Appendix 3D – Ore Dock and Ship Loading Comparison of Options

This Appendix contains three technical reports prepared by HATCH related to the Milne Port Ore Dock:

1) H349000-ZX003-90-236-0001, Rev. 0 - Ore Dock and Ship Loading - Comparison of Options, May 15, 2013.
2) H349000-2220-12-124-0001, Rev. A - Study for Panamax Ore Dock at Milne Inlet, February 28, 2013.
3) H349000-2220-12-124-0002, Rev. A - Milne Ore Dock Optimization, May 23, 2013.

Detailed costing and financial information has been removed from these reports as this information is confidential.

Project Report

May 15, 2013

Baffinland Iron Mines Corporation
Mary River Project - ERP

DISTRIBUTION

Hatch	BIM
H. Charalambu	R. Hampton
S. Perry	D. Matthews

Ore Dock and Ship Loading - Comparison of Options

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Note:
Sections 9, 10 and 11 are removes as they contain confidential information.

1. Introduction

Baffinland Iron Mines Corporation (BIM) is implementing the Early Revenue Phase (ERP) of the Mary River Project (the Project), commencing with on-site activity in 2013. The Project is located in northern Baffin Island. The purpose of the ERP project is to enable the mining of iron ore at Mary River and its shipment from a marine terminal at Milne Inlet, starting in 2015 and extending to 2019 or beyond.

Iron Ore shipments for the Milne site will be made, using Supramax, Panamax and Post Panamax vessels, during the brief open water season commencing in the third week of July and extending to mid-October.

A marine berth (dock) will be required to allow ships to tie up while being loaded by a pair of dock-mounted shiploaders. The shiploaders are required to have sufficient capacity and redundancy to enable exportation of the required annual throughput of 3.5 million tons of iron ore.

Two dock options have been examined, namely:

- A fixed berth permanently supported on the seabed and permanently connected to the shoreline (Fixed Dock).
- A floating berth face, connected to the shore by temporary means (Floating Dock).

For the Fixed Dock option, it has been assumed that BIM will retain a contractor(s) to construct the dock and install the shiploading system and BIM would be directly responsible for loading the ore ships. For the Flaoting Dock option it has been assumed that BIM will retain a contractor to both install the dock and be responsible for the ship loading operation.

This analysis was performed to determine whether BIM should select a fixed dock or a floating dock for the ore export berth at Milne Inlet. The analysis is therefore comparative and not intended to provide absolute costs for the two dock options nor to help decide between the two proposals received for the Floating Dock option.

BIM is also investigating the feasibility of shipping a bulk sample of up to 500,000tons of iron ore from Milne in 2014, but this was not considered in this analysis.

2. The Dock Options

The two dock options investigated are described below. In both cases the berth face is situated in approximately 17.0 metres of water at low tide, sufficient for a fully loaded Post-Panamax vessel. An extra 0.5 depth will be necessary for the Fixed Dock option to accommodate a scour mat, which is not necessary for the floating Dock option.

2.1 Fixed Dock

The fixed dock is comprised of three large (two approximately 30m in diameter and one approximately 18.5m in diameter) circular cells consisting of a shell of steel sheet piles driven into the sea floor and filled with crushed rock. The circular cells are about 38 metres apart on centres thus creating a berth face of about 80 metres. Two steel gangways connect the three cells to allow personnel and light vehicular access. Top of dock elevation is +5.3m giving a freeboard of about 3m at high tide. This freeboard has been provided to reduce the possibility of ice build-up on the dock.

Two smaller diameter sheet piles cells act as mooring dolphins for the bow and stern lines of the vessels. Fixed mooring dolphins were selected to allow for a longer operational window as the facility would be available during the ice transition periods (before and after the “Open Water Season”) when ships could possibly operate. Floating mooring buoys were considered for the fixed dock option as well, but were not recommended for the following reasons:

- Mooring buoys would need to accommodate several lines both at the bow and stern of the ship.
- Mooring buoys would have to be of the large displacement type, which unfortunately, because of the relative steep rise of the depth contours to the shore, the anchors for the mooring buoys could have difficulty holding.

A rock protected gravel causeway connects the dock area to shore.

Two shiploaders, one on each of the outboard dock cells, enable Handymax, Panamax and Post Panamax ships to be loaded at up to 4000 tons per hour.

BIM has requested proposals from construction contractors to construct the Fixed Dock based on design prepared by BIM’s engineers. Receipt of these proposals is imminent.

The general arrangement of the Fixed Dock facility is shown in Appendix A.

2.2 Floating Dock

Proposals for the design, installation and operation of the floating dock option were received from Northern Stevedoring Inc and from Logistec Stevedoring Inc. The dock systems proposed by the proponents are similar therefore a single system is described here.

The dock consists of two barges (76mx22mx4.6m) beached in a parallel manner about 76 metres apart with one end of each barge projecting out to sea in about 10 metres of water at low tide. Each of these two barges is pinned to the ground using four large diameter piles driven through the barge structure and into the sea floor. The barges are partially filled with water as ballast. A larger barge (128mx24mx7.5m) is positioned across the seaward side of the two parallel barges to act a floating berth face. The floating barge although tied back to the pinned barges with wire rope, is able to slide relatively freely against the pinned barge so is able to move up and down with the tides.

Although not clear from the submissions it appears the top of deck elevation for the two fixed barges will be around +5m, which is similar to the elevation selected for the Fixed Dock. It is not evident how this elevation will be achieved given the geometry of the smaller barges and the topography at the dock location.

In the Floating Dock proposals, the two shiploaders locations are as follows:

- Northern Stevedoring Inc is proposing to mount the shiploaders on the two beached barges.
- Logistec Stevedoring Inc is proposing to mount the shiploaders on the floating barge.

The general arrangement of the Floating Dock facility is shown in Appendix A.

3. Operations

Regardless of whether the Fixed or Floating Dock option is chosen the shiploading operations have similar features as follows:

- Reclaiming from stockpile is by front-end loaders excavating the stored iron ore then feeding mobile feeders which discharge onto a long reclaim conveyor running between the ore stockpiles and the dock area. A large dozer will assist as necessary with the reclaim operation by pushing material toward the mobile feeders.
- The reclaim conveyor feeds one or both of the shiploaders at the berth face for loading into the ore ship. The shiploaders can slew, shuttle and luff in order to load ships up to post Panamax size without the need to move the ship.
- Two tugs will be used to assist ships berthing and de-berthing at the dock.

For the Fixed Dock option it has been assumed that BIM will operate both the stockpile reclaim system and the shiploading system. Consequently operating fleet requirements, operating costs, maintenance costs and fuel requirements have been provided by BIM.

For the Floating Dock option, this analysis has used data provided by Northern Stevedoring Inc.

A summary of the key operating features is provided in Table 3-1.

Table 3-1: Operating Features of Dock Options

ITEM	FIXED DOCK	FLOATING DOCK
Reclaiming		
Rate (tph)	6000	4000
Front End Loaders (Type & Number)	CAT 992 - 8 or CAT 994 - 4	CAT 992 - 5 CAT 988 - 1
Other Equipment	Dozer CAT D10- 1 Excavator CAT 345 - 1	Excavator CAT 345 - 1
Feeders (number)	3	2
Reclaim Belt (size)	60" - 1	48" - 1
Shiploading		
Shiploaders (number)	2	2
Shiploader Capacity (tph each)	3500	7000
Shiploader Ops (one or two same time)	Both	Single
Nominal Loading Rate (entire system)	5300	3431
Berth Utilization (%)	51%	71%
Number of Days to load 3.5mt	40	52
Shiploader Power Consumption (kVA)	~2500	?
Fuel Consumption		
Reclaiming (liters/yr)	2,100,000	1,140,000

For Larger vessels Northern Stevedoring noted in their clarification document to enquiries #1 and #2 dated April 17, 2013 that “shiploaders would best be fitted onto a permanent structure to achieve the maximum use of the system to load capsize vessels”.

4. Approvals & Permitting

Both the floating and fixed dock options require a change to the Pre Development Area as well as the Inuit Owned Land lease. Also, they both require the use of tugs at Milne which has not been previously captured in the Final EIS. This is to assist the ships to berth and de berth from the dock and these tugs will need to be refuelled in Milne, either from shore to ship (not in the FEIS) or from ship to ship. The comparison of the two options from an environmental perspective is provided in Table 4-1.

Table 4-1: Comparison of Floating and Fixed Dock - Environmental

Floating Dock	Fixed Dock
The HADD is different as the floating dock is expected to be removed after around 5 years of operation. The sea bottom coverage will occur for a finite period of time and the sea life under the footprint should recover once the barges are removed.	The HADD is a defined area as the dock is permanent.
There is a higher risk of spills from the floating dock after ~5 years of operation. Longer than 5 years of operation, the two barges that are piled into the sea bed will be showing signs of wear and have a higher potential for spillage to occur into the sea. Tidal movement with high wind could affect wind dispersion of dust (assuming the dock/system is affected by the tides).	System will be more controlled for dust as the dock is unaffected by tidal movement.
The sediment movement along the shore is from East to West. Normal sedimentation can continue with the floating dock. Scouring may occur underneath the two pinned barges and need infill rock to maintain structural integrity. This will affect the footprint of the HADD.	The sediment movement along the shore is from East to West. The Fixed option will affect the sediment movement as it creates a permanent barrier.

5. Implementation Schedule

The implementation schedules for the two options are summarized in Table 5-1 and Table 5-2.

5.1 Schedule - Fixed Dock

The summary schedule for the Fixed Dock shown in Table 5-1 is derived from BIM's project schedule for the ERP project.

Table 5-1: Summary Implementation Schedule – Fixed Dock Option

Element	Start	Finish
Dock Design	April 22, 2013 (late)	June 17, 2013
Place Order for Shiploaders		May 23, 2013
Place order for dock piles		August 27, 2013
Geotechnical Investigation	April 01, 2014	April 25, 2014
Receive Dock Piles on Site		July 26, 2014
Receive Shiploaders on Site		September 20, 2014
Mobilize Barge & Tug to Site		August 04, 2014
Install Sheet Pile Cells	August 05, 2014	September 27, 2014
Backfill Dock Cells	September 28, 2014	October 27, 2014
Build Embankment to Shore	October 28, 2014	January 13, 2015
Install Ship Loader Foundation	January 21, 2015	February 24, 2015
Install/Dry Commission Shiploaders	February 25, 2015	July 29,2015
First Shipment of Ore		August 01,2015
Commission Reclaim/Shiploading	August 01, 2015	August 05, 2015

5.2 Schedule - Floating Dock

The summary schedule for the Floating Dock shown in Table 5-2 is derived from the schedule submitted with the Floating Dock proposals.

Table 5-2: Summary Implementation Schedule – Floating Dock Option

Element	Start	Finish
Place Order for Shiploaders	June 01, 2013	
Receive Shiploaders on Site		September 20, 2014 [1]
Barge Dock Shipped to Site		September 20, 2014 [1]
Install Land Based Barges	July 26, 2015	August 05, 2015
Install Floating Barge	August 06, 2015	August 08, 2015
Commission Shiploading Equipment	August 09, 2015	August 11, 2015
First Shipment of Ore		August 12, 2015
Commission Reclaim/Shiploading	August 12, 2015	August 16, 2015

1. Could be as late as 26 July 2015 if shipped fully assembled on dock barge(s).

6. Shipping and Shiploading

Shiploading operations at Milne will only occur in the summer months, typically between mid July and mid-October. The actual length of shipping season each year will vary depending on ice conditions at Milne and along the eastern seaboard of Baffin Island. For planning purposes for this study, reference is made in this section to navigation restrictions found in Canada's arctic shipping legislation and to experience of arctic shippers such as Fednav who have been advising BIM.

The Zone/Date System (Z/DS) as described under the Arctic Shipping Pollution Prevention Regulations, divides the Canadian Arctic waters into sixteen Shipping Safety Control Zones, and stipulates the opening and closing dates for each zone for each of nine Arctic Class ships, and five Type ships. The Z/DS divides the Arctic into 16 zones of ice severity and establishes opening and closing dates for each 14 classes of ship between Arctic Class 10 and no ice class.

The Z/DS is a fixed system that does not reflect long term trends and annual variability in ice conditions. Due to this constraint, in 1996 Transport Canada introduced the more flexible Arctic Ice Regime System (AIRSS). Ships may continue to use the Dates of Entry Table for basic passage planning for estimating when certain ice conditions may occur. AIRSS is currently used only when making access decisions outside of the established dates.

Based on the success of the AIRSS, the potential exists for broader application of the AIRSS, with the Z/DS acting as guidelines. Visibility, vessel speed, maneuverability, the availability of an icebreaker escort, and the knowledge and experience of the crew must be considered when applying the AIRSS.

The AIRSS is intended to minimize the risk of pollution in Arctic waters due to damage of vessels by ice; to emphasize the responsibility of the ship owner and master for safety; and to provide a flexible framework for decision-making. It applies to CAC and Type (Baltic Class) ships, and requires accurate information for voyage planning, timely ice-charts, and consistent observation of ice conditions.

Based on its experience in Arctic shipping, Fednav Group has proposed a shipping season for Milne, based on AIRSS, as shown in Figure 6-1. In the case of Ice Class 1C and No Ice Class vessels Fednav's experience indicates a longer shipping window than determined by the Zone/Date System.

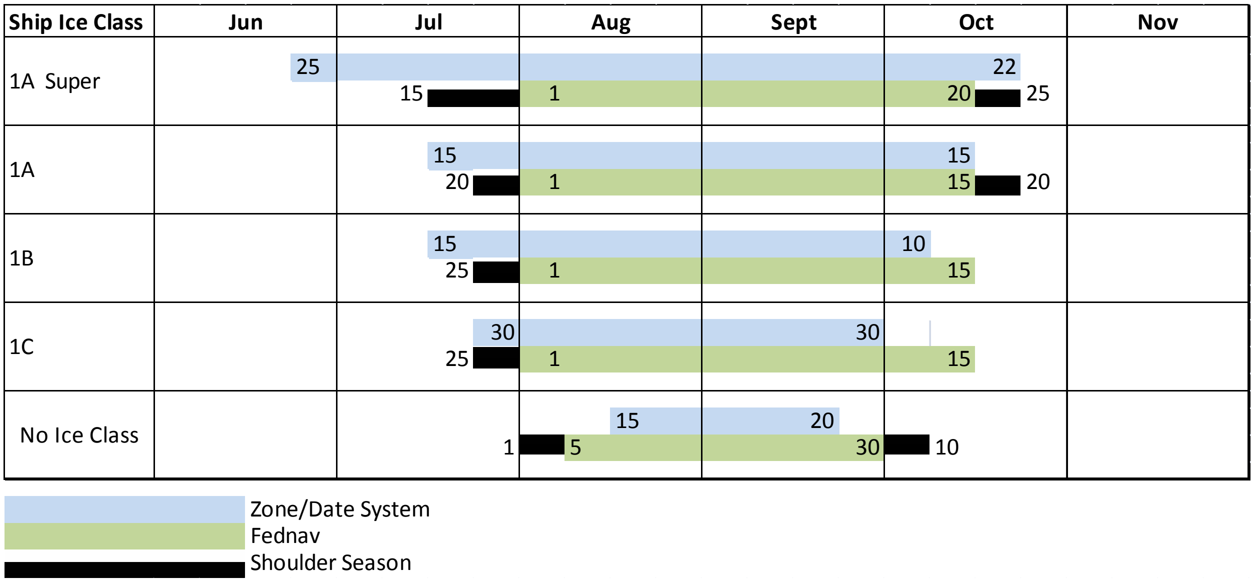

Figure 6-1: Vessel Access to Milne by Ice Class (ref Fednav)

Adopting the "Fednav approach" with Ice Class 1C ships, the typical shipping season at Milne can be expected to commence on July 25 and end on October 15. Arcelor Mittal shipping has further recommended that October 8 would be a "prudent" last planned date for ore shipments from Milne. This yields a total shipping window of around 76 days. Allowing for 25% lost time due to weather delays, a total of 57 days have been assumed to be available annually for shipping. Therefore an average daily ship loading rate of around 61, 500 ton will be required in order to export 3.5 million tons of ore per year.

Referring to the implementation schedule in Section 5 the potential shipping window for the two dock options for 2015 (first year of shipment) are shown in Table 6-1.

Table 6-1: Potential Shipping Days for Milne in 2015

Dock Option	A First Shipping Date	B Last Shipping Date	C Total Available Window (Days)	D Commission Time for First Ship(Days)	E Annual De-Commission (Days)	E Shipping Days (84% of C-D-E)
Fixed Dock Option	August 01, 2015	October 8, 2015	69	6	0	47
Floating Dock Option	August 12, 2015	October 8, 2015	57	2	2	40

Using a daily average shiploading capacity of 61,500 tons, it would be possible to export about 2.5 million tons of ore in 2015 based on the assumed implementation schedule and assuming that sufficient ore could be mined and trucked to Milne and provided that ships are continuously available for loading.

7. Health & Safety

The two dock options are compared from an H & S perspective. Key observations are as follows:

- Floating dock has two additional moving surfaces as compared to a stationary dock.
- Ship access by workers for the floating dock will require crossing over water 3 times as opposed to once with a stationary dock.
- Similarly conveyor repair will require work over a floating dock and over three water access points.
- Accessing the conveyor with elevated work platforms would be more difficult with a floating dock.
- Floating dock used as a conveyor support will likely require increased conveyor maintenance.
- Stationary dock can be sloped/graded to shore providing ready vehicle access to the ship in case of medical, spill or other emergency.
- Same as above for pedestrian access, maintenance, clean up, repair, etc.
- Stationary dock may allow increased footprint for storage of equipment or materials.
- The floating dock requires disassembly at the end of each shipping season to enable placement of the floating barge in an appropriate winter storage location. Also prior to the start of each shipping season the floating barge must be brought back and reattached to the shore mounted barges. The fixed dock does not require such annual assembly and disassembly.

On balance, operation of the fixed dock is inherently safer due to fewer moving elements and in that it does not require re-assembly at the beginning of each shipping season and disassembly at the end of the shipping season. With appropriate design, operational procedures and operator training, both dock options can be operated safely.

8. Risk Assessment

8.1 Fixed Dock

Table 8-1 lists five key risks associated with the Fixed Dock Option.

Table 8-1: Fixed Dock Options Key Risks

Hazard	Impact	Potential Mitigation
Delayed clearing of ice.	Delayed start of season or delayed start of dock installation.	Consider staging construction equipment at Milne in 2013. Higher capacity shiploaders.
Unknown or differing geotechnical conditions.	Difficulty or inability to construct sheet pile cells or piles for shiploader foundation.	Perform geotechnical investigation off-ice in spring 2014.
Over consolidation or freeze up of cell fill.	Difficulty in driving piles for shiploader.	Consider driving piles in unfilled cell or use vibro hammer.
Limited land access to dock.	Difficulty installing shiploaders.	Consider using ice as a construction platform.
Delay in delivery of shiploader(s).	Compromised or aborted 2015 shipping of ore.	Expedite order placement for shiploaders and expedite fabrication and shipping to site.

8.2 Floating Dock

Table 8-2 lists six key risks associated with the Floating Dock Option.

Table 8-2: Floating Dock Option Key Risks

Hazard	Impact	Potential Mitigation
Delayed clearing of ice.	Delayed start of season or delayed start of dock installation.	Consider staging construction equipment at Milne in 2013. Higher capacity shiploaders.
Uneven beach area.	Difficulty and delay in placing the fixed barges.	Survey landing area and ensure adequate earth moving equipment available to effect installation.
Sea bed erosion under fixed barges.	Increase of cantilevered length of barge(s) resulting in higher rotational forces with possibility of foundation and/or structural failure of barg(s).	Monitor seabed regularly and apply gravel and rip rap under free end of barge(s). Ensure barge designs account for this risk.
Ice forces against fixed barges.	Dislocation or dislodgement of “free-end” of fixed barges resulting in misalignment with floating barge and shiploading equipment and possible delays to start of shipping or loss of part or all of a shipping season.	Reposition and re-spud barges at the start of the shipping window. Requires the availability of a large pile driver and crane at the start of each season.
Ice Forces against floating moorings.	Dislocation or damage to floating moorings over winter.	Design for adequacy under ice loadings or remove and store mooring points each winter.
Delay in delivery of shiploader(s).	Compromised or aborted 2015 shipping of ore.	Expedite order placement for floating dock and operations contract.

12. Conclusions

On an NPV basis, the Floating Dock option is more attractive than the Fixed Dock option (-$100,817,000 vs. -$138,000,000 when considering the period 2015 to 2019. Over a much longer term, the Fixed Dock will become more attractive.

A major schedule risk for both options is the possibility of the late arrival or delayed on-dock assembly of the two shiploaders. This can be better mitigated with the Floating Dock option if the shiploaders or pre-assembled on the dock barges before shipment to site.

From a risk perspective, the Floating Dock option raises some concerns particularly with the placement accuracy, longer term stability and alignment of the two grounded barges. If it is decided to proceed with this option it is strongly recommended that the structural adequacy (particularly longer term) of the cantilevered barges be clearly demonstrated by the vendor (during the bidding stage), as well as a plan regarding how the two “land-fast” barges can be repositioned to account for over-winter shifting.

Another concern that must be addressed by the Floating Dock provider is how the risk of the sea-bed erosion under the cantilevered portions of the grounded barges will be mitigated. This must be adequately addressed prior to contract award.

Appropriate contract language should be included in the agreement to clearly define that the floating dock provider is fully responsible for the design, installation, operation and maintenance of the shipping facility. Liquidated Damage provisions should be considered for failure to perform as specified.

From a safety perspective, the operation of the fixed dock is inherently safer due to fewer moving elements and in that it does not require re-assembly at the beginning of each shipping season and disassembly at the end of the shipping season and likely periodic adjustment at the start of each shipping season.

Another consideration in making a selection would be whether BIM envisages, in the future, the need for an all year berth or extended season berth using ice strengthened ore carriers. In this case, the Floating Dock would unlikely be suitable due to its insufficient operational robustness and likelihood of becoming ice-bound, and therefore the fixed dock has an advantage in this respect.

Although not considered in this analysis, a hybrid option may make sense. In this case the floating option may be considered for the first few years then replaced by a fixed dock, which could be built off the critical path. The shiploaders and other major equipment, installed with the floating dock, would be re-used and could be relocated to the new dock between shipping seasons.

Harry Charalambu
HM:lm
Attachments – Appendix A

Appendix A

Drawings of Dock Options

RÉVISION	DATE	PAR

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TULAKTARVIK

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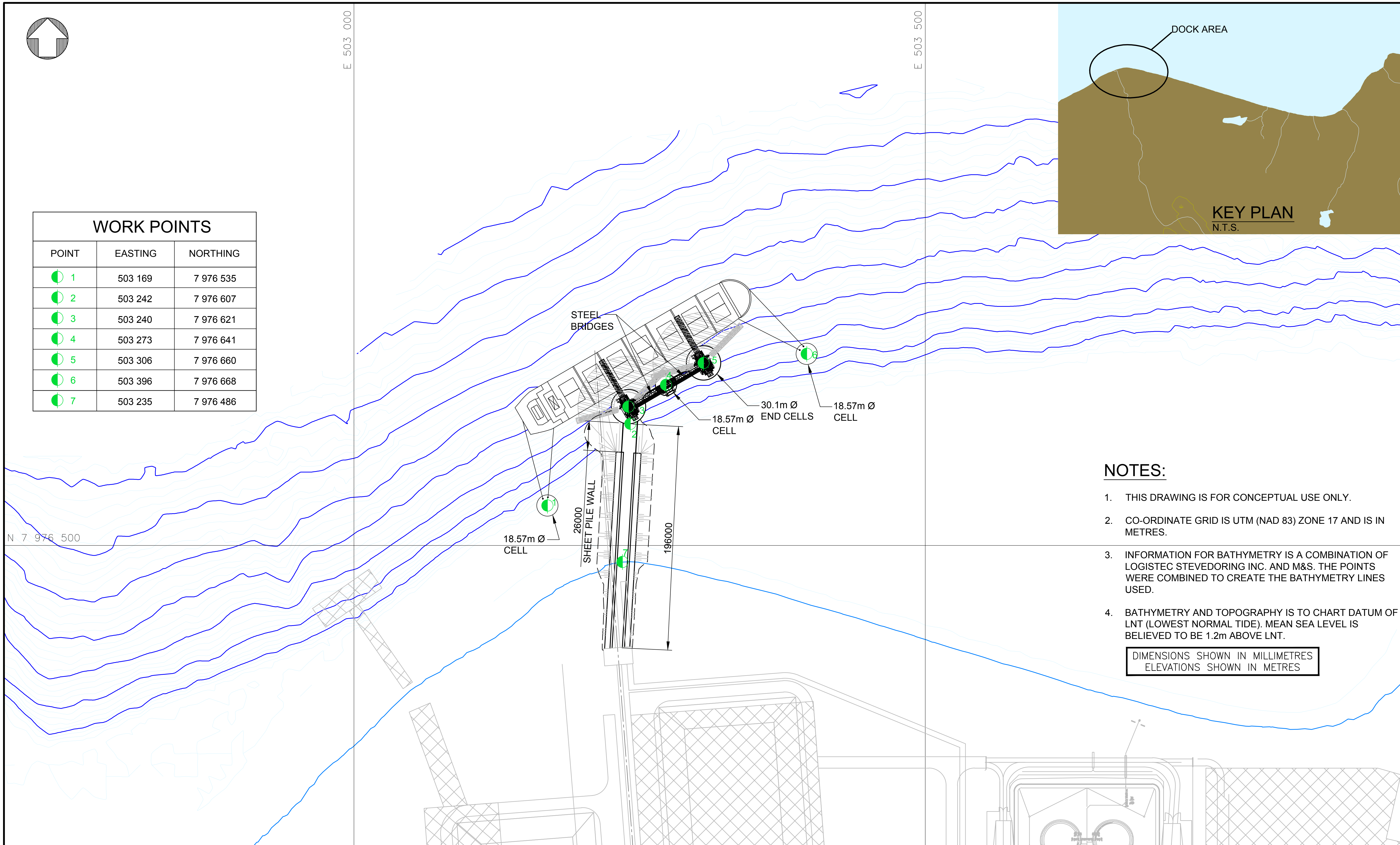
OFFER FOR 2015 AND UP

date : 22 fev. 2013	échelle : N/A	conçu par :	approuvé par :
No. de projet 500500		dessiné par : Y. CADIEUX	vérifié par :
No. de dessin TMO-SO-13-0258		RÉVISION A	PAGE : 2 DE 3



WORK POINTS

POINT	EASTING	NORTHING
1	503 169	7 976 535
2	503 242	7 976 607
3	503 240	7 976 621
4	503 273	7 976 641
5	503 306	7 976 660
6	503 396	7 976 668
7	503 235	7 976 486

NOTES:

1. THIS DRAWING IS FOR CONCEPTUAL USE ONLY.
2. CO-ORDINATE GRID IS UTM (NAD 83) ZONE 17 AND IS IN METRES.
3. INFORMATION FOR BATHYMETRY IS A COMBINATION OF LOGISTEC STEVEDORING INC. AND M&S. THE POINTS WERE COMBINED TO CREATE THE BATHYMETRY LINES USED.
4. BATHYMETRY AND TOPOGRAPHY IS TO CHART DATUM OF LNT (LOWEST NORMAL TIDE). MEAN SEA LEVEL IS BELIEVED TO BE 1.2m ABOVE LNT.

DIMENSIONS SHOWN IN MILLIMETRES
ELEVATIONS SHOWN IN METRES

PLAN

SCALE: 1:3000

Fig.1

Baffinland Iron Mines Corporation
Mary River Project - ERP
HATCH

Optimized Ore Dock

Plot Scale
Apr 17, 2013, 8:59am Login name: Grah57916 Layout: 11x17
Drawing Name: C:\prj\projectwise\grah57916\dms79521\11x17 Optimized Ore Dock Fig. 1.dwg

Baffinland Iron Mines Corporation
Mary River Project – ERP

Study for Panamax Ore Dock at Milne Inlet

2013-02-28	A	Internal/Client Review	V. Lake	S. Perry	H. Charalambu	
DATE	**REV.**	**STATUS**	**PREPARED BY**	**CHECKED BY**	**APPROVED BY**	**APPROVED BY**

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Appendices

1. Introduction

Baffinland Iron Mines (BIM) has requested that Hatch provide a study of the feasibility for a Panamax Ore Dock at Milne Inlet, located approximately 100km north of the Mary River mine site. This dock will operate during the Open Water Season, approximately July 15 to October 15 for a period of five years during the Early Revenue Stage.

This report provides a high-level trade off study of the design and capital cost (CAPEX) for the construction of a Panamax berth at Milne Inlet. This assessment also provides an expected construction duration.

1.1 Limits of Study

The following items are excluded from this study:

- Operating Costs (OPEX);
- Environmental implications.

1.2 Location

The location of the berth will be the same as provided in the report "HATCH – Milne Construction Dock / Freight Dock Options, Impact on Construction Capital Costs, Trade-off Study" issued by Hatch on June 22, 2011 (Document Number: H337697-3020-12-124-0002).

The approximate coordinates of the centreline of the causeway are:

- 504030 N, 7976340 E.

2. Study Assumptions

The following sections outline the assumptions have been made for the purposes of this study.

2.1 Design Life

The design life of all structures is assumed to be 5-years.

2.2 Bathymetry and Topography

Two sets of bathymetric data are available for Milne Inlet.

- Data from Logistec Stevedoring, 2010;
- Hydrographic Survey of Milne Inlet completed by Monteith and Sutherland on September 9, 2011.

Topographic data was obtained from Terra Point Canada.

2.3 Datum and Tides

Canadian Geodetic Datum (CGD) 0.0 has been calculated to be 1.20 m above Chart Datum (CD) 0.0 (Monteith and Sutherland 2011);

- High Water Level (HWL): elevation +2.33 m CD;
- Low Water Level (LWL): elevation 0.0 m CD;
- Thickness (level ice): 2.0 m.

2.4 Metocean Conditions

Pending a review of the available data, wave conditions are assumed as follows:

- The berth structures will be designed for a wave of return period of 10 years. The corresponding wave has a significant height of 1.44 m and a peak critical period of 3.26 s (refer to Hatch document, H337697-3100-12-124-0003).

Wind conditions and currents for the design life are to be confirmed.

2.5 Vessel

Panamax vessel dimensions are shown in Table 2-1.

Table 2-1: Panamax Vessel Parameters

CSL Spirit	
Deadweight (DWT)	70,108
Length Overall (m)	225
Beam (m)	32.2
Draft (m)	14.4
Number Holds	7
Total Hold Length (m)	162

For comparison, the dimension of the Handymax vessel considered (CSL Atlantic Superior) are shown in Table 2-2:

Table 2-2: Handymax Vessel Parameters

CSL Atlantic Superior	
Deadweight (DWT)	38,510
Length Overall (m)	222
Beam (m)	23.1
Draft (m)	10.4
Number Holds	5
Total Hold Length (m)	159

2.6 Subsurface Conditions

Geotechnical conditions as of the time of issue of this report are contained in: “Mary River Project, Steensby Inlet and Milne Inlet Port Offshore Geotechnical Investigation Summary of Results , File 19-1605-126:, by Thuber Consultants dated November 9, 2011.

Previous investigations have indicated a site stratigraphy as follows:

- Loose to compact sand at surface;
- Underlain by sand containing varying amounts of gravel and cobbles.

Thickness of sand layer was not determined during the site investigations.

Bedrock was not encountered during the geotechnical investigation. Tests were driven to a maximum of -45 m CD and bedrock was not encountered.

2.7 Shiploader

Panamax vessels will be loaded at a rate of 6,000 tph using two (2) crane tower shiploaders.

Conceptual drawings of the shiploader can be seen in Appendix B.

2.8 Material Availability

Sheet piles are assumed to be AS500-12.7, Grade 400WT. The availability of the sheet piles is to be confirmed by BIM. No allowance was made for corrosion in this study. Sheet piles are available in lengths up to 31 m.

3. Technical Considerations

3.1 Ore Dock

The ore dock is arranged according to generally recommended principles used in the industry such as British Standard 6349. The length of the dock required will be verified based on shipper's requirements. Options include a dock of three (Option 2) or four (Option 1) steel sheet pile cells of 30 m diameter. The addition of the fourth cell provides greater contact points for the vessel and a more symmetrical arrangement.

The dock has been placed in approximately 17 m of water depth (at low tide) in order to accommodate the vessel's draft plus an underkeel clearance of 15% of the vessel's draft. It should be noted that for the Laker the depth of water required is approximately 12 m.

The elevation of the dock is assumed to be +5.33 m CD. This should protect the deck from 2 m of ice accumulation at high tide by providing 1 m of freeboard.

3.2 Causeway

A causeway will be constructed from shore to the ore dock. The width of the causeway is assumed to be 10 m to accommodate a single lane roadway and the ore conveyor. Armour stone sized for the predominant wave and ice conditions will be provided with slopes of 1.75H:1V. The crest of the causeway will also be +5.33 m CD.

3.3 Loads

The loads considered for this conceptual design are discussed in the following sections.

3.3.1 Live Load

A live load of 15 kPa has been considered on the slab deck for the main cells. A live load of 10 kPa was considered on the mooring cells.

3.3.2 *Berthing*

The abnormal berthing force of the Panamax vessel was calculated to be 850 kN-m. Floating foam fenders will be provided along the berth face.

3.3.3 *Mooring*

The mooring load of the Panamax vessel was taken from BS 6349 as 890 kN (recommended bollard load of 100 tonf). Two bollards have been provided on each cell.

Bollards have been provided along the berth face to accommodate vessel spring lines. Two mooring cells have been provided at the bow and stern of the vessel to accommodate the breast lines.

Mooring buoys (MB’s) were considered but not recommended for the following reasons:

- MS’s would need to accommodate six (6) mooring lines on three (3) Quick Release Mooring Hooks (QRMH's), one the at bow and one at the stern.
- MB's would have to be large displacement type MB's (such as Resinex Type PEM 58's), unfortunately, because of the relatively steep rise of the depth contours to the shore the anchors for the MB's would likely have difficulty holding and would therefore have to be piled, or run to the shore (if possible). Deadweight anchors would not work for the anticipated loads.
- MB’s would have to be taken out prior to each ice season and then replaced as the ice breakup and conditions allowed. This is a difficult and expensive task.
- Fixed mooring dolphins allow for a longer operational window as the facility would available during the ice transition periods (before and after the “Open Water Season”) when ships could still possibly operate.

3.3.4 *Ice*

More investigation into an appropriate load for ice is recommended. Prior studies indicate a load of approximately 80 MN on the berth structure. The cost estimates include an ice impact beam which is provided to absorb the force of the ice.

For the main berth cells, a piece of ice 2.7 m x 2.0 m will govern.

For the mooring cells, a piece of ice 0.89 m x 2.0 m will govern.

4. Summary of Design

The factor of safety recommended for a berthing and mooring cell is 2.5 (Sheet Pile Design, Pile Buck). The minimum acceptable factor of safety that can be accepted is 1.5.

Table 4-1 and Table 4-2 outlines the results of the design for the sheet pile cells:

Table 4-1: Berthing and Mooring Cells

Load Case	Factor of Safety
Berthing	6.3
Mooring	6.2
Ice	1.5
Interlock Stress	2.6

Table 4-2: Mooring Cells

Load Case	Factor of Safety
Mooring	2.0
Ice	1.5
Interlock Stress	5.1

5. Drawings

The following drawings of the Panamax and Handymax ore dock can be found in Appendix A.

- H349000-2221-12-042-0010;
- H349000-2221-12-042-0011;
- H349000-2221-12-042-0020;
- H349000-2221-12-042-0021.

6. Scheduling

6.1 Assumptions

The following assumptions have been made in order to determine the approximate construction duration.

- Shift of 24 hours per day;
- Production Rates have been taken from Dragados rates submitted in 2012, which were based on 24 hour work days;
- Two (2) barges have been considered for operations;
- Sheet piling material and other materials and accessories are delivered during the open water season the year prior to construction;
- All fill material, for the causeway and cells, is available at the start of the construction season.

The following production rates have been assumed based on a 24 hour shift:

- Installation of environmental protection (silt screens, bubble curtains...): 5 days;
- Sheet Pile Template Fabrication: 15 days for large cells;

- Sheet Pile Template Fabrication: 10 days for small cells;
- Sheet Pile Driving: 24 sheets/day;
- Steel Pile Installation (shiploader foundation): 6 pile/day;
- Sheet Pile Cell Fill: 2000 m3/day;
- Causeway Rock Fill: 1250 m3/day;
- Causeway Armour and Sub Armour Stone: 1250 m3/day;
- Concrete slabs and beams: 200 m3/day;
- Placement of Scour Protection: 2000 m3/day;
- Rails and Guards: 24m/day;
- Fenders, Bollards: 1 each/day.

6.2 Construction Duration

The following tables outline the estimated durations. Addition of a third barge would be necessary to reduce the total duration of on water activities to less than 90 days. Concrete slabs should be done prior to the first freeze, but not necessarily during the Open Water Season.

Table 6-1: Option 1, Open Water Season

Open Water Season Activities	Duration (days)
Environmental Protection	5
Sheet pile cells, template and installation	97
Concrete Impact Beams	3
Fill Cells	18
Drive Steel Piles	2
Install Scour Protection (single barge)	4
Total On Water	**129**
Concrete Slabs (not included in total)	**13**
Causeway (not included in total)	**46**

Table 6-2: Option 1, Off Season

Other Activities	Duration (days)
Install Fenders and Bollards	18
Install Catwalk	2
Install Berthing Aid System	2
Install Ladders, Rails and Guards	47
Total	**69**

Table 6-3: Option 2, Open Water Season

Open Water Season Activities	Duration (days)
Environmental Protection	5
Sheet pile cells, template and installation	80
Concrete Impact Beams	2
Fill Cells	15
Drive Steel Piles	2
Install Scour Protection (single barge)	3
Total On Water	**107**
Concrete Slabs (not included in total)	**11**
Causeway (not included in total)	**46**

Table 6-4: Option 2, Off Season

Other Activities	Duration (days)
Install Fenders and Bollards	15
Install Berthing Aid System	2
Install Ladders, Rails and Guards	42
Total	**59**

6.3 Construction on Ice

Information on the experience of the installation of sheet cells on ice can be found in Appendix D. Experience dictates that installation from ice can be cheaper than from the water, assuming the crew is experienced. If this option is chosen, the cells must be backfilled prior to the breaking up of the ice.

7. Estimate of Probable Cost

The estimated capital cost of the ore dock is (excluding contingency and indirects):

- Option 1, 4 cells: $45,405,000;
- Option 2, 3 cells: $39,635,000.

Contingency should be estimated at 25% and indirects at about 20%. Refer to Appendix C for detailed estimates.

Please note this is an order of magnitude estimate.

8. Comparison of Panamax Dock versus Handymax Dock

8.1 Quantities

The following tables, Table 8-1 and Table 8-2, outlines the change in quantities from the Handymax freight dock to the Panamax Ore Dock.

Table 8-1: Quantity Comparison Handymax Freight Dock vs. Panamax Ore Dock (4 cells)

Estimated Volumes		Study June 2011	Study February 2013	Change in Qty
		Handymax Freight Dock	Panamax Ore Dock (4)	
Dredging	M3	5,000	0	-5,000
Cell Fill	M3	22,280	71,100	48,820
Armour Stone	M3	10,500	20,000	9,500
Sub-Armour Stone	M3	5,350	8,000	2,650
Core Material	M3	0	45,000	45,000
Other Material	M3	62,428	0	-62,428
Scour Protection	M3	0	6,300	6,300
Sheet Piles – Main Cells	MT	1,260	2,240	980
Sheet Piles – Mooring Cells	MT	0	1,110	1,110
Sheet Pile Templates	MT	200	848	648
Installation	MTH	2	9	7
Concrete	M3	1,400	2,472	1,072
Fenders	EA	7	6	-1
Mooring Buoys	EA	2	0	-2
Bollards	EA	7	12	5
Ladders	EA	7	6	-1
Wheel Guards	M	120	401	281

Table 8-2: Quantity Comparison Handymax Freight Dock vs. Panamax Ore Dock (3 cells)

Estimated Volumes		Study June 2011	Study February 2013	Change in Qty
		Handymax Freight Dock	Panamax Ore Dock (3)	
Dredging	M3	5,000	0	-5,000
Cell Fill	M3	22,280	56,800	34,520
Armour Stone	M3	10,500	20,000	9,500
Sub-Armour Stone	M3	5,350	8,000	2,650
Core Material	M3	0	45,000	45,000
Other Material	M3	62,428	0	-62,428
Scour Protection	M3	0	5,005	5,005
Sheet Piles – Main Cells	MT	1,260	1,790	530
Sheet Piles – Mooring Cells	MT	0	1,110	1,110
Sheet Pile Templates	MT	200	688	488
Installation	MTH	2	8	6
Concrete	M3	1,400	2,066	666
Fenders	EA	7	5	-2
Mooring Buoys	EA	2	0	-2
Bollards	EA	7	10	3
Ladders	EA	7	5	-2
Wheel Guards	M	120	330	210

8.2 Costs - Removed as they contain confidential information.

The following tables, Table 8-3 and Table 8-3, outlines the change in cost from the Handymax freight dock to the Panamax Ore Dock (for both the 4 cell and 3 cell options).

8.3 Schedule

The Handymax freight dock schedule for circular cells was not included in the Hatch June 2011 Trade-Off Study. However, only 2 months of barge rental was assumed in the estimate.

8.4 Handymax Berth

The Panamax berth designed here requires a water depth of at least 17 m at low tide and a deck height of +5.33 m CD. The Laker will require a water depth of at least 12 m at low tide.

In order to more accurately compare the previously designed Handymax freight dock cost to an ore dock, the following direct cost adjustments can be made:

- Mooring Dolphins: addition of $7,529,000;
- Shiploader Foundations: addition of $1,075,000.

The table below provides a summary of the options explored in this study.

Table 8-5: Cost Comparison Panamax vs. Handymax Docks

Study	Dock Type	Vessel	Water Depth (m, CD)	Option 1: 4 cells	Option 2: 3 cells	5 cells*
2013	Ore Dock	Panamax	17	$ 45,405,000	$ 39,635,000	
2013	Ore Dock	Handymax	12	$ 41,488,000	$ 36,098,000	
2013	Ore Dock	Handymax	9.5	$ 40,123,000	$ 34,828,000	
2013	"Revised" Freight Dock	Handymax	13			$ 30,866,450
2011	Freight Dock	Handymax	13			$ 22,262,450

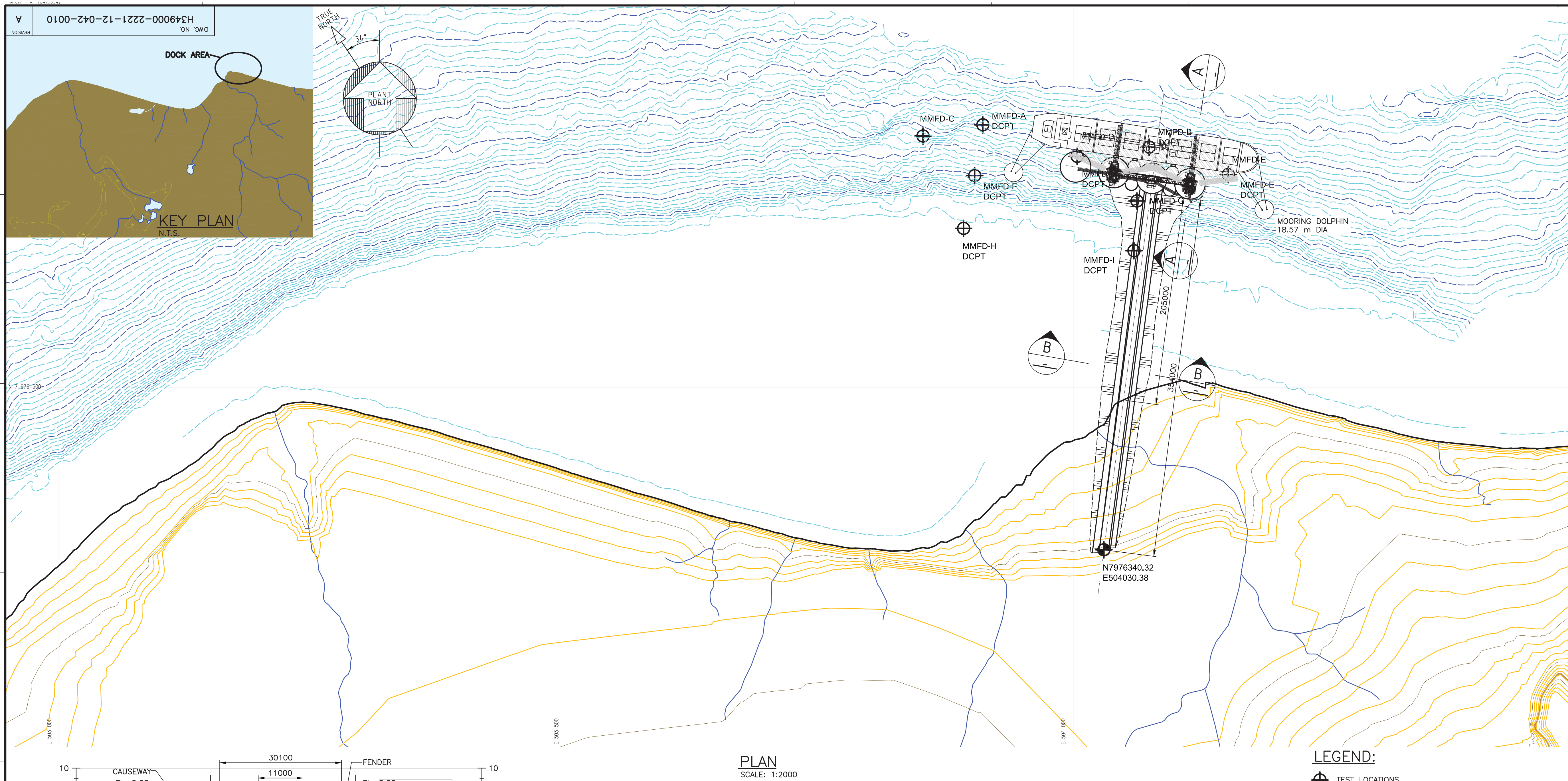
*Note: Estimate from June 2011 study refers to 5 cells, but no layout drawings were provided

9. Conclusions

In summary, final layout of the ore dock should be verified with the shipper's requirements in order to determine if 3 or 4 cells is acceptable. In order to minimize CAPEX, the 3 cell Panamax layout dock is preferred. This option is approximately $18.6 million (direct cost only) more than the BIM Early Revenue Phase (ERP) study by BIM in December 2012 (approximate direct cost of $21 million). However, the Hatch trade-off study used for the ERP study was not designed as an ore dock and did not include an allowance for shiploader foundations or mooring dolphins (it should be noted that no drawing is available for this layout). If these allowances are included, the direct cost increase for constructing a Panamax ore dock becomes $8.8 million.

Appendix A

Ore Dock Drawings



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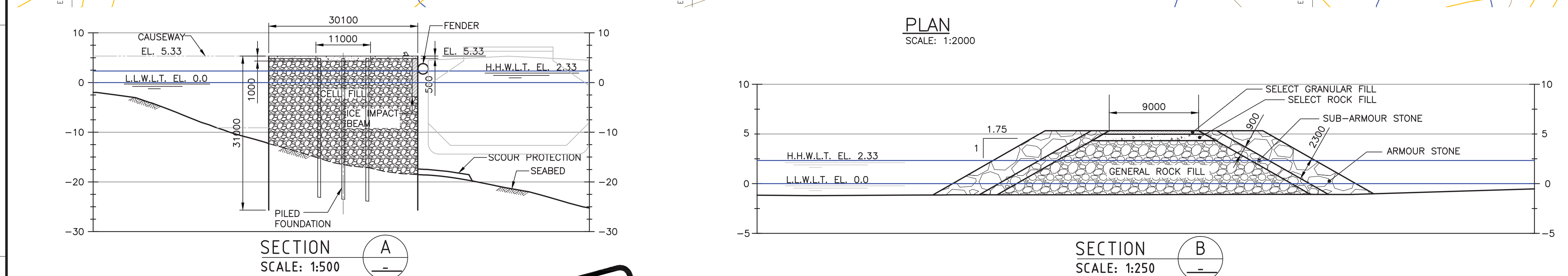

LEGEND:

⊕ TEST LOCATIONS

NOTES:

1. CO-ORDINATE GRID IS UTM (NAD 83) ZONE 17 AND IS IN METRES.
2. INFORMATION FOR BATHYMETRY IS A COMBINATION OF LOGISTEC STEVEDORING INC. AND M&S. THE POINTS WERE COMBINED TO CREATE THE BATHYMETRY LINES USED.
3. GEOTECH INFORMATION RECEIVED FROM THURBER.
4. BATHYMETRY AND TOPOGRAPHY IS TO CHART DATUM OF LNT (LOWEST NORMAL TIDE). MEAN SEA LEVEL IS BELIEVED TO BE 1.2m ABOVE LNT.

0 50 100 150 200 m
Scale: 1:2000

PRELIMINARY

DRAWING NO.	DRAWING TITLE
REFERENCE DRAWINGS	

NO.	DESCRIPTION	BY	CHK'D	APP'D	DATE
REVISIONS					

REV.	ISSUE FOR	AUTH. BY	DATE
A	ISSUED FOR REVIEW		02/26/2013
ISSUE AUTHORIZATION			

HATCH

DESIGNED BY: V. LAKE	DRAWN BY: S. GRAHAM
DATE	DATE 01/28/2013
CHECKED BY	DISCIP. ENGR.
DATE	DATE
PROJ. DES. COORD.: T. THERTELL	PROJ. ENGR.: S. PERRY
DATE	DATE
PROJ. MGR.: H. CHARALAMBU	
DATE	

Baffinland

MARY RIVER PROJECT – ERP

MILNE INLET
ORE DOCK–PANAMAX
OPTION 1.

SCALE	DRAWING NO.	REVISION
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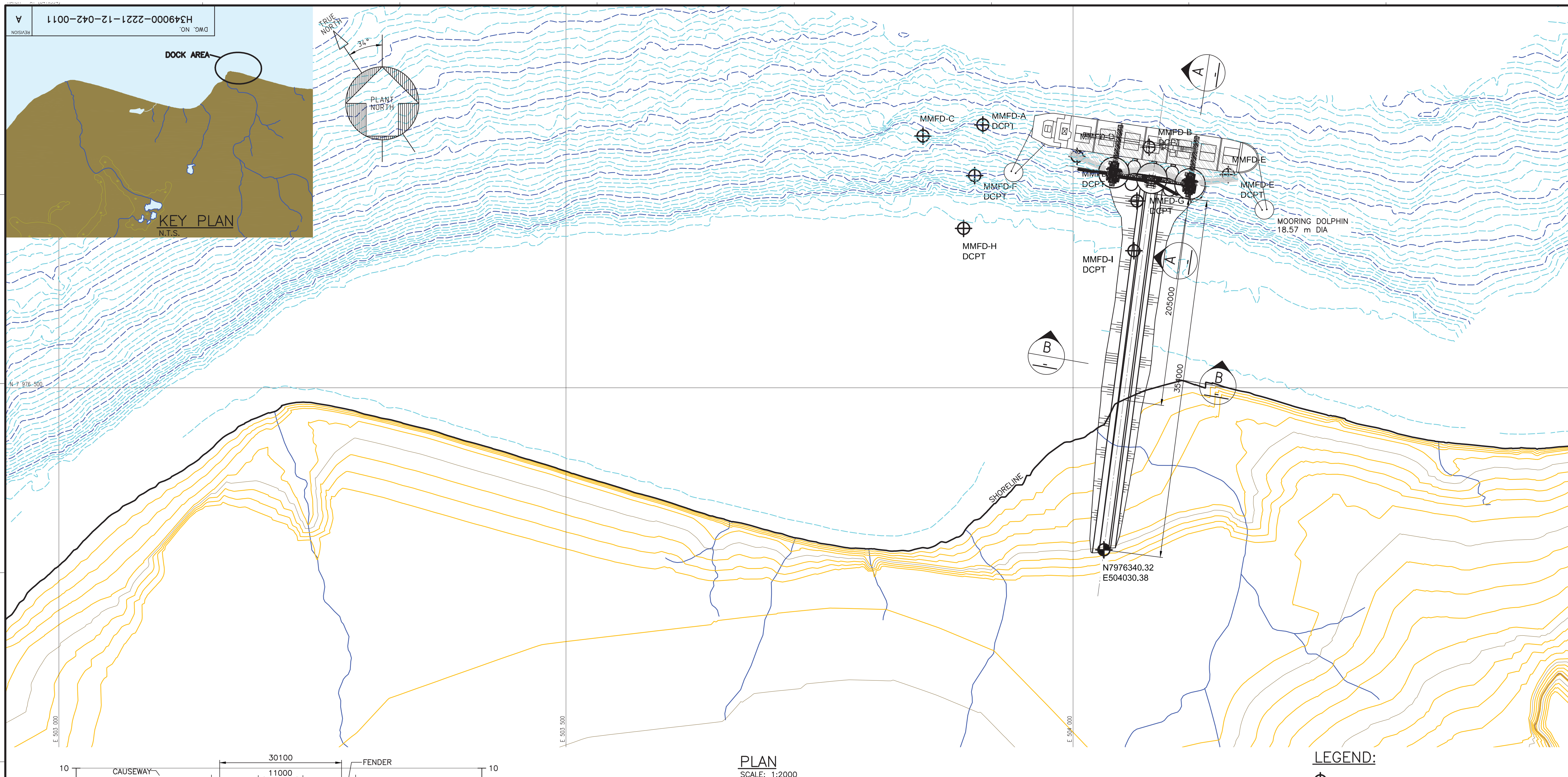

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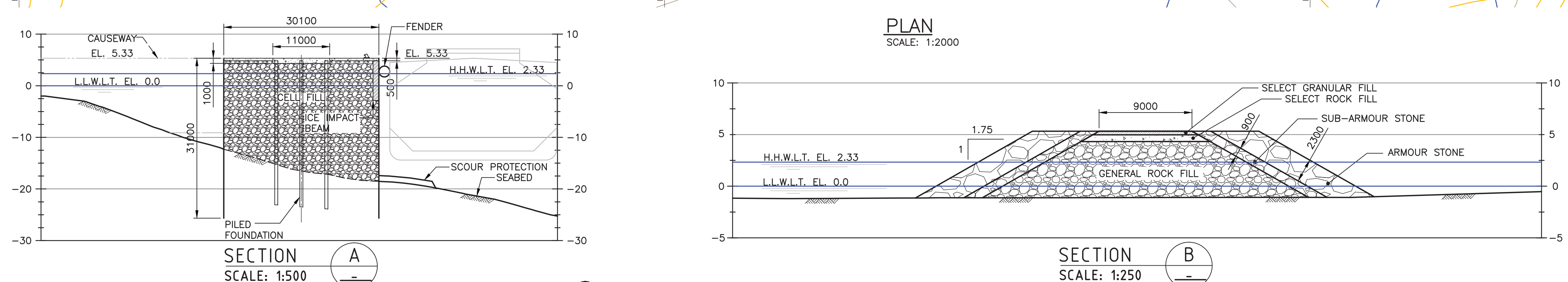

LEGEND:

⌖ TEST LOCATIONS

NOTES:

1. CO-ORDINATE GRID IS UTM (NAD 83) ZONE 17 AND IS IN METRES.
2. INFORMATION FOR BATHYMETRY IS A COMBINATION OF LOGISTEC STEVEDORING INC. AND M&S. THE POINTS WERE COMBINED TO CREATE THE BATHYMETRY LINES USED.
3. GEOTECH INFORMATION RECEIVED FROM THURBER.
4. BATHYMETRY AND TOPOGRAPHY IS TO CHART DATUM OF LNT (LOWEST NORMAL TIDE). MEAN SEA LEVEL IS BELIEVED TO BE 1.2m ABOVE LNT.

0 50 100 150 200 m
Scale: 1:2000

PRELIMINARY

DRAWING NO.	DRAWING TITLE
REFERENCE DRAWINGS	

NO.	DESCRIPTION	BY	CHK'D	APP'D	DATE
REVISIONS					

REV.	ISSUE FOR	AUTH. BY	DATE
A	ISSUED FOR REVIEW		02/26/2013
ISSUE AUTHORIZATION			

HATCH

DESIGNED BY: V. LAKE	DRAWN BY: S. GRAHAM
DATE	DATE: 02/01/2013
CHECKED BY	DISCIP. ENGR.
DATE	DATE
PROJ. DES. COORD.: T. THERTELL	PROJ. ENGR.: S. PERRY
DATE	DATE
PROJ. MGR.: H. CHARALAMBU	
DATE	

Baffinland

MARY RIVER PROJECT – ERP

MILNE INLET ORE DOCK– PANAMAX OPTION 2.

SCALE	DRAWING NO.	REVISION
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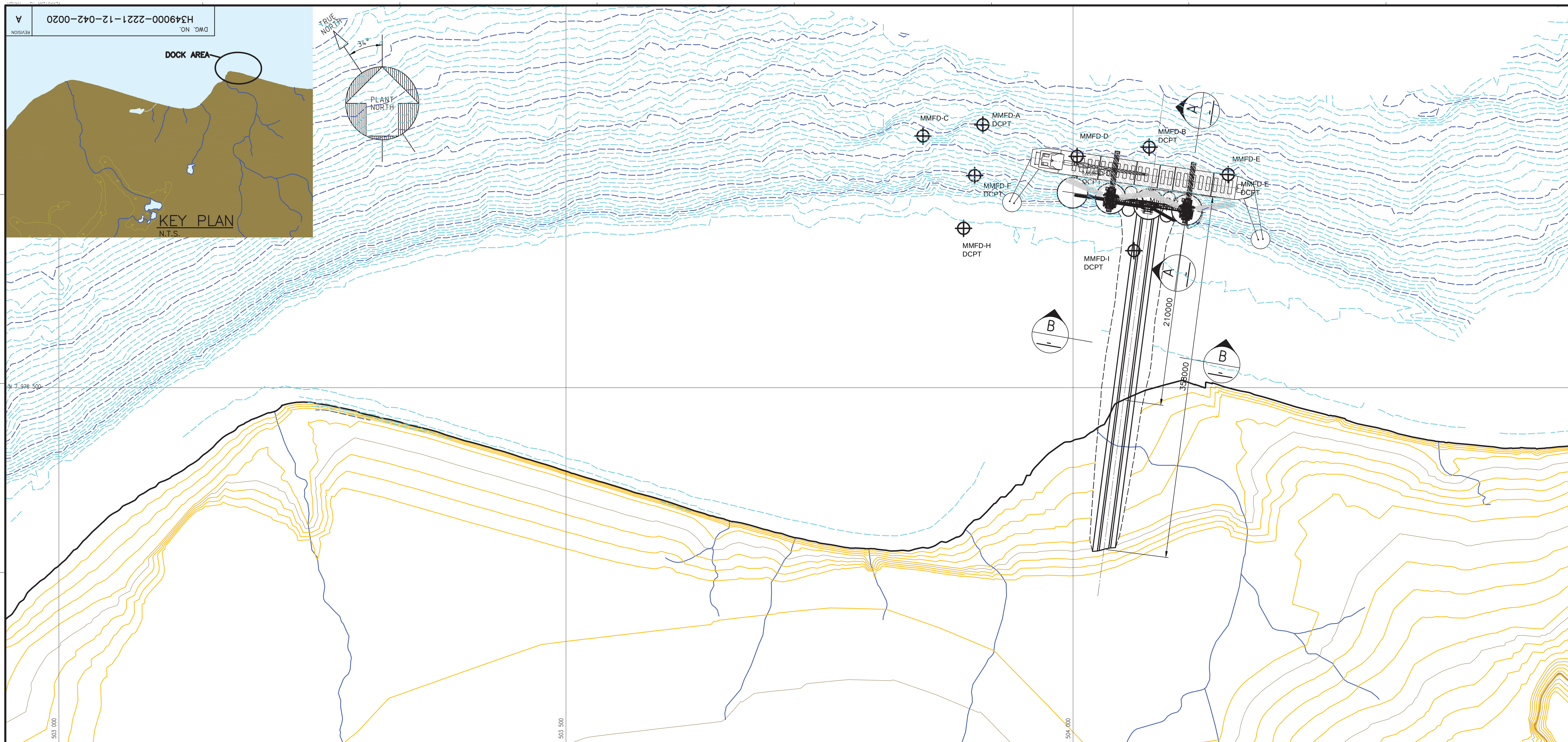

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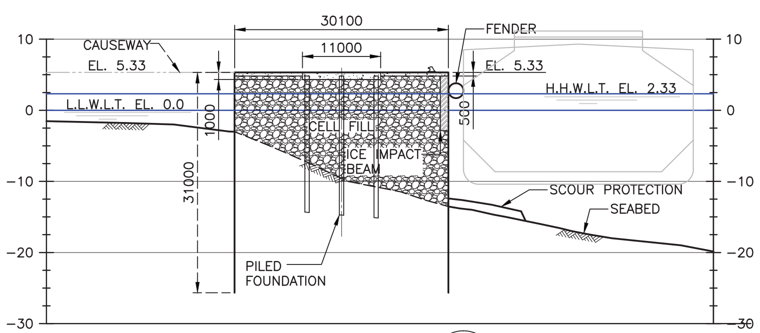

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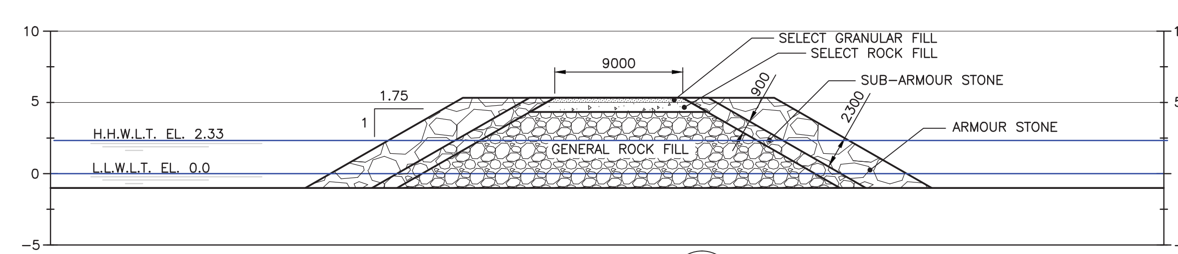

SECTION A
SCALE: 250

LEGEND:

⊕ TEST LOCATIONS

NOTES:

1. CO-ORDINATE GRID IS UTM (NAD 83) ZONE 17 AND IS IN METRES.
2. INFORMATION FOR BATHYMETRY IS A COMBINATION OF LOGISTEC STEVEDORING INC. AND M&S. THE POINTS WERE COMBINED TO CREATE THE BATHYMETRY LINES USED.
3. GEOTECH INFORMATION RECEIVED FROM THURBER.
4. BATHYMETRY AND TOPOGRAPHY IS TO CHART DATUM OF LNT (LOWEST NORMAL TIDE). MEAN SEA LEVEL IS BELIEVED TO BE 1.2m ABOVE LNT.

0 50 100 150 200 m
Scale: 1:2000

PRELIMINARY

DRAWING NO.	DRAWING TITLE
REFERENCE DRAWINGS	

NO.	DESCRIPTION	BY	CHK'D	APP'D	DATE
REVISIONS					

REV.	ISSUE FOR	AUTH. BY	DATE
A	ISSUED FOR PERMITTING		02/26/2013
ISSUE AUTHORIZATION			

HATCH

DESIGNED BY: V. LAKE	DRAWN BY: S. GRAHAM
DATE	DATE: 02/15/2013
CHECKED BY	DISCIP. ENGR.
DATE	DATE
PROJ. DES. COORD.: T. THERTELL	PROJ. ENGR.: S. PERRY
DATE	DATE
PROJ. MGR.: H. CHARALAMBA	
DATE	

Baffinland

MARY RIVER PROJECT – ERP

MILNE INLET ORE DOCK– HANDYMAX OPTION 1.

SCALE	DRAWING NO.	REVISION
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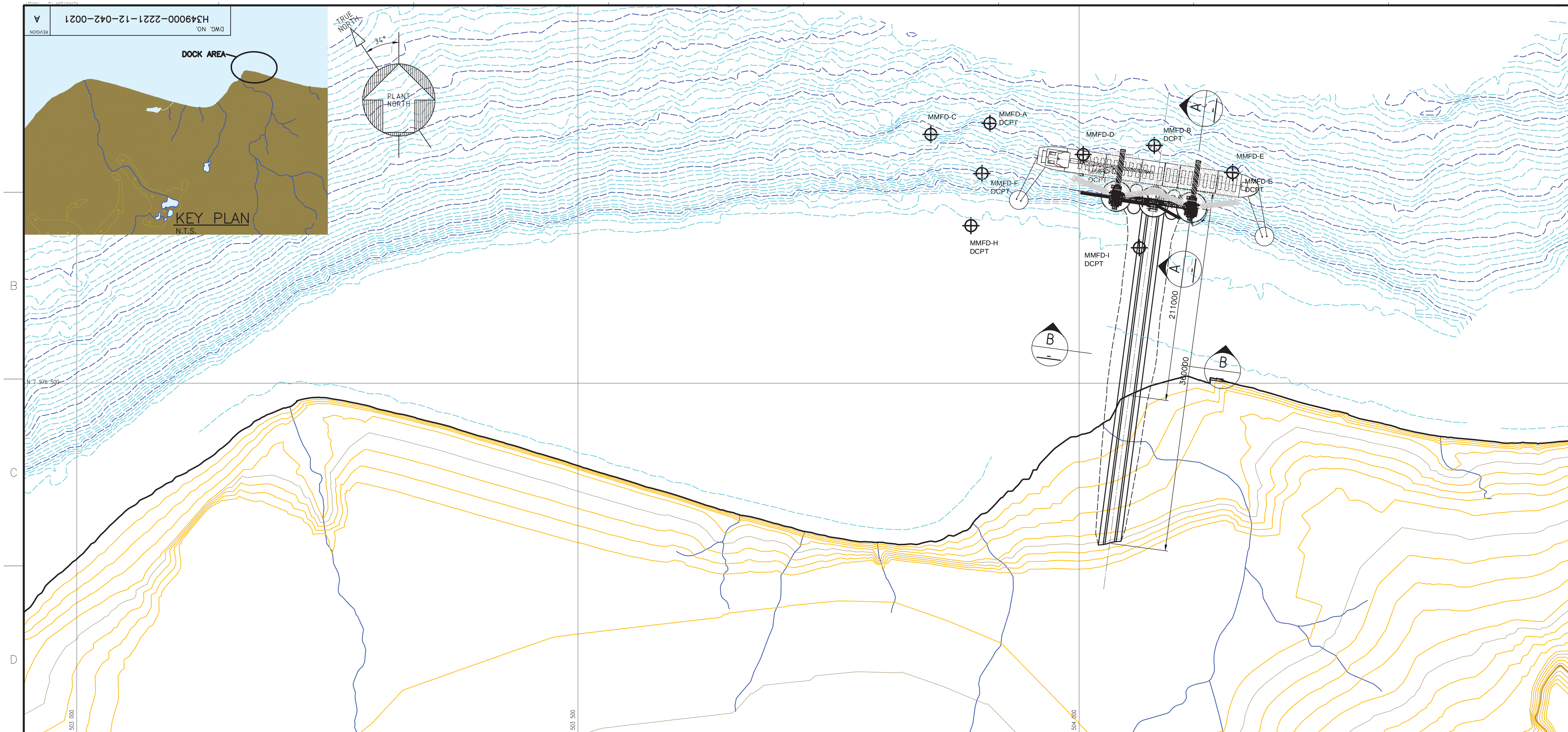

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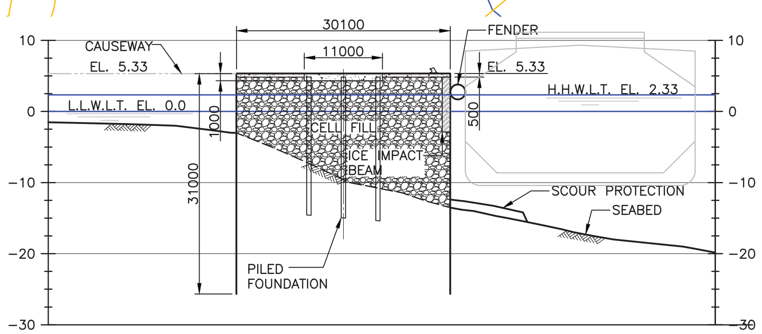

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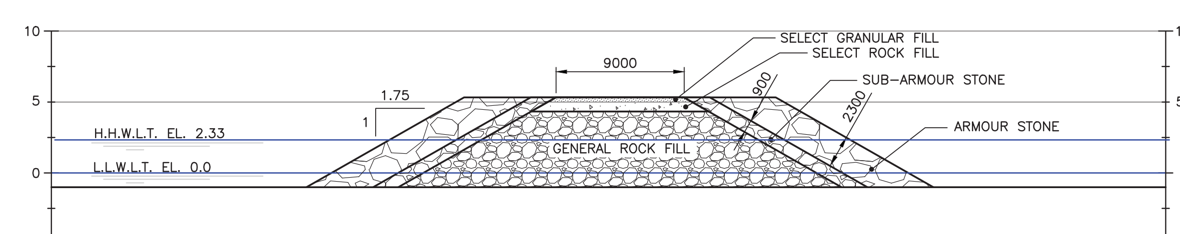

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LEGEND:

⊕ TEST LOCATIONS

NOTES:

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2. INFORMATION FOR BATHYMETRY IS A COMBINATION OF LOGISTEC STEVEDORING INC. AND M&S. THE POINTS WERE COMBINED TO CREATE THE BATHYMETRY LINES USED.
3. GEOTECH INFORMATION RECEIVED FROM THURBER.
4. BATHYMETRY AND TOPOGRAPHY IS TO CHART DATUM OF LNT (LOWEST NORMAL TIDE). MEAN SEA LEVEL IS BELIEVED TO BE 1.2m ABOVE LNT.

0 50 100 150 200 m
Scale: 1:2000

DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

PRELIMINARY

NO.	DESCRIPTION	BY	CHK'D	APP'D	DATE

REVISIONS

REV.	ISSUE FOR	AUTH. BY	DATE
A	ISSUED FOR PERMITTING		02/26/2013

ISSUE AUTHORIZATION

HATCH™

DESIGNED BY	DRAWN BY
V. LAKE	S. GRAHAM, DATE 02/15/2011
CHECKED BY	DISCIP. ENGR.
PROJ. DES. COORD.: T. THERTELL	PROJ. ENGR.: S. PERRY
PROJ. MGR.: H. CHARALAMBU	

Baffinland

MARY RIVER PROJECT – ERP

MILNE INLET ORE DOCK– HANDYMAX OPTION 2.

SCALE	DRAWING NO.	REVISION
AS SHOWN	H349000-2221-12-042-0021	A

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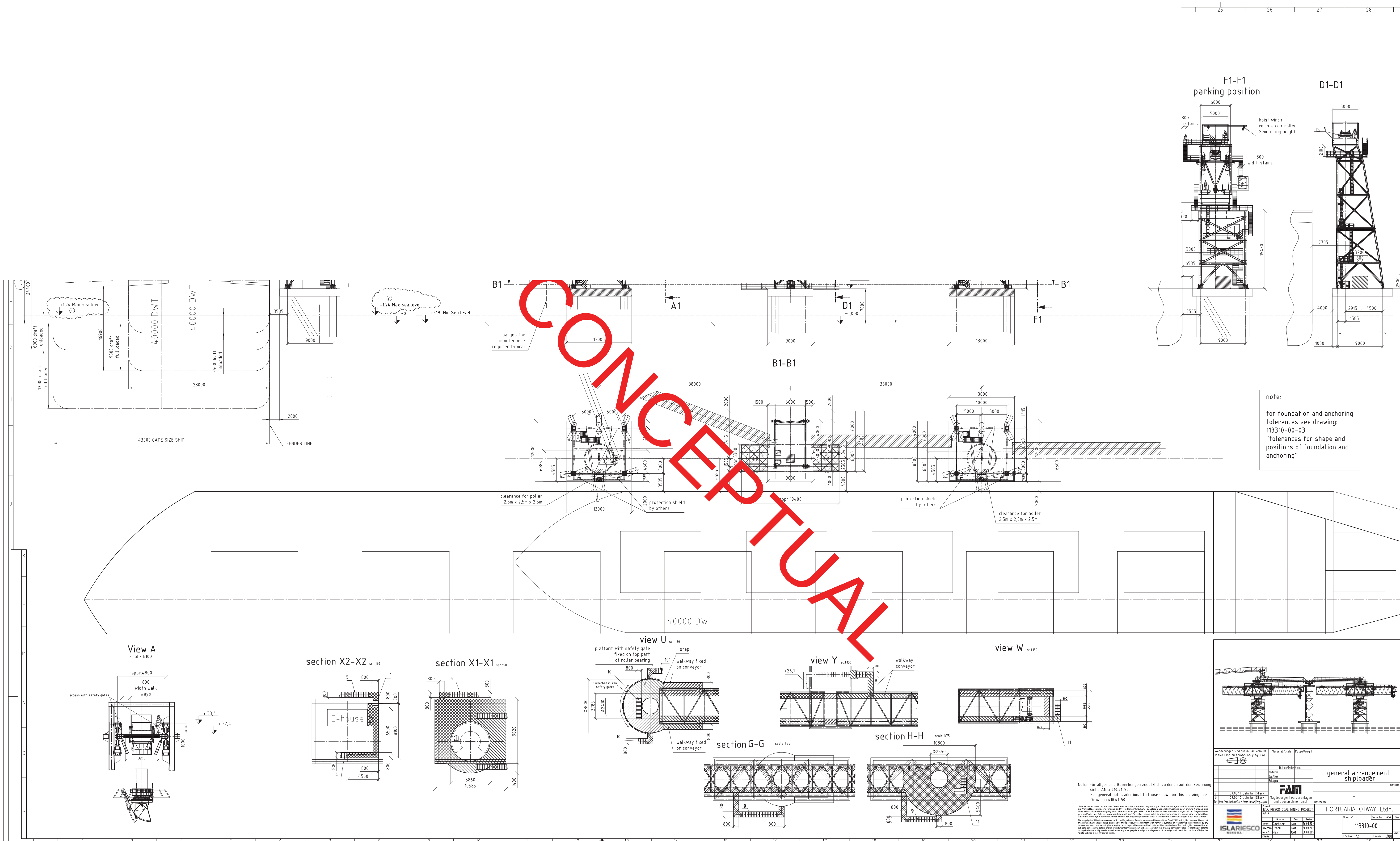
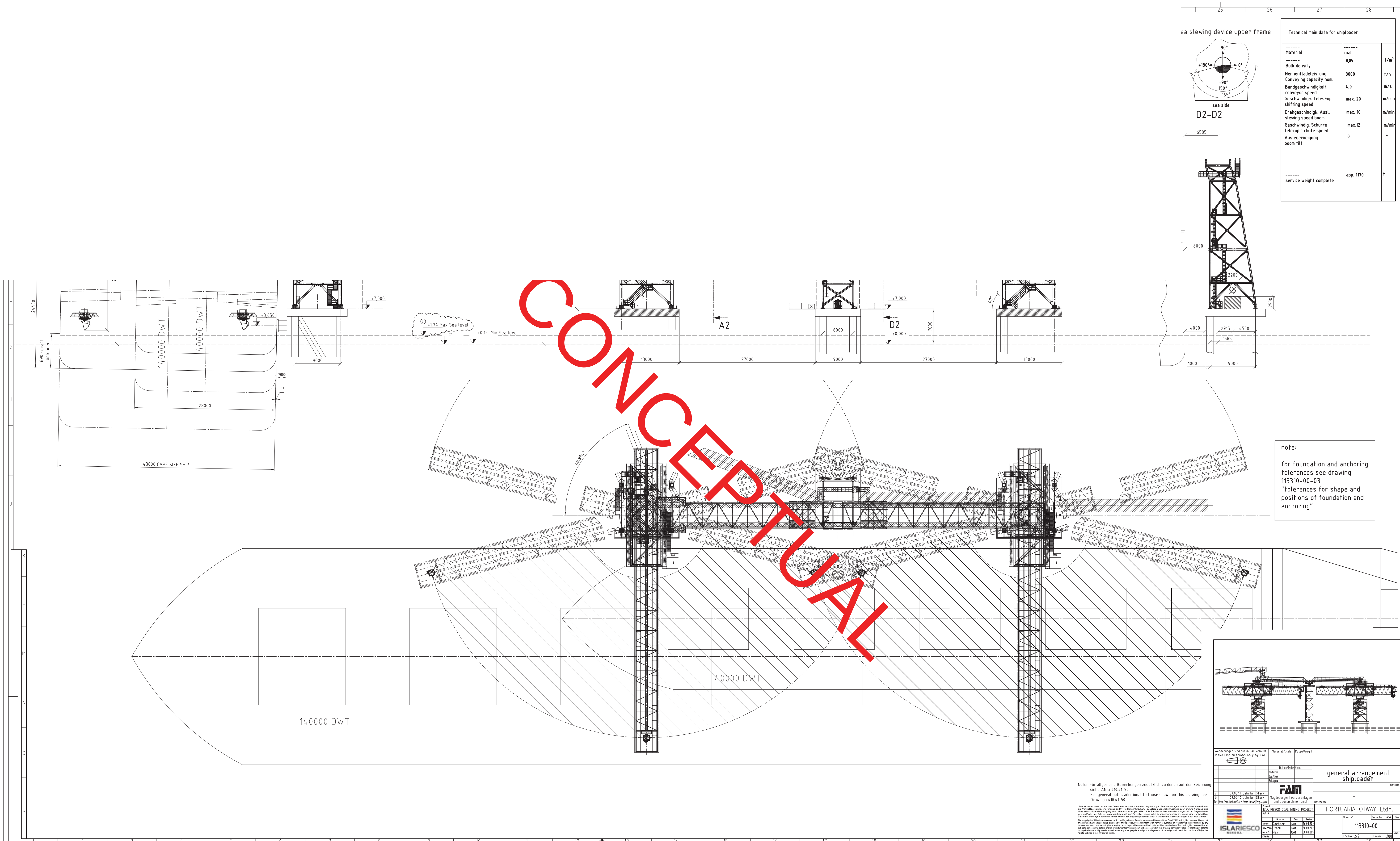
Appendix B

Shiploader Drawings


CONCEPTUAL
F1-F1
parking position
D1-D1
hoist winch II remote controlled 20m lifting height
800 width stairs
note:
for foundation and anchoring tolerances see drawing: 113310-00-03 "tolerances for shape and positions of foundation and anchoring"
B1-B1
A1
D1
F1
+1.74 Max Sea level
+0.19 Min Sea level
barges for maintenance required typical
140000 DWT
40000 DWT
43000 CAPE SIZE SHIP
FENDER LINE
6900 draft unloaded
17000 draft full loaded
9500 draft full loaded
3500 draft unloaded
clearance for poller 2,5m x 2,5m x 2,5m
protection shield by others
appr 19400
View A
scale 1:100
access with safety gates
section X2-X2
E-house
section X1-X1
view U
platform with safety gate fixed on top part of roller bearing
walkway fixed on conveyor
view Y
walkway conveyor
section G-G
section H-H
view W
general arrangement shiploader
PORTUARIA OTWAY Ltda.
113310-00
ISLA RIESCO COAL MINING PROJECT
ISLARIESCO
FAM
Magdeburger Foerderanlagen und Baumaschinen GmbH



Technical main data for shiploader		
Material	coal	
Bulk density	0,85	t/m³
Nennentladeleistung Conveying capacity nom.	3000	t/h
Bandgeschwindigkeit. conveyor speed	4,0	m/s
Geschwindigk. Teleskop shifting speed	max. 20	m/min
Drehgeschindigk. Ausl. slewing speed boom	max. 10	m/min
Geschwindig. Schurre telecopic chute speed	max.12	m/min
Auslegerneigung boom tilt	0	°
service weight complete	app. 1170	t

Note: Für allgemeine Bemerkungen zusätzlich zu denen auf der Zeichnung siehe Z.Nr.: 410.41-50
For general notes additional to those shown on this drawing see Drawing : 410.41-50

Aenderungen sind nur in CAD erlaubt! Make Modifications only by CAD!

Maszstab/Scale | Masse/Weight

Rev.	Aend./Mod.	Datum/Date	Bearb./Drawn	Freig./Approv.
c		07.03.11	Lehmbr.	Stark
b		09.07.10	Lehmbr.	Stark

FAM Magdeburger Foerderanlagen und Baumaschinen GmbH

general arrangement shiploader

Blatt/Sheet: -

Reference:

ISLARIESCO MINERA

Proyecto : ISLA RIESCO COAL MINING PROJECT

O./T. N° :

	Nombre	Firma	Fecha
Dibujó	Doebber	FAM	26.03.2010
Rev./Apr.	Stark	FAM	30.03.2010
Aprobó	Max	FAM	30.03.2010
Cliente			

PORTUARIA OTWAY Ltda.

Plano N° : 113310-00 | Formato : A04 | Rev. C

Lámina :2/2 | Escala : 1:200

Appendix C

Capital Cost Estimate

Removed - Confidential Information

Appendix D

Article: Construction on Ice

HEAVY CONSTRUCTION NEWS

AUGUST 18, 1975

The CONSTRUCTION BUSINESS publication

Ore-loading dock built on ice 450 miles north of Arctic Circle

Details of this and other projects in Special Report on

MARINE CONSTRUCTION

HCN/SPECIAL REPORT

MARINE CONSTRUCTION

Sheet pile cells for loading dock installed from Arctic ice in Strathcona Sound

By George A. Peer
HCN Engineering Field Editor

In Strathcona Sound at Baffin Island, 450 miles (724 km) north of the Arctic Circle, a contractor has overcome extreme cold, wind and isolation to install three sheet pile cells from 6 ft (1.8 m) of sea ice which rose and fell with the tide.

The entire job was done by a six-man crew, hand-picked by Poole Construction Ltd. of Edmonton. They drove 32 500 lineal ft (9 912 m) of extra-long sheet piles during a two-month period last spring — one month short of the planned schedule and well within budget.

The cells were driven as part of a dock structure designed for loading zinc and lead concentrates into large bulk carriers. The off-shore project is part of a $50 million ore concentrate mine which is being developed by Nanisivik Mines Ltd., a subsidiary of Mineral Resources International Ltd. of Toronto.

Its approximate latitude of 73° and longitude of about 85° makes the Strathcona site truly remote. It's about 1 500 air miles (2 414 km) northeast of Edmonton and more than 2 000 miles (3 218 km) north of Toronto. Supplies are flown in all year round and shipped in by sea for two months in late summer when the sound is free of ice.

Overall project management is being handled by Strathcona Mineral Services Ltd. of Toronto. The firm's president and project manager is Graham Farquharson.

Carr & Donald & Associates Ltd., the Toronto consulting engineers, who designed the dock facility, are also supervising the marine construction. According to Bill Donald, one of the firm's partners, investigations indicated that the cells should be built from the ice rather than from barges, since open-water techniques would have been much more costly.

"Even though the ice at Strathcona Sound fluctuates in elevation with the tide, it does not drift the way ice does in some parts of the far north," Donald explained. "Instead, it remains stable, steadily growing in thickness once it starts to form in October."

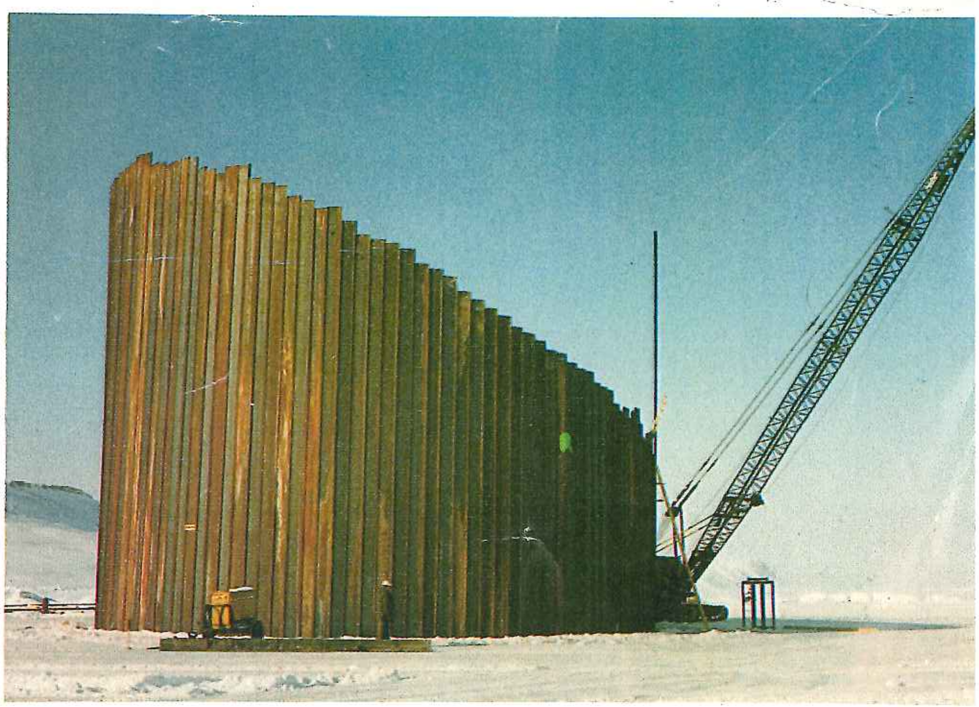
Poole's contract is based on providing labour only. Cranes, compressors, earthwork equipment and service trucks were supplied by Nanisivik Mines. Most of the equipment has been on the site since 1973 when it was shipped up for exploration work.

Poole's project manager, Al Federson, told HCN that six of his more experienced men were selected for the job. "Under such isolated conditions, every man-hour had to count," he said. Leading the pile-driving team was Stan Radzick, a construction veteran of 27 years.

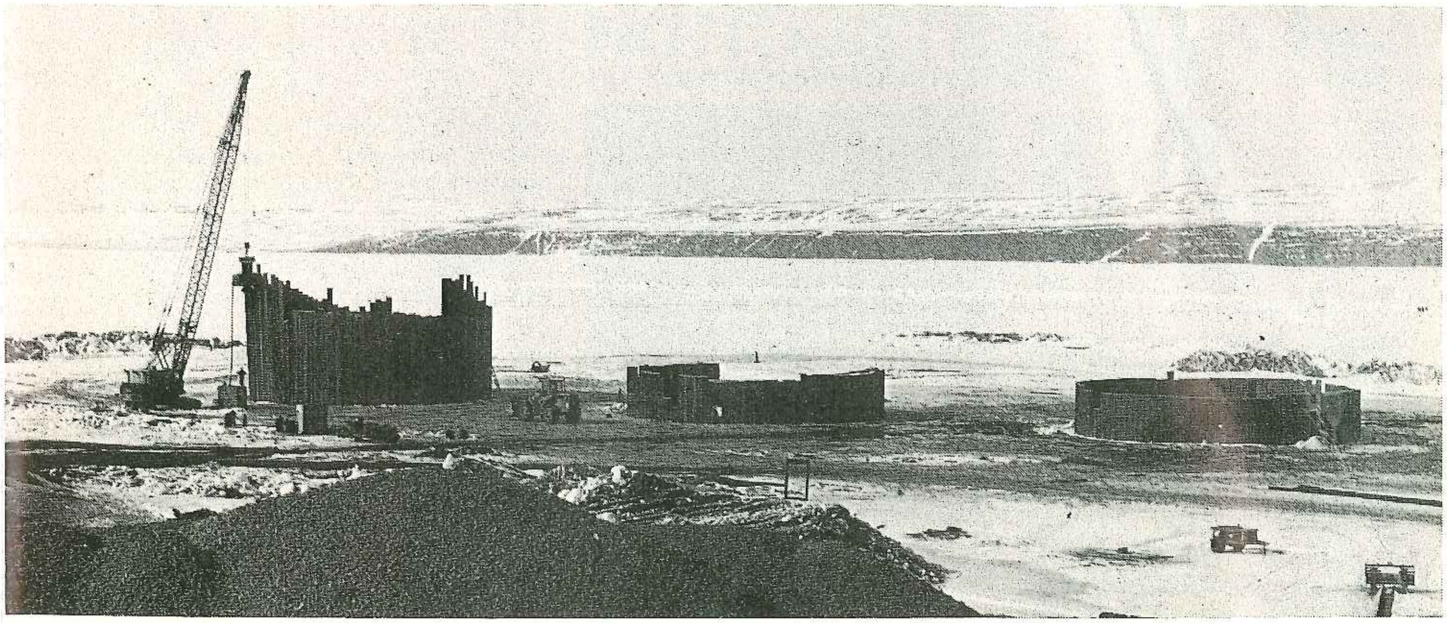
When Poole arrived on the site in mid-March the ice was 5½ ft thick (1.7 m), more than adequate to support the two machines which would do most of the work — a Bucyrus-Erie 30-B 60-ton (54 t) crawler crane and a P&H 30-ton (27 t) mobile crane.

Before the sheet piling could begin, a circular template had to be fabricated on the ice. Holes were then cut through the ice to allow eight well greased H piles to be driven into the bay bottom. The template was then

Site is ice-locked 10 months of the year.



Sloping bay bottom caused sheet piles to project 20 to 60 ft above ice surface.



Foster hammer, held by Bucyrus-Erie crane, drove three sheet pile cells from 6 ft thick ice which rose and fell with tide.

raised and connected to the piles.

First step in the sheet piling progam was to cut a doughnut-shaped trench 5 ft (1.5 m) wide and 80 ft (24 m) in diameter into the ice, stopping within 6 to 18 in. (15 to 46 cm) of the bottom of the ice. Radzick said this was done so that the trench would not flood and cause new ice to form ahead of the piling work.

A Davis tractor equipped with a chainsaw-type ice cutter was able to cut into the ice with ease. Five-foot cubes of ice were clammed out with the P&H crane. Once the trench was completed, preparations were made to drive the first of the 20-in. (50 cm) wide, 80-ft-long sheet piles. Rather than have each pile punch through the final few inches of ice, thereby damaging the pile tip, Radzick had a gigantic "ice pick" fabricated from three H beams welded together. He used the Bucyrus-Erie crane to punch the 4 500 lb (2 040 kg) pick through the ice and clammed out all loose material.

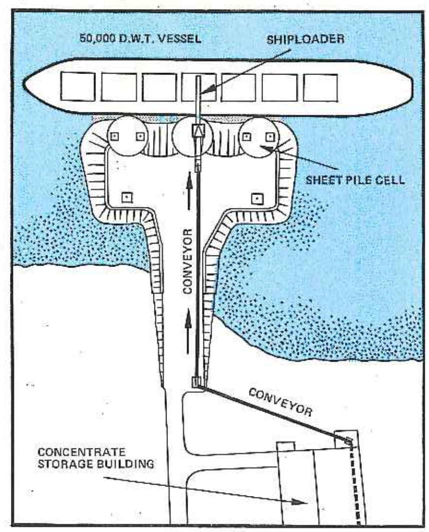
Davis tractor, fitted with chainsaw-type ice cutter, simplified first step of cutting doughnut-shaped trench; crane clammed out 5 ft cubes of ice.

The circular template guided the BPB12.7 flat-web sheet piles as they were lowered to the bay bottom with the Bucyrus-Erie unit. However, because the bay bottom in the area sloped steeply from the shoreline, and the piles followed the contour of the bottom, the in-shore piles projected almost 60 ft (18.3 m) above the ice, while the outer piles had only a 20 ft (6.1 m) projection. All 134 sheet piles used for each cell settled a few feet into the sandy bottom as they were positioned.

According to Radzick, the wide range in pile projection was the reason why only one template was used: "As a result, those piles which had a stick-up of 40 to 60 ft (12.2 to 18.3 m) were well above the template. This created a real problem when any wind came up — driving and threading simply couldn't be done."

Driving piles into the dense sand went relatively smoothly with a Foster 2-40-E electric vibratory driver/extractor. Leased from L. B. Foster Co., of Hamilton, the hammer and its generator were the only pieces of equipment which had to be flown in for the marine work.

Held in place by the Bucyrus-Erie, the hammer drove the in-shore piles a maximum of 50 ft (15.25 m) into the bay bottom. Alternate piles were



Sheet pile cells are part of Strathcona dock structure designed for loading zinc and lead ore into bulk carriers.

driven at 10 ft (3 m) intervals to prevent locking or "walking". Outer piles were driven only about 30 ft (9 m).

So that the last sheet pile for each crib could be properly driven, adjacent piles had to be pulled about 10 ft (3 m) to loosen up the toe. Actual driving time for each cell was about five days.

The crew quickly developed a respect for the cold, Radzick said. "Care was taken to clean out new ice from inside a piling trench since ice attached to the piles would only spell trouble."

Another problem was the tide which moved the ice 5 to 7.5 ft (1.5 to 2.3 m) up and down every day. Undriven piles had to be kept free from ice.

Depth of pile penetration proved to

MARINE CONSTRUCTION

be less than 20 ft for the outer piles for the second and third cells. As a result, 5 and 7 ft (2.1 m) long sections had to be welded to about 25% of the piles. By alternating the longer piles with standard lengths a better toe-hold was established on the outer side of each of these cells.

Consulting engineer Bill Donald told HCN that the sheet piling had to be ordered from Europe. Because the steel had to have high-impact resistance to the extreme cold, United States mills could not promise delivery before eight months. The contract for the required 850 tons (770 t) of piling eventually went to a Luxembourg firm, ARBED Esch-Belval, because the firm narrowed the delivery time down to eight weeks. The piling order was placed with Skyline Industries Inc. of Burlington, Ont.

With temperatures dropping to minus 35 and 40°C during evenings in March and April, all equipment, including the welding generators, had to be kept running 24 hours a day. In addition, the pile driving hammer had to be heated up every morning before it could be operated.

The work crew took advantage of the continuous northern daylight starting in mid-March; for the next six weeks they stretched their normal 10-hour daily shift to 14 hours.

Piling work was completed in early May, one month earlier than planned. At this time the first two cells had been backfilled with beach gravel to the low tide level. Before backfilling could be started, the ice had to be removed from inside each cell. A 5 ft grid was first cut with the Davis tractor; then the P&H clammed out the ice blocks.

It was important that backfilling work not be delayed since there was a danger of the ice drifting as break-up approached. Most of the gravel was placed with the P&H clam. Once the water level had been reached, the operation was completed with a Caterpilar 966 front-end loader.

Two Cat 627B scrapers and a Cat D8 dozer stockpiled gravel within a section of nearby beach. A pair of Warner & Swasey ST5A scoop trams with 5 cu yd (3.8 m³) buckets carried gravel out to the cribs. The three cells took 22 000 cu yd (16 608 m³) of fill.

Until next fall Poole will be hauling and placing 70 000 cu yd (53 480 m³) of granular borrow for a 270x90 ft (82x27 m) dock apron

Pile-driving hammer and generator were the only equipment that had to be flown to remote site for marine work.

which will encompass the cribs, and a 60-ft-wide, 300-ft-long (18x92 m) causeway to shore. The sides of the apron fill are being topped off with 2½-ton (2.3 t) armour rock.

Under a separate contract, foundations will be poured about 300 ft from shore for a 740-ft-long, 150-ft-span (226x46 m) metal clad ore storage building. Plans call for the building to be erected in spring 1976; an interior slab will be poured the following summer. About 150 000 tons (136 050 t) of concentrate will be stockpiled inside the building every year for shipment to Europe.

The shipping season for the new Baffin Island mine will be limited. Ships without ice-strengthened hulls will be able to reach the new dock only during a five-week period beginning in mid-August. Ice-strengthened ships with Arctic Class two classification will be able to operate for a 14-week period, starting in late June.

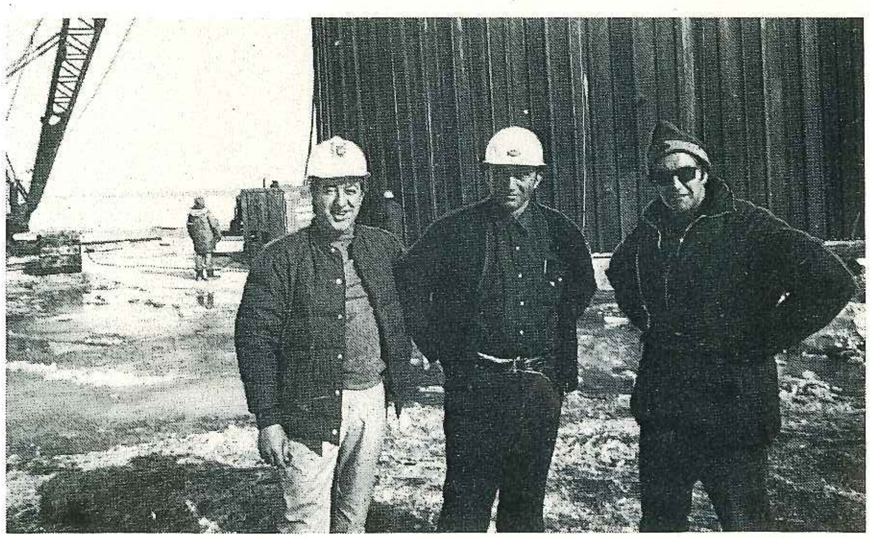
The new dock will handle ore carriers up to 50 000 dead weight tons in size. Dredging will not be necessary at dockside since water at low tide is 45 ft deep.

As the storage building takes shape next year, FMC of Canada Ltd. of Toronto will be installing an 1 800 ton/hour (1 632 t/h) belt conveyor and shiploading system which Carr & Donald designed to carry ore from the storage building to the new dock. Inside the building, a 36 in. (91 cm) wide 713 ft (217 m) long outhaul conveyor will be fed by two wheel-mounted portable belt conveyors.

An additional 749 ft (228 m) of 36 in. conveyor will carry the ore from the building to a 36-in. wide, 170-ft-long (52 m) rail-mounted shuttling shiploader. A pivoted luffing boom at the outer end of the shiploader will load the concentrates into the ship's hold. The shiploader will be on the middle cell (see sketch p. 13).

The mine should be operational in fall 1976. Annual production will be 140 000 tons (126 980 t) of zinc and 14 000 tons (12 698 t) of lead. The ore body is about two miles (3.2 km) from the marine facility. Mill design is by Kilborn Engineering Ltd. of Toronto.

The Ministry of Transport, which owns 18% of Nanisivik Mines Ltd., is funding the development of the dock as well as an airport and townsite. ♠



Poole pile-driving team was headed by Stan Radzick, shown here, centre, at Strathcona site with Carr & Donald consulting engineers Wade, left, and Donald.

Baffinland Iron Mines Corporation
Mary River Project - ERP

Milne Ore Dock Optimization

2013-05-23	A	Client/Internal Review	V. Lake	C. Rosner	S. Perry	N/A
DATE	**REV.**	**STATUS**	**PREPARED BY**	**CHECKED BY**	**APPROVED BY**	**APPROVED BY**
HATCH						**CLIENT**

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1. Introduction

Baffinland Iron Mines Corporation (Baffinland) proposes to develop an open-pit iron ore mine in northern Baffin Island, Nunavut Territory.

The Mary River Project Early Revenue Phase (ERP) consists of the construction, operation, closure, and reclamation of an open-pit mine and associated infrastructure for extraction, transportation and shipment of 3.5 Mt/yr of iron ore from Milne port.

Milne Port will be the main transportation hub for supporting construction of the Mine Site. This site is critical to the transport of 3.5 Mt/a of iron ore during operations which are scheduled to continue for five years.

1.1 Limit of Study

1.2 Previous Studies

A trade-off study, completed in February 2013, provided a high-level trade-off evaluation of the construction of a Panamax versus a Handimax berth at Milne Inlet. This report is titled, Study for Panamax Ore Dock at Milne Inlet (Hatch Document Number: H349000-2220-12-124-0001).

1.3 Location

The location for the ore dock was optimized from the orientation recommended in the report titled, Milne Metocean Conditions (Hatch Document Number: H349000-2200-12-124-0003) dated May 21, 2013. The recommended orientation placed the dock at an angle of 10 degrees from the natural contours. This pushed the dock into deeper water than was required. As a compromise, the dock was angled at 5° from the natural contours and a transfer point was added to the feed conveyor. Refer to Appendix A for sketches associated with this optimization.

The location of the ore dock will be approximately as shown in Table 1-1:

Table 1-1: Ore Dock Coordinates

Description	Northing	Easting
Center of West Cell	7,976,621	503,240
Center of Middle Cell	7,976,641	503,273
Center of East Cell	7,976,660	503,306
Causeway (at shoreline)	7,976,486	503,235

2. Study Assumptions

All assumptions from the previous trade-off study remain the same with the exception of the following.

2.1 Site Conditions

Site conditions are defined in Standard Specification – Site Conditions, H349000-S003120.

2.2 Tides

Department of Fisheries and Oceans (DFO) provided the following tidal levels based on the data recorded at Milne Inlet Station (received March 25, 2013):

- Tides: Semi-diurnal
- Highest Astronomical Tide (HAT): elevation +2.4 m CD (1.2 m GD)
- High High Water Large Tide (HHWLT): elevation +2.3 m CD (+1.1 m GD)
- High High Water Mean Tide (HHWMT): elevation +2.0 m CD (+0.8 m GD)
- Mean Water Level (MWL): elevation +1.2 m CD (0.0 m GD)
- Low Low Water Mean Tide (LLWMT): elevation +0.5 m CD (-0.7 m GD)
- Low Low Water Large Tide (LLWLT): elevation 0.0 m CD (-1.2 m GD)

Note: These levels differ from those provided on Canadian Hydrographic Service Chart 7212.

2.3 Metocean Conditions

Marine structures will be designed for a return period of 10 years. The following conditions will apply.

2.3.1 Waves

The 10 year return period wave corresponds to:

- Significant Wave Height, Hs = 1.6 m
- Period, T = 5 s

2.3.2 Currents

The 10 year return period current corresponds to:

- Current = 1.3 m/s

2.4 Vessels

Design vessels for the ore dock are shown in Table 2-1.

Table 2-1: Ore Dock Vessel Parameters

Description	Supramax	Panamax	Post-Panamax
Name	tbn Krania	CSL Spirit	M/V AM Ghent
Deadweight (DWT)	57,400	70,108	93,167
Length Overall, LOA (m)	190.00	225.02	229.02
Beam, B (m)	32.26	32.19	38.0
Moulded Depth (m)	18.50	19.51	20.70
Loaded Draft (m)	13.02	14.42	14.9
Number Holds	5	7	7
Total Hold Length (m)	135.44	162	170.85

2.5 Material Availability

Sheet piles are assumed to be AS500-12.7, Grade 400WT, Category 3, up to 35 m in length. No allowance for corrosion was provided in this exercise.

3. Technical Considerations

3.1 Ore Dock

The ore dock is arranged according to generally recommended principles used in the industry such as British Standard 6349.

The dock has been placed in approximately 17.6 m of water depth (at low tide) in order to accommodate the vessel's draft, a underkeel clearance of 15% of the maximum design vessel's draft, plus a 0.5 m allowance for scour protection placed on the seabed. The dock is rotated 5° off tangent from the natural bathymetry of the seabed in order to provide a reasonable balance between orienting the berth to minimize marine structure depths and aligning the berth with the prevailing current and wind directions.

The elevation of the dock is assumed to be +5.3 m CD. This will protect the deck by providing a 1m freeboard above an assumed 2 m build-up of ice above the static water level at high tide. The height of the deck will be further optimized during detailed design.

3.2 Causeway

A causeway will be constructed from shore to the ore dock. The width of the causeway is assumed to be 10 m to accommodate a single lane roadway and the ore conveyor. Armour stone sized for the predominant wave and ice conditions will be provided with slopes of 1.75H:1V. The crest of the causeway will also be +5.3 m CD.

4. Berth Optimization

4.1 Previous Ore Dock Layout

The ore dock layout that was developed prior to this optimization effort is shown in Figure 4-1. This layout consisted of three circular steel sheet pile cells connected with interlocking arcs. The dock was located to provide a berth pocket with 17 m of water depth at low tide.

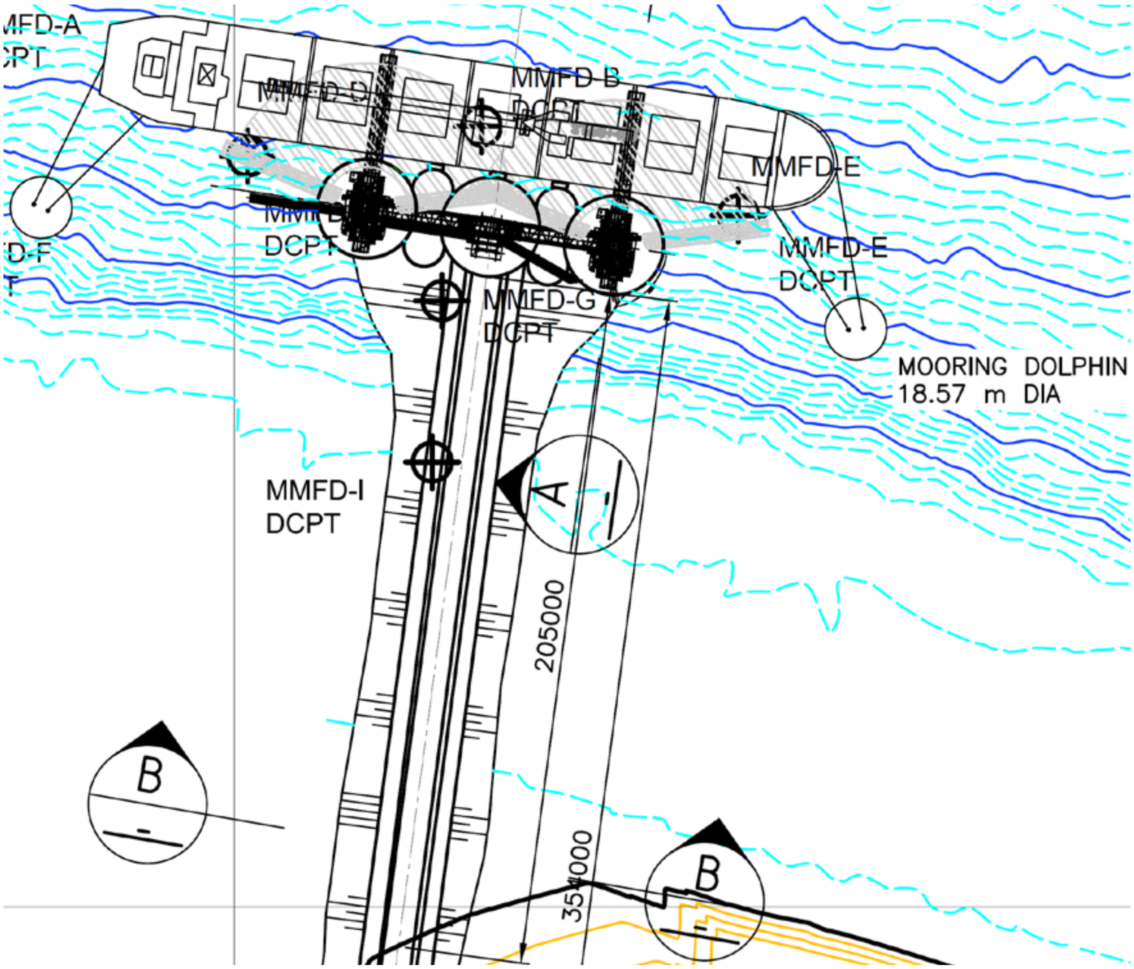


Figure 4-1: February 2013 Ore Dock Layout, East Location

4.2 Revised Ore Dock Layout

In order to reduce overall costs, the interlocking arcs connecting the steel sheet pile cells have been removed and replaced with bridges that will accommodate pickup truck and pedestrian access. The berth has been slightly relocated to provide a minimum water depth of 17.6 m in the berth pocket as well as maintain a minimum navigational clearance of 2 x LOA (overall length of largest vessel) between the ship and the nearest grounding contour (to the west). Refer to Figure 4-2 for the general layout of the optimized berth. In order to maintain the 2 x LOA requirements, the alignment of the feed conveyor was changed and this will require the addition of a transfer tower onshore.

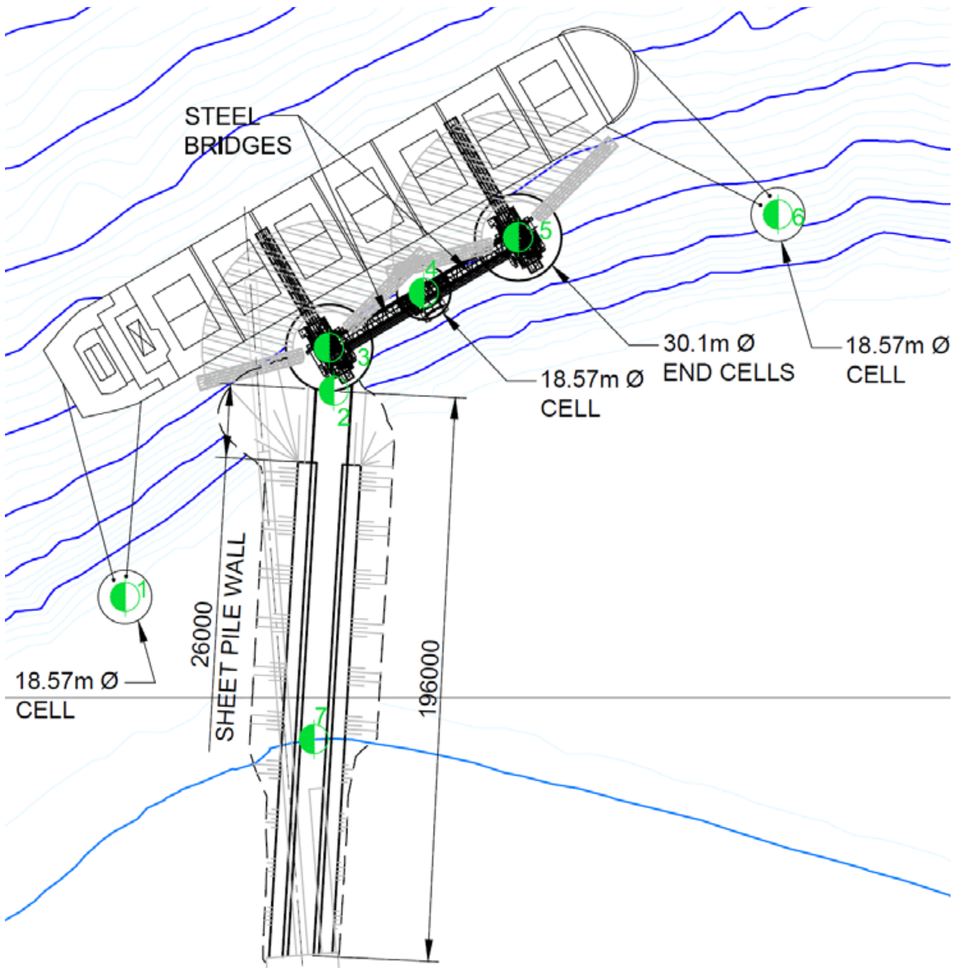


Figure 4-2: Optimized Ore Dock Layout, West Location

In order to further minimize costs, three different mooring dolphin options were investigated. The balance of the berth essentially remains the same for all mooring dolphin options. The three mooring dolphin options investigated include:

- Option 1: Steel Sheet Pile Cells
- Option 2: Steel Monopiles; and
- Option 3: Mooring “Islands”

4.2.1 Option 1- Steel Sheet Pile Cells

Option 1 uses steel sheet pile cells for the mooring dolphins similar to the rest of the berth structures. These sheet pile cells are gravity based structures and achieve overall stability though bottom friction and self weight against overturning moments and horizontal forces caused by ice and mooring loads. Internal shear and friction forces are also critical.

Reinforced concrete caps will be used to anchor the mooring hardware and transfer the loads into the cell structure. A nominal amount of riprap will be placed around each cell structure to prevent scour along the seabed line.

Refer to Appendix A, Figure 1 for the drawing of this option.

4.2.2 Option 2 – Steel Monopiles

Option 2 utilizes large diameter steel pipe monopiles filled with concrete as the mooring dolphins. These structures are designed as vertical cantilevers installed deep enough below the seabed to provide bottom fixity. As a result they mainly resist lateral forces through bending and shear. Based on current ice loading parameters and an assumed depth of fixity of 12 m below the seabed, the preliminary diameter of these monopiles is 6.1 m (20 ft). It is anticipated the required size of the monopiles may be reduced once the final ice loading and local geotechnical conditions are confirmed.

The concrete fill will be used to anchor the mooring hardware and transfer the loads into the monopile. A nominal amount of riprap will be placed around each monopile to prevent scour along the seabed line.

Refer to Appendix A, Figure 2 for the drawing of this option.

4.2.3 Option 3 – Mooring Islands

Option 3 utilizes armoured rubble mound islands as mooring points. Similar to the sheet pile cells, these fill structures are deigned to be stable against ice loading and other lateral forces through their large mass and wide base footprints. For stability, the armour has been provided at the 1.75:1 slope similar to the preliminary causeway design. However, the design of the armour has not been finalized and at this slope, the toe of the armour protection extends into the berth pocket potentially reducing the underkeel clearance of the vessel. Mooring hardware will be anchored into the fill mass through concrete pilecaps and vertical pipe piles. The design of the armour stone needs to be verified in order to proceed with this option.

Refer to Appendix A, Figure 3 for the drawing of this option.

5. Scheduling

5.1 Assumptions

The following assumptions have been made in order to determine the approximate construction duration:

- Shift of 24 hours per day
- Production Rates have been taken from Dragados rates submitted in 2012, which were based on 24 hour work days
- Two (2) barges have been considered for operations

- Sheet piling material and other materials and accessories are delivered during the open water season the year prior to construction
- All fill material, for the causeway and cells, is available at the start of the construction season

The following production rates have been assumed based on a 24 hour shift:

- Installation of environmental protection (silt screens, bubble curtains...): five days
- Sheet Pile Template Fabrication: 15 days for large cells
- Sheet Pile Template Fabrication: 10 days for small cells
- Sheet Pile Driving - Cells: 24 sheets/day
- Sheet Pile Driving – Wall: 3 m/day
- Steel Pipe Pile Installation (shiploader foundation): two piles/day
- Sheet Pile Cell Fill: 2000 m3/day
- Steel Access Bridge: one span/day
- Causeway Rock Fill: 1250 m3/day
- Causeway Armour and Sub Armour Stone: 1250 m3/day
- Concrete slabs and beams: 200 m3/day
- Placement of Scour Protection: 2000 m3/day
- Rails and Guards: 24 m/day
- Fenders, Bollards: one each/day

5.2 Option 1 - Steel Sheet Pile Cells

The following tables (Table 5-1 and Table 5-2) outline the estimated durations for the activities that must be completed for Option 1.

Table 5-1: Option 1, On Water Activities

On Water Activities	Duration (days)
Environmental Protection	5
Sheet pile cells, template and installation	91
Sheet pile walls, walers, tie rods	36
Concrete Impact Beams	3
Fill Cells	22
Install Steel Pipe Piles	14
Install Scour Protection	3
Install Steel Bridges	2
Causeway	22
Total On Water – Assuming 2 Barges	**99**

Table 5-2: Option 1, Other Activities

Other Activities	Duration (days)
Concrete Slabs	8
Install Fenders, Bollards, etc.	15
Install Berthing Aid System	2
Install Handrails and Guardrails	33
Total	**58**

5.3 Option 2 – Steel Monopiles

The following tables (Table 5-3 and Table 5-4) outline the estimated durations for the activities that must be completed for Option 2.

Table 5-3: Option 2, On Water Activities

On Water Activities	Duration (days)
Environmental Protection	5
Sheet pile cells, template and installation	61
Sheet pile walls, walers, tie rods	36
Concrete Impact Beams	2
Fill Cells	18
Install Steel Pipe Piles	14
Install Scour Protection	3
Install Steel Bridges	2
Install Steel Monopiles	14
Causeway	22
Total On Water – Assuming 2 Barges	**89**

Table 5-4: Option 2, Other Activities

Other Activities	Duration (days)
Concrete Slabs	7
Install Fenders, Bollards, etc.	15
Install Berthing Aid System	2
Install Handrails and Guardrails	33
Total	**57**

5.4 Option 3 – Mooring Islands

The following tables (Table 5-5 and Table 5-6) outline the estimated durations for the activities that must be completed for Option 3.

Table 5-5: Option 3, On Water Activities

On Water Activities	Duration (days)
Environmental Protection	5
Sheet pile cells, template and installation	61
Sheet pile walls, walers, tie rods	36
Concrete Impact Beams	2
Fill Cells	18
Install Steel Pipe Piles - shiploader	14
Install Scour Protection	3
Install Steel Bridges	2
Causeway	22
Island Fill	39
Install Steel Pipe Piles - mooring	4
Total On Water – Assuming 2 Barges	**103**

Table 5-6: Option 3, Other Activities

Other Activities	Duration (days)
Concrete Slabs	7
Install Fenders, Bollards, etc.	15
Install Berthing Aid System	2
Install Handrails and Guardrails	33
Total	**57**

6. Constructability

6.1 Option 1 - Steel Sheet Pile Cells

Installation of the sheet pile cell option for the mooring dolphins will be the same as the steel sheet pile cells for the rest of the berth. To ensure proper alignment, templates will be used to drive or vibrate the steel sheet piles to depth. Engineered fill will be placed in lifts inside the cell structure to the appropriate elevation and a concrete cap will be poured to complete the gravity-based structure.

Installation of the sheet piles can potentially be conducted during winter months by using the pack ice as a construction platform.

6.2 Option 2 – Steel Monopiles

The monopile option may present some unique constructability challenges due to the potentially large diameter required to resist ice loading through bending. Large diameter piles may be able to be driven or vibrated to depth using large multi-hammer pile driving equipment. Alternatively, a specialized drill rig may with a large diameter drill auger could be used to install the piles by advancing the hole and allowing the monopile to be installed like a casing. Regardless of the installation method, specialized equipment would need to be transported to site thereby increasing overall equipment and mobilization costs.

The total installed length of the monopile may be up to 40 m. The monopile will likely be installed in sections that can be accommodated by the height of the equipment leads or by the capacity and height of the crane used to stage the pile. Field weld splices will be required to join the sections which may be a time consuming and costly process depending on the number of field splices required. The monopile itself will need to be prefabricated from plate material and shipped to site in sections.

Installation of the monopiles can be conducted from a barge during the summer months. Alternatively, installation of the monopiles piles can potentially be conducted during winter months by using the pack ice as a construction/drilling platform.

Once the monopile is installed concrete fill can be placed inside to complete the structure. Engineered fill and a concrete cap can be used as an alternative to completely filling the monopile with concrete, however the diameter and wall thickness of the steel shell will need to be increased to compensate.

6.3 Option 3 – Mooring Islands

Since the rubble mound mooring points are not connected to land and are some distance from shore, they will likely require the use of flat deck barges in order to be constructed. Front end loaders, backhoes, and similar equipment would be used to place fill material from the barges and build the island from the seabed up. The island mounds would be placed in various lifts including core, filter stone and armoured layers to ensure proper stability and resistance to scour or ice forces.

7. Estimate of Probable Cost

The estimated capital cost of the ore dock (excluding contingency and indirects) for the three options are:

- Option 1: $32,834,000
- Option 2: $34,813,000
- Option 3: $35,357,000

Please note this is an order of magnitude estimate. The capital costs are given in Q1 2012 Canadian dollars and do not include any price escalation to account for future inflation. Refer to Appendix B for cost estimate details.

8. Conclusions

Based on the estimated capital costs, the most economical option is the Optimized 3-Cell Berth with Mooring Cells (Option 1). Compared to the original "3-cell configuration" berth layout presented previously, an "optimized" 3-cell berth with mooring cells has a savings of approximately $6.8 million. For comparison purposes the capitol costs for the original concepts and the "optimized" concepts with various mooring options are summarized below:

Table 8-1: Capital Cost Comparison of Previous and Optimized Concepts

Layout Option	Berth Configuration	Mooring Point Configuration	Direct Cost*
4 cell	4 cell Continuous Berth	Sheet Pile Cells	$45,405,000
3 cell	3 cell Continuous Berth	Mooring Dolphins	$39,635,000
New Option 1	Optimized 3 cell berth with discrete cells	Mooring Dolphins	$32,834,000
New Option 2	Optimized 3 cell berth with discrete cells	Monopiles	$34,813,000
New Option 3	Optimized 3 cell berth with discrete cells	Islands**	$35,357,000
* Excludes contingency and indirect costs			
** Requires refinement of armour stone as it spills into berth pocket			

This preliminary optimization effort has been based on the project information currently available. It is expected that the berth layout will be further optimized and refined during detailed design as additional critical information is obtained. Such information will include relevant geotechnical data and revised ice loading.

In addition to capital costs, each option should be evaluated in terms of its constructability, and design efficiency. The advantages and disadvantages of each option are summarized in the following sections.

8.1 Option 1 - Steel Sheet Pile Cells

The advantages and disadvantages of the Steel Sheet Pile Cell Mooring Dolphin option are summarized in the following sections.

8.1.1 Advantages

- Potential winter construction using pack ice as construction platform
- Smaller sheet pile sections easier to stage and install

8.1.2 Disadvantages

- Requires template for sheet piles

8.2 Option 2 – Steel Monopiles

The advantages and disadvantages of the monopile mooring dolphin option are summarized in the following sections.

8.2.1 Advantages

- Potential winter construction using pack ice as construction platform
- Template not required

8.2.2 Disadvantages

- Requires mobilization of special driving or drill equipment and higher capacity cranes
- Potential for long lead time for procurement of large diameter, thick walled pipe section
- Requires staging and handling large heavy pipe sections
- Requires field splicing of large diameter, thick walled pipe sections

8.3 Option 3 – Mooring Islands

The advantages and disadvantages of the Island Mooring Point option are summarized in the following sections.

8.3.1 Advantages

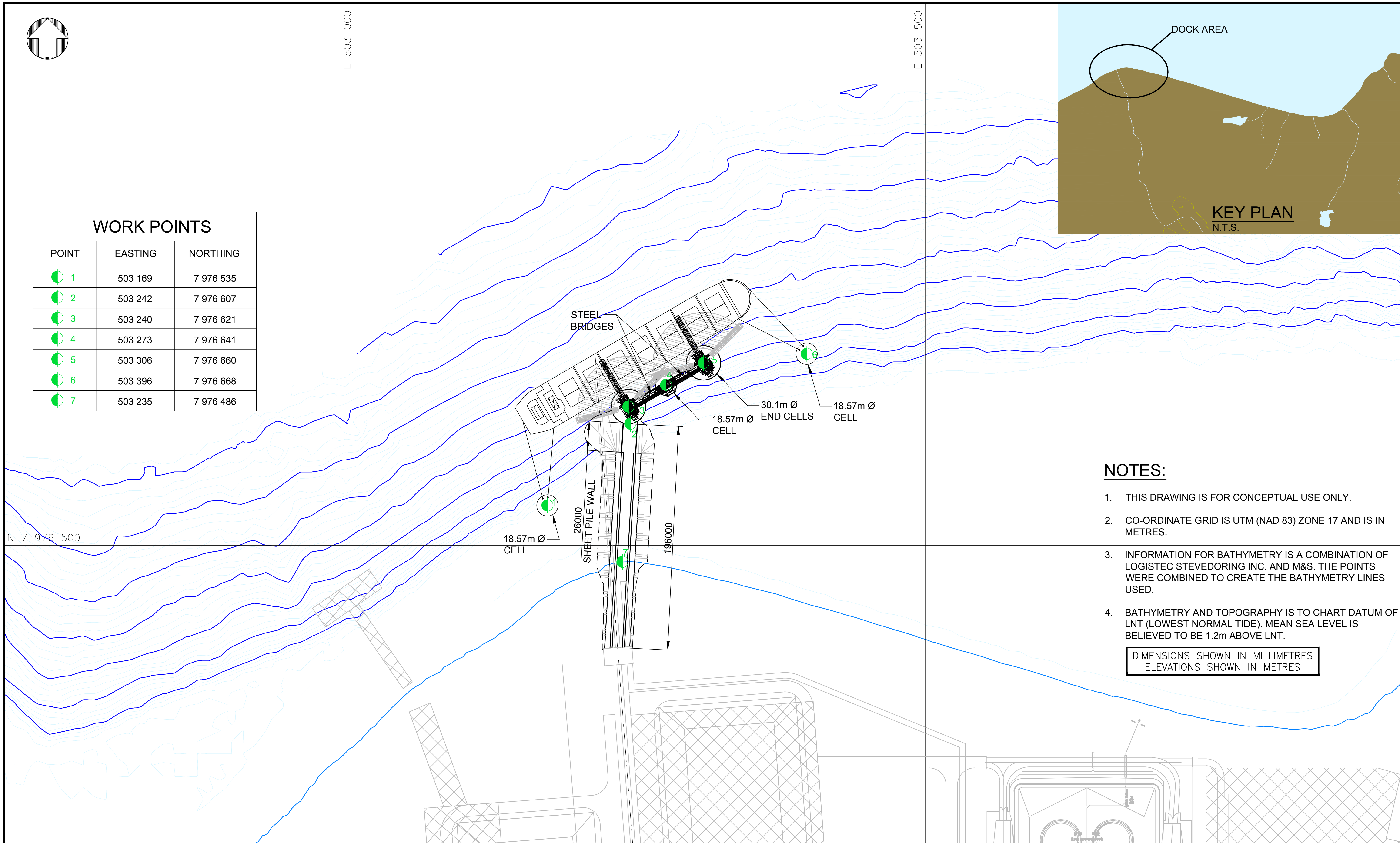
- Embedded pile foundations can be optimized for mooring loads only as they will not be affected by ice loading

8.3.2 Disadvantages

- May require import of additional quantities of fill and riprap material
- Utility boat docking area required on each 'Island" for handling mooring lines

Appendix A

Drawings



WORK POINTS

POINT	EASTING	NORTHING
1	503 169	7 976 535
2	503 242	7 976 607
3	503 240	7 976 621
4	503 273	7 976 641
5	503 306	7 976 660
6	503 396	7 976 668
7	503 235	7 976 486

NOTES:

1. THIS DRAWING IS FOR CONCEPTUAL USE ONLY.
2. CO-ORDINATE GRID IS UTM (NAD 83) ZONE 17 AND IS IN METRES.
3. INFORMATION FOR BATHYMETRY IS A COMBINATION OF LOGISTEC STEVEDORING INC. AND M&S. THE POINTS WERE COMBINED TO CREATE THE BATHYMETRY LINES USED.
4. BATHYMETRY AND TOPOGRAPHY IS TO CHART DATUM OF LNT (LOWEST NORMAL TIDE). MEAN SEA LEVEL IS BELIEVED TO BE 1.2m ABOVE LNT.

DIMENSIONS SHOWN IN MILLIMETRES
ELEVATIONS SHOWN IN METRES

PLAN

SCALE: 1:3000

Fig.1

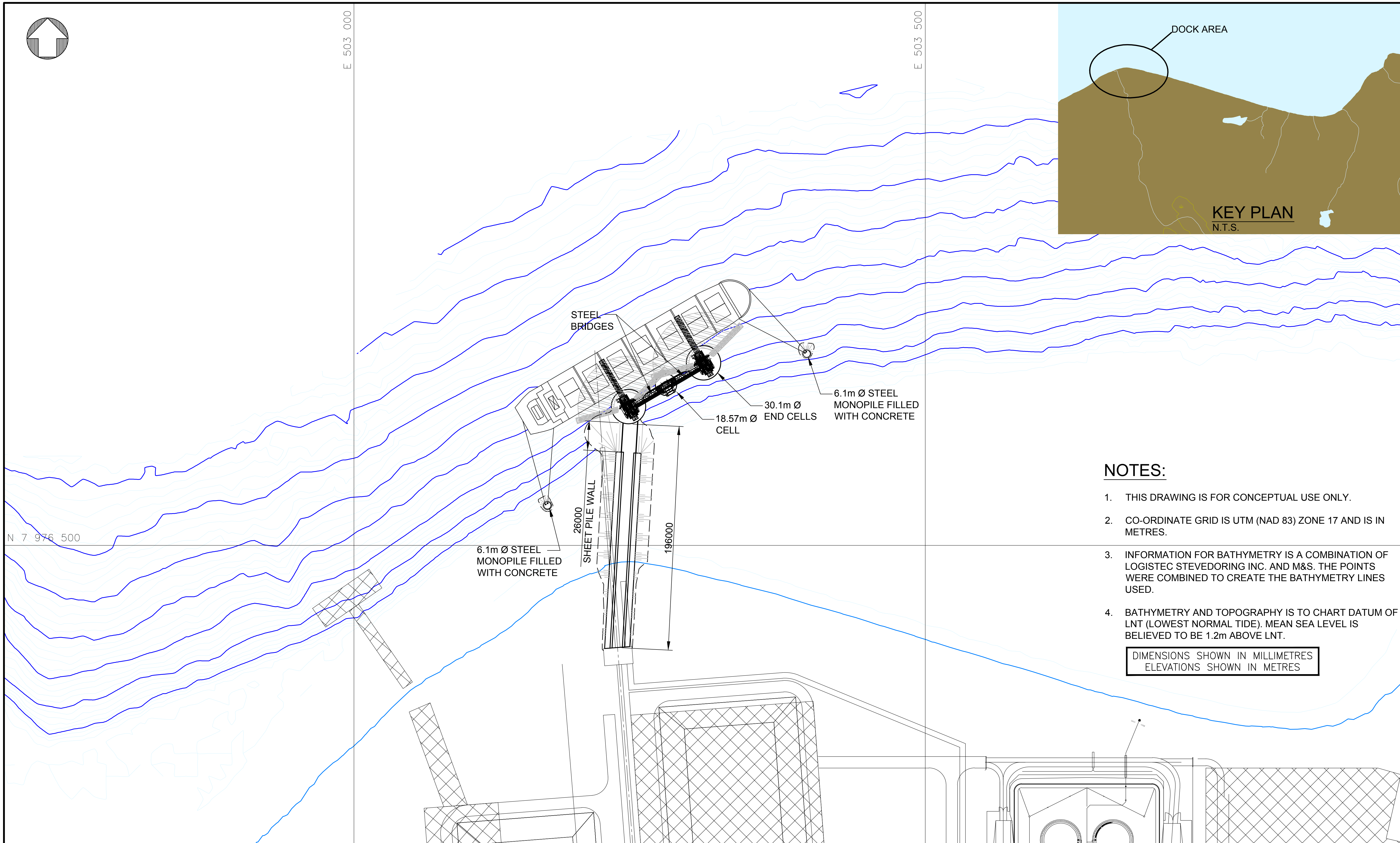
Baffinland Iron Mines Corporation

Mary River Project - ERP

HATCH

Optimized Ore Dock

Plot Scale
Apr 17, 2013, 8:59am Login name: Grah57916 Layout: 11x17
Drawing Name: C:\prj\projectwise\grah57916\dms79521\11x17 Optimized Ore Dock Fig. 1.dwg



NOTES:

1. THIS DRAWING IS FOR CONCEPTUAL USE ONLY.
2. CO-ORDINATE GRID IS UTM (NAD 83) ZONE 17 AND IS IN METRES.
3. INFORMATION FOR BATHYMETRY IS A COMBINATION OF LOGISTEC STEVEDORING INC. AND M&S. THE POINTS WERE COMBINED TO CREATE THE BATHYMETRY LINES USED.
4. BATHYMETRY AND TOPOGRAPHY IS TO CHART DATUM OF LNT (LOWEST NORMAL TIDE). MEAN SEA LEVEL IS BELIEVED TO BE 1.2m ABOVE LNT.

DIMENSIONS SHOWN IN MILLIMETRES
ELEVATIONS SHOWN IN METRES

PLAN

SCALE: 1:3000

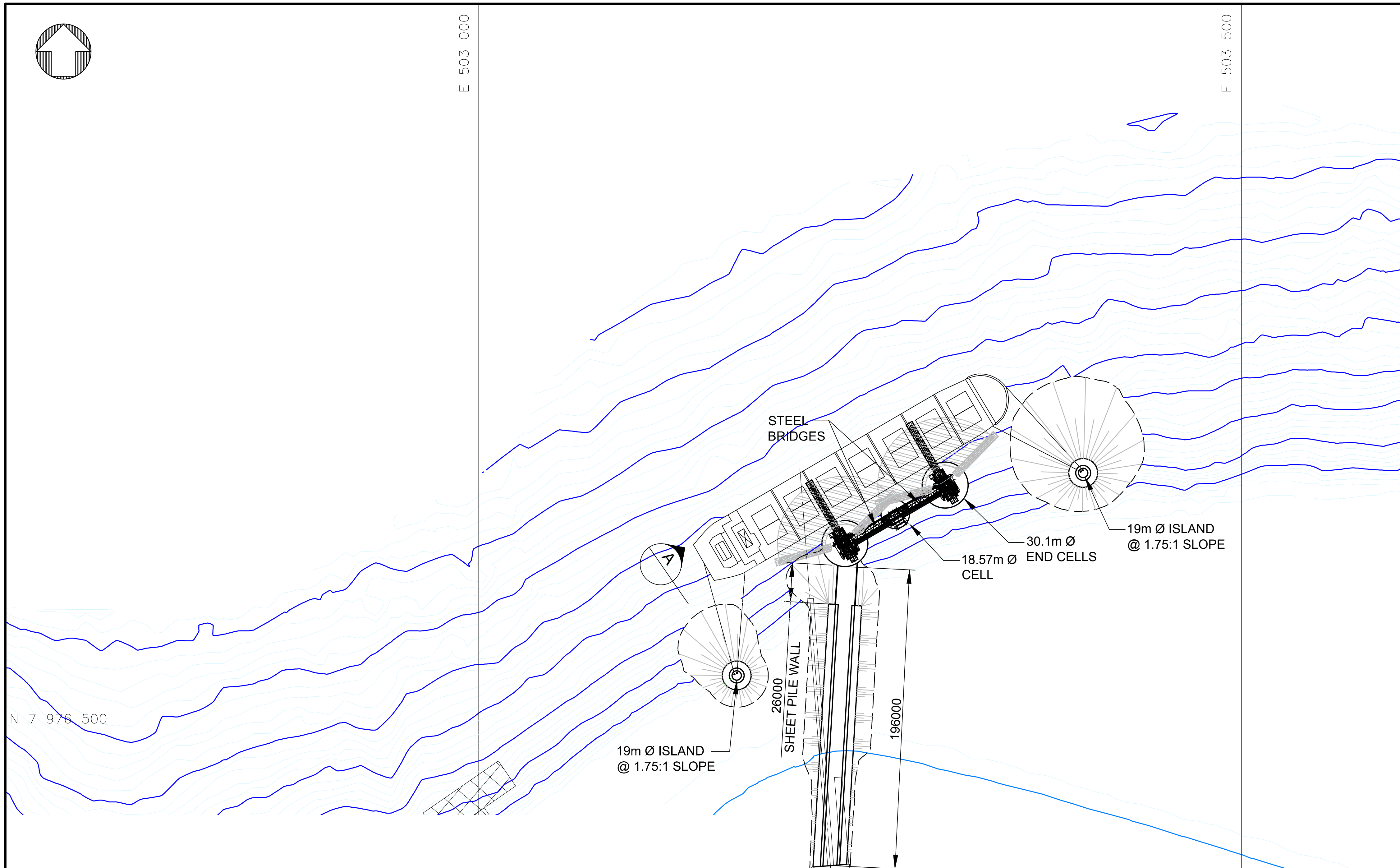
Fig. 2

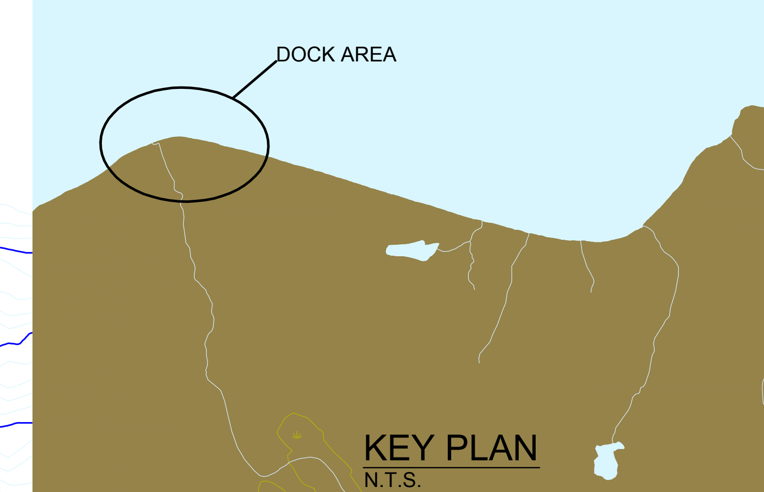
Baffinland Iron Mines Corporation

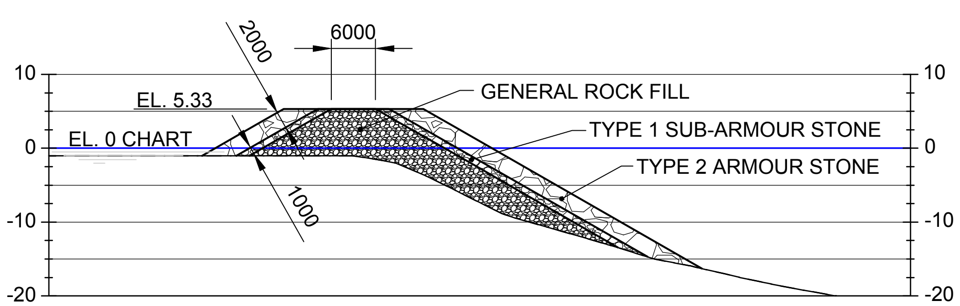
Mary River Project - ERP

HATCH

Steel Monopile Option







SECTION A

SCALE 1:1000

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DIMENSIONS SHOWN IN MILLIMETRES
ELEVATIONS SHOWN IN METRES

PLAN

SCALE: 1:3000

Fig. 3

Baffinland Iron Mines Corporation

Mary River Project - ERP

"Filled" Mooring Island Option

HATCH

Appendix B

Estimate of Probable Cost

Removed - Confidential Information