

13th February 2009

RML003

Redbank Mines Limited
Level 2, BGC Centre
28 the Esplanade
Perth WA 6000

Attention: Craig Hall, Exploration Manager

Dear Mr. Hall,

GEOTECHNICAL ASSESSMENT FOR THE DESIGN OF OXIDE PITS FOR THE REDBANK, AZURITE AND BLUFF DEPOSITS, NORTHERN TERRITORY

Executive Summary

In June 2008 SRK Consulting was contracted to carry out a limited geotechnical assessment of existing sources of information for the Redbank Copper Project. The aim of the assessment was to provide input into the design of the proposed pits for mining the oxide materials at the Redbank, Azurite and Bluff deposits.

Following geotechnical analyses, design recommendations were made for each element of the pit walls according to appropriate factors of safety. These designs are illustrated in detail in Section 5.1. The recommended design parameters for the major pit wall elements are provided in the following table.

Deposit	Overall Slope Angle (°)	Zone	Slope Geometry			
			Depth (m)	Number of Benches	Inter Ramp Angle (°)	Bench Stack Angle (°)
Redbank and Bluff	48	Upper	0 - 6	1	40	Only one bench
		Main	6 - 36	3	46	53
Azurite	46.5	Upper	0 - 15	2	39	47
		Main	15 - 35	2	43	53

It is recommended that a number of orientated holes be drilled to provide targeted geotechnical information prior to the finalisation of the oxide pit designs at the next level of study. These holes will greatly increase the distribution and confidence of rockmass data for input into geotechnical assessments.

Piezometers should be installed in selected holes to provide accurate groundwater level data for stability evaluations. Laboratory testing of selected core samples will be required in order to obtain confident information concerning intact rock strengths and deformation properties.

1 Introduction

Redbank Mines Limited (“RML”) is developing the Redbank Copper Project in the Northern Territory, which comprises six Mineral Leases (MLN631 to MLN635 and MLN1108) and an Exploration Retention Lease (ERL94). In July 2007, SRK completed an estimation of the mineral resources for these projects. Subsequent to a programme of additional drilling, SRK was approached in June 2008 to provide a further re-estimation and classification for the Redbank, Azurite and Bluff deposits at the site. It was at this time decided that a limited geotechnical assessment of existing sources of information should be carried out. The aim of this assessment was to provide input into the design of the proposed pits for mining the oxide materials at these three sites.

1.1 Site Description

The Redbank Copper Project is located in the Northern Territory, close to the Queensland Border, approximately 50km south of the Gulf of Carpentaria.

Geology

The majority of rock in the Redbank area is part of the Tawallah Group, the lowermost unit of the Macarthur Basin sequence. The materials encountered in the vicinity of the study deposits include trachybasalts with interbedded volcanoclastics and rhyolites of the Gold Creek Volcanics, and arenaceous units of the overlying Masterton Sandstone Formation.

Deposits

The Redbank and Azurite deposits are located in close proximity (approximately 300m) to each other. A small existing excavation is present at the Redbank site, from mining carried out in the first half of the 20th Century. The Bluff deposit is located some 2.5 km to the east of the Azurite deposit.

A pit of 40m depth has been recently excavated at the Sandy Flats Deposit. This site is located approximately 2km southwest of the Redbank and Azurite deposits but is not included in the scope of these geotechnical assessments

2 Fieldwork

A field visit for geotechnical inspection of the deposit sites and of relevant drill cores was carried out, with SRK Senior Engineering Geologist Ian de Bruyn on site on the 1st and 2nd of July, 2008. The aim of this inspection was to collect data so as to provide an assessment of the geotechnical conditions on each of the sites within the limitations of the timeframe and the available information sources.

2.1 Geotechnical Core Logging

The available core within the oxide zone from five (5) diamond drill holes completed in 2007 and 2008 was selected by Ian de Bruyn and Craig Hall for logging. The positions of these drill holes within the Redbank and Azurite deposits are shown in Figure 1. The logging was conducted according to the SRK interval logging system for assessment of rockmass quality using the Rock Mass Rating (RMR) system of Laubscher, 1990. The core logged is summarised in Table 1.

Table 1: Summary of drill core logged

Deposit	Drill hole No.	Section Logged	Comment
Redbank	RB-07-07	0.0 – 56.5m	No sampling – drill hole entirely within waste.
Redbank	RB-08-17	0.0 – 45.2m	Certain sections of core had already been sampled.
Azurite	AZ-07-17	0.0 – 52.4m	No sampling – drill hole entirely within waste.
Azurite	AZ-08-30	0.0 – 30.2m	Certain sections of core had already been sampled.
Bluff	BL-08-18	0.0 – 34.2m	Certain sections of core had already been sampled.

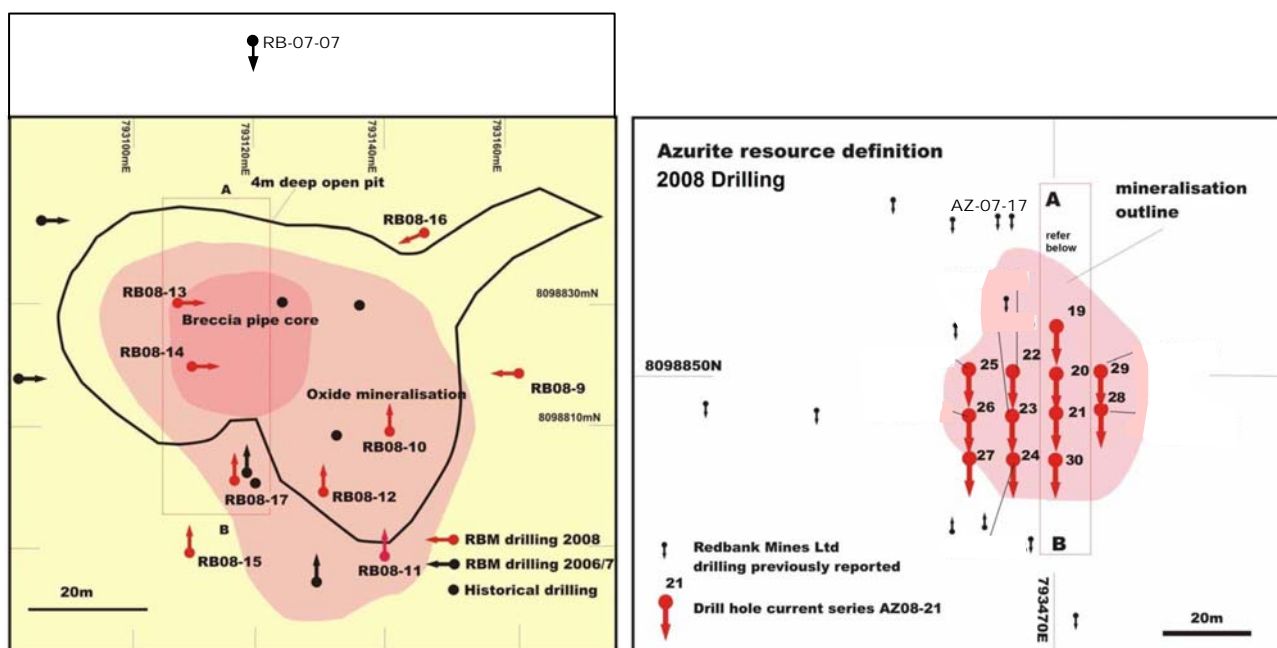


Figure 1: Figures Showing Localities of Drill holes RB-08-17 and RB-07-07 in the Redbank Deposit (left); and AZ-08-30 and AZ-07-17 in the Azurite Deposit (right). Modified after: Redbank Mines Further High Grade Intercepts (2008).

Certain sections of core from within drill holes of the 2008 campaign (RB-08-17, AZ-08-30, BL-08-18) was not able to be logged in detail because it has had already been sampled for metallurgical testing. These sections of material were observed as core pieces and fragments in several sample bags and therefore a basic idea of their likely strength properties was obtained.

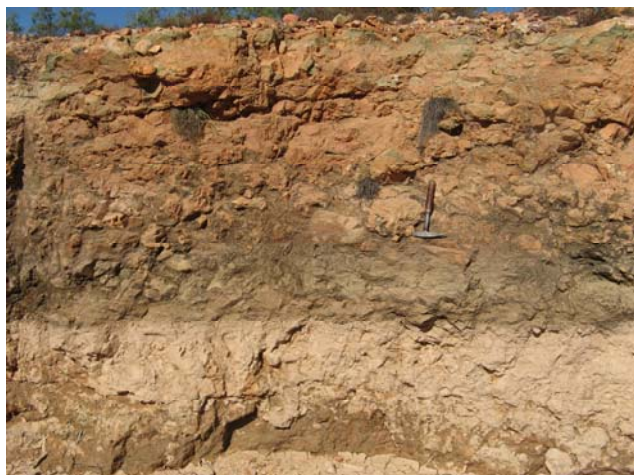
Unlike the core within holes RB-07-07 and AZ-07-17, the holes logged from the 2008 drilling campaign have been drilled largely through the orebody materials. These materials are generally expected to be weaker and of poorer quality than the waste rocks that will comprise the walls of the oxide pits. Therefore it is the core from RB-07-07 and AZ-07-17 (both drilled to the north of their respective deposits) that has provided the most reliable information for the materials that will comprise the final oxide pit walls. At this stage it was not possible to obtain a spread of geotechnical data from drill core on various sides of each of the deposits.

2.2 Observation of Existing Outcrops at the Deposit Sites

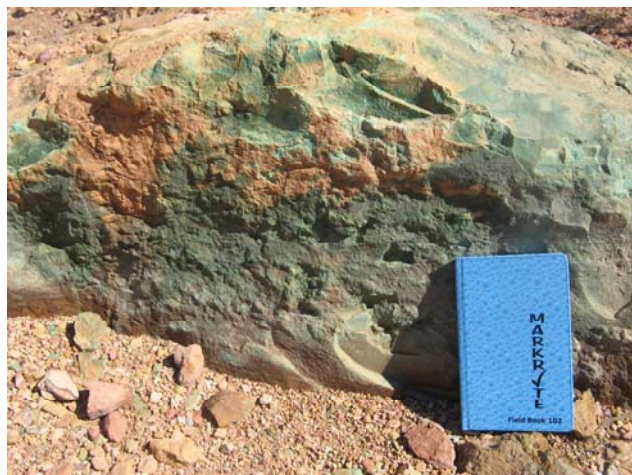
Redbank

Outcrop at the site of the proposed Redbank oxide pit includes small surface outcrops and the 2 to 3m high exposures currently presented in the remaining old excavation. These consist of oxidised brecciated

material of varying quality. In places it is quite hard and compact right from surface. However it can be locally softer material that breaks easily into small blocks along pre-existing weakness planes. Outcrops at the Redbank site are illustrated in Figure 2.



A – Weak to moderately strong, weathered rock in old excavation



B – Strong, compact rock in outcrop

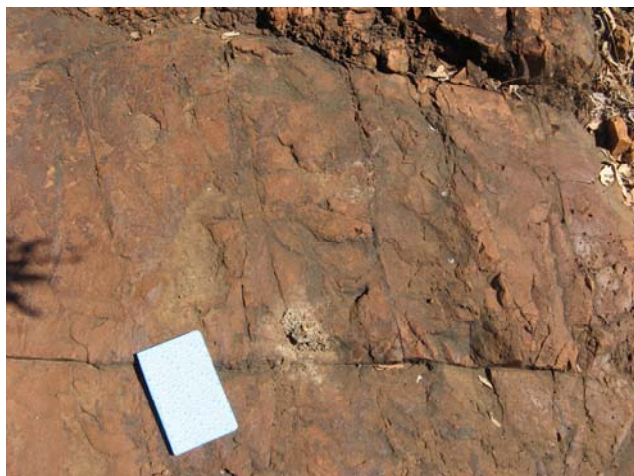
Figure 2: Outcrops at the Redbank site.

Azurite

No hard rock outcrop is present in the immediate vicinity of the proposed Azurite oxide pit.

Bluff

Arenaceous materials outcrop as part of the nearby “bluff” itself, however these are unlikely to form a significant part of the oxide pit wall. There are some existing exposures of competent hard rock of estimated 60MPa strength within the site of the Bluff oxide pit. These outcrops exhibit several joint sets that divide the rockmass into medium to small blocks (from 0.8m³ to 0.3m³). At least two subvertical sets, one horizontal set and one inclined set are present, with maximum continuity of approximately 3m. The joint surfaces are smooth undulating in the small scale, and undulating to curved in the large scale, with thin coatings or staining of iron oxide. The exposed rock is in place weaker and of lower density, with strength of around 10 to 20 MPa. This material breaks easily into smaller blocks of 5cm³ along incipient weakness planes. Outcrops at the Bluff site are illustrated in Figure 3.



A – Strong rock in outcrop, with moderately-spaced joints



B – Moderately strong to strong rock, with a small blocky fabric

Figure 3: Outcrops at the Bluff site.

Sandy Flats

The existing 40m deep pit at the Sandy Flats deposit unfortunately does not provide much information for input into the design of the oxide pits at the Redbank, Azurite and Bluff deposits. The pit is currently filled with water to within about 4 or 5m from the surface. The materials exposed above the water level include ferruginous cemented detritus of much younger (Quaternary) age than those materials encountered at the other three sites.

3 Geotechnical Data Evaluation

3.1 Empirical Assessment

In order to assess the in situ conditions for a rock mass, the SRK system of geotechnical logging divides the drill core into geotechnical intervals. These are zones that are expected to behave uniformly when exposed in an open pit or underground excavation. Data from this geotechnical logging provides the basis for empirical rock mass characterization using the Rock Mass Rating (RMR) classification system (Laubscher, 1990), which is described briefly here. The collated data and RMR values calculated for the intervals is provided in Appendix 1.

RMR Calculation

Geotechnical parameters are recorded for each interval in accordance with the RMR system and are allocated ratings up to the following maximums:

Intact Rock Strength (IRS) Rating	20
Discontinuity Spacing Rating	40
Rock Quality Designation (RQD) Rating	15
Joint Spacing (Js) Rating	25
Joint Condition (Jc) Rating	40
Total RMR:	100

The average intact rock strength for each interval has been estimated. Where the core is of particularly poor quality such that individual joints cannot be reliably identified, the strict RMR calculations cannot be adhered to. In this case, estimates of the RMR based on observation and experience have been made.

The quality of the rock mass within each interval can be classified as indicated in Table 2.

Table 2: Rock Mass Rating Classes

Rock Mass Rating	100 - 80	80 - 60	60 - 40	40 - 20	20 - 0
Description	Very Good	Good	Fair	Poor	Very Poor

Identification of Basic Geotechnical Zones

Variations in RMR occur along the lengths of each of the drill holes that were geotechnically logged, as a result of variations in rock strength and fracture frequency. In general, an upper zone has been defined for each pit that is composed of poor to very poor material, whilst the remainder of the rockmass down to 35m (the expected depth of the pits) is of generally fair quality material of moderately strong to strong rock that is widely to moderately jointed. This is referred to here as the main zone. The boundary between the upper and main zones is not simply defined by intensity of weathering. Materials that may be described as highly weathered are encountered down to between 15m and 40m depth, which includes a large part of the main zone at each of the deposits sites.

Relatively thin horizons or limited regions of poor quality material are present within the main zone. Such regions are very difficult to individually take into account for pit wall design. For this reason, the RMR values calculated for all intervals within both the upper and lower zones within each drill hole have been weight-averaged in order to obtain what is considered a most representative value for each zone for each deposit. These are summarised in Table 3.

Table 3: Representative RMR Values for the Upper and Lower Zones for each Drill Hole

Deposit	Material	Drill hole	Representative RMR			
			Upper Zone		Main Zone	
			Depth (m)	RMR	Depth (m)	RMR
Redbank	Waste	RB-07-07	0 – 6	27	6 – 49	46
	Ore	RB-08-17	0 – 6	30	6 – 39	40
Azurite	Waste	AZ-07-17	0 – 15	27	15 – 45	42
	Ore	AZ-08-30	0 – 18	28	18 – 26	33
Bluff	Ore	BL-08-18	0 - 5	30	5 - 30	43

Calculation of MRMR

The Mining Rock Mass Rating (MRMR) classification system of Laubscher (1990), as augmented by SRK for slope design uses the results of the rock mass characterisations to provide mining rock mass ratings, which are then used to provide indicative bench stack slope angles (IBSA). This MRMR classification system is an extremely useful and robust method of utilising all of the relevant rock mass parameters to assist with mine design. The values derived in this manner may generally be on the conservative side of the design envelope and provide a useful first pass to determine slope design parameters.

In order to simulate the response of the rock mass in a mining environment, percentage adjustments are applied to RMR values to obtain MRMR values. These adjustments are made to account for the potential time-dependent deterioration of the rock mass upon exposure, the unfavourable orientation of discontinuities with respect to excavation stability, the stress environment, and damage induced by blasting. The adjustments chosen are listed in Table 4.

Table 4: MRMR Adjustments

Material	Adjustments				Total
	Weathering	Orientation	Stress	Blasting	
Upper Zone	0.72	0.85	1.00	0.94	0.58
Main Zone	0.84	0.85	1.00	0.94	0.67

The weathering adjustment chosen was based on the observed nature of the core materials. A greater adjustment is considered necessary for the upper zone than for the underlying materials, as it is considered that these materials will be more susceptible to decomposition upon exposure, even within the short duration of oxide mining operations.

Although little data concerning the identification and orientation of discrete joint sets was able to be acquired, it is evident from observation of the core that the rock at the deposit sites generally does not exhibit many *strongly developed* joint sets. Joint orientation adjustments of 85% have therefore been used for the materials present in both the upper zone and the main zone.

No adjustments were made for the effects of in situ stress, as the stress field is considered benign given the shallow depth of mining of the oxide pits.

It is expected that a significant proportion of the excavation of the pits within the upper zone may be achieved by mechanical excavators. Observation of compact, relatively hard rock outcrop at surface at both the Bluff and Redbank sites, however, indicates that some blasting may well be required within the upper zone. Therefore a slightly conservative adjustment of 94% was assigned for all materials, which assumes that good quality conventional blasting, with pre-split where required, will be achieved where blasting is necessary.

The overall weight-averaged MRMR calculated for the materials within each of the zones in each of the pits is presented in Table 5.

3.2 Slope Angle Determination

The Indicative Bench Stack Angle (IBSA) for each zone is selected from Figure 4 (Haines and Terbrugge, 1991). This chart utilises the relationship between MRMR and stack height to determine design bench stack angle for a range of Factors of Safety (FoS). The methodology is empirically derived, and relates to average MRMR versus stack height and stack angle. Experience has proven the use of this methodology is appropriate for preliminary design purposes.

Because of the shallow depth of the oxide pits, the entire pit slopes with the upper and main zones have been analysed as bench stacks, for which SRK considers a Factor of Safety (FoS) of 1.2 to be appropriate in determining indicative slope angles.

The MRMR values and expected stack heights for the upper and main zones for each of the pits have been plotted on Figure 4. The slope angles that are assessed as being suitable for a FoS of 1.2 are presented in Table 5. These figures represent the angle from the toe of the deepest bench to the crest of the highest bench and thus are bench stack angles (BSAs). The corresponding inter-ramp angles (IRAs), representing the slope angles from crest to crest, are presented in Table 6.

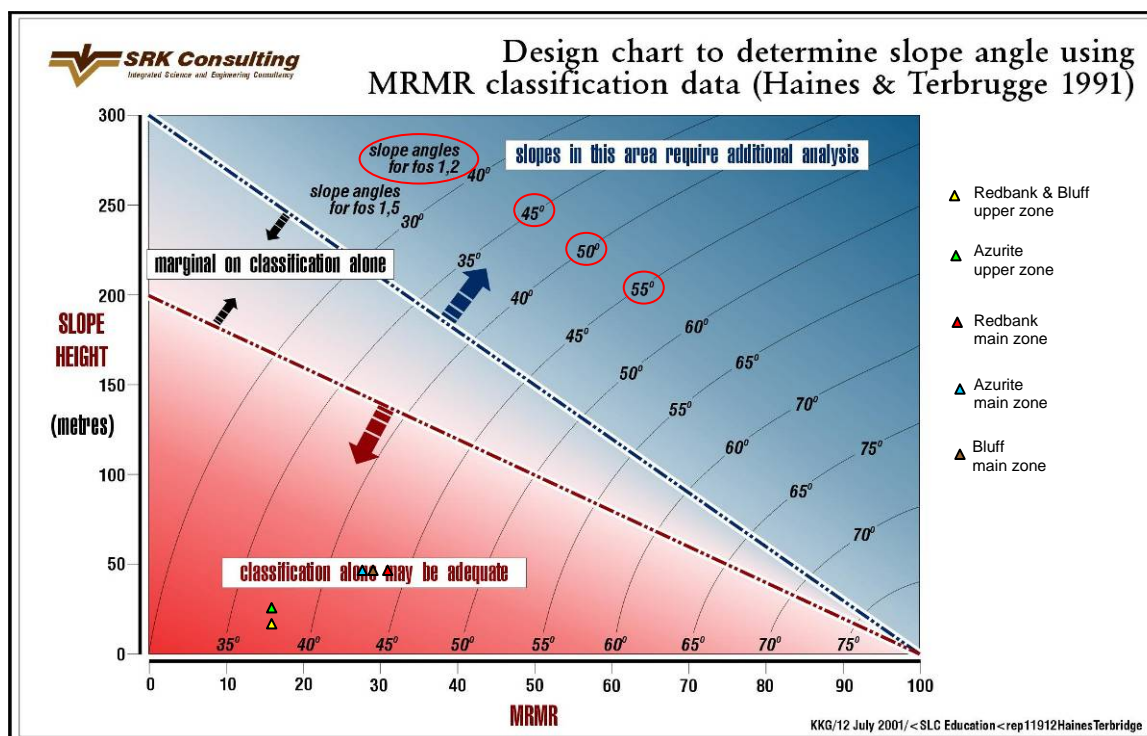


Figure 4: MRMR versus Bench Stack Angle Relationship

Table 5: Empirically-derived Bench Stack Angles for Hard Rock

Deposit	Zone	Depth (m)	Representative RMR	Total Adjustment Factor	MRMR	Slope Angle (BSA) for FOS = 1.2
Redbank	Upper	0 - 6	27	0.58	16	48
	Main	6 - 35	46	0.67	31	54
Azurite	Upper	0 - 15	27	0.58	16	47
	Main	15 - 35	42	0.67	28	52
Bluff	Upper	0 - 6	27	0.58	16	48
	Main	6 - 35	43	0.67	29	53

The slope angles derived for each zone of the Redbank, Azurite and Bluff pits are relatively steep for materials that may be considered of poor to moderate quality. This is because the pit walls within these zones are of such limited height that the stresses created upon excavation will not be excessive.

3.3 Bench Geometry

Individual bench heights are expected to be in the order of 10m. From the basis of experience, it is recommended that bench face (batter) angles do not exceed 60° for materials within the upper zone of each oxide pit. Batter angles of around 70° are considered appropriate for the nature of the materials present within the main zone. This is so that excessive ravelling of bench faces can be avoided, especially where drainage and depressurisation of the pit walls is slow.

4 Numerical Modelling

In order to check the suitability of the slope angles and bench geometries recommended, detailed slope profiles have been generated and their stability analysed using Rocscience SLIDE software. These slope geometries are summarised in Table 6. These slope geometries are illustrated in Figure 5.

In the absence of any laboratory testing of sample materials, field assessment and geotechnical experience has been relied upon for material properties to be assumed for each of the zones within each of the pits. These properties are listed in Table 7.

The SLIDE analyses for each pit geometry were carried out using alternative groundwater profiles - essentially the assumed “best” and “worst” case scenarios. From the observed level of water in the Sandy Flats Pit, the natural groundwater level has been assumed to be approximately 4m below surface at all deposit sites. The “best case” scenario then assumes that the groundwater level is drawn down to the toe of the pit from a radius of 20m around the circumference of the pit crest. The “worst case” scenario assumes that the groundwater level is drawn to the toe of the pit down from a radius of only 6m around the circumference of the pit crest (i.e. the saturated conditions are present close behind the pit wall). These groundwater profiles are illustrated on the SLIDE sections in Appendix 2.

Table 6: Slope Geometries used for Slope Stability Analyses

Deposit	Zone	Slope Geometry			Bench Scale Geometry			
		Height (m)	BSA°	IRA°	Number of Benches	Bench Height (m)	Bench Face Angle (°)	Spill Berm Width (m)
Redbank and Bluff	Upper	6	Only one bench	40	1	6	60	5
	Main	30	53	46	3	10	70	6
Azurite	Upper	15	47	39	2	~7.5	60	5
	Main	20	53	43	2	10	70	7

Table 7: Material Properties used for Slope Stability Analyses

Deposit	Zone	Cohesion c (MPa)	Friction Angle ϕ (°)	Dry Unit Weight (kN/m ³)	Saturated Unit Weight (kN/m ³)
Redbank	Upper	0.110	28	23	25
	Main	0.280	35	25	27
Azurite	Upper	0.100	28	22	24
	Main	0.175	35	24	26
Bluff	Upper	0.100	27	25	25
	Main	0.230	35	25	27

The results of the SLIDE stability analyses, are presented Appendix 2, and are summarised in Table 8 below (expressed as FoS for the pit walls).

Table 8: Material Properties used for Slope Stability Analyses

Deposit	Factor of Safety (FoS) for Overall Pit Slope Profile	
	"Best case" groundwater level scenario	"Worst case" groundwater level scenario
Redbank	2.79	2.51
Azurite	2.25	2.02
Bluff	2.48	2.22

Although a FoS of 1.2 was used in the empirical analysis for preliminary slope angle determination, the FoS that is usually considered appropriate for overall pit slopes is 1.35. It was against this benchmark that the stability of the proposed pit geometries was assessed during numerical modelling. It can be seen from Table 8 that the slope geometries proposed for each of the deposits have FoS of greater than 2, even for assumed "worst case" groundwater profiles.

5 Recommendations

5.1 Pit Slope Design Parameters

Due to the shallow depth of the oxide pits, the materials that comprise the oxide pit walls are not expected to be under significant stresses. The pit design geometry is therefore not particularly sensitive to variations in ground conditions within the ranges expected at the sites. It is recommended that the slope geometries proposed in Table 6 represent suitable, practical designs for the respective deposits. These are illustrated in Figure 5 and Figure 6 below.

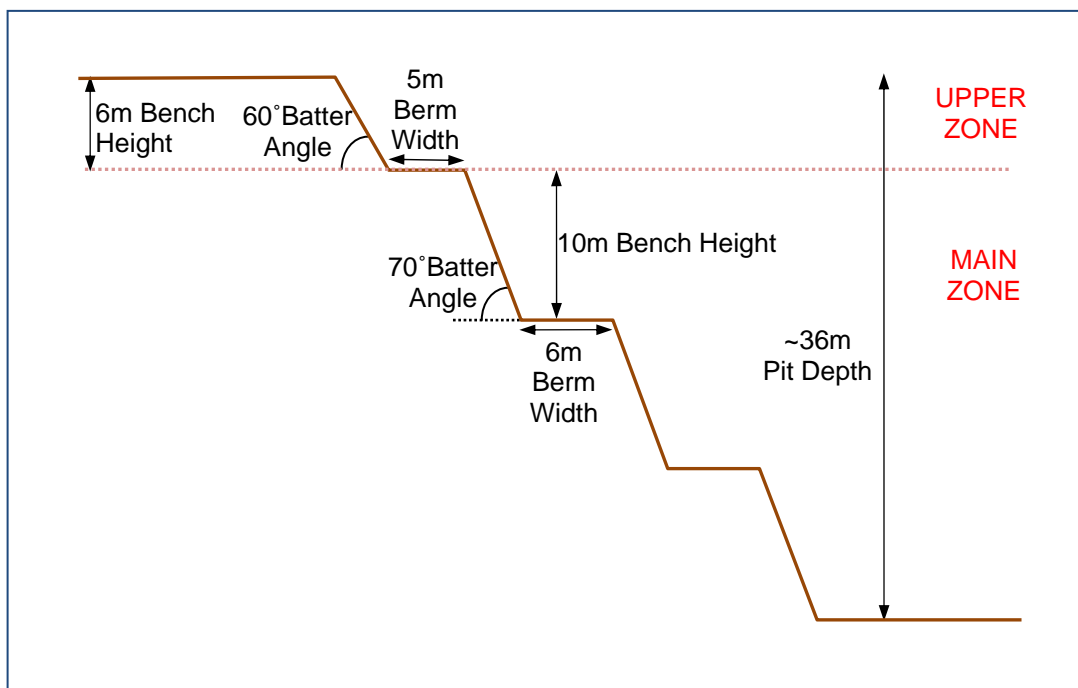


Figure 5: Illustration of Recommended Pit Slope Geometries for the Redbank and Bluff Deposits

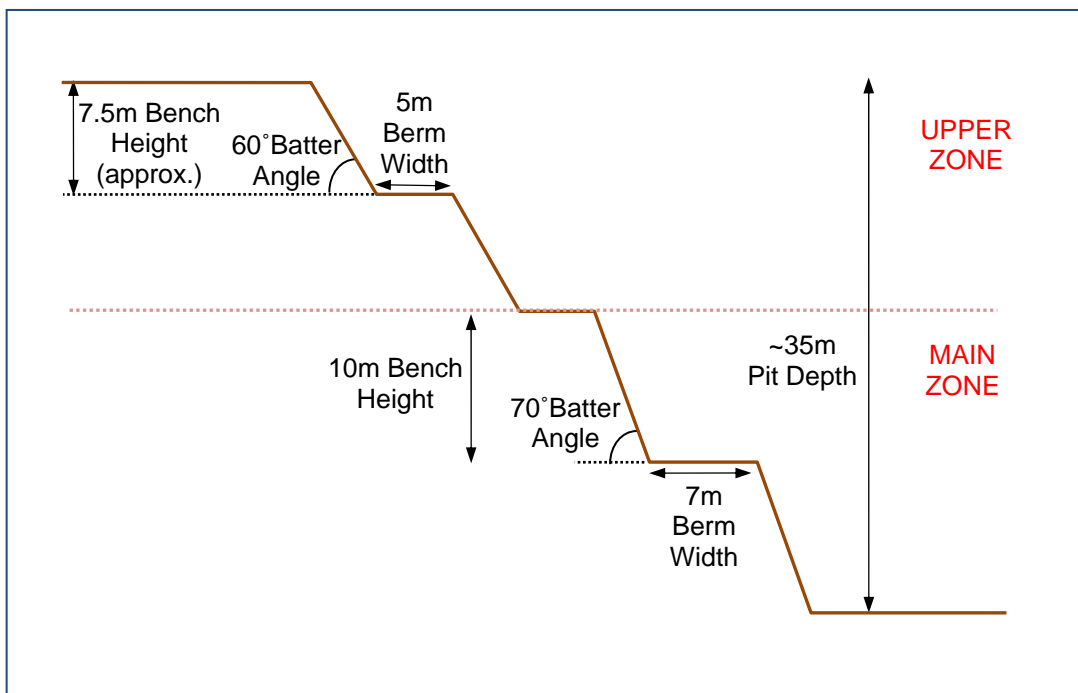


Figure 6: Illustration of Recommended Pit Slope Geometries for the Azurite Deposit

5.2 Dewatering

It is considered that short horizontal drainage holes in the pit walls could be needed to aid in the dewatering and depressurisation of the adjacent rockmass. This can be considered in more detail at a next level of study.

Measures will need to be put in place so that surface water runoff from wet season rainfall events will be intercepted before it can drain into the pits. Surface water or groundwater that has drained into the pits will need to be pumped out and discharged in an environmentally acceptable manner.

5.3 Further Investigation

It is recommended that a number of dedicated, orientated holes be drilled for targeted geotechnical information prior to the finalisation of the design of the oxide pits. The design of these holes should be discussed with the consultant. Geotechnical interval logging and structural logging of the drill core will allow for suitable data to be obtained for structural (kinematic) failure analysis, and will greatly increase the distribution and confidence of rockmass data for input into empirical analysis and numerical modelling.

Piezometers should be installed in selected holes to provide accurate groundwater level data for revised stability evaluations.

Laboratory testing of selected core samples will be required in order to obtain confident information concerning intact rock strengths and deformation properties.

I trust that this assessment has met your current requirements.

Yours Sincerely,
SRK Consulting



Ian de Bruyn
Senior Consultant (Engineering Geology)



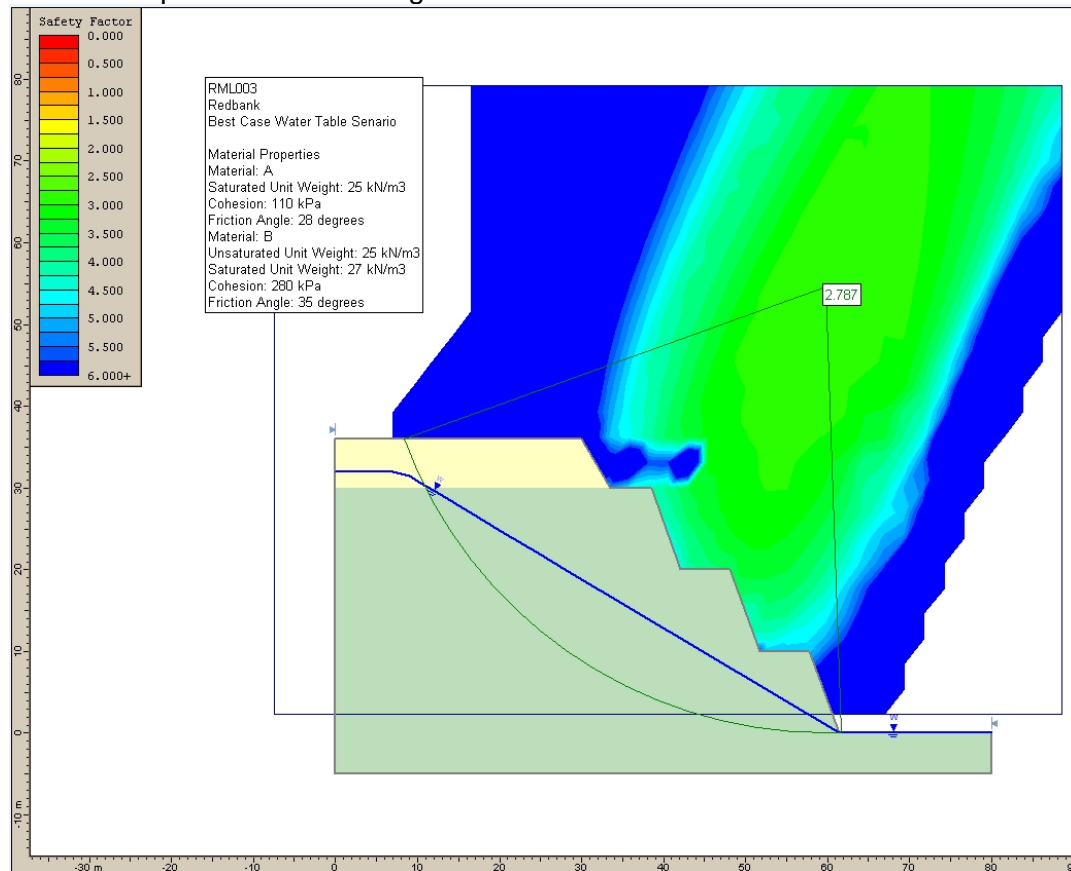
Jeff Price
Principal Consultant (Geotechnical Engineering)

Appendix 1: Summary of Geotechnical Interval Logging Data

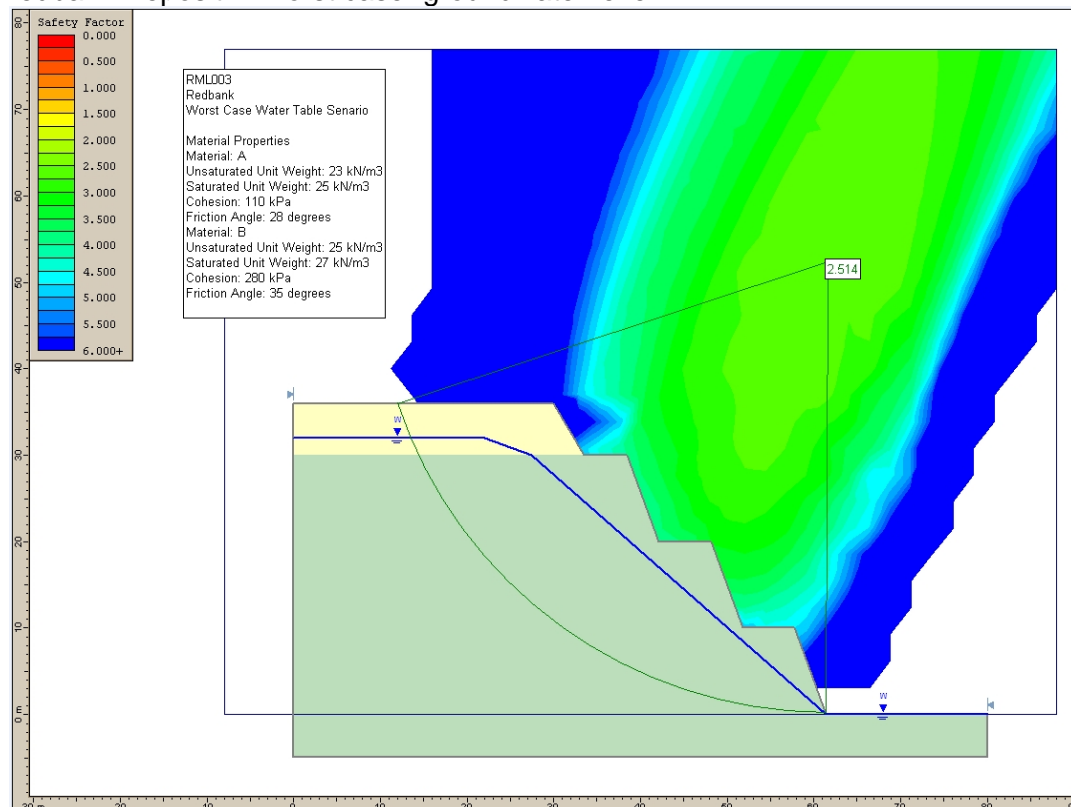
Hole #	RMR	Non RMR Int	From (m)	To (m)	Interval (m)	Rock Type	Hardness (MPa)	Weathering
RB07-07	27	Y	2.50	7.00	4.50	Rhyolite	25	HW
	54		7.00	9.60	2.60	Brecciated rhyolite	30	HW
	31		9.60	10.60	1.00	Rhyolite	75	HW
	54		10.60	18.50	7.90	Brecciated rhyolite	40	HW
	25	Y	18.50	21.00	2.50	Brecciated rhyolite	10	HW
	50		21.00	27.50	6.50	Brecciated rhyolite	50	HW
	30	Y	27.50	31.70	4.20	Brecciated rhyolite	35	HW
	44		31.70	37.00	5.30	Basalt	90	MW
	30	Y	37.00	40.60	3.60	Basalt	40	MW
	52		40.60	56.50	15.90	Basalt	90	SW
RB-08-017	30	Y	0.00	7.00	7.00	Brecciated rhyolite	25	HW
	45	Y	7.00	30.00	23.00	Brecciated rhyolite	40	HW
	20	Y	30.00	37.50	7.50	Brecciated rhyolite	5	HW
	48		37.50	45.20	7.70	Brecciated rhyolite	55	HW
AZ-07-17	0	Y	0.00	0.75	0.75	Reworked/residual material	0.1	CW
	25	Y	0.75	10.80	10.05	Rhyolite	45	HW
	30		10.80	17.50	6.70	Rhyolite/basalt	70	HW
	50		17.50	23.00	5.50	Rhyolite	80	HW
	37		23.00	29.00	6.00	Rhyolite/basalt	90	MW
	35	Y	29.00	30.40	1.40	Rhyolite/basalt	70	MW
	38		30.40	34.80	4.40	Rhyolite/basalt	90	MW
	35	Y	34.80	41.30	6.50	Brecciated Rhyolite	50	HW
	47		41.30	52.40	11.10	Brecciated Rhyolite	75	MW
AZ-08--030	25	Y	0.00	9.00	9.00	Brecciated Rhyolite	20	HW
	30	Y	9.00	21.20	12.20	Brecciated Rhyolite	30	HW
	30		21.20	24.20	3.00	Rhyolite/basalt	10	HW
	38		24.20	25.80	1.60	Brecciated Rhyolite/volcaniclastic	20	HW
	34		25.80	30.20	4.40	Rhyolite/basalt	10	HW
BL-08-018	10	Y	0.00	3.00	3.00	Completely weathered basalt	1.0	CW
	30	Y	3.00	4.10	1.10	Basalt	20	HW
	39		4.10	6.20	2.10	Basalt & volcaniclastics	40	HW
	40	Y	6.20	9.40	3.20	Basalt		HW
	43		9.40	14.90	5.50	Brecciated Basalt	50	HW
	15	Y	14.90	16.20	1.30	Highly weathered basalt	1	HW
	40	Y	16.20	17.00	0.80	Basalt	45	MW
	40	Y	17.00	20.00	3.00	Basalt		MW
	42		20.00	25.00	5.00	Basalt & volcaniclastics	50	MW
	50	Y	25.00	30.00	5.00	Basalt & volcaniclastics		MW
	49		30.00	34.20	4.20	Brecciated basalt	45	HW

Appendix 2: Results of Slide Modelling Analyses

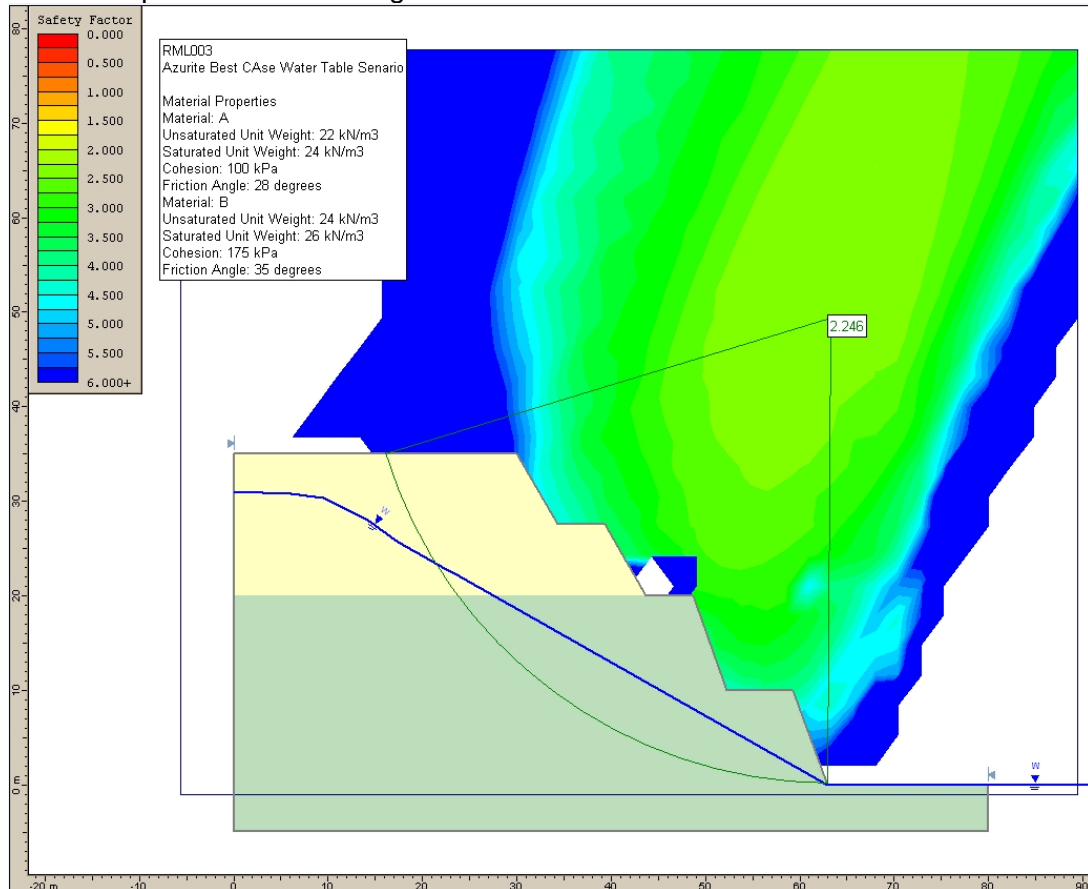
Redbank Deposit – “best case” groundwater level



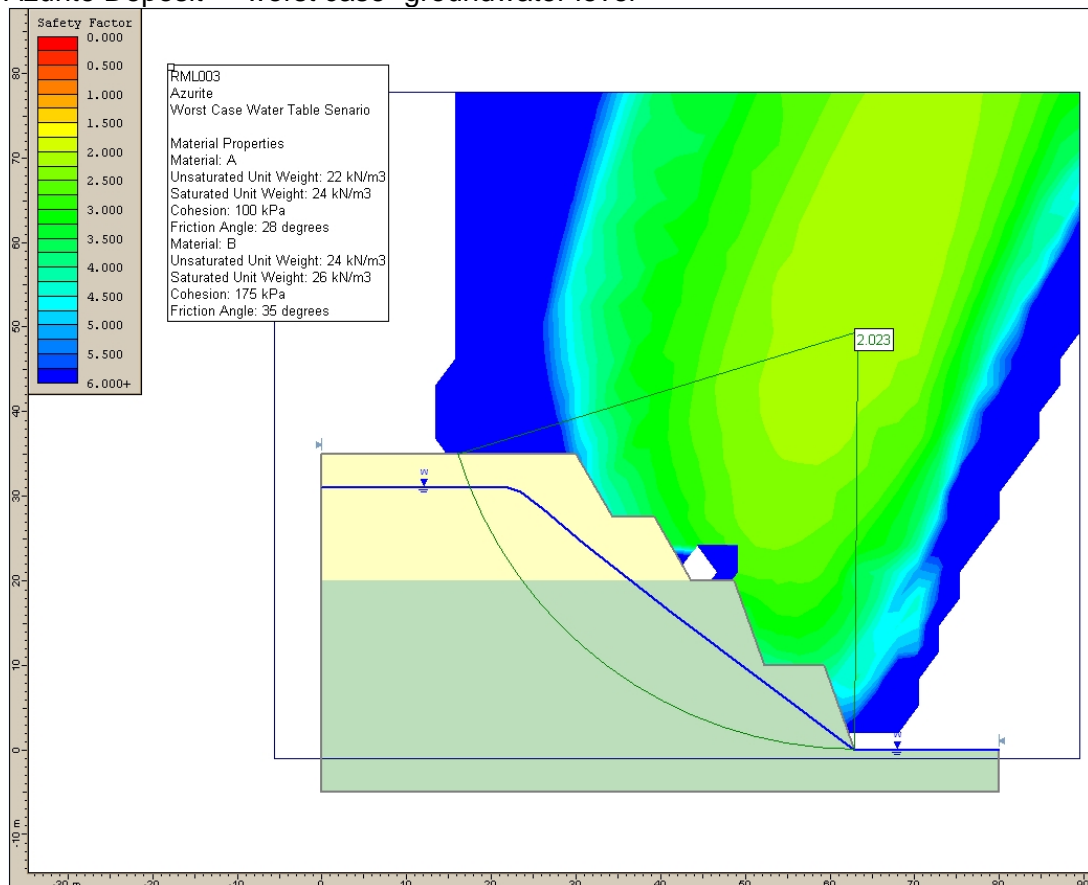
Redbank Deposit – “worst case” groundwater level



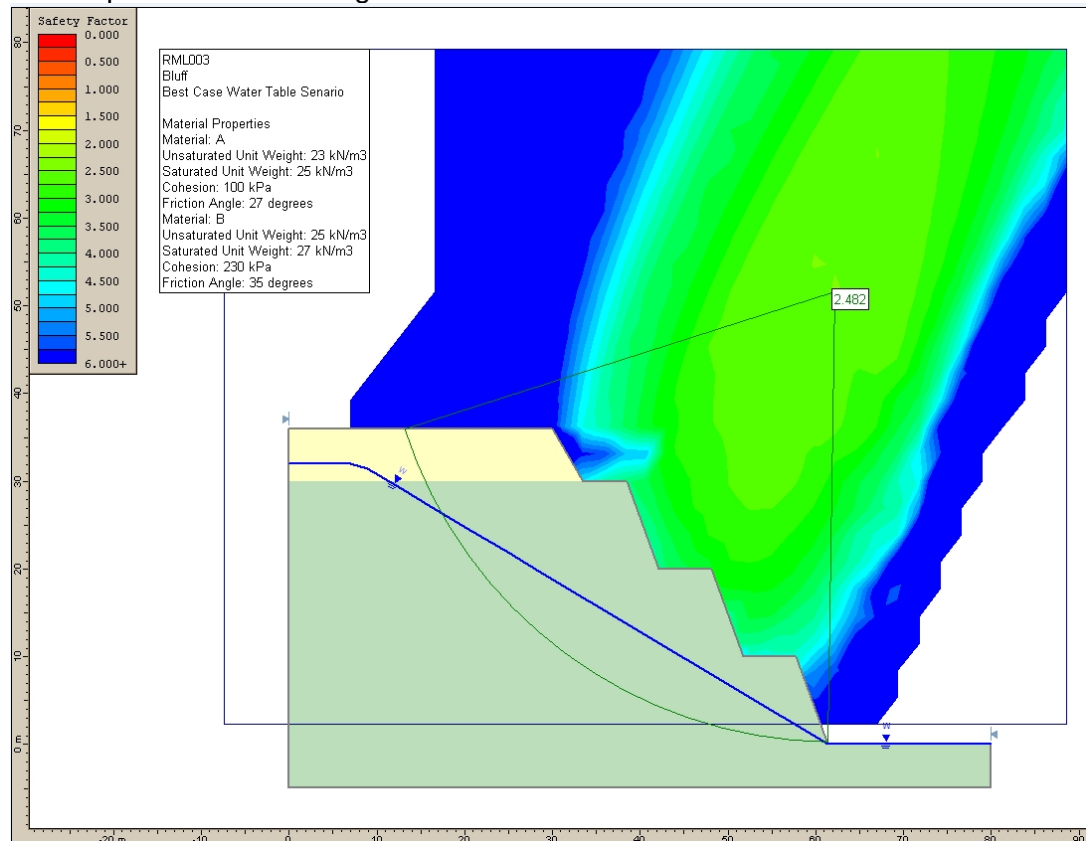
Azurite Deposit – “best case” groundwater level



Azurite Deposit – “worst case” groundwater level



Bluff Deposit – “best case” groundwater level



Bluff Deposit – “worst case” groundwater level

