Attachment A EBA All-Season Road Report

CREATING AND DELIVERING BETTER SOLUTIONS

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AREVA RESOURCES CANADA LTD.

KIGGAVIK PROJECT
NORTHERN & SOUTHERN ALL-SEASON ROADS REPORT

V33101016

October 2010

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APPENDICES

1.0 INTRODUCTION

The Northern and Southern All Season Road Report is one of a group of studies performed by EBA of various aspects related to access and infrastructure for the proposed Kiggavik Mine Project. The other studies include:

- Haul Road Report
- Physical Environment Within the DEIS Report
- Andrew Lake Dyke Report
- Port Facility Report
- Mine Site airstrip Report
- Winter Road Report
- Mine Site Building Foundations Report

Figure 1.0-1 below shows the general location of the Kiggavik Project.

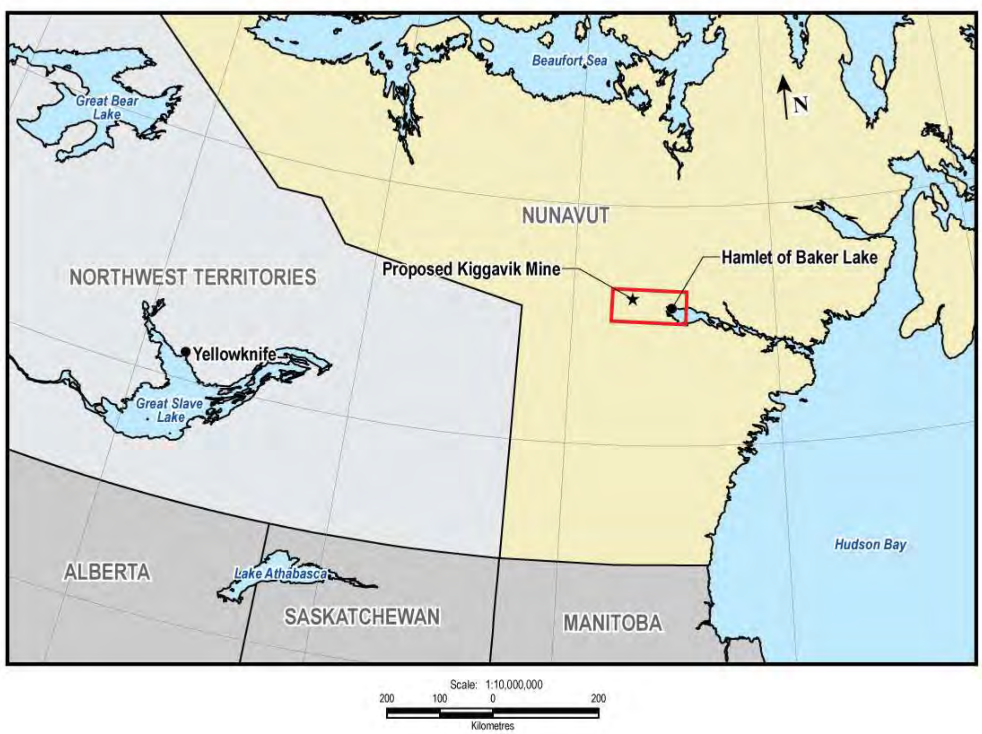
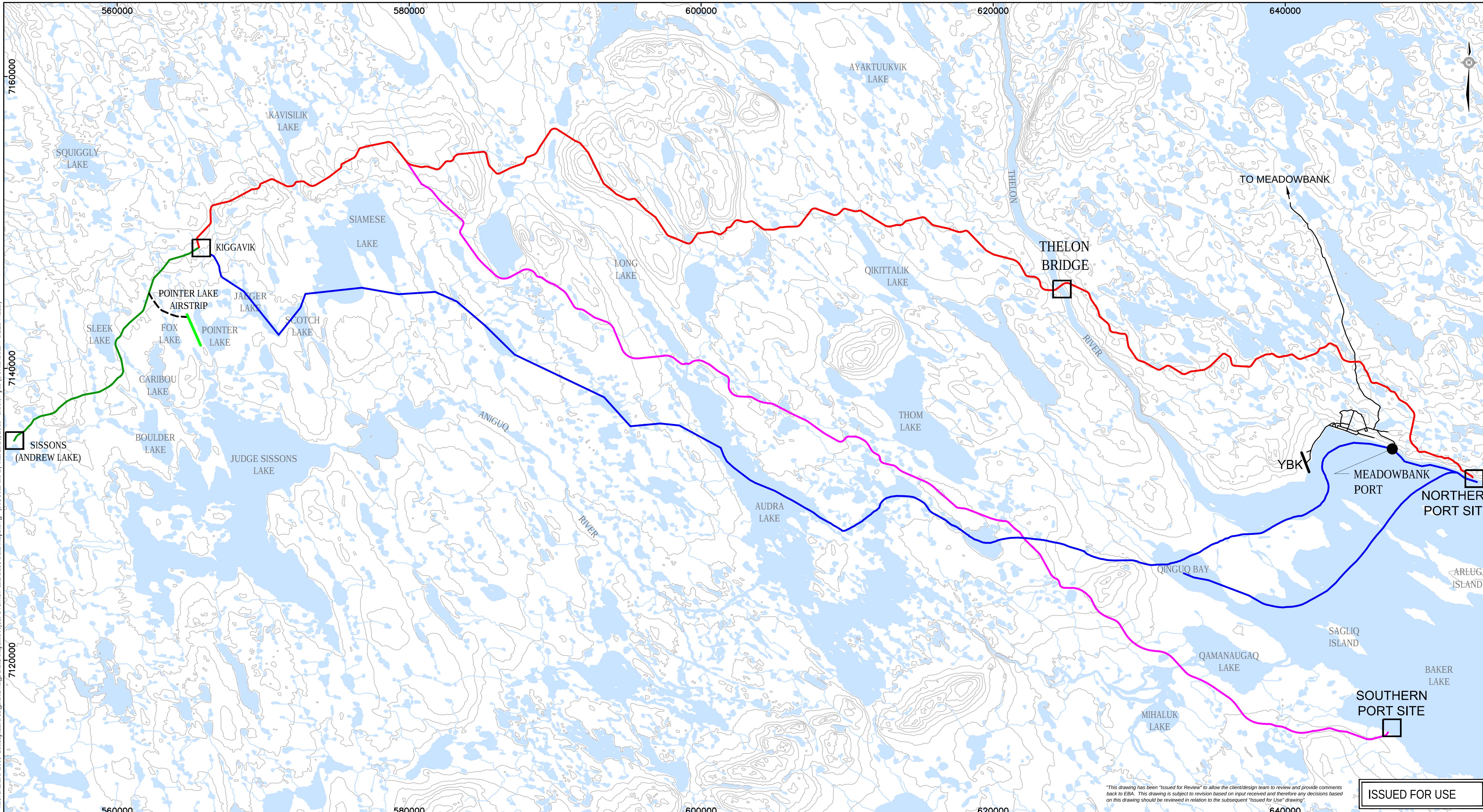


Figure 1.0-1 Key Plan

Figure 1.0-2 on the following page shows the various project elements discussed within this Report and the other Reports listed above.



Q:\Vancouver\Transportation\V331\Projects\V33101016 - Areva\CADD\2009 Conceptual Design\Drawings\DEIS Report\Project Overview and Base Data Maps.dwg [FIGURE 1.0-2] March 26, 2010 - 2:00:07 pm (BY: ANDREW DEEPWELL)

PROPOSED

- Northern All Season Road
- Southern All Season Road
- Haul Road
- Winter Road
- Pointer Lake Airstrip

EXISTING

- Roads
- 20m Contour - NTS Base Data
- YBK Airport

SCALE 1:250,000

2 0 2 6 10km

PROJECTION: UTM Zone 14

DATUM: NAD 83

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KIGGAVIK PROJECT
CIVIL INFRASTRUCTURE REPORT

PROJECT OVERVIEW MAP

PROJECT NO.	DWN	CKD	REV	
V33101016	AJD	DCD	-	Figure 1.0-2
OFFICE	DATE			
VANC	March 26, 2010			

2.0 ACCESS ROAD OPTIONS

2.1 INTRODUCTION

In 2007, EBA completed a Pre-feasibility Study which examined and evaluated ten distinct transportation options, with some variations in each. (See Figure 2.1-1) This high-level desktop study outlined the advantages and disadvantages of each option based on estimated construction costs, maintenance costs, reliability, operational logistics, and construction logistics. Areva then consulted with various environmental consultants involved in the Kiggavik project as well as the local community. From this process three options were selected for further study. These three options are shown previously in Figure 1.0-2, and are described in detail as follows:

1. Northern All Season Road
2. Southern All Season Road
3. Winter Road

2.2 AREVA'S FUNCTIONAL REQUIREMENTS FOR THE ACCESS ROAD

- The Kiggavik Project requires that the majority of fuel, reagents and supplies required for yearly operations be transported from a port facility on Baker Lake each year that the mine is in operation. In addition to this annual re-supply, the building materials and construction/mining equipment required to construct and operate the site will also need to be transported in the same manner.

Based on the current estimate of annual supplies (Areva, 2008) the required road-based transportation requirements will be 81,000 tonnes of supplies and equipment, and 57,000 tonnes (70 million litres) of fuel. For purposes of design, the assumed primary hauling unit is a Super B-Train, which could have a configuration similar to that show in Figure 2.2-1 as follows:

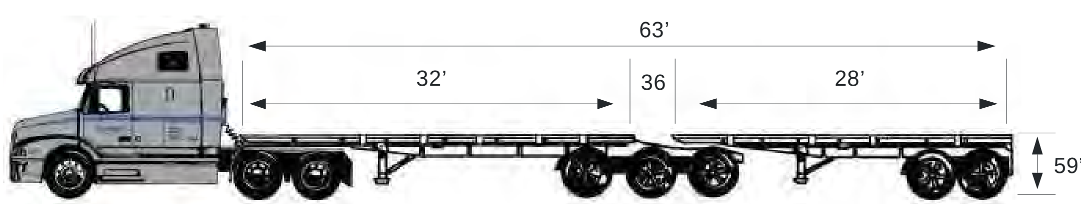
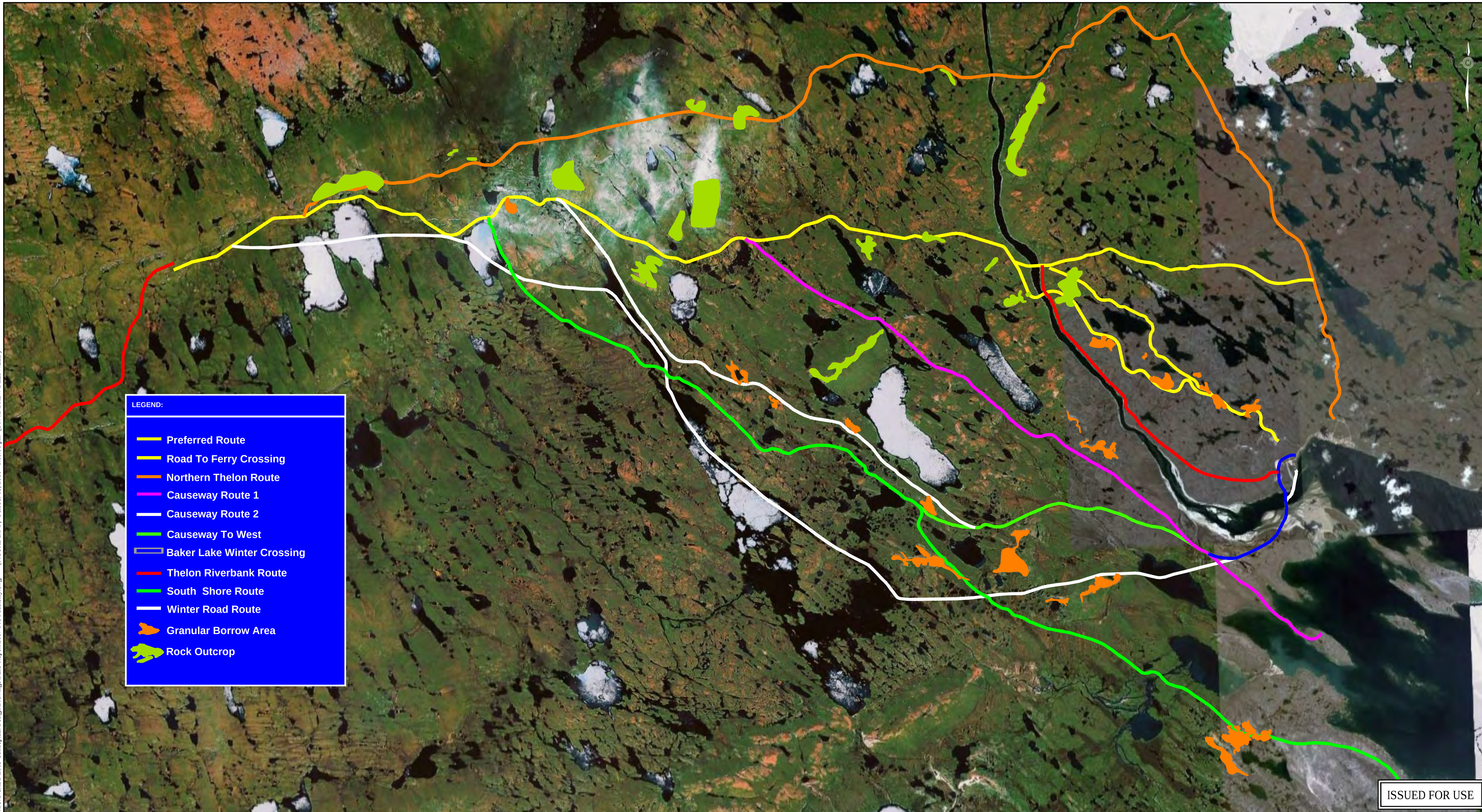


Figure 2.2-1: Super B -Train

The Kiggavik Project - Project Proposal, November 2008, states that 1,375 truck loads of fuel and 2250 truck loads of supplies and equipment will be required annually for these transportation requirements. It should be noted that the design vehicles will be hauling slightly less on average than the maximum allowable truck haul loads which are in the order of 40-45 tonnes. Additional traffic on the road should be expected due to maintenance



SCALE 1:250,000

2 0 2 6 10km

PROJECTION: UTM Zone 14

DATUM: NAD 83

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CIVIL INFRASTRUCTURE REPORT

2007 PRE-FEASIBILITY STUDY
OPTIONS EVALUATION

PROJECT NO.	DWN	CKD	REV
V33101016	MM	KJ	-
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VANC	March 26, 2010		

Figure 2.1-1

Q:\Vancouver\Transportation\V331\Projects\V33101016 - Areva\CADD\2009 Conceptual Design\Drawings\DEIS Report\2007 Pre Feasibility.dwg [FIGURE 2.1-1] October 05, 2010 - 6:10:06 pm (BY: ANDREW DEEPWELL) vehicles, employee vehicles, and pubic vehicles from Baker Lake. The life of the road should be designed at least for the life of the operating mine.

2.3 NORTHERN ALL SEASON ROAD

2.3.1 General

The proposed Northern All Season Road extends from the proposed Kiggavik Mine/Mill site to a proposed port site on the north shore of Baker Lake, east of the community, as shown on Figure 2.3-1 (a and b). There are a number of variations to the alignment around the Hamlet that have yet to be fixed. These are discussed in later sections.

The proposed Northern All Season Road is 114 km in length from Kiggavik to the proposed port site.

There are 13 bridges (less than 50 meters in length) proposed along the route, with one major bridge (approximately 450 meters in length) crossing the Thelon River. The remainder of the water crossings have been accommodated with culverts. Additional bridges may be required if fisheries issues dictate the need for a bridge rather than a culvert.

The road will be 10 meter wide, built with Run-of-Quarry (ROQ) rock embankment (fill). There will be no earth cuts along the alignment, and the only cut sections will be through rock, which will service as quarry material.

Material for the rock embankment and road surfacing will be derived from rock quarries developed along the road.

2.3.2 Design Principles & Criteria

The design principles developed for this project are based on:

- Producing a design that is cost-effective with respect to construction costs;
- A design that produces good operating characteristics for the design vehicles;
- Minimal maintenance requirements, both on an annual and life-cycle basis;
- Respecting the environmental and archaeological constraints.

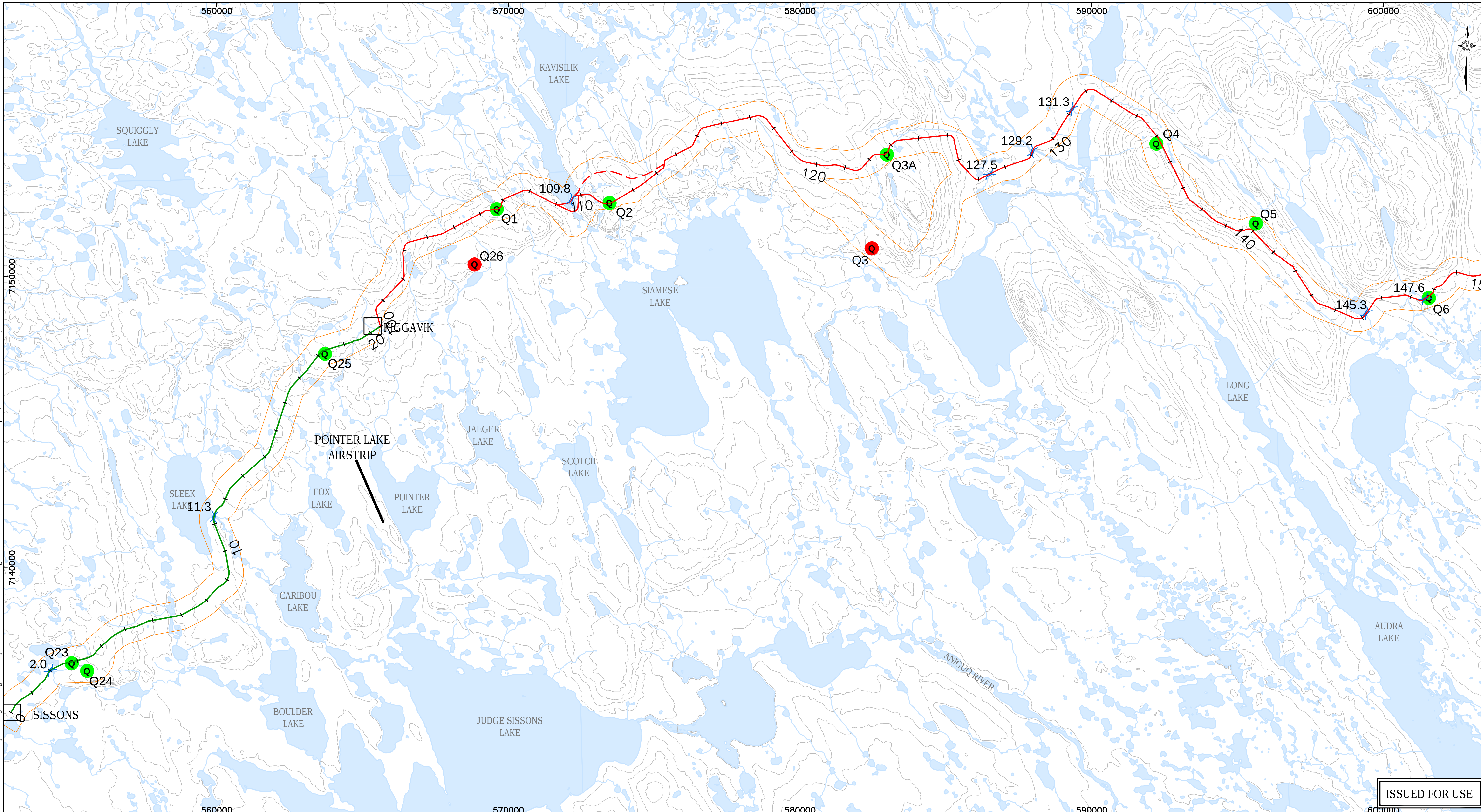
The following sections outline these principles and detail the road design criteria.

2.3.2.1 Routing Selection

Numerous options and variations have been developed and evaluated to arrive at the preferred option presented in this report.

The route has been located generally on higher ground. The reasons for this are as follows:

- Higher areas tend to be less ice-rich, which presents fewer geotechnical issues for constructing the road;



PROPOSED
- Northern All Season Road
- Alternate Alignment
- Haul Road
- Probable Quarry Sites
- Quarry Site (Eliminated)
- km Marker
- Bridge

EXISTING
- Quarry
- 10m Contour - NTS Base Data
- Extents of Road LiDAR Survey (2009)

SCALE 1:125,000

1 0 1 3 5km

PROJECTION: UTM Zone 14
DATUM: NAD 83

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NORTHERN ALL SEASON ROAD
KM 100-150

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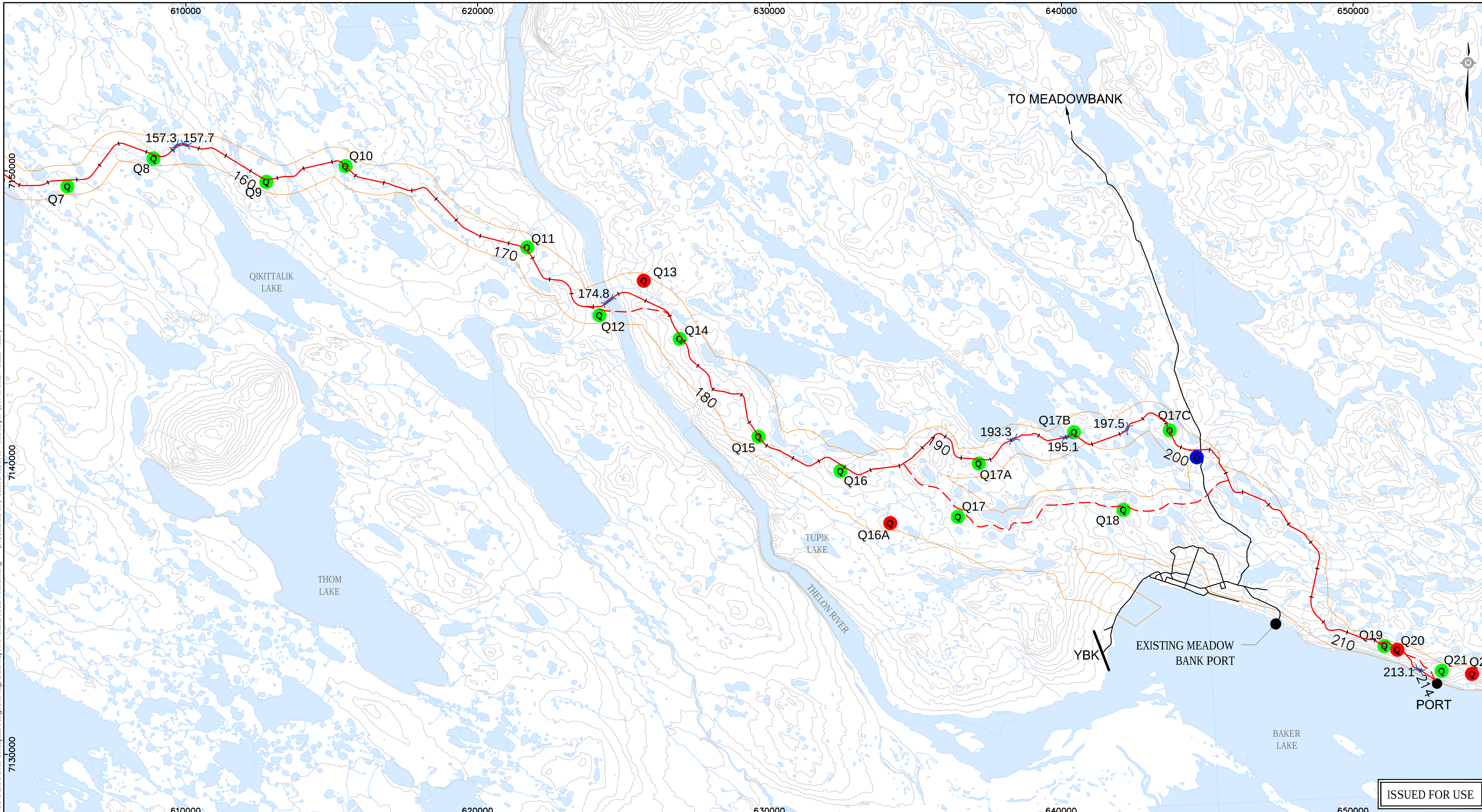
Figure 2.3-1A

Q:\Vancouver\Transportation\V331\Projects\V33101016 - Areva\CADD\2009 Conceptual Design\Drawings\DEIS Report\Overland Route Northern.dwg [FIGURE 2.3-1A] October 05, 2010 - 6:20:12 pm (BY: ANDREW DEEPWELL)



PROPOSED

- Northern All Season Road
- Alternate Alignment
- Haul Road
- Probable Quarry Sites
- Quarry Site (Eliminated)
- km Marker
- Bridge

EXISTING

- Quarry
- 10m Contour - NTS Base Data
- Extents of Road LiDAR Survey (2009)

SCALE 1:125,000

1 0 1 3 5km

PROJECTION: UTM Zone 14

DATUM: NAD 83

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NORTHER ALL SEASON ROAD
KM 150 TO POTENTIAL PORTS

PROJECT NO.	DWN	CKD	REV
V33101016	AJD	DCD	A
OFFICE	DATE		
VANC	March 26, 2010		

Figure 2.3-1B

Q:\Vancouver\Transportation\V331\Projects\V33101016 - Areva\CADD\2009 Conceptual Design\Drawings\DEIS Report\Overland Route Northern.dwg [FIGURE 2.3-1B] October 05, 2010 - 6:18:02 pm (BY: ANDREW DEEPWELL)

- Higher areas tend to have fewer areas of diffuse drainage patterns, which are hard to accommodate in construction;
- Higher areas have fewer cross-drainage surface flow;
- Higher areas are less prone to snow drifts, which can become a major maintenance issue;
- Higher areas tend to have more areas of bedrock which improves the bearing capacity of the road and reduces the embankment fill requirement;
- Suitable quarries are located in higher areas.

Areas of geotechnical instability, environmental and archeological constraints also guided the route selection.

The location of the major bridge crossing across the Thelon River and the proximity of the Hamlet of Baker Lake also factored in the selection of the preferred location for the road.

2.3.2.2 Geometric Design Criteria

The criteria for the design of the Northern All Season Road are listed in Table 2.3-1 below. These criteria are based on the findings and recommendations of previous design work completed on similar projects in the Canadian north, and reflect information gathered from experienced haulers and northern road construction contractors. Since very few roads of the proposed type currently exist in Nunavut, reference has been made to the Government of Northwest Territories (GNWT) Department of Transportation where territorial highways exist in conditions similar to the Kiggavik project area.

TABLE 2.3-1: SUGGESTED DESIGN CRITERIA SUMMARY

Design Element	Criteria	Comments
Road Surface width	10 m	Width based on the design vehicle in winter conditions. Conforms to Transportation Association of Canada (TAC) table 2.2.13.4 and typical GNWT Department of Transportation Practices.
Design Speed	70 km/h minimum with exceptions	Exceptions are based on topographical considerations and in areas in the vicinity of the Mine site and Baker Lake. Where conflicts with other traffic is more common.
Design Vehicle	Super B-Train	This is the typical haul unit currently used supply mines in NWT.
Min. Horizontal Radius	190 m	This radius was selected to maintain a 10 meter road surface width for adequate width for Super B-train to pass a WB-20. Also conforms to minimum radius for design speed of 70 km/h - TAC table 2.1.2.6.

TABLE 2.3-1: SUGGESTED DESIGN CRITERIA SUMMARY		
Design Element	**Criteria**	**Comments**
		No spirals have been used in the development of the alignment. This is in keeping with ambient design conditions of similar roads in NWT and typical GNWT Department of Transportation Practices.
Min. Crest /Sag Vertical K Value	20 crest 22 sag	Headlight Control assumed. Minimum curve length of 70m. TAC tables 2.3.3.2 and 2.3.3.4. Midrange of curves to be used for design.
Maximum Grade	6%	Based on rural collector maximum grades TAC table 2.3.3.1.
Cross Fall	3%	Follows typical GNWT Department of Transportation Practices for gravel roads.
Maximum Super-elevation	6%	Follows typical GNWT Department of Transportation Practices.
Side Slopes	3:1 in fill 0.25: 1 in rock cut	Fill Sideslopes conform to TAC table 2.3.13.4.
Barriers	none	Not considered appropriate for the typical operating conditions of the design vehicle.
Bridges	Canadian Highway Bridge Design Code. S6-2000	
Road Structure	19 mm gravel over rock fill	Variable, depending on subsurface conditions.
Traffic	20 year design life (assumed mine life and construction/decommissioning)	Must be capable of handling 3,625 loaded Super B-Trains and an equal number of return vehicles each year.

2.3.2.3 Geotechnical Design Cross Sections for Varying Subsurface Conditions

In non-permafrost areas, it is common for road designs to incorporate both cuts and fills to establish the final grade along the alignment. However, in permafrost areas, disturbing sensitive overburden soils and surface vegetation can result in thaw degradation and the creation of unstable ground. Consequently, the design for this project calls for fill-construction only, wherever the road passes over overburden soils. Minimum depth of embankment fill is specified for various "terrain types", and is designed to be sufficient to construct a stable road embankment and to protect the underlying permafrost. In this design, cuts have only been incorporated in bedrock.

The following generalized "terrain types" have been considered in the design of the road:

Terrain Type 1:

Terrain Type 1 is relatively dry, stable, till and outwash deposits, on level terrain overlain by a thin organic cover. There is little surface expression of ice-rich permafrost conditions. Figure 2.3-2 shows the typical road cross-section associated with traversing this type of terrain.

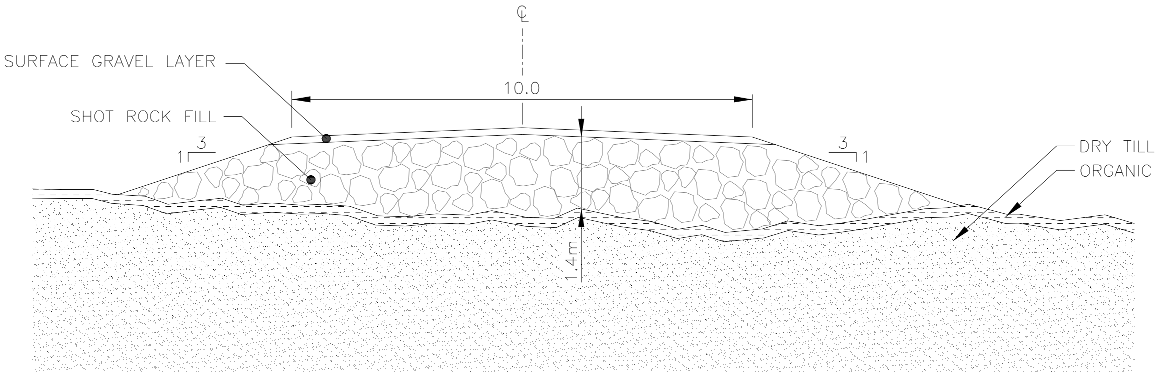


Figure2.3-2: Typical Road Cross Section on Relatively Dry, Stable, Till (Terrain Type 1)

Terrain Type 2:

Terrain Type 2 includes wet till and till with ice-rich permafrost features indicative of thermally sensitive terrain. The terrain is relatively wet, with some expression of ice-rich permafrost conditions, overlain by a thin to moderate organic cover Figure 2.3-3 shows the typical road cross section associated with crossing this type of terrain.

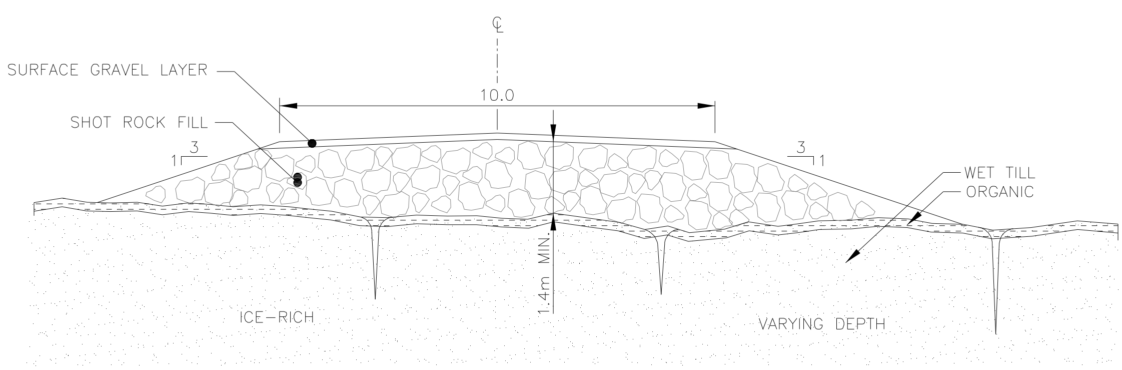


Figure 2.3-3: Typical Road Cross Section on Wet Till or Till with Ice-Rich Patterned Ground (Terrain Type 2)

Terrain Type 3:

Terrain Type 3 includes alluvial silts & sands and/or organic peatlands & ice-rich permafrost. This generalized terrain usually consists of thick organics and poorly drained, fine grained, deposits with moderate to thick organic cover and distinct expressions of ice-rich permafrost conditions. In general, this terrain is unfavourable and was avoided wherever possible. Figure 2.3-4 shows the typical road cross section associated with traversing this type of terrain.

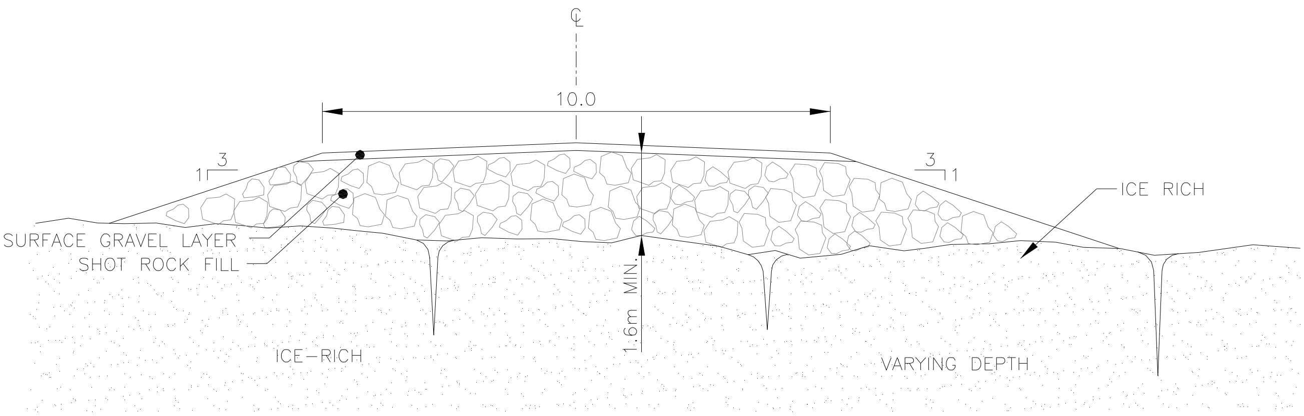


Figure 2.3-4 Typical Road Section on Organic and Wet Fine Grained Deposits (Terrain Type 3)

Terrain Type 4:

Terrain Type 4 comprises frost shattered and boulder covered terrain. The terrain has rugged micro-relief and sometimes depressions are infilled with sediment and/or organics. The fill height required on this terrain is controlled by the micro-relief and geometric constraints to provide a reliable road surface.

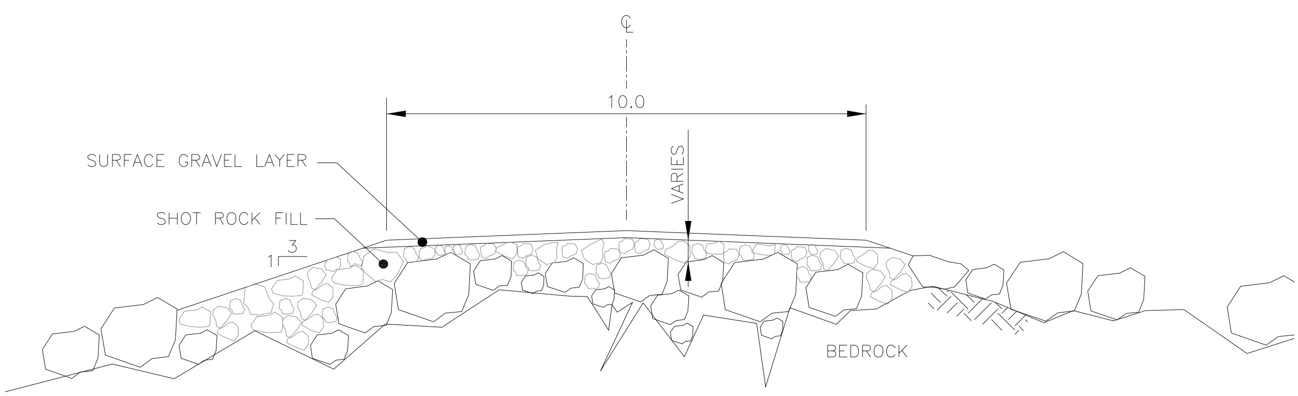


Figure 2.3-5 Typical Road Section on Frost Shattered and Boulder Covered Terrain (Terrain Type 4)

Terrain Type 5:

Terrain Type 5 comprises all bedrock terrain, including exposed/shallow undulating bedrock. This terrain unit is typically irregular and non or sparsely vegetated. This terrain unit is present at the quarry sites and at other areas where exposed bedrock was found. Figure 2.3-6 shows the typical road cross section associated with traversing this type of terrain.

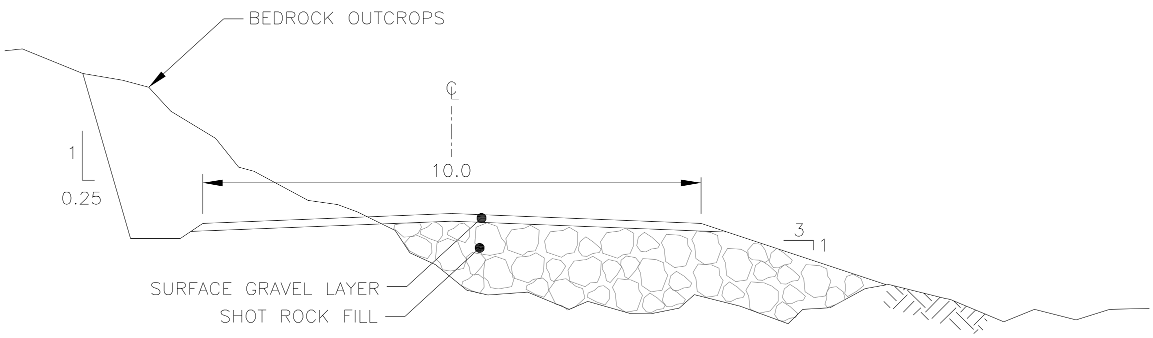


Figure 2.3-6: Typical Road Cross Section on Bedrock (Terrain Type 5)

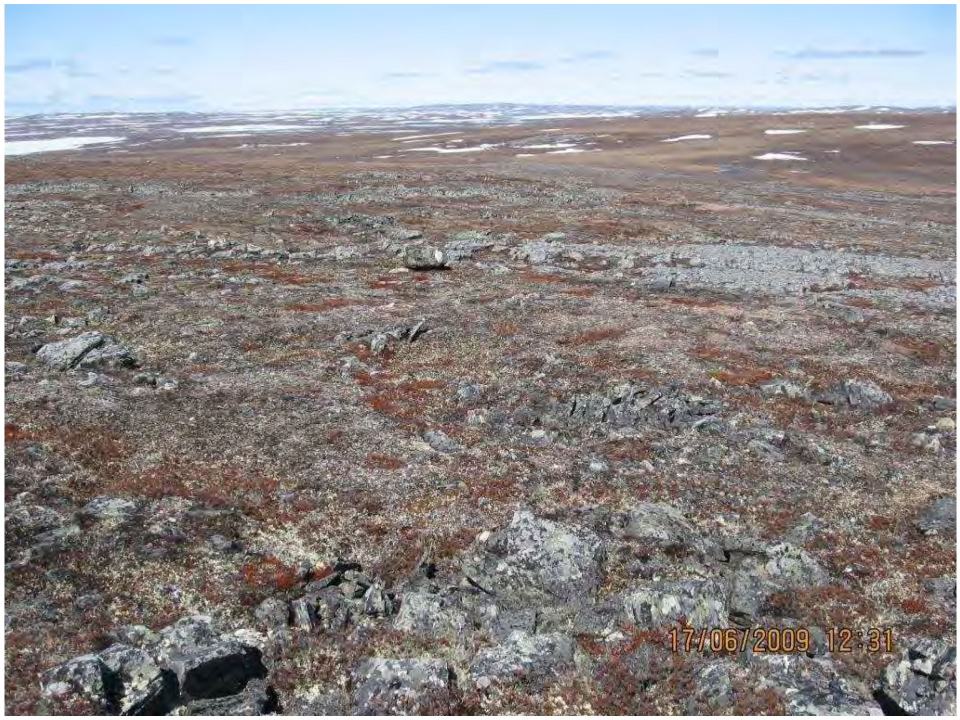
Table 2.3-2 provides the design parameters for minimum depth of embankment fill by Terrain Type.

TABLE 2.3-2: DESIGN PARAMETERS FOR MINIMUM DEPTH OF EMBANKMENT FILL

Terrain Type	Terrain Description	Depth of Embankment Fill
1	Dry (Ice-poor) Till (relatively dry, stable, upland till and outwash deposits, on level terrain overlain by a thin organic cover)	1.4 m
2	Wet (Ice-medium to Ice-rich) Till (relatively wet, with some expression of ice-rich permafrost conditions, overlain by a thin to moderate organic cover)	1.4 m - 1.6 m
3	Alluvial Silts & Sands (Ice-rich) or Thick Organic Peatlands & Ice-Rich Permafrost (wet, fine grained, deposits with distinct expressions of ice-rich permafrost conditions, moderate organic cover)	1.6 m - 1.8 m
4	Frost shattered and boulder covered terrain - rugged micro-relief, with depressions infilled with sediment and/or thin organics)	0.5 m to 1.0 m - Varies based on size of rock (smooth over)
5	Exposed Bedrock - rock (irregular to relatively smooth outcrops, rock cuts)	<0.5m

As indicated in Table 2.3-2, a minimum depth of quarried rock embankment of about 1.4 m is recommended over glacial till terrain for construction, operational and maintenance considerations. Construction with less fill often results in greater maintenance effort and cost, and ultimately additional fill materials will be required. Increased depths of embankment will be required across low-lying, wet areas and areas of ice-rich ground that cannot be avoided, as shown in the photo below, and will most likely be 1.8 m thick or greater.

Construction across wet, undefined drainage channels containing thick organics will also require a greater depth of embankment fill to bridge-over and protect the underlying terrain and allow for a competent road surface. The required depth of embankment over bedrock-exposed terrain will be controlled by the micro-topography of the area, as shown in the photo below, but in general will be 0.3 m to 0.5 m thick.



2.3.3 Detailed Route Description

2.3.3.1 Road Geometry

Horizontal alignments and vertical profiles have been developed using digital terrain models created from the LiDAR survey. The alignment and profiles have been developed in 5km sections using Autodesk Civil 3d 2010. All of the alignments and profiles meet the design criteria specified in Section 2.3.2.2. These plans and profiles are included in Appendix B. and include quarry and water crossing locations.

In general, the grades are gentle, in the order of 1 to 3%. There are some sections that reach the maximum end of the design criteria range of 5-6%. The longest section of this steep gradient (500 meters) is around Km 133.5. The gradient, however, is favourable for loaded vehicles travelling towards the mine.

There are two potential routes around the Hamlet of Baker Lake. The more northerly route is approximately 2 km north of the southerly route which skirts the hamlet by approximately 1-2 km. Both routes are feasible from a geometric and geotechnical perspective. The routes cross the existing Meadowbank Road which connects to an existing port facility. EBA understands that Areva will choose the final route based on discussions with the Hamlet and Agnico-Eagle the Owner/Operator of the Meadowbank mine.

2.3.3.2 Geotechnical Route Description

The surficial landforms along the Northern All Season Road between the Sissons and Kiggavik mine/mill sites and the north shore of Baker Lake comprise mainly glacial till overlying precambrian intrusive igneous and metamorphic bedrock. The periglacial geomorphic processes in the area are characteristic of permafrost conditions associated with excess ground ice.

The eastern portion of the proposed alignment near Baker Lake is below the most recent glacial marine transgression; consequently the elevations near Baker Lake are covered by marine reworked sediments, and the till deposits appear reworked by nearshore marine processes, forming flights of raised strandlines (McMartin, I., Dredge, L.A., and Aylsworth, J.M. 2008). Widespread areas of marine reworked sands are present near Baker Lake and along its shoreline.

Further inland, the glacially deposited overburden soils are interrupted by bedrock outcrops that are more prevalent inland (west). Widespread areas of thin till veneer are present and bedrock boulder fields frequent the route. – also called block fields (or felsenmeer) – as a surface layer of angular shattered rocks formed in either a modern or Pleistocene periglacial environment More recent alluvial sediments occur as thin deposits of fine-grained sand and silt and present themselves locally in topographic depressions (low-lying areas) and along recent stream channels. The project area in general is devoid of glaciofluvial sediments, although there are areas north of Judge Sissons Lake that show evidence of proglacial and subglacial meltwater erosion and deposition (McMartin, I., Dredge, L.A., and Aylsworth, J.M. 2008).

The general surficial geology of the project area is described by the Geologic Survey of Canada, Schultz Lake south, Nunavut, Map 2120A at scale 1:100,000 (McMartin, I., et al., 2008; Aylsworth, J.M., 1990); and Aylsworth, J.M. et al., 1990, 1989, 1985).

Generalized terrain and topographic conditions observed along the proposed Northern All Season Road beginning at the proposed Kiggavik Mine/Mill site at the west end of the route (Km 100) and traveling east towards a proposed port location east of the Hamlet of Baker Lake along the shoreline of Baker Lake (Km 214) are described in Table 4.3-3 below. Generalized Design cross sections for the varying subsurface conditions (Terrain types referenced in table 2-3.3) are shown in the table. These design cross sections will be revised and refined during the next stages of design as more information becomes available.

TABLE 2.3-3: GENERALIZED TERRAIN CONDITIONS ALONG PREFERRED ALIGNMENT			
Kilometre			Description of Terrain Conditions
100	106.5	1	The proposed North All Season road alignment departs the Kiggavik site at an elevation of about 215m and travels along rolling till moraine terrain gradually climbing in elevation to a pronounced rock outcrop at Km 106.5, an elevation of 260 m. This is the location of the first of many proposed rock quarries along the route.
106.5	109.7	1	The alignment then descends at grades of 2 to 5 % for about 3 km to the south end (outflow) of Kavisilik Lake (about elevation 170 m). The terrain grades towards Siamese Lake to the southeast.
109.7			Between Km 109 and Km 110, the road traverses a topographic low along the south end of Kavisilik Lake, separating Kavisilik Lake from Siamese Lake. An open channel water crossing requiring a bridge structure is located at about Km 109.7.
110	111	1	At Km 110, the road climbs in elevation at grades of 3 to 5 % to a topographic high. A route along lower elevations near Siamese Lake was initially investigated, but was judged to be a more difficult alignment because it crossed very wet terrain with many drainage channels that originated from the higher ground. It was decided that a better route would traverse along the higher terrain that avoided the less favorable wet, sensitive ground and significant cross-drainage flow.
111	121.5	4	At Km 111, the road travels along a topographic high ridge top for about 11 km, varying in elevation from 205 m to 230 m. The section of road from Km 116 to Km 121.5 is particularly smooth
121.5	125.0	4	From Km 121.5 to Km 122.5, the terrain becomes more irregular and then begins a long descent from Km 212.5 to Km 125.0 along grades of 2 to 6 % to an elevation of about 125 m at Km 125.0. The alignment crosses a prospect quarry site at Km 122.6 km.
125.0	132.5	1	From Km 125 to Km 132.5, the route further decends in elevation from about 125 m to 90 m at Km 132.5, and crosses two significant stream crossings and several smaller drainage channels that will require culverts or other cross-drainage measures.
127.4			Alignment crosses an open water channel requiring a bridge structure.
129.1			Alignment crosses an open water channel requiring a bridge structure.
132.5	135.0	1	At Km 132.5, the route begins a 3 to 6 % climb from elevation 90 m to 180 m over a distance of about 2.5 km.
135.0	138.0	4	From Km 135.0 to Km 136.5, the route traverses a ridge top and then descends along the southeast side of the ridge at a grade of about 2% to Km 138. The alignment passes by another quarry prospect at about Km 135.
138.0	143.5	1	From Km 138 to Km 143.5, the route traverses relatively smooth ground with a cross slope from an area of topographic high to the lowlands at Km 143.5.
143.5	149.0	1	From Km 143.5 to 144.6, the route decends in elevation and crosses a stream crossing at approx Km 145.1 at an elevation of about 100 m, and then climbs away from the topographic low to about an elevation of 130 m at Km 164 and continues along rolling terrain to about Km 149.
145.1			Stream crossing will require a bridge structure.
147.5			Stream crossing will require a bridge structure.
149.0	157.2	1	The route decreases along relatively smooth terrain for 1 km and then travels along level to gradually rolling terrain weaving around several lakes to the next major crossing at Km 157.2. At 156.2 the route travels by another quarry.
157.2			Stream crossing will require a bridge structure.

Kilometre			Description of Terrain Conditions
157.2	170.0	1	The route continues along relatively favorable, rolling terrain varying in elevation from 90 m to 110 m. At Km 160.5 and Km 163.5 the route passes by two quarry prospects.
170.0	174.4	1	At Km 170.0, the route begins a general decent towards the Thelon River (Km 174). Another prospect quarry site exists at Km 170.5.
174.4	174.8	1	The Thelon River is the most significant crossing along route with a river channel width of about 400 m
174.8	177.0	4	After crossing the Thelon River, the route ascends gradual slopes to rolling terrain. The route connects to a network of existing ATV trails that follow dry ridge tops and generally favorable terrain from the Thelon River towards Baker Lake. The proposed all- season road follows acceptable horizontal and vertical grades along the general direction of the ATV trails.
177.0	182.5	4	From Km 177 to Km 182.5, elevations vary from 90 m to 110 m. Quarry prospects are located at about Km 177.8 and Km 182.5.
182.5	185.0	2	The route passes by two lakes and wet low-lying areas.
185.0	192.0	1	The route ascends in elevation onto more favorable, dry, stable terrain. The route follows the topography of the terrain through this section. From Km 185 to Km 192.0 the route follows relatively dry stable terrain with few lakes. The route crosses low-lying sections from Km 187.4 to Km 187.9, and cross-drainage depressions at Km 189.6, Km 190.4 and Km 191.4 km. Quarry prospects are located at about Km 186.3 m and near Km 191.6.
192.0	195.0	2	At Km 192.0, the route begins descending to a dispersed drainage crossing at Km 193 and continues along low-lying terrain to another stream crossing at Km 195.
193.0			Stream crossing will require a bridge structure.
195.0			Stream crossing will require a bridge structure.
195.0	200.5	1	Beyond about Km 195, the frequency of water bodies increases and the route is forced to navigate around them. The elevation of the terrain from Km 195 to Km 200.5 varies from 70 to 90 m. A Quarry prospect exists at Km 199.2.
197.3			Stream crossing will require a bridge structure.
200.5	213.5	2	The route initially climbs in elevation and then decends over a distance of 1 km before coming to a section of wet terrain from Km 202.5 to Km 203.5, Between Km 207 and Km 208 the route crosses a lowland section that connects a series of lakes that is wet with no defined flow. The route continues along progressively decending terrain to a proposed port site at about Km 213.5 and passes by a rock quarry site at Km 211.3..

Bedrock outcrops along the route are the best available sources of fill material (Rock-of-Quarry) for constructing the road. Quarry sites are available inland along the route, and possible locations have been identified along the entire route.

Morainal/till materials generally provide suitable foundation conditions on which a road can be constructed. These materials are typically moderately well drained comprising of fractions of sand, gravel and cobbles within a fine-grained matrix. They present few limitations to road construction except in areas with steep slopes or where drainage is poor and ice-rich.

Alluvial and organic deposits comprise a small percentage of the materials that will be encountered along the route. Alluvial materials are transported and deposited by streams and gravity and are found along water courses. From a geologic perspective, alluvial deposits could represent potential borrow sources, however, these materials are often fine grained, and ice-rich, and are located in sensitive areas, in close proximity to water bodies. These deposits are of small volume and relatively unmapped, so should not be relied upon as material sources.

2.3.3.3 Water Crossings and Drainage

The route crosses many minor diffuse drainage paths, and many are many of these are ephemeral (dry for most of the year). Defined, but still minor stream crossings will be accommodated using culverts. Larger streams (> 2 meters in width) will be spanned with bridges.

The concept for culvert installation is similar to that commonly used in northern Canada. Culverts of appropriate size are laid in place with little disturbance to the existing ground, at locations where drainage paths have been identified in the detailed design. Fill material is placed and compacted around and over the culverts. In some cases, multiple smaller diameter culverts may be used instead of a single large diameter culvert to avoid having to cut the foundation of the large culvert into the existing ground to maintain the vertical road profile, or to avoid having to create a crest curve or "hump" in the roadway profile where the embankment is constructed over the culvert. Appropriate culvert sizing and location will be confirmed in the detailed design stages of the work.

The route crosses numerous water courses along its length. During the route selection process the alignment was often moved to higher ground where it could run along local drainage divides. This eliminated many of the smaller crossings, and limited the size and flow that would be encountered in others. The water crossings are shown in Appendix B on the Plan/Profile Drawings.

Hydrology work on the Kiggavik project has been undertaken by Golder Associates (Golder). This information has been used to aid in the initial assessment of the stream crossing requirements for the road design. During detailed design, the hydrology information collected by Golder will be used to help determine the type and size of structures to be used. EBA has assumed more culverts and bridges than Golder based on the need for short term drainage and construction issues during freshet where ponding water could compromise the integrity of the road. EBA anticipates the following typical structure types will be used:

- 1 Multi-span bridge at the Thelon River;
- 14 Single-span bridges;
- 13 Culverts;
- 69 Coarse rock fills.

The following table 2.3.3.3 summarizes the water crossings and proposed crossing methods.

TABLE 2.3.3.3: WATER CROSSINGS NORTHERN ALL SEASON ROAD

Crossing #	Plan/Profile Sheet #	Crossing Type	Bridge Length
100.2	101	culvert	
102.8	101	rockfill	
103.1	101	rockfill	
103.4	101	rockfill	
104.2	102	rockfill	
104.7	102	rockfill	
104.7	102	rockfill	
107.0	102	culvert	
107.2	102	culvert	
107.8	102	rockfill	
108.8	103	rockfill	
109.0	103	rockfill	
109.2	103	rockfill	
109.4	103	rockfill	
109.8	103	bridge	20-50m
110.5	103	rockfill	
111.0	103	culvert	
112.9	104	rockfill	
115.3	104	rockfill	
115.4	104	rockfill	
120.2	106	rockfill	
121.2	106	rockfill	
121.4	106	rockfill	
122.4	106	rockfill	
123.8	106	rockfill	
126.1	107	rockfill	
127.5	107	bridge	50m
129.2	108	bridge	50m
129.7	108	rockfill	
130.1	108	rockfill	
131.3	108	bridge	5-10m
132.7	109	rockfill	
134.7	109	rockfill	
134.9	109	culvert	
135.6	109	rockfill	
136.0	110	culvert	
136.8	110	rockfill	
137.2	110	rockfill	
138.0	110	multiple culverts	

Crossing #	Plan/Profile Sheet #	Crossing Type	Bridge Length
138.7	110	rockfill	
139.8	110	rockfill	
140.0	111	rockfill	
140.1	111	rockfill	
140.3	111	rockfill	
140.4	111	rockfill	
140.8	111	rockfill	
143.0	111	rockfill	
145.3	112	bridge	35m
146.1	112	rockfill	
147.1	112	rockfill	
147.6	112	bridge	20m
148.0	112	rockfill	
149.0	113	rockfill	
149.4	113	rockfill	
151.4	113	rockfill	
152.3	114	rockfill	
154.8	114	rockfill	
157.3	115	bridge	50m
157.7	115	bridge	15m
159.5	115	culvert	
161.5	116	rockfill	
163.2	116	rockfill	
163.9	116	rockfill	
168.0	117	rockfill	
169.4	118	rockfill	
172.2	119	rockfill	
174.3	119	rockfill	
174.8	119	bridge	470m
179.8	120	rockfill	
184.6	122	culvert	
185.0	122	multiple culverts	
187.2	122	rockfill	
187.8	122	rockfill	
190.6	123	rockfill	
191.2	123	rockfill	
193.3	124	bridge	20m
195.1	124	bridges	20m and 15m
196.1	125	rockfill	
196.9	125	rockfill	
197.5	125	bridge	40m
197.9	125	rockfill	
198.3	125	rockfill	

Crossing #	Plan/Profile Sheet #	Crossing Type	Bridge Length
199.9	125	rockfill	
202.0	126	culvert	
203.0	126	culvert	
205.2	127	rockfill	
205.6	127	rockfill	
206.6	127	rockfill	
207.6	127	rockfill	
209.4	128	rockfill	
210.9	128	rockfill	
211.7	128	rockfill	
212.2	129	culvert	
212.8	129	rockfill	
212.9	129	culvert	
213.1	129	bridge	20m

Culverts have been used throughout the Canadian north with varying degrees of success. When installed in areas with permafrost, they tend to require more maintenance and fail more often than culverts installed in more temperate climates, especially in areas with thick organic layers and ice-rich ground conditions. For this reason EBA suggests using permeable rock fills to allow passage of water in wet lowland areas with seasonal channelized flows. Specifically selected coarse single graded rock is placed to above the waterline to facilitate the cross drainage in this concept.

2.3.3.4 Borrow Sources and Quarry Locations

Material to be used for constructing road embankments should be either rock or granular material. However, there is minimal granular material of sufficient quality available along the route to consider using it as a source of fill. Most of the route has exposed bedrock of appropriate quality and quantity close to the alignment. The bedrock coutcrops can be developed into suitable quarries for embankment fill material.

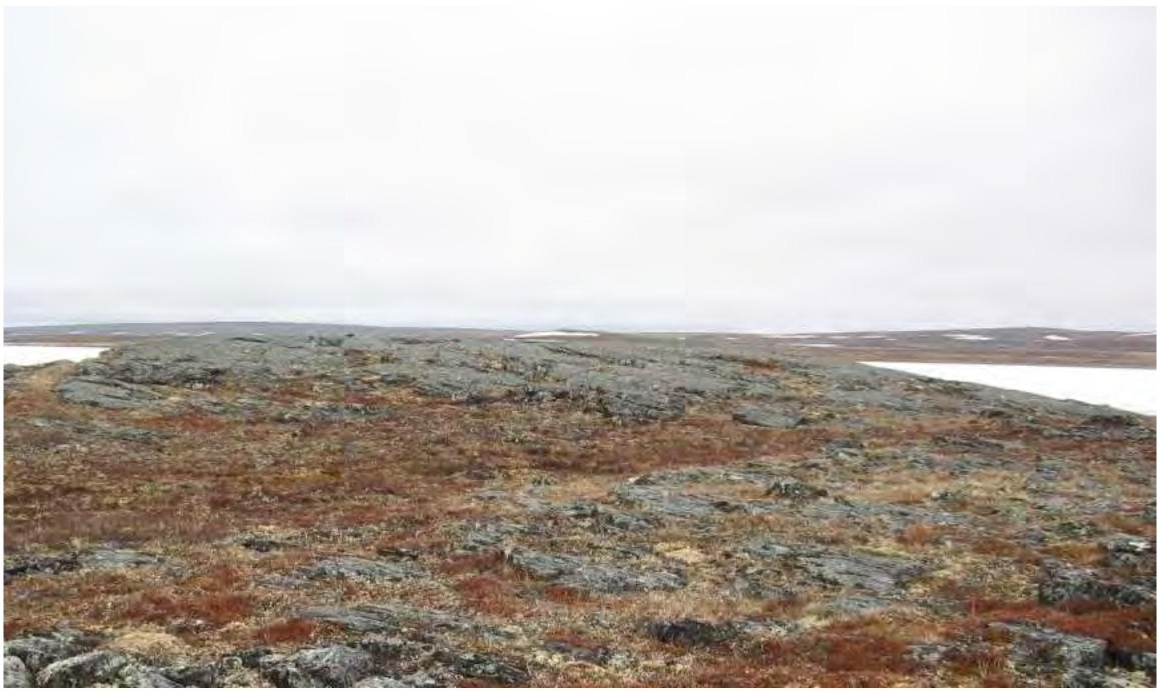
Sources of granular material found along the route include till and alluvial deposits and Glaciofluvial outwash deposits are uncommon. Granular materials found in alluvial areas are often finer grained, ice-rich, and located in sensitive areas, in close proximity to water bodies, and are of small volume and relatively unmapped, so have not been considered as significant material sources. Glaciofluvial outwash deposits occur in the region, but are relatively infrequent and of minimal depth, so they also have not been considered as significant material sources.

The basic road building material used throughout the length of the road will be rock excavated from bedrock quarries situated at various locations along the route. The surface gravel will likely be 19-25 mm crushed gravel produced from the quarried rock, and will be placed in a layer approximately 300 mm thick.

The potential quarry locations are shown previously in Figures 2.3-1a and 2.3-1b. The quarry selection was based upon a combination of factors.

- Accessibility (proximity to alignment);
- Most economical haul distances (approx. 5 km max. based on past experience);
- Potential quarry size (enough volume);
- Ease of excavation (relief and potential face);
- Amount of overburden;
- ARD and ML potential.

The size and final locations of quarries will be developed during detailed design. A typical potential rock quarry site is shown below



2.3.3.5 ARD and ML Potential

A desktop screening assessment of the potential for acid rock drainage (ARD) and metal leaching (ML) within the identified quarries has been undertaken.

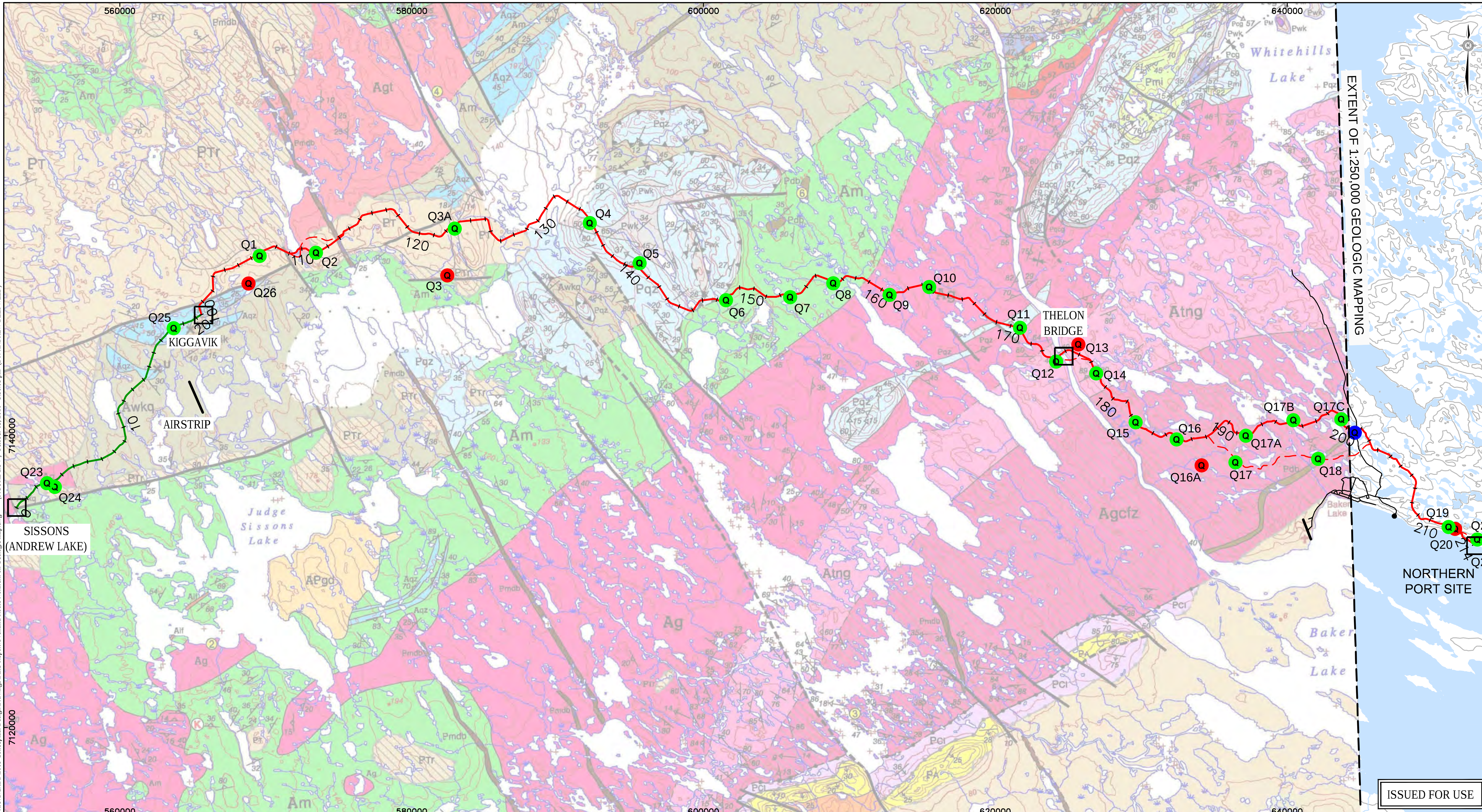
The screening level assessment involved a desktop review of available geological information on the study area, and an analysis of rock chip samples gathered along the alignment in 2009. In addition, information on ARD and ML from other projects in, or near to, the study area was also reviewed in order to identify any common specific geologic rock types or units that have already been found to be of concern.

The proposed access road traverses a number of different lithologies as shown on Figure 2.3-7. The scale of the regional geologic mapping for the route to Baker Lake is at 1:125,000 which means that some local variation in the geology may occur without being shown on the map. The regional geologic mapping for the area of the proposed port facilities is only available at a scale of 1:1,000,000. The broad spatial extent of each unit means that there may be some geochemical variability associated with similar rock types within the same rock unit.

Table 2.3-4 contains a summary of the individual regional geologic units occupied by the proposed quarries. The table also contains a range of the anticipated ARD and ML potential based on the available geologic information for the rock units. From this table it can be seen that the majority of the rock that would be excavated from quarries along the proposed route are not anticipated to have a significant ARD or ML potential.

TABLE 2.3-4 REGIONAL GEOLOGIC MAPPING OF PROPOSED QUARRY LOCATIONS

Geologic Unit	Proposed Quarries within Unit	Anticipated Acid Rock Drainage Potential	Anticipated Metal Leaching Potential
PT: Thelon Formation; quartz arenite; cross-stratified fluvial and eolian sandstones.	Q1, Q2, Q3, Q3A, Q24	None to Low	None to Low
Pwk: KetYet Group metawacke, flaggy to schistose, pervasive carbonate	Q4	None to Low	None to Low
Pqz: quartzite, locally crossbedded and rippled; white but locally hematitic	Q5, Q11	Low to High	None to Moderate.
Am: meta volcanic rocks; minor intermediate to felsic volcanic and volcaniclastic rocks, also undifferentiated meta sedimentary rocks; locally schistose.	Q6, Q7, Q8	**Volcanic rock:** Low to Moderate **Sedimentary rock:** None to Low	**Volcanic rock:** Low to Moderate **Sedimentary rock:** None to Low
Ag/Agcfz: un-subdivided granitoid rocks: granite, granodiorite, tonalite, minor diorite and gabbro: biotite + hornblende; medium to coarse grained; foliated to gneissic.	Q9, Q10, Q15, Q16, Q16A, Q17, Q17A, Q17B, Q17C, Q23	None to Low	None to Low
Atng: porphyritic to inequigranular granodiorite, tonalite and amphibolite; gneissic to layered.	Q12, Q13, Q14	Low to Moderate	Low to Moderate
Pbd: undifferentiated diabase or metagabbro dykes	Q18	None to Low	None to Low
Aqz: quartzite; massive to schistose.	Q25	Moderate to High	Low
Agn: gneiss (undifferentiated)	Q19, Q20, Q21, Q22	Low to Moderate	Low to Moderate



Q:\Vancouver\Transportation\V331\Projects\V33101016 - Areva\CADD\2009 Conceptual Design\Drawings\DEIS Report\Overland Route Northern on Geologic map.dwg [FIGURE 2.3-7] October 05, 2010 - 5:36:05 pm (BY: ANDREW DEEPWELL)

PROPOSED

- Northern All Season Road
- Alternate Alignment
- Haul Road
- km Marker
- Proposed Quarry Site
- Quarry Site (Eliminated)
- Existing Quarry

SCALE 1:250,000

2 0 2 6 10km

PROJECTION: UTM Zone 14
DATUM: NAD 83

CLIENT

AREVA

EBA Engineering Consultants Ltd.

KIGGAVIK PROJECT
CIVIL INFRASTRUCTURE REPORT

NORTHERN ALL SEASON ROAD
GEOLOGIC MAPPING

PROJECT NO.	DWN	CKD	REV
V33101016	AJD	DCD	-
OFFICE	DATE		
VANC	March 26, 2010		

Figure 2.3-7

The highest ARD potential is expected to be associated with the quartzite and hematitic rock types with some ARD potential also expected to exist within the volcanic rock units that may be excavated along the proposed alignment. The ARD and ML potential may be elevated in rock located near to geologic structural features, such as fault zones, where metamorphic alteration may be higher.

The results of the desktop screening assessment and the analysis of the rock chip samples gathered in the field in 2009 are inconclusive with respect to accurate prediction of the ARD/ML potential of the rock contained in each of the proposed quarry sites. Further testing done by EcoMetrix however, confirms that the aggregate samples are non-acid generating , with paste pH values ranging from 6.1 to 8.4. The preliminary results of the leach tests suggest that the potential aggregate rock materials are not likely to represent an issue with respect to leaching of constituents of potential concern..

Because of this anticipated low potential for ARD/ML, it is not unreasonable to consider proceeding with construction and dealing with the issue at that time. Construction procedures will need to be established that call for only clean rock (ARD/ML free) to be placed in areas where roadway drainage has the potential to enter fish bearing streams. Further testing of the rock being excavated from each quarry should be done at time of construction, and decisions made regarding its suitability for placement in these specific areas of critical environmental concern. In general, the roadway fills placed along the majority of the proposed alignment are in areas that are not subject to generation of drainage that will directly enter fish bearing streams, and as such are not of particular concern.

Proceeding with construction in this manner will, however, result in some minor risk that a designated source of rock excavation could turn out to have a higher level of ARD/ML potential than originally anticipated, and the changes made during construction could have a financial implication.

2.3.4 Thelon River Crossing

2.3.4.1 Design Approach

Mr. Darrel Gagnon, P.Eng. of Buckland and Taylor Ltd. reviewed the potential crossing locations of the Thelon River for the proposed access road and the conceptual bridge design previously prepared by EarthTech (See Figures 2.3-8A and 2.3-8B). In general, the preferred alignment appears to provide several desirable attributes for a bridge compared to the alternate alignment. This preferred alignment provides for shorter or fewer bridge spans, more user friendly approach roadway profiles, and would be more suitable for a launching erection method for the superstructure girders. However, good quality rock at a reasonable depth would be required at either location for the river piers. Initial GPR information provided some preliminary information regarding the depth to bedrock at the preferred location. Bedrock was observed near or at surface on the east bank of the crossing and appeared near the riverbed through the river. On the west bank the GPR did

LEGEND

Northern All Season Road
Northern All Season Road Alternate
1m Contour
100m Marker

SCALE 1:5000
50 0 50 100 200m

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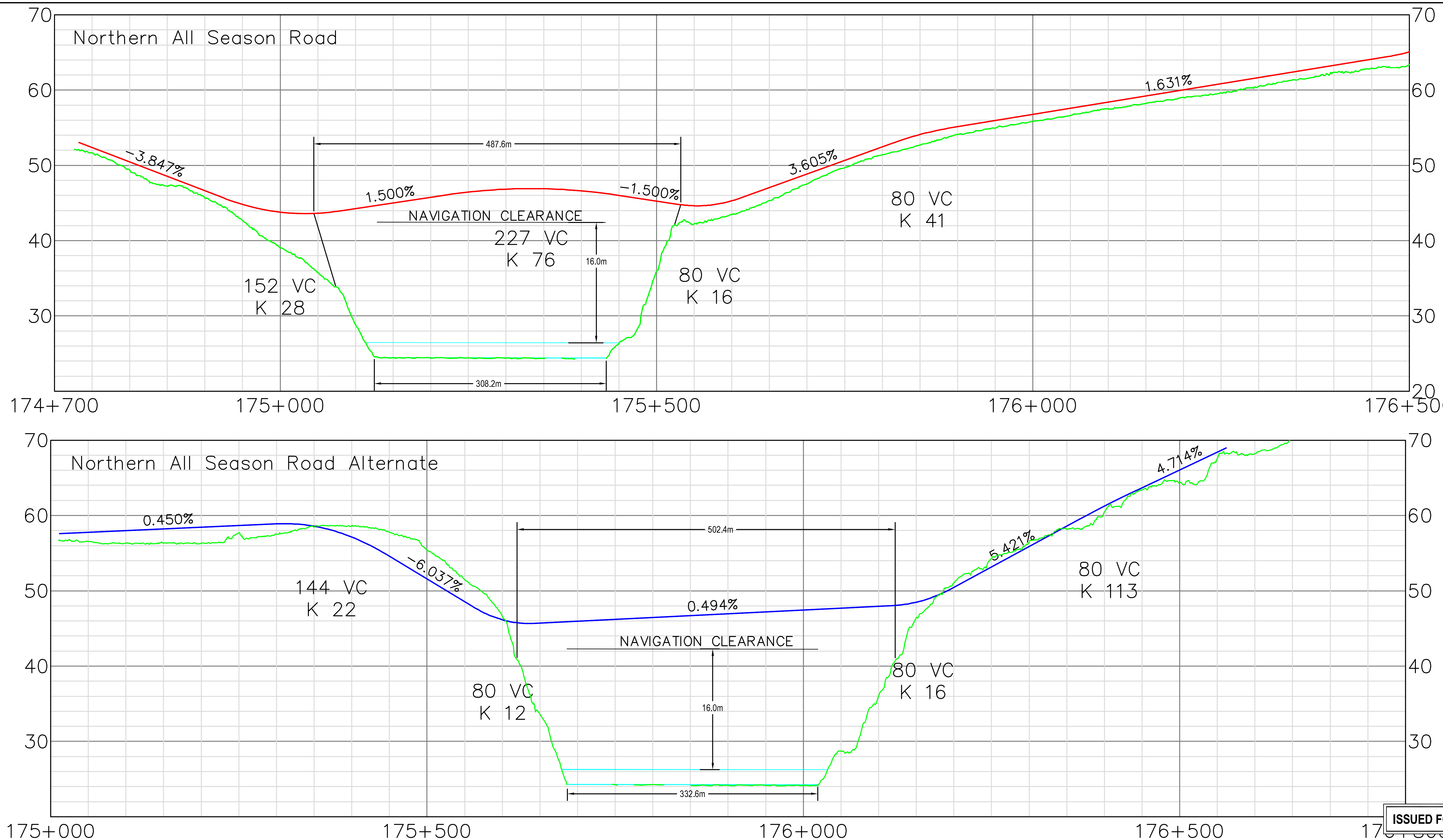
KIGGAVIK PROJECT
CIVIL INFRASTRUCTURE REPORT

THELON RIVER BRIDGE
OPTION DEVELOPMENT

PROJECT NO.	DWN	CKD	REV	
V33101016	AJD	DCD	-	Figure 2.3-8A
OFFICE	DATE			
VANC	March 26, 2010			

Q:\Vancouver\Transportation\V331\Projects\V33101016 - Areva\CADD\2009 Conceptual Design\Design Files\624-627 Alignments and Profiles.dwg [FIGURE 2.3-8A] October 05, 2010 - 5:32:16 pm (BY: ANDREW DEEPWELL)



ISSUED FOR USE

LEGEND

- Northern All Season Road
- Northern All Season Road Alternate

10:1 Vertical Exaggeration

SCALE 1:5000

50 0 50 100 200m

CLIENT

AREVA

EBA Engineering Consultants Ltd.

KIGGAVIK PROJECT
CIVIL INFRASTRUCTURE REPORT

THELON RIVER BRIDGE
OPTION DEVELOPMENT PROFILE

PROJECT NO.	DWN	CKD	REV	
V33101016	AJD	DCD	-	Figure 2.3-8B
OFFICE	DATE			
VANC	March 26, 2010			

Q:\Vancouver\Transportation\V331\Projects\V33101016 - Areva\CADD\2009 Conceptual Design\Design Files\624-627 Alignments and Profiles.dwg [FIGURE 2.3-8B] October 05, 2010 - 5:33:14 pm (BY: ANDREW DEEPWELL) not provide usable data on the depth to bedrock. This could be due to particular soil conditions interfering with the unit, such as clay which cannot be penetrated by the radar signal or indicates that the bedrock was deeper than the radar was capable of penetrating.

The remote location of the bridge site, short summer season and severity of winter conditions will have a significant impact on the construction of the bridge. Extensive use of prefabricated bridge components that can be readily transported to the site will be important to reduce construction costs, duration of construction, and the risk of construction delays.

For the preferred alignment, a five-span bridge with a total bridge span between 409 m to 475 m is expected depending on how close fill materials can be placed to the river. This results in individual spans of 86 m to 100 m. This arrangement would minimize the number of piers required in the river while maintaining a cost efficient superstructure design. Constant depth welded plate girders would likely be used for the superstructure as they typically provide good cost efficiency, can be transported long distances by truck and can be erected using a number of different techniques. Although bridge spans exceeding 100 m can be achieved with constant depth girders, the economics and constructability decline considerably. The five-span arrangement is also desirable as it centers the piers on the river which avoids having a pier located near the center of the river. This minimizes the protrusion of berms into the river, if berms are required/permitted for pier construction. The BLUE alignment is less desirable structurally, as six spans are required to maintain individual spans below 100 m. This results in an additional river pier that is centered in the river.

Access to install the piles/piers and the superstructure steel may be an issue. It is understood that ice forms all the way across the Thelon River at this location during the winter. The GPR survey carried out from the ice surface in April 2009 indicated consistent ice thickness across the entire river at this location. This may provide a window of opportunity where some heavy equipment can be operated on the ice. This can be ideal for installation of the piles and pier construction, as well as for the erection of the superstructure steel. However, doing all of these tasks on a bridge this size is a lot to expect during one winter season. Piles and piers could also be installed from barge mounted rigs or from berms placed in the river but this is subject to environmental approvals and can be vulnerable to high water events. Superstructure steel could be installed from berms, barges or launching the steel pier to pier from one side of the river. Launching can be accomplished during open water times with little relative impact on the river.

2.3.4.2 Construction Staging and Costs

Construction Staging

Access to the proposed bridge site could be staged out of Baker Lake by either barge transportation or via an overland route if available. The base equipment required for pier construction generally consists of a large crane outfitted with a drill attachment capable of creating rock sockets of the required diameter, a vibro hammer and a mobile concrete batch plant. General construction materials would consist of large diameter pipe piles, reinforcement cages and concrete materials. All these materials and equipment could be delivered by barges or via trucks depending on what type of access route is available. Note that numerous additional but smaller types of equipment and the appropriate personnel would also be required.

Bridge construction could commence in either summer or winter depending on the type of access selected for pier construction. While it is likely that pier construction can be completed during one summer or winter construction season, it should be possible to change the type of construction access should the work extend beyond the end of the season.

Depending on construction timing and environmental approvals, two different construction sequences can be envisioned:

Option A: Mobilize all equipment and materials to the crossing site in time to start construction of the river piles when the ice (ice bridge) has sufficient thickness to support the rigs/cranes. Note that construction of an appropriate ice bridge will have to be accelerated by flooding the ice. This has a good probability of allowing the completion of the river piles and piers (hoarding and heating required for pier construction). A contingency plan would be to leave the pier closest to shore for last, as this could be completed from an access berm in open water with the least impact on the river environment. Construction of the far shore abutment and approach embankment would also need to be completed using the ice bridge as access. Construction of the near shore abutment could occur following breakup of the river, but needs to be ready for launching of the steel girders. Launching of steel girders is now a fairly common construction technique, and is expected to be feasible during the spring and summer months. Once the steel girders are in place, precast deck panels can be progressively placed across the spans using the previously installed panels for access. Final grouting of the panels will require relatively warm conditions but could be conducted with hoarding and heating if necessary.

Option B: If environment permits allow, construction of the piles and piers could be conducted using berms and work bridges. This method tends to be more expensive since effective access and supply may only be available from one side of the open river thus requiring a work bridge. However, if the piles and piers are installed during the open water season, erection of the structural steel and deck panels could be more economically conducted in the winter from the ice. Final grouting of the deck panels would likely need to be conducted during warmer conditions in the spring.

Option A will probably be the most economical approach but both options contain significant potential for delays due to unexpected weather conditions and equipment breakdown. It appears from the 2009 GPR survey that ice develops at this location with generally consistent thickness at the crossing location. However, there is potential for thinner ice to develop in areas where currents are stronger and this must be further evaluated before a decision is made to utilize an ice bridge for construction.

If operations are well planned and supported, it may be possible to complete the structure within one year, but two years should be allowed for in the schedule.

Protection of the environment and the remoteness of the site will have a substantial influence on the design and construction of the proposed Thelon River bridge crossing.

Access for River Pier Construction

Construction access to the individual pier locations can be accomplished by a number of means, each with pros and cons as discussed in the following.

Berms constructed from the riverbank to the pier locations using fill materials have often been used to provide access for river pier construction. In addition to access, the berms provide a stable work platform from which to install the piers. However, the installation and removal of the berm material can have a significant impact on the environment and once installed the berms also constrict the flow of the river. From a construction risk point of view, the berms can be vulnerable to high water events and provide access from only one side of the river at a time. Although the bridge superstructure could be installed from berms, it is unlikely that the summer work season would be long enough to complete both pier construction and superstructure erection.

Using barges to provide equipment access for pier construction has proven successful for other northern bridge sites and could be used for the Thelon Bridge if sufficient depth of water, at least 2.0 m, is present at all pier locations. In addition to the barges, substantial additional equipment/materials will be required such as tugs, service boats and temporary barge landings. Since rock socket drilling operations occur over open water, some of the drill spoil would likely enter the watercourse. However, the overall impact is expected to be much less than that of berm construction and removal.

Construction of a temporary work bridge across the river parallel to the permanent bridge would also provide construction access to all pier locations. A work bridge could be constructed from one shore by driving piles and placing superstructure progressively from the end of the already completed bridge. However, it is unlikely that a work bridge could be practically designed to resist the higher ice forces expected on the Thelon. Therefore, the work bridge would need to be constructed and removed in one summer construction season which may not provide sufficient time to complete the work.

As noted the long, cold winter conditions at the site should permit the construction of an ice bridge from which pier construction could be accomplished. An ice bridge would provide flexible access for equipment and materials to all pier locations simultaneously. This approach would probably minimize the construction impact on the environment as there is little or no contact with open water. The primary risks using an ice bridge are the accidental damage to the bridge during construction or insufficient time to complete all piers due to either construction delays or a short ice bridge season due to warmer than expected climatic conditions. Erection of the bridge superstructure can be readily accomplished from an ice bridge, but it would be very aggressive to try to complete both the piers and superstructure in one ice bridge season.

While all of the above methods of access for pier construction should be investigated further, at this time it appears that use of an ice bridge may be the best option for this bridge site.

Superstructure Erection

A bridge superstructure consisting of steel plate girders can be erected by launching the girders from one side of the river or erected using cranes located on an ice bridge or work bridge. Launching of the steel can be conducted in any season but carries some premium for additional equipment required for the launch. Cranes located on an ice bridge can also erect the bridge girders. Similarly, cranes could erect the steel from a temporary work bridge but this would only be economical if the same work bridge was used for pier construction which may not be possible with the relatively short summer construction season.

Precast deck panels can be erected progressively across the bridge using a small crane starting at one end of the bridge using previously installed deck panels to provide access. Alternatively, if an ice bridge or work bridge is still available, the deck panels could be erected along the length of the bridge using a larger crane.

Material Quantities

Further advancement of the bridge design is required to provide reasonably accurate material quantities. However, the following quantities are being provided based on similar previous designs.

- Large diameter steel piles (2.0 to 2.4 m) with 19 mm wall – 120 m or approximately 45 tonnes.
- Cast-in-place reinforced concrete for pier piles – 1300 m^3.
- Steel girders – approximately 700 tonnes of steel.
- Precast concrete deck panels – approximately 135 panels at about 12 tonnes each (7.0 m X 3.0 m X 0.25 m).
- Steel railings.

Cost Estimate

Northern bridge construction projects in remote locations are typically dominated by costs to mobilize equipment and to deploy and maintain personnel on site. As part of our initial investigation we contacted personnel in the NWT Ministry of Transportation for more recent tender costs for remote bridges. The following approximate unit prices for somewhat similar remote bridges were obtained.

- Bear River Bridge – This 500 m bridge requiring barge access for construction was tendered circa 2007. Tender prices in the range of \$15,000 to \$19,000 per m^2 of bridge deck were received near the peak of the construction market. The tender was not awarded.
- Blackwater Bridge – This 300 m long single lane bridge was recently completed using barge access and winter roads. The construction costs were reported to be \$10,800 per m^2 of bridge deck. This project would have been tendered shortly after the peak in construction prices.

Although construction prices have generally reduced in the past 12 to 18 months, it is recommended that bridge construction costs (direct and indirect) in the range of \$11,000 to \$15,000 per m^2 of bridge deck be budgeted for at this time. This corresponds to bridge construction costs between \$30,000,000 to \$43,000,000 for a 7.0 m wide bridge with a total length of 410 m.

2.3.4.3 Bridge Configuration

The proposed bridge configuration can be seen on Figure 2.3-9.

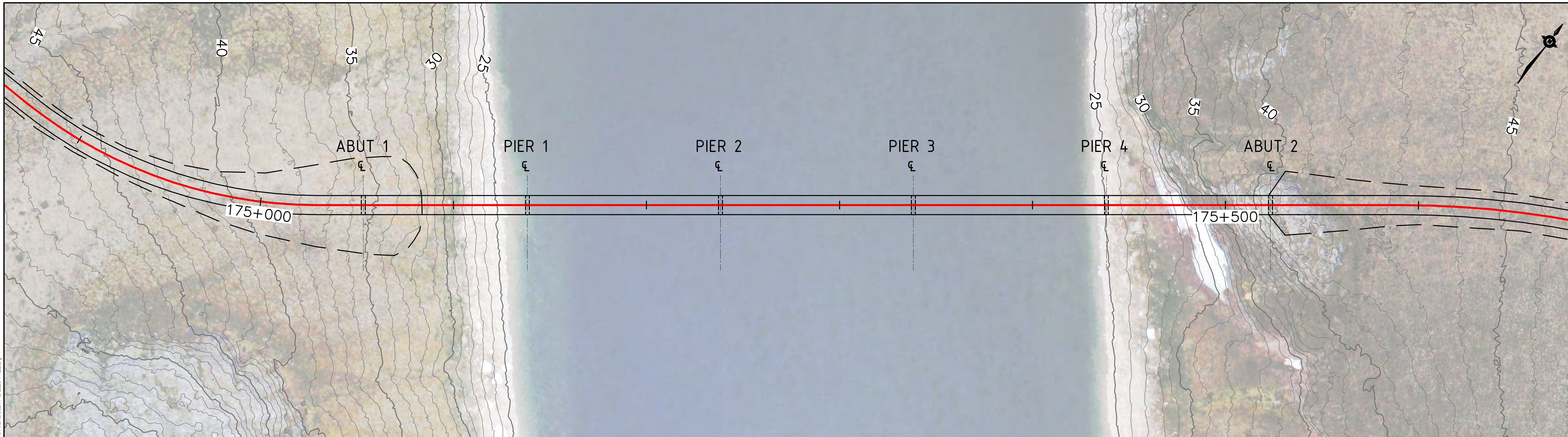
2.3.4.4 Foundation Types

Surficial geology mapping by the GSC of the general area denotes an irregular blanket of glacial till overlying bedrock.

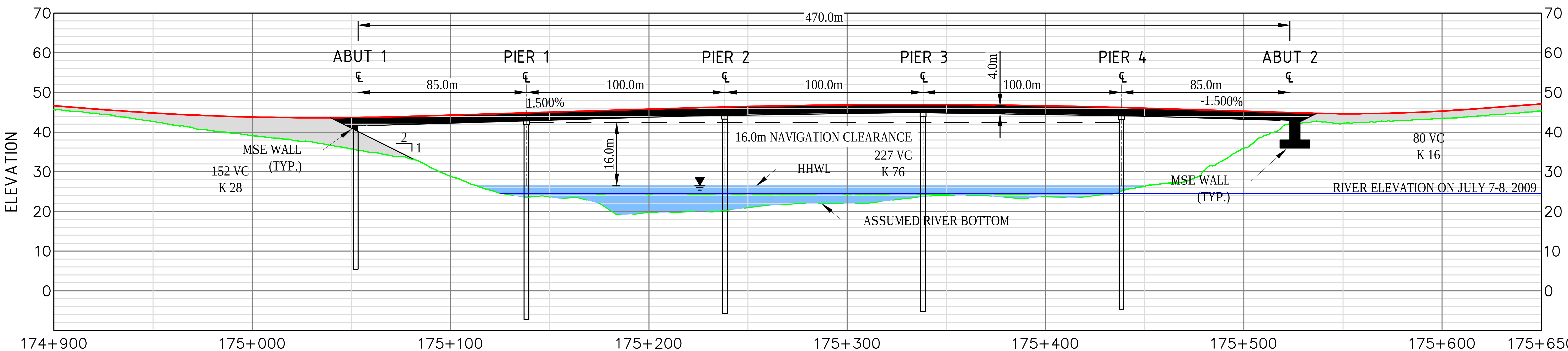
The geophysical survey (GPR and OhmMapper) in the area of the proposed crossing provides an indication of the stratigraphy, refer to Appendix A. In general, bedrock appears to be at relatively shallow depth on the east abutment and across the bottom of the river. It would appear that the depth to bedrock is on the order of 3.0 m or less in these portions of the crossing. Unfortunately, the survey was inconclusive with respect to the depth to bedrock on the east abutment, perhaps due to a higher percentage of clay in the overlying till or potentially a thicker till blanket in this area through which the GPR signal could not penetrate. The three GPR profiles across the river clearly show that the river bed topography is highly variable in this area.

Currently no subsurface borehole data exists for the proposed crossing location. At minimum, boreholes should be advanced at both abutment locations and at each pier location.

Large diameter piles, as indicated in the concept drawings, have proven successful in terms of economics and reducing environmental impacts for other northern river crossings (Suncor Bridge near Ft. McMurray is an example). However, the use of such piles will depend on the existence of appropriate geotechnical conditions at the selected crossing location. Decent rock at a reasonable depth is typically required to develop the necessary end bearing capacities and to provide sufficient lateral resistance against ice forces. However, using steel caissons allows the piles to be installed without dewatering through significant thicknesses of softer overburden materials. At Suncor the piles extended



PLAN



PROFILE

ISSUED FOR USE

LEGEND

- Northern All Season Road
- 1m Contours
- 2:1 Vertical Exaggeration
- Elevations measured above sea level

SCALE 1:2000

20 0 20 40 80m

CLIENT: AREVA

BUCKLAND & TAYLOR LTD. Bridge Engineering

eba

KIGGAVIK PROJECT
CIVIL INFRASTRUCTURE REPORT

THELON RIVER BRIDGE
GENERAL ARRANGMENT

PROJECT NO.	DWN	CKD	REV
V33101016	AJD	DCD	-
OFFICE	DATE		
VANC	March 26, 2010		

Figure 2.3-9

through up to 17.0 m of sand prior to being rock socketed into the underlying limestone layers. Other types of river piers are possible, but will likely require coffer dams or dewatering within containment berms to construct. This would increase the duration of construction and the exposure of the project to the higher risks associated with dewatered construction or high water events and unseasonable weather.

Although a variety of designs and construction methodologies could be used for the river piers, the use of large diameter pile type piers would be desirable at this location. Each river pier would consist of two large diameter piles (2.0 to 2.4 m in diameter) that are likely interconnected near water level and by a pier cap. In the last 10 to 15 years, the construction of such river piers has proven to be rather economical with lower impacts on the environment.

The primary advantage of large diameter pile type pier is that they can be constructed from the surface of the river without the need for dewatering. This avoids many of the construction risks and environmental impacts inherent in more traditional cofferdam construction techniques. The construction process for these piers starts with large diameter steel pipe piles being vibro-hammered through the riverbed materials down to the top of bedrock. A large diameter auger drill is then advanced through the pipe pile into the bedrock to form a socket into the bedrock. A reinforcement cage is placed into the pipe pile and rock socket, and tremie concrete is then placed to complete the pile. The steel pipe acts as formwork, environmental containment and protection against abrasion from future ice floes.

Typically, competent bedrock at depths not greater than 20 m below water level is required to make this type of pier viable. The preliminary data from the GPR survey would indicate that this type of foundation would therefore be appropriate.

2.3.5 Examples of Alternatives Considered

The route selected to be carried through to design was developed in accordance with the design principles and routing selection criteria stated in Section 2.3.2.

The following examples are indicative of the process used to reach the current level of design.

2.3.5.1 Geotechnical Stability Issue at Km 135-140

The prefeasibility report had a gentle grade following the base of the valley slope that stayed as far away as possible from the ice-rich terrain and water courses. Examination in the field revealed that this ground was unstable and should be avoided. There are numerous locations along this corridor that show evidence of previous landslides. These landslides occur only in ice-rich soils in permafrost regions. Retrogressive thaw flows develop in ice-rich, fine-grained sediments and result from the thawing and subsequent flow of water-saturated ground. These failures can occur on very gentle slopes and hundreds of these features line the river banks and tundra lakes in the project area. These landslides are typically relatively small, but over time can retreat some distance back from the rim and from the escarpment.

The photo on the following page shows a typical slide in this area. These slides could have a significant impact on a road if one were to occur.

As a result of this geotechnically unstable area, the road was re-routed to the top of the ridge to avoid any potential landslides. This was also beneficial from an embankment perspective as it allowed us to use less fill material. From a maintenance perspective, it avoided areas of snowdrifts that would have occurred at the base of the slope.

Further details of this area of geotechnical instability, including the alignments considered are illustrated in Figure 2.3-10.

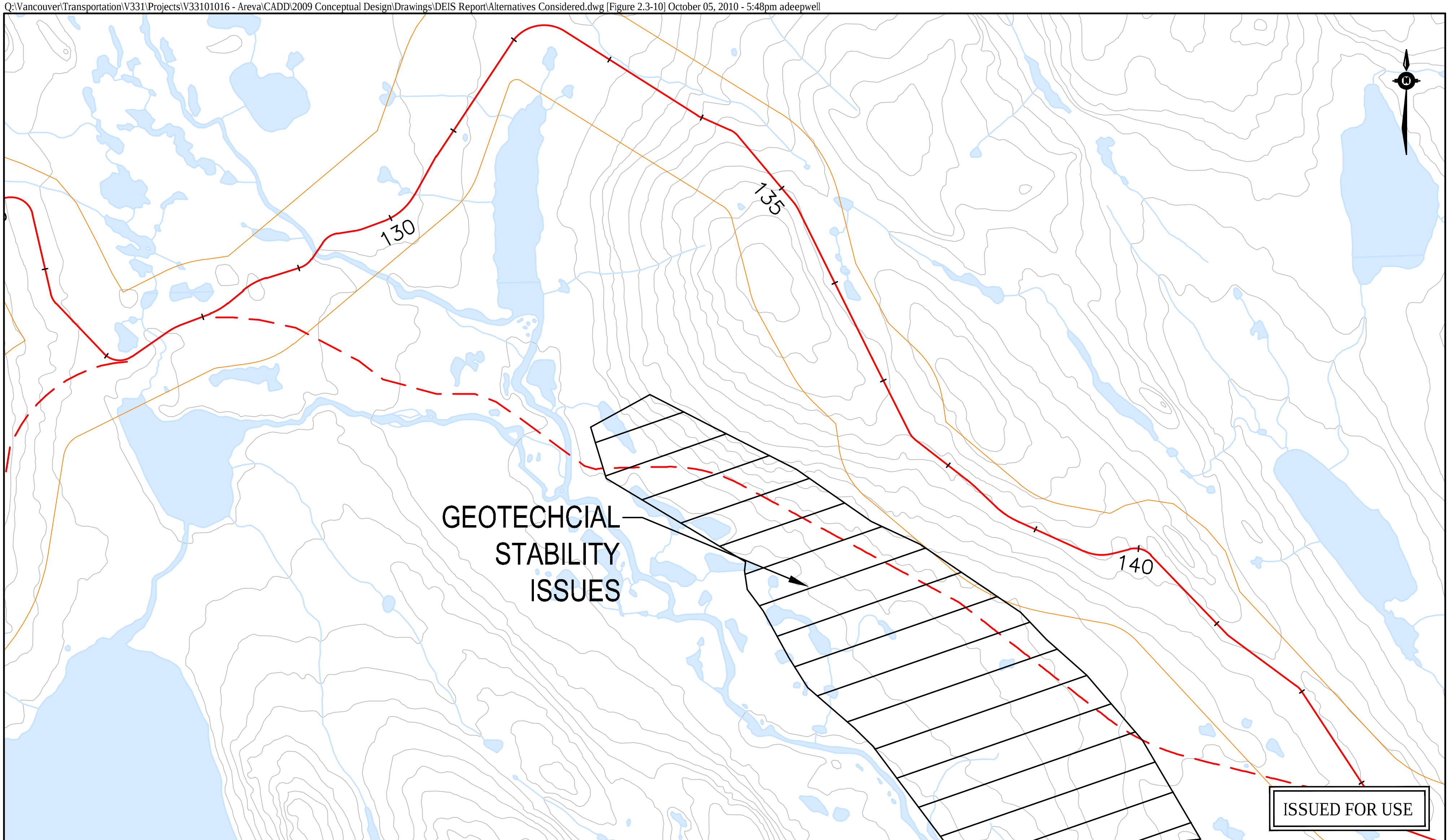
2.3.5.2 Raptor and Maintenance Issues at Km 120-125

The initial field visit located an acceptable route in the lowlands with minimal gradient changes. It was determined later that this route was close to a raptor nest. An alternative route was then developed to avoid the raptor nest. This alternative route was examined in the field during early spring, at which time was evidence was observed of more snow drifts along the original route than the alternative.

The original alignment would have resulted in significant maintenance issues if it had been chosen. Although the alternate route has a steeper gradient, the combination of avoiding snowdrifts and raptor nests makes it the preferable route.

Figure 2.3-11 is a plan of this area, including the alignments considered to avoid the raptor nest and the large snow drift area.

Q:\Vancouver\Transportation\V331\Projects\V33101016 - Areva\CADD\2009 Conceptual Design\Drawings\DEIS Report\Alternatives Considered.dwg [Figure 2.3-10] October 05, 2010 - 5:48pm adeepwell



PROPOSED

- Northern All Season Road
- Previous Alignment
- Haul Road
- km Marker

EXISTING

- Quarry
- 10m Contour - NTS Base Data
- Extents of Road LiDAR Survey (2009)
- Raptor Nest

SCALE 1:50,000

0.5 0 0.5 1.0 2.0km

PROJECTION: UTM Zone 14
DATUM: NAD 83

CLIENT

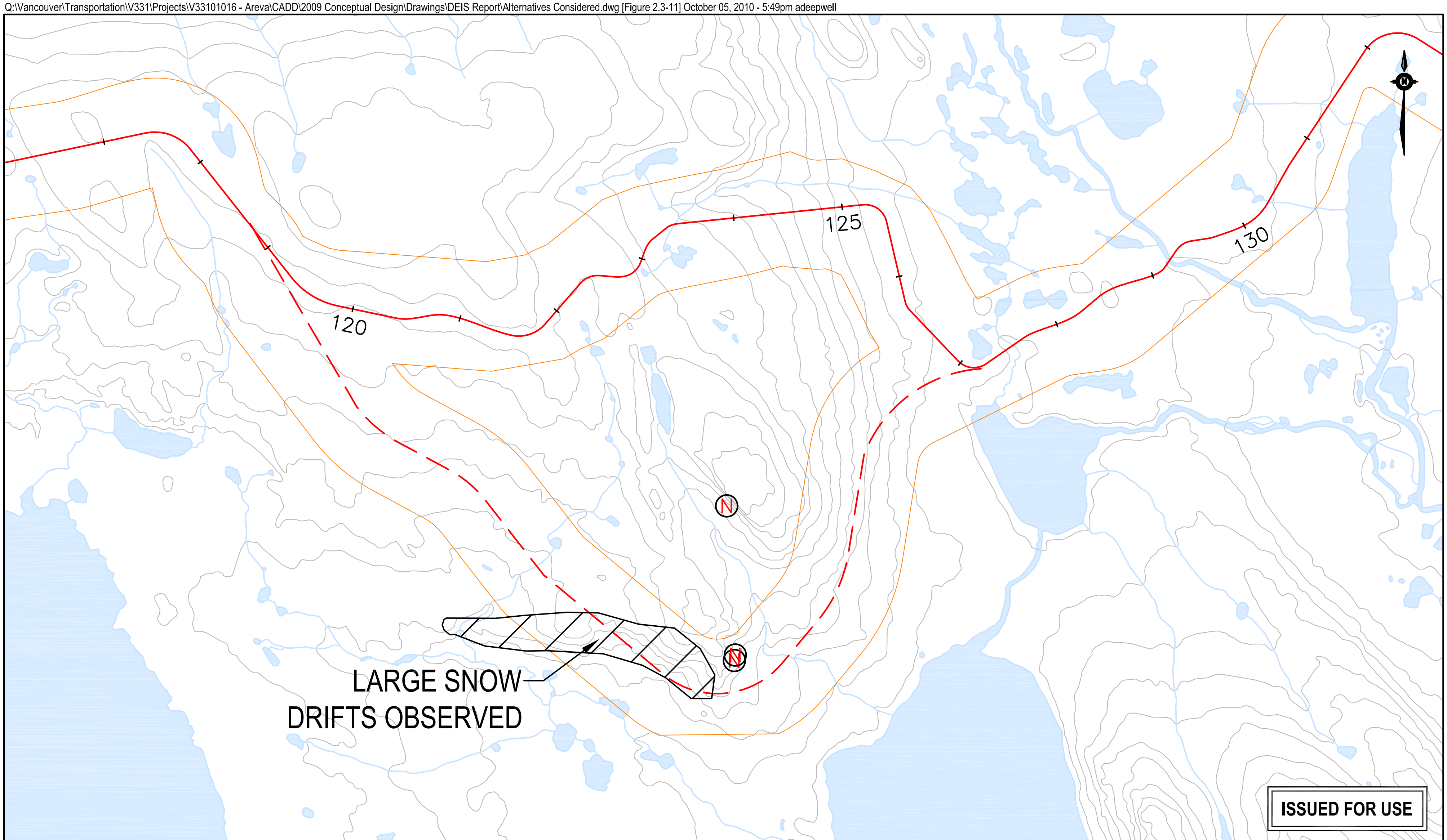
AREVA

EBA Engineering Consultants Ltd.

KIGGAVIK PROJECT
CIVIL INFRASTRUCTURE REPORT

NORTHERN ALL SEASON ROAD
GEOTECHNICAL STABILITY ISSUES 135-140km

PROJECT NO.	DWN	CKD	REV	
V33101016	DCD	GEW	-	Figure 2.3-10
OFFICE	DATE			
EBA-VANC	March 26, 2010			



PROPOSED
- Northern All Season Road
- Previous Alignment
- Haul Road
- km Marker

EXISTING
- Quarry
- 10m Contour - NTS Base Data
- Extents of Road LiDAR Survey (2009)
- Raptor Nest

SCALE 1:50,000

0.5 0 0.5 1.0 2.0km

PROJECTION: UTM Zone 14

DATUM: NAD 83

CLIENT

AREVA

EBA Engineering Consultants Ltd.

KIGGAVIK PROJECT
CIVIL INFRASTRUCTURE REPORT

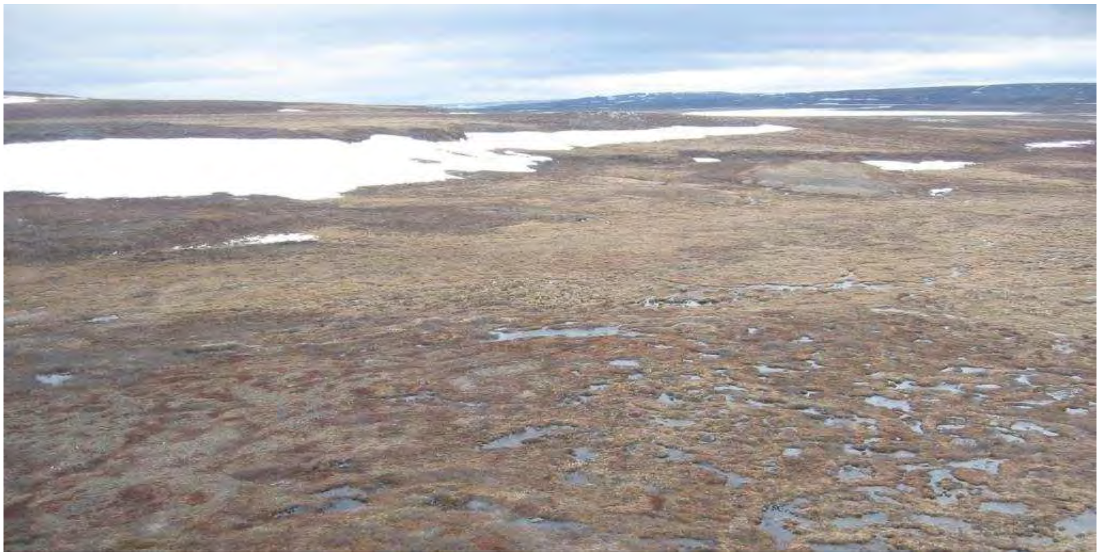
NORTHERN ALL SEASON ROAD
RAPTOR NEST AND MAINTENANCE ISSUES

PROJECT NO.	DWN	CKD	REV
V33101016	DCD	GEW	-

OFFICE	DATE
EBA-VANC	March 26, 2010

Figure 2.3-11

The following photo shows one of the many large snow drifts along the original route.



2.3.5.3 Terrain Types and Drainage Issues at Km 100-109

The prefeasibility route was designed on having gentle gradients. More detailed terrain typing and field investigation has revealed that the prefeasibility route was prone to ice-rich areas and was located in areas of diffuse drainage. The road was then re-routed to a dryer, higher area with minimal or no cover over the bedrock. The following photo illustrates an area of ice-rich terrain and diffuse drainage.

The following photo illustrates a preferable location for the road, as it is a dryer, higher area with minimal or no cover over the bedrock.

This shift in routing allowed for an embankment design that required less material, fewer culverts, and fewer drainage solutions.

Figure 2.3-12 is a plan showing the relocation of the alignment to the higher, dryer area.

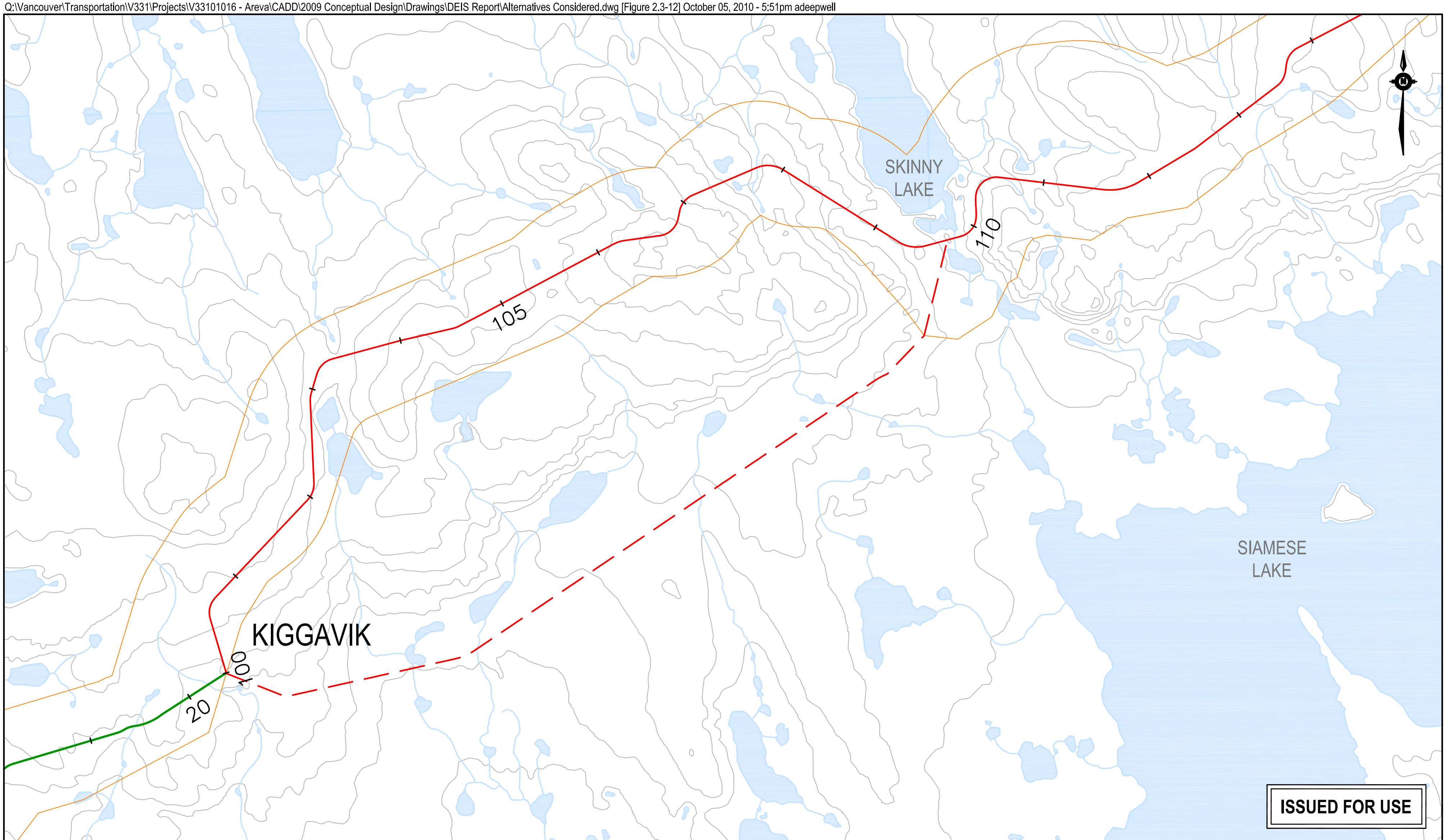
2.3.5.4 Archeological and Caribou at Km 109-110

Multiple routes in this area were developed as information on the location of Archeological and Caribou crossings became available. Routes included crossing further south in the valley as well as to the north on the edge of Skinny Lake as shown on Figure 2.3-13.

All of these routes are acceptable from a geometric and geotechnical perspective, however, the final route will be determined based on further guidance from the Archeological and Caribou team members.

The following photos show the valley crossing south of Skinny Lake, and the spit at the end of Skinny Lake.

Q:\Vancouver\Transportation\V331\Projects\V33101016 - Areva\CADD\2009 Conceptual Design\Drawings\DEIS Report\Alternatives Considered.dwg [Figure 2.3-12] October 05, 2010 - 5:51pm adeepwell



PROPOSED
- Northern All Season Road
- Previous Alignment
- Haul Road
- km Marker

EXISTING
- Quarry
- 10m Contour - NTS Base Data
- Extents of Road LiDAR Survey (2009)
- Raptor Nest

SCALE 1:50,000

0.5 0 0.5 1.0 2.0km

PROJECTION: UTM Zone 14
DATUM: NAD 83

CLIENT

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KIGGAVIK PROJECT
CIVIL INFRASTRUCTURE REPORT

NORTHERN ALL SEASON ROAD
ALIGNMENT RELOCATIONS

PROJECT NO.	DWN	CKD	REV
V33101016	DCD	GEW	-

OFFICE: EBA-VANC
DATE: March 26, 2010

Figure 2.3-12

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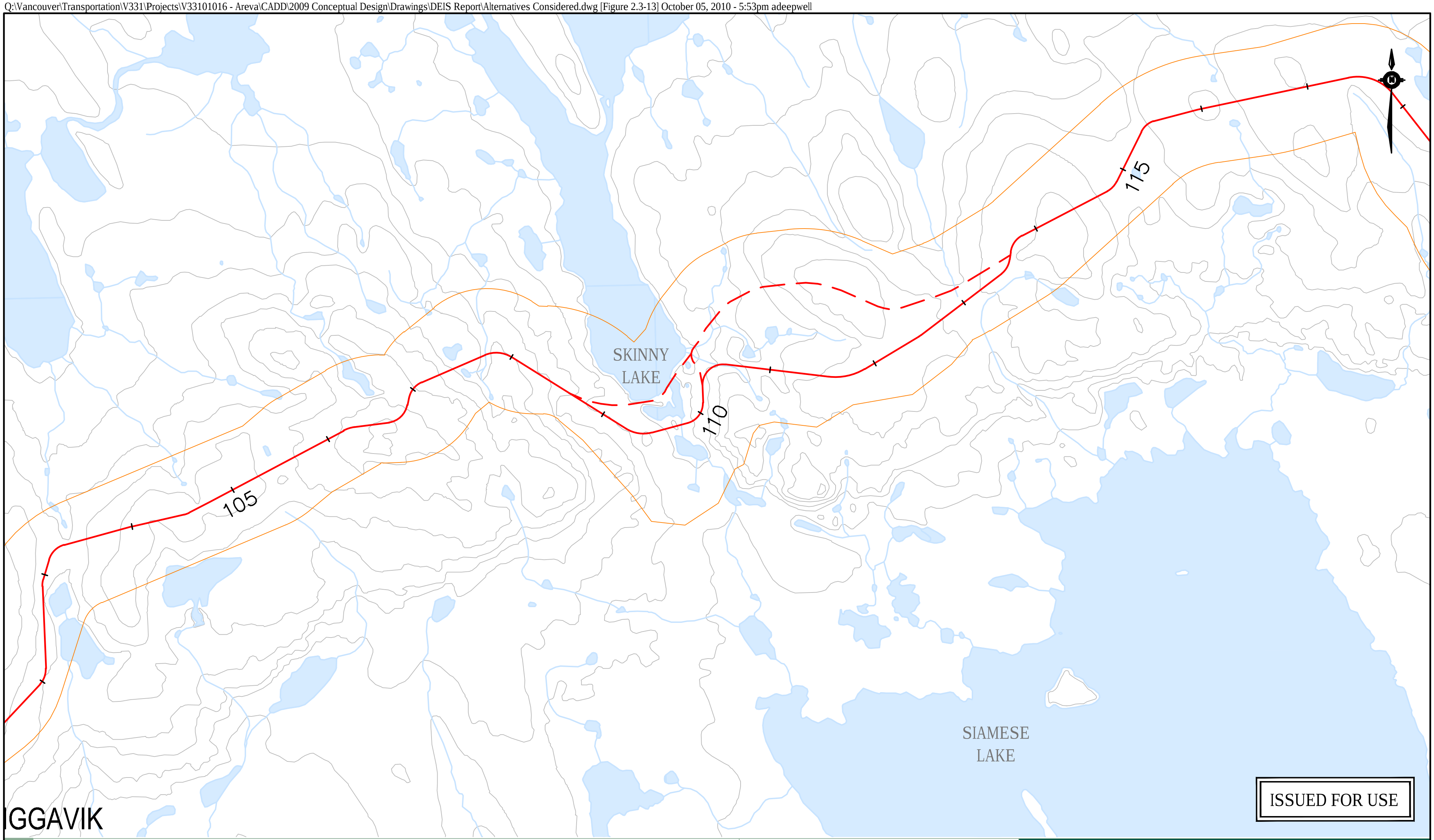


PROPOSED
- Northern All Season Road
- Previous Alignment
- Haul Road
- km Marker

EXISTING
- Quarry
- 10m Contour - NTS Base Data
- Extents of Road LiDAR Survey (2009)
- Raptor Nest

SCALE 1:50,000
0.5 0 0.5 1.0 2.0km

PROJECTION: UTM Zone 14
DATUM: NAD 83

CLIENT
AREVA

EBA Engineering Consultants Ltd.
eba

KIGGAVIK PROJECT
CIVIL INFRASTRUCTURE REPORT

NORTHERN ALL SEASON ROAD
ARCHEOLOGICAL AND CARIBOU CONCERNS

PROJECT NO.	DWN	CKD	REV
V33101016	DCD	GEW	-
OFFICE	DATE		
EBA-VANC	March 26, 2010		

Figure 2.3-13

2.3.6 Construction Staging

For purposes of estimating the probable approach that a contractor would take in constructing the northern all season road, and to estimate the time that it would take to construct, we have divided the project up into distinct sections as shown on the following key plan:

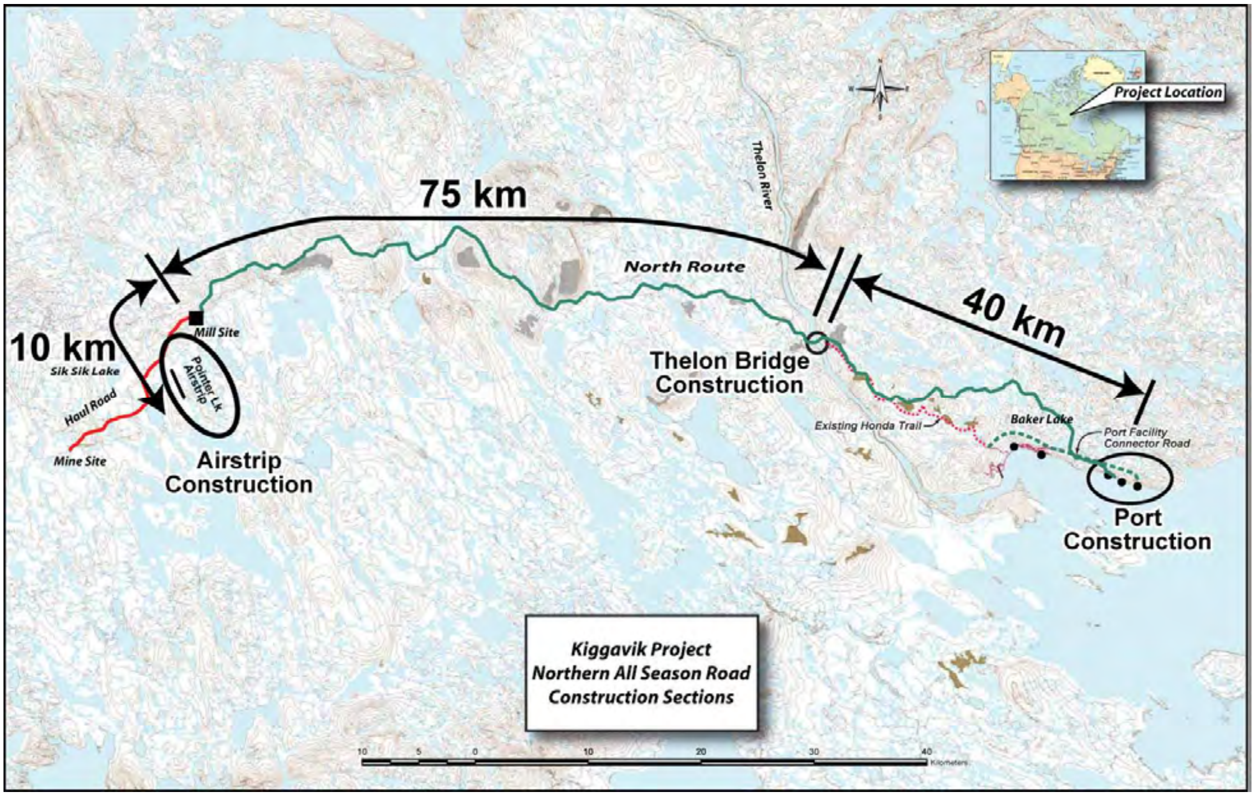


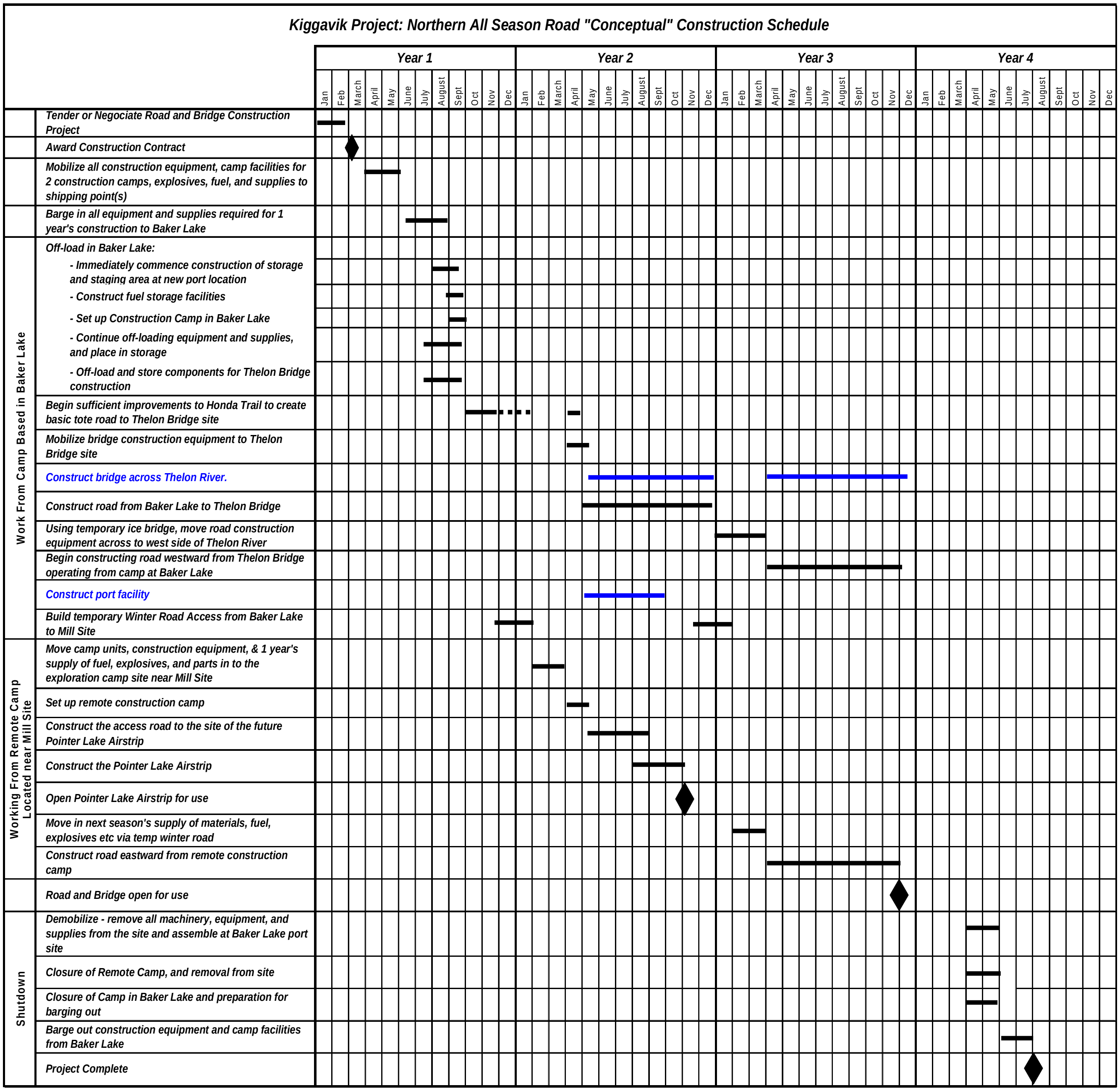
Figure 2.3-14: Construction Sections Map

In summary, the distinct sections of construction work will include:

- Construction of the port facilities. This could also be a suitable location for the Baker Lake temporary construction camp;
- Construction of approx. 40 km of road from the port facility to the Thelon River Bridge site. A portion of this alignment already crosses and parallels portions of the Honda Trail. Detailed design would determine the exact location of the road in with respect to the Honda Trail. If the Honda Trail was incorporated into the road, it would need to be reconstructed and upgraded to the full all season road standard;
- Construction of the Thelon River Bridge;
- Construction of approx. 10 km of road from the mill site to the site of the proposed Pointer Lake Airstrip. This work would be based out of a temporary construction camp to be located in the vicinity of the existing exploration camp;

- Construction of the Pointer Lake Airstrip;
- Construction of approx. 75 km of road from the Thelon River Bridge to the mill site.

Since the design of the road and bridge is presently at an early preliminary stage, precise quantities and details of items of construction are still unknown. However, sufficient work has been done to estimate a possible schedule of work. The following chart outlines a scenario where construction is based out of two (2) separate construction camps, one located in Baker Lake, and the other near the mill site.



As outlined on the previous chart, the construction work would take place over a three (3) year period, with the final demobilization and removal of construction equipment occurring in the shipping season of the fourth year.

The phasing of construction work is illustrated further as follows:

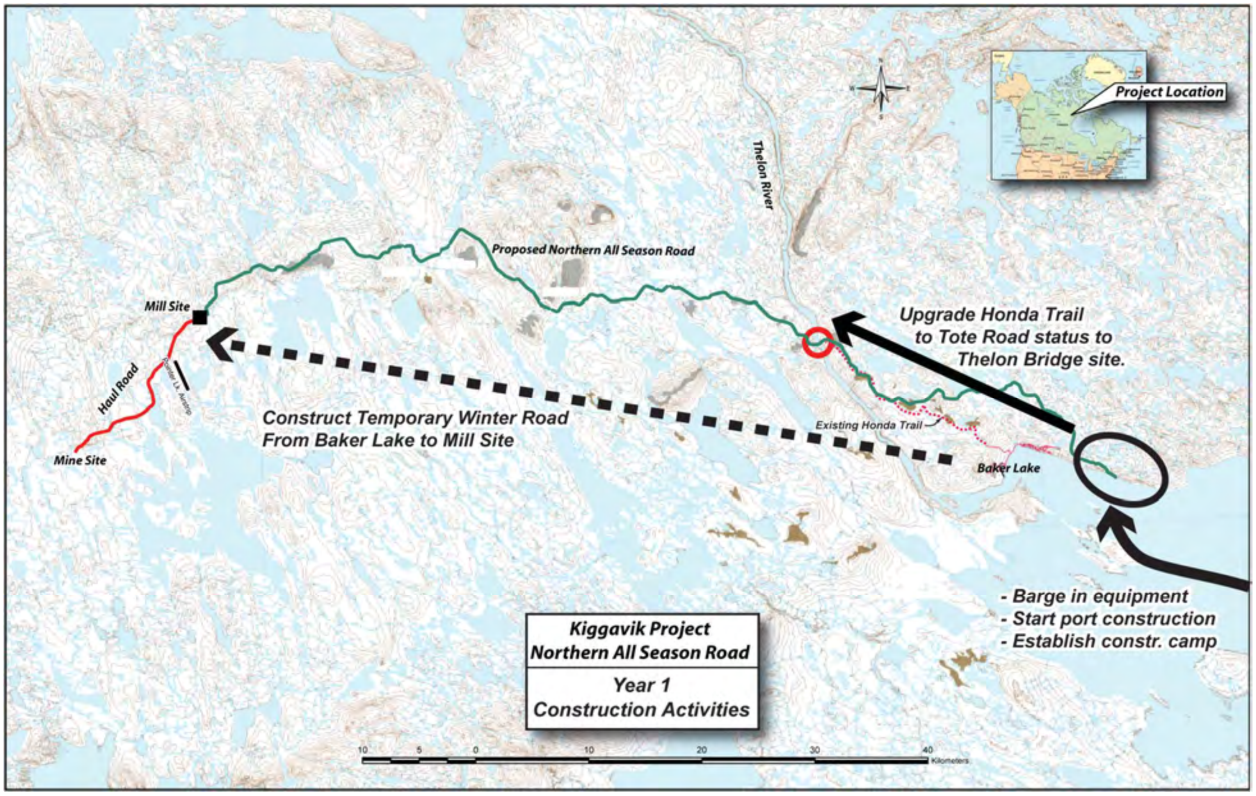


Figure 2.3-15: Year 1 Construction Activities

The extent of construction during Year 1 is somewhat limited by the earliest date that equipment and supplies can be barged into Baker Lake. It is assumed that shipping channels will become open sometime in July or August.

The immediate construction activity will be to prepare a storage area at the future port site suitable to receive all the construction equipment, supplies, and camp facilities that will be arriving by barge. Construction will then commence on upgrading the existing Honda Trail to a tote road status adequate for moving the Thelon Bridge construction equipment up to the site. A construction camp will be established at a suitable location near Baker Lake, or possibly at the site of the new port facility.

During the winter months, a temporary winter road will be established connecting Baker Lake to the Mill Site for purposes of mobilizing the second campsite and construction spread.

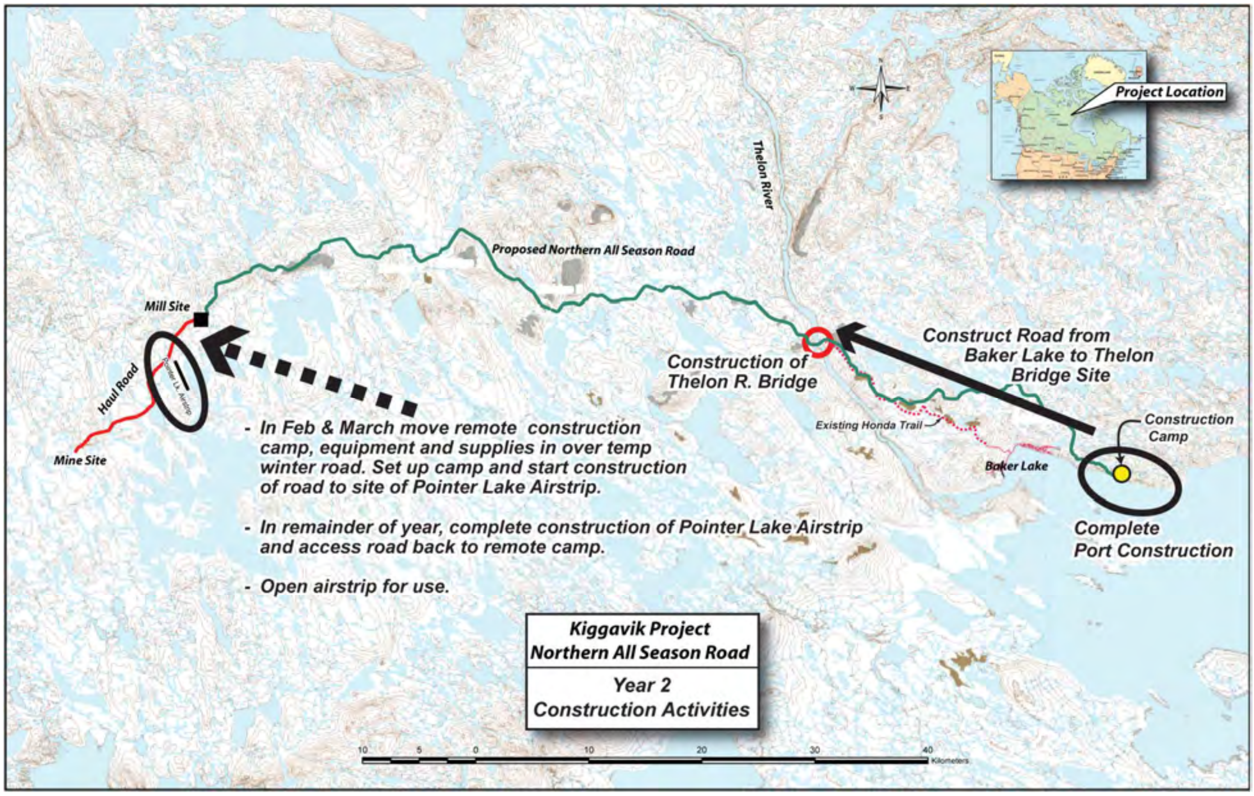


Figure 2.3-16: Year 2 Construction Activities

It is assumed that the temporary winter road will be suitable for use in February and March of the 2nd Year. At this time the remote camp will be moved into place somewhere near the existing exploration camp, and construction of the access road to the site of the future airstrip will commence. Work will continue all season finishing the airstrip and access road.

Meanwhile, construction of the road from Baker Lake to the Thelon River Bridge will be underway, as well as construction of the port facility, and initial construction of the Thelon Bridge.

At the end of Year 2, a temporary winter road will once again be put into place to facilitate the hauling into the remote campsite of all the supplies, fuel, explosives, parts, etc that will be required for Year 3.

As illustrated on the following graphic, construction in the 3rd Year will consist of building the Northern All Season Road from the east and west simultaneously. In addition, construction of the Thelon Bridge will be completed, allowing the road to be put into service late in the year.

Final demobilization of equipment will have to wait until the following year, as barging services out of Baker Lake will not be available until approximately June or July.

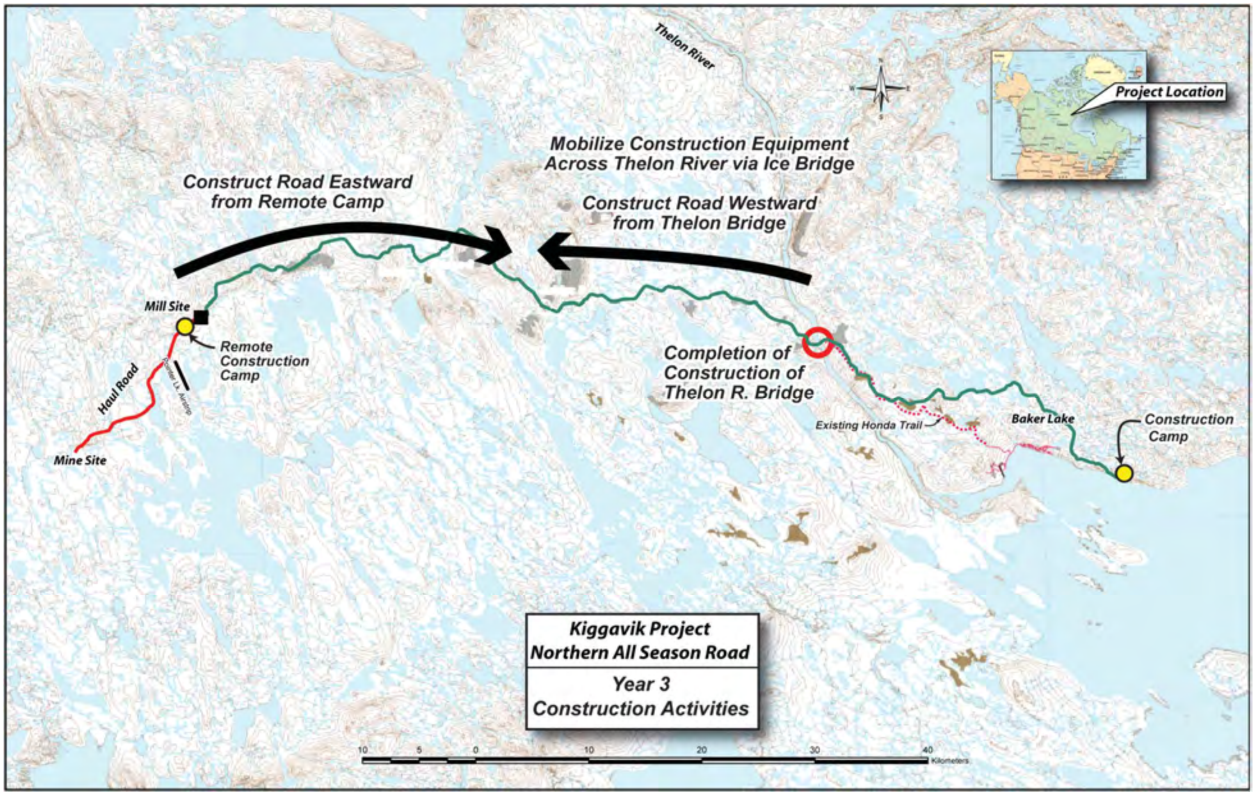


Figure 2.3-17: Year 3 Construction Activities

2.3.7 Quantities and Cost Estimate

2.3.7.1 Quantity Estimates

Approximate preliminary material quantities were developed using the Lidar information along the road. The quantities were calculated applying the typical sections outlined in Section 2.3.2.3.and modeling the finished road surface in Civil3D. Results are summarized below and have been extrapolated from representative sections that were carefully designed along the alignment.

The volume of embankment is in the range of 2.5 Million cubic meters.

The volume of road surfacing has been estimated to be 375 Thousand cubic meters.

The following table shows estimated volumes based the level of design completed to date.

TABLE 2.3.7.1 NORTHERN ROUTE QUANTITIES				
Start Station (km)	End Station (km)	Design Terrain Type	Embankment Fill (m^3)	Surfacing Material (m^3)
100	106.5	1	143,000	22,000
106.5	110	1	77,000	12,000
110	111	1	22,000	3,000
111	121.5	4	210,000	35,000
121.5	125	4	70,000	12,000
125	132.5	1	165,000	25,000
132.5	135	1	55,000	8,000
135	138	4	60,000	10,000
138	143.5	1	121,000	18,000
143.5	149	1	121,000	18,000
149	157.2	1	180,000	27,000
157.2	170	1	280,000	42,000
170	174.4	1	96,000	15,000
174.4	174.8	1	9,000	1,000
174.8	177	4	44,000	7,000
177	182.5	4	110,000	18,000
182.5	185	2	62,000	8,000
185	192	1	154,000	23,000
192	195	2	75,000	10,000
195	200.5	1	121,000	18,000
200.5	213.5	2	325,000	43,000
		Total	**2,500,000**	**375,000**

2.3.7.2 Cost Estimate

In estimating the construction costs of a remote northern project such as this, one needs to consider the following variables that can all have an influence on costs:

- The state of the heavy construction industry at the time of tendering or negotiating the contract: When construction work is generally abundant, prices tend to rise. In times of scarcity of construction activity, competition intensifies, and prices tend to fall.
- Time allowed for construction: When very tight time frames are imposed on the construction contractor, prices will correspondingly rise. For example, on a project such as this one, shortening the allowable time for construction could result in the necessity of mobilizing and operating from multiple headings, all of which results in a price premium.

The preliminary estimate of the “order of magnitude” construction costs of the Northern All Season Road based on the staging scenario described above, not including the Thelon River Bridge, is in the range of \$1.1 to \$1.4M/km. For a length of 125km, this equates to a range of from $125,000,000 to $160,000,000. This has been based on EBA's knowledge of construction costs and in the Arctic and discussions with Contractors. EBA recommends the employment of a road construction contractor to determine a more accurate construction cost estimate.

A cost breakdown into specific items (both direct and indirect) will not render this estimate any more accurate at this point. While we have reasonable estimates of the overall major quantities as shown in 2.3.7.1, EBA does not have a strong feel for the associated unit prices associated with the quantities. There are limited historical unit costs that are relevant to this project as there are few roads of this magnitude constructed in this remote part of the Arctic.

The following Table 2.3.7.2 outlines a breakdown into its main constituents.

TABLE 2.3.7.2: NORTHERN ROUTE COST ESTIMATE

Item	Unit Price	Unit	Est. Quantity	Cost
Mob/Demob	10%	LS		$ 12,911,000
Rock Excavation & Embankment Placement	35	m^3	2,500,000	$ 87,500,000
Granular Base	55	m^3	375,000	$ 20,625,000
Bridges	4000	m^2	2,765	$ 11,060,000
Culverts	1000	l.m.	325	$ 325,000
Camps	1	Each	9,600,000	$ 9,600,000
Other Indirect & Contingency	15%	LS		$ 19,366,500
			Total	**$ 161,387,500**

*Bridges do not include Thelon River bridge

2.4 SOUTHERN ALL SEASON ROAD

2.4.1 General

The proposed Southern All Season Road extends from the proposed Kiggavik Mine/Mill site to a proposed port site on the south shore of Baker Lake, southeast of the Thelon River., as shown on Figure 2.4.1. The northern 20 kilometers of the route is the same route as the Northern All Season Road. The proposed Southern All Season Road is 104 km long from Kiggavik to the proposed port site.

The location of the port site was based on a combination of the shortest causeway length and a navigable shipping approach. This allowed EBA to shorten the overall road length by 10 kilometers from previous work.

Five bridges (less than 50 meters in length) and two longer bridges (one at approximately 60 meters and one at about 120 meters in length) are planned along the route. The remainder