Environmental and Design Considerations
Naujaat Community Access Trail

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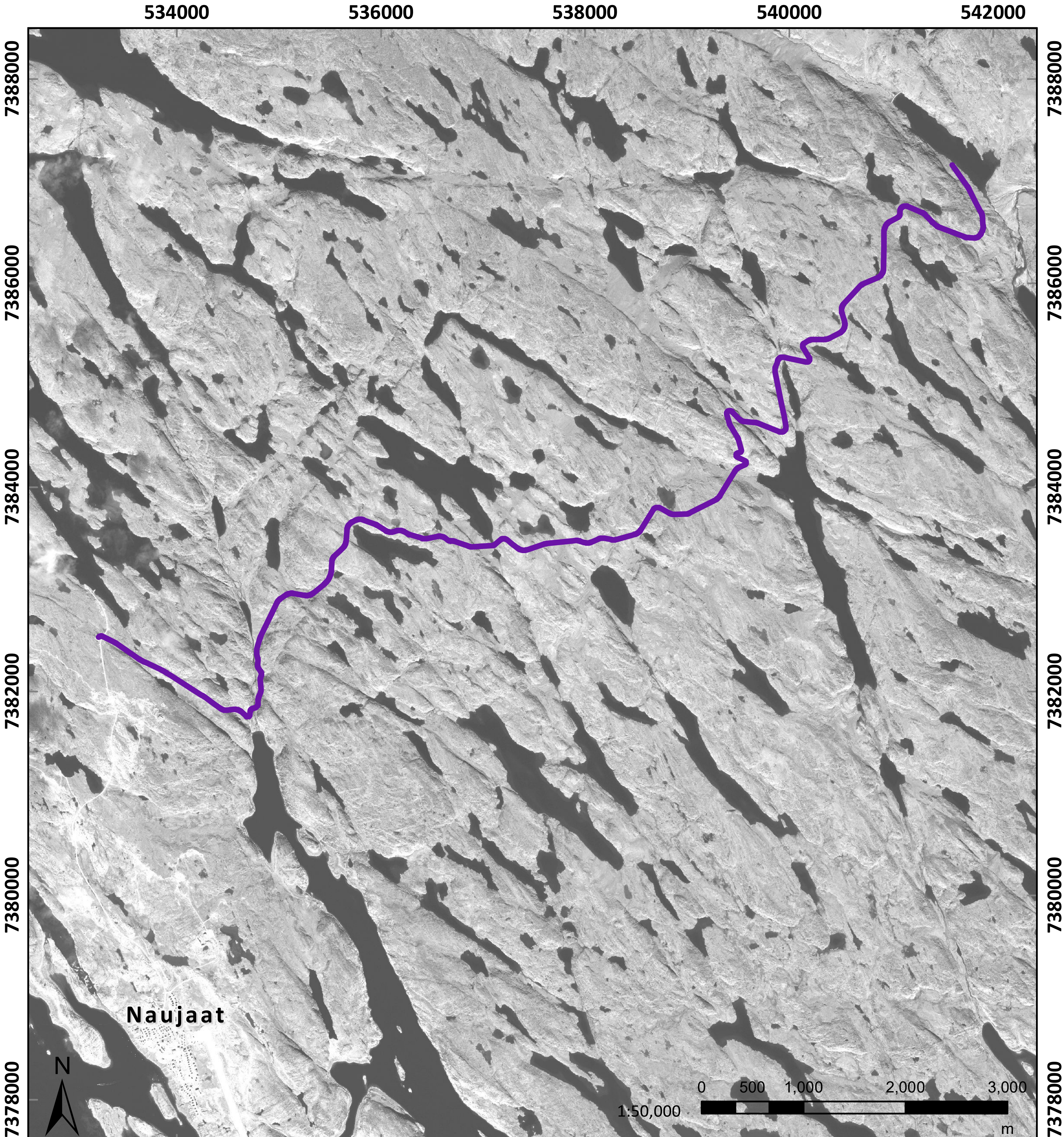
1. INTRODUCTION

The Hamlet of Naujaat is proposing to construct a community access trail within municipal boundaries. The proposed alignment is approximately 14.76 km long (Figure 1) and follows an existing All-Terrain Vehicle (ATV) trail. The alignment starts on the existing road network approximately 4 km north of Naujaat just before the community water filling station. In general, the alignment follows the existing ATV trail to the southeast to a major stream crossing just off the end of the inlet that is east of Naujaat, then travels northeast following benches and valleys to a lake and large gravel deposit and caribou hunting grounds. The route ends approximately 1.8 km inside the municipal boundary.

The community's interest in constructing the trail is multi-faceted: safer access by community members to caribou hunting grounds; access to potential sand, gravel, and carving stone resources; the development of eco-tourism and educational opportunities; and the facilitation of industrial opportunities (e.g., North Arrow Minerals' exploration activities of the Q1-4 kimberlite deposit).

The community is currently exploring funding options (e.g., Community Transportation Initiatives Program). If successful in acquiring funding, the community is planning taking the lead on the construction of the access trail, with assistance from companies such as EcoLogic Consultants Ltd. (environmental), Onsite Engineering Ltd. (design engineering, construction management), and North Arrow Minerals (logistical and financial support). It is the community's desire to start this project in 2019.

The intent of this document is to describe the Project, summarize existing environmental conditions, provide design engineering details, and assess potential Project effects on the environment.



North Arrow Minerals Naujaat Project

Proposed Community Access Trail, Naujaat, NU

Date: 11/19/2018
Map Number: NAM-012
Coordinate System: NAD 1983 UTM Zone 16N
Projection: Transverse Mercator
Datum: North American 1983

Legend

Proposed Community Access Trail

North Arrow MINERALS INC.

ECOLOGIC environmental consulting

2. EXISTING CONDITIONS

There is no standardized ecosystem land cover classification (LCC) system currently recognized for Nunavut. As such many projects are carried out using stand-alone LCC systems designed for one specific project. In order to make use of the existing classifications, EcoLogic and Onsite developed an LCC system that builds upon relevant classifications from a number of other studies:

- Ecosystem Classification in the Lac de Gras area (BHP Diamonds 1995);
- Ecosystem Classification in the Hope Bay Belt (Burt 2003; Golder Associates 2009);
- Vegetation Classification for the West Kitikmeot/Slave Study Region (1997-2001) (Matthews et al. 2001);
- Tibbett to Contwoyto Winter Road Ecological Land Classification (EBA 2002);
- Ecosystem Classification of the Bathurst Port and Inlet Road Project (Rescan 2010);
- Courageous Lake Project: Ecosystem Classification (unpublished, prepared by EcoLogic);
- Hackett River Ecosystem Classification (unpublished, prepared by author of this report);
- Back River Project: 2012 Ecosystem and Vegetation Baseline Report (Rescan ERM 2013); and
- Ecosystem Mapping for the Chidliak Project (EcoLogic 2017).

Of these, the system used for the Chidliak Project is the most advanced, having already incorporated data from all listed projects. This system uses nested classifications, with broad classes such as Tundra, Wetlands, Barren/Sparse, and Open Water subdivided into more narrowly defined associations.

2.1 Regional Classification

2.1.1 Regional Ecology

The Project is located on the north end of Repulse Bay on the southern end of Melville Peninsula, within the Wagner Bay Plateau Ecoregion of the massive Northern Arctic Ecozone. The Northern Arctic Ecozone is associated with low relief (non-mountainous) Arctic islands, northwest Keewatin, Baffin Island (except in the eastern coast) and the very north of Quebec. At 1.5 million square kilometers, it is one of the largest ecosystems in the world. Temperatures are extremely low and darkness during the winter is pervasive. Snow can fall at any time of the year and can remain on the ground from September until June. The landscape is dominated by low relief plains with occasional hills and plateaus; which can be barren or covered with variable (but often thin) quaternary deposits. This landscape is often gullied, either in the past by glacial meltwater, or by modern streams and rivers. Post-glacial parent materials include fluvial and aeolian (wind-blown) deposits. Permafrost lies beneath the entire ecozone under a thin active layer (generally less than 2 m and often less than 1 m), which freezes in winter and thaws each summer; permafrost may extend almost 1 km downwards. The constant freezing and thawing creates areas of unstable soils that form cell-like shapes known as patterned ground. The Wagner Bay Plateau Ecoregion covers over 380,000 square kilometers, from Southampton Island (Hudson Strait) in the east, to Back River in the west, and south to Chesterfield Inlet.

Classified as a low Arctic ecoclimate, mean annual temperate is -11°C with precipitation ranging from an annual mean of 100 to 200 mm. Discontinuous tundra vegetation characterizes the ecoregion, with common species including dwarf birch (*Betula nana*), willow (*Salix* spp.), northern Labrador tea (*Rhododendron tomentosum*), *Dryas* spp., and *Vaccinium* spp. Wetlands and wet sites contain a variety of willow and sedges (*Carex* spp.), while warmer sites may contain taller dwarf birch, willow, or alder (*Alnus* spp). Southern regions contain open, dwarf coniferous forests. Lichen-covered bedrock outcrops are common throughout the region.

Broad sloping uplands, plains and valleys of massive Archean rocks of the Canadian Shield characterize the landscape, with elevations rising from sea level in the east to over 600 meters above sea level (masl). Turbic and Static Cryosols are the dominant soil types, occurring discontinuously on thin sandy moraine and alluvial deposits. Coastal areas contain large extents of Regosolic Static Cryosols on marine deposits. Permafrost is continuous with low ice content.

2.2 Permafrost Features

The community of Naujaat is located in the zone of continuous permafrost, with permafrost thickness likely exceeding depths of several hundred metres. Because permafrost restricts the downward flow of water, precipitation and melt water within the active zone move horizontally along the frozen layer, either as surficial runoff or as shallow underground seepage within the active layer of the soil. Consequently, the soils within the seepage areas are saturated throughout the growing season. Annual freezing and thawing of these soils creates several phenomena, including patterned ground, solifluction, and occasional thermokarst features.

Solifluction, the slow downslope movement of saturated overburden across a frozen or otherwise impermeable substrate, occurs on even gentle slopes in this area. Common landforms that result from this process include solifluction lobes, which are tongue-shaped features resulting from spatially variable flow rates within a substrate. The variation is due to numerous factors, including texture of substrate, ice content, slope and surface lithology.

Thermokarst, the process by which characteristic landforms result from the thawing of ice-rich permafrost, is not overly common in this area. This is due to the thin layers of marine sediments and till over bedrock, which are landscape features not conducive to ice rich soils.

Well-developed frost boils are not common throughout much of the area but poorly developed boil-type features are prevalent in the sandy marine sediments. Frost boils are typically circular (1 to 3 m in diameter) upwellings of sediment that are created by frost heave and cryoturbation in permafrost areas. Common characteristics include an elevated center, a formation of an organic layer on the outer edge, and resistance of the soil surface to vegetation colonization.

2.3 Soil Development

Soil development is influenced by the interaction of factors associated with local climate, characteristics of surficial deposits (parent material), topography (especially how it affects hydrology), biotic influences, and time since disturbance. In general, the rates of soil development in the general area are very slow, typically in the order of a few millimetres per century. Only peat-derived organic materials accumulate considerably faster, but these are of very limited extent in the local area.

Continuous permafrost and harsh climatic conditions confine soil development close to the ground surface, with little development at depth beyond cryoturbation. The frequent freeze-thaw cycles associated with cold environments contribute to annual frost heaving (cryoturbation), which brings mineral material to the surface. The presence of shallow permafrost and cryoturbation affect both the pedogenic process and soil classification. Therefore, most soils in the area have been classified as Cryosols, which are usually poorly developed.

Soil parent materials include marine sediments, till (mostly of silty loam texture with coarse fragments), glaciofluvial sandy deposits, and weathered bedrock. The chemical characteristics of till usually reflect the chemistry of the rocks from which it originated. Veneers or blankets of morainal till may give rise to Static or Turbic Cryosols, depending on drainage regimes. Glaciofluvial deposits, due to their coarse texture, are rapidly drained and nutrient-poor.

2.4 Land Cover Classification

2.4.1 Field Observations

There are several distinct LCCs within the general area of the access trail:

- Tundra Associations
  - Gramminoid Tundra
  - Heath Tundra
  - Fell Field Tundra
  - Tussock Tundra
- Wetland Associations
  - Cottongrass Sedge Fen
  - Shallow Open Water
- Barren/ Sparse Associations
  - Bedrock
  - Marine Beach
  - Freshet Drainage Channels

  - Late Snow Pack
  - Cliff
- Open Water Features
  - Rivers
  - Lakes
- Anthropogenic (minor component not discussed further)

2.4.2 Landform Cross-section

Generally, Arctic landforms tend to repeat themselves in a predictable pattern in response to moisture shedding and accumulation (due to permafrost melt, permafrost depth, soil texture, potential for solifluction, slope and aspect). Figure 2 presents a typical landform cross-section that occurs in a predictable manner in the study area. This artist rendering of the landscape is based upon the observations taken in the field by EcoLogic.

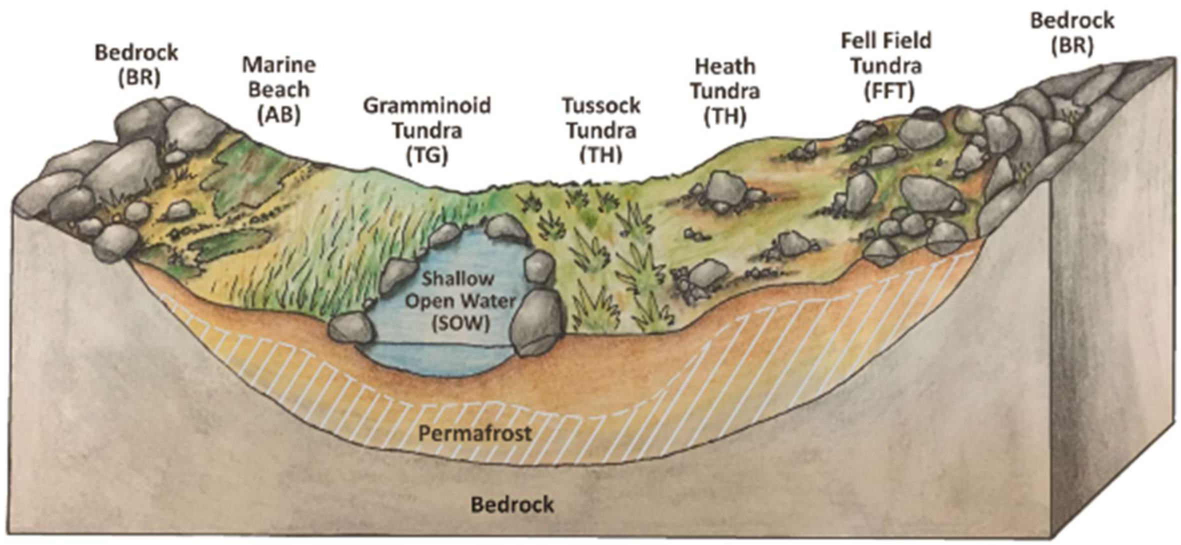


Figure 2. Land Cover Class Cross-section

2.4.3 Tundra Associations

Tundra associations cover the majority of the area surrounding the access trail alignment. Tundra is often defined as a treeless plain with perennially frozen soil, supporting the growth of lichens, mosses, small herbs, and dwarf shrubs. For LCC purposes, additional requirements include greater than 10% coverage of vegetation, and evidence of some soil-forming processes (e.g., organic matter accumulation, transfer of soil weathering products with the solum).

The tundra cover classes are typically found as part of a continuum or sequence expressed along elevational gradients and/ or within microtopography. For the most part, moisture retention within the soil is responsible for ecosystem development and distribution. This moisture comes from seasonal melting of the permafrost active layer (about 1 m at the surface). Thin skeletal soils, such as those soil veneers found over bedrock, tend to shed water quickly, while areas in landscape positions inundated with seasonal permafrost meltwater collect moisture. As the non-active layer acts as an impermeable boundary to vertical water movement, water moves horizontally to low landscape positions. This same ecological sequence can also occur along a moisture gradient in response to microtopography.

2.4.4 Wetland LCC Associations

Wetlands are uncommon in the proximity of the access trail alignment. Wetlands develop in areas of saturation, where soil development occurs in an anoxic environment and hydrophilic vegetation persists. Typically, fine-textured sediments or organic accumulation is required for wetland development. Neither of these is found in large quantities in the area, as parent materials tend to be sandier and skeletal. Wetlands include a cottongrass-sedge fen, which occupies most commonly the margins of lakes and the wetter valley bottoms, often in association with tundra tussock. Wetland associations also include shallow open-water features, which are a transition stage between lakes and wetlands including marshes and fens. Water depth is usually less than two metres, shallow enough that light can reach the feature bottom.

2.4.5 Barren/Sparse Association

The Barren/Sparse Association areal extent in the vicinity of the proposed alignment is exceeded only by the Tundra Associations. Classes within this association include any area with less than 10% vegetation cover (excluding bryophytes and lichens). These classes may be sparse or barren for a number of reasons, including abundance of bedrock (Bedrock and Blockfield), exposure to wind (Aeolian Beach), erosion activity (Freshet Drainage Channels and Ephemeral Streams), and recent deglaciation.

2.4.6 Open Water Features

Non-terrestrial land cover classes include open water features such as lakes, streams, and rivers.

3. DESIGN CONSIDERATIONS

3.1 ROAD ALIGNMENT

The proposed alignment is approximately 14.76 km long. The alignment starts on the existing road network approximately 4 km north of Naujaat just before the community water filling station. In general, the alignment follows the existing ATV trail to the southeast to a major stream crossing just off the end of the inlet that is east of Naujaat, then travels northeast following benches and valleys to a lake and large gravel deposit and caribou hunting grounds. The route ends approximately 1.8 km inside the municipal boundary.

Kilometre 0 to 4.3

The alignment in this section follows bedrock controlled terrain features but avoids areas where rock blasting will be necessary to achieve the desired alignment. Notable features on this portion include a steep descent and a large stream crossing at approximately 1.4 to 1.9 km at the head of Wagner Bay. The proposed route follows the existing trail network except for one short realignment to reduce trail grades.

Kilometre 4.3 to 8.5

This section continues to follow the general alignment of the traditional trail as it traverses east. In general, the topography along this route is heavily bedrock controlled and traverses the low ridges and valleys between local lakes. There are three significant sand and gravel deposits and three minor deposits along this alignment. This section has a surplus of sand and gravel and does not require blasting to construct the trail prism.

Kilometre 8.5 to 14.76

This section continues to follow the general alignment of the traditional trail as it traverses northeast. However, as the existing ATV trails disperse and become harder to find in this section, the route follows an alignment that best reduces trail grades. In general, the topography along this route is heavily bedrock controlled and traverses the low ridges and valleys between local lakes where possible but ascends and descends three major hills resulting in several sections of trail grades of 8 to 10%.

3.2 GENERAL CONSTRUCTION CONSIDERATIONS

The proposed alignment is to be constructed as an all-weather/season gravel surfaced trail with a design speed of 50 km/hr or less. It is possible to construct the route to these standards with local material. The trail embankment fills and surfacing will use local surficial deposits.

Drainage structures must be installed at all stream crossings (ten in total), in low points in the vertical alignment, and in all low wet areas (see Section 3.3). These can be corrugated steel pipe (CSP) culverts except for the large stream crossing at 1.9 km, which will require a bridge. Cross drain culverts should be placed at intervals along sustained grades in addition to the natural drainage paths and low points. Hydrotechnical studies will be conducted in advance of project construction to ensure that all culverts are sized appropriately for expected flow regimes.

The trail will be 6 m wide with a crowned gravel surface. On high rocky ridges the trail prism can be formed from the rubbly surficial materials and capped with manufactured or pit-run sand and gravel. Surfacing depths should range from 0.2 to 0.3 m depending on the subgrade. Ditches should be cut to at least 1 m below the finished trail surface except in bedrock where ditch depths can be 0.5 m or less.

In low wet areas where the organic soils are saturated and have a very shallow active layer, the trail must be constructed with minimal disturbance to the ground cover and have a minimum 1.5 m of free draining fill with shallow fill slopes to avoid permafrost degradation and sloughing of fill slopes. Fill slopes should be no steeper than 3H:1V. The trail will be a full-fill granular prism that overlays the undisturbed existing ground.

Any large fills required for approaches to stream crossings, to maintain grades, or for overland construction in shallow ice rich permafrost should be constructed by placing and compacting free-draining material in lifts. It is expected that a construction workforce of 20 members can build this trail in one season. Although some of the construction could progress in frozen, snow-free conditions, it is more appropriate to construct the trail in the summer months. The construction crews and staging are anticipated to include the following:

- Lead crew with an excavator, gravel truck, dozer, and supervisor. This crew will work with the surveyor who will mark out the alignment ahead. Duties will include general earthworks for cuts and fills, forming the road prism, and establishing overall grade and ditches.
- Crossing crew with an excavator, culvert truck, and two labourers. This crew will work behind the lead crew installing culverts and completing final trimming.
- Bridge crew. This crew will come in only for the bridge construction. They can make use of the excavators from the other crews. Expect four workers on this crew.
- Surfacing crew with an excavator, crusher or screen, loader, gravel trucks, water truck, roller compactor, and grader. This crew will manufacture surfacing from the borrow areas, haul and spread/shape surfacing, and finally compact the surface.

Construction equipment will be powered by diesel fuel brought to the machines in the crew truck fuel tanks from Naujaat. Any blasting materials, if required, will be stored in town at an approved facility and brought to site as required. The only other hazardous materials required for this type of construction are fuel oil, grease, and hydraulic fluids.

Some water may be used to moisture condition the surfacing depending upon weather conditions during construction and the in-situ water content of the borrow areas. It is not anticipated that this will be more than 10,000 litres per day.

With the workforce described above, the estimated construction duration will be four months. This is based on tabulated machine productivities adjusted for the conditions observed at this site. The average daily diesel fuel consumption is estimated to be 2,100 litres with a total estimated fuel consumption of 167,400 litres.

4. ENVIRONMENTAL CONSIDERATIONS

4.1 Environmental Benefits

The development of a permanent community access trail would result in two primary environmental benefits. The first is a decrease in the amount of vehicle traffic through sensitive tundra and wetland ecosystems. The existing ATV trails is highly braided in some areas, as ATV drivers attempt to find the driest possible routes to their destinations (Plate 1). This results in a larger area of disturbance than necessary to sensitive tundra ecosystems.

Plate 1. Examples of rutting on existing ATV track.

The second, and related, benefit is reduction in effects on all watercourse currently traversed by the ATV trail. The creation of permanent, properly engineered watercourse crossings would:

- maintain local surface hydrology,
- minimize disturbance to sensitive vegetation communities,
- minimize direct impacts to fish and fish habitat, and
- minimize erosion into and sedimentation of watercourses.

4.2 Potential Environmental Effects

4.2.1 Project Interactions

The construction and use of the community access trail has the potential to interact with several environmental features (Table 1).

Table 1. Potential Project Interactions with Environmental Feature

	Trail Construction	Trail Use
Air Quality	o	o
Climate and Meteorology (including climate change)	o	o
Noise and Vibration	o	o
Terrestrial Environment (including soils)	o	o
Permafrost and Ground Stability	o	o
Hydrology and Hydrogeology	o	o
Groundwater and Surface Water Quality	o	o
Sediment Quality	o	o
Freshwater Aquatic Environment	o	o
Native Vegetation	o	o
Terrestrial Wildlife (including birds and species at risk) and Wildlife Habitat	o	o

Note:

o = no adverse interaction expected.

o = potential adverse effect requiring mitigation; however, any residual adverse effect will be eliminated or reduced to negligible levels through permitting and the application of mitigation, including industry standard best management practices.

o = potential adverse effect requiring Project-specific mitigation measures; additional assessment warranted.

4.2.2 Potential Environmental Effects

The potential interactions were used to determine which environmental feature required additional consideration:

- Air Quality – Construction activities will result in air emissions. However, with the adherence to regulatory requirements and the implementation of standard mitigation measures and best management practices, any potential adverse effects are expected to be eliminated or reduced to negligible levels. Therefore, no additional assessment is required.

- Climate and Meteorology – The Project is not expected to have any adverse interactions with climate or meteorology, nor is the Project projected to have any climate change-related interaction. No additional assessment is required.
- Noise and Vibration – Construction activities will result in noise emissions and ground vibration. The short-term nature of the construction activities and the distance from Naujaat will eliminate or minimize any potential noise or vibration concerns. However, the potential interaction between noise and wildlife requires additional consideration, and will be addressed in a wildlife-focused discussion (Section 4.2.3).
- Terrestrial Environment – The construction of the Project is expected to reduce impacts to the terrestrial environment in the surrounding area by concentrating vehicle traffic in a single, engineered trail, rather than the current system of braided ATV trails across the tundra ecosystems. The interaction between the Project and the terrestrial environment (including soils) will be primarily limited to construction. Temporary ground disturbance will be required during construction activities. Mitigation measures and best management practices focused on minimizing the disturbance footprint and facilitating reclamation activities will eliminate potential adverse effects or reduce them to negligible levels. Therefore, no additional assessment is required.
- Permafrost and Ground Stability – The construction and use of the access trail will not result in any interaction with the permafrost layer. The construction will likely improve terrain stability in the vicinity of the existing ATV trail through improved route engineering. No additional assessment is required.
- Hydrology and Hydrogeology – The proposed construction methods will not interact with groundwater resources. In addition, the installation of appropriately sized and engineered watercourse crossings is expected to improve the overall hydrology of the land in the vicinity of the access trail. No additional assessment is required.
- Groundwater and Surface Water Quality - The proposed construction methods will not interact with groundwater resources. Mitigation measures and best management practices focused on minimizing transports of materials from the construction area to the surrounding environment will eliminate potential adverse effects or reduce them to negligible levels. No additional assessment is required.
- Sediment Quality – The construction of the Project has the potential to introduce sediment to local water courses. However, design engineering (e.g., appropriately sized and installed culverts), mitigation measures and best management practices focused on erosion and sediment control are expected to eliminate potential adverse effects or reduce them to negligible levels. Therefore, no additional assessment is required.
- Freshwater Aquatic Resources – There is the potential for the Project to interact with fish and fish habitat, although the fish-bearing nature of the proposed crossing is unknown at the time. This work will be completed in advance of construction activities. However, the installation of appropriately sized and engineered watercourse crossings and the elimination of vehicle travel

through watercourses along the route is expected to improve conditions for freshwater aquatic resources, including fish and fish habitat. Therefore, no additional assessment is required.

- Native Vegetation – The construction of the Project is expected to reduce impacts to the native vegetation in the surrounding area by concentrating vehicle traffic in a single engineering trail, rather than the current system of braided ATV trails across the tundra ecosystems. The interaction between the Project and native vegetation will be primarily limited to the construction period. Temporary ground disturbance will be required during construction activities. Mitigation measures and best management practices focused on minimizing the disturbance footprint and facilitating reclamation activities will eliminate potential adverse effects or reduce them to negligible levels. Therefore, no additional assessment is required.
- Wildlife and Wildlife Habitat – The construction and use of the community access trail has the potential to negatively interact with wildlife and wildlife habitat (Section 4.2.3).

4.2.3 Potential Effects to Wildlife and Wildlife Habitat

The construction and use of the community access trail has the potential to have direct and indirect impacts on wildlife through three pathways: mortality, sensory disturbance, and disruption of movement.

- Mortality
  - Direct – The construction of an engineered trail surface could result in more traffic moving at higher speeds than is currently the case along the existing ATV trails. As a result, the community access trail could potentially result in increased vehicle collisions with wildlife (e.g., Jalkotzy et al. 1997). However, as most wildlife species of concern in the area (e.g., caribou, polar bears) demonstrate aversive reactions to both noise and moving vehicles (see Sensory Disturbance below), the increased probability of vehicle-wildlife collisions is unlikely to have an appreciable effect on wildlife populations in the vicinity.
  - Indirect – The construction of an engineered trail surface may increase hunting and trapping pressure in an area as the current levels are limited by the difficulty of access (e.g., McLellan and Shackleton 1988), with the attendant potential effect on local wildlife populations. The Hamlet of Naujaat has committed to working closely with community members to carefully manage this potential effect.
- Sensory Disturbance
  - Sensory disturbance occurs when noise, light, dust, or human activity generates behavioural changes in wildlife. The potential for this effect will be highest during the construction phase of the community access trail.
  - Caribou have been observed altering their behaviour in response to noise disturbance (McLaren and Green 1985); the duration and magnitude of the response is positively correlated with the duration and magnitude of the disturbance (e.g., Horejsi 1981; Murphy and Curatolo 1987). Once the disturbance has passed (e.g., traffic, construction activity),

caribou typically resume pre-disturbance behaviour patterns (Horejsi 1981). Similar patterns are observed for other wildlife species (e.g., bears).

- The construction-phase aspects of this potential effect will be short-term, limited in geographic scope, and are considered reversible (i.e., the effect subsides once construction is completed).
- The use of the community access trail, once completed, will still generate some level of disturbance. However, the restriction of travel to a single corridor, typically by machines with small engines (e.g., ATVs), will constrain the disturbance to a relatively small physical footprint.

- Disruption of Movement
  - Activity and infrastructure can create sensory or physical barriers to movement among daily or seasonal habitats. Linear features on a landscape that is typically devoid of linear structures are common sources of this potential effect (Dyer et al. 2002). The magnitude of the effect is dependent on many factors, the most important of which are the presence of vertical structures (e.g., power lines that are visible from a distance) and, for roads, traffic rates and the height of the road surface above the height of surrounding land.
  - There are no power lines associated with the community access trail. On average, the crown of the community access trail surface will be between 0.5 to 1.0 m above the height of surrounding land. Available evidence suggests that roads, when no traffic is present, are not consistent barriers to caribou movement (Wolfe et al. 2000, Dyer et al. 2002).

In conclusion, it is likely that the construction and use of an engineered trail surface will have potentially adverse effects on wildlife. However, the magnitude and duration of these effects are unlikely to be long-lasting or have population-level consequences. The relatively small construction footprint of the road, combined with its limited elevation stature, will limit the potential adverse direct effects on wildlife habitat (i.e., limited habitat removal).

4.3 Environmental Management Plan

4.3.1 Drainage, Erosion and Sediment Control

This EMP section provides guidance on how the Project will work to minimize the exposure of erosive soils and to minimize or eliminate the discharge of sediment-laden waters to the receiving environment during construction. The Project will ensure that:

1. Water leaving active work areas will be managed and treated if necessary with appropriate erosion and sediment control (ESC) measures to ensure that water quality is maintained at all times during construction activities.

2. The Project will regularly monitor, maintain, and repair all drainage and ESC measures as necessary to ensure functionality until there is no risk of a sediment release to aquatic environments.
3. The Project is committed to the protection of surface water quality and will endeavor to minimize the input of sediments into receiving environments at all times.

4.3.1.1 Drainage

Site drainage control can be effectively used to prevent additional sediment entrainment in surface run-off and groundwater drainage. To control site drainage, the following management practices will be implemented when and where appropriate:

- Water released from construction areas will not be released into streams unless it meets approved water quality guidelines.
- Water that does not meet the guidelines (e.g., turbid water) will be filtered and/or treated as required to meet the guidelines before discharge.
- Carrying capacities of all local ditches will be assessed and cleaned out prior to construction if necessary.
- Ditches and culverts will be used (as required) to manage drainage.
- Diversion channels, ditches, and diversion pumps may be used to direct clean water away from the area being constructed and back into the natural drainage system.
- Water bars will be constructed within work areas and around access routes (as required) to control surface water run-off and erosion. Water bars will be designed to simulate any slope contours and direct and diffuse surface water away from disturbed areas.
- Drainage structures (culverts, side drains, drainage ditches, swales, flumes, pipes, etc.) will be continuously inspected, maintained, and periodically cleaned to ensure that they are free-draining and continuing to prevent sedimentation and/or modification of runoff patterns.

4.3.1.2 Erosion Control

Erosion prevention will be the primary control implemented on the Project.

Erosion prevention is by far the most cost- and time-effective way to maintain site water quality. Preventing sediment entrainment results in the requirement for fewer sediment control structures which are typically time- and cost-intensive to install and maintain.

Erosion prevention best management practices (BMPs) may include one or many of the following:

- scheduling and staging construction to minimize open ground when heavy rains are forecast;
- slope texturing – including swales and other run-off control mechanisms;
- application of mulches;

- placement of erosion control products (e.g., Curlex "logs" or similar) in ditches to act as check dams;
- topsoil re-application and seeding;
- water bar and rolling dip installations;
- diversion ditches;
- rock and/or sandbag check dams;
- lining diversion and collecting ditches with rock;
- rolled erosion control products (RECP) in ditches to minimize erosion;
- temporary diversion ditches and berms;
- energy dissipation units to reduce water energy and velocity;
- hydro-seeding; and
- polyethylene sheeting and other soil covers (e.g., filter fabric, tarps).

Various combinations of these erosion control methods may be utilized on the Project.

4.3.1.3 Sediment Control

If there is no erosion, no sediment will be produced, and no sediment control will be required. Sediment controls are not a replacement for erosion controls.

Sediment control is treating the symptom of imperfect erosion prevention. Erosion is inevitable with earth-work construction, and all efforts should be made to minimize sediment generation. Once sediments have been entrained in water treatment devices rely on collecting the sediment-laden water, reducing its velocity, which will allow for some soil particles to settle out. Sediment control BMPs include:

- sediment fencing – this is used to keep sediment out of surface waters;
- sediment retention berm – similar purpose as sediment fencing but more permanent;
- continuous berms or earth dykes to keep erosive soils away from drainage structures;
- sediment retention ponds that allow entrained particles to settle out and be stored in a pond structure. Ponds must be adequately sized and must be cleaned of sediment when they reach 50% capacity;
- pumps and sediment filter bags that can be used to isolate and treat dirty water; and
- flocculent or chemical additives, which aid in the settling of fine particulate matter that is entrained in solution.

Various combinations of these sediment control methods may be utilized on the Project.

4.3.2 Working in and Around Water

When working in or around water, the Project will ensure that:

- No substance, sediment, debris, or material that could adversely impact a watercourse is allowed to enter or be placed near, used, or stored in a watercourse.
- There is no disturbance or removal of stable natural materials and vegetation that contribute to riparian stability and habitat except as authorized under a Project permit or Project-engineered issued for construction drawing.
- Temporary material, fill, bridges, culverts, pumps, pipes, conduits, ditches, or other structures used during the construction of any works are used only during the period of construction, and are removed on completion of the works.
- All cast-in-place concrete and grouting is completely separated from drainage structures or any waterbody for a minimum of 48 hours.
- Any water used to control dust on roads or trails will not enter the local drainage system to avoid sediment-laden water introduction to storm sewers or waterbodies.
- These requirements apply to all manner of in-stream work including, but not limited to, road crossings, riprap placement, cofferdam installation and maintenance, in-water excavations, structure placement below top-of-bank, etc.
- Instream construction activities are avoided on fish-bearing watercourses during construction of access road crossings where feasible.
- Clear-span structures are designed and constructed to avoid placement of materials such as abutments and riprap below the high water mark of any watercourse where feasible.
- Instream construction areas are isolated as authorized in an applicable permit or approval.
- Approaches are designed and constructed so that they are perpendicular to watercourses to reduce disturbance to or loss of riparian vegetation where feasible.
- Bridges are designed and constructed so that stormwater runoff from bridge decks, side slopes, and approaches is directed into a retention pond or vegetated area to remove suspended solids, dissipate velocity, and prevent sediment and other deleterious substances from entering watercourses.
- If replacement rock reinforcement/armoring is required to stabilize eroding inlets and outlets of a culvert, the following measures shall be incorporated:
    - Place appropriately sized, clean rocks into the eroding areas associated directly with the inlet or outlet.
    - Obtain rocks from above the high water mark of any watercourse.
    - Avoid the use of rock that is acid-generating.
    - Install rock at a similar slope to maintain a uniform stream bank and natural stream alignment.

- Do not place rock where it interferes with fish passage or constricts the channel width.

Protection of water quality within the Project area is one of the primary focuses of this plan. The Project will protect water and habitat quality for aquatic life within adjacent waterbodies by ensuring complete and thorough isolation of their work area. Total suspended solids (TSS) in runoff water during normal dry weather shall not exceed 25 mg/litre and must be less than 75 mg/litre of suspended solids above background levels during storm events.

4.3.3 Hazardous Materials Handling Procedures

Hazardous waste, as defined in Nunavut, includes wastes that are recycled, treated, abandoned, handled, spilled, stored, recycled, or in transit before recycling, treatment, or disposal. The Project will adhere to all relevant regulations and ensure that no hazardous wastes reach local terrestrial, aquatic, or atmospheric receiving environments. All site workers will be trained in the proper handling of any hazardous material during the site orientation. All Project hazardous material Safety Data Sheets (SDS) will be kept on site.

If not immediately disposed of offsite, any hazardous wastes generated on the Project will be stored on-site for routine transport and proper off-site disposal in appropriate containment containers (greater than 110% volume) to prevent unsafe human exposure or release to local terrestrial, aquatic, or atmospheric receiving environments. Storage and transport will be conducted in compliance with applicable regulations. Any hazardous wastes will be disposed of at an approved waste-handling location.

4.3.4 Site-situated Plant and Equipment Maintenance Facilities

For this Project, any and all equipment required will be delivered to the Project site in good working order and be free of leaks. Any major maintenance required will be completed in Naujaat. Any minor maintenance required will be conducted at least 30 m from any waterbody. Proper ground protection will be used to catch any fluid drips from maintenance activities.

4.3.5 Solid Waste Handling Procedures

The following is a list of non-hazardous solid wastes that may be generated during construction:

- food waste and other animal attractants;
- paper and cardboard;
- waste wood;
- scrap metal;
- plastics;
- clearing brush and non-merchantable timber;
- overburden – organic soils;

- waste rock (non-acid-generating, non-metal-leaching);
- mineral soils; and
- waste concrete (from existing bridge abutments).

All waste will be transported to Naujaat. No food or food waste will be left overnight at any work sites.

4.3.6 Spill Prevention and Emergency Response

The Project will ensure that spill response equipment, preventive measures, and all regulatory requirements are adhered to and met.

This Project will follow an approved Health and Safety Plan, which will detail emergency response procedures and methods. This plan will be shown and communicated to all site personnel during Project site orientations. A copy will be kept at the Project site. The Health and Safety Plan lists all the emergency contacts.

The following emergency response procedure will be followed in case of a spill (e.g., fuel, oil):

1. Ensure your own safety and assess the situation. Use caution when flammable materials are spilled. Eliminate sources of ignition.
2. If safe to do so, stop the flow and ensure the remaining material stays in its container by:
    - closing a valve,
    - turning the pump off,
    - righting the container,
    - plugging the hole, or
    - turning the equipment off.
3. Secure the area by keeping all others away from the spill site.
4. Contain the spill by preventing the spilled material from spreading. It is critical to prevent the material from reaching catch basins, creeks, or any other watercourse. Use material on-site to contain the spill, such as:
    - absorbent pads or booms from a spill kit, or
    - plastic sheets or tarpaulins.
5. Cleanup/Disposal
    - Water spill: If equipment is available, skim oil off water and pump oil/water mixture into drum/tanks that will safely contain material.
    - Land spill: Use absorbent materials to soak up oil. Dispose of absorbent material and contaminated soils in the appropriate site containers.

4.3.7 Soil Management

Any soil material borrowed for the Project will be free of noxious weeds and not have any contamination product that could be introduced into terrestrial and aquatic environments. Handling of excavated soils and granular materials will be conducted to protect soils from erosion, accidental discharge, and co-mingling with other materials. Excavated material will either be properly disposed of or re-used during construction activities. Re-used soils and granular materials will be stored in areas where it is protected from erosion (precipitation) by use of poly sheeting, and in areas where the soils and materials will not migrate into drainage ditches or waterbodies.

4.3.8 Wildlife Management

Direct disturbance to wildlife will be minimized by adhering to the following mitigations:

- Wildlife shall not be chased, caught, diverted, followed, or otherwise harassed by Project participants.
- Environmental Monitors will monitor wildlife response to construction activity.
- A record log will be kept of large wildlife sightings and road-kill, and nuisance wildlife shall be reported to the authorities.
- Food remains and garbage from construction sites will be removed daily.
- Crews shall not leave garbage or litter at work sites.
- Environmental and wildlife awareness training, with regular briefings, shall be implemented for all personnel.
- All persons on site shall be made aware of the potential for encounters with bears, and attend awareness and safety training including emergency response and reporting requirements.

The following mitigation measures will be used to minimize effects to wildlife associated with transportation:

- Vehicles will adhere to safe speed limits, particularly around blind corners.
- Vehicles will yield to wildlife on roads.
- Vehicle collisions with wildlife will be reported to the Environmental Monitor.
- Wildlife sightings, if any, and appropriate behaviours/driving protocols around wildlife will be discussed during the tailgate meetings.

Should blasting activity be determined to be necessary, Naujaat will work with its selected construction contractor and regulators to develop wildlife management plans specific to blasting.

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