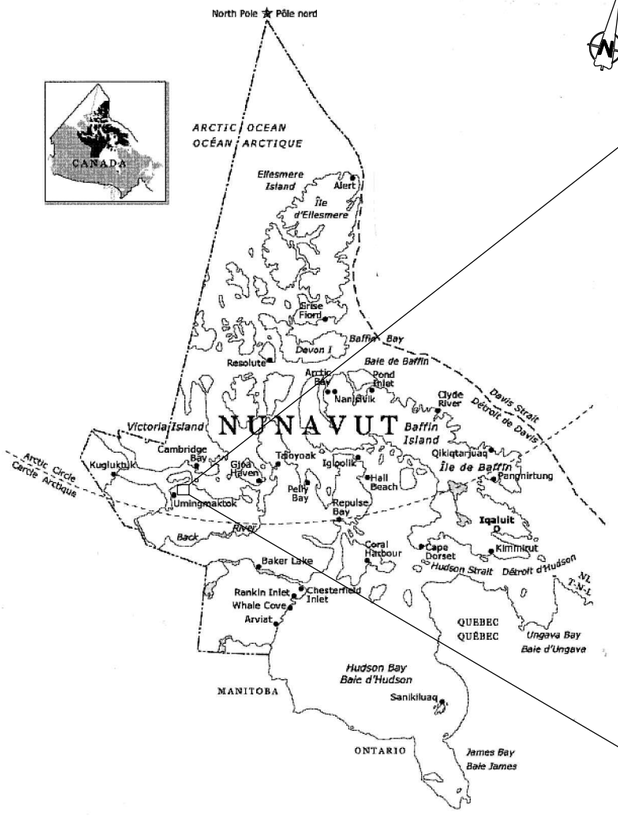
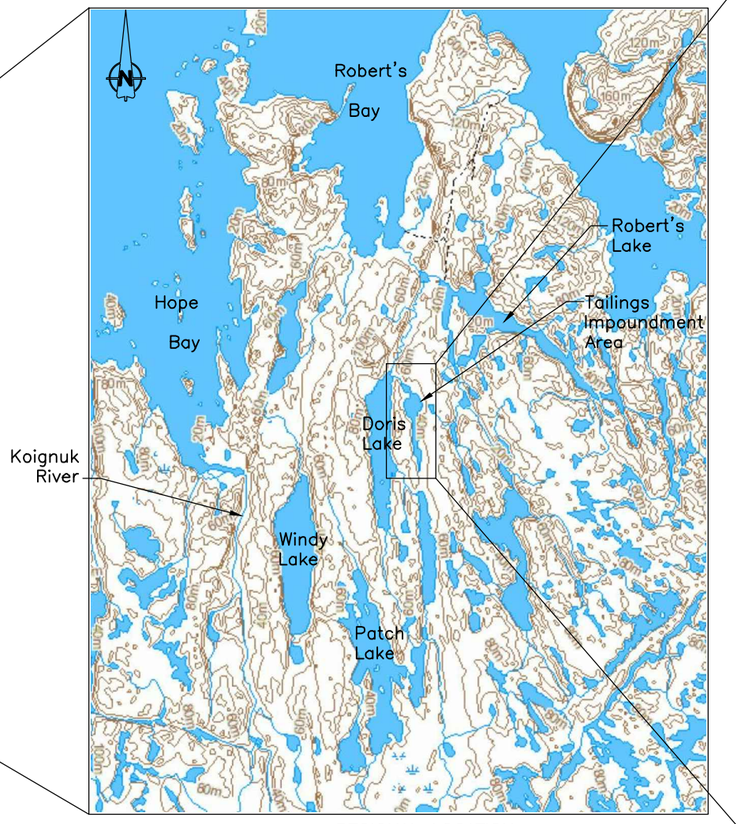


TERRITORIAL LOCATION

Approx. Scale 0 500 1000 Km



REGIONAL LOCATION

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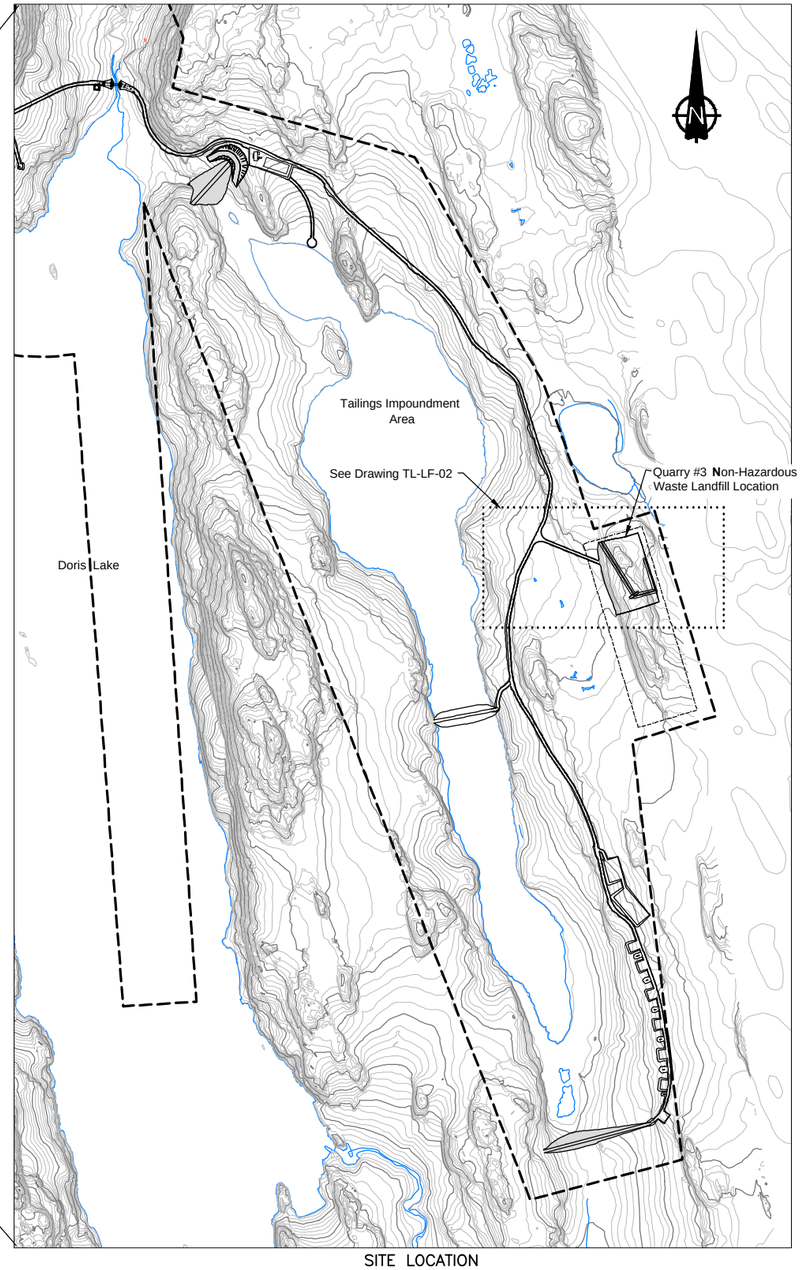

SITE LOCATION

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REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	ISSUED FOR DISCUSSION	LW	EMR	29May15

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srk consulting

DESIGN:	DRAWN:	REVIEWED:
LW	NV	LW
CHECKED:	APPROVED:	DATE:
LW	EMR	May 29, 2015

FILE NAME: 1CT022.002 TL-LF-01.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CH022.002.200.1500

Doris North

DRAWING TITLE:

Quarry 3 Non-Hazardous Waste Landfill Location Map

DRAWING NO.	SHEET	REVISION NO.
TL-LF-01	2 OF 6	A

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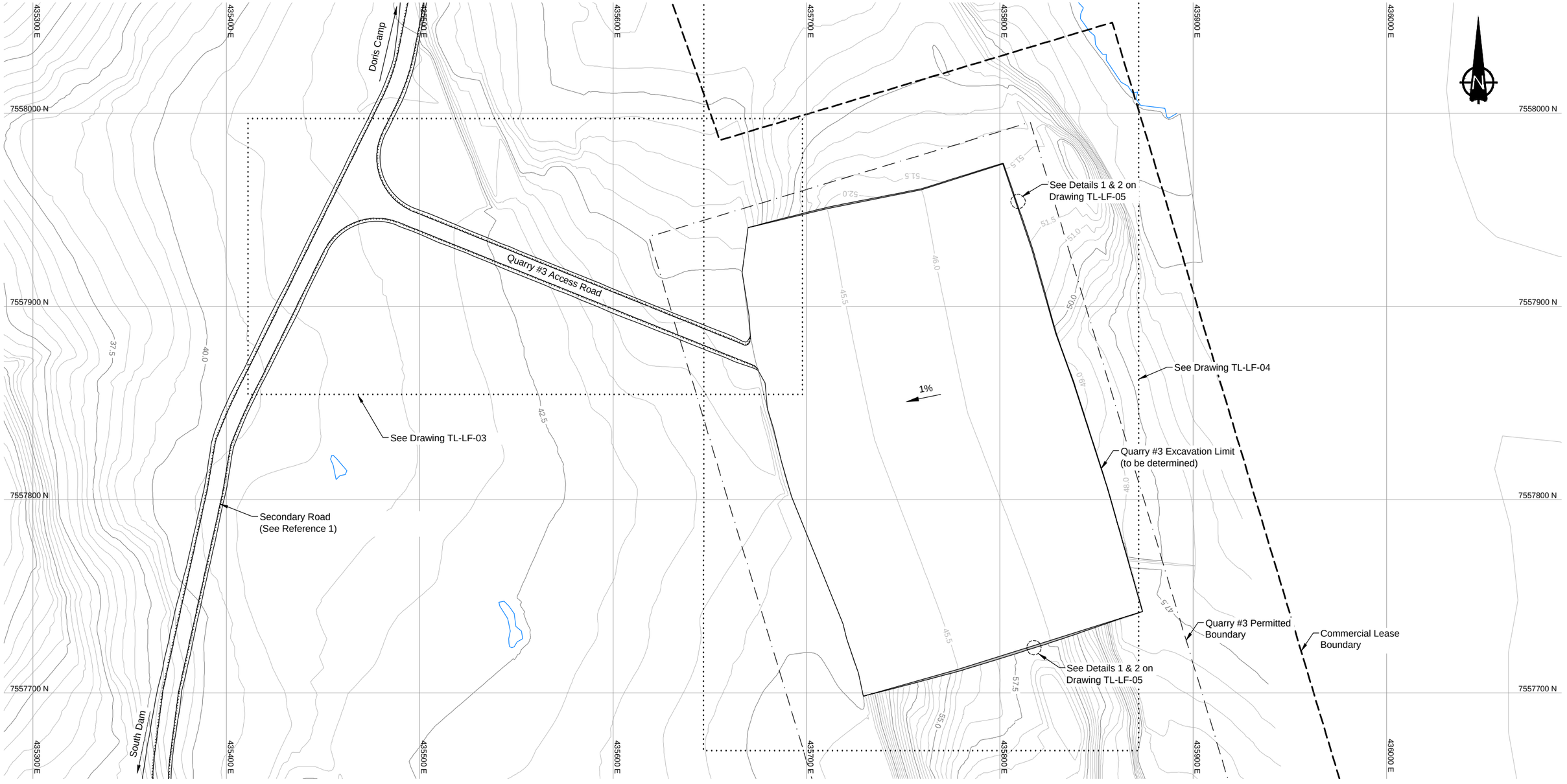

LEGEND

- Ponds, Lakes or Permanent Water Bodies
- Commercial Lease Boundary
- Quarry #3 Permitted Boundary

REFERENCE

1. SRK Consulting (Canada) Inc. 2011. Engineering Drawings for the Doris North Secondary Road, Doris North Project, Nunavut, Canada, Revision 6. Issued for Construction. Drawing Package prepared for Hope Bay Mining Limited. Project Number: 1CH008.033. December 9, 2011.

0 10 20 30 40 50
Scale in Metres

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FILE NAME: 1CT022.002-TL-LF-02_03_04.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CH022.002.200.1500

Doris North

DRAWING TITLE:

Quarry #3 Conceptual Excavation

DRAWING NO.	SHEET	REVISION NO.
TL-LF-02	3 OF 6	A

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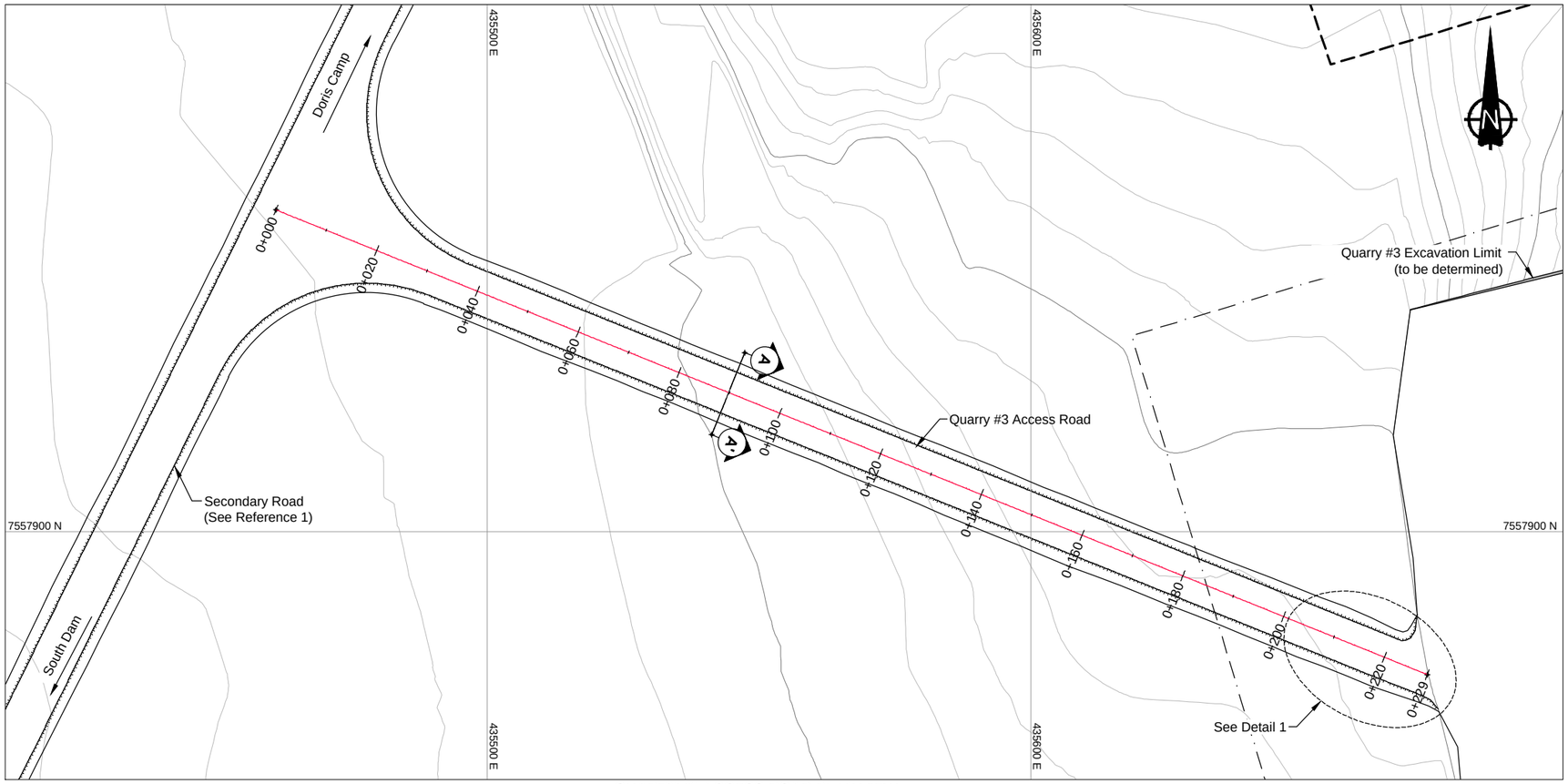


QUARRY #3 ACCESS ROAD PLAN VIEW

0 5 10 15 20 25
Scale in Metres

LEGEND

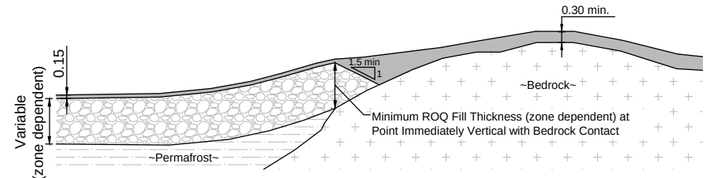
- Ponds, Lakes or Permanent Water Bodies
- Commercial Lease Boundary
- Quarry #3 Permitted Boundary
- Surfacing Material (1-1/4" Crushed Rock)
- Run of Quarry Material

NOTES

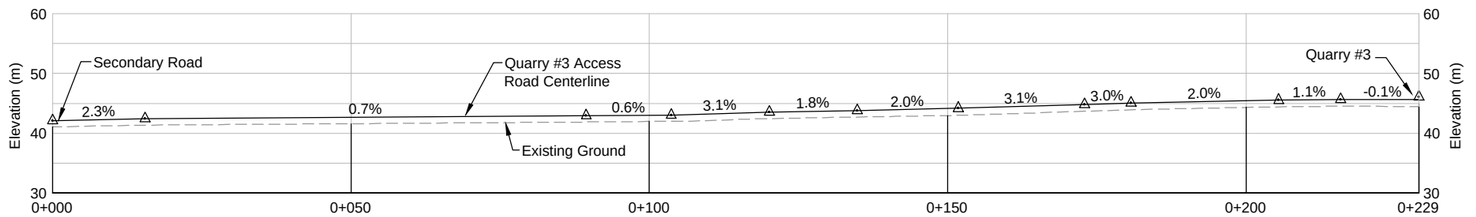
1. All dimensions in metres unless noted otherwise.
2. Minimum design thickness must be maintained for all sections of the all-weather road including turnouts.
3. Notes in this drawing apply to all other active drawings.

REFERENCE

1. SRK Consulting (Canada) Inc. 2011. Engineering Drawings for the Doris North Secondary Road, Doris North Project, Nunavut, Canada, Revision 6. Issued for Construction. Drawing Package prepared for Hope Bay Mining Limited. Project Number: 1CH008.033. December 9, 2011.



QUARRY #3 ACCESS ROAD PROFILE
TRANSITION FROM PERMAFROST TO BEDROCK
(1) NTS



QUARRY #3 ACCESS ROAD PROFILE

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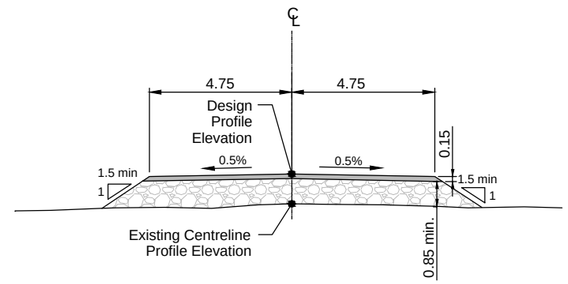
Scale in Metres

PROFILE LEGEND

- △ Point of Vertical Intersection
- 6.1% Grade

Fill Zone 1



TYPICAL
QUARRY #3 ACCESS ROAD SECTION
(A)

0 1 2 3 4 5
Scale in Metres

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srk consulting

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LW	EMR	May 29, 2015

FILE NAME: 1CT022.002-TL-LF-02_03_04.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CH022.002.200.1500

Doris North

DRAWING TITLE:

Quarry #3 Access Road Design

DRAWING NO.	SHEET	REVISION NO.
TL-LF-03	4 OF 6	A

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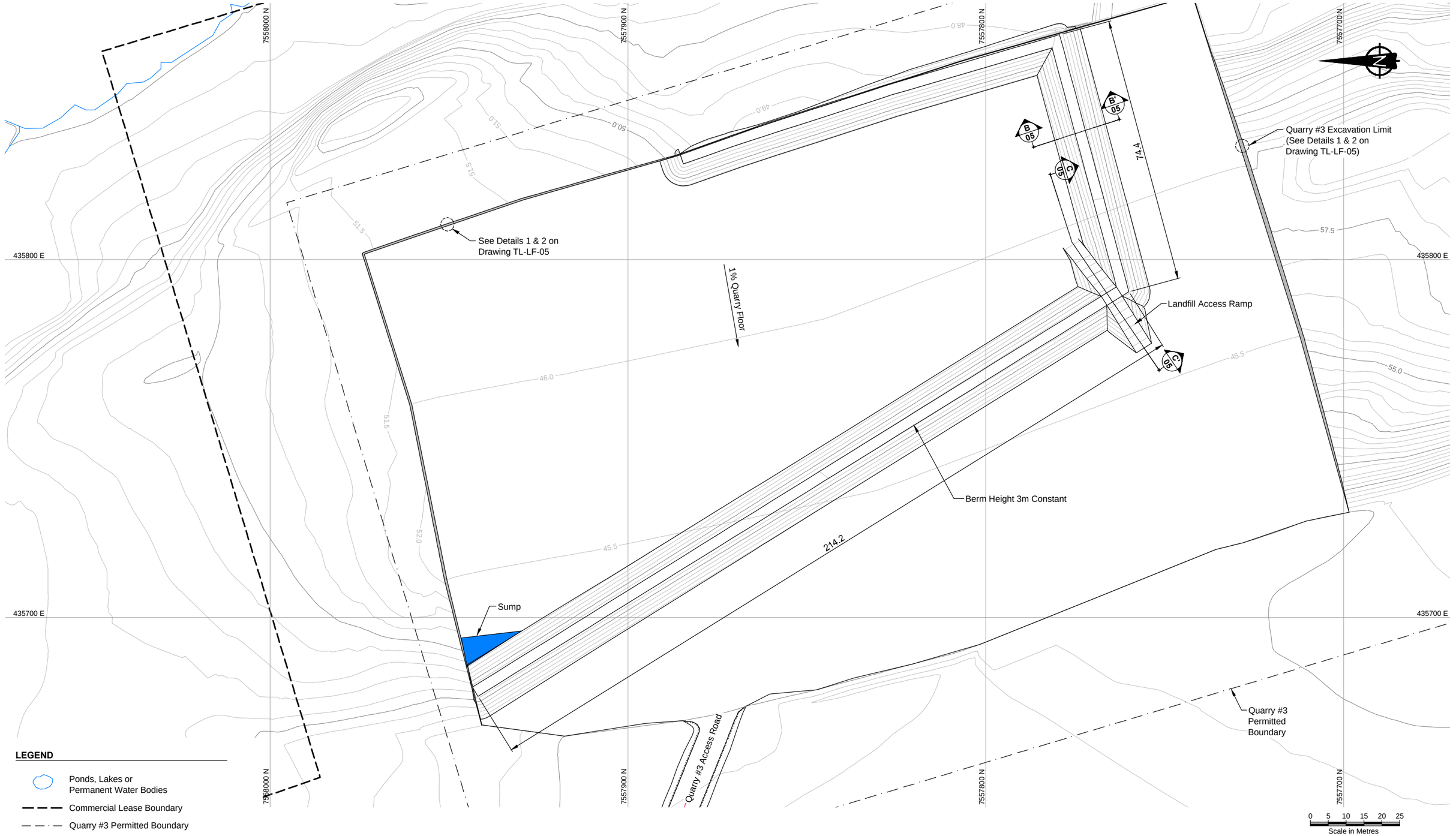

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NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	ISSUED FOR DISCUSSION	LW	EMR	29May15

REVISIONS

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srk consulting

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LW	NV	LW
CHECKED:	APPROVED:	DATE:
LW	EMR	May 29, 2015

FILE NAME: 1CT022.002-TL-LF-02_03_04.dwg

TMAC RESOURCES

HOPE BAY PROJECT

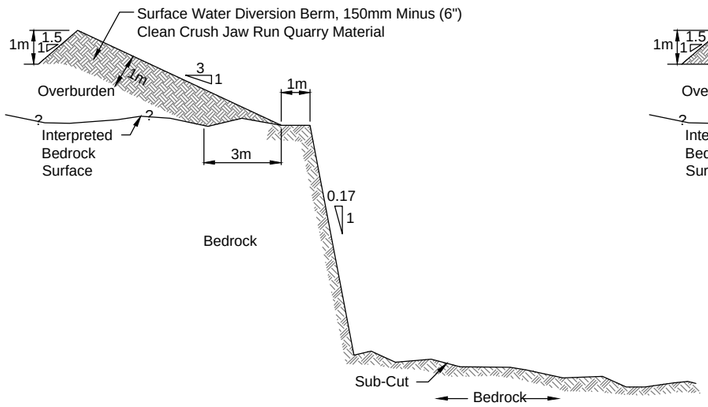
SRK JOB NO.: 1CH022.002.200.1500

Doris North

DRAWING TITLE:

Non-Hazardous Waste Landfill Design

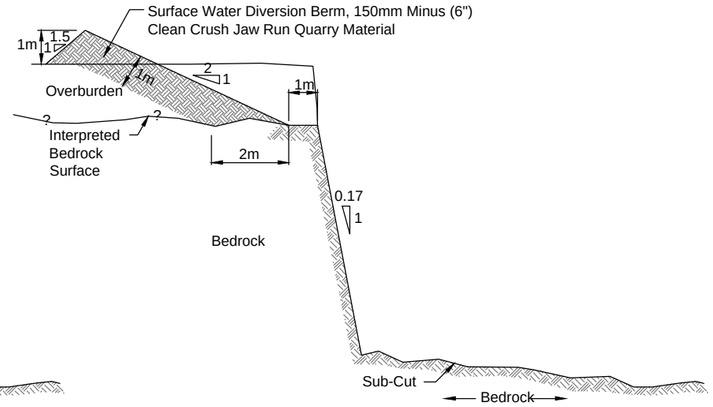
DRAWING NO.	SHEET	REVISION NO.
TL-LF-04	5 OF 6	A



DETAIL 1

TYPICAL SECTION AT QUARRY #3 HIGHWALL FOR OVERBURDEN < 1.5m THICK

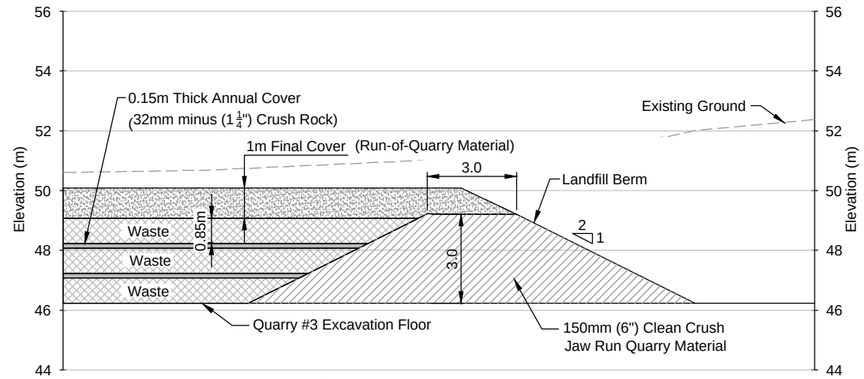
NTS



DETAIL 2

TYPICAL SECTION AT QUARRY #3 HIGHWALL FOR OVERBURDEN < 1.5m THICK

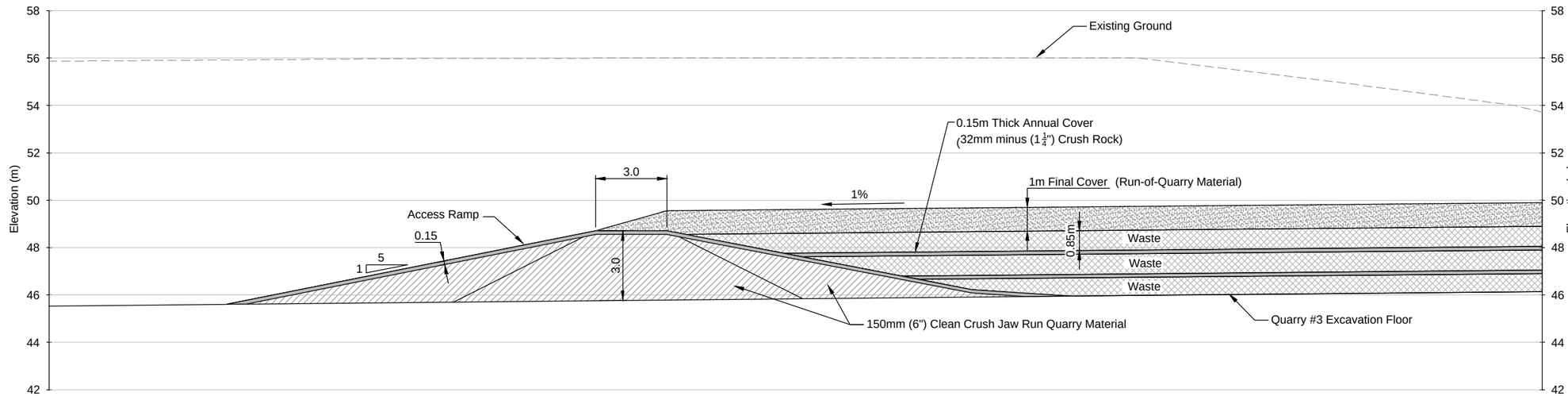
NTS



B 04 **SECTION B - B'**

0 1 2 3 4 5

Scale in Metres



C 04 **SECTION C - C'**

0 1 2 3 4 5

Scale in Metres

MATERIAL LIST AND QUANTITIES

Item	Volume		Description
1. Run-of-Quarry Material	1m Final Cover within Berm	19,520 m^3	Approximate In-Place Neat-line Volume
2. Jaw Run Quarry Material 150mm (6") Clean Crush	Quarry #3 Access Road	2,200 m^3	Approximate In-Place Neat-line Volume
	Berm (includes access ramp)	9,900 m^3	
	Total	12,100 m^3	
3. Surface Grade Material 32mm minus (1 1/4") Crush Rock	Quarry #3 Access Road	320 m^3	Approximate In-Place Neat-line Volume
	0.15m Annual Covers	5,860 m^3	
	Access Ramp	30 m^3	
	Total	6,210 m^3	
4. Non-Hazardous Waste	Storage Capacity	46,550 m^3	Approximate In-Place Neat-line Volume

Note: No allowance has been accounted for the surface water diversion berm along the top of the Quarry #3.

LEGEND

- Non-Hazardous Waste
- 32mm minus (1 1/4") Crush Rock
- 150mm (6") Clean Crush Jaw Run Quarry Material
- Run-of-Quarry Material (Final Cover)

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
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REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
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srk consulting

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LW	EMR	May 29, 2015

FILE NAME: 1CT022.002-TL-LF-02_03_04.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CH022.002.200.1500

Doris North

DRAWING TITLE:

Non-Hazardous Waste Landfill Sections and Details

DRAWING NO.	SHEET	REVISION NO.
TL-LF-05	6 OF 6	A

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Package 6
Engineering and Design Documents

P6-5 Reclamation and Security

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www.srk.com

Memo

To:	John Roberts, TMAC	**Client:**	TMAC Resources Inc.
From:	Iozsef Miskolczi, PEng	**Project No:**	1CT022.002.200.2200
Cc:	Maritz Rykaart, PhD, PEng, SRK	**Date:**	June 11, 2015
Subject:	Costing Assumptions Summary for Doris North Mine Interim Closure and Reclamation Plan		

1 Introduction

SRK Consulting (Canada) Inc. (SRK) was retained by TMAC Resources Inc. (TMAC) to prepare an updated Interim Closure and Reclamation Plan (the Plan) for the Doris North Mine at the Hope Bay site (TMAC 2015a). The Plan assumes closure will occur once all ore from Doris North, Doris Connector, and Doris Central has been mined and processed.

The closure cost estimate associated with the Plan was prepared using an Excel workbook and the estimating inputs are all included in supporting worksheets (TMAC 2015b). This memorandum documents the assumptions and inputs that form the basis of the estimated costs, with one section dedicated to providing a summary of the changes in comparison with the previous closure plan update.

2 Cost Estimate Basis

2.1 Third Party Contractor

The cost estimate assumes that all work is carried out by an independent qualified third party contractor. All labour, equipment and materials required to execute the work are supplied by the contractor.

2.2 Quantities

Quantity estimates needed as input to the cost estimates were derived using standard engineering calculations based on topographic maps, as-built surveys and aerial photographs. All buildings and facilities reclaimed at closure were included, as detailed in the Plan (TMAC 2015a). Most of the calculations are straight forward and the details of the quantity estimates are provided in the “Structures” and “Reclamation Areas” worksheets respectively (TMAC 2015b).

2.3 Unit Costs

2.3.1 Equipment Rates

Equipment rates were provided by TMAC in 2015, based on quotations from the independent on-site construction contractor (Nuna Logistics). Where 2015 rates were not available, unit rates used in the previous versions of the estimate were updated to represent 2015 CAD dollars by applying a 3% annual increase. The rates include ownership, overhead and profit, but exclude maintenance labor which is accounted for as a line item elsewhere in the estimate.

2.3.2 Labour Rates

Labor rates were provided in 2015 by the construction contractor (Nuna Logistics) and include overhead and profit. The labour rates do not include the costs of camp accommodation or travel to and from site, which is included as owner's costs.

2.3.3 Material Costs

Estimates of material costs were obtained from the following sources:

- Specific vendor quotes;
- Specific costs from third party consultants;
- Cost Mine 2015 (InfoMine 2014);
- "Environmental Remediation Cost Data – Unit price" 11th Annual Edition, (Martin et al 2004); and
- Recent SRK experience on other projects.

Older material quotes were adjusted to 2015 dollars based on the seasonally adjusted Consumer Price Index listed on the Bank of Canada website. Material costs were factored up by 15% to include freight and shipping to site.

2.3.4 Task Unit Costs

The Task Unit Rate worksheet calculates the cost per unit quantity based on the labour, equipment and materials required to complete the task. The productivity for each task was obtained from the following sources:

- Equipment specifications obtained from manufacturer's data, in this case the Caterpillar Handbook;
- "Environmental Remediation Cost Data – Unit Price" 11th Annual Edition, (Martin et al 2004); and
- Recent SRK experience on other projects.

2.3.5 Relocation Unit Costs

The relocation unit costs consist of the transport of materials from the various reclamation areas to Roberts Bay or the landfill in Quarry #3 over all-weather roads. The equipment used was chosen to match equipment used on site during the construction phase. Regular haul trucks or 20 foot cargo containers on a trailer were assumed to be used for hauling waste or equipment to Roberts Bay or the landfill, as the case may be. The trailer and the tractor would be mobilized from off-site.

Details of the calculations are provided in the 'Relocation Unit Cost' worksheet (TMAC 2015b). Costs for loading and unloading the Seacans were included elsewhere in the estimate.

2.4 Indirect Costs

Indirect costs were defined as any costs that cannot be directly associated with individual tasks.

Many of the indirect costs depend on the project duration. The project duration was estimated as the summation of the individual task quantities (Units) divided by the task productivity (Units/hr). The work was assumed to occur over a 10-hour work day.

2.4.1 Mobilization and Demobilization

The Mobilization/Demobilization costs were included as a lump sum in the cost estimate. The details of the costs are provided in the 'MobDemob' worksheet (TMAC 2015b).

Mobilized equipment was assumed to originate from Edmonton, AB. Equipment is hauled by truck to Hay River, NT, and shipped by barge to Roberts Bay. A lump sum cost is included for the trucking, while the barging costs were calculated based on the footprint area for each piece of equipment.

Stand-by costs were included where appropriate, representing the cost for the period of time the equipment is idle waiting for demobilization by the sealift after completion of reclamation work. This assumes that sealift is possible once every year, within a narrow window of a few of weeks in September.

Two distinct Mobilization/Demobilization events were considered, assuming the Doris North Camp and most of the facilities will be demolished and reclaimed in the year following closure, and while final closure of the TIA (breach of North Dam) will have to be performed once active water management in the TIA is no longer required, i.e. year 8 after closure.

2.4.2 General and Administration Costs

Labour benefits were included in the labour unit costs.

Estimated camp costs were provided by TMAC and included a rate of $500 per day per person for a large camp (over 25 person) and $2,000 per day per person for a small camp. In addition, a camp management rate of $677 per day was allowed for the duration of the project. The camp

rental of $400,000 per year was also included, based on supplier quotes for a 20-man self-sufficient camp. Air travel to and from camp is included in the camp operations cost.

2.4.3 Field Support

It was assumed that a supervisor would be on site throughout the project duration. An allowance for equipment maintenance support was included, with a mechanic assumed to be on-site for 10% of the project duration.

Helicopter support used for the Doris Mountain demolition work was assumed to be required for 6 hours per day at a rate of $2,230/hour.

2.4.4 Engineering and Consultants Services

The costs associated with site visits, sample analysis, and reporting are included in this category.

2.4.5 Contingency

A contingency of 20% of direct costs (excluding the cost of shipping and disposing of the demolition waste off site) was added to the estimate.

2.4.6 Post-closure Monitoring

Lump sums were included for each of the various post-closure monitoring items, according to the schedule showing the required frequency and duration.

3 Variance from Previous Estimate

The previous closure cost estimate was prepared as part of the March 2014 update of the Closure and Reclamation Plan (SRK 2014) and amounted to a total of $21.5 million. The new 2015 estimate of closure costs is $25.1 million, representing an increase in closure liabilities of $3.6 million. The substantial difference is caused by the significant changes in the project scope and facilities. A summary of these changes is provided in Table 1 below. Where no changes in the assumptions were made, the change in the total cost is due to unit rates escalation to 2015.

Table 1: Summary of Assumptions Compared to Previous Version

Area / Facility	Changes from previous version
Roberts Bay	• Expanded laydown surface area • Included new facility (Roberts Bay Discharge System)
Airstrip	• Removed Explosives Mixing Facility (relocated underground)
Reagent Pads	• Removed Cyanide and Reagents Storage Facility, and the Lubricant Storage Facility respectively
Waste Management Area	• No change
Quarry 2	• No change
Doris Camp	• Increased camp size to 280 person • Addition of Pad T and Pad U

Doris Mountain	• No change
Doris Windy Road	• No change
Tailings Impoundment Area	• Subaerial tailings requiring final closure cover • Addition of Interim Dike
Secondary Road Area	• Removal of Explosives Storage Facility • Removal of catch basins
Quarry 3	• Addition of landfill
Underground Workings	• Addition of two vent raises
Pipeline Area	• This item was not part of the previous revision
Post-closure Water Management in TIA	• Post-closure active water management in TIA was decreased to 3 years (from 7) according to the updated water quality model

4 Compatibility with RECLAIM Version 7.0

The Canadian Government liability estimate is required by Aboriginal Affairs and Northern Development Canada (AANDC), formerly Indian and Northern Affairs Canada. AANDC requires that a spreadsheet model (RECLAIM) be used to estimate closure costs.

The RECLAIM model is a spreadsheet model originally developed by SRK in 1992, and subsequently modified and updated by Brodie Consulting (Brodie 2014). The model has pre-set sheets that can be expanded to describe a specific project. The model template includes a default list of unit costs for most tasks and materials used in closure work. Typical low and high equipment and labor unit rates are suggested, but the user is encouraged to apply known unit rates instead of the default rates wherever possible. Some indirect costs are estimated as user-specified percentage of direct costs (Engineering and Project Management). Mobilization/Demobilization costs are calculated based on unit rates.

The methods used by SRK and RECLAIM to estimate costs are similar. Both models are based on the same facilities, use the same quantities, unit rates and indirect costs. The methods differ by how this information is organized within the spreadsheets. The cost information is summarized similarly. Because of this, the SRK cost estimate is at minimum an adequate alternative to the RECLAIM cost estimate.

Closure costs in RECLAIM are apportioned to water or land to reflect the portion of the closure liability that is accounted for under the Nunavut Water Board Water licences or the land lease agreements with the Kitikmeot Inuit Association. The split between land and water closure liability is open to interpretation.

5 References

Brodie Consulting Ltd., 2014. RECLAIM Version 7.0 User Manual. MS Excel Workbook and User Manual prepared for Aboriginal Affairs and Northern Development Canada – Water Resources Division. March 2014.

InfoMine 2014. *Cost Mine Mining Cost Services Section SU Supplies and Miscellaneous Items*. Accessed May 15, 2015.

Martin, S., Rast, J., Rast, R., Eds. 2004. *Environmental Remediation Unit Cost Book*; 11th Annual Edition; R.S. Means Company Inc.

SRK Consulting (Canada) Inc., (2014). *Doris North Mine Closure and Reclamation Plan – March 2014.* Prepared for TMAC Resources Inc. SRK Project: 1CT022.000, March 2014.

TMAC 2015a. TMAC Resources Inc. Doris North Mine Interim Closure And Reclamation Plan May 2015 Hope Bay, Nunavut. Prepared by SRK Consulting (Canada) Inc. Project Number: 1CT022.002.200.2100. June 2015.

TMAC 2015b. TMAC Resources Inc. Doris North Mine Interim Closure And Reclamation Plan May 2015 – Detailed Cost Estimate Hope Bay, Nunavut. Prepared by SRK Consulting (Canada) Inc. Project Number: 1CT022.002.200.2100. June 2015.

Package 6
Engineering and Design Documents

P6-6 Roberts Bay Discharge System: Water Management Options

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Memo

To:	John Roberts	**Client:**	TMAC Resources Inc.
From:	Sarah Portelance	**Project No:**	1CT022.002.200.800
Cc:	Lowell Wade, SRK Maritz Rykaart, SRK	**Date:**	June 11, 2015
Subject:	Doris North Project: Roberts Bay Discharge System Water Management Options		

1 Introduction

TMAC Resources Inc. (TMAC) have reviewed the disposal requirements of groundwater, from the Doris Mine and the reclaim water from the Tailings Impoundment Area (TIA) for the Doris North Project (Project) in the Kitikmeot Region of Nunavut, Canada.

The Project, including the proposed Roberts Bay Discharge System, is constructed on Kitikmeot Inuit Association (KIA) land and TMAC has secured a Commercial Lease for the property, including the area covered by the proposed Roberts Bay Discharge System.

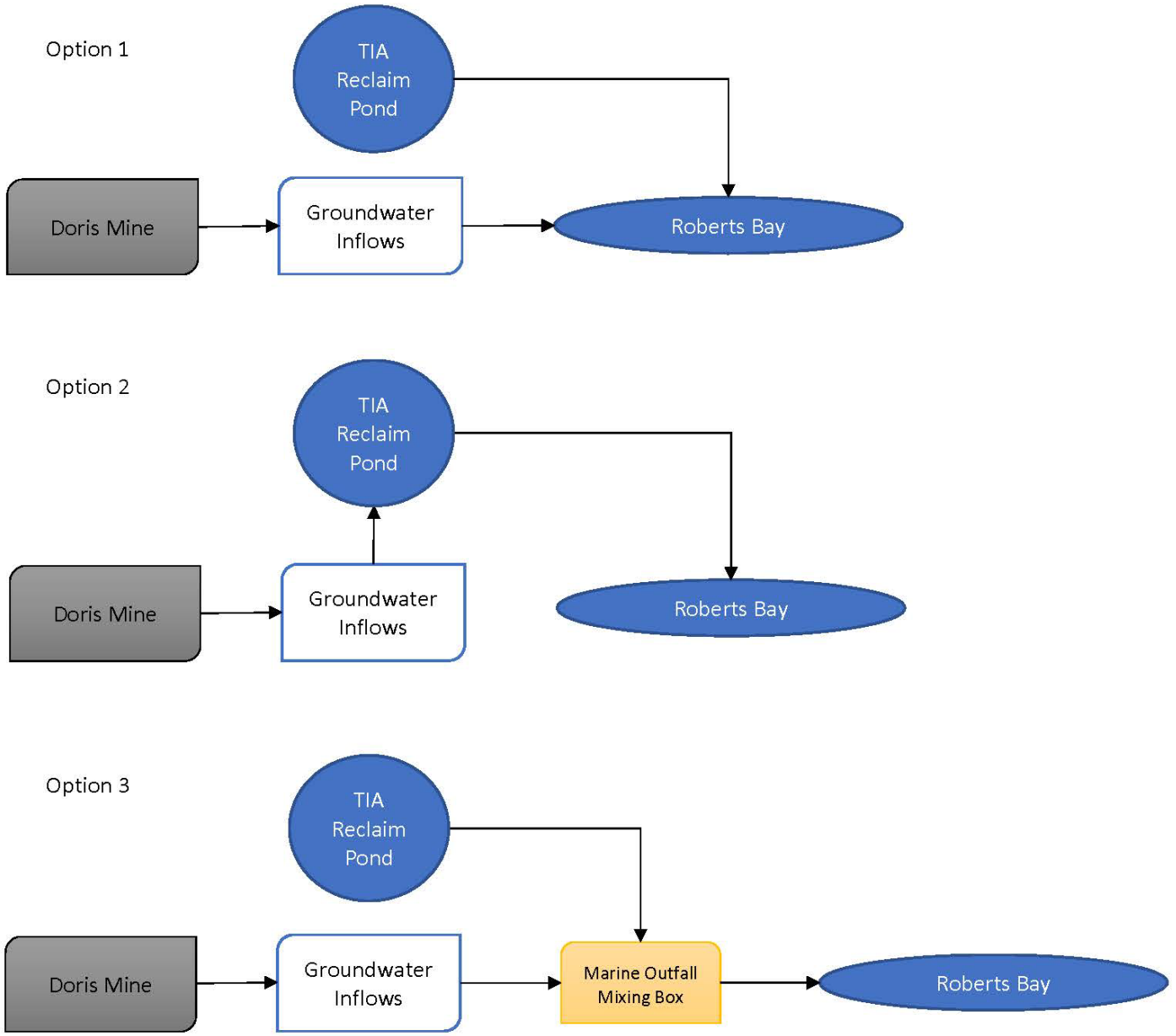
This memo provides a summary of the water management strategy for the Roberts Bay Discharge System and should be read in conjunction with SRK (2015a, b).

2 Discharge System Concept Alternatives

Under the existing Water Licence, 2AM-DOH1323, excess reclaim water from the TIA can be discharged to Doris Creek where discharged flows cannot exceed 10% of background flows in Doris Creek. During the period of discharge, water quality must meet effluent quality limits as specified in the existing Water Licence, 2AM-DOH1323.

Since the combined volumes of groundwater, from Doris Mine, and treated excess reclaim water, from the TIA, exceeds the discharge limits into Doris Creek, TMAC is proposing to discharge the groundwater and the excess reclaim water by a pipeline to Roberts Bay approximately 5 km north of Doris Mine known as the Roberts Bay Discharge System. During operations and closure, water discharged into Roberts Bay will meet marine discharge targets as described in Section 3. Prior to decommissioning the TIA, at final closure of the Doris Mine and the TIA, discharge water will need to meet freshwater discharge limits as summarized in the existing Water Licence, 2AM-DOH1323.

Three Discharge System alternatives were evaluated to manage the saline groundwater and reclaim water from the TIA. The three alternatives are shown in Figure 1.



srk consulting	MAC RESOURCES	Roberts Bay Discharge System
		Excess Water Management Alternatives
Job No: 1CT022.002.200.800 Filename: Figure 1.pptx	Hope Bay Project	Date: June 11, 2015 / Approved: SPB / Figure: **1**

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- *Option 1 - Two Separate Pipelines.* This option has two separate pipelines to Roberts Bay, one to manage the saline groundwater from Doris Mine, and one to manage excess water from the TIA. The saline groundwater from Doris Mine would be pumped through the Roberts Bay Discharge System year round while excess reclaim water from the TIA would be pumped through the Roberts Bay Discharge System only during the open water season. Intercepted groundwater is anticipated to have high chloride levels. Pumping groundwater directly to Roberts Bay and not to the TIA reduces the risk of high salinity levels in the reclaim water which cannot be used in the Process Plant. Of the three investigated options, this option is the easiest to operate.

  This option was not selected as it would require two pipelines and associated infrastructure, as well as maintenance costs compared to a single pipeline option.

- *Option 2 - Single Pipeline from the TIA.* This option has one pipeline used to carry saline groundwater from Doris Mine to the reclaim pond within the TIA. A second pipeline from the TIA to the Marine Outfall within Roberts Bay would be used to discharge excess reclaim water and the saline groundwater into the marine environment. The Roberts Bay Discharge System would only operate during the open water season. The saline groundwater pumped to the TIA would provide additional reclaim water to be used in the Process Plant during the winter season.

  Although the infrastructure cost for this option would be less than Option 1, this option was not selected as it is anticipated that the chloride concentrations in the intercepted groundwater will be as high as 10,000 mg/L (SRK 2015c). The high chloride concentrations would increase salinity within the reclaim pond of the TIA, to levels which are unacceptable in the Process Plant.

- *Option 3 - Single Pipeline from the Mill Building.* This option involves saline groundwater from Doris Mine, and excess reclaim water from the TIA pumped to the Marine Outfall Mixing Box within the Mill Building on Pad D at the Doris North Camp in separate pipelines. From the Marine Outfall Mixing Box, a single pipeline would then convey the blended water to the Marine Outfall within Roberts Bay. This option is challenging to design as the pipeline from the Mill Building to the Marine Outfall will need to be sized to handle either the groundwater, from Doris Mine, or the excess reclaim water, from the TIA, as well as be able to accommodate both streams at the same time. Since the Roberts Bay Discharge Pipeline will operate year-round it will need to be heat traced and insulated.

  Although this option is more challenging to design, this option was chosen as the preferred option as it is the most cost effective to construct. As well, there is no risk of salinizing the reclaim pond within the TIA.

3 Water Quality Objectives for the Roberts Bay Discharge System

An annual water and load balance was implemented to ensure that the design flows and effluent water quality of the preferred option would meet water quality objectives for a marine discharge.

Marine water quality guidelines, specifically the Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of marine aquatic life (CCME 2015), were used to evaluate the water quality requirements for a proposed discharge to the marine environment for the Project. The Metal Mining Effluent Regulations (MMER) water quality limits for deleterious substances (MMER 2015), were used as the proposed authorized limits at the end of the Marine Outfall Pipeline. Table 1 provides a summary of the water quality limits at the discharge end of the Roberts Bay Discharge System (i.e. MMER) and at the edge of the mixing zone (i.e. CCME) within Roberts Bay.

Table 1. Water Quality Objectives.

Parameter	Units	MMER	CCME
pH		6 to 9.5	7.0 to 8.7
Total Suspended Solids	mg/L	15	
Total Cyanide	mg/L	1	
Salinity	%		10% change
Nitrate Nitrogen (N)	mg/L as N		16
Arsenic (As)	mg/L	0.5	0.0125
Cadmium (Cd)	mg/L		0.00012
Chromium	mg/L		0.0575
Copper	mg/L	0.3	
Lead	mg/L	0.2	
Mercury	mg/L		0.000016
Nickel	mg/L	0.5	
Zinc	mg/L	0.5	
Radium	Bg/L	0.37	

4 Conceptual Water Balance for the Roberts Bay Discharge System

Figure 2 illustrates a conceptual water balance for the TIA. Freshwater make-up will be obtained from Doris Lake and potable water from Windy Lake. The tailings slurry will be pumped to the TIA upstream of the interim dike, and reclaim water pumped from the reclaim pond to the Process Plant where it will be used in the milling process. Excess reclaim water, from the TIA, will be mixed with the pumped saline groundwater after being treated for solids removal, if required, prior to being discharged to Roberts Bay.

Table 2 provides a summary of the total catchment areas included in the annual water and load balance where it was assumed that the maximum ponded area of the TIA after completion of the tailings deposition will be 0.8 km^2.

Table 2: Water Balance Catchment Areas.

Parameter	Area (m^2)	Comment
Doris North Camp	262,850	Includes all Pads, sedimentation pond, and pollution control ponds.
Tailings Beach Area	419,315	Based on final deposition plan.
Maximum Reclaim Pond Area	802,125	Based on final deposition plan and stage-storage curve for TIA.
TIA Watershed Area	3,198,560	Total undisturbed upstream watershed area of TIA not including the tailings beach or reclaim pond area.

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CT022.002_2015_Hope Bay Ongoing Support\200_Type_A_Water_License\700_Site_Wide_WQ_Model\Analysis\WB Calculations_rev05_061015.xlsx

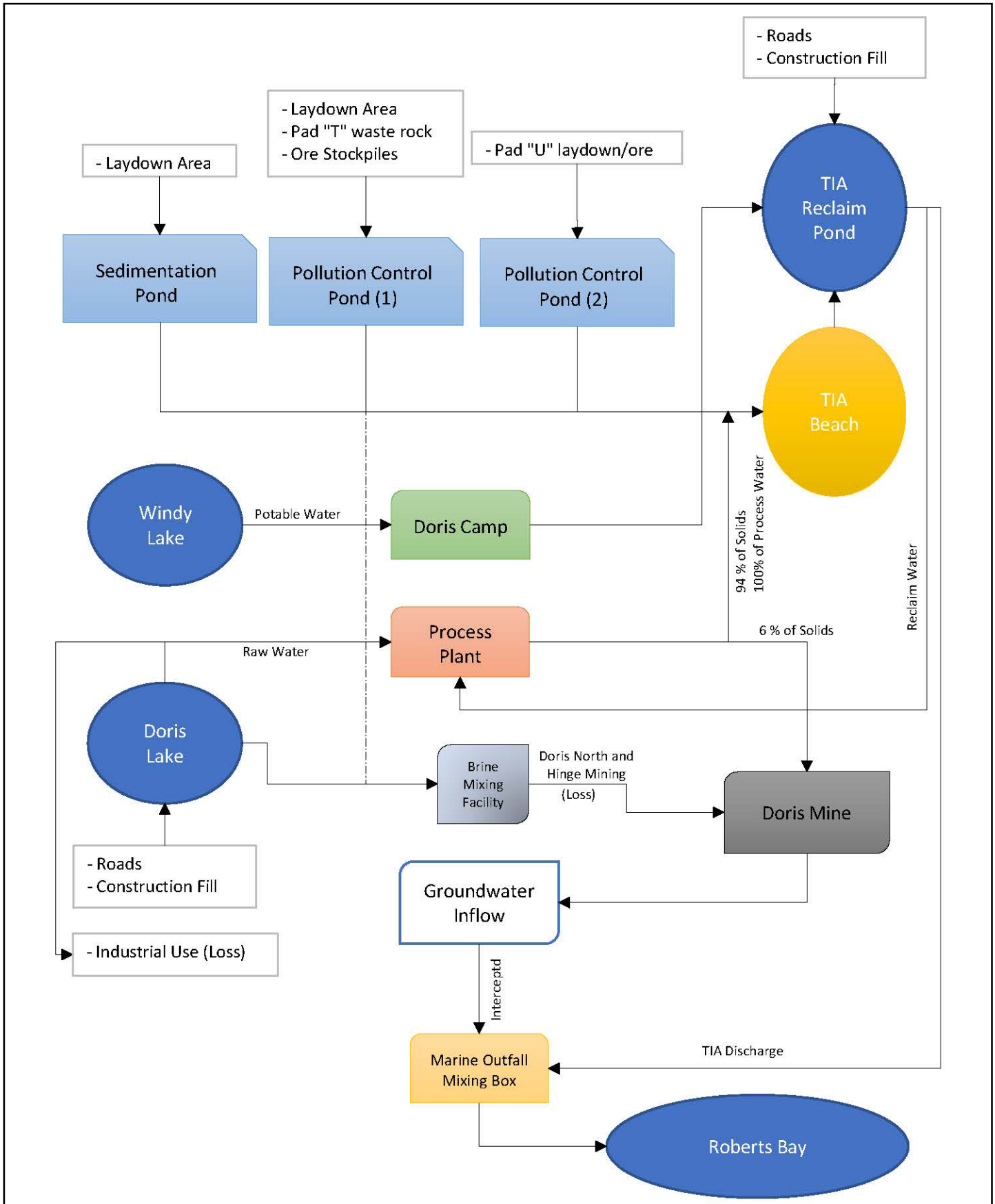
Table 3 provides the input parameters included in the annual water balance based on the hydrology and climate analysis conducted for the Project area (SRK 2015d). Table 4 provides a summary of the parameters used to calculate water lost to tailings voids, reclaim demand and storage capacity consumed by tailings deposition. For a production rate of 2,000 tpd, the slurry will be composed of 3,019 m^3/d of water and 1,429 m^3/d of solids where 6% of the solids will be deposited underground and 94% upstream of the Interim Dike sub-aerially.

Table 3: Water Balance Inputs.

Parameter	Value
Mean Annual Precipitation	216 mm/year
Mean Annual Evaporation	220 mm/year
Average Annual Runoff Coefficient*	0.5
Beach Runoff Coefficient	0.8
Process Plant Raw Water Use	113 m^3/d

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CT022.002_2015_Hope Bay Ongoing Support\200_Type_A_Water_License\700_Site_Wide_WQ_Model\Analysis\WB Calculations_rev05_061015.xlsx

Note: * Based on the calibrated water balance model (SRK 2015d)



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TMAC RESOURCES

Roberts Bay Discharge System

Conceptual Water Balance

Job No: 1CT022.002200.800

Filename: Figure 2.pptx

Hope Bay Project

Date:	Approved:	Figure:
June 11, 2015	SPB	2

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Table 4: Milling Rates and Parameters.

Parameter	Value	
Specific Gravity of Tailings	2.8 tonne/m^3	
Tailings Dry Density	1.4 tonne/m^3	
Void Ratio	1.0	
Slurry Percent Solids	0.39	
Ore Moisture Content	0.96	
Average Production Rate	1,000 tpd	2,000 tpd
Average Reclaim Rate	1,509 m^3/d	3,019 m^3/d
Process Freshwater Demand	301 m^3/d	602 m^3/d

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CT022.002_2015_Hope Bay Ongoing Support\200_Type_A_Water_License\700_Site_Wide_WQ_Model\Analysis\WB Calculations_rev05_061015.xlsx

Table 5 provides a summary of the average annual water balance for the TIA assuming an average production rate of 2,000 tpd. For an average hydrological year, the maximum reclaim rate (3,019 m^3/d) can be achieved without drawing down the Reclaim Pond. For average hydrological conditions, it is anticipated that approximately 372,000 m^3 of water will be accumulated annually within the TIA. During the open water season, excess water will be discharged to Roberts Bay to maintain water levels in the TIA. It was determined that an average pump rate of 4,000 m^3/d would be able to maintain the required water level within the TIA.

Table 5: Average Annual Water Balance.

Inflows / Outflows	Annual Volume (m^3)
Inflows	
Direct Precipitation	174,000
Upstream Runoff	346,000
Beach Runoff	73,000
Site Water Pumped	29,000
Sewage Water	42,000
Process Water	1,011,000
Total Inflows	1,672,000
Outflows	
Pond Evaporation	177,000
Loss to Voids	245,000
Reclaim Pumped	883,000
Total Outflows	1,304,000
Water Remaining at year end	369,000

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CT022.002_2015_Hope Bay Ongoing Support\200_Type_A_Water_License\700_Site_Wide_WQ_Model\Analysis\WB Calculations_rev05_061015.xlsx

5 Water Quality Discharge Alternatives

Table 6 provides a summary of the calculated total metal water quality model inputs for the identified parameters listed in Table 1. Discharged groundwater quality was based on talik, bedrock, and mixed freshwater intercepted during underground development (SRK 2015c).

Table 6: Water Quality Input Data.

Parameter	Units	Upstream Runoff	Beach Runoff	Site Water[1]	Sewage Water	Process Water	Groundwater[2]
Total Cyanide	mg/L	0.0025	0	0.027	0	0.56	0.00356
Chloride	mg/L	62	0	1620	0	0	14780.0
Nitrate	mg/L as N	0.028	0	92	1	0.1	0.93
Arsenic	mg/L	0.00044	0.032	0.0014	0.0001	0.0079	0.0024
Cadmium	mg/L	0.000006	0.000064	0.00014	0.001	0.00049	0.00012
Chromium	mg/L	0.00065	0	0.0045	0.0001	0.0099	0.00086
Copper	mg/L	0.0014	0.0011	0.008	0.0024	0.079	0.0012
Lead	mg/L	0.0001	0	0.0002	0.0001	0.0027	0.0003
Mercury	mg/L	0.00001	0.000023	0.00002	0	0.0001	0.000049
Nickel	mg/L	0.002	0.0000034	0.0057	0.004	0.013	0.0019
Zinc	mg/L	0.0034	0	0.019	0.002	0.048	0.15
Radium	Bg/L	0	0	0	0	0	0

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CT022.002_2015_Hope Bay Ongoing Support\200_Type_A_Water_License\700_Site_Wide_WQ_Model\Analysis\WB Calculations_rev05_061015.xlsx

Note:
[1] Based on median water quality concentration from the sedimentation pond (ST-2)
[2] Based on the median concentrations of all sample depths and mixed concentration from SRK (2015c).

Table 7 provides a summary of the estimated water quality in the TIA during a 2,000 tpd process rate and mixed effluent concentrations discharged to the TIA to illustrate a range of possible effluent water quality. Three discharge scenarios were investigated:

- Scenario 1 – Groundwater only;
- Scenario 2 – TIA only; and
- Scenario 3 – Groundwater and TIA combined.

Table 7: Water Quality Prediction Results.

Parameter	Units	MMER	CCME	Scenario 1	Scenario 2	Scenario 3
Total Cyanide	mg/L	1		0.00356	0.33903	0.19526
Chloride	mg/L			14,780	43	6,360
Nitrate	mg/L as N		16	0.93	1.8	1.4
Arsenic	mg/L	0.5	0.0125	0.0026	0.0064	0.0047
Cadmium	mg/L		0.00012	0.00012	0.0003	0.00023
Chromium	mg/L		0.0575	0.003	0.0084	0.0061
Copper	mg/L	0.3		0.0017	0.049	0.029
Lead	mg/L	0.2		0.00038	0.0017	0.0012
Mercury	mg/L		0.000016	0.000055	0.000069	0.000063
Nickel	mg/L	0.5		0	0.0086	0.0049
Zinc	mg/L	0.5		0.15	0.031	0.083
Radium	Bg/L	.037		0	0	0

Source: \\VAN-SVR0\Projects\01_SITES\Hope Bay\1CT022.002_2015_Hope Bay Ongoing Support\200_Type_A_Water_License\700_Site_Wide_WQ_Model\Analysis\WB Calculations_rev05_061015.xlsx

The end of pipe discharged water quality for all three scenarios was determined to be below MMER limits (MMER 2015). The highlighted parameters in Table 7, were found to be greater than the CCME water quality guidelines for the protection of marine aquatic life listed in Table 1. To meet the CCME water quality guidelines within the marine environment mixing zone, a 20:1 dilution (i.e. 20 parts seawater to 1 part discharge water) would need to be achieved.

6 References

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Package 6
Engineering and Design Documents

P6-7 Roberts Bay Discharge System: Surface Infrastructure

TMAC RESOURCES

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Memo

To:	John Roberts, TMAC	**Client:**	TMAC Resources Inc.
From:	Lowell Wade, MSc, PEng Maritz Rykaart, PhD, PEng	**Project No:**	1CT022.002.200.900
Cc:		**Date:**	May 29, 2015
Subject:	Doris North Project: Roberts Bay Discharge System Surface Infrastructure Design Brief		

1 Introduction

TMAC Resources Inc. (TMAC) have reviewed the requirements for disposal of saline groundwater from the Doris Mine and the excess reclaim water from the Tailings Impoundment Area (TIA) for the Doris North Project (Project) in the Kitikmeot Region of Nunavut, Canada.

The Project, including the proposed Roberts Bay Discharge System, is constructed on Kitikmeot Inuit Association (KIA) land and TMAC has secured a Commercial Lease for the property, including the area covered by the proposed Roberts Bay Discharge System.

This memo describes the design details of the surface infrastructure associated with the Roberts Bay Discharge System. This memo should be read in conjunction with the attached Issued for Discussion (IFD) engineering drawings (Attachment 1).

2 Design Concept

The design concept of the Roberts Bay Discharge System is based on the current water management practice of using pipelines and pumps to transport large volumes of water around the project area (SRK 2012a).

The saline groundwater from within Doris Mine will be pumped through a multiple stage pump and sump system, using an insulated pipeline to the Mill Building, located on Pad D at Doris North Camp. The excess reclaim water from the TIA will be combined with the saline groundwater and pumped from the Mill, in an insulated pipeline called the Roberts Bay Discharge Pipeline, to Roberts Bay. The Roberts Bay Discharge Pipeline will run from Doris North Camp, adjacent to the east side of the Primary Road and the Airstrip. At the north end of the Airstrip, the Roberts Bay Discharge Pipeline will pass through the Primary Road and continue to follow the west side of the Primary Road out to the Roberts Bay Laydown Area. At the Roberts Bay Laydown Area, the pipeline will run in front of the Roberts Bay 20 Ml Fuel Tank Farm, along the south side of the Roberts Bay Jetty Access Road and Laydown Pads, to the Roberts Bay

shoreline along the south side of the Roberts Bay Discharge Access Road. The Roberts Bay Discharge Pipeline will enter Roberts Bay through the Marine Outfall Berm, which extends from the shoreline to approximately the 4 m bathymetric contour. From the Marine Outfall Berm, the Marine Outfall Pipeline (known as "the Roberts Bay Discharge Pipeline" on land) will extend to the 40 m bathymetric contour and terminate at the Roberts Bay Marine Diffuser.

3 Discharge System Concept Alternatives

Three options were considered for the location of the discharge system as it enters into Roberts Bay:

- East Side of Roberts Bay. For this routing, the Roberts Bay Discharge Pipeline would extend from Doris North Camp to the Roberts Bay Area by following the east side of the Primary Road. The Roberts Bay Discharge Pipeline would run along the east side of Roberts Bay Laydown Area and follow the Roberts Bay Fuel Transfer Access Road where it would enter the marine environment. From there the Marine Outfall Pipeline would continue to follow the shoreline and extend northward to the 40 m bathymetric contour and terminate at the Roberts Bay Diffuser.

  This option was not selected as a significant length of the Marine Outfall Pipeline would be in shallow waters which would require protection from the deflection and scouring forces of sea ice.

- Roberts Bay Jetty. For this routing, the Roberts Bay Discharge Pipeline would extend from Doris North Camp to the Roberts Bay Area by following the east side of the Primary Road to the north end of the Doris North Airstrip where it would cross through the Primary Road to the west side of the Primary Road. Once at the Roberts Bay Laydown Area the Roberts Bay Discharge Pipeline would run in front of the Roberts Bay 20 Ml fuel tank Farm and along the north side of the Roberts Bay Jetty Access Road to the Roberts Bay Jetty. The Roberts Bay Discharge Pipeline would then be trenched into the existing Roberts Bay Jetty. From the toe of the Roberts Bay Jetty, the Marine Outfall Pipeline would follow the steepest bathymetric contour gradient to the 40 m bathymetric contour and terminate at the Roberts Bay Marine Diffuser.

  This option was not selected due to the risk of damaging the Marine Outfall Pipeline by marine traffic using the Roberts Bay Jetty, during the annual sea-lift.

- West Side of Roberts Bay. For this routing, the Roberts Bay Discharge Pipeline would follow the alignment described in the second option to the Roberts Bay Laydown Area. At the Roberts Bay Laydown Area, the pipeline will run in front of the Roberts Bay 20 Ml Fuel Tank Farm, along the south side of the Roberts Bay Jetty Access Road and Laydown Pads, and to the Roberts Bay shoreline along the south side of the Roberts Bay Discharge Access Road. The Roberts Bay Discharge Pipeline will enter Roberts Bay through the Marine Outfall Berm, which extends from the shoreline to approximately the 4 m bathymetric contour. From the Marine Outfall Berm, the Marine Outfall Pipeline (*aka*

the Roberts Bay Discharge Pipeline on land) will extend to the 40 m bathymetric contour and terminate at the Roberts Bay Marine Diffuser.

This was selected as the preferred option as it required minimal protection of the Marine Outfall Pipeline from sea ice and it relocates the Marine Outfall Pipeline away from the annual sea-lift marine and terrestrial traffic.

4 System Design

4.1 Design Criteria

The surface infrastructure associated with the Roberts Bay Discharge System consists of a pipeline, placed on the tundra and on the seabed, a diffuser at the terminal end of the pipeline, an all-weather access road, and a rock fill berm armoured with rip-rap, as summarized in Table 1.

Table 1: Surface Infrastructure associated with the Roberts Bay Discharge System.

Infrastructure Component	Dimensions	Limitations
Roberts Bay Discharge Pipeline	5.64 km long	Must follow surface infrastructure
Marine Outfall Pipeline	2.3 km long	Must follow the steepest grade of bathymetric contours
Marine Diffuser	0.09 km long	Must be anchored to the sea bed
Roberts Bay Discharge Access Road	0.55 km long by 9.5 m wide	Must be 31 m back from shoreline
Marine Outfall Berm	0.09 km long by 9.5 m wide	Will require active monitoring and maintenance

4.2 Roberts Bay Discharge Pipeline

4.2.1 Design Criteria

The conceptual design of the 5.64 km long Roberts Bay Discharge Pipeline is described in SRK (2015).The 10“ (254 mm) diameter HDPE PE4710 Roberts Bay Discharge Pipeline will originate at the Mill, located on Pad D at Doris North Camp and run from Doris North Camp, adjacent to the east side of the Primary Road and the Airstrip. At the north end of the Airstrip, the Roberts Bay Discharge Pipeline will pass through the Primary Road and continue to follow the west side of the Primary Road out to the Roberts Bay Laydown Area. At the Roberts Bay Laydown Area, the pipeline will run in front of the Roberts Bay 20 Ml Fuel Tank Farm, along the south side of the Roberts Bay Jetty Access Road and Laydown Pads, and to the Roberts Bay shoreline along the south side of the Roberts Bay Discharge Access Road.

4.3 Marine Outfall Pipeline

4.3.1 Design Criteria

The conceptual design of the 2.3 km long Marine Outfall Pipeline is also described in SRK (2015) and is based on the previous work by Rescan (2013).

The Roberts Bay Discharge Pipeline will enter Roberts Bay through the Marine Outfall Berm, which extends from the shoreline to the 4 m bathymetric contour. The Marine Outfall Pipeline (*aka* the Roberts Bay Discharge Pipeline on land) will emerge from the face of the Marine Outfall Berm below 3 m depth and extends 2.3 km north to the 40 m bathymetric contour and terminates at the Marine Diffuser. The Marine Outfall Pipeline will be anchored to the seabed by concrete counter buoyancy weights spaced every 5 m along the Marine Outfall Pipeline.

Approximately 300 m north of the Roberts Bay Jetty is a rocky shoal. The shoal is less than 2 m deep and portions are emergent at low tide. The Marine Outfall Pipe alignment will stay to the west of this shoal, avoiding the shallow depths and the related damage from sea ice.

4.4 Marine Diffuser

4.4.1 Design Criteria

The Marine Diffuser is designed to optimize the effects of initial jet momentum and fluid buoyancy to achieve the highest dilution as close to the discharge ports as possible. The high mixing ratios also work to trap the discharged water at a depth below the euphotic zone.

The design of the Marine Diffuser was provided by Rescan (2013). The 95 m long Marine Diffuser is an extension of the Marine Outfall Pipeline with 20 horizontal discharge ports at 5 m spacing. The Marine Diffuser will be anchored to the seabed by concrete counter buoyancy weights spaced every 5 m along the Marine Diffuser.

4.5 Roberts Bay Discharge Access Road

4.5.1 Design Criteria

The Roberts Bay Discharge Access Road is a 0.55 km long by 9.5 m wide access road to the Marine Outfall Berm which extends from the west side of the Roberts Bay Laydown Pad to the shoreline of Roberts Bay.

Given the ground conditions, most of this alignment would be designed to have a 1 m minimum road thickness with 1.5H:1V side slopes to protect the permafrost. A double culvert at kilometer 0+80 would allow the flow of surface water under the road alignment as it drains towards Roberts Bay.

The design criteria for the Roberts Bay Discharge Access Road are the same as for the Doris-Windy All-Weather Road (SRK 2012b). The key design criteria are:

- The maximum allowable grade is 10% (10H:1V); however, wherever possible grades less than 4% will be targeted;
- A minimum thickness of 1 m over tundra must be maintained and 0.3 m over bedrock;
- The roadway will be crowned to promote drainage by means of 0.5% surface grading in both directions from the centreline of the roadway;
- Road shoulders will be graded to 2H:1V in areas where fill thickness is more than 1.5 m otherwise the road shoulders will be graded to 1.5H:1V;
- No cut is allowed, except in designated rock quarries, and then only to a grade at least 0.5 m above the surrounding tundra elevation; and
- The roadway will be widened by 1 m for barriers to be placed where road fill is greater than 3 m.

4.5.2 Foundation and Road Fill Materials

The all-weather road design incorporates Run-of-Quarry (ROQ) fill material and a layer of surfacing material. On the tundra, fill thicknesses will typically range from 1 m or greater. This is based on terrain conditions inferred from the satellite imagery of the area but will be revised based on aerial field reconnaissance as well as on experience gained from surrounding areas. On exposed bedrock, fill thicknesses will be determined by the grade of the alignment.

4.5.3 Drainage Crossings

Two 0.5 m diameter corrugated steel culverts will be required for the Roberts Bay Discharge Access Road. These culverts will be installed along the surface water drainage channels at the approximate chainage of 0+080 and will allow surface water drainage into Roberts Bay.

4.6 Marine Outfall Berm

4.6.1 Design Criteria

The transition from the Roberts Bay Discharge Pipeline, on land to the Marine Outfall Pipeline, in Roberts Bay occurs at the shoreline of Roberts Bay through the Marine Outfall Berm. A rock fill berm will be constructed over the pipeline, out to the 4 m bathymetric contour, to protect the pipeline from the displacement and scouring forces of sea ice. The design criteria for the Marine Outfall Berm will be similar to that for the Roberts Bay Jetty (SRK 2005 and PND 2013):

- Design Storm Event of 50-year, 35 knot wind, 0.9 m wave;
- Wave Run-Up for a 50-year event of 2.3 m;

- Design Gross Vehicle Weight for a loaded CAT 725 Rock Truck, 45,000 kg, set back 3 m from end; and
- Top of Armor Rock of 1.5 m above Lower Low Water Level (LLWL).

Annual sea ice development within Roberts Bay has been measured to be up to 2 m thick (Rescan 2009). This is consistent with the calculated maximum seasonal ice thickness for the pond within the TIA (SRK 2011a). To protect the Marine Outfall Pipeline from the deflection and scouring forces of the annual sea ice, the Marine Outfall Berm extends into Roberts Bay such that the Marine Outfall Pipeline exits from the base of the Marine Outfall Berm below the 3 m bathymetric contour. This provides a 1 m allowance, based on engineering judgement, to prevent the Marine Outfall Pipeline from being impacted by the annual sea ice.

A technical consideration associated with the stability of the rock fill Marine Outfall Berm is the low strength characteristics of the marine sediments, upon which it is constructed. The low strength characteristics of the marine sediments may result in differential settlement of the rock fill berm over time. This differential settlement would lead to displacing the Marine Outfall Pipeline which could cause the pipeline to rupture. To help mitigate against this differential settlement, two layers of geogrid would be laid on the seabed prior to placing the rock fill as was done for the Roberts Bay Jetty to help improve the bearing capacity of the marine sediments (SRK 2007a). To further protect the Marine Outfall Pipeline from differential settlement and from being damaged by the overlaying rock fill, the pipeline will run through a 24 inch (610 mm) diameter Schedule 80 steel pipe. This steel pipe will also act as a sleeve, allowing for the replacement of the Marine Outfall Pipeline through the Marine Outfall Berm, if required.

Just as for the Roberts Bay Jetty, monitoring and maintenance protocols will be implemented to ensure the integrity of the Marine Outfall Pipeline is maintained.

4.7 Design

The Roberts Bay Discharge Pipeline will be placed either on the tundra, adjacent to all-weather roads or along the edge of surface infrastructure pads. Due to the natural topography, the Roberts Bay Discharge Pipeline will not be free draining and will require a mechanical method to clear the Roberts Bay Discharge Pipe of any water to prevent freezing, should a shut-down of the system be required.

The Marine Outfall Berm and Pipeline will be constructed on the existing sea bed; settlement during construction is expected. As such, the actual material quantities required to complete construction of the Marine Outfall Berm and Pipeline will be greater than the material quantities listed in the attached IFD engineering drawings (Attachment 1).

Details of the Roberts Bay Discharge System are provided in SRK (2015).

4.8 Survey Data

The design of the Roberts Bay Discharge Access Road, Marine Outfall Berm, as well as the profiles for the Discharge and Marine Outfall Pipelines are on topographic contours produced

from 2007 aerial photography supplied by Hope Bay Mining Limited (HBML). No detailed ground surveys have been completed. The Roberts Bay bathymetry was supplied by Rescan (2013).

4.9 Foundation Conditions

Comprehensive geotechnical investigations have been carried out at the Hope Bay Site (SRK 2009). This information confirms that the area lies within the zone of continuous permafrost, with the permafrost being up to 550 m deep. Permafrost temperature at the surface is about -8ºC and the active layer is generally less than 1 m thick. Laboratory and in-situ tests on disturbed and undisturbed samples indicate that the overburden soils and marine sediments are predominantly comprised of marine silts and clays, and the pore-water in these soils has high salinity, depressing the freezing point to -2ºC. These ice-rich soils are typically between 5 and 20 m deep, before encountering competent bedrock, predominantly basalt. On land, bedrock is frequently exposed, rising columnar 5 to 100 m above the surrounding landscape.

Thermal modelling has determined that a 1 m minimum of rock fill cover would allow permafrost to aggrade into the Roberts Bay Discharge Access Road (SRK 2006). Permafrost will not aggrade into the Marine Outfall Berm as shown by the ground temperature data collected from the Roberts Bay Jetty (SRK 2014a)

The geotechnical design parameters for Hope Bay have been summarized in SRK (2011b).

5 Construction Methodology

The Roberts Bay Discharge Access Road and Marine Outfall Berm will be constructed with engineered fill excavated from the permitted and approved Quarry #2. SRK (2007b) discusses the complete details pertaining to geochemical characterization of these rock quarries confirming their suitability for use in construction. The management and monitoring of quarry development for the construction of the infrastructure pads and access roads is discussed in SRK (2014b).

Construction of the Roberts Bay Discharge Access Road will be carried out in the same manner as all other all-weather roads within the Project area with construction activities carried out during winter conditions.

The Marine Outfall Berm will be constructed in the same manner as the Roberts Bay Jetty (SRK 2005). Prior to the start of construction, the entire perimeter of the Marine Outfall Berm will be encircled by a silt curtain deployed approximately 20 m from the footprint of the Marine Outfall Berm (SRK 2007c). Construction activities will be carried out during the summer open water season, in Roberts Bay.

The Roberts Bay Discharge Access Road and Marine Outfall Berm will be constructed in accordance with SRK's Technical Specifications (SRK 2011c).

6 References

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Attachment 1
Engineering Drawings for the Roberts Bay Discharge System Surface Infrastructure

Engineering Drawings for the Roberts Bay Discharge System, Hope Bay Project, Nunavut, Canada

ACTIVE DRAWING STATUS

DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS
RBDS-00	Engineering Drawings for the Roberts Bay Discharge System, Hope Bay Project, Nunavut, Canada	A	May 29, 2015	Issued For Discussion
RBDS-01	General Arrangement Roberts Bay Discharge System	A	May 29, 2015	Issued For Discussion
RBDS-02	Roberts Bay Discharge and Marine Outfall Pipeline Profile	A	May 29, 2015	Issued For Discussion
RBDS-03	Roberts Bay Discharge Access Road and Marine Outfall Berm	A	May 29, 2015	Issued For Discussion
RBDS-04	Marine Outfall Berm Design Plan and Profile	A	May 29, 2015	Issued For Discussion
RBDS-05	Typical Sections and Details	A	May 29, 2015	Issued For Discussion
RBDS-06	Diffuser Details and Material Quantities	A	May 29, 2015	Issued For Discussion

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PROJECT NO: 1CT022.002.200.900
Revision A
May 29, 2015
Drawing RBDS-00