BATHURST INLET
PORT AND ROAD PROJECT
Updated Description of BIPR Project
Part 1

the BATHURST INLET
PORT AND ROAD PROJECT

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UPDATED DESCRIPTION OF PROJECT

Updated Description of Project

1.1 Overview

The Bathurst Inlet Port and Road Project (the BIPR Project) was the subject of a Draft Environmental Impact Statement (DEIS) submitted to the Nunavut Impact Review Board (NIRB) in 2008; however, the project review was suspended shortly after by the former proponent. With reactivation of the BIPR Project in 2012 by the new proponent, changes described below have been proposed. Upon review of the proposed changes, the NIRB concluded in February 2013 that the changes do not significantly change the original scope of the BIPR Project but requested that additional details be provided.

This document is intended to describe the updated BIPR Project. The BIPR Project is located in the West Kitikmeot region of Nunavut (Figure 1.1-1) and is comprised of a proposed 217 km all-weather road and related deep water port facilities including a wharf, camp, airstrip and fuel storage facility, and a small camp and maintenance depot at the southern (Contwoyto Lake) end of the road (Table 1.1-1). The port will be located near the south end of Bathurst Inlet and will be accessible to vessels such as freight carriers or fuel tankers of about 50,000 deadweight tonnes (DWT). The BIPR Project will be constructed in two phases, with the first phase consisting of the port and related facilities and 85 km of the all-weather road. This section of the road, to be constructed as soon as possible after project's approval, will support the development of the Hackett River and Back River mining projects (supply of fuel and supplies). Once other projects in the region have identified the need for the construction of Phase 2, the all-weather 217 km road will connect the port with Contwoyto Lake, where seasonal connection will be made with the existing Tibbitt to Contwoyto Winter Road (TCWR) that currently services the diamond mines in the Lac de Gras area in Northwest Territories.

Table 1.1-1. BIPR Project Main Components

Component	Description	Phase
Port	Wharf on Bathurst Inlet suitable for year round use by 50,000 dead weight tonne (DWT) ships, laydown and container storage area	1
Tank farm	12 steel tanks of 18 ML each for a total of 216 ML of fuel storage	1
Airstrip	1,200 m gravel airstrip and related support facilities	1
Camp	150 person operations camp with related generators, maintenance shop, accommodation, water supply and treatment, sewage treatment, kitchen and administration facilities	1
Excavated Material Stockpile	Area to stockpile overburden	1
Quarries	Quarry to supply material to build port infrastructure and road	1 and 2
All-weather road	217 km access road between the port and Contwoyto Lake	1 and 2
Contwoyto Camp	Camp with all necessary facilities to accommodate maintenance crew and truck drivers as required	2

PROJECT # 1098-003-20 GIS # BPR-15-042 March 28, 2013

Figure 1.1-1

the BATHURST INLET PORT AND ROAD PROJECT

Location of Bathurst Inlet Port and Road Project within Canada

Figure 1.1-1

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The BIPR Project will provide infrastructure to stimulate and support economic development in the West Kitikmeot region of Nunavut by reducing the cost of access for mining, and will facilitate the participation of Inuit people and organizations in that development.

The port will be constructed using proven and conventional Arctic construction techniques and will be capable of operating year round. While it is anticipated that most fuel and supply shipping will take place during the ice-free period, ice strengthened ships will be able to access the port throughout most of the year if or when extension of the shipping season is needed. Between 7 and 12 ships are expected at the port each year for fuel and supplies. The proposed access to Bathurst Inlet is from the North Atlantic Ocean via Lancaster Sound, Barrow Strait, Peel Sound, Franklin Strait, Larsen Sound, Victoria Strait, Queen Maud Gulf, Dease Strait and Coronation Gulf. The all-weather road will be constructed along a route that avoids lakes, seasonal creek crossings, and steep slopes of high relief bedrock topography using locally quarried rock and borrow materials. The proposed construction methods have been proven in Arctic conditions and will address concerns with stability and durability in permafrost conditions. The proposed alignment considers the proximity of known mineral deposits with production potential.

Stream crossing structures will be built in a manner that minimizes adverse effects on fish and aquatic habitat. The road embankments will accommodate migrating caribou and heavy truck traffic will be halted during key caribou migration periods to avoid adverse effects on the sustainability of the herds. The all-weather road will be used year round, with operational restrictions during active caribou migration periods and adverse weather conditions. The overall number of truck trips will be similar to that proposed in the original Project Description, but they will be dispersed over the year, resulting in about 18 trips per day rather than the original 73 trips per day.

The current proponent proposes to develop the BIPR Project to support the development of the Hackett River and Back River mining projects, rather than the operation of the Lac de Gras area diamond mines as originally proposed. Other changes to the BIPR Project are listed in Table 1.1-2. The BIPR Project will be constructed in two phases. The first phase will include the port and the first 85 km of road extending southwards from the port. The second phase will see construction of the remainder of the road through to Contwoyto Lake.

Any potential effects of the use of Project infrastructure by the Hackett River or Back River projects that are above and beyond the fuel and supply quantities for the BIPR Project will be assessed in the Environmental Impact Statement for each respective project, and in the cumulative effects chapter of the BIPR DEIS.

Table 1.1-2. Changes from the Original BIPR Project Compared to the Current Project Proposal

Component	Original Proposal	Current Proposal	Rationale
Initial clients	NWT diamond mines	Hackett River and Back River mining projects	Clients committed to near term development
Construction sequencing	Whole project constructed at same time	Phased approach with port and northern 85 km of all-weather road constructed first, and second portion of road and Contwoyto L. Camp	Hackett and Back River projects need near term road access. Joint development reduces overall project footprints
Road operation schedule	Summer only road usage, 73 trucks per day for 3 months	Year round road usage, 18 trucks per day, with suspension during critical caribou migration periods	Less intense traffic. Less storage required at mine sites. More flexibility to accommodate caribou migration
Shipping schedule	Ice-free season	Potentially year round	Less intense shipping schedule. Less on-site storage required. Ship availability on the market and port capacity.
Ships	6-8 ships	7- 12 ships	Ship capacity modification due to updated project needs. Ship availability on the market and port capacity.
Wharf location	Located on the east side of the peninsula, near the northern tip	Located about 2.2 km southeast of the original	Improved geotechnical conditions for wharf stability, less environmental effects from dredging, smaller in-water footprint
Wharf construction method	Closed cell sheet pile	Open Cell sheet pile	Simpler winter installation, more stable in weak soils
Road width	8 m with turnouts	10 m with no turnouts	More efficient two-way traffic, allows larger loads, reduced truck maintenance
Bridge foundations	Spread footing on permafrost	Deep pile-supported in permafrost or cast in place concrete on bedrock	Ice-rich permafrost is a poor foundation
Bridge decking	Timber decking	Concrete decking	Concrete has a longer design life
Stream crossings	Arch pipe or bridges on spread footings	Bridge on pile-supported foundation	Ice-rich permafrost is a poor foundation
Minor stream crossings	Rockfill fords	Culvert batteries	Improved road operating efficiencies

(continued)

Table 1.1-2. Changes from the Original BIPR Project Compared to the Current Project Proposal (completed)

Component	Original Proposal	Current Proposal	Rationale
Tank farm foundations	Spread footing on permafrost	Remove frozen overburden and expose bedrock for tank foundations	Ice-rich permafrost is a poor foundation
Fuel tanker offload	Booster pumps to tank farm	Use ship pumps	Tanker offload pumps are adequate to transfer fuel directly to tank farm
18 ML fuel storage tanks	41 m x 15 m tanks	45.7 m x 12 m tanks	Lower tanks with larger base cost less and are easier to erect
Sea water pump station, sewage treatment and potable water plants	Onsite erection and commissioning	Pre-fabricated and pre-commissioned modules	More efficient installation
Temporary fuel storage	Not included	6 to 8 ML portable fuel bladders at the wharf laydown area	Required to support construction

1.2 Project Ownership

The BIPR Project will be owned by Bathurst Inlet Port and Road Company, a business that is in turn currently owned by Xstrata Zinc Canada (Xstrata) and Sabina Gold & Silver Corp. (Sabina)[1]. The Company would consider the addition of a local partner from the Kitikmeot Region.

Xstrata Zinc Canada is the proponent for the Hackett River Project, a large proposed zinc, silver, copper, lead and gold mine located about 85 km south of the proposed port and about 20 km west of the proposed all-weather road alignment. Xstrata is currently preparing a Draft Environmental Impact Statement for submission in late 2013. Construction and operation of the Hackett River mine will require access to shipping facilities and corridors to transport metal concentrates from the mine site to market. The permitting and construction of the BIPR Project will provide this access. Potential effects of the use of the BIPR Project by the Hackett River mine beyond the current proposed use will be addressed in the Hackett River Environmental and Social Impact Assessment.

Sabina Silver & Gold Corp. is the proponent for the Back River Project, which consists of several gold deposits located between about 70 km and 130 km south of the proposed port. Sabina is currently preparing a Draft Environmental Impact Statement for the Back River Project to be submitted in late 2013. Sabina has proposed to construct either a winter road or an all-weather road to connect the Back River Project site with a port on Bathurst Inlet in order to

[1] At the time of this report the BIPR Project is owned by Sabina Gold & Silver Corp., but the intent is to transfer ownership to the Bathurst Inlet Port and Road Company.

import materials for construction of the Back River Project. Sabina could alternatively use the proposed BIPR road and port, thereby reducing their overall footprint.

1.3 Project Location

1.3.1 Location

The BIPR Project will be located in the West Kitikmeot Region of Nunavut, as illustrated in Figure 1.3-1. The port will be located on the east shore of a small point of land about 24 km north northwest of the head of Bathurst Inlet, at about Latitude 66°32'04"N and Longitude 107°29'00"W. It is about 300 km south of the community of Cambridge Bay and about 41 km southeast of the settlement of Kingaok (Bathurst Inlet). The road route will start at the port and follow a southwest direction for 217 km. It will cross the Mara River and terminate at the south end of Contwoyto Lake where the Contwoyto Camp will be located.

1.3.2 Land Ownership

The use of Inuit Owned Land (IOL) and Crown land will be required for the construction of the BIPR Project facilities. The BIPR Project will require surface leases for the use of land from the Kitikmeot Inuit Association (KIA) and Aboriginal Affairs and Northern Development Canada (AANDC). Surface leases will be sought only in areas where exclusive right of occupancy will be required. The roadway may require a lease or licence of occupation for the right of way (tenure). Permits will be required for quarries. Once the locations of BIPR Project facilities have been finalized and the extent of land ownership defined, negotiations will commence to secure their use.

All the elements of the BIPR Project are situated entirely within Nunavut. The BIPR Project and related infrastructure proposed will be located on Inuit Owned Lands (IOL) owned by the KIA and on Federal Crown land, with a total land area of 643.2 ha. The BIPR Project will require surface leases from AANDC for the port development (Phase 1) and from the KIA for the Contwoyto Camp (Phase 2).

Phase 1:

- Facilities on IOL will include:
  - 34.2 km of all-weather road.
- Facilities on Federal Crown land will include:
  - Port site including camp, fuel storage area, roads and airstrip, and
  - 51 km of all-weather road.

Phase 2:

- Facilities on IOL will include:
  - Contwoyto Camp and
  - 55.6 km of all-weather road.
- Facilities on Federal Crown land will include:
  - 76.6 km of all-weather road.

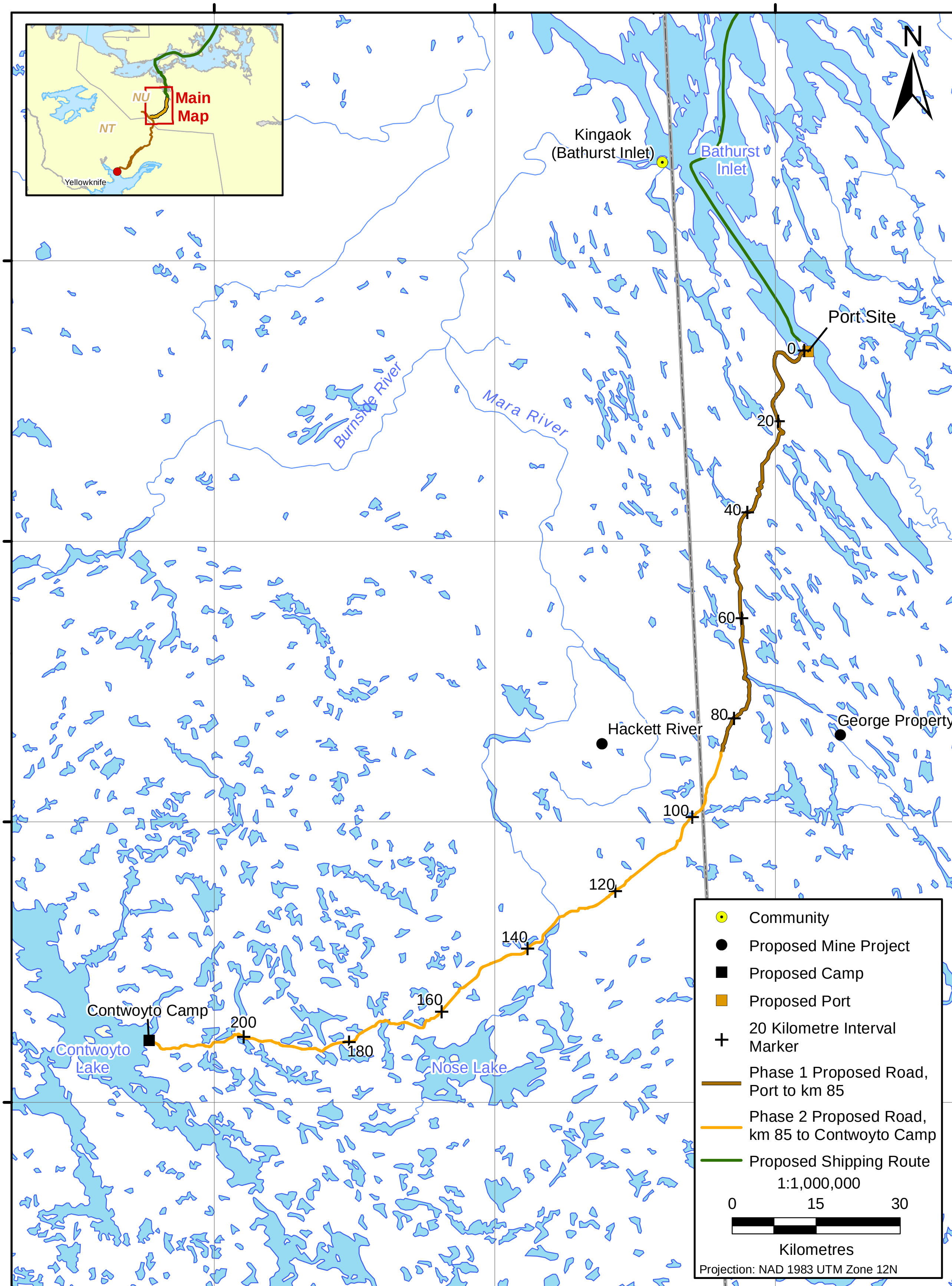

Figure 1.3-1

Location of Bathurst Inlet Port and Road Project

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The roadway may require a lease or licence of occupation for the right of way. Quarries will need land use permits and quarry licences. Table 1.3-1 illustrates the area and status of lands underlying the proposed port, all-weather road and Contwoyto Camp. Figure 1.3-2 shows the locations of relevant IOLs in the BIPR Project area.

Table 1.3-1. Land Status of Port, Road, and Contwoyto Camp

Facility	Location (km mark)	Land Ownership	Disturbed Area (ha)		Total (ha)	
			Road**	Quarry	IOL	Federal
Port, camp and airstrip	NA	Federal Crown	12.7	13.4	0	60.6
Port to Contwoyto Lake Road	0 to 19	IOL: BB-27/76 J*	40.8	11.9	52.7	0
	19 to 28.5	IOL: BB-27/76 G, J*	0	0.2	0.2	0
		Federal Crown	19.8	5.1	0	24.9
	28.5 to 35.2	IOL: BB-16/76 G, J*	14.8	0	14.8	0
	35.2 to 56.2	Federal Crown	44.5	11.7	0	56.2
	56.2 to 60.6	IOL: BB-16/76 G, J*	10.6	2.4	13.0	0
	60.6 to 68.5	IOL: BB-16/76 G, J*	0	1.7	1.7	0
		Federal Crown	15.3	3.0	0	18.3
	68.5 to 72.1	IOL: BB-16/76 G, J*	7.7	0	7.7	0
	72.1 to 103.3	Federal Crown	67.5	13.9	0	81.4
	103.3 to 117.3	IOL: BB-04/76 F*	30.2	3.5	33.7	0
	117.3 to 129.7	Federal Crown	27.4	8.9	0	36.3
	129.7 to 153.3	IOL: BB-05/76 F*	52.2	10.1	62.3	0
	153.3 to 159.4	Federal Crown	13.5	6.6	0	20.1
	159.4 to 169.6	IOL: CO-17/76 F*	21.6	4.0	25.6	0
	169.6 to 208.8	Federal Crown	85.5	19.7	0	105.2
	208.8 to 217	IOL: CO-12/76/E*	17.8	7.1	24.9	
Contwoyto Camp	km 217	IOL: CO-12/76/E*			3.6	
Inuit Owned Land	± 240.2 ha					
Federal Land	± 403.0 ha					
Total	**± 643.2 ha**		**481.9**	**123.2**	**240.2**	**403.0**

*** Alphanumeric code is the specific block of IOL affected.**
**** Road Disturbed area is based on a 10 m all-weather road top and 1:1.5 fill slope.**

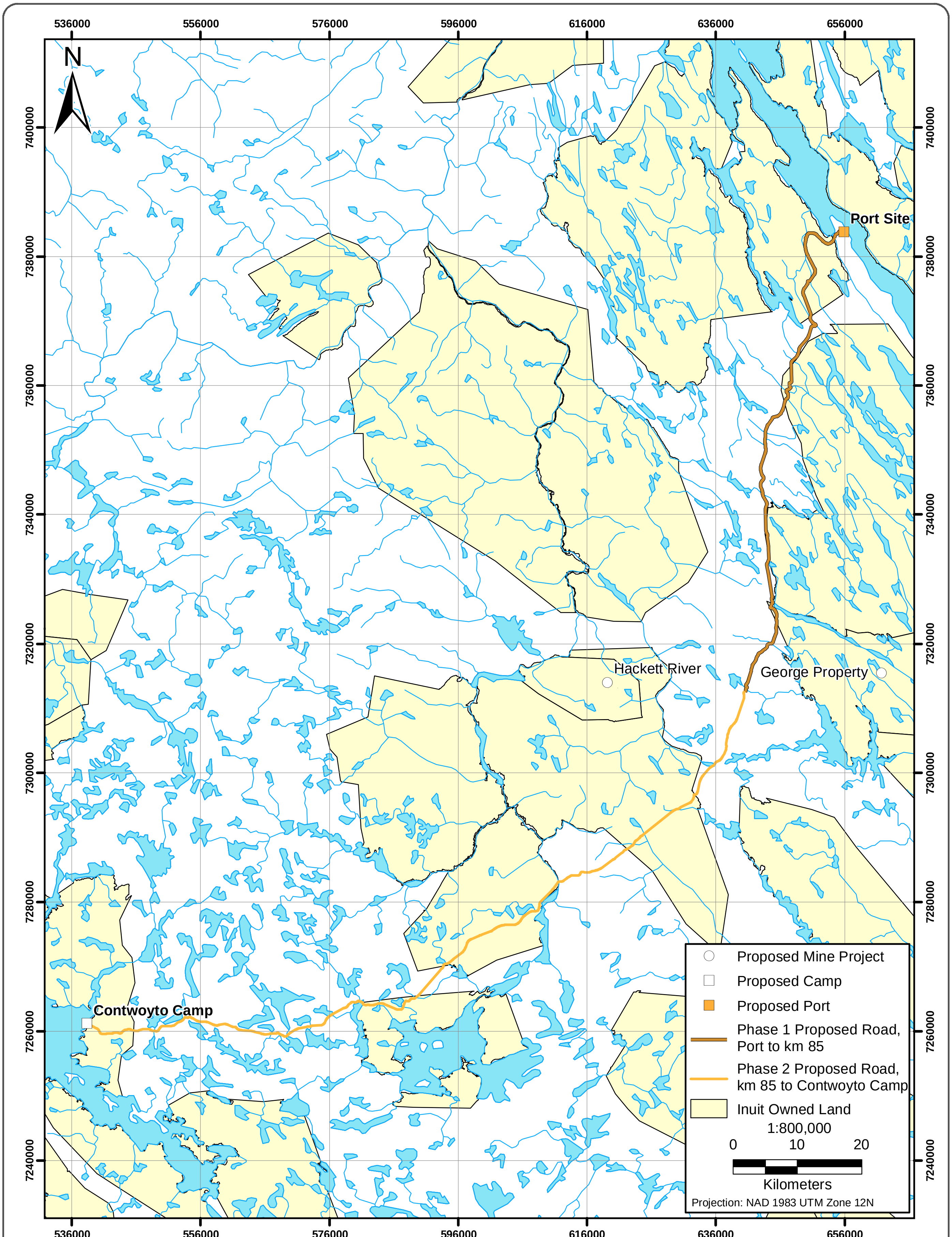

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Figure 1.3-2

Inuit Owned Lands

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1.4 Regional Resources

1.4.1 Regional Geology

The Kitikmeot region is located within the Canadian Shield, and is underlain by rocks of Archean and Proterozoic age, comprising portions of the Slave, Bear, and Churchill geological provinces. The BIPR Project is within the northern portion of the Slave Geological Province ("SGP"). The SGP has a surface area of approximately 198,000 square kilometres and is a geologically distinct region of the Canadian Shield. The SGP extends over Nunavut and the Northwest Territories. Approximately 40% of the SGP is within Nunavut.

The bedrock of the SGP ranges in age from early Archaean (ca. 3.2 billion years ago) to mid Devonian (370 million years ago), and is overlain by unconsolidated Quaternary (i.e. last 2 million years) sediments (JWEL 2001). There are three principal bedrock-type associations in the study area: 1) Archean Yellowknife Supergroup metasedimentary and metavolcanic rocks; 2) Archean intrusives, gneisses and migmatites; and 3) Paleoproterozoic Great Slave Supergroup metasedimentary clastics and carbonates.

The abundant mineral endowment of the SGP of Nunavut has been known for several decades. The SGP has produced minerals continuously since the 1930s, however, the full potential of this area has not yet been realized due, for the most part, to the lack of transportation infrastructure.

1.4.2 Regional Resource Assessment

The SGP of the West Kitikmeot has been explored for many mineral commodities, including diamonds, gold, and base metals. Despite the lack of infrastructure, exploration has been successful in identifying many showings and deposits. Figure 1.4-1 shows mineral showings recorded in the Nunavut Geoscience database in the area. Figure 1.4-2 shows the location of advanced mineral exploration projects and past mineral producers in the same area. It should be noted that more showings would be subjected to advanced exploration if improved infrastructure were available to reduce the costs of exploration and development, particularly for base metal mines.

1.5 Project Need and Purpose

The BIPR Project is located entirely within the Kitikmeot region of Nunavut, and is crucial infrastructure for creating employment and business opportunities for residents in local communities and expanding the economy of the Kitikmeot region and Nunavut. The BIPR Project infrastructure could service the existing diamond mines in the Slave Geological Province once the second phase is constructed and help to attract capital investment for on-going exploration and development of new mines. It may also reduce the cost of essential bulk materials (e.g. fuel) to Kitikmeot communities, thereby reducing the cost of living in these communities.

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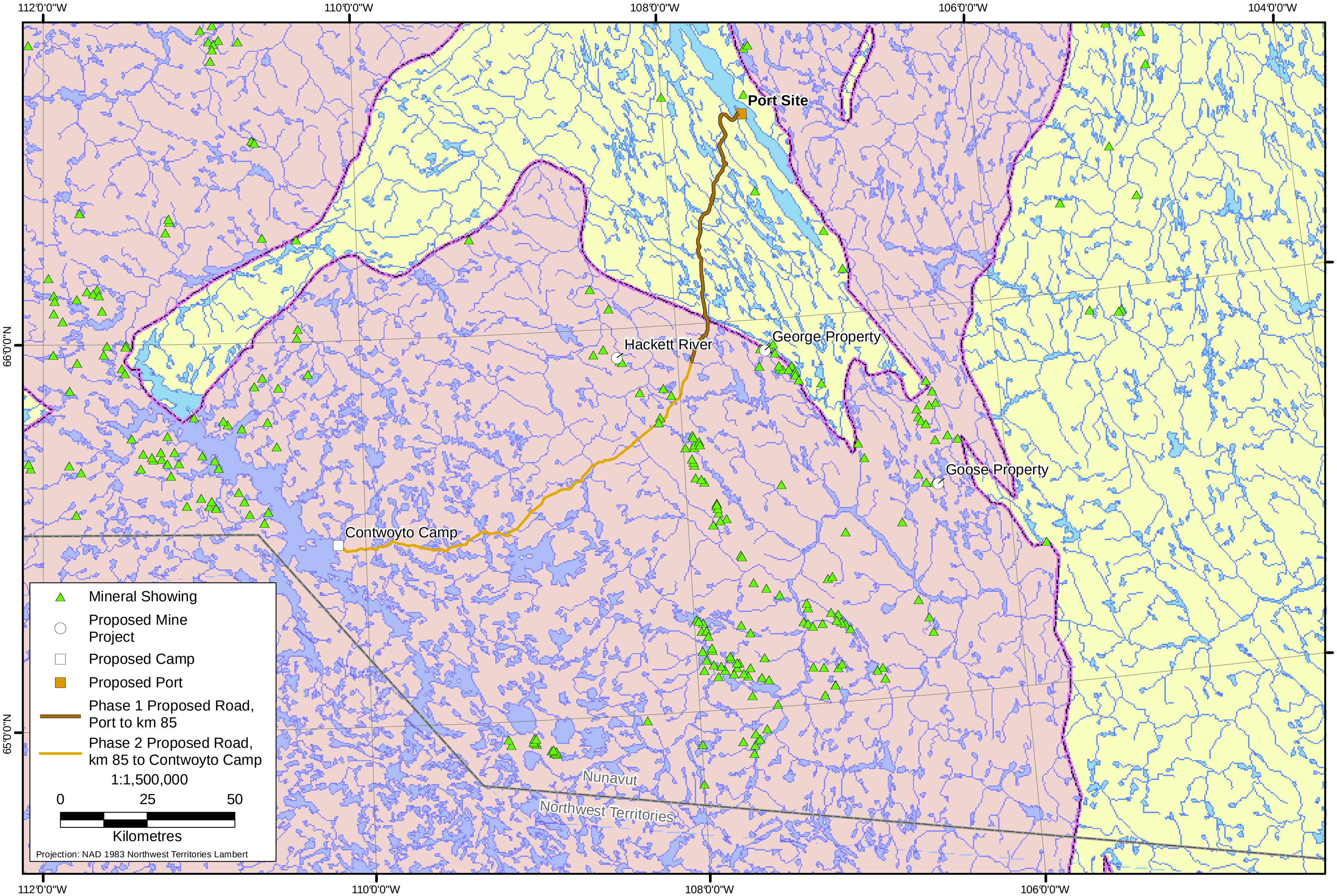

Figure 1.4-1

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Mineral Showings in the Slave Province (purple colour) of West Kitikmeot

Figure 1.4-1

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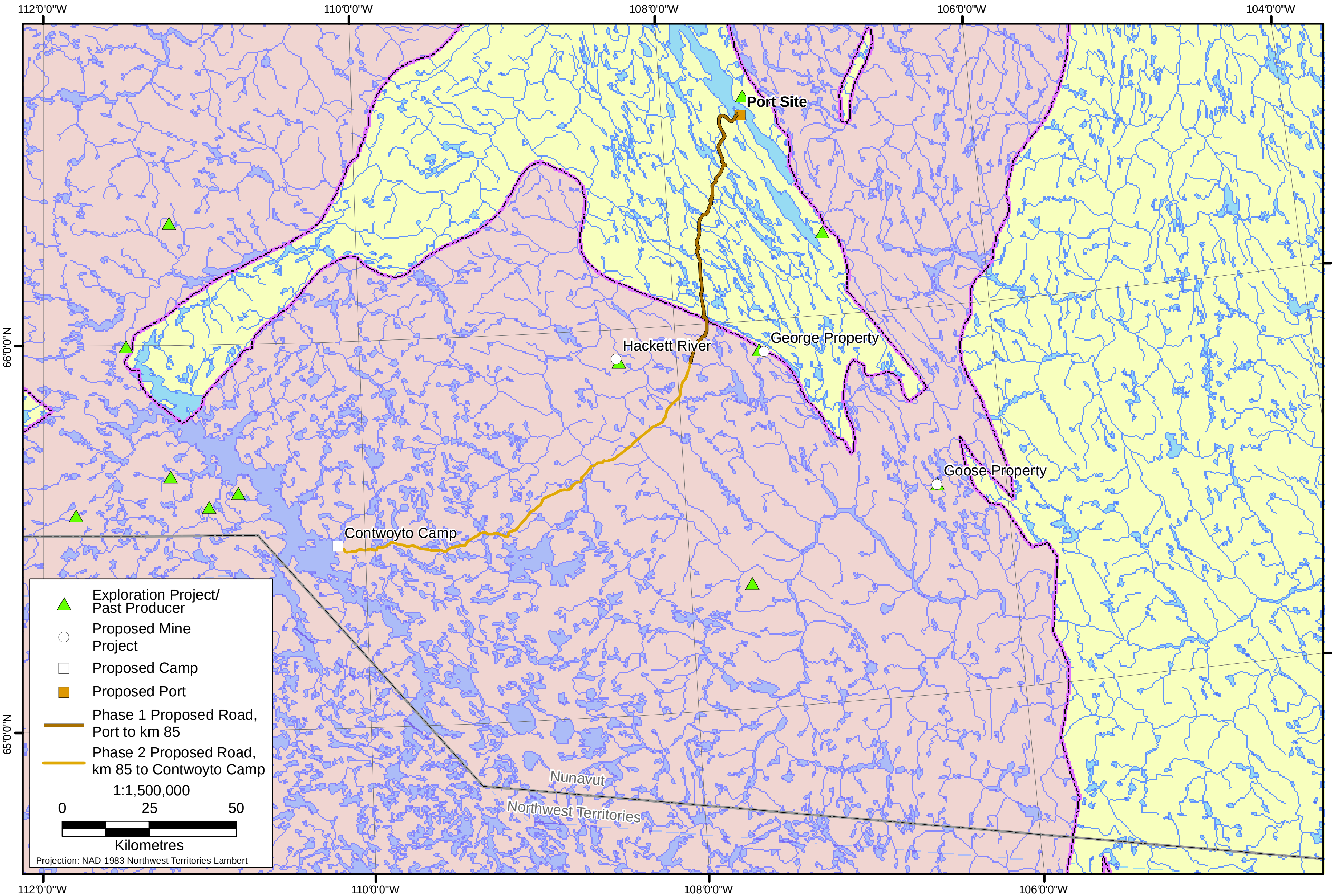

Figure 1.4-2

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Advanced Exploration Projects and Past Producers in the Slave Province (purple colour) of West Kitikmeot

Figure 1.4-2

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Taking into consideration current and potential future developments in the Slave Geological Province, the BIPR Project will deliver the following benefits:

- Economical and environmentally responsible shared access for the development of the Back River and Hackett River mining projects, resulting in a smaller overall footprint than if developed separately (The effects of the use of the BIPR Project for the operation of these proposed mines that are above and beyond the current scope of the BIPR Project will be addressed in their individual EISs.);
- increased certainty of supply, combined with a lower landed cost, of fuel and other bulk goods destined for the diamond mines in NWT once the second phase is constructed;
- lower landed cost of fuel and other bulk goods destined for Kitikmeot communities via the port on Bathurst Inlet;
- potential for earlier arrival of materials at similar or lower landed cost from western Canada destined for Kitikmeot communities shipped north on the winter road via Yellowknife;
- increased training, employment, and business development opportunities for workers and businesses in the Kitikmeot region;
- overall increased wage income and business activities in the Kitikmeot region that will contribute increased tax revenues to the governments of Nunavut and Canada;
- significantly reduced capital and operating costs for future mineral exploration and mine development in the Nunavut portion of the SGP; and
- provision of capacity to allow additional development to occur in the region.

In addition, the shipping route and the port will help further the federal initiative of increased Arctic sovereignty, particularly along the Northwest Passage. The advent of port development and the regular presence of commercial shipping to and from a port on the Canadian central Arctic coast will demonstrate Canada's presence in these northern passages and will support the Government of Canada's Northern Strategy."[2]

1.6 Project History

Although government and industry have acknowledged that a well-developed transportation system could lay the foundation for significant mining and secondary development in the region, prior to 2001, only pre-feasibility level studies were conducted to determine the feasibility of an Arctic Ocean port and road network in the Kitikmeot region. Nuna Logistics Limited, an Inuit-owned company that recognized the economic potential of such a project, joint ventured with the Kitikmeot Corporation in 2001 to investigate and promote the BIPR Project.

[2] Minister of Indian Affairs and Northern Development and Federal Interlocutor for Metis and Non-Status Indians. 2009. Canada's Northern Strategy: Our North, Our Heritage, Our Future.

The resulting Bathurst Inlet Port and Road Joint Venture Ltd. acted as proponent for the BIPR Project in the Nunavut Impact Review Board (NIRB) process as detailed below:

- March 2002: Initial BIPR Project Description submitted.
- May 2003: Revised BIPR Project Description submitted.
- December 2004: BIPR Project Final Guidelines issued by the NIRB.
- January 2008: Submission of the Draft Environmental Impact Statement (DEIS).
- June 2008: Responses to Information Requests.
- November 2008: Technical Review Comments received.
- November 2008: Technical Review suspended.
- July 2011: BIPR Joint Venture advised the NIRB that it will not re-engage in the Technical Review Process due to the withdrawal of one of the potential users of the BIPR Project.

In November of 2011, Sabina acquired the BIPR Project and Xstrata acquired the Hackett River Project. Sabina and Xstrata advised the NIRB in March of 2012 their intention to re-engage the NIRB process for the BIPR Project. Subsequently further engineering studies and design work has been initiated to advance the BIPR Project, resulting in some minor changes. In December 2012, Sabina and Xstrata provided to the NIRB a summary description of these changes. In January of 2013, the NIRB sought submissions from government agencies and other parties regarding the changes. In February 2013, the NIRB advised Xstrata and Sabina that with respect to the issue of the scope of the BIPR Project, the NIRB concluded that the changes proposed in the amendment to the BIPR Project as presented by Xstrata and Sabina in December 2012 do not significantly change the original scope of the BIPR Project.

Xstrata and Sabina propose to develop the BIPR Project to support their own respective mines as the first priority in Phase 1 of the BIPR Project. Otherwise, the general objectives of the BIPR Project are unchanged. The characteristics of the updated BIPR Project are:

- The updated BIPR Project has the same overall objectives as described in the 2007 DEIS:
  - Re-supply of fuel and goods for mining operations and Kitikmeot communities;
  - However, different mining operations are now identified as the main targets for re-supply (Hackett River and Back River instead of Jericho, Diavik, EKATI and Snap Lake).
- The same route for the all-weather road and similar port facilities as described in 2007 will be used, however a different construction schedule will be utilized:
  - Phase 1: Bathurst Inlet Port and infrastructure plus 85 km of all-weather road to be built by the current proponent following necessary approvals (NIRB certificate, Water Licence, Land Use Permits);
  - Phase 2: 132 km of all-weather road and camp and maintenance shop facilities at Contwoyto Lake will be built when future users are identified and ready to use the infrastructure.

- The same shipping route will be used as described in 2007.
- The initial shipping schedule will be limited to the ice-free period, however there is potential for an extended schedule for specific projects in the future subject to their review, including consideration of caribou and community effects.
- A similar number of supply/fuel trucks per year (7,000) as stated in 2007 but dispersed over the year (with operational restrictions during active caribou migration periods) instead of three months resulting in an average traffic rate of 18 vehicles/day.
- The current BIPR Project proponent will seek the support and involvement of Inuit and local organizations.

1.7 Project Schedule

1.7.1 Project Phasing

The BIPR Project is currently envisioned as being completed in two phases to address the differing demands for development access along the proposed alignment (Table 1.7-1). Potential clients of the all-weather road at the Contwoyto Lake end of the proposed road currently have alternative access via the TCWR. Potential mining clients closer to Bathurst Inlet currently have no alternatives for ground-based access. For this reason, the port facilities and the 85 km-long section of the road closest to the port will receive priority and will be permitted and constructed first as Phase 1. The operational period for the port for Phase 1 will be 17 years and decommissioning and closure would take 1 year.

1.7.2 Phase One Schedule

Additional fieldwork will be completed in 2013 to collect information for the Final Environmental Impact Statement. This fieldwork will provide improved geotechnical information for the wharf and other port infrastructure, enhance current understanding of ice movement at major crossings, and provide enhanced topographic and hydrology information.

Construction will require approximately 2.5 years once permitting has been completed. The overall Phase 1 construction schedule is shown in Table 1.7-2.

1.7.2.1 Year 1 Construction

1.7.2.1.1 Ice Road

In order to support Phase 1 all-weather road construction from km 85 to the port, an ice road will be installed in winters of Year 1 or Year 2. The ice road will extend the existing TCWR, all the way to km 85 (Figure 1.7-1). The ice road will serve to mobilize road construction equipment, temporary camps, bridges, and fuel. Construction and use of the ice road to mobilize road construction equipment, materials, and crews is expected to require about two months.

Table 1.7-1. Conceptual Overall Project Schedule

Description		Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19	Y20	Y21
Permitting																						
Phase 1 Construction																						
Phase 1 Operation																						
Conceptual Phase 2 Construction (2 years)					?	?	?	?	?	?	?											
Conceptual Phase 2 Operation								?	?	?	?	?	?	?	?	?	?	?	?	?	?	
Abandonment and Reclamation																						

Note: Y = Year

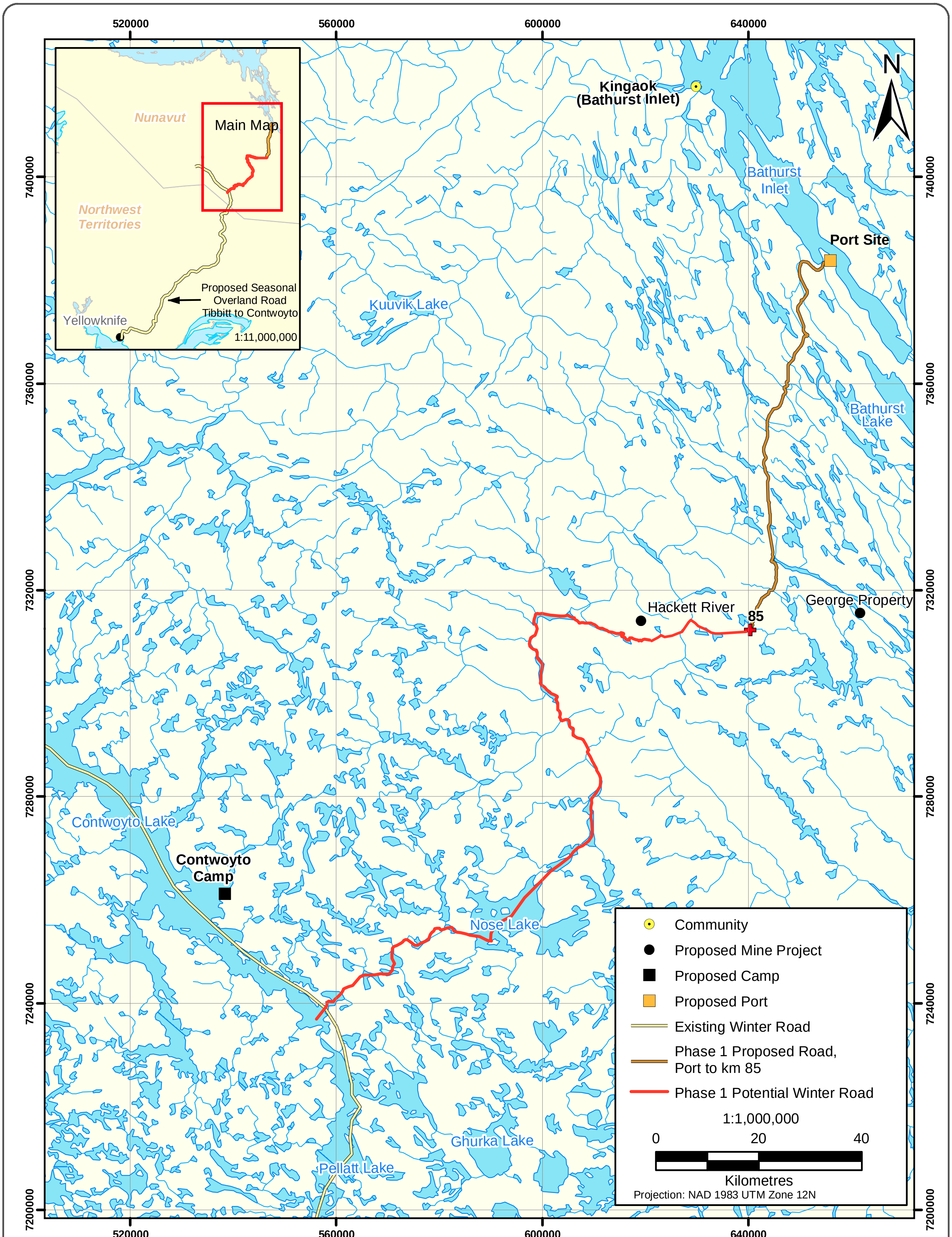

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Figure 1.7-1

Potential Location of Phase 1 Winter Road

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Table 1.7-2. Overall Phase 1 Construction Schedule

Description	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Sealifts			■				■				■	
Airstrip				■								
Port , Camp, and Road from km 0				■	■	■	■	■	■	■	■	
Tank Farm					■	■	■				■	
Ice Road*	■											
Road from km 85*		■	■	■	■	■						

Ice road could be in Year 1 or Year 2 and will depend on timing of Project Approval

1.7.2.1.2 All-weather Road

The all-weather road will be constructed by two road construction crews proceeding from opposite ends of the Phase 1 segment. The first road crew will start by March at the termination of ice road at km 85 and proceed northward. The second road crew will mobilize to the temporary port to be established on Bathurst Inlet in August and start road construction soon afterward, proceeding southward. Each road construction crew will include a dedicated bridge crew that will construct the bridge foundations and erect the bridge girders. Camps for the road crews will include a mobile construction camp to be staged at km 85, a mobile camp starting at km 0 and a floating camp to be staged at the Bathurst Inlet port site.

1.7.2.1.3 Temporary Port

A temporary port will be established near the head of Bathurst Inlet to support construction of the Phase 1 all-weather road and permanent port infrastructure. The temporary port facilities will consist of laydown pad, floating camps, fuel bladders, portable shop, and barge offload. Plate 1.7-1 is a photograph of a similar temporary port used for the development of the Hope Bay mine. The temporary port facilities will be replaced with permanent infrastructure as it is constructed and commissioned according to the schedule. The permanent wharf and cargo laydown area will be constructed within the same footprint as the temporary port.

1.7.2.1.4 Airstrip and Quarry

The airstrip is necessary during construction to support crew changes and consumable imports. The airstrip will include the necessary equipment to support weekly year round flights including generator, runway temporary lights, fuel tanks and de-icing equipment. Permanent lights will be installed the following summer.

The quarry site will be stripped of overburden at freeze up in December. The stripped overburden will be placed in the designated stockpile site.

1.7.2.2 Year 2 Construction

The annual sealift to the temporary port will include fuel, and equipment and materials required to construct the permanent wharf and tank farm. Year 2 construction will consist of the main activities described below.

Plate 1.7-1. Floating camp and laydown pad at Hope Bay, Nunavut.

1.7.2.2.1 All-weather Road

Construction will emphasize the activities necessary to complete the Phase 1 all-weather road by third quarter of Year 2 and to complete a useable transportation corridor from the temporary port to km 85. Bridge crews will complete the construction of foundations in the winter to minimize disruption to riparian habitats. Pile drilling operations are simpler in the winter as the necessary freezing conditions are maintained during the slurry backfill operations when installing piles. A third bridge crew will be mobilized in the winter to assist with the longer multi-span bridges which will require lifting of larger girder sections from the grounded river ice. Plate 1.7-2 shows an example of the lifting of girder sections from grounded river ice from another Arctic project. Any necessary river crossings in the summer will be performed using temporary bridge structures.

1.7.2.2.2 Wharf

Wharf construction will start at the end of Year 2 in the winter when the inlet is frozen to support construction of the offshore causeway fill. Sheet pile driving will start soon after filling is complete at the beginning of Year 3 in the winter. The offshore filling operation will involve the construction of an ice road from the quarry site to the offshore causeway fill pad along the inlet. Open water will be created by excavating the ice, and rock-fill will be pushed into the open water to create the causeway approach to the wharf face. The causeway fill will freeze rapidly creating a stable pad to stage heavy equipment such as the 250 tonne pile driving crane.

Plate 1.7-2. Lifting bridge girder sections from grounded ice, Kuparuk River, Alaska.

1.7.2.2.3 Tank Farm

Tank farm construction will start in the winter by stripping overburden and placing the granular pad and liner directly on the exposed bedrock. The overburden will be hauled and placed in the designated stock pile area. The steel tank construction will start during the summer of Year 2 directly on the prepared tank farm pad. Steel tanks require precision plate bending and welding to tight specifications and work is best performed during the summer months.

1.7.2.3 Year 3 Construction

Major construction items to be completed in Year 3 will include the following described below. In Year 3 the annual summer sealift will for the first time will be offloaded on the newly completed sheet pile wharf which will be constructed during the previous winter.

1.7.2.3.1 Wharf

Following completion of the offshore causeway fill, the sheet pile face of the wharf will be constructed in the winter with the heavy pile driving equipment staged from the frozen causeway fill pad (see Plate 1.7-3). Sheet pile will be advanced below the water line with vibratory hammer driving equipment, which generates significantly less noise in terms of sound amplitude than a typical impact hammer (URS 2007; Jones et al. 2009). In Anchorage, test piles were driven by both vibratory and impact pile driving. The mean peak noise measured at depth during vibratory pile driving was 166 dB; with impact pile driving, the mean peak noise was 181 dB (URS 2007). Ice will be excavated in front of the sheet pile face as necessary to prevent binding and minimize any ice forces from affecting the unsupported sheet pile until backfill can be placed behind the sheet pile. By the end of winter all fill and sheet pile will be installed.

Plate 1.7-3. Causeway and wharf under construction in winter, Beaufort Sea.

1.7.2.3.2 Tank Farm

The remaining group of steel tanks will be erected during the summer season. The first group of tanks (completed in Year 2) and the 200 mm fuel line from the wharf to the partially completed tank farm will be pressure tested and commissioned by the time the first fuel tanker arrives in August or September. After filling the partially completed tank farm, the fuel bladders at the temporary port will be decommissioned. In addition, the truck fueling pad will be completed and commissioned so that trucks can begin hauling fuel on the all-weather road to the interior as demand requires.

1.7.2.3.3 Camp and Buildings

Placement of camp fill pad will be completed and compacted into place. Building pads and foundations for structures requiring major concrete work including generators, generator stacks, warehouse and shop building will be completed during the summer season. Upland building foundations at the port site that require pile driving will be completed for the seawater pump and fuel offload modules.

1.7.2.4 Phase 1 Construction Equipment

Equipment required for the construction of Phase 1 of the BIPR Project is summarized in Table 1.7-3. This list is conceptual and the actual numbers and models of equipment may vary depending upon availability and further design work.

1.7.3 Phase Two Schedule

Phase 2 of the all-weather road (km 85 to km 217), including the camp at Contwoyto Lake, will be completed once construction is justified by demand for this segment of the road. Details of road use will be determined once road users are identified. There is currently no fixed schedule for this phase regarding start date for construction, although it is anticipated that construction will require two years to complete.

Table 1.7-3. Conceptual Listing of Equipment Required for Phase 1 Construction

Item	Number of Units	Item	Number of Units
D4 Dozer	2	Pressure Washer	2
D6 Dozer	2	Welder	6
D8 Dozer	2	Crewcab Pickup	26
D9 Dozer	4	1 Ton Flatbed Truck	6
Cat 345 Excavators	2	Concrete Mixer Truck	2
Cat 385 Excavator	4	Lowboy & Tractor (85 Ton)	2
Cat 16H Grader	2	Crane (60 to 200 Ton)	11
CAT 740 Truck	12	Ambulance	2
CAT IT 28 Backhoe	2	Compacter (563)	1
CAT 930 Loader	2	Diesel Pile Hammer	2
CAT 966 Loader	4	Water Truck	2
CAT 966 with Iron Wolf Crusher	1	Vibratory Pile Hammer	2
CAT 966 with Snow Blower	2	Steamer Truck	2
CAT 988 Loader	4	Godwin Pump	2
Ingersoll Rand 690 Drill	6	Ice Drill/Pumper	2
Service and Powder Trucks	4	Generators (12 to 400 KW)	12
Mechanics' Truck	4	Manlift	6
Bobcat	2	Forklift	6
ANFO Bag Plant	1	Barge Camps (power)	1
Clemro Crushing Plant	2	50 Man Camp (power)	3
Compressor (185 CFM)	2	Dry Shacks	4
Heaters	6	Lunch Room (power) x1	2
Light Towers	8	Construction Camp Incinerator	2

1.8 Shipping

1.8.1 Anticipated Ship Types and Sizes

The vessels that will serve the Bathurst Inlet port will include bulk or fuel carriers. Deliveries will be handled by cargo vessels and fuel tankers of capacities from 30,000 dead weight tonne (DWT) to up to approximately 50,000 DWT Handymax size vessels. Lightering barges may be used to offload vessels at anchor or at the wharf. It is expected that between seven and 12 ships per year will be required to deliver the anticipated level of supplies, meaning that a ship will pass through the inlet between 14 and 24 times a year if both inbound and outbound trips are counted. Most ship traffic will occur during the ice free months.

Estimated annual inbound bulk cargo capacity from both Hackett and Back River is listed below:

- 216 million liters of fuel;
- 135,000 tonnes of supplies (up to 7,000 full containers); and
- 11,000 tonnes of explosives.

1.8.2 Vessel Operations and Route

The proposed access to Bathurst Inlet is from the North Atlantic Ocean via Baffin Bay, Lancaster Sound, Barrow Strait, Peel Sound, Franklin Strait, Larsen Sound, Victoria Strait, Queen Maud Gulf, Dease Strait and Coronation Gulf (Figure 1.8-1).

Sea ice on this proposed route is reported to freeze fast to the shoreline and become immobile each winter except for the eastern portion of Barrow Strait (consolidates in 80% of winters) and Lancaster Sound (consolidates in 40% of winters). Sea ice in Baffin Bay remains mobile all winter.

The average dates for in situ sea ice melting in Bathurst Inlet range between July 2 and July 6, with the earliest recorded being June 27 and the latest recorded being August 8. By the fourth week of July, open water is present for the majority of the shipping route (SNC-Lavalin 2007; Environment Canada 2012).

Freeze-up in most channels begins in early October. Sea ice growth is rapid through the months of October and November with most channels along the proposed route, being frozen to the shoreline (consolidated) by late November. The earliest and latest consolidation dates are October 22 and November 20 respectively. The initial shipping schedule will be limited to the ice-free period, however there is potential for an extended schedule for specific projects in the future subject to their review, including consideration of caribou and community effects.

Bulks and initial diesel fuel cargoes are anticipated to come from Europe or the Canadian East Coast. The longest vessel travel time is estimated to be approximately 11 to 12 days from Europe to Bathurst Inlet.

For the construction of the BIPR Project, additional routes for delivery of construction materials, supplies, and fuel are from the west and have traditionally supplied the region. British Columbia via the Bering Strait and Hay River via the Mackenzie system are common shipping origination points (Figure 1.8-1).

1.8.2.1 Ship Navigation Route in Bathurst Inlet

The proposed ship navigation route to the proposed port site is from the existing surveyed navigation corridor in the north-eastern part of the Coronation Gulf, at a location approximately 16.5 nautical miles (NM) due west of Cape Franklin on the Kent Peninsula (Figure 1.8-2) (SNC-Lavalin 2007).

The proposed ship route was defined and surveyed by the Canadian Hydrographic Services (CHS) in 1997/98 which resulted in the publishing of new hydrographic charts of Bathurst Inlet and Melville Sound. CHS Charts numbers 7779, 7781, 7792, 7793 and the *Arctic Canada Sailing Directions, Volume 3, 5th Edition* were used in assessing the ship route. The route is described in some detail in SNC-Lavalin (2007).

The transit distance from the location east of Cape Franklin to the proposed port site is approximately 145 nautical miles (NM), and the estimated transit time is estimated in the range of 12 to 13 hours. Table 1.8-1 shows the waypoints, distances and indicative speeds along the proposed routes.

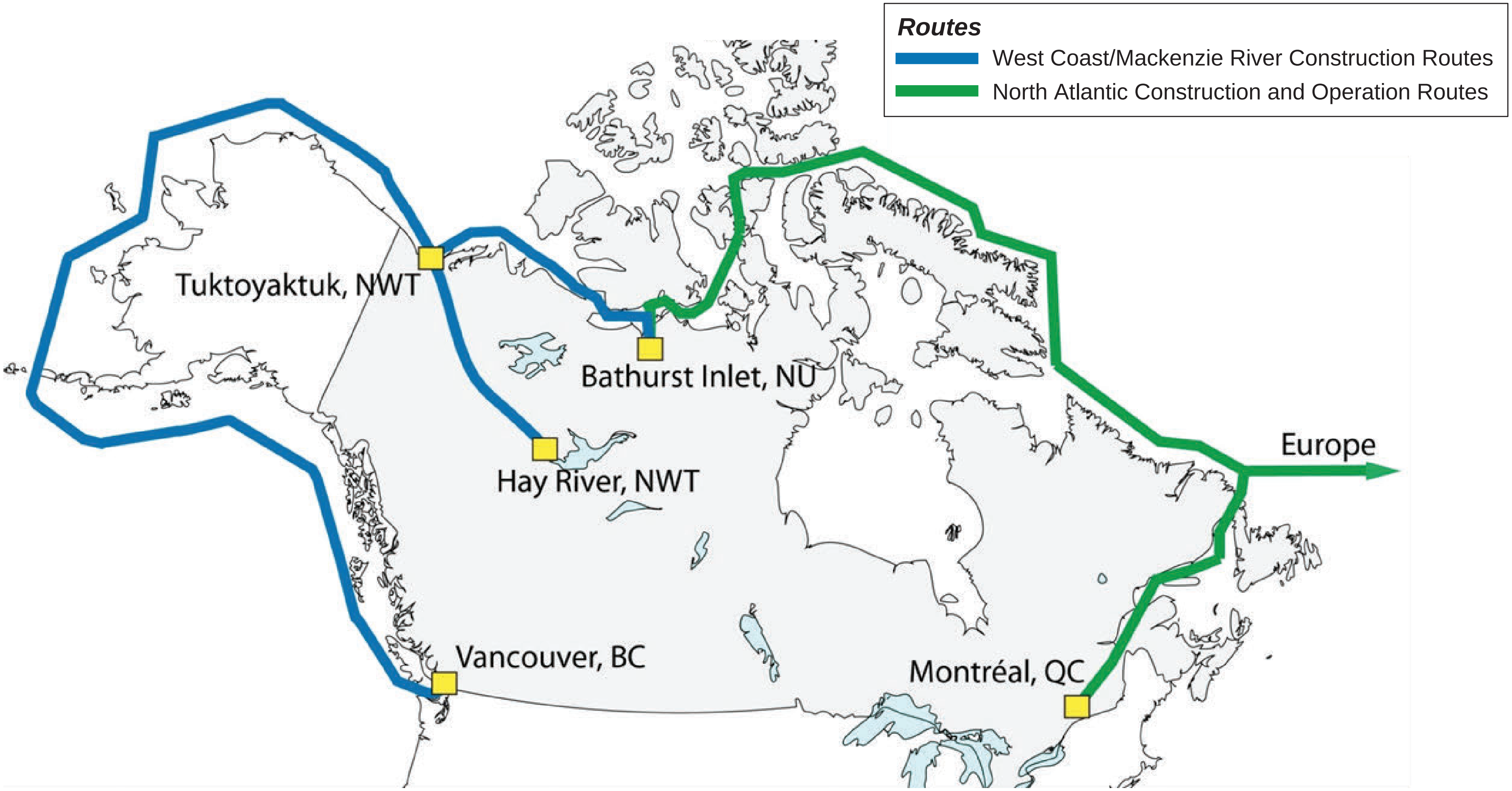

Figure 1.8-1

the Bathurst Inlet Port and Road Project

Shipping Origination Points and Transport Routes

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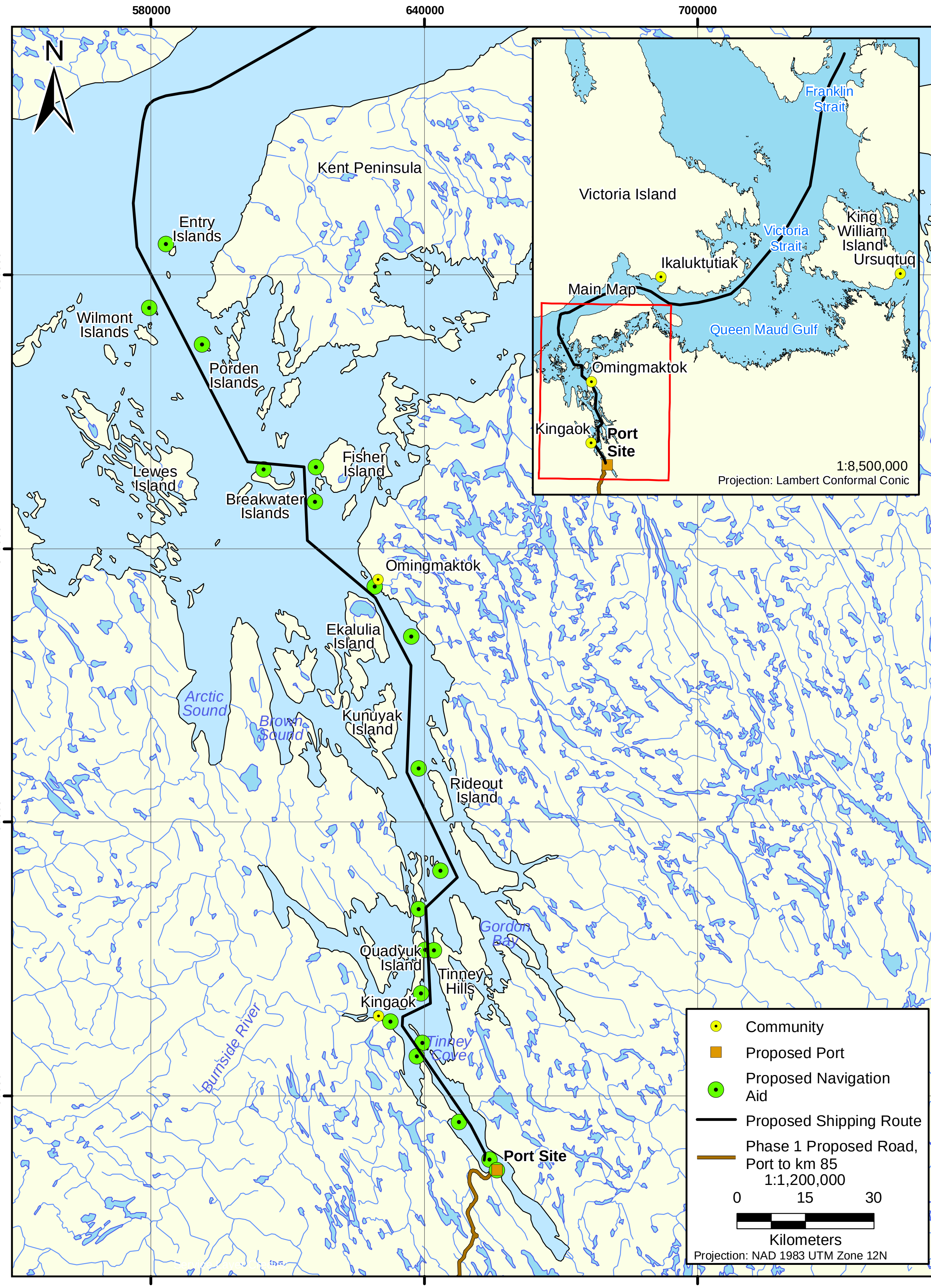

the BATHURST INLET PORT AND ROAD PROJECT

Figure 1.8-2

Vessel Approach

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Table 1.8-1. Waypoints, Distances, and Indicative Speeds along the Proposed Route from Proposed Port Location to Dease Strait

Waypoint No.	Latitude	Longitude	Course (ºT)	Dist. (NM)	Speed (knots)	Time (hours)	Remarks
1	68º 35' N	109º 07.6' W	180	12.4	13.5	0.92	South side of existing east/west survey passage across the Coronation Gulf
2	68º 22.65' N	109º 07.65' W	155	27.1	12	2.26	3.5 NM W of the Entry Islands
							Minus 3.2 m and plus 0.7 m shoal patches 0.6 NM to port and starboard respectively
3	67º 56.85' N	108º 35' W	98	6.75	8	0.84	12.5 m patch and the northeast end of Breakwater Islands 0.5 NM to port and starboard respectively
4	67º 55.95' N	108º 17.4' W	180	8.75	10	0.88	2 m rock and most southerly of Fisher Island group 0.5 NM to starboard and port respectively
5	67º 47.3' N	108º 17.4' W	133	10.3	12	0.86	
6	67º 40.2' N	107º 57.04' W	155	9.05	12	0.75	Baychimo Harbour entrance to port
7	67º 32' N	107º 47' W	187	12.8	12	1.07	Radar Beacon 1.05 NM to port
8	67º 19.4' N	107º 50.7' W	156	14.9	11	1.35	12.6 m patch to port
9	67º 06.75' N	107º 36.4' W	230	5.2	10	0.52	Shoal patch lying north of Manning Point to port
10	67º 03.4' N	107º 46.4' W	180	11.5	10	1.15	"Narrows" transit
11	66º 52.05' N	107º 46.4' W	248	3.7	8	0.46	11.2 m and 16.2 m patches to port
12	66º 50.65' N	107º 54.95' W	188	1.1	8	0.14	Rounding the spit at the tip of the northwestern arm of Tinney Cove
13	66º 49.55' N	107º 55.3' W	148	14.3	12	1.19	
28	66º 37.4' N	107º 36.3' W	155	3.6	10	0.36	
29	66º 34.1' N	107º 32.6' W	128	1.3	5	0.26	
30	66º 33.3' N	107º 33.0' W					Port Site to starboard

Total distance 143 NM and transit time 13 hrs from NW P
Total distance 130 NM and transit time 12 hrs from Entry Island
Source: CHS Surveys of Mellville Sound & Bathurst Inlet July Aug 1998, Revised way points (SNC-Lavalin 2007)

In summary, the majority of the transit route is considered relatively "clear" of hazards from a navigational perspective. There is adequate water depth and adequate navigable width for a safe passage. The passage through Bathurst Inlet to the proposed port site is considered viable for a well-equipped modern ship operated by professionally qualified personnel.

1.8.2.2 Wharf Approach and Berthing

The location of the dock will allow for both starboard (right) and port (left) "side to dock" berthing. The starboard approach will be direct from the north without any turning. Berthing with the starboard side against the wharf will make it more difficult to depart because the vessel will have to clear the berth in a loaded condition and make a relatively sharp "short round" or "star" turn to port to set a course to the north and out of Bathurst Inlet (refer to Figure 1.8-3). The water depths of 90 to 100 m (with a mud seabed) in the mid channel section adjacent to the berth will allow the ship to “walk out” and then deploy an anchor if required to assist in the turning maneuver. It is not planned to have any tug assistance at the port and it is expected that prevailing wind and current conditions will dictate which approach will be favoured for a particular berthing. Local weather reporting (wind speed, direction, and wave height) will be provided to assist incoming vessels.

1.8.2.3 Bathurst Inlet Aids to Navigation

The purpose of providing aids to navigation in the shipping channels accessing the proposed BIPR port site would be to increase the safety of navigation for ships transiting the shipping route from the eastern end of Coronation Gulf through Bathurst Inlet (SNC-Lavalin 2007).

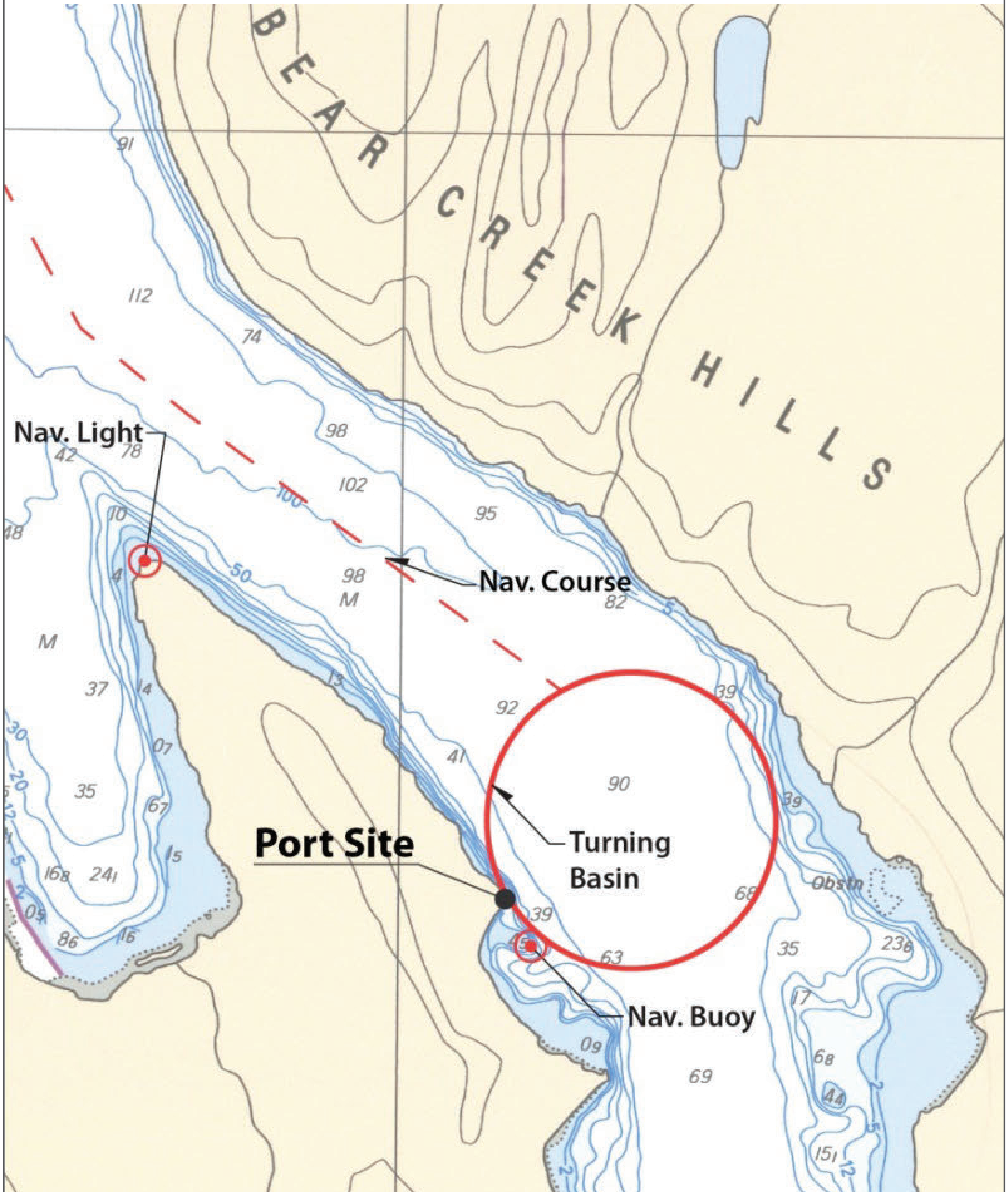
The regulatory authority responsible for approval of aids to navigation in Canadian waters is the Department of Fisheries and Oceans (DFO), and specifically the Canadian Coast Guard (CCG), a Special Operating Agency of DFO. While this Ministry is mandated to provide aids to navigation in Canadian waters, it is feasible that BIPR could provide the required aids to navigation, in which case they would be classed as private aids to navigation, and be the responsibility of BIPR. This section of the report is presented as a starting point for discussion with the regulatory agencies; it provides a conceptual plan of proposed additions to the existing system of aids to navigation, based on the ship access route already defined for access to port facilities at Bathurst Inlet.

This section addresses the proposed locations and types of aids as opposed to the design of these aids, or the specification of the particular manufacturer or particular light characteristics. The reason for this general approach is in anticipation that the CCG may be involved in the design of specific aids, and have a preference for specific manufacturers that allow integration and standardization of equipment or equipment components within the total aids to navigation system in this area of the Arctic. If however the aids will be installed and maintained as private aids by BIPR, detailed design will be required.

Aids to navigation in the Arctic are less than adequate for commercial shipping. The only existing aid to navigation in Bathurst Inlet is a radar beacon to the northwest of Rideout Island. There are no lit or electronic aids in the eastern end of the Coronation Gulf. There are a number of options available for the provision of aids to navigation over the access route to Edwards Cove. It is recommended that these aids be located on-shore where they are not subject to ice loads and have lower maintenance costs.

The proposed locations for navigation aids (see Table 1.8-2) are for the most part simple systems of omni-directional light beacons which allow conventional bearing and (radar range) distance position fixing augmented by the installation of range marks for the critical route sections:

- north of Breakwater Islands;
- south of Red Islands; and
- south of Quadyuk Island, to mark the centerline of the transit along these sections of the route.



Note: Depth in meters.

Figure 1.8-3

Port Site Navigation

Table 1.8-2. BIPR Aids to Navigation - Location

Item No.	Location	Type	Description
1	Entry Islands North Islet	Shore Beacon	MLED 200, Racon Beacon and tower
2	Wilmot Islands (north end of eastern island)	Shore Beacon	ML 155 and tower
3	Patsy Klengenburg Island (west side)	Shore Beacon	ML 155 and tower
4	North Breakwater Island (northern islet)	Shore Beacon	ML 155 and tower
5	Fisher Island (western side)	Range Lights	MLED 155 front, RL 200 rear + towers
6	Isle 2.5 NM SW of Fisher Island	Shore Beacon	MLED 120 and tower
7	Baychimo Harbour eastern arm islet (SW tip)	Shore Beacon	MLED 120 and tower
8	Shoe Island western side	Shore Beacon	MLED 120 and tower
9	Exposed Rock 2.1 NM NW of Rideout Island	Shore Beacon	MLED 120 (on existing tower)
10	Islet in shoal area SE of most eastern Red Islands	Shore Beacon	MLED 120
11	North Quadyuk Island (1.5 NM south of "Finger Bay") (1)	Range Lights	ML 155 front RL 200 rear + towers
12	West "Narrows", 3.0 NM south of Manning Point	Shore Beacon	MLED 120 and tower
13	East "Narrows", 3.5 NM south of Manning Point	Shore Beacon	MLED 120 and tower
14	Southeast peninsula of Quadyuk Island	Shore Beacon	MLED 120 and tower
15	South side of Elliot Point Peninsula (Bathurst hamlet area)	Range Lights	ML 155 front RL 200 rear + towers
16	Tip of the northwest arm of Tinney Cove	Shore Beacon	MLED 120 and tower
17	Young Point	Shore Beacon	MLED 120 and tower
18	Outer southeast point of Fishing Creek Bay	Shore Beacon	MLED 120 and tower
19	Port Peninsula (northern tip)	Shore Beacon	MLED 120 and tower
20	Port Berth	Shore Light	MLED 120

Source: SNC-Lavalin 2007

One additional navigation marker is recommended based on the selection of a new port site. A navigation buoy should be added to mark the end of the sandbar approximately 500 m south of the wharf (refer to Figure 1.8-3). This sandbar is located at the edge of the turning basin and would present a hazard to any vessel making a final approach for port side berthing.

The number and range of lights allows overlap point to point coverage, and reduces the range for lights to a level which can be supported by small battery and solar panel units, and consequently reduces the costs of the lighted aids. Conversely, it requires access to a larger number of navaid "sites" and increases the cost of site foundations, and possibly site clearing. A more detailed inspection of the route and of potential site locations is recommended prior to finalizing the number and type of aids to be installed.

All light beacon towers should be fitted with suitable day marks, and if on low lying ground, with radar reflectors. It is assumed that the design parameters such as the elevation of lights, range, colour, flash characteristics, and daymark characteristics will be defined in consultation with the CCG.

As noted in the equipment location table, the 20 units of aids to navigation proposed to be installed along the main access route include the marking of the berth facility. It is expected that the main berth will be well lit by working lights when ships are berthing at these facilities, the main purpose of the berth lights is to warn small craft which may be navigating in the area that there are fixed structures in these locations. Generally, the berth light would be placed on the outer extremity of the structure and would be of distinctive colour and flash characteristic such as quick flash amber.

1.9 Port Facility

1.9.1 Introduction

The proposed marine facilities at the Bathurst Inlet port site will consist of a continuous vertical sheet pile bulkhead with separate berths for large vessels and barges. The large vessel berth will be capable of serving bulk carriers, fuel tankers, and large cargo ships and the barge berth will be used for trans-shipment of fuel and cargo to local communities.

During the initial construction period the facilities will consist of a barge landing and laydown area that will be located within the footprint of the eventual permanent facilities.

1.9.1.1 Alternative Sites

The currently proposed port site is located about 2.2 km southeast of the site proposed in the 2003 Project Description submitted to the NIRB. The original port site selected at the north end of the peninsula was situated offshore on a 20 m thickness of very weak soft marine clays unsuitable for a stable wharf foundation. Considering constructability and previous experience in similar offshore geotechnical conditions, the risks associated with these weak marine clays can only be mitigated by a very large amount of dredging (> 1 million m^3). The original location also involved disturbing a significant area of the seabed.

Four alternative locations, including the original port site, were considered and evaluated in order to identify the site with the best offshore bottom foundation conditions for a rock-fill wharf structure and to minimize impacts to fish habitat (Figure 1.9-1). They are discussed in the following sections.

the BATHURST INLET PORT AND ROAD PROJECT

Figure 1.9-1

Port Site Alternatives

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1.9.1.1.1 Original Port Site

The original port site proposal was located at the north end of the peninsula. An offshore geotechnical investigation conducted at this site identified 20 m of soft marine clays on bedrock in 15 m of water depth (SNC-Lavalin 2007). Laboratory analysis and additional geotechnical analysis determined that the marine clays are very weak and represent a high risk for failure when considered as structural support for a rock-fill structure. To improve the constructability of this alternative and reduce risk, the wharf would have to be repositioned closer to land where the bedrock becomes shallower and the marine clays are thinner. However, accommodation of this reconfiguration would require significant dredging of a shipping channel into the new wharf position. Preliminary estimates indicated it would require a very large in-water affected area including over one million cubic metres (m^3) of dredging plus regular maintenance dredging. This alternative was eliminated as a viable location for a rock-fill wharf structure due to the large in-water environmental effects associated with the required dredge quantities. Upland work for the temporary laydown area and the in-water work for the jetty would lead to additional environmental effects.

A suitable temporary laydown area and barge landing would also be require to support the initial sealift. The best temporary barge landing and laydown with suitable bottom conditions and upland area is located on the sand and gravel beaches and esker located in the protected inlet 3 km south of this site (Figure 1.9-1).

1.9.1.1.2 Alternative A

Alternative A is located at a rocky extension from shore approximately 1.5 km south of the originally proposed port site. An offshore geophysical survey conducted in 2012 indicated that a rock bench is located at this site, but the bedrock is extremely steep (> 50% slope). Preliminary calculations to determine the factor of safety against sliding on steeply dipping bedrock were unacceptable without modifications to the bottom. Underwater blasting and dredging would be required to create a flat bench to improve stability against sliding. Soft marine sediments on bedrock are common in Bathurst Inlet and are generally observed in the Slave Geologic Province. The site is assumed to consist of the same soft marine sediments on bedrock as the original port site and would need to be dredged. Environmental effects would be associated with in-water marine blasting and dredging as well as the additional effects that would be required at the temporary barge landing and laydown pad.

1.9.1.1.3 Alternative B

Alternative B is located approximately 2 km south of the original port site. It is situated at the junction of the north face of an exposed bluff of the northwest-trending esker that appears to extend offshore. The beach in this location likely consists of the same sands and gravels as the esker which would extend offshore. The offshore geophysical data collected cannot distinguish grain size of the marine sediments but the bedrock interface was determined to be 15 m to 20 m deep with a mild slope (< 35% slope), capable of supporting a rock-fill structure with an adequate factor of safety against sliding. Additional offshore geotechnical drilling would be required to verify the offshore bottom conditions and evaluate properties of the marine sediments.

Establishing a port at this site would require stabilizing the bluff behind the wharf and would not require any dredging. The uplands area behind the wharf, however, is very limited and it does not have adequate space for the laydown area required for an efficient operation adjacent to the wharf. This alternative is not situated adjacent to the temporary barge landing and laydown area. As a result, this is not the best alternative, but should be considered as a backup to the preferred alternative until an offshore geotechnical drilling program is completed.

1.9.1.1.4 Preferred Port Site- Alternative C

Alternative C is located adjacent to the temporary barge landing and laydown area. This wharf location will include the temporary facilities within the boundary footprint of the completed BIPR Project, reducing total upland impact area significantly compared to all the other alternatives. Offshore conditions at this site, based on beach observations, likely consist of sands and gravels similar to the uplands esker. Bedrock is located approximately 15 m to 20 m deep and slopes less than 35% according to offshore geophysical results. The sands and gravels at this site and location of bedrock provide a suitable structural foundation support for a rock-fill wharf pending confirmation with a detailed offshore geotechnical investigation.

The site was also found to be adequate for vessel approach and departure positioning without tug assistance. Some minor dredging (< 15,000 m^3) will be required for construction to provide adequate draft of 15 m across the entire length of the dock. The dredged material will be re-used as backfill behind the sheet pile wall. This site has numerous advantages and as a result was selected as the preferred alternative. The overall area potentially impacting fish habitat was reduced by 9,700 m^2 partly due to no longer requiring a barge jetty area. Infrequent maintenance dredging might be required during operation of the Port.

1.9.2 Port Facilities

The marine facilities to be located on the southwest side of the long arm of Bathurst Inlet will be designed to meet the berthing requirements for large ocean going vessels. These facilities will include the main loading and receiving dock and a temporary shallow draft dock. The permanent dock structure will be of the gravity type consisting of an area developed by rock filling behind steel sheet pile cells. This type of structure was selected as it is considered the best suited to resist ice pressures. It also is the most reliable in Arctic conditions, based on case histories to date. The assumed vertical live loading applied at the surface will be 50 kPa (1,000 lbs/ft^2) which is considered quite adequate for safe movement of almost all heavy construction equipment, including heavy lift transporters using axle lines. This capacity means that equipment for future mines can be offloaded over the dock should the need occur.

The facility will consist of the main berthing area with fenders and 100 tonne mooring bollards to permit the mooring of vessels directly adjacent to the dock. Also, the main berthing area will accommodate the arrival of general goods in containers and diesel fuel in bulk, with allowance of sufficient space behind the loading/unloading equipment to be used for the required safety and environmental support services.

The reference datum used for these facilities is Chart (CD) or Hydrographic (H) zero, which is at Quadyuk Island and is 0.4 m below mean water level (SNC-Lavalin 2007). Canadian Hydrographic Services (CHS) chart No. 7793 indicates soundings and other control data.

1.9.2.1 Wharf

The main loading berth, or permanent dock, will be constructed to elevation +5.00 m CD, with a berthing face of about 120 m and 13.5 m draft at low water.

Two eskers have been mapped on the peninsula, and generally trend southeast to northwest. The preferred port site is located offshore from the northernmost esker. The north side of this esker is exposed to the prevailing winds, has no vegetation, and is a steep bluff that has experienced some erosion due to wave attack (see Plate 1.9-1; Table 1.9-1). The south side of this esker is located on a small inlet with exposure mainly to the south, has some vegetation, and slopes moderately (approximately 8%) from the inlet up to the top of the esker. At the base of the esker in the inlet, the vegetation gives way to a very stable sandy beach approximately 10 m wide.

Plate 1.9-1. North side of the esker at the proposed port site, exposed to wind and wave attack.

1.9.2.1.1 Field Investigation

The port reconnaissance study completed in 2012 included both upland and offshore field work. The upland field work was limited to visual observations of surface soils and bedrock outcrops. The offshore field work consisted of bathymetric surveys and sub-bottom profile geophysical work to identify bedrock depth.

The work confirmed adequate depth to support shipping activities and the presence of bedrock under a thick layer of sediments. According to the survey, the sediments vary in thickness with an approximate average thickness of close to 20 m, and top of bedrock surfaces vary between mild and steeply sloping.

Table 1.9-1. Environmental Design Considerations (Kugluktuk) for the Port

Wind: Based on Environment Canada Data and National Building Code	Prevailing wind from northwest quadrant	
	Hourly wind pressure 1/10 year return period	0.33 kPa
	Hourly wind pressure 1/30 year return period	0.42 kPa
	1/30 year wind (north-west)	92km/h
Earthquake: Based on Geological Survey of Canada data and National Building Code	Za	0
	Zv	1
	V	0.05
Snow: Ground snow loads based on Environment Canada Data	Snow component	2.4 kPa
	Rain component	0.1 kPa
Temperature	Extreme maximum temperature	32ºC
	Extreme minimum temperature	-50ºC
	January design temperature 2.5%	-44ºC
	July design temperature 2.5% dry bulb	20ºC
	July design temperature 2.5% wet bulb	13ºC
	Heating degree-days mean annual	1,075
Maximum Design Vessel	Size	50,000 DWT
	Length Overall (LOA)	190 m
	Beam	32 m
	Loaded draft	12 m
	Maximum light freeboard	17.2 m
	Hatch envelope	150 m x 16 m (0.7 LOA x 0.5 B)
	Number of cargo holds	6 or 7
	Number of ship cranes	3 each of 30 tons capacity and equipped for 10 m^3 clam shell grabs
	Dead-weight at loaded draft	50,000 tonnes
	Displacement at loaded draft	62,000 tonnes

Source: SNC-Lavalin 2007

Helicopter observations and analysis of aerial photographs suggest that erosion of the esker bluff is not significant, probably due to the short open water season. Longshore transport of sands and gravels to the south can be expected.

The approximately 11 years of non-contiguous wind data available at the proposed port site are not sufficient for the extreme value analysis necessary for the port design. However, up 24 years of wind data are available from the nearby Lupin Aerodrome and Bernard Harbour stations, and these datasets are useful for determining 50-year return maximum wind speeds in the region. Both stations have similar wind direction distributions with the highest wind speeds occurring from either the northwest or southeast, a feature also often observed within the BIPR port site wind dataset.

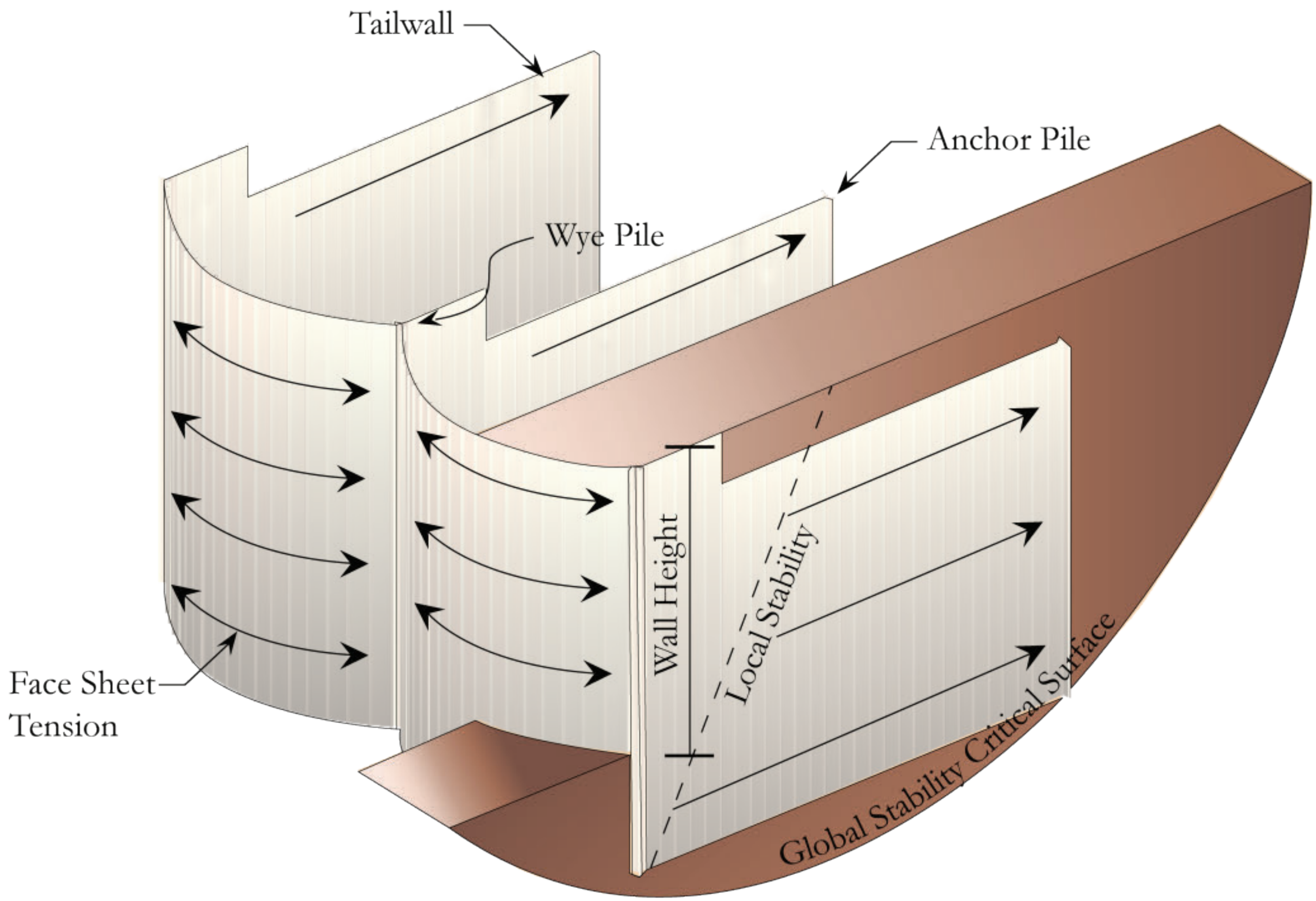
Available wind data were analysed and wave heights were calculated; the findings indicate that the proposed wharf design is reasonable for the anticipated conditions.

1.9.2.1.2 Wharf Design

Three wharf designs were considered: gravity fill caissons and two types of steel sheet pile cell structures: closed cell structures and Open Cell Sheet Pile®. The Open Cell Sheet Pile® type was selected as the most appropriate for the conditions expected at the site.

The Open Cell Sheet Pile® reinforced earth dock system uses vertical steel sheet piles that have a distinct scalloped appearance on the front face (Plate 1.9-2). Tailwalls extend into the fill section approximately every 9 m and are designed to reinforce the soil material in tension similar to a geotextile-reinforced earth wall. The face sheets exposed along the scalloped front edge are restrained by the tailwalls and are therefore not reliant on face sheet embedment depth. Soil pressure against the face sheets engages the interlocks of the sheet pile and the resulting tension forces are transferred into the tailwalls through the wye piles (Figure 1.9-2). The tailwall resistance strength is developed through soil friction with the compacted fill between the cells. The pressure of the compacted fill also helps to resist ice loads on the face of the bulkhead.

Plate 1.9-2. OPEN CELL reinforced earth bulkhead, Arctic Beaufort Sea.



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OPEN CELL SHEET PILE® Bulkhead System

Figure 1.9-2

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The main advantages of the OPEN CELL system are constructability in Arctic conditions and proven track record of survivability in extreme ice conditions. The OPEN CELL system reinforces the soil with the same flat sheet piles as the closed cell system but uses activated soil pressures inside the cells to provide some of the internal structural strength, reducing interlock stresses significantly (see Figure 1.9-2). An active wedge forming inside each cell provides opposing forces to resist environmental loads from ice and waves, and operational loads from mooring vessels.

The OPEN CELL system uses only two different components, extruded wye piles and flat sheet piles, and simple repetitive construction methods that result in high production rates even in Arctic winter conditions. Actual production rate achieved by skilled Arctic contractors in -35 degree temperatures can average two to three days per cell.

About 24 OPEN CELLs will be arranged as shown in Figure 1.9-3 to form the face of the dock. Backfill will be placed in the cells behind the sheet piles and between the tailwalls. The ultimate port configuration is shown in Figure 1.9-4.

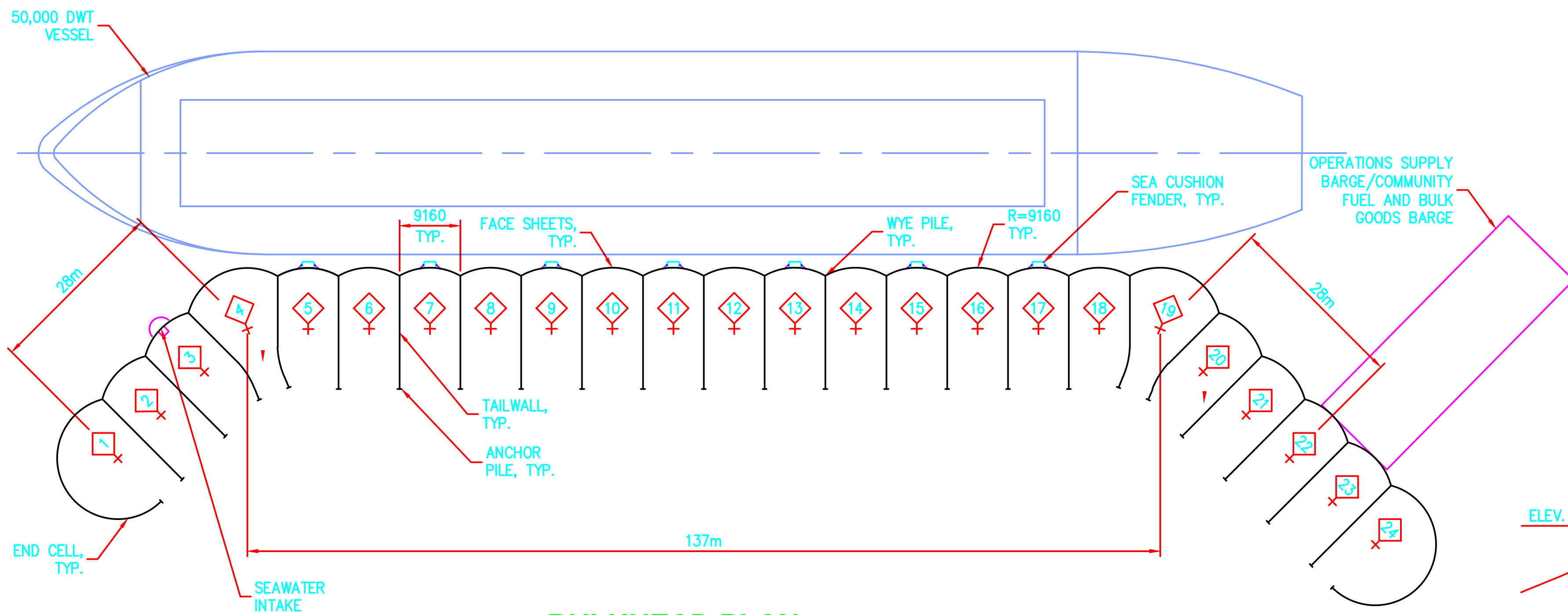
Backfilling the sheet pile is an efficient process that uses normal road construction equipment to dump, place, and compact the fill in between the tail walls and can be performed in winter or summer. There are many examples of OPEN CELL systems and winter construction with the following advantages:

- Wharf structure can be started in the winter and completed by the following open water season ready for usage having a one year advantage over a closed cell system.
- High productivity levels and shorter construction durations mean less fuel usage and less noise and air impacts.
- More efficient to stage smaller equipment and work crews from a large ice laydown pad.
- Ice roads from rock-fill material source sites can be accessed with more direct haul routes across winter ice roads.
- Reduces pressure on camp space that is at a premium during the summer.
- Equipment such as large cranes that are used only by the summer vertical construction crews can be used in the winter.
- Experienced pile driving crews that are normally very busy during the summer month are more available in the winter.

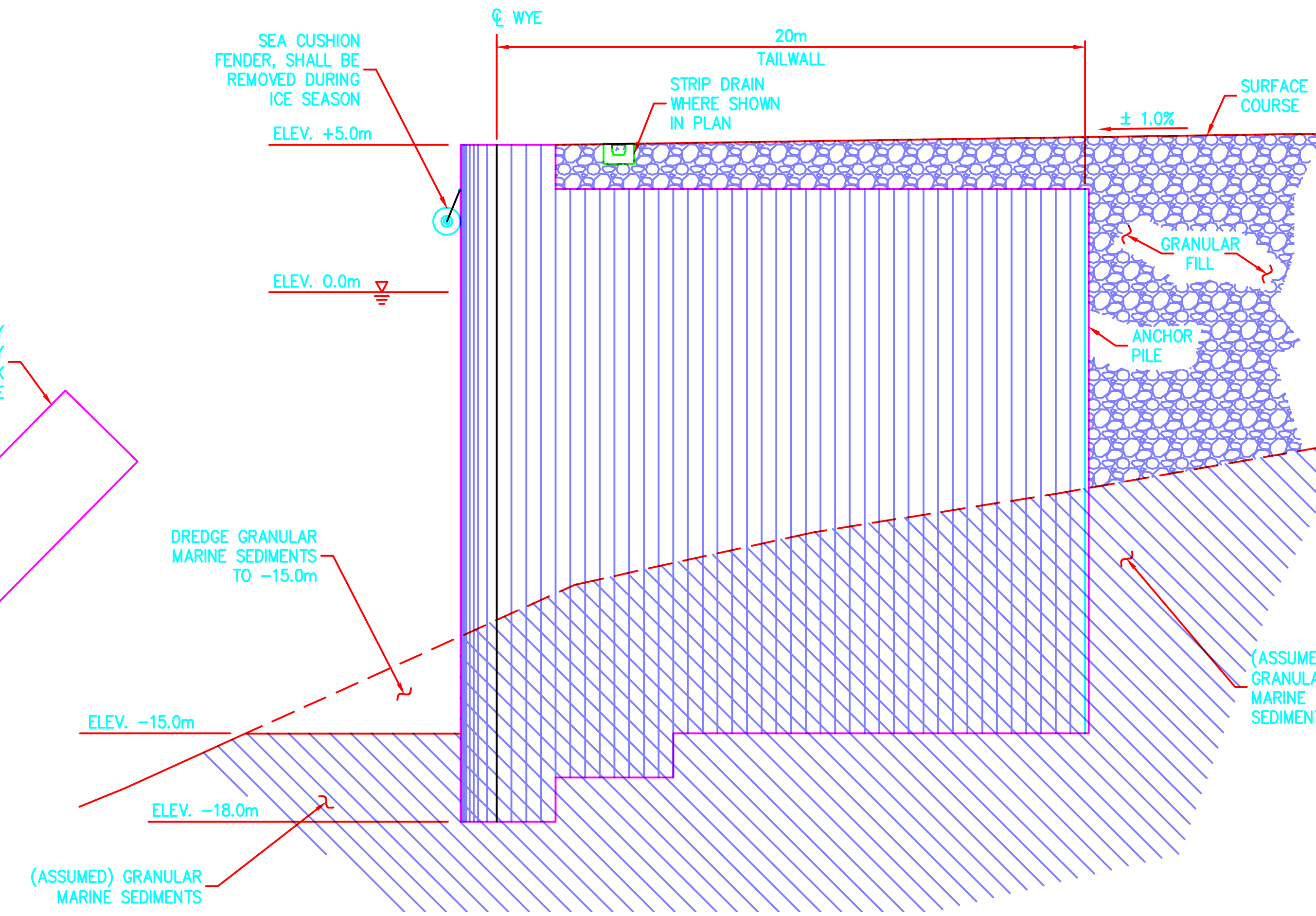
1.9.2.1.3 Wharf Stability

A sensitivity analysis was performed on the proposed OPEN CELL wharf to determine the controlling limit states of global stability and local stability failures. The primary variables that affect the factor of safety are:

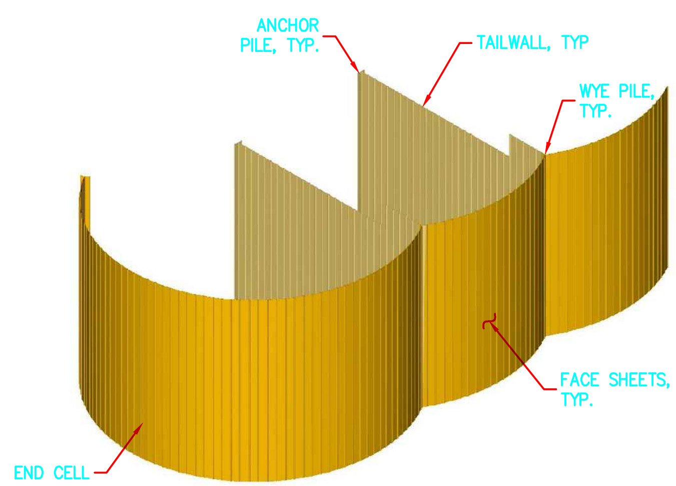
- Soil Friction Angle – natural failure angle of the fill material used in the bulkhead;
- Tailwall Length – longer tailwalls reduce the depth of the active wedge that develops behind the tailwall; and
- Sheet Embedment – depth of face sheet embedment into base material.



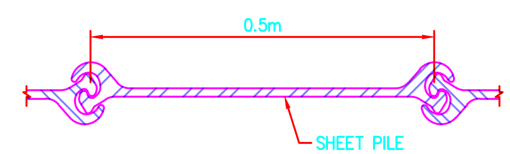
BULKHEAD PLAN



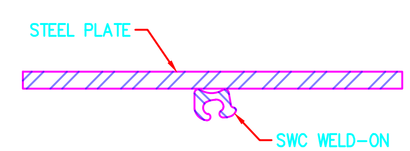
TYPICAL SECTION



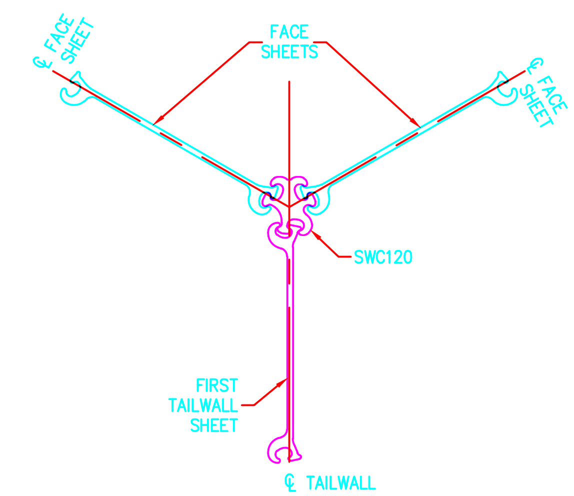
3D RENDERING



SHEET PILE



ANCHOR PILE



SWC120 WYE PILE

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Figure 1.9-3

Bulkhead Plan and Details

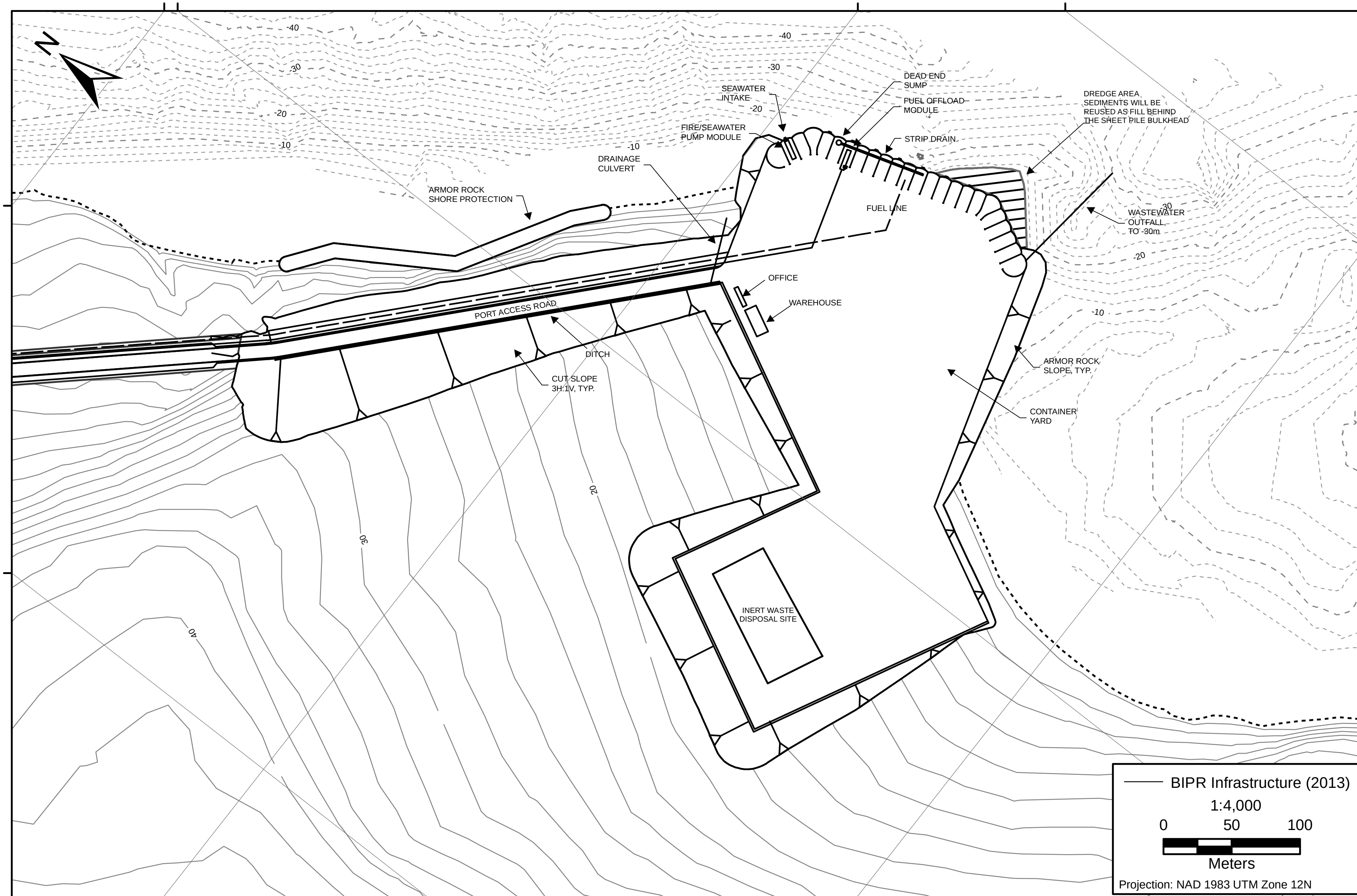

Figure 1.9-4

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Port Layout

Figure 1.9-4

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The soil friction angle and the tailwall length can be controlled in the design. The friction angle of the soil is dependent upon the selected material used for backfill and will be verified in future geotechnical investigations. The slope of the ground, angle of friction of rock-fill and weight of the sliding block rock-fill mass are used to calculate the factor of safety against sliding.

Based on the summer 2012 geophysical field studies, 20 m to 25 m of material overlie the bedrock. The esker is believed to extend below the existing shoreline, so this soil is assumed as granular material.

The following calculations have been completed along with recommended factors of safety and preliminary calculation results are presented in Table 1.9-2.

Table 1.9-2. Summary of Preliminary Factors of Safety for OPEN CELL Structures

Check	Recommended Factor of Safety	Calculated Factor of Safety
Global Stability	1.5	1.5
Sliding Block	1.5	4.3
Active Wedge	1.5	5.8
Overturning	2.0	9.1
Interlock Tension	2.0	6.7

Load combinations for design of the dock and marine facilities will be derived by factored groups of the following:

- dead load;
- live load (uniformly distributed, line and point);
- ice loads, both horizontal and vertical;
- wave and current loads;
- wind loads (on structure and equipment); and
- berthing loads; mooring loads; and seismic loads.

As a preventative measure, the sheet pile will be coated with a zinc spray metalizing to mitigate against the potential microbial induced corrosion in the low tide zone. Sacrificial zinc anodes will also be installed below the low tide zone to reduce the corrosion potential in the deep water zone.

In order to prevent erosion along the north side of the esker a 6 m wide and 1 m thick rock berm will be constructed above the high water line for a length of approximately 500 m.