traffic. It is assumed that the upland bird density will decrease by 50% within this 200 m area adjacent to the Project footprint.

The average number of upland breeding birds observed on PRISM plots at Meadowbank Mine between 2003 and 2015 was 1.15 birds per ha (Table 5.5-8) and 1.41 birds per hectare, as reported during Project baseline studies (Volume 5, Appendix 5-C, Section 4.3.3.1). The area of a 200 m buffer surrounding the Whale Tail Pit and the haul road encompasses 372 ha and 3,895 ha respectively (not including the footprint). Using the higher Project baseline density of 1.41 birds per ha (Volume 5, Appendix 5-C, Section 4.3.3.1), sensory disturbance from the Project may affect approximately 500 upland birds surrounding the Whale Tail Pit and a further 5,500 upland birds surrounding the Project haul road route. This represents approximately 15% and 1% of the estimated number of birds in the LSA and RSA, respectively. In other words, approximately 15% of the upland bird population in the LSA may be affected by the Project. However, the studies described above indicate that changes to upland bird density or productivity are unlikely to be detectable.

5.5.3.4 Primary Pathway Barriers to Migration

- **Barriers to migration, which may affect population connectivity and distribution**

Roads can be a barrier to wildlife migration due a to range of factors including the road structure, dust, noise, presence of moving vehicles, and learned avoidance due to hunting. Disruption of migration can affect wildlife ability to use the area surrounding the Project or lead to energetic costs. Results of camera monitoring of caribou adjacent to roads at Ekati from 2011 to 2013 indicated that caribou were deflected from crossing the Misery Road in less than 1% of encounters, suggesting that it is not acting as a barrier to caribou (and carnivore) movements (ERM Rescan 2014). Studies of collared caribou in Alaska noted that up to 30% of collared caribou took longer to cross roads in some years, indicating that roads may act a semi-permeable barrier (Wilson et al. 2016). Hunters and elders also suggest caribou seek out roads for insect relief (Golder 2011b). The Elders also noted that caribou are not as afraid of both human activity and development as they previously were (Agnico Eagle 2014a, Kendrick and Manseau 2008). Conversely, Elders have also indicated a concern about the potential effect of the road on caribou, after observing a large caribou herd attempting to cross the existing Meadowbank road for many days (Agnico Eagle 2015c). As a result of these findings and for the purposes of this assessment, the Project haul road is expected to be a potential barrier to wildlife (primarily caribou), which may affect population connectivity and distribution. This pathway considers both the Project haul road and the Meadowbank AWAR.

Collar data were queried by season to describe the number of collared individuals that entered the LSA, how many of these individuals went on to cross the road, and if so, how frequently that individual caribou crossed the road. The query included both actual interactions with the Meadowbank AWAR and expected interactions with the proposed Project haul road route (Volume 5, Table 5-D-2, Appendix 5-D). Caribou entering the Meadowbank or Project LSAs have a high probability of interacting with the AWAR or proposed Project haul road route. Out of all of the unique individual caribou that were documented in the Meadowbank and Project LSAs, 83% crossed the existing AWAR from Baker Lake to Meadowbank Mine and 98% crossed the proposed Project haul road route (note that the Project haul road did not exist when the collar data was collected, this is presented as an expected road crossing frequency). This is equal to 0.3 caribou crossing the AWAR per kilometre and 0.6 caribou predicted to cross the proposed Project haul road route per kilometre. The higher likelihood of caribou crossing the proposed Project haul road route may be due to higher utilization of the Project LSA by caribou or deflections.

The interactions of caribou with the Meadowbank AWAR are considered for the purposes of this analysis to be predictive of the interactions with the Project haul road. To date, there has been a high likelihood that caribou approaching the active AWAR eventually cross it. According to the data, individuals do not usually make repeated crossings of the existing AWAR or proposed road route. The maximum number of crossings per individual for the active AWAR ranged from one to two. The maximum number of crossings per individual for the proposed Project haul road route was slightly higher at one to five crossings per individual, however the majority of the individuals still crossed only once.

At the Meadowbank Mine, caribou regularly cross the AWAR and mitigation includes closing the AWAR to avoid creating barriers to migration. Table 5.5-3 summarizes road closures for caribou migrations. The AWAR may cause some deflection whereby caribou walk along the road to select a crossing point, but based on the use of the AWAR, the proposed haul road presents a limited physical barrier to movement. Similarly, the reduction in habitat quality would not be accompanied by a reduction in survival, as harvesting from the Project haul road will be discouraged.

To avoid disrupting movement patterns of caribou at the Project, particularly during the spring and fall migratory period, mitigation includes designing roads with low profiles, avoiding build-up of snowbanks in winter, and enforcing speed limits (see TEMP, Road, and Borrow Pits management plans, Volume 8). In addition to providing all wildlife with right-of-way, when large aggregations of caribou are observed on or adjacent to roads during construction or operations, activities will cease until animals have moved past the area of activity (or disturbance). Upon closure (see Interim Closure and Reclamation Plan, Volume 8, Appendix 8-F.1), the Project haul road will be decommissioned and re-contoured to facilitate caribou crossings. Further details regarding mitigation is provided in the Whale Tail Pit Haul Road Management Plan and TEMP (Volume 8, Appendix 8-C.1 and 8-E.7, respectively).

5.5.3.5 Primary Pathway Destruction of Nests

- **Destruction of nests and flooding from construction activities including increased flows or water levels can increase risk of mortality to individual birds, which can affect population sizes.**

Flooding at the Project site is anticipated due to the construction of new dikes in the South basin of Whale Tail Lake. Some of the flooding will occur during the nesting season and may lead to the loss of nests near the shoreline of the lake. This is likely to result in a measurable change to measurement indicators that could contribute to residual effects to upland and water birds. This may cause changes to bird survival and reproduction because it can increase risk of mortality to individual birds, which can affect population sizes. To assess the possible effects of flooding to bird nesting, bird nest densities were estimated, and used to estimate the number of nests that may be lost due to flooding.

According to Environment Canada’s General Nesting Periods of Migratory Birds in Canada website (EC 2014) the nesting period for federally protected migratory birds species nesting in the area of the Project spans from mid-May to mid- August. The peak nesting period is early-June to late-July. As water birds nest primarily in low-lying areas along shores with direct access to water, their nests are the most likely to be affected by flooding.

Two water diversions are planned as part of the Project’s Water Management Plan, including the South Whale Tail Lake diversion and the North-East diversion (Volume 8, Appendix 8-B.2). An analysis of the anticipated areas to be flooded was conducted and is presented in Volume 6, Appendix 6-F. The amount of terrestrial shoreline habitat that will be inundated will vary year to year and only flooding between the months of May and August is predicted to threaten upland and water bird nests. The total maximum terrestrial area from both diversions that will be lost to flooding during the nesting period is 176 ha.

Nest surveys were conducted within the Meadowbank Mine site LSA from 2005 to 2012 and along the AWAR from 2007 to 2012 (Table 6.1 and 6.2, Gebauer et al. 2013). These surveys were used for the purposes of this analysis to forecast the potential destruction of nests at the Project. The total survey length along wetland ELC units within the mine site was 51.5 km and 37.8 km around lakes and ponds within 200 m of the AWAR. The average number of water bird nests observed during these surveys was 1.38 and 9.17 per year respectively. Assuming that observers recorded water bird nests within a 20 m wide swath, the nest density for the Meadowbank Mine LSA is 0.01 nests per ha and 0.12 nests per ha for the AWAR. These density numbers are considered conservative as the water bird annual surveys were conducted along lake shorelines, where densities of water birds are expected to be highest.

Shoreline surveys during the Project baseline field work examined 62.8 km of shoreline along lakes and streams (Volume 5, Appendix 5-C). In total, 24 species of birds were observed and several nests were located including three semipalmated sandpiper nests, two semipalmated plover nests, one dunlin nest, one herring gull nest and one cackling goose nest. Assuming that observers recorded nests that were observed within a 20 m swath surveyed by two people, the nest density for the Project is 0.06 nests per ha. Given the area of flooding expected to occur at the Project, and assuming densities are the same as that observed during baseline studies, approximately seven nests in 2019 and three nests in 2020 of the shorebirds, gulls and waterfowl groups may be displaced by flooding if no mitigation is undertaken (Table 5.5-11).

Table 5.5-11: Predicted Number of Bird Nests Displaced from Flooding

Nesting Period Year[a]	South Whale Tail Lake Diversion			North-East Diversion		
	Change in Flooded Terrestrial Area (ha)	Predicted Number of Nests Displaced		Change in Flooded Terrestrial Area (ha)	Predicted Number of Nests Displaced	
		Shoreline Survey	PRISM Survey		Shoreline Survey	PRISM Survey
2018	0.21	0.01	0.10	0	0	0
2019	115.96	6.96	57.98	6.58	0.42	3.29
2020	41.38	2.48	20.69	11.86	0.75	5.93
2021	0	0	0	0	0	0
2022	-64.94[b]	0	0	-18.45[b]	0	0

[a] The nesting period used included the months of May, June, July, and August.

[b] Between May and August 2020 the total flooded habitat area and the flooded terrestrial area is expected to decrease in size.

PRISM = Program for Regional and International Shorebird Monitoring; ha = hectare.

Upland birds have been surveyed at Meadowbank from 2003 to 2015 using PRISM protocols. The Project PRISM surveys found 3.8 pairs of breeding birds per plot during 2015. As PRISM plots are 16 ha in size this indicates a density of 0.24 pairs per ha. The average nests observed per PRISM plot was 0.6 nests, or 0.04 nests per ha. It is assumed that not all the nests or breeding pairs were detected during the 2015 baseline studies so a nest density of 0.5 nests per ha was used to calculate the number of nests displaced due to flooding. It is predicted that approximately 61 upland bird nests will be displaced in 2019 and approximately 27 nests in 2020 if no mitigation is undertaken at the Project (Table 5.5-11). This does not account for possible reduced nesting activity due to sensory disturbance.

The *Migratory Birds Convention Act* prohibits the harm of migratory birds and the disturbance or destruction of nests and eggs. Mitigation will be considered as a means to prevent the harm of migratory birds, nests and eggs by reducing the likelihood that birds will nest in the area and will be discussed with Environment Canada. This may include the use of deterrents and the removal of vegetation along shorelines prior to flooding. Where practical, natural drainage patterns will be used to reduce the use of ditches or diversion berms. The TEMP and Water Quality Monitoring and Management Plan for Dike Construction Dewatering include additional mitigation (Volume 8, Appendix 8-E.7 and 8-A.2).

5.5.4 Residual Impact Classification and Determination of Significance

The purpose of the residual impact classification is to describe the residual effects of the project on VCs using a scale of common words rather than numbers and units. To determine whether or not an impact may have a significant adverse effect on a VC, each impact was assessed according to the criteria and descriptions in Section 3.7.

The assessment and classification of residual impacts was based on the predicted cumulative changes from reference conditions through application of the Project and into the future case. All sources of information (i.e., existing and collected data, new analyses, existing publications, and IQ) were considered equally in the classification of residual impacts. The spatial boundary of the assessment for Project impacts is at the regional scale. The incremental effects from the Project relative to current baseline conditions are also classified. Essentially, the only difference in the outcome of impact criteria between cumulative and incremental effects from the Project is in the magnitude and geographic extent of impacts. The magnitude for cumulative impacts involves changes from reference conditions through application of the Project and into the future case, while incremental impacts are based on changes from the Project relative to baseline values. Cumulative impacts from the Project and other developments influence the entire annual range of wildlife populations (i.e., regional scale). In contrast, the geographic extent of incremental impacts from the Project may have a local or regional influence on populations. Specific definitions for the criteria used for residual impact classification are provided in Volume 3, Appendix 3-E.

5.5.4.1 Residual Effect Significance

- *Direct loss and fragmentation of wildlife habitat from the Project footprint*

Direct loss and fragmentation of wildlife habitat due to the Project footprint are expected to have a measurable effect on caribou and upland birds). Overall, the habitat loss is anticipated to have a moderate effect on wildlife populations in the study area (Table 5.5-12). Specifically for caribou, approximately 2% of the preferred habitat in the LSA will be directly disturbed by the Project, considering both the growing and winter seasons. As this habitat loss is confined to the LSA, it is local in geographic extent.

Some habitat losses will last for the duration of the Project but the landscape will begin to recover after closure. It is not expected that the habitat types within the Project footprint will return to baseline conditions post-closure but areas of the footprint will be recolonized by upland birds as vegetation re-establishes. Other aspects of the Project footprint will lead to permanent and irreversible habitat loss (such as pit lakes and the Whale Tail WRSF). The amount of habitat that will be changed permanently will be at the local scale and is not likely to have a continuous effect on wildlife populations due to the amount of habitat available for wildlife populations in the RSA and beyond.

Within the ranges of the caribou herds that interact with the Project, there are mines, exploration camps, winter and all-weather roads and communities (Volume 3, Appendix 3-D), exposing caribou to the potential for cumulative effects. Likewise for other wildlife with smaller ranges, the RSA includes the Meadowbank Mine and AWAR, and nearby is the community of Baker Lake. Therefore, the cumulative impacts from direct habitat loss and fragmentation from the Project and other developments on population size and distribution are beyond regional in geographic extent. However, this community, road, mine complex represents an area within the caribou range of unusually high development in relation to the remainder of the caribou herd range, and the Project does not overlap with any known calving grounds (Volume 7, Appendix 7-A); large areas of which remain pristine and unlikely to be developed within the lifetime of the Project. Thus the magnitude of the cumulative effects of habitat loss to wildlife remains low.

- *Sensory disturbance from vehicles, on-site equipment, human presence and vibrations, can change the amount of different quality habitats, and alter wildlife movement and behaviour*

Indirect habitat loss due to sensory disturbance (such as noise and movement) will extend beyond the footprint and have negative effects at the regional level (Table 5.5-12). Evidence from existing mines shows that wildlife habituates to sensory disturbance and some wildlife are even attracted to development. This is consistent with Elders noting that caribou are not as afraid of both human activity and development as they previously were (Agnico Eagle 2014a, Kendrick and Manseau 2008). However, indirect changes to preferred habitat from the Project have the potential to affect the population size and distribution of caribou through altered movement and avoidance behaviour, as caribou have been shown to avoid mines and roads.

The impact of indirect habitat loss from sensory disturbance to caribou and upland birds is considered moderate as it is assumed that some degradation of habitat quality or reduced wildlife activity at the LSA scale will occur. It was assumed that upland birds within 200 m of the Project footprint may be affected, but monitoring to date does not indicate that this effect will be detectable. If the preferred habitat in the LSA is no longer selected because of its proximity to the Project, this will affect no more than 6% of the preferred habitat in the RSA, for caribou. Further, the RSA is not frequently used by caribou; collared caribou of the Wager Bay herd, which was the herd which spent the greatest amount of time in the RSA, spent only 2.1% of their time in the RSA. Noise created by the Project is anticipated to be similar to that caused by the Meadowbank Mine, indicating that sensory disturbance from the Project will be similar to or less than that of the Meadowbank Mine. Impacts from sensory disturbance will be continuous throughout the life of the Project but are anticipated to be reversed following closure (i.e., medium-term) when dust, noise and activity are no longer present.

Considering other developments and activity that may lead to cumulative effects, caribou encountering the Project may also be exposed to the Meadowbank Mine, AWAR, and community of Baker Lake. Other activities such as mineral exploration, winter roads, camps and contaminated sites are, or have been, present within caribou ranges (Volume 3, Appendix 3-D), leading to the possibility of cumulative sensory disturbance to caribou. Caribou calving grounds are respected among the Inuit and this period is considered a critical and sacred time when caribou should be left alone (Volume 7, Appendix 7-A). However, as the vast majority of the caribou range is undisturbed and does not overlap with any known calving grounds (Volume 7, Appendix 7-A), the magnitude of the effect is no greater than at the RSA level.

- *Barriers to migration, which may affect population connectivity and distribution*

The Project is likely to have a negative effect on caribou, by presenting barriers to their migration at a regional scale (Table 5.5-12). Mitigation to limit these effects includes designing roads with low profiles, avoiding the build-up of snowbanks in the winter, enforcing speed limits and enacting road closures. Movements of collared caribou near the AWAR indicate that most caribou that approach the road will cross it, an observation supported by monitoring at Ekati (ERM Rescan 2014). However, during the fall 2015 consultation meeting, Elders indicated a concern about the potential effect of the road on caribou, after observing a large caribou herd attempting to cross the AWAR for many days (Agnico Eagle 2015c). The effect of the Project and haul road on caribou migration is expected to be moderate, as some deflections will likely occur as caribou select a crossing point. Upon closure, there will be no remaining traffic and the Project haul road will be scarified. It is anticipated that caribou will cross the road freely following closure (i.e., medium-term) and that the impact will be reversed at this time. Based on consultations with Elders in 2015 periodic road closures during fall caribou migrations appear to be effective mitigation (Agnico Eagle 2015c).

There are historic, existing and foreseeable future developments that are in the range of the caribou herds likely to interact with the Project (Volume 3, Appendix 3-D). However, only one of the foreseeable future projects is within the Project RSA, and no more than three active mineral exploration operations were identified in any of the herd ranges. There are no other all-weather roads, and few seasonal winter roads. Thus, the cumulative effect of the Project and other developments to caribou migration of low magnitude, but beyond regional extent as it extends beyond the RSA.

- *Destruction of nests and flooding from construction activities including increased flows or water levels can increase risk of mortality to individual birds, which can affect population sizes*

Flooding at the Project, due to the construction of dikes will have a negative effect on upland and water birds due to the loss of breeding habitat and the possible destruction of nests (Table 5.5-12). Mitigation will be considered to prevent birds from nesting in the area that will be flooded. Other components of the Project will be initiated outside of the upland bird nesting season to avoid nest loss. As nest loss also occurs through natural cycles such as storms and predation, the effect is classified as a low magnitude effect to the population. As it is confined to the Project footprint, it is local in geographic extent. Flooding will be isolated and will only take place in the first three years of construction and operations. This is a short-term impact because following the construction of the dikes there will no longer be a risk of nest destruction. The impact of any nests that are destroyed during construction is reversible as these impacts are not anticipated to have a long-term effect on the LSA population. Regionally, no other projects were identified that may lead to destruction of nests, assuming that other developments follow the typical practice of removing upland bird habitat only outside of the nesting season.

Table 5.5-12: Residual Impacts Classification and Determination of Significance on Terrestrial

Effects Pathway	VC	Direction	Magnitude		Geographic Extent		Duration	Frequency	Reversibility	Likelihood
			Incremental	Cumulative	Incremental	Cumulative				
Direct loss and fragmentation of wildlife habitat from the Project footprint	Caribou Upland Birds	negative	moderate	low	local	beyond regional	permanent	continuous	irreversible	highly likely
Sensory disturbance from vehicles, on-site equipment, human presence and vibrations, can change the amount of different quality habitats, and alter wildlife movement and behaviour	Caribou Upland birds	negative	moderate	moderate	regional	beyond regional	medium-term	continuous	reversible	highly likely
Barriers to migration, which may affect population connectivity and distribution	Caribou	negative	moderate	low	regional	beyond regional	medium-term	continuous	reversible	highly likely
Destruction of nests and flooding from construction activities including increased flows or water levels can increase risk of mortality to individual birds, which can affect population sizes	Water birds Upland birds	negative	low	negligible	local	local	short-term	isolated	reversible	highly likely

VC = valued component.

5.5.4.2 Cumulative Effects

Cumulative effects were considered in all pathways (Table 5.5-12), based on the summary of past, present reasonably foreseeable future projects (Volume 3, Appendix 3-D). The cumulative effects summary indicates past and reasonably foreseeable future developments within the ranges of affected caribou herds, and within the RSA. The cumulative effects summary considered the Ahiak, Lorillard and Wager Bay caribou herds. Within the ranges of these herds, there are several communities, the Meadowbank Mine, mineral exploration camps and tourism lodges currently in operations. Historic developments included camps, fuel caches, mineral exploration camps and contaminated sites. Mineral exploration was the most common type of development, followed by camps and miscellaneous activities. No more than three active mineral exploration operations were identified in any of the caribou ranges. For the purposes of this assessment, it was assumed that these camps were active throughout the year, while exploration camps are more often seasonal. Communities are likely the largest sources of disturbance to caribou in their ranges (from mortality and possibly also from habitat loss), exaggerated by roads providing increased hunting access. There are three communities within the Lorillard caribou range, and one each within the Ahiak and Wager Bay herd ranges.

Cumulative effects to other wildlife VCs of the terrestrial environment (including upland birds, water birds, raptors, predatory mammals and muskox) were indicated through the other developments present in the RSA. The Meadowbank Mine and AWAR are the only other developments present in the RSA. Beyond the RSA is the community of Baker Lake, a source of hunting activity particularly along the AWAR. The combination of the Project, an existing mine, a community and an all season road connection between them may lead to localized cumulative effects to these VCs.

Considering the reasonably foreseeable future developments, all of the eight possible future projects considered in Volume 3, Appendix 3-D are within the range of either the Ahiak, Lorillard or Wager Bay caribou herds (Figure 3-D-4). Two of the possible future developments are in the range of all three herds, while the Ahiak herd would be most affected with six projects within its range. Should most or all of these reasonably foreseeable future projects proceed within a similar timeframe, cumulative effects to caribou may become a concern. Only one reasonably foreseeable future project was located within the RSA; the Greyhound mineral exploration project.

5.5.4.3 Assessment of Significance

This section considered how the primary pathways would affect the measurement endpoints of changes to wildlife habitat quantity (through direct habitat loss), changes to wildlife quality (through sensory disturbance and barriers to movement) and changes to wildlife survival and reproduction (through the destruction of nests). Secondary pathways were also considered from the perspective of these measurement endpoints. Project effects of low to moderate magnitude are anticipated, extending to the regional scale. The effects will be short-term in cases where the effect only lasts during a particular Project phase, or permanent in the case of direct habitat loss that may require decades or centuries to recover in the Arctic environment. Cumulative effects were considered, but are not likely to cause noticeable effects as there is very little development in the Kivalliq region or within the range of the caribou herds interacting with the Project. Overall, the weight of evidence, and the experience from the Meadowbank Mine, indicates that incremental and cumulative effects from the Project will not have a significant adverse effect on the existing self-sustaining and ecologically effective wildlife populations.

5.5.4.4 Uncertainty

The purpose of the uncertainty section is to identify the key sources of uncertainty in the impact assessment and to discuss how uncertainty has been addressed to increase the level of confidence that impacts are not worse than predicted. Confidence in the assessment of environmental significance is related to the following elements:

- adequacy of baseline data for understanding current conditions and future changes unrelated to the Project (e.g., extent of future developments, climate change, catastrophic events);
- understanding of Project-related impacts on complex ecosystems that contain interactions across different scales of time and space (e.g., exactly how the Project will influence caribou); and
- knowledge of the effectiveness of the environmental design features and mitigation for reducing or removing impacts (e.g., revegetation of wildlife habitat).

Uncertainty has been addressed by applying a conservative estimate of effects in the residual impact classification and in the determination of significance. Like all scientific results and inferences, residual impact predictions must be tempered with uncertainty associated with the data and the current knowledge of the system. It is anticipated that the baseline data is moderately sufficient for understanding current conditions, and that there is a moderate level of understanding of Project-related impacts on the ecosystem. Some of the information or knowledge gaps include the following:

- While caribou collar data provide useful insight into caribou movements and Project interactions, the portion of the herd that is collared is small, leaving uncertainty surrounding exact spatial and temporal distribution of the herd. The lack of equivalent information for other large mammal VCs (wolves, muskox, and grizzly bears) also leaves an information gap.
- Wildlife populations fluctuate with time, and wildlife movements lead to uncertainty regarding presence near the Project from year to year. Changes in populations of caribou, muskox or water birds through the duration of the Project may change the effects assessment to these VCs.
- It is understood that development activities will directly and indirectly affect habitat, and wildlife behaviour and movement; however, long-term monitoring studies documenting the resilience of wildlife to development and the time required to reverse impacts are lacking. Direct disturbance from previous, existing, and future development footprints was calculated to be a small proportion of their range, and the understanding of the success of mitigation policies and practices for limiting impacts to caribou has increased over the past decade. However, uncertainty remains surrounding the degree to which some effects may occur (e.g., magnitude and duration).
- Forecasting a future that may be outside the range of observable baseline environmental conditions is clearly challenging (e.g., climate change). Uncertainty grows with the duration of the forecast. Therefore there is more certainty in short- term than long-term effects.

5.5.5 Monitoring and Follow-up

5.5.5.1 Adaptive Management

Monitoring and mitigation form part of the adaptive management cycle (Agnico Eagle 2015b). The environmental management plans cited in this section outline specific procedures and actions to reduce, eliminate, or control the potential adverse effects from the Project. The environmental management plans include various responses (i.e., mitigation measures and strategies) designed to be commensurate to the potential adverse effects. The environmental management plans also include monitoring provisions and programs designed with the objective of assessing effectiveness of the planned mitigation measures after such measures have been implemented. Agnico Eagle will adaptively manage its activities, mitigation measures, and monitoring programs to confirm that its mitigation measures are effective in managing the environment, The sections below provide examples of how adaptive management has been implemented at Meadowbank. These learnings will be applied to the Project, and adaptive management will continue at the Project.

5.5.5.1.1 Adaptive Management of Waste

Effective waste management practices and staff education are key to decreasing the availability of wildlife attractants at mine sites. Operations and management of on-site waste is an important component of wildlife management at Meadowbank. In 2014, waste management and segregation at Meadowbank continued from the success of previous years but with greater emphasis on inspections and follow-up by environmental personnel. The continued use of covered garbage bins for incinerator waste and diversion of food waste from the landfill has limited access to food waste by wildlife. Weekly formal inspections and daily inspections of mine facilities were conducted to confirm that garbage is handled appropriately, attractants are not present and personnel are not feeding wildlife. Improved practices for waste segregation and incineration, the use of enclosed food waste facilities and skirting around building seem to have improved wildlife presence and wildlife-human interactions at the Mine (Gebauer et al. 2015). Prevention of wildlife issues through managing attractants and human activity has been more effective than repeatedly monitoring and deterring wildlife from the site.

Implementation of waste management and wildlife education have been effective at limiting the risks of injury and death to wildlife at the Meadowbank Mine. Most of the wolf and Arctic fox mortalities occurred before 2011 when the Bearwise audit recommendations were implemented and improved waste management was implemented (Table 5.5-6).

Environmental personnel actively deterred the wolverines following the Bearwise Program deterrence training, yet the kitchen, sludge dump, and the landfill dump continued to attract wolverine, and wolverine starting to show signs of habituation. Following a wolverine mortality in 2013, additional metal grating was installed around the grease trap shed to prevent wildlife from accessing this area.

5.5.5.1.2 Adaptive Management of Raptor Nesting

Raptor species observed or expected in the Project RSA include the short-eared owl, snowy owl, rough-legged hawk, peregrine falcon, and gyrfalcon. Of these species, peregrine falcon and short-eared owl are federally listed as special concern (COSEWIC 2016; Table 5.5-1).

In 2009, an active peregrine falcon nest was observed at Quarry 19. This prompted the initiation of a dedicated raptor nest survey in 2010, which has continued through 2015. In 2010, a raptor nest management plan was developed for Quarry 3. This plan was distributed to applicable personnel and explained the sensitivity and behavioural tendencies of the falcons. Mine staff were prohibited from approaching the nest site and efforts were made to decrease the activity near the nest, including creating an alternate entrance to the quarry. In 2013, the Peregrine Falcon Management and Protection Plan was developed to provide site-specific protective measure and deterrence options and has been updated to include the Project (Volume 8, Appendix 8-E.7, Appendix A).

5.5.5.1.3 Adaptive Management of Wildlife Incidents and Mortalities

Wildlife mortalities have occurred in most years of the Meadowbank Mine construction and operations, at both the Mine site and on the Meadowbank AWAR. All mortalities within the Meadowbank Mine LSA are reported immediately to environmental staff and carcasses are removed to avoid attracting scavengers, especially predatory mammals, following protocols in the TEMP and the Wildlife Protection and Response Plan. If there is no obvious reason that can be attributed to the mortality, the animal is examined by the environmental supervisor to determine if a necropsy is necessary. All wildlife incidents and mortalities are investigated and reported in the annual wildlife reports (Gebauer et al. 2008 to 2015). Most mortalities at Meadowbank have been considered mine-related, but there have been instances of natural mortalities and individuals euthanized for humane reasons (Table 5.5-5 and Table 5.5-6).

5.5.5.1.4 Noise Mitigation and Monitoring

Noise is believed to cause sensory disturbance to some wildlife species, and may result in avoidance or reduction of time spent in otherwise suitable habitat. In 2014, the Noise Monitoring and Abatement Strategy Plan (Agnico Eagle 2014g) was developed in an attempt to minimize potential disturbances to wildlife. Activities at the Meadowbank Mine that generate noise include aircraft, vehicles, generators, and blasting. Mitigation practices to decrease noise include avoiding low altitude flights and checking that noise abatement devices in vehicles are in good working order during maintenance (Table 2, Agnico Eagle 2014g). It has been found that people (and therefore, potentially, wildlife) are more tolerant of louder continuous background noise than a quieter baseline punctuated by high-level peaks. Therefore, the intense noise abatement strategy acknowledges the common continuous noise sources, and aims to reduce the occurrence of intense noise peaks.

Noise monitoring is completed by Mine staff twice a year at various locations around the Mine site (Agnico Eagle 2014g). Each survey is for a three to four day period, so that the data on average noise level during a typical day and variability of noise levels can be reported.

5.5.5.2 Terrestrial Effects Monitoring Plan

Terrestrial monitoring at Meadowbank is guided by the TEMP (Volume 8, Appendix 8-E.7). The purpose of the TEMP is to manage the interaction between the Project and the terrestrial environment so that residual impacts (i.e., effects that remain after mitigation has been implemented) to vegetation, wildlife, and wildlife habitats are acceptable. Detailed monitoring and mitigation procedures are provided in the TEMP, and reporting from the wildlife monitoring is provided in annual reports to NIRB (Gebauer and Boulanger, 2007, Gebauer et al. 2008 to 2015). The adaptive management described above will occur under the auspices of the TEMP. Ongoing review of the TEMP and annual Wildlife Monitoring Summary Reports by regulatory agencies, technical reviewers, and stakeholders will further confirm that local and regional concerns are adequately addressed as the monitoring work continues.

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