Appendix 19

Design Brief: Doris North Project Expanded Waste Rock Storage Pad (U; SRK, November 2013)

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Memo

To:	Lea-Marie Bowes-Lyon, TMAC	**Client:**	TMAC Resources Ltd.
From:	Lowell Wade	**Project No:**	1CT022.000
Cc:	Maritz Rykaart, SRK	**Date:**	November 6, 2013
Subject:	Design Brief: Doris North Project Expanded Waste Rock Storage Pad (Pad U)		

1 Introduction

TMAC Resources (TMAC) is currently in the process of reviewing the waste rock storage requirements for the Doris North Project (Project) in the Kitikmeot Region of Nunavut, Canada.

Due to the increased mine life of the Doris North Project, there is a need to increase the waste rock storage space at the mine site to 1.7M tonnes. To accommodate this a new waste rock storage area with a capacity of 0.9M tonnes is required. The proposed new waste rock storage pad, referred to as Pad U, would be constructed immediately east of the portal, at a location between the Secondary Road and Doris Lake. The pad will have a dedicated lined Pollution Control Pond constructed immediately downstream to ensure proper water management. Depending on the requirements for waste rock storage at any stage of the Project, Pad U may be used for additional waste rock storage or as general surface infrastructure pads, or any combination thereof. Due to the terrain configuration, and depending on the functional use of Pad U, the pad will be tiered.

This memo provided details of the pad design, and should be read in conjunction with the attached set of engineering drawings (Attachment A).

2 Design Concept

Although this waste rock location requires construction of a new Pollution Control Pond and crossing of the Secondary Road with haul trucks; it is located on good foundation conditions and provides good access and functional use if required.

Total waste rock storage requirements for the Project is 1.7M tonnes, which cannot be serviced by the current waste rock storage Pad I, as well as future waste rock storage on Pads F and G. The new waste rock storage pad (Pad U) provides for this necessary increased storage capacity. Existing ore and waste rock pads, for the project, has been designed on the basis that immediately overlaying the tundra, there will be a 1 m thick layer of geochemically acceptable

material, upon which the ore and/or waste rock can be stockpiled. Pad U has been designed on the same basis.

Proper water management from Pad U will be ensured through the construction of a lined Pollution Control Pond immediately downstream of the pad.

The Project, including the proposed Pad U is constructed on KIA land and TMAC has secured a Commercial Lease for the property, including the proposed expansion.

3 System Design

3.1 Design Criteria

The design criteria for the rock fill pad and Pollution Control Pond are as follows:

- Ramp grades for non-mining underground fleet shall not exceed 10%.
- Ramp grades for mining underground fleet shall not exceed 7%.
- Ramps shall have a minimum width of 8 m and a turning radius of 12 m.
- The minimum general drainage gradient shall be 0.5%.
- A minimum 0.85 m thick Run-of-Quarry (ROQ) fill base overlain by a 0.15 m surfacing material shall be constructed.
- Maximum pad side-slope gradient shall be 1.5H:1V where fill thickness is less than 2 m and 2H:1V if the fill thickness exceeds 2 m.
- The upstream face of the Pollution Control Pond berm will incorporate an HDPE Liner system to ensure run-off is adequately diverted.
- The overall slope of the waste rock dump should not exceed 2.5H:1V for long-term storage.
- The minimum storage volume for the Pollution Control Pond is 2,700 m^3.
- All facilities must be outside of the 31 m shoreline setback to the nearest water body (Doris Lake).
- If an elevation difference exceeds 3 m, safety barriers will be constructed along the edge of the pad.

3.2 Survey Data

The design of Pad U is based on 2010 as-built information received from Nuna Logistics and a topographic contour set provided by Hope Bay Mining Limited, based on 2007 aerial photography. Contour intervals shown are typically 1 m.

3.3 Foundation Conditions

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

Thermal modeling was completed to determine how much fill would be required over the tundra to ensure the permafrost would be preserved for infrastructure construction (SRK 2006). In the case of Pad U, the minimum fill thickness would be 1 m; however due to the nature of the topography the pad's actual fill thickness will exceed this value.

3.4 Waste Rock Dump

Waste rock will be stockpiled on Pad U. The maximum height of the stockpile is about 30 m and the overall slope of the pile will be 2.5H:1V. Actual construction of the dump will be via end-dumping in benches of about 5 m thick, placed at angle of repose for the rock. Benches between lifts will be spaced to ensure compliance with the overall long-term slope angle. Haul ramps to the stockpile and between lifts will be limited to a 7% grade. Attachment B contains a detailed waste rock pile stability analysis.

3.5 Pollution Control Pond

The new lined Pollution Control Pond immediately downstream of Pad U is designed to capture subsurface and surface drainage emanating from the pad and any associated waste rock stockpiled on it. The design containment volume of the pond is 2,708 m^{3}. This ensures containment of the 100-yr return duration storm event of 48.9 mm.

The pond is designed as an event pond and will operate as normally empty. Water collected in the pond will be pumped into the tailings pump box in the mill building, from where it will be pumped to the tailings impoundment. Pumping capacity will be designed such that the entire volume of the pond can be drained in six hours, similar to the other event ponds on site. Pumping would start as soon as the contained volume is large enough for one hour of continuous pumping.

3.6 Construction Methodology

Pad U and the Pollution Control Pond will be constructed using conventional load-haul-dump-place techniques. Geochemically acceptable rock (either ROQ or waste rock) will be used. The waste rock would originate from the Doris North Portal and quarried rock from any of the approved rock quarries forming part of the Project.

For the Pollution Control Pond a specialist contractor will be used to install an HDPE liner keyed into permafrost to ensure a leak-proof cut-off. The liner will be protected using a series of geosynthetic products (geotextile), bedding material and finally riprap.

Complete material quantities for constructing Pad U and the new Pollution Control Pond are presented in Attachment A.

SRK Consulting (Canada) Inc.

Lowell Wade, PEng (NWT/NU)
Senior Consultant

Reviewed By:

Maritz Rykaart, PEng (NWT/NU)
Principal Consultant

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

4 References

SRK Consulting (Canada) Inc., 2006. Doris North Project – Thermal modeling to support design thickness for granular pads. Technical Memorandum, Prepared for Miramar Hope Bay Limited. Project Number 1CM014.008. August 20, 2006.

SRK Consulting (Canada) Inc., 2009. Hope Bay Gold Project: Stage 2 Overburden Characterization Report. Report Prepared for Hope Bay Mining Limited. Project Number 1CH008.002. September 2009.

Attachment 1

Engineering Drawings for the Pad U (Waste Rock Expansion) Area

Engineering Drawings for the Pad U (Waste Rock Expansion) Area Doris North Project, Nunavut, Canada Water License Amendment

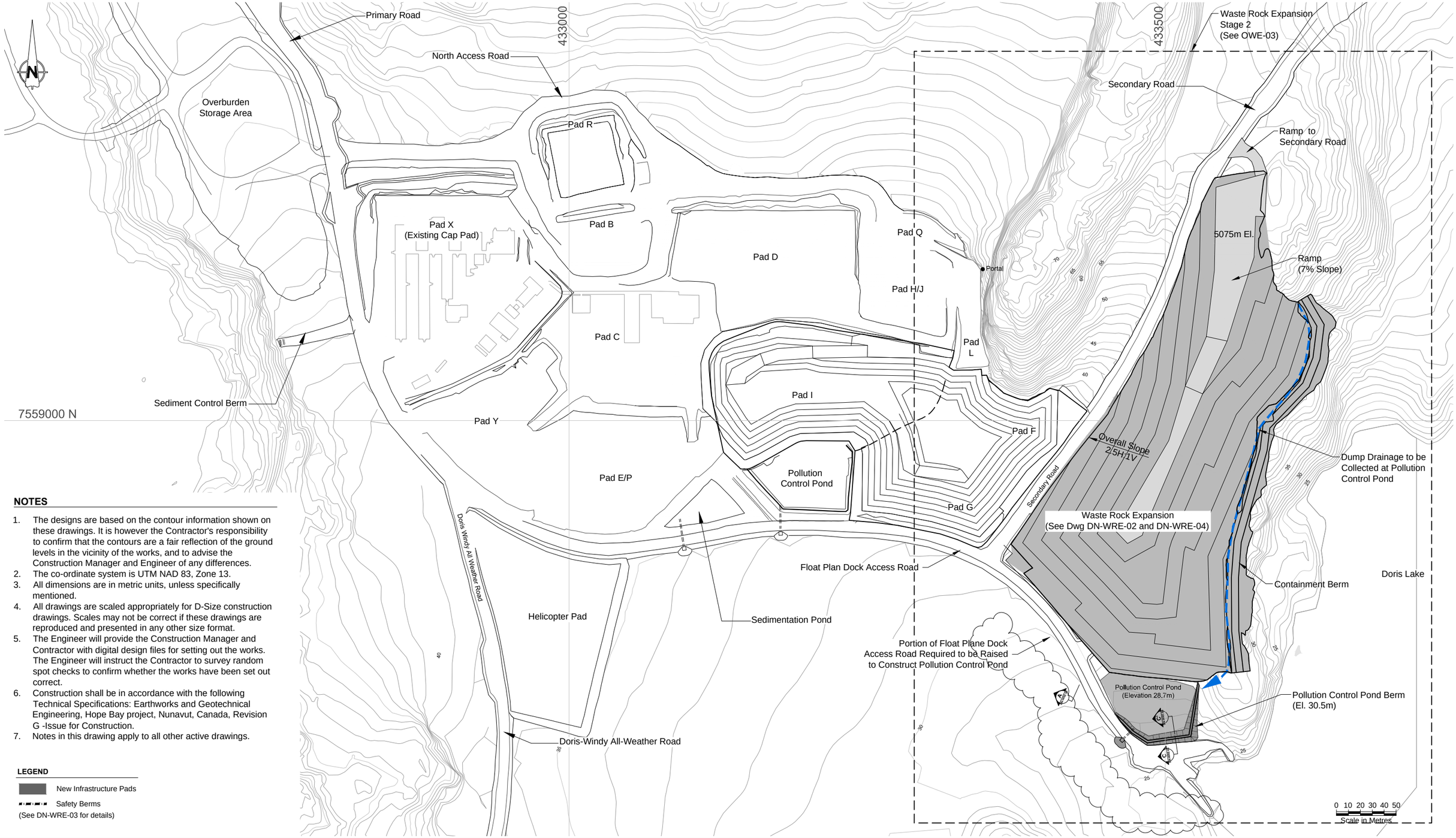
ACTIVE DRAWING STATUS

DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS	OLD/REPLACED REVISIONS
DN-WRE-00	Engineering Drawings for the Pad U (Waste Rock Expansion) Area, Doris North Project, Nunavut, Canada	B	Nov. 1, 2013	Issued for Discussion	Rev.A, June 13, 2011
DN-WRE-01	Pad U - General Arrangement	B	Nov. 1, 2013	Issued for Discussion	Rev.A, June 13, 2011
DN-WRE-02	Additional Waste Rock Storage - General Arrangement	B	Nov. 1, 2013	Issued for Discussion	Rev.A, June 13, 2011
DN-WRE-03	Sections and Details 1of 2	B	Nov. 1, 2013	Issued for Discussion	Rev.A, June 13, 2011
DN-WRE-04	Sections and Details 2 of 2	B	Nov. 1, 2013	Issued for Discussion	Rev.A, June 13, 2011

TMAC RESOURCES LTD.

srk consulting

PROJECT NO: 1CT022.000
Revision B
November 1, 2013
Drawing DN-WRE-00 / HB+R-CIV-CIV-OND-0001



NOTES

1. The designs are based on the contour information shown on these drawings. It is however the Contractor's responsibility to confirm that the contours are a fair reflection of the ground levels in the vicinity of the works, and to advise the Construction Manager and Engineer of any differences.
2. The co-ordinate system is UTM NAD 83, Zone 13.
3. All dimensions are in metric units, unless specifically mentioned.
4. All drawings are scaled appropriately for D-Size construction drawings. Scales may not be correct if these drawings are reproduced and presented in any other size format.
5. The Engineer will provide the Construction Manager and Contractor with digital design files for setting out the works. The Engineer will instruct the Contractor to survey random spot checks to confirm whether the works have been set out correct.
6. Construction shall be in accordance with the following Technical Specifications: Earthworks and Geotechnical Engineering, Hope Bay project, Nunavut, Canada, Revision G -Issue for Construction.
7. Notes in this drawing apply to all other active drawings.

LEGEND

- New Infrastructure Pads
- Safety Berms (See DN-WRE-03 for details)

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

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued For Discussion	LW	EMR	01NOV13
A	Issued For Review	JBK	EMR	22OCT10

REVISIONS

Original Drawings
Stamped and
Signed by Engineer

PROFESSIONAL ENGINEERS STAMP

DESIGN: LW/JBK	DRAWN: DJ	REVIEWED: EMR
CHECKED: LW	APPROVED: EMR	DATE: Nov. 1, 2013

FILE NAME: DN–Pad–U Gen Arrange.dwg

TMAC RESOURCES

DORIS NORTH PROJECT

SRK JOB NO.: 1CT022.000

Pad U Waste Rock Expansion

DRAWING TITLE:

Pad U Waste Rock Expansion
General Arrangement

DRAWING NO.	SHEET	REVISION NO.
DN-WRE-01	2 of 5	B

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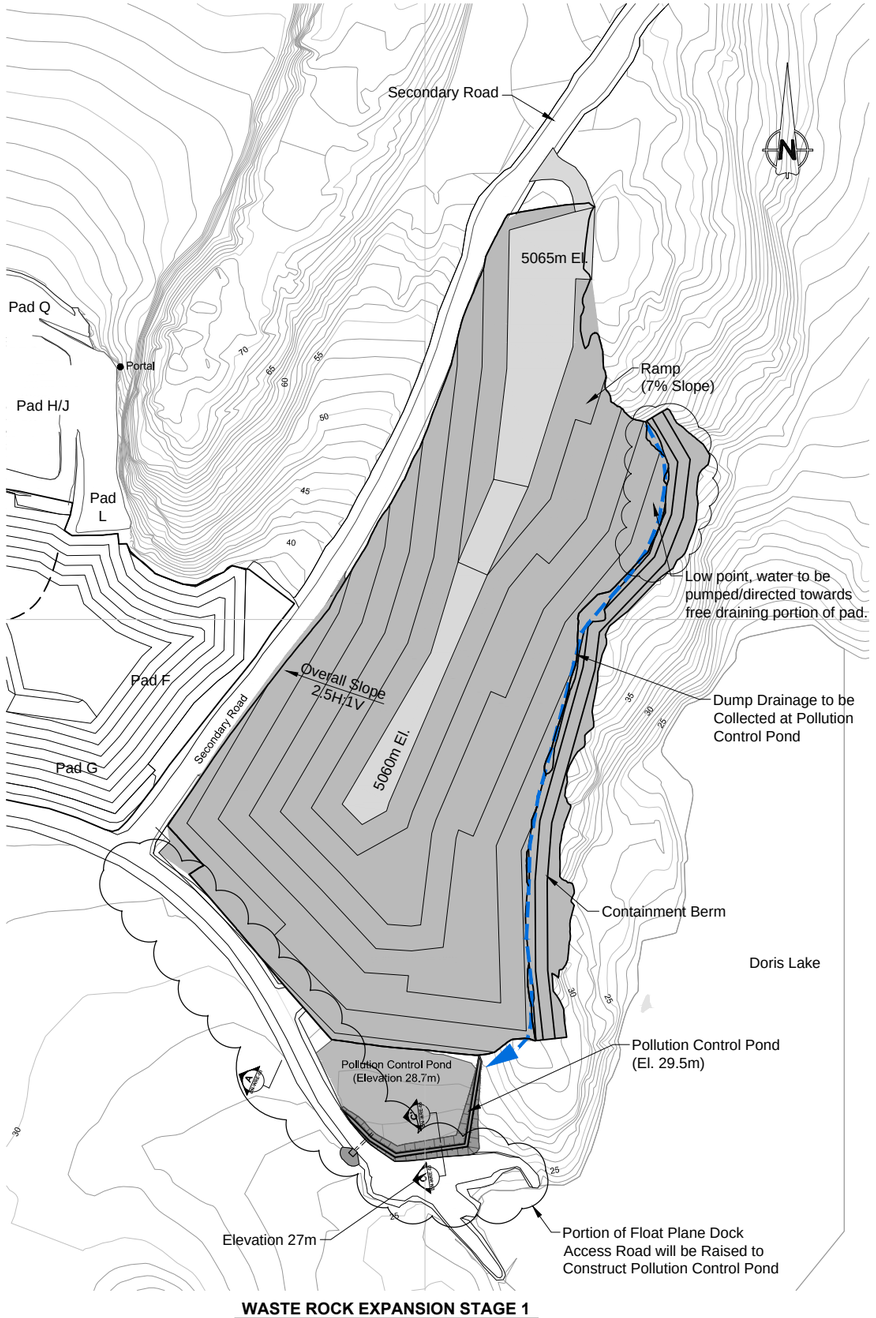

WASTE ROCK EXPANSION STAGE 1

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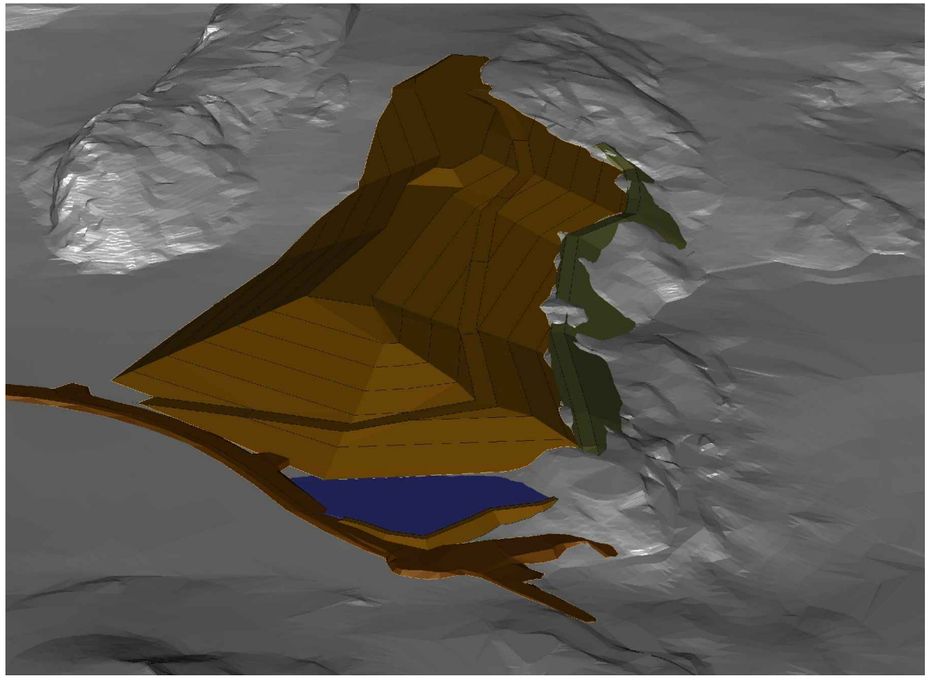
Scale in Metres



WASTE ROCK EXPANSION STAGE 1 ISOVIEW

NTS

NOTES

1. The designs are based on the contour information shown on these drawings. It is however the Contractor's responsibility to confirm that the contours are a fair reflection of the ground levels in the vicinity of the works, and to advise the Construction Manager and Engineer of any differences.
2. The co-ordinate system is UTM NAD 83, Zone 13.
3. All dimensions are in metric units, unless specifically mentioned.
4. All drawings are scaled appropriately for D-Size construction drawings. Scales may not be correct if these drawings are reproduced and presented in any other size format.
5. The Contractor and Construction Manager shall familiarize themselves with all appropriate Licences and/or Permits petaining to execution of the Works. The Engineer will not be responsible for any infringements.
6. The Contractor is to take due care that no wildlife or birds' nest are disturbed during contruction. The Construction Manager is to be immediately notified if such sites are found.
7. The placement of rockfill material will be by CAT 773 and CAT 730 haul trucks. The Contractor must supply the Construction Manager and Engineer with a written procedure for how these works will be constructed using these trucks prior to the start of any construction.
8. The Contractor shall employ best practices to ensure sediment control and to prevent erosion.
9. Notes in this drawing apply to all other active drawings.

Materials List and Quantities

Item Description	Quantity / Area / Volume	Description
Run of Quarry Material	1m Pad Base = 57,305 m³ Surface Area = 57,305 m² Containment Berm = 10,309 m³ Pollution Control Berm = 1,647 m3 Float Plane Dock Access Road Raise = 13,200m³ **Total 82,461m³**	Approximate in-Place Neat-line Volumes (no allowance has been made for losses and/ or tundra embedment) Volumes derived with Autocad *Float Pane Dock Access Road Raise estimated from typical expected sections.
Waste Rock Storage Volume	Stage 1 = 505,492 m³	Storage volumes derived by Gemcom.

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

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued For Discussion	LW	EMR	01NOV13
A	Issued For Review	JBK	EMR	22OCT10

REVISIONS

Original Drawings Stamped and Signed by Engineer

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN:	DRAWN:	REVIEWED:
LW/JBK	DJ	EMR
CHECKED:	APPROVED:	DATE:
LW	EMR	Nov. 1, 2013

FILE NAME: DN–Pad–U Gen Arrange.dwg

MAC RESOURCES

DORIS NORTH PROJECT

SRK JOB NO.: 1CT022.000

Pad U Waste Rock Expansion

DRAWING TITLE:

Additional Waste Rock
Storage - General Arrangement

DRAWING NO.	SHEET	REVISION NO.
DN-WRE-02	4 of 5	B

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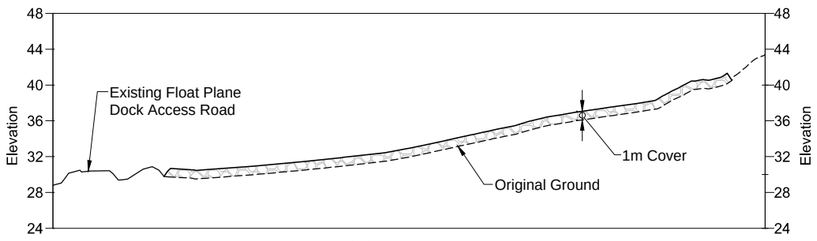

A DN-WRE-01 **SECTION A - A'**

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Horizontal Scale in Meters
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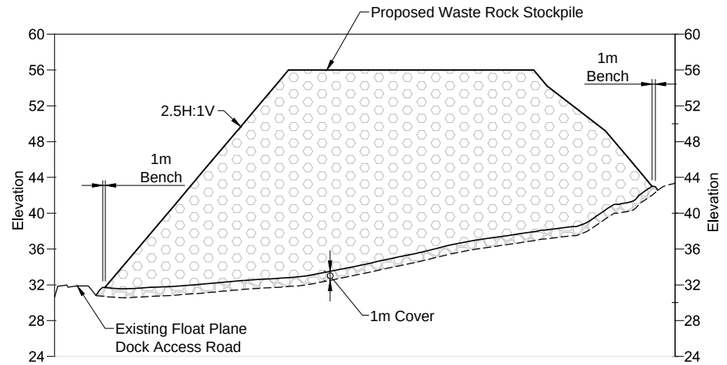
3X Vertical Exaggeration Scale in Meters



B2 DN-WRE-02 **OPTION 2 - REGRADE PAD U**
SECTION B - B'

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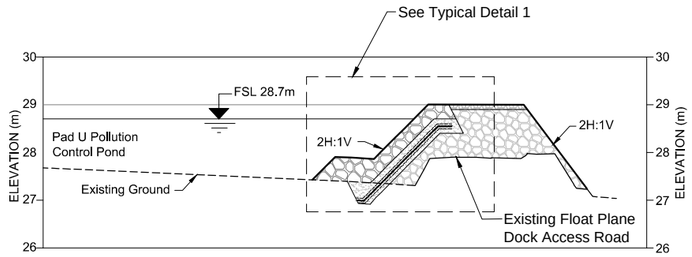
3X Vertical Exaggeration Scale in Meters



C DN-WRE-01 **SECTION C - C'**

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Horizontal Scale in Meters
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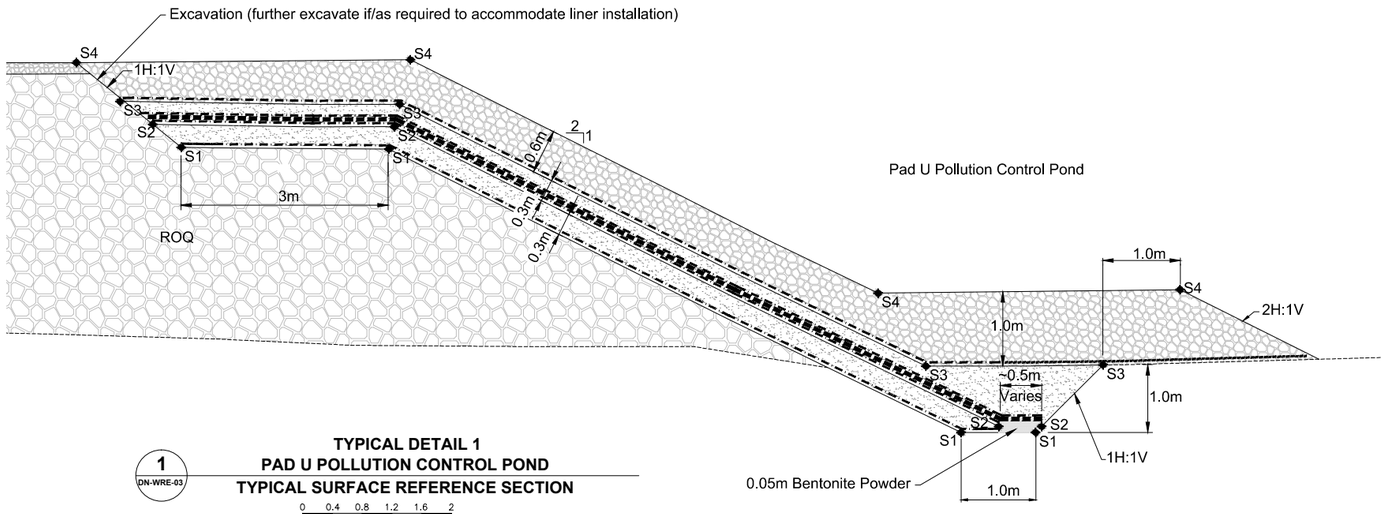
4X Veritical Exaggeration Scale in Meters



1 DN-WRE-03 **TYPICAL DETAIL 1**
PAD U POLLUTION CONTROL POND
TYPICAL SURFACE REFERENCE SECTION

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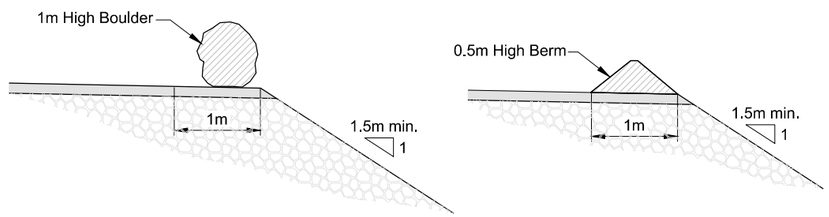
Scale in Meters



2 DN-WRE-01 **DETAIL 2**
TYPICAL BERM BARRIER OPTIONS
NOT TO SCALE

LEGEND

- ¾" Crushed Material
- 1 ¼" Crushed Material
- Run of Quarry Material
- Rip Rap
- Existing ground surface
- Textured 60 mil HDPE Liner
- 12 oz. Non-woven Geotextile

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	ISSUED FOR DISCUSSION	LW	EMR	01NOV13
A	ISSUED FOR DISCUSSION	JBK	EMR	13JUN11

REVISIONS

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DESIGN:	DRAWN:	REVIEWED:
JBK	DJ	LW
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LW	EMR	Nov. 1, 2013

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TMAC RESOURCES

DORIS NORTH PROJECT

SRK JOB NO.: 1CT022.000

Pad U Waste Rock Expansion

DRAWING TITLE:
Sections and Details
1 of 2

DRAWING NO.	SHEET	REVISION NO.
DN-WRE-03	4 OF 5	B

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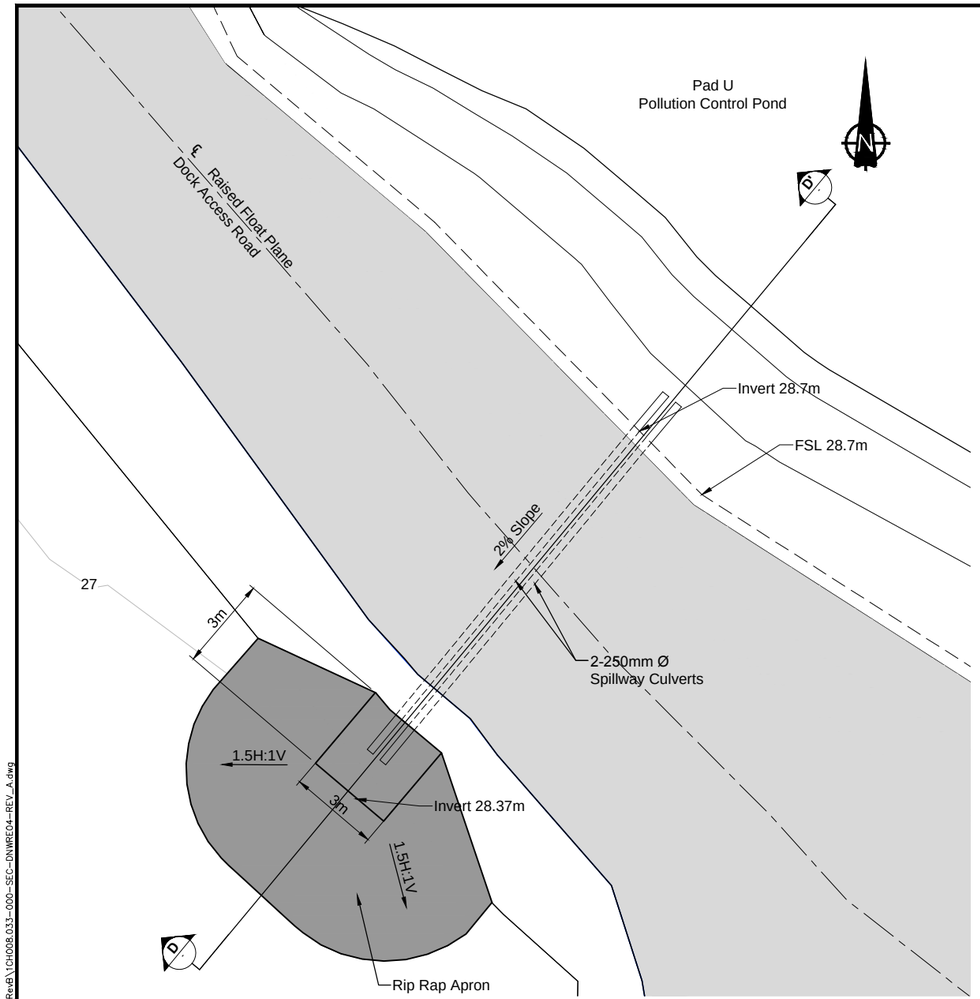
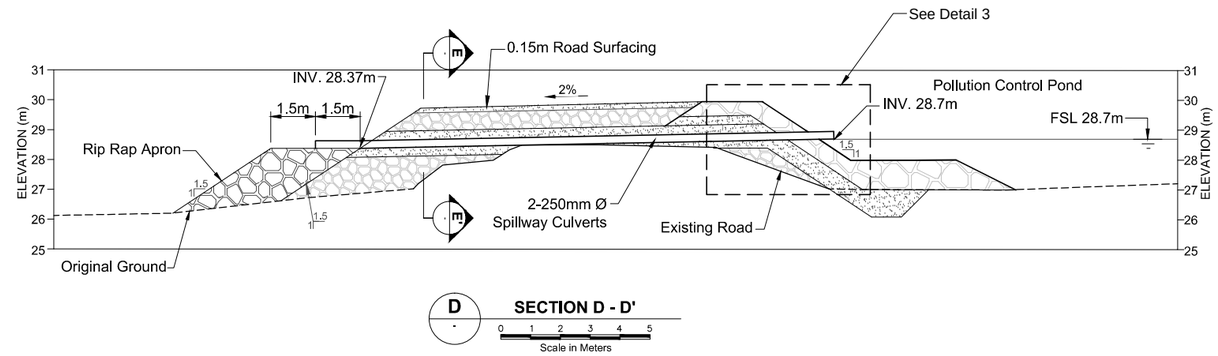


DETAIL 3 - POLLUTION CONTROL POND SPILLWAY CULVERT

3 DN-WRE-01

NOT TO SCALE



SECTION D - D'

D -

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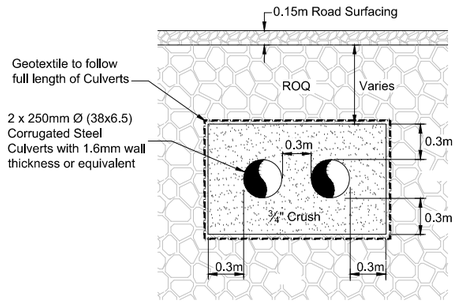
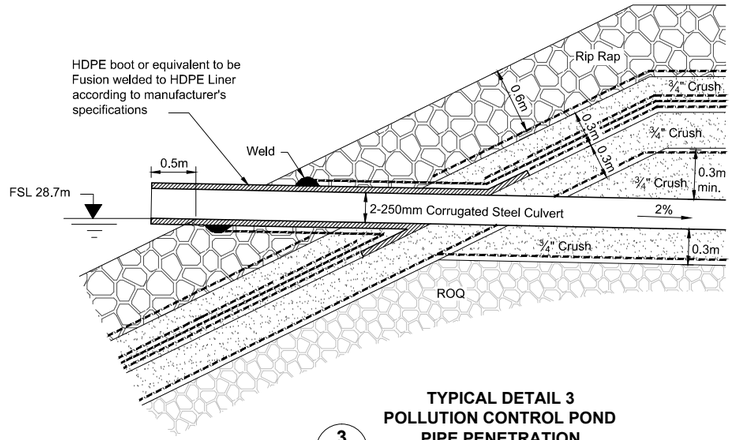
Scale in Meters



SECTION E-E'
SPILLWAY CULVERT SECTION

E -

NOT TO SCALE



TYPICAL DETAIL 3
POLLUTION CONTROL POND
PIPE PENETRATION

3 -

NOT TO SCALE

LEGEND

- ¾" Crushed Material
- 1 ¼" Crushed Material
- Run of Quarry Material
- Rip Rap
- Existing ground surface
- Textured 60 mil HDPE Liner
- 12 oz. Non-woven Geotextile

REFERENCE DRAWINGS				REVISIONS				
DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
				B	ISSUED FOR DISCUSSION	LW	EMR	01NOV13
				A	ISSUED FOR DISCUSSION	JBK	EMR	13JUN11

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srk consulting

DESIGN:	DRAWN:	REVIEWED:
JBK	DJ	LW
CHECKED:	APPROVED:	DATE:
LW	EMR	Nov. 01, 2013

FILE NAME: 1CH008.033-000-SEC-DNWRE04-REV_A.dwg

TMAC RESOURCES

DORIS NORTH PROJECT

SRK JOB NO.: 1CT022.000

Pad U Waste Rock Expansion

DRAWING TITLE:

Sections and Details
2 of 2

DRAWING NO.	SHEET	REVISION NO.
DN-WRE-04	5 OF 5	B

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Attachment 2

SRK Memo: Doris North Pad U Waste Rock Pile Stability Analysis

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Memo

To:	Project File	**Date:**	June 29, 2011
		From:	Murray McGregor
Copy to:	Maritz Rykaart	**Project #:**	1CH008.033
Subject:	Doris North Pad U Waste Rock Pile Stability Analysis		

1 Introduction

This memo presents the results of a slope stability analyses for the planned waste rock pile on top of Pad U in Doris Camp. The stability analysis was carried out using the Morgenstern-Price method as applied in SLOPE/W. The model is set up using three materials: marine silt and clay, run of quarry foundation pad, and run of mine waste rock. The typical active layer thickness for uncovered marine silt and clay is about 1 m. It will be assumed that the run of quarry foundation pad protects the permafrost of the silts and clays that it sits atop. The run of quarry foundation pad is assumed to be unfrozen since it is the thickness of the active layer. The waste rock is assumed to be unfrozen because the rate it will be dumped will likely surpass the freezeback of the pile.

Table 1 summarizes the material properties used in the analysis taken from the previous Doris Creek Bridge Abutments stability analysis (SRK, 2010).

Table 1: Material Properties

		Run of Quarry Foundation Pad	Waste Rock	Marine Silt and Clay Foundation
Saturated Unit Weight (kN/m^3)		20	20	18.5
Degree of Saturation		30%	30%	85%
Porosity		0.3	0.3	0.52
Volumetric Water Content		0.09	0.09	0.442
Unfrozen	Apparent Cohesion c' (kPa)	0	0	0
	Friction angle, φ ^{0}	40	39	30
Frozen	Apparent Cohesion c' (kPa)	5	n/a	112
	Friction angle, φ ^{0}	40	n/a	26

2 Method

The analysis is carried out using a critical cross-section of the waste rock pile, taking into consideration the foundation slope and ultimate pile height. This typical section, complete with assigned material zones, is presented in Figure 1.

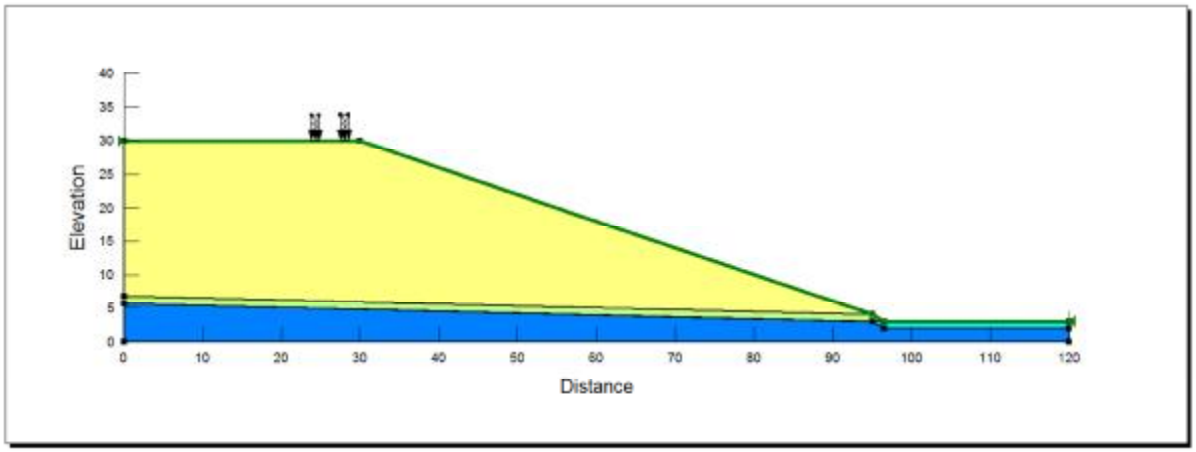


Figure 1: Critical Section of the waste rock pile used for the slope stability analysis.

The critical slip surface was evaluated under two conditions; for a free standing waste rock pile without consideration of haul truck wheel loads at the crest, and with wheel loads. A sample calculation for haul truck wheel loading is included as Appendix A. Both rotational slip surfaces and blocks failure modes were considered in each case.

The Project site is located in a stable seismic zone of Canada with low peak ground accelerations. Because of this, the stability analysis under seismic conditions was not assessed.

Graphic results for the critical slip surfaces of each analysis are presented in Appendix B. In each case where haul truck wheel loads are included, a load induced failure occurs near the crest of the pile. For the case where no wheel loads are considered, the critical slip surface appears as a shallow skin failure along the outer edge of the pile.

Table 2: Calculated Factors of Safety from SLOPE/W Models

	Calculation Method	Numerical Method	Factor of Safety	Critical Slip Surface Location
Haul Truck Wheel Loads Considered	Entrance and Exit	Morgenstern-Price	1.189	Load induced failure occurs near the crest of the pile
		Bishop	1.124	
	Block Specified	Morgenstern-Price	1.058	
		Bishop	1.370	
Free Standing Waste Pile	Entrance and Exit	Morgenstern-Price	2.029	Shallow skin failure along the outer edge of the pile
		Bishop	2.029	
	Block Specified	Morgenstern-Price	2.033	
		Bishop	2.058	

A dump stability rating for the waste rock pile was completed in accordance with the guidelines set by the British Columbia Mine Waste Rock Pile Research Committee (1991). For frozen foundation conditions the stability rating of the waste rock pile is 200 (Class I Stability), while for unfrozen foundation conditions the stability rating increases to 400 (Class II Stability).

The level of stability analysis presented in this memo is in accordance with the stated stability rating assessed for the waste rock pile.

The client should implement measures to ensure proper setback distances for haul trucks from the operating crest of the waste rock pile. Installation of thermistors to monitor foundation frost conditions is recommended to warn against possible onset of unfrozen conditions.

3 References

SRK Consulting (Canada) Inc. 2010. Secondary Road Bridge Abutment Slope Stability Analysis. Prepared for Hope Bay Mining Limited. Project Number: 1CH008.033, May 25, 2010.

British Columbia Mine Waste Rock Pile Research Committee, 1991. Mined Rock and Overburden Piles Investigation and Design Manual Interim Guidelines.

Appendix A
Sample Calculation of Haul Truck Wheel Loading

SRK Consulting
Engineers and Scientists

Project No. 1CH008.027 Site Vancouver

Prepared by Murray McGregor Date Nov. 23, 2010

Approved by _____ Date _____

Subject Vehicle Loading on Waste Rock Piles Calculation Sheet 1 of 1

From Manufacturer Website:

CAT 773 Gross Operating Weight: 222,000 lbs = 100,698 kg

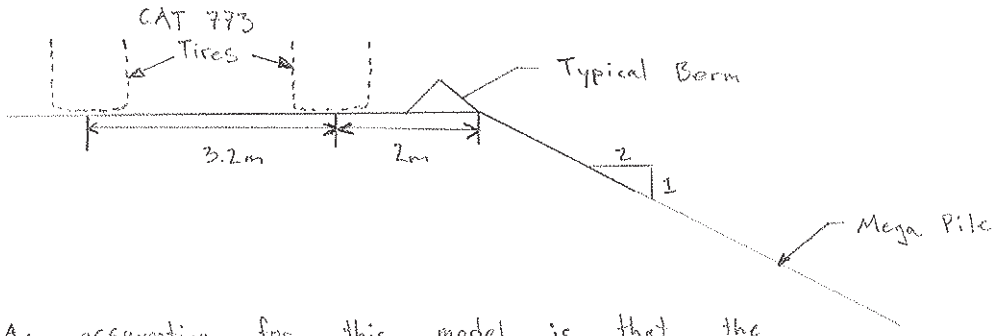
Load Weight Distributions: Front 35% Rear 65%

Rear Tire Load: $(100{,}698\ kg)(65\%)\left(\frac{1\ tire}{Axle\ (2)}\right)\left(\frac{9.81\ N}{kg}\right) = 321\ kN$

Centerline Front Tire Width: 10.5 ft ≅ 3.2m

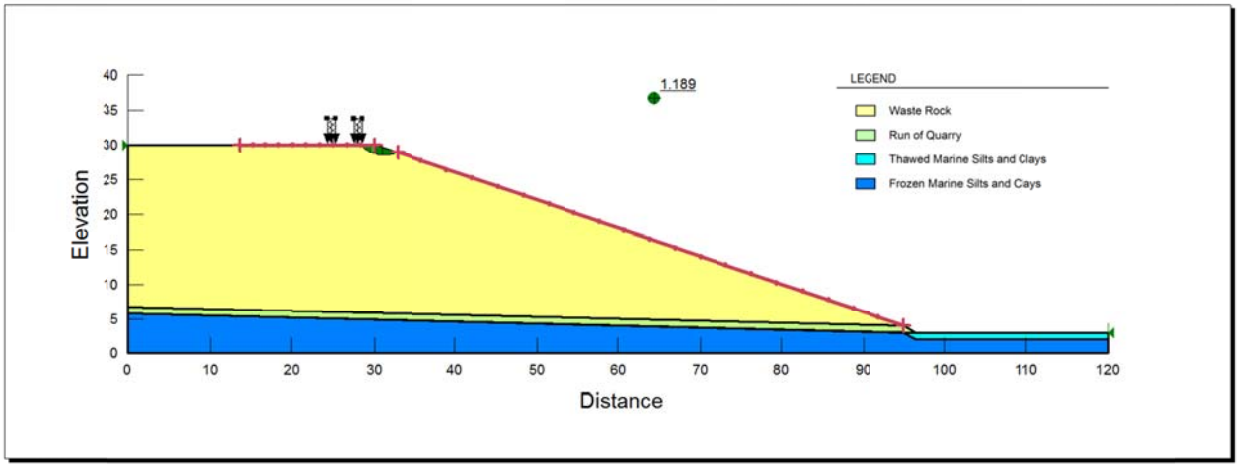
Offset from Slope Edge: (Berm width) + (½ tire width) ≅ 2.0m

Typical Berm Width = 1 meter minimum

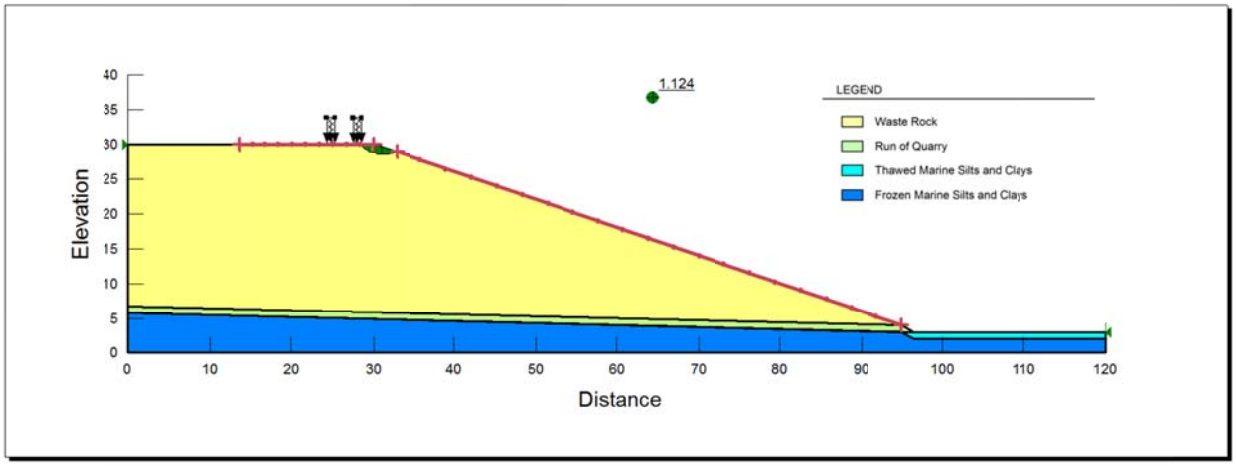


An assumption for this model is that the tires act as equal pressure loads over 1m² areas.

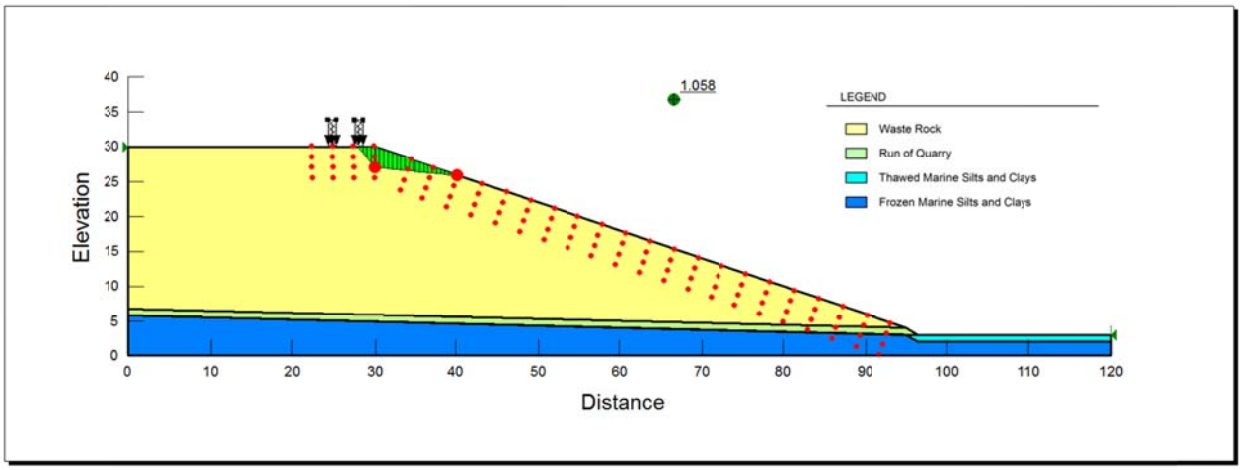
Appendix B
Graphic Results of Critical Slip Surfaces



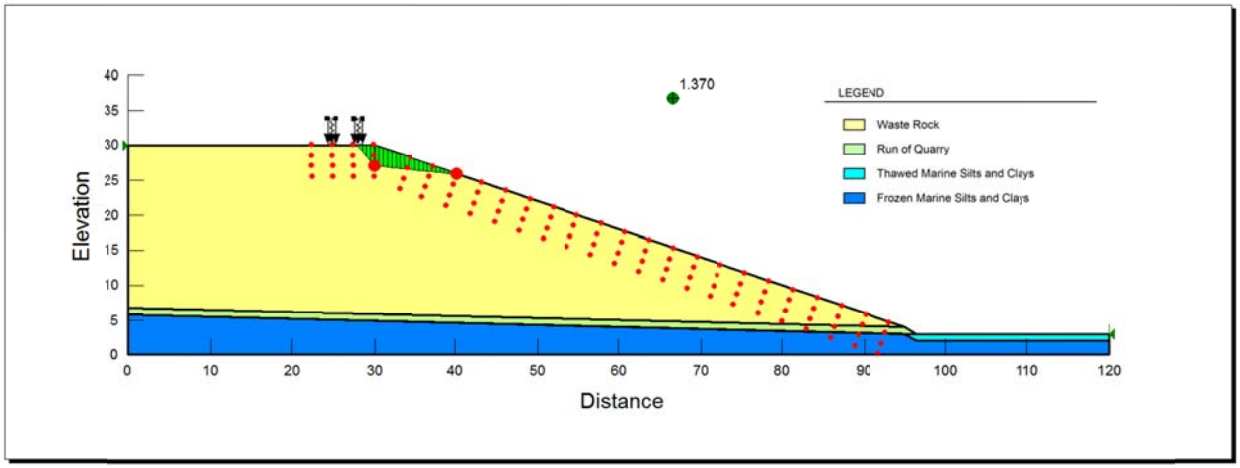
Entry-exit critical slip surface using Morgenstern-Price method with applied wheel loads.



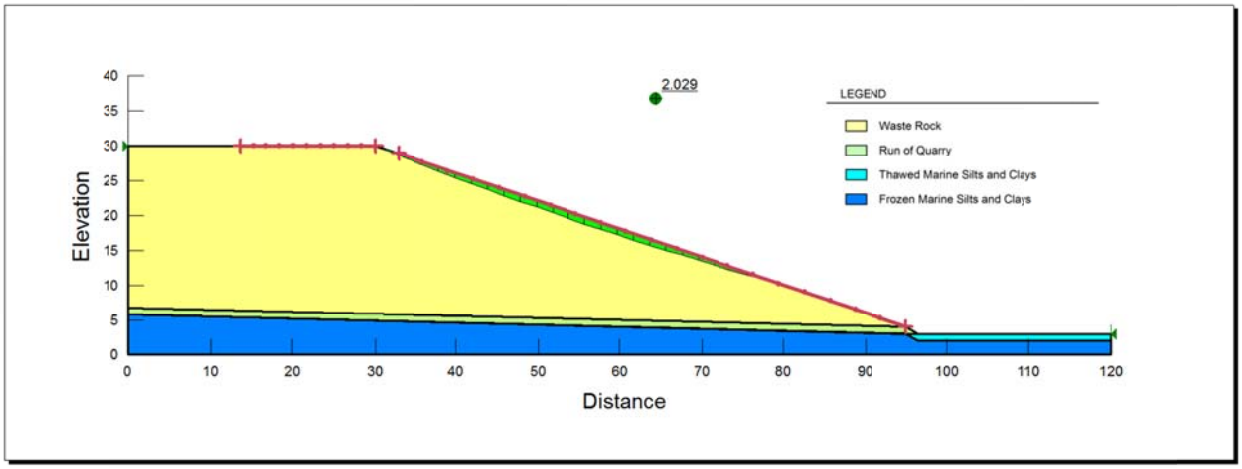
Entry-exit critical slip surface using Bishop method with applied wheel loads.



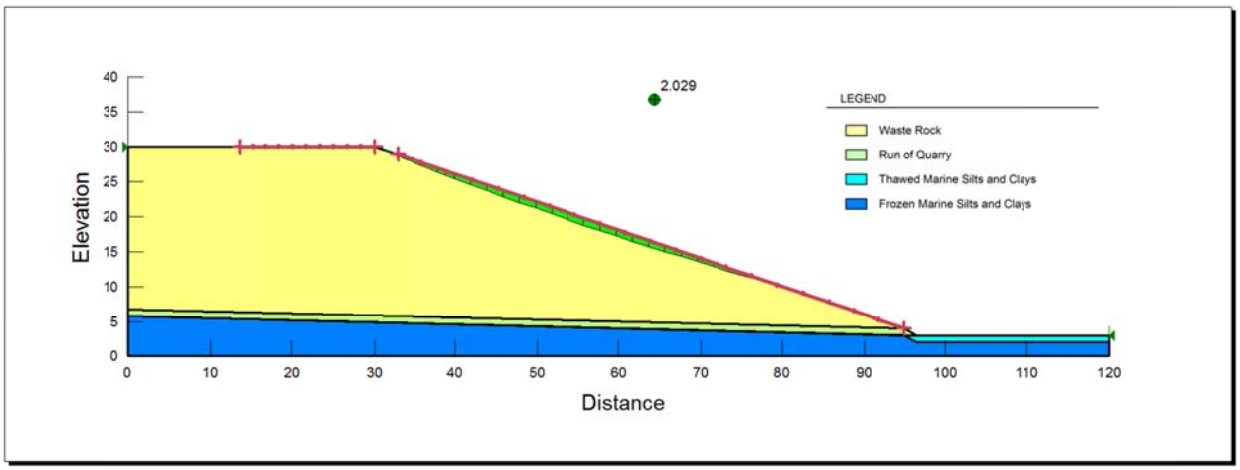
Block specified critical slip surface using Morgenstern-Price method with applied wheel loads.



Block specified critical slip surface using Bishop method with applied wheel loads.



Entry-exit critical slip surface using Morgenstern-Price method for the free standing pile.



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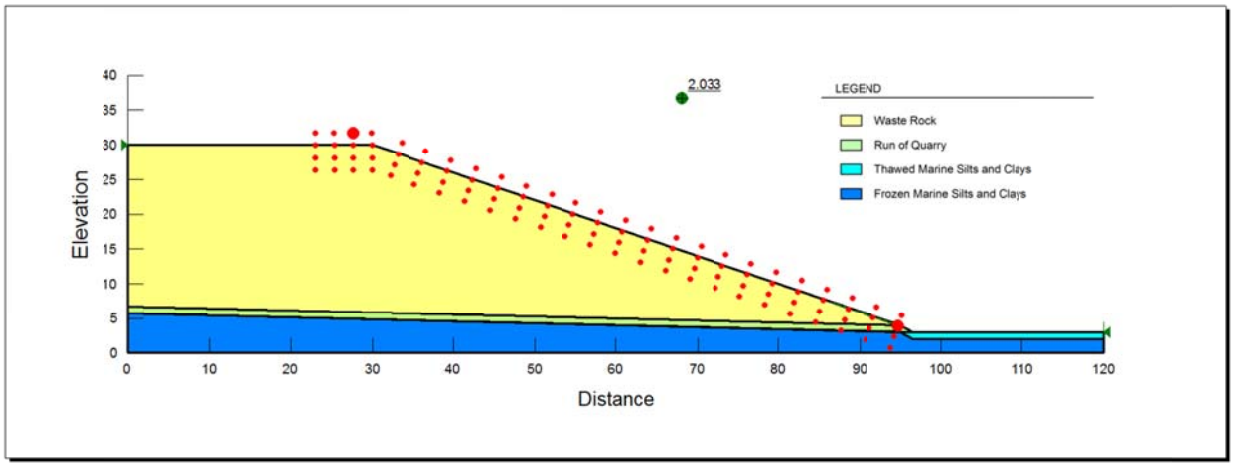

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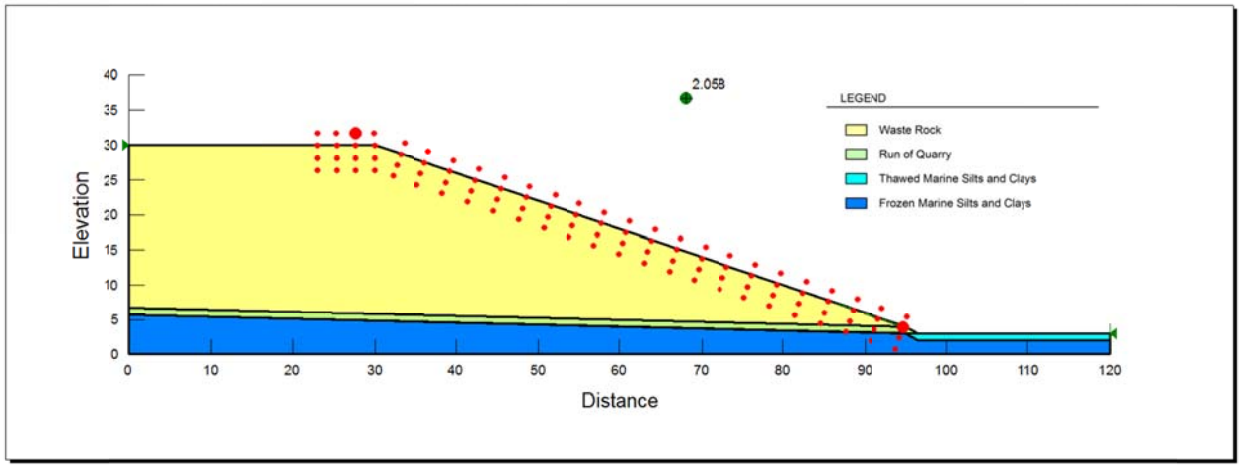

Block specified critical slip surface using Bishop method for the free standing pile.

Appendix C
Waste Rock Pile Stability Ratings

Stability Factor	Description	Points
Dump Height	Maximum 26m	0
Dump Volume	306,800m^3	0
Dump Slope	2.5:1 = 21.8° Flat	0
Foundation Slope	5° < 10° Flat	0
Confinement	Convex pile shape - (Unconfined)	100
Foundation Type	Compotent (Frozen) / Weak (Unfrozen)	0 / 200
Dump Material Quality	Strong - (High)	0
Construction Method	Lifts <25m - (Favourable)	0
Peiziometric / Climate	High infiltration into dump - (Intermediate)	100
Dumping Rate	5m^3 per liniar meter per day (Slow)	0
Seismicity	Low seizmic risk zone	0
	Total	200 / 400