Volume 1 Annex V1-7 Type A Water Licence Applications

Package P5-10

Hope Bay Project: Roberts Bay Cargo Dock Preliminary Design

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Memo

To:	John Roberts, PEng, Vice President Environment	**Client:**	TMAC Resources Inc.
From:	Kaitlyn Kooy, EIT	**Project No:**	1CT022.013
Reviewed By:	Maritz Rykaart, PhD, PEng	**Date:**	November 30, 2017
Subject:	Hope Bay Project: Roberts Bay Cargo Dock Preliminary Design		

Change Log

The following table provides an overview of material changes to this report from the previous version issued as Appendix V3-3B as part of the DEIS for Phase 2 of the Hope Bay Project dated December 2016.

Changes by Section

Information Request, Technical Comment, or Other Change	Section	Comments
INAC-IR30 (a)	5	Provided confirmation that silk curtains will be used in open water construction.
INAC-IR31	5	Clarified sheet pile installation methodology, geogrid specification and installation, and transition material placement.
Other	4.3	Alternate dock design for unfavourable foundation conditions

1 Introduction

1.1 General

The Hope Bay Project (the Project) is a gold mining and milling undertaking of TMAC Resources Inc. The Project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory, and is situated east of Bathurst Inlet. The Project comprises of three distinct areas of known mineralization plus extensive exploration potential and targets. The three areas that host mineral resources are Doris, Madrid, and Boston.

The Project consists of two phases; Phase 1 (Doris project), which is currently being carried out under an existing Water Licence, and Phase 2 (Madrid-Boston project) which is in the environmental assessment and regulatory stage. Phase 1 includes mining and infrastructure at Doris, while Phase 2 includes mining and infrastructure at Madrid and Boston located approximately 10 and 60 km due south from Doris, respectively.

All equipment and supplies needed to support the Project are transported to the site via the annual sealift during the short open water season in the late summer. The existing Roberts Bay jetty is not designed to accommodate the medium-draft cargo vessels that are required to meet the fuel and equipment needs of the expanded project. The proposed Roberts Bay cargo dock will allow cargo vessels to dock and offload cargo more easily and safely.

1.2 Objective

This memo provides the preliminary design details for the Roberts Bay cargo dock. Design of the cargo dock access road is provided in SRK (2017a).

2 Design Concept

2.1 Approach

The overall design concepts for the Roberts Bay cargo dock is based on previous work performed by SRK as part of the Roberts Bay Jetty design (SRK 2007), the alternatives assessment carried out by PND Engineers Inc. (PND 2012), and updated design concept drawings prepared by PND Engineers Inc. in 2017 (PND 2017). The cargo dock will be designed to minimize the footprint and disturbance to the environment. The cargo dock will become the main port where cargo is unloaded.

2.2 Components

The Roberts Bay cargo dock will consist of the cargo dock and causeway. The cargo dock is the marine structure at which cargo vessels will berth and the causeway will connect the dock to the access road on land.

2.3 Topographic Data

Design of the Roberts Bay cargo dock and access road is based on topographic contour maps with 1.0 m vertical resolution, (PhotoSat 2012), and bathymetry data with 1.0 m resolution (Golder 2006). The topographic contour maps were produced from 2012 satellite imagery and bathymetry was produced from bathymetric surveys using Sidescan sonar. Detailed ground surveys have not been completed.

2.4 Foundation Conditions

The offshore overburden in Roberts Bay appear to be of similar origin to those in the rest of the Hope Bay Belt. The bay is characterized by deep low-strength sediments of up to 20 m deep. Typically submarine permafrost is often present in areas of the bay with an average water depth of 1 m. Submarine permafrost is not expected in deep water. For more details on the foundation conditions refer to SRK (2017b).

The Roberts Bay coast consists of a large area of exposed bedrock. The most prevalent rock type on site with surface exposure is mafic volcanics, predominantly basalt. Permafrost soils are comprised mainly of marine clays, silty clay and clayey silt, with pockets of moraine till underlying these deposits. The marine silts and clays contain ground ice on average ranging from 10 to 30% by volume, but occasionally as high as 50%. The till typically contains low to moderate ice contents ranging from 5 to 25%.

2.5 Environmental Setbacks

The following environmental setbacks have been applied when selecting the location of the cargo dock:

- Minimum 30 m buffer zone from known rare plants; and
- Minimum 30 m buffer zone from known archeological sites.

While priority was given to avoid these areas, in some cases the minimum buffer around archeological sites could not be maintained. In these instances, the archeological site will be mitigated in accordance with the Heritage Resources Protection Plan (TMAC 2016).

3 Alternatives

3.1 Dock Type

An alternatives assessment for dock type was carried out in 2012 (PND 2012). Two of the dock types evaluated in 2012, as well as extending the existing jetty were considered for the current Project. A summary of each type of dock is summarized in Table 3.1.

Table 3.1: Berth Structure Type Summary

Alternative	Details
Existing Jetty Extension	Extension of the existing jetty to increase the water depth to allow larger vessels to berth.
Barge Dock	Designed to berth shallow-draft barges. Requires a minimum water depth of 5.5 m. The existing jetty is this type of structure, so construction of an additional barge dock would not greatly improve shipping logistics.
Cargo Dock	Designed to berth medium draft vessels and large ocean-going barges. Requires a minimum water depth of 9 m.

The cargo dock was the chosen alternative as it provides the most versatility and allows vessels to unload more safely.

3.2 Dock Location

Four different locations of the cargo dock were considered as part of the alternatives assessment carried out in 2012 (PND 2012). No additional locations were considered in this assessment. The cargo dock options are described in Table 3.2 and are shown in Figure 1 (Attachment 1).

Table 3.2: Alternative Cargo Dock Locations

Alternative	Details
C1	Located approximately 3 km northwest of the existing Roberts Bay jetty. The water is deep and very near the shore reducing the length of the dock required to meet the minimum depth design criteria. This location provides suitable large vessel maneuverability.
C2	Located approximately 2 km northwest of the existing Roberts Bay jetty. The water is deep and very near the shore reducing the length of the dock required to meet the minimum depth design criteria. This location provides suitable large vessel maneuverability.
C3	Located approximately 1.5 km northwest of the existing Roberts Bay jetty. The water is much shallower at this location which requires the dock to be longer to reach the necessary minimum water depth. This location does not provide suitable large vessel maneuverability.
C4	Located approximately 1 km northwest of the existing Roberts Bay jetty. The water is much shallower at this location which requires the dock to be longer to reach the necessary minimum water depth. This alternative interferes with the Roberts Bay discharge system. This location does not provide suitable large vessel maneuverability.

Location C2 was selected as the preferred location as it, provides suitable large vessel maneuverability, requires the least amount of fill to construct the dock, has a relatively short access road, and does not interfere with any other planned infrastructure at Roberts Bay.

4 Design

4.1 Design Criteria

The design criteria for the Roberts Bay cargo dock are listed below. These design criteria were developed by PND (PND 2012) and updated in 2017 (PND 2017) to optimize the design and increase the draft depth to allow for larger vessels to berth. The use of larger vessels will allow for direct offload of fuel and cargo as opposed to the current practice of lightering fuel from large vessels to the shallow water jetty. Direct offload of fuel will reduce cost, improve safety, and minimize potential for accidental spills.

- The design vessel for the cargo dock is a general cargo vessel with an overall length of 140 m, a breadth of 21.0 m, a draft of up to 10.0 m, and a deadweight tonnage of 45,000 tonnes;
- The approach channel width will be a minimum of four times the breadth of the design vessel;
- The under keel clearance will be 15% of the design vessel draft while maneuvering and 10% of the design vessel draft while in the berth.
- The turning basin will not be less than 2.5 times the overall length of the design vessel;
- The breasting face length of the cargo dock will be a minimum of 0.4 times the overall length of the design vessel;
- There will be four mooring fixtures: two interior breasting lines and two outer mooring lines at approximately 45° at the bow and stern;
- The dock will withstand the maximum forces generated by the design vessel under action of the most severe wind, waves, and current; and
- The cargo dock will have a minimum factor of safety of 1.6.

4.2 Design

The overall cargo dock, inclusive of the causeway, will have an overall length of 125 m and a total draft depth of 12 m. The dock will consist of a 75 m long causeway and 50 m long dock.
The dock face is 70 m wide. The total footprint of the cargo dock and causeway is approximately 10,000 m^2.

A cargo dock laydown area will be established within the footprint of Quarry AE. The laydown area will allow efficient loading and off loading of cargo from berthed vessels to minimise mooring time. Quarry AE will be developed to produce a floor with an slope of approximately 1% within the designated laydown area. Surfacing material of a minimum 0.15 m thick will be spread across the laydown area footprint. The laydown area design is provided in SRK (2017a).

The cargo dock will have a vertical face, extending 2 m above the normal highwater mark with a scalloped appearance. The cargo dock will consist of a series of interlocking extruded sheet piles that are driven to bedrock and tied back with anchor sheet piles into a mechanically stabilized embankment (MSE). The vertical face sheets are restrained by the tailwall anchor sheet piles that extend into the MSE approximately every 9 m (PND 2012). The MSE will be made up of transition material and covered with 0.15 m of surfacing material. The vertical sheet pile front face will be equipped with fenders.

The causeway will be constructed with run-of-quarry (ROQ) material and armoured with rip rap on either side. The driving surface will be covered with 0.15 m of surfacing material. The causeway will be underlain with geogrid to reduce embedment of the marine sediments in the ROQ.
Fill thickness will vary based on the depth to the ocean floor. The causeway slopes into the water will be protected with a minimum of 1 m of rip rap.

Preliminary design drawings for the cargo dock is provided in Drawings CDR-01 and CDR-02 (Attachment 1).

For optimum handling of the sheet piles the depth to bedrock should be no greater than 26 m below sea level. The depth to bedrock in this area is unknown and will be confirmed with a drilling program. Should the bedrock surface be deeper than 26 m below water level or the marine sediments deemed unsuitable, an alternate Cargo Dock design will be implemented as described below.

4.3 Alternate Design

The alternate dock design is a floating berth consisting of a steel barge and two transfer bridges spanning from shore abutments.

Similar to the preferred cargo dock design, the shore abutments will have a vertical face extending 2 m above the normal highwater mark. The abutments will consist of a series of interlocking extruded sheet piles driven to bedrock and tied back with a single anchor sheet pile on each abutment. The abutments will have a draft of approximately 5 m as they will be constructed much closer to shore. The two abutment causeways will be constructed in the same way as is described in Section 4.2. The abutments and causeways have a total footprint of approximately 4,000 m^2.

The floating barge will be 120 m long and 30 m wide and equipped with fenders and pile hoops to allow it to be secured in place with 1800 mm diameter piles drilled to bedrock. Prior to freeze up each year the barge will be dragged onto the beach and stored for the winter months. The deck of the barge will be reinforced to accommodate the weight of cargo being offloaded.

To access the barge from the abutments, two 6 m wide and 75 m long steel transfer bridges with pin connections will span from the abutments to the barge. The pin connections will allow the barge to float freely with the tide.

Conceptual design drawings for the alternative floating berth is provided in Drawing CDR-04 (Attachment 1).

5 Construction

All construction fill materials will be obtained from geochemically suitable permitted quarries or geochemically suitable run-of-mine rock. Management and monitoring of these quarries will be according to the quarry management and monitoring plan (TMAC 2017). Surfacing (32 mm minus) and transition (150 mm minus) materials will be produced at an on-site crusher located within Quarry AE. The estimated construction quantities are provided in Drawing CDR-03 (Attachment 1).

Based on previous surface infrastructure construction on the Project, it is assumed that the construction fleet will consist of CAT 730 haul trucks, CAT 773 haul trucks, CAT D8 dozers, CAT C330 excavator(s), CAT CS563 compactor and a crusher. A vibratory hammer and barge will be required for the installation of the sheet piles.

Prior to construction, a silt curtain will be installed surrounding the cargo dock and remain in place throughout construction. At no time will disturbance of the tundra vegetation or soils be allowed outside of the infrastructure footprint, and no permafrost disturbance will be allowed. Surfacing material and rip rap will not be placed until the transition material or ROQ material layer is at design grade and level. All construction should be performed in accordance with the technical specifications (SRK 2011).

The sheet piles will be installed to bedrock or to a deep bearing layer with a vibratory hammer from a barge. Temporary sheet pile templates will be installed and supported by temporary piles to provide stability to the sheet piles before being filled with transition material. The cells will initially be filled using a work barge starting from the dock face and moving inward towards land. Steps will be taken to ensure that the underlying sediments have consolidated prior to placing the next lift of transition material. While removal of the weak marine sediments is not required prior to construction, removal of obstructions from the sheet pile footprint may be required before the piles are driven. No dredging of marine sediments will be carried out.

The causeway will be underlain with geogrid to minimize marine sediment embedment into the ROQ material. Prior to the placement of any ROQ, biaxial synthetic geogrid will be placed in two layers by Arctic divers on the marine sediment. The ROQ will then be placed from land.

If the alternate dock design is implemented, the sheet pile abutments will be constructed in much the same way as described for the preferred cargo dock design, except the abutments will most likely be constructed from land. The 1,800 mm steel piles will be installed from a work barge and will require drilling rather than pile driving. All drill cuttings and drilling fluid will be retained on the barge until it is deposited within the sheet piles of the abutment.

The cargo dock should be constructed in the open water season (PND 2012). Summer construction will require careful screening of the shoreline for nesting birds, and modifications to the construction schedule may be required to avoid disturbing nesting populations.

6 References

Golder Associates Ltd. 2006. Sidescan Sonar Bathymetry Data prepared for Hope Bay Miramar Ltd.

Photosat. 2012. Digital Elevation Map Data prepared for Hope Bay Mining Ltd. Received on January 12, 2012.

PND Engineers Inc. 2012. Port Facilities Alternatives Assessment, Hope Bay Project Phase 2, Memo prepared for SRK Consulting, August 2012.

PND Engineers Inc. 2017. Hope Bay Deepwater Dock – Proof of Concept, Hope Bay Project, Memo prepared for SRK Consulting, November 2017.

SRK Consulting (Canada) Inc. 2007. Design of the Surface Infrastructure Components, Doris North Project, Hope Bay, Nunavut, Canada. Report prepared for Miramar Hope Bay Ltd. Project No.: 1CM014.008.420. March 2007.

SRK Consulting (Canada) Inc. 2011. Technical Specifications Earthworks and Geotechnical Engineering, Hope Bay Project Nunavut, Canada, Revision G – Issued for Construction. Report Prepared for Hope Bay Mining Limited. Project No.: 1CH008.033. March 2011.

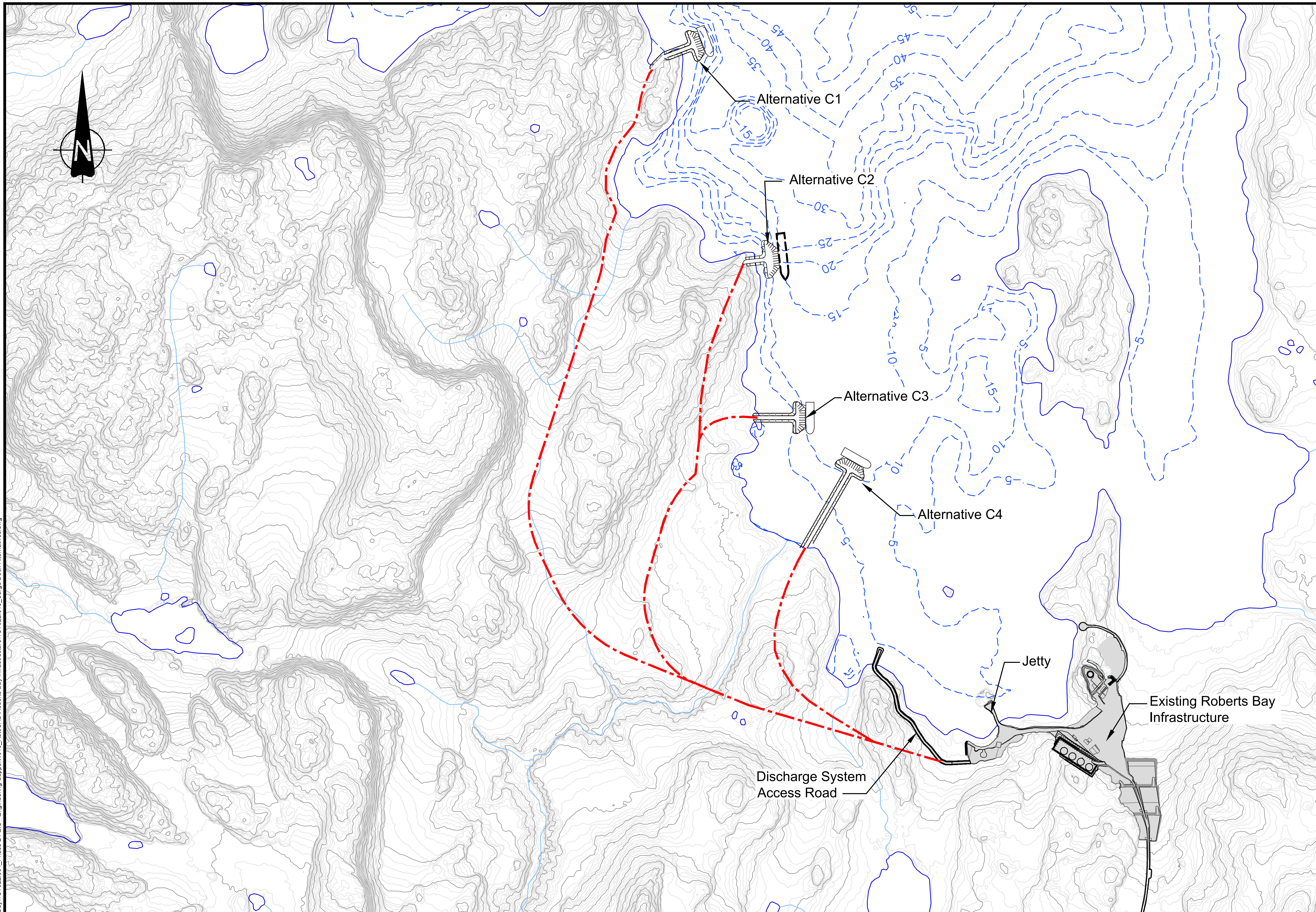
SRK Consulting (Canada) Inc., 2017a. Hope Bay Project: Roberts Bay Cargo Dock Access Road Preliminary Design. Memo Prepared for TMAC Resources Inc. 1CT022.013. November 2017.

SRK Consulting (Canada) Inc., 2017b. Geotechnical Design Parameters and Overburden Summary Report, Hope Bay Project. Report Prepared for TMAC Resources Inc. 1CT022.013. November 2017.

TMAC Resources Inc., 2016. Hope Bay Project, Heritage Resources Protection Plan, Management Report. December 2016.

TMAC Resources Inc. 2017, Quarry Management and Monitoring Plan, Hope Bay, Nunavut. February 2017.

Figure



LEGEND

Cargo Dock Access Road Alternative Alignments

Bathymetry Topography

NOTES

1. Cargo dock location alternatives developed by PND Engineers Inc. as part of the Port Facilities Alternatives Assessment August 2012.

0m 100 200 300 400 500 600

Scale in Metres

srk consulting

SRK JOB NO.: 1CT022.013

FILE NAME: 1CT022.013-Cargo Dock Alternatives.dwg

TMAC RESOURCES

HOPE BAY PROJECT

Roberts Bay Cargo Dock

Cargo Dock Location Alternatives

DATE:	APPROVED:	FIGURE:
OCT. 2017	KNK	1

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Attachment 1: Engineering Drawings for the Roberts Bay Cargo Dock

Engineering Drawings for the Roberts Bay Cargo Dock Hope Bay Project, Nunavut, Canada

ACTIVE DRAWING STATUS

DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS
CD-00	Engineering Drawings for the Roberts Bay Cargo Dock Hope Bay Project, Nunavut, Canada	B	Nov. 24, 2017	Issued for Discussion
CD-01	Cargo Dock General Arrangement	B	Nov. 24, 2017	Issued for Discussion
CD-02	Cargo Dock Plan and Sections	B	Nov. 24, 2017	Issued for Discussion
CD-03	Material List and Quantity Estimates	B	Nov. 24, 2017	Issued for Discussion
CD-04	Alternate Cargo Dock Design Plan and Sections	B	Nov. 24, 2017	Issued for Discussion

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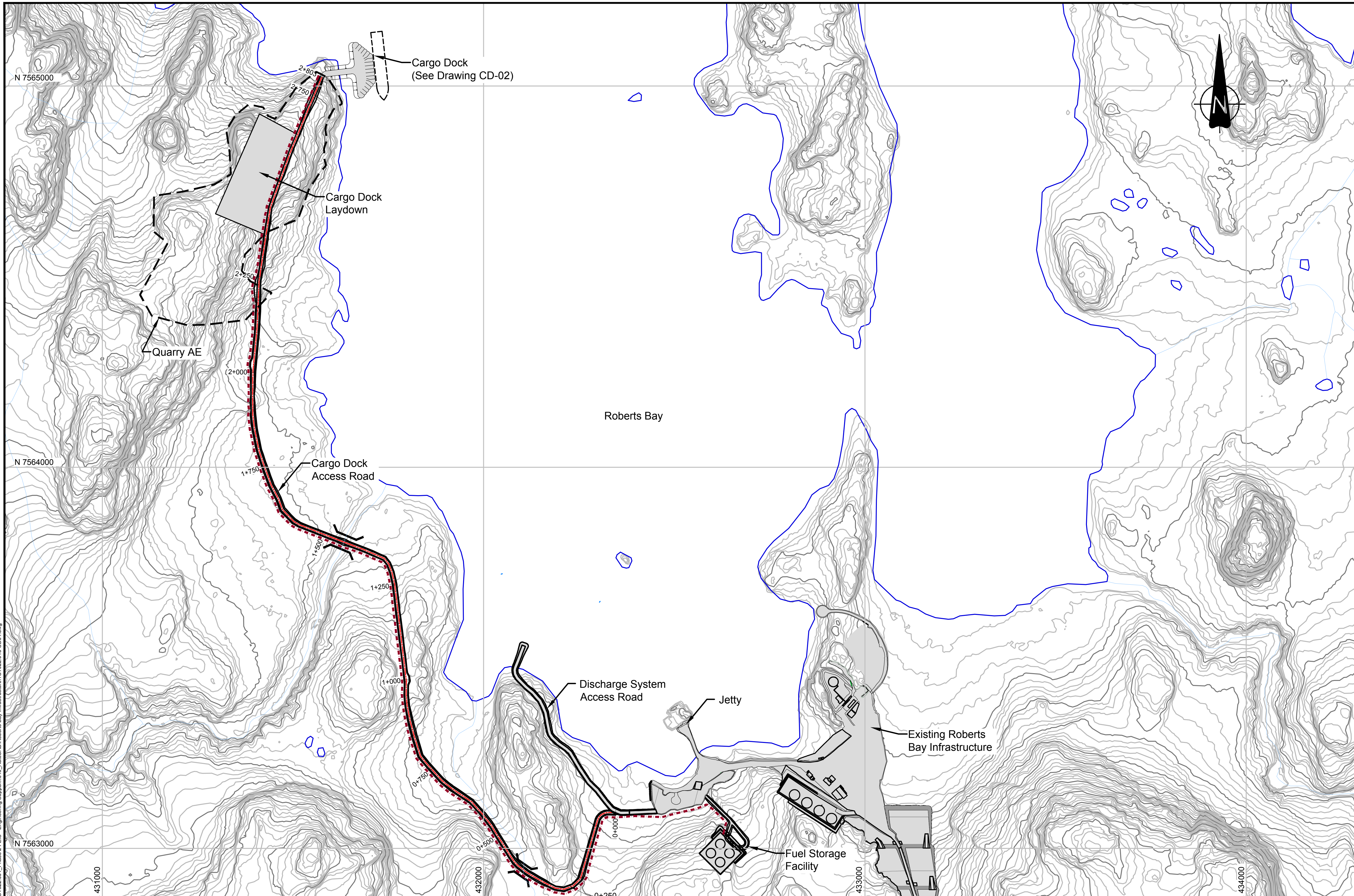
PROJECT NO: 1CT022.013
Revision B
November 24, 2017
Drawing CD-00



LEGEND

- Road Centerline (1+000)
- Turnout Location
- Crossing Location
- Fuel Pipeline

NOTE

Cargo dock design developed by PND Engineers Inc. as part of the Port Facilities Alternatives Assessment August 2012. The cargo dock design was optimized by PND as part of Hope Bay Deepwater Dock – Proof of Concept November 2017.

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued for Discussion	KNK	EMR	24Nov17
A	Issued for Discussion	KNK	EMR	25NOV16

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

PROFESSIONAL ENGINEERS STAMP

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DESIGN: KNK	DRAWN: MDDS	REVIEWED: KNK
CHECKED: KNK	APPROVED: EMR	DATE: Nov. 2017

FILE NAME: 1CT022.013–CD01.dwg

TMAC RESOURCES

HOPE BAY PROJECT

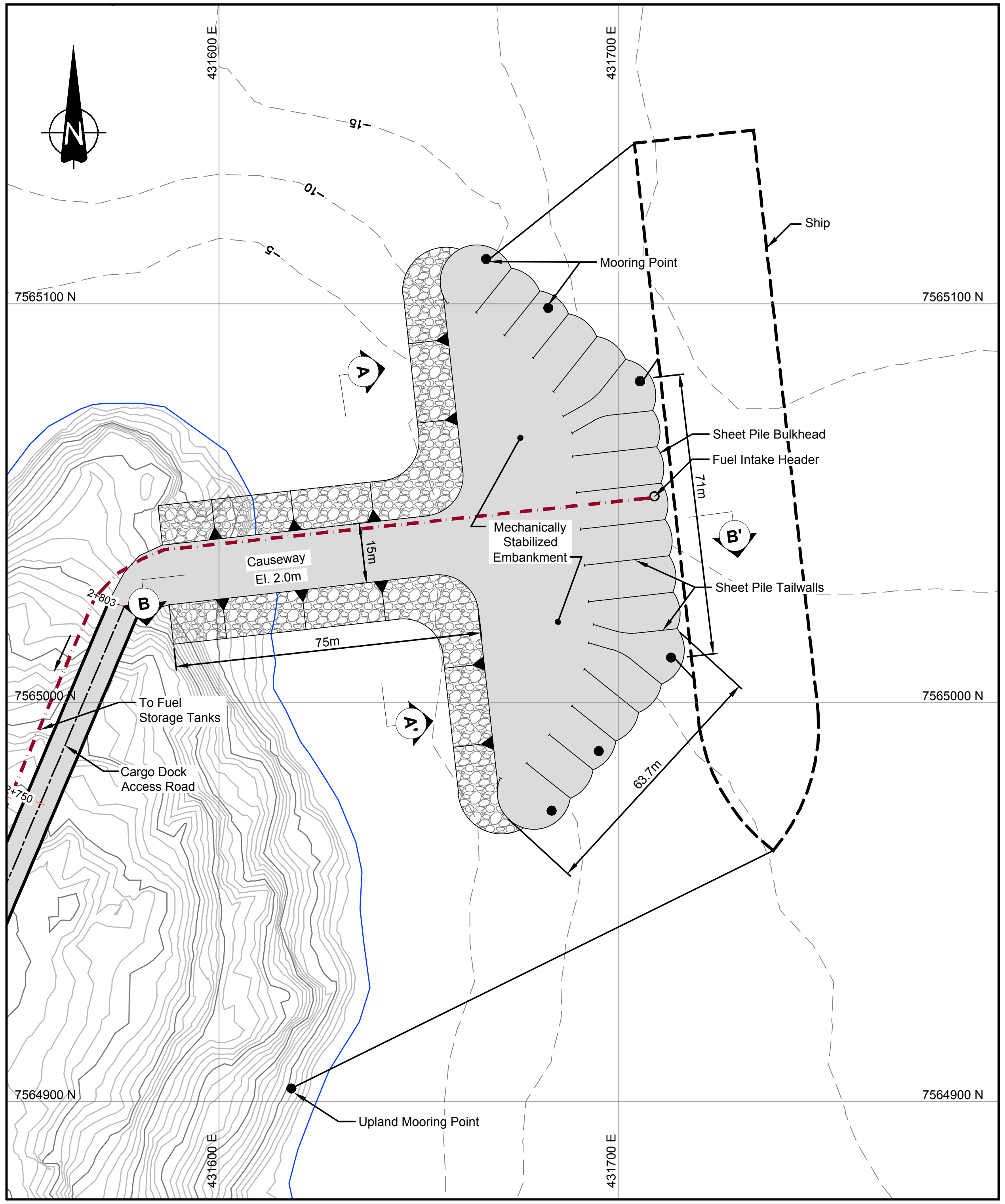
SRK JOB NO.: 1CT022.013

Roberts Bay Cargo Dock

DRAWING TITLE:

Cargo Dock
General Arrangement

DRAWING NO.	SHEET	REVISION NO.
CD-01	2 OF 5	B



PLAN VIEW
CARGO DOCK

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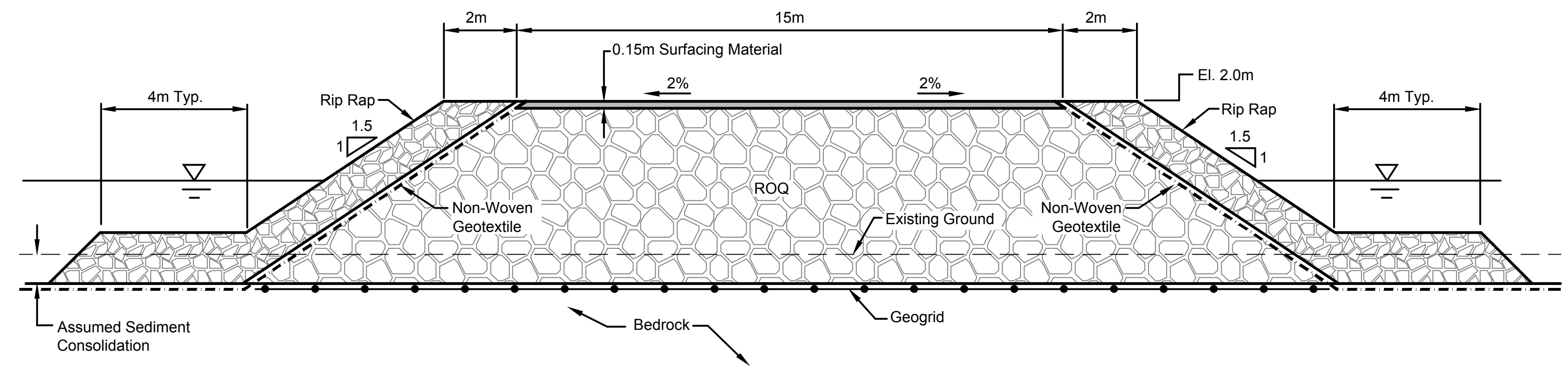
Scale in Metres



SECTION A
TYPICAL CAUSEWAY

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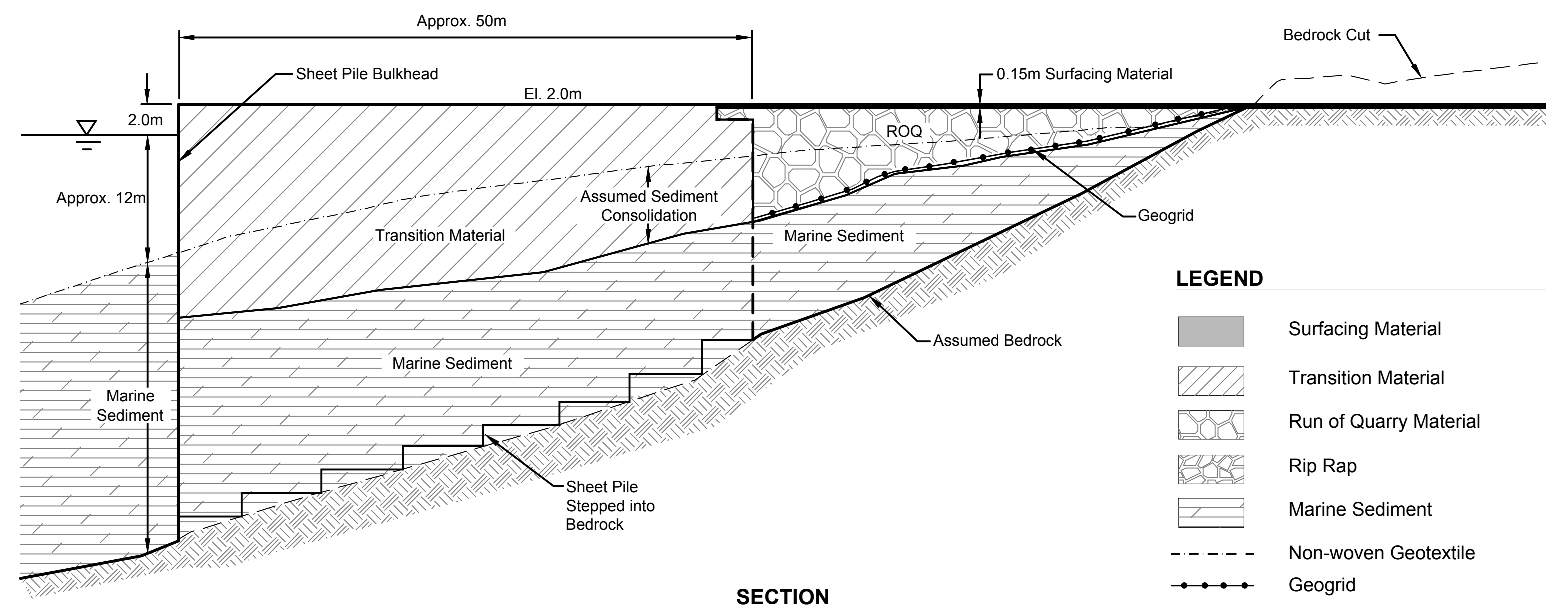

SECTION B
TYPICAL BULKHEAD AND CAUSEWAY

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Scale in Metres

LEGEND

- Surfacing Material
- Transition Material
- Run of Quarry Material
- Rip Rap
- Marine Sediment
- Non-woven Geotextile
- Geogrid
- 5.0 Bathymetry Topo
- Fuel Line

NOTE

Cargo dock design developed by PND Engineers Inc. as part of the Port Facilities Alternatives Assessment August 2012. The cargo dock design was optimized by PND as part of Hope Bay Deepwater Dock – Proof of Concept November 2017.

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued for Discussion	KNK	EMR	24Nov17
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REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

PROFESSIONAL ENGINEERS STAMP

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DRAWN: MDDS
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CHECKED: KNK
APPROVED: EMR
DATE: Nov. 2017
FILE NAME: 1CT022.013-CD02-03.dwg

MAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Roberts Bay Cargo Dock

DRAWING TITLE:
Cargo Dock Plan and Sections

DRAWING NO.: CD-02
SHEET: 3 OF 5
REVISION NO.: B

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Materials List and Quantity Estimates

Item	Quantity / Area / Volume	Description
1. Run of Quarry Material	Cargo Dock: 12,450m^3	- no allowance has been made for losses and/or marine sediment embedment) -Approximate In-place Neat-Line Volume -actual volume will be higher
2. Transition Material	Cargo Dock: 94,000m^3	- no allowance has been made for losses and/or marine sediment embedment) -Approximate In-place Neat-Line Volume -actual volume will be higher
3. Surfacing Material	Cargo Dock: 170m^3	- no allowance has been made for losses and/or marine sediment embedment) -Approximate In-place Neat-Line Volume -actual volume will be higher
4. Rip Rap	Cargo Dock: 3,550m^3	- no allowance has been made for losses and/or marine sediment embedment) -Approximate In-place Neat-Line Volume -actual volume will be higher
5. Geogrid	Cargo Dock: 3,200m^2	- Based on 3D Surface Area
6. Geotextile	Cargo Dock: 3,300m^2	- Based on 3D Surface Area
7. Sheet Piles	Cargo Dock: 9,000m^2	

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued for Discussion	KNK	EMR	24Nov17
A	Issued for Discussion	KNK	EMR	25NOV16

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

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CHECKED: KNK APPROVED: EMR DATE: Nov. 2017
FILE NAME: 1CT022.013-CD02-03.dwg

TMAC RESOURCES

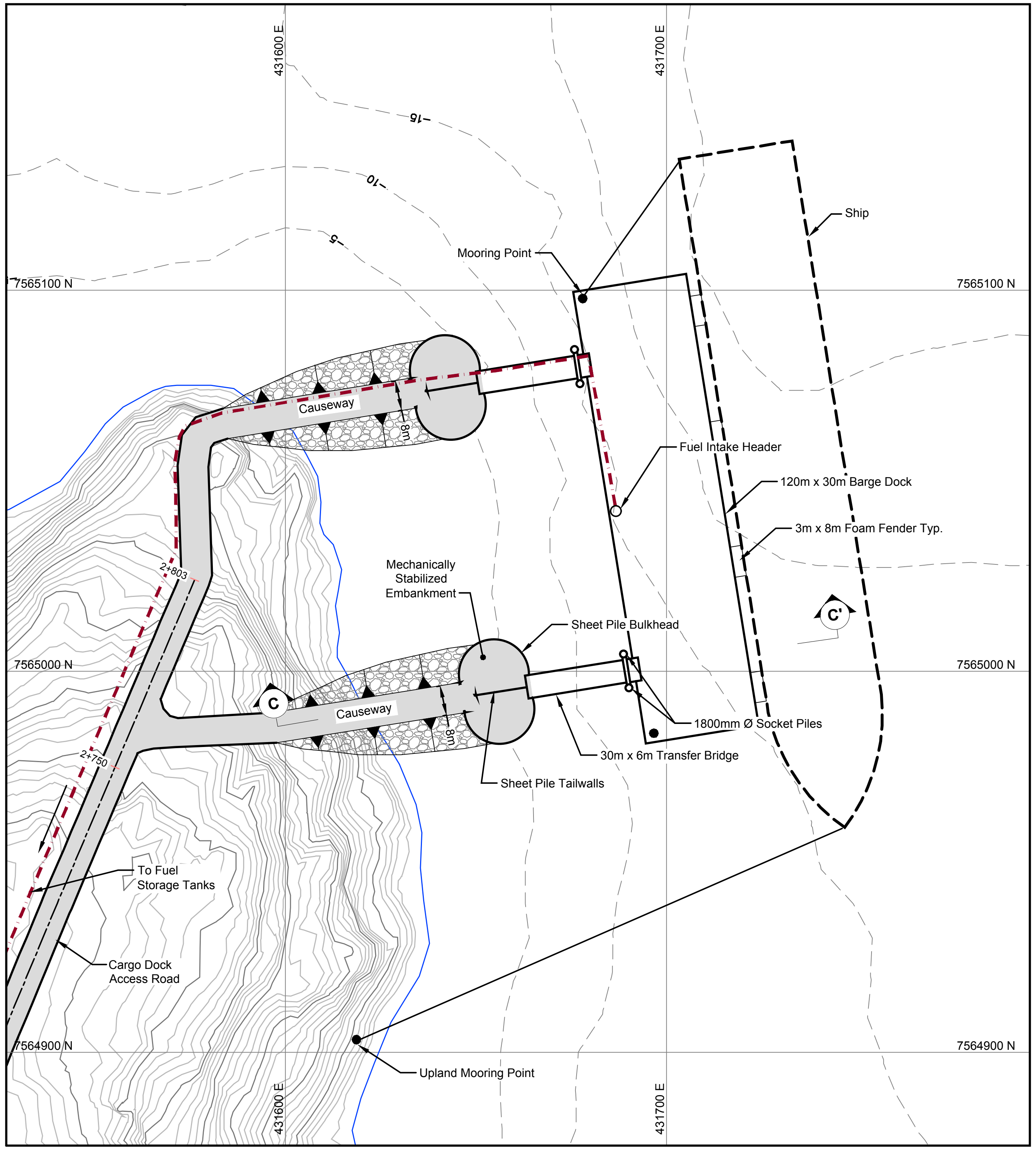
HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Roberts Bay Cargo Dock

DRAWING TITLE:
Material List and Quantity Estimates

DRAWING NO. CD-03 SHEET 4 OF 5 REVISION NO. B



PLAN VIEW
ALTERNATE CARGO DOCK DESIGN

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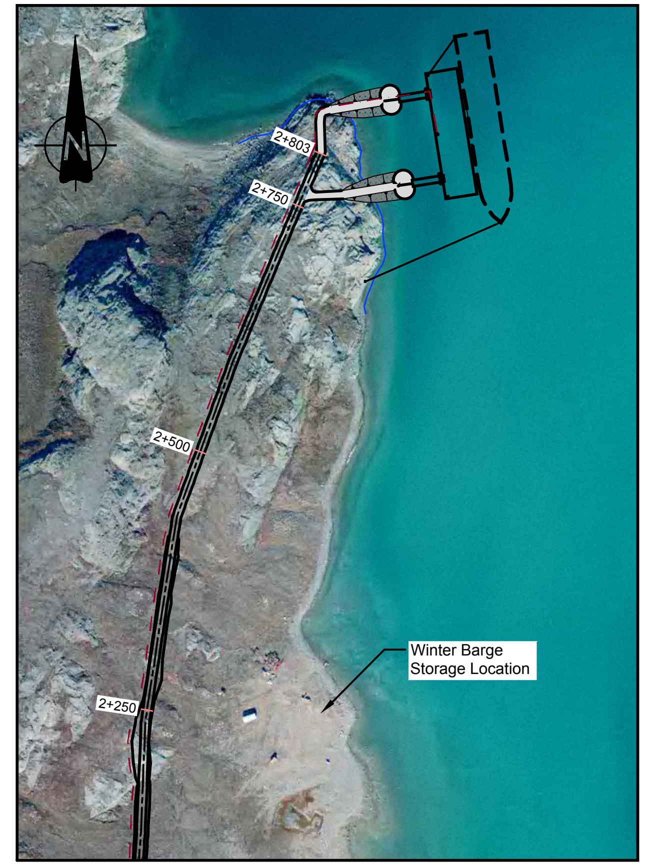
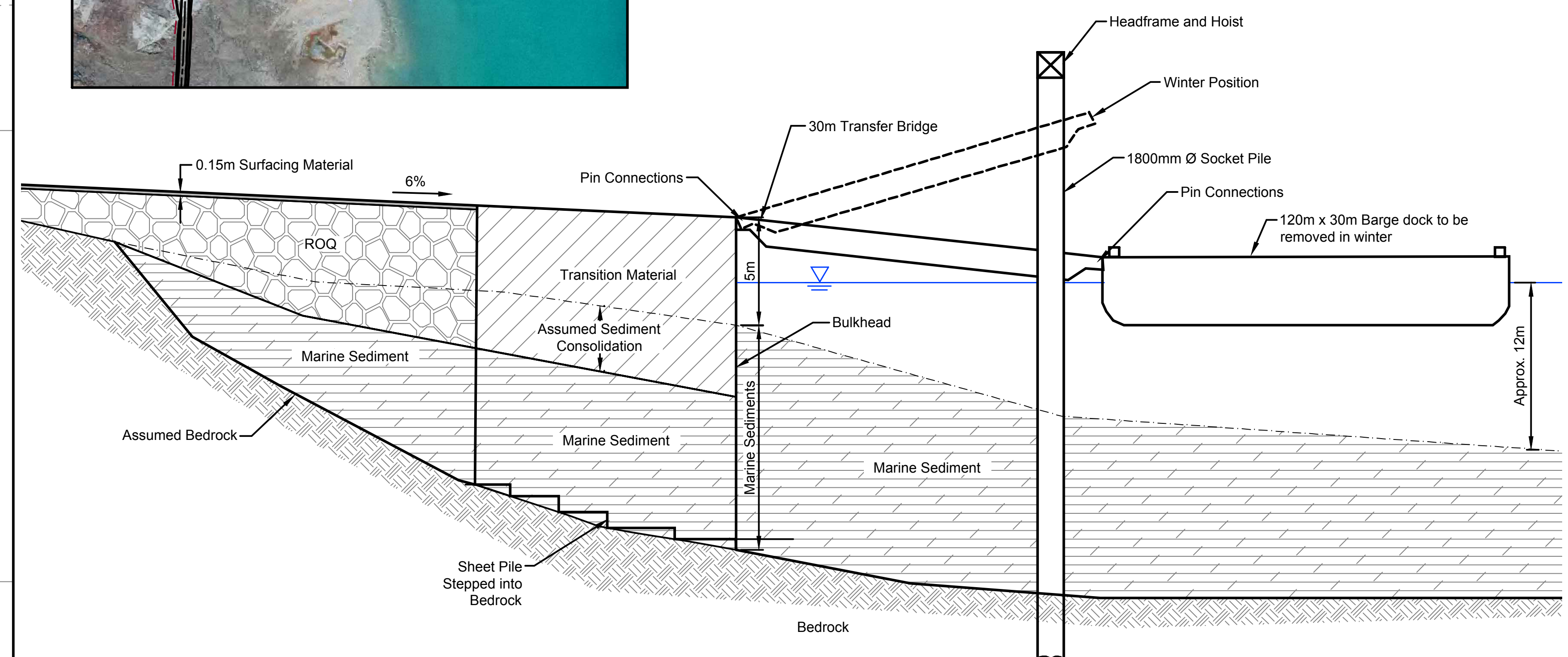
Scale in Metres





SECTION C
TYPICAL CAUSEWAY

0 2 4 6 8 10
Scale in Metres

LEGEND

- Surfacing Material
- Transition Material
- Run of Quarry Material
- Rip Rap
- Marine Sediment
- Bathymetry Topo (−5.0)
- Fuel Line

NOTE

Cargo dock design developed by PND Engineers Inc. as part of Hope Bay Deepwater Dock - Proof of Concept November 2017.

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued for Discussion	KNK	EMR	24Nov17
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REVISIONS

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REFERENCE DRAWINGS

PROFESSIONAL ENGINEERS STAMP

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DESIGN: KNK
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TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Roberts Bay Cargo Dock

DRAWING TITLE:
Alternate Cargo Dock Design
Plan and Sections

DRAWING NO.: CD-04
SHEET: 5 OF 5
REVISION NO.: B

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