January 23, 2017

File No.:VA101-00640/02-A.01
Cont. No.:VA17-00110

Mr. Jim Newton
Mining Engineer
BMC Minerals (No. 1) Ltd.
530 - 1130 West Pender Street
Vancouver, British Columbia
Canada, V6E 4A4

Dear Jim,

Re: Kudz Ze Kayah Pre-Feasibility Study – Updated Design of Class B and Class C Storage Facilities and Overburden Stockpile

INTRODUCTION

BMC Minerals (No.1) Ltd. (BMC) is currently developing the Kudz Ze Kayah Project (the project), a proposed copper-zinc-lead-gold mine, to a Pre-Feasibility Study (PFS) level. The project is located in the Saint Cyr Range area of the Pelly Mountains approximately 250 km northeast of Whitehorse, Yukon Territory, Canada. This area is categorized by steep, high walled valleys with thin glaciofluvial and morainal deposits in the valley base. Glacial, periglacial, and fluvial processes are the main processes that have been involved in the creation of landforms and are the origin of surficial deposits.

Knight Piésold Ltd. (KP) is providing overall geotechnical support work for the PFS. Details of the PFS waste and water management designs are presented in KP report VA101-640/02-3.

BMC has specified the following key components for the storage of rock and overburden:

- Class B Storage Facility to contain Weakly Potentially Acid Generating (WPAG) rock
- Class C Storage Facility for Potentially Acid Consuming (PAC) rock, and
- Overburden Stockpile (from stripping of the open pit).

Filter pressed tailings and Strongly Potentially Acid Generating (SPAG) rock will be co-disposed in the Class A Storage Facility located north of the Class B Facility.

This letter presents the designs and design process for the Class B and Class C Storage Facilities and the overburden stockpile, which includes:

- Delineating the storage facilities and stockpile footprints
- Determining geotechnical parameters for the storage facilities, stockpile, and foundation materials, and
- Completion of static and seismic stability analyses using limit equilibrium methods.

PREVIOUS WORK AND BACKGROUND INFORMATION

Previous site investigation and design programs were conducted in the project area since 1995 by others. This work includes:

- Feasibility Level Geotechnical and Hydrogeological Site Investigation – ABM Deposit by Golder, January 1996. Seventy-five geotechnical drillholes and eighty-seven test pits completed by Golder and Cominco in 1995 for the proposed mine, waste dump, tailings, and Mill Site locations. The site investigation program also included piezometer installation, temperature measurements, and laboratory testing of overburden samples.
- 1996 Geotechnical Site Investigations for the ABM Deposit by Golder, October 1996. The site investigation program also included forty-nine test pits and laboratory testing of overburden samples.

- Tetra Tech EBA Inc. (Tetra Tech) Monitoring Well Installation Program, 2015. Installed eleven monitoring wells.

KP completed an initial geotechnical and hydrogeological site investigation in 2015, carried out during November and December (KP Ref. No VA101-640/02-1, Rev 0, October 5, 2016), which included:

- Drilling and logging of six geotechnical and hydrogeological drillholes
- Standard Penetration Testing (SPT) in overburden
- Hydraulic conductivity packer testing and falling head testing in bedrock
- Installation of solid PVC pipe for thermistor installation, and
- Installation and calibration of four thermistors and data loggers.

KP completed a second geotechnical and hydrogeological site investigation from May to September 2016 (KP Ref. No. VA101-640/03-1, Rev0, October 20, 2016), which included:

- Drilling and logging of 16 geotechnical drillholes
- Excavation and logging of 53 test pits
- Hydraulic conductivity packer testing of bedrock at 6-10 m intervals
- Installation of 3 vibrating wire piezometers in 1 drillhole
- Installation of 10-node thermistor cables in 9 drillholes
- Installation of water quality monitoring wells in 9 drillholes, and
- Laboratory testing of select rock and soil samples

Geotechnical data from the 1996 Golder Associates, 2015 KP, and 2016 KP site investigations were utilized for the Class B and C stockpiles and the overburden stockpile stability analyses and PFS design.

DESIGN BASIS

Rock from the open pit excavation will be separated during excavation into Class A rock, Class B rock, and Class C rock, and stored in three separate locations. The Class B Storage Facility is north of the open pit, along the west slope of the valley. The Class C Storage Facility is located in a small valley offshoot along the east side of the project area. Both storage facilities are designed to contain the rock fill indefinitely. Class A rock will be co-disposed with tailings in the Class A Storage Facility located north of the Class B Facility.

Overburden stripped from the open pit excavation is required for closure, and will be placed in a stockpile along the valley slope north of the Class C Storage Facility. This stockpile will store overburden for the life of the mine, and be excavated during closure and reclamation to provide reclamation material for the Class A, B, and C Storage Facilities.

Table 1 to Table 3 summarizes the design basis for the Class B Storage Facility, Class C Storage Facility, and Overburden Stockpiles, respectively.

Table 1 Class B Storage Facility Parameters

Parameter	Value	Source
Total Class B Rock Tonnage	47.5 Mt	BMC
Rock Density	2.0 t/m^3	KP Estimate
Total Rock Volume	24 Mm^3	Calculated value
Overall Pile Slope Angle	3H:1V	Specified by KP
Bench Height	15 m	Specified by KP
Crest Elevation	1,570 masl	Specified by KP
Overburden Description	Glaciofluvial, glaciolacustrine, and glacial moraine sediments with some glacial till. Typically compact to dense, varying from sand with some silt, to sandy gravel with some silt and trace cobbles.	Golder, 1996
Permafrost	No permafrost observed in test pits 3.3 m deep or less.	Golder, 1996
Depth to Bedrock	10 m at the south end, 1.3 to 7.32 in the central area, and 12.5 at the north end of the pile	Golder, 1996
Bedrock Description	Weathered and fractured chlorite calcite schist with tuff fragments.	Golder, 1996
Groundwater level (mbgs)	Artesian to 4.0 m	Golder, 1996, and KP (Oct 20, 2106)

Table 2 Class C Storage Facility Parameters

Parameter	Value	Source
Total Class C Rock Tonnage	64 Mt	BMC
Rock Density	2.0 t/m^3	KP Estimate
Total Rock Volume	32 Mm^3	Calculated value
Overall Pile Slope Angle	3H:1V	Specified by KP
Bench Height	15 m	Specified by KP
Crest Elevation	1,530 masl	Specified by KP
Overburden Description	Glaciofluvial and weather colluvial sediments. Typically compact to dense gravelly, silty, sands with trace clay.	Golder, 1996
Permafrost	Permafrost encountered in the northern portion of pile area, in excess of 3.05 m deep. Not observed in the southern portion.	Golder, 1996
Depth to Bedrock	3.05m to 18.51 m, from the south to north boundaries respectively.	Golder, 1996
Bedrock Description	Weathered and fractured interbedded argillite mudstone, mafic tuff, and chlorite calcite schist	Golder, 1996
Groundwater level (mbgs)	2.5 m, measured within the sand and gravel overburden layer.	Golder, 1996

Table 3 Overburden Stockpile Parameters

Parameter	Value	Source
Total Overburden Tonnage	16.1 Mt	BMC
Disturbed Overburden Density(1)	1.8 t/m^3	Calculated value
Stockpile Volume	8.9 Mm^3	Calculated value
Stockpile Overburden Description	Glacial till and glaciolacustrine sediments, comprised of compact to very dense sandy silt to silty sand and gravel with occasional cobbles and boulders.	Golder, 1996
Stockpile Slope Angle	2.2H:1V	Specified by KP
Stockpile Crest Elevation	1,500 masl	Specified by KP
Foundation Overburden Description	Glaciofluvial and weather colluvial sediments. Typically compact to dense gravelly, silty, sands with trace clay.	Golder, 1996
Permafrost	Permafrost encountered in excess of 0.6 m to 1.82 m deep.	Golder, 1996
Depth to Bedrock	Approximately 3.65 m in the north to 4.5 m in the south, based on depth to bedrock at north area of Overburden stockpile.	Golder, 1996, and KP (Oct 20, 2016)
Bedrock Description	Weathered and fractured chlorite calcite schist with tuff fragments.	Golder, 1996
Groundwater level (mbgs)	10 to 19 m	Golder, 1996, and KP (Oct 20, 2016)

NOTES:
1. The in situ density of overburden was determined to be 2 t/m^3, based on volume and tonnage estimates provided by BMC. A 12% swell factor for excavated material was assumed to determine the density of the disturbed overburden after placement.

The majority of the data used to characterize the foundation conditions for the storage facilities and overburden stockpile was sourced from the 1996 site investigation data report (Golder 1996), which was completed to support a feasibility level study. Drill logs, SPT results, and thermistor readings from the 2015 and 2016 Site Investigation (SI) program were used to supplement the 1996 data.

STORAGE FACILITY AND STOCKPILE MODELLING

Storage facility and stockpile models were developed in Muck3D (Minebridge Software Inc. 2015). The Class B and Class C Facilities were located in the original locations shown in the 1996 feasibility design, with the Class C Facility placed in a small valley along the east valley wall, and the Class B Facility along the western valley slopes.

However, the footprints were modified from the 1996 designs to meet the following conditions:
- Class B and C rock placement at 3H:1V overall slopes.
- Reduction of the catchment areas by decreasing the lateral extents of each facility along the valley slopes.
- A minimum 200 m distance from the pit crest.
- Containment of the total Class C rock volume in the side-valley northeast of the open pit, confining the pile along the north, east, and south sides.
- Reduction of the lateral extent of the Class B Storage Facility to accommodate room for the Class A Storage Facility and mill site, which are also located along the west valley slope.

The Class B Storage Facility, Class C Storage Facility, and Overburden Stockpile locations are shown in Drawing C300.

MATERIAL PARAMETERS FOR LIMIT EQUILIBRIUM MODEL

Four geotechnical units were defined for the purpose of the stability analysis:

- In Situ Overburden
- Stockpiled Overburden
- Waste Rock, and
- Bedrock.

The 1996 SI program encountered discontinuous permafrost in the northern area of the Class C Storage Facility. Thermistors were installed in the 2015 SI program drillholes, and initial readings indicated soil temperatures as low as -2.1°C. Geotechnical parameters were defined for both frozen and unfrozen in situ overburden to assess pile and stockpile stability on permafrost foundations.

Overburden strength parameters were derived from available standard penetration test data from the 2015 SI program, used in correlation with typical soil properties for compact to dense sands and gravel (Carter and Bently, 1991). Frozen soil strength parameters were based on published geotechnical parameters for slope stability assessments in frozen soils (Nater et. al., 2008).

Class B and C rock fill strength parameters were defined using lower bound shear strength to normal stress correlations developed by T.M. Leps (Leps, 1970). Leps compiled the results of numerous tests on the shear strength of rock fill piles, and empirically derived a series of shear strength to normal stress correlations. The lower bound representative value of these correlations represents the strength of weak rock fill masses.

Table 4 summarizes the strength parameters defined for the waste rock and overburden units.

Table 4 Overburden and Waste Rock Strength Parameters

Material Type	Model	Unit Weight γ kN/m^3	Effective Friction ϕ' degrees	Effective Cohesion c' kPa
Class B and C Rock Fill[1]	Shear/Normal Function (Lower Leps)	19.6	-	-
In Situ Overburden[2]	Mohr-Coulomb	17.2	36	0
In Situ Overburden (Frozen)[2, 3]	Mohr-Coulomb	17.2	20	270
Stockpiled Overburden	Mohr-Coulomb	17.5	36	0

NOTES:

1. Shear strength of waste rock based on Leps (1970) and Yanaguchi (2009). Unit weight is based on values provided by BMC.
2. Unit Weight and effective friction angle estimated based on Carter and Bently, 1991.
3. Effective friction angle and cohesion for frozen soils based on Smith, 1996.

Three drill holes were completed within the Class B facility, and five holes were completed and C facility during the 2015 and 2016 SI programs. Data from these holes were used to define rock mass strength parameters for the bedrock unit. This data includes:

- Field estimates of rock mass strength
- Laboratory strength testing of rock core samples, and

- Rock mass quality determined using the Rock Mass Rating (RMR) system by Bieniawski, 1989.

The bedrock unit for the stability analyses was modelled using the generalized Hoek-Brown Strength Criteria. This criterion utilizes the Unconfined Compressive Strength (UCS), Geological Strength Index (GSI), intact rock constant m_i of the rock mass to estimate the strength of a jointed rock mass. The density of the rock mass was calculated using open pit excavation tonnage and volume data provided by BMC. Table 5 presents the rock mass parameters used in the stability analysis.

Table 5 Rock Mass Strength Parameters

Material Type	Model	Unit Weight kN/m^3	GSI -	UCS MPa	m_i -
Schist	Generalized Hoek-Brown Criteria	25.6	35	25	6

WASTE PILE STABILITY RATING SCHEME

The Investigation and Design Manual Interim Guidelines (BC MWRPRC, 1991) provides recommendations for stability assessment of mine waste piles. These guidelines include a Dump Stability Rating (DSR) scheme. The DSR system provides a semi-quantitative method for assessing the relative potential of pile stability and recommends the appropriate level of pile investigation and design. This is based on individual point ratings for each of the main factors affecting pile stability. Each factor is given a point rating based on qualitative and/or quantitative descriptions accounting for the possible range of conditions. An overall DSR is calculated as the sum of the individual ratings for each of the various factors. Copies of Table 5.1 “Dump Stability Rating Scheme” and Table 5.2 “Dump Stability Classes and Recommended Level of Effort” from the waste pile research committee guidelines are included in Appendix A.

The pile rating guidelines were used to classify the waste and stockpiles at the Kudz Ze Kayah Project. A summary of the results is presented in Table 6. The Overburden Stockpile, Class B Storage Facility, and Class C Storage Facility are classified as Class III, Moderate Hazard. The Moderate Hazard classification recommends that additional site investigations, including laboratory testing and a detailed stability analysis, be completed for the next level of design.

The pile stability classification indicates a basic stability analysis is required. Provincial guidelines (BC MWRPRC, 1991) and standard industry practice specify the minimum acceptable Factor of Safety (FOS) for waste piles under static conditions are 1.5 for both short-term operating conditions and after reclamation and abandonment. The BC Mine Waste Rock Pile Research Committee (MWRPRC) interim guidelines for design factor of safety are presented in Appendix A (Table 6.4).

Table 6 Pile Stability Rating Scheme Results

	Hazard Ratings			
Facility	Overburden Stockpile	Class B Storage Facility	Class C Storage Facility	
Section	1	2	3	4
Pile Height (m)	90	160	110	45
Pile Volume (Million BCM)	9	25	34	34
Pile Slope (°)	24	18	18	18
Foundation Slope (°)	10	8	10	10
Degree of Confinement	Unconfined	Unconfined	Moderately Confined	Confined
Foundation Type	Intermediate	Intermediate	Intermediate	Intermediate
Pile Material Quality[2]	Poor	Poor	Poor	Poor
Method of Construction	Favourable	Favourable	Favourable	Favourable
Piezometric and Climactic Conditions	Intermediate	Intermediate	Intermediate	Intermediate
Dumping Rate	Moderate	Moderate	Moderate	Moderate
Seismicity	Low	Low	Low	Low
Total Rating	**750**	**750**	**750**	**600**
Pile Stability Class	**III**	**III**	**III**	**II**
Failure Hazard	**Moderate**	**Moderate**	**Moderate**	**Low**

NOTES:
1. Sections, pile heights, and foundation slopes are based on the plan view and sections shown in Drawings C300 to C302.
2. Pile Material Quality is conservatively assumed to be poor.

STABILITY ANALYSIS

Stability analyses of the Class B Storage Facility, Class C Storage Facility, and Overburden Stockpile were completed using SLOPE/W (GeoStudio 2012), a limit equilibrium modelling program.

Cross sections for the analyses were selected based on the height of each facility and grade of the original ground surface, such that the analyses would conservatively consider the tallest slopes and steepest foundations. Overburden thickness was assumed to be a consistent 10 m thick layer for both models, based on measured overburden depths from the 1996 and 2015 geotechnical drilling programs. Groundwater was modelled by defining the phreatic surface within the overburden layer to simulate saturated overburden and bedrock conditions.

Four scenarios were analyzed for each model:

- Static (non-seismic) conditions with unfrozen overburden
- Static conditions with frozen overburden
- Seismic conditions with unfrozen overburden, and
- Seismic conditions with frozen overburden.

The peak horizontal ground acceleration for the 1:2,475-year earthquake event (0.131g) was utilized for the seismic analyses. This value was determined using the 2015 National Building Code of Canada seismic hazard calculator.

The cross sections for the Class B Storage Facility, Class C Storage Facility, and Overburden Stockpile are presented in Figure 1 to Figure 3.

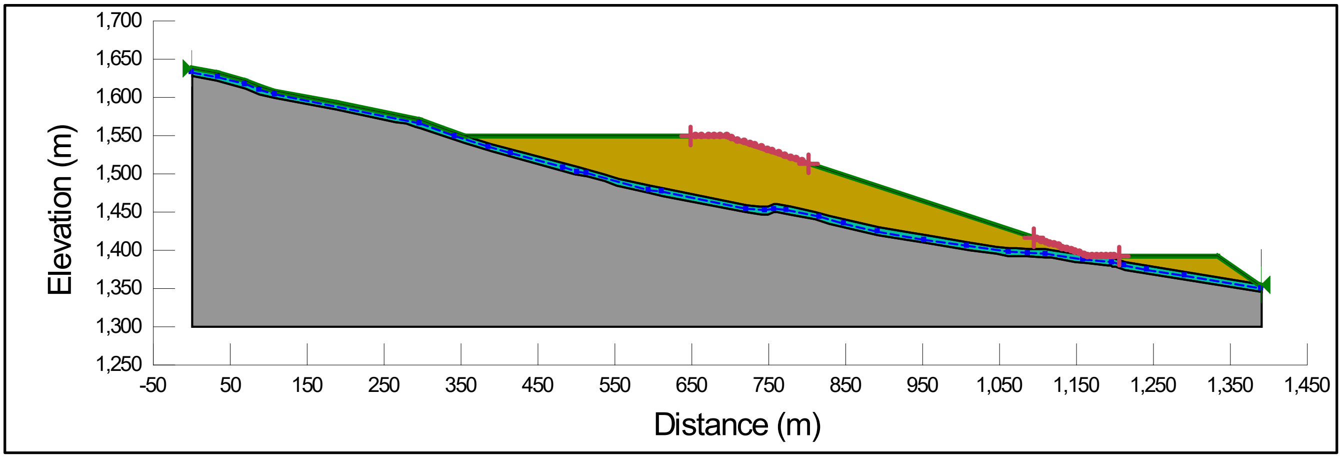

Figure 1 Class B Storage Facility Model (Facing North)

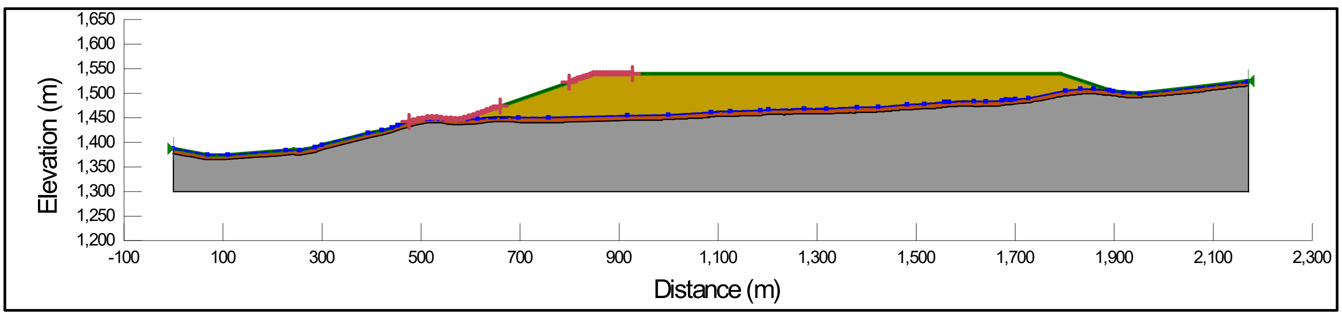

Figure 2 Class C Storage Facility Model (Facing North)

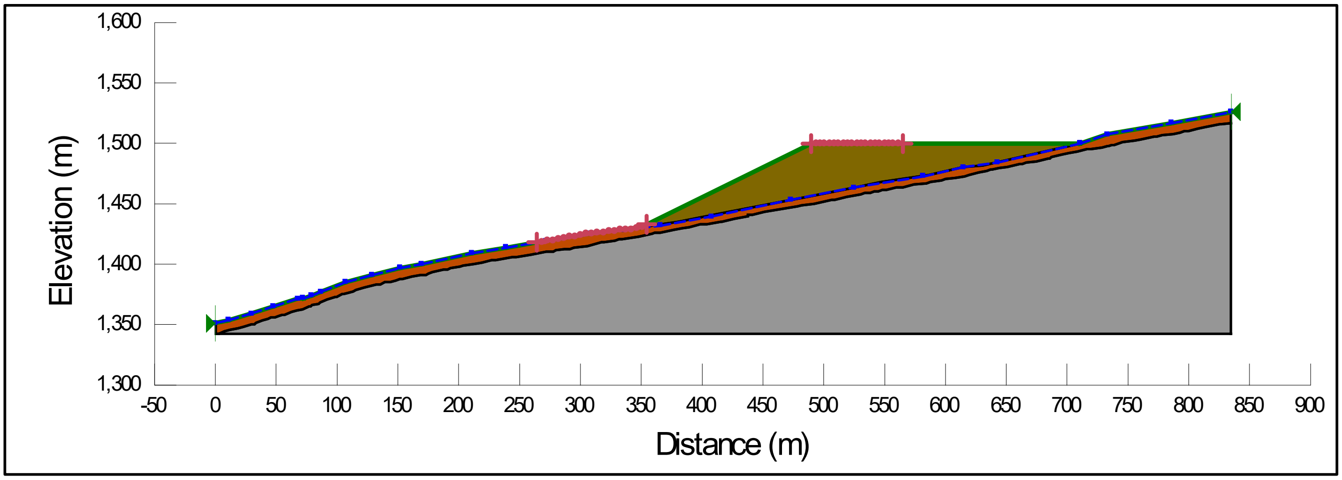

Figure 3 Overburden Stockpile (Facing North)

The results of the stability analysis are presented summarized in Table 7. FOS of 1.5 was targeted for static conditions, and above 1.1 for seismic conditions. It can be seen that the FOS criteria were met by each facility and stockpile under both static and seismic conditions =.

Table 7 Limit Equilibrium Stability Analysis Results

Facility	Overburden Condition	Factor of Safety	
		Static Conditions	Seismic Conditions
Class B Storage Facility	Unfrozen	2.3	1.6
	Frozen	2.3	1.6
Class C Storage Facility	Unfrozen	2.3	1.6
	Frozen	2.4	1.7
Overburden Stockpile	Unfrozen	1.5	1.1
	Frozen	1.6	1.2

EFFECTS OF PERMAFROST ON WASTE PILE STABILITY

Existing geotechnical SI data indicate permafrost is not ubiquitous throughout the project area. Zones of permafrost were encountered during the 1996 Golder SI program, primarily within the northern boundaries of the Class C Storage Facility and Overburden Stockpile areas. Drill holes completed downslope of the Class B and Class C facilities during the 2015 and 2016 KP SI program did not show evidence of permafrost. Permafrost was not observed within the Class B Storage Facility area in either site investigation program.

However, the effect of permafrost on slope stability is an important consideration in waste pile design, and the effects on slope stability need to be considered despite the limited coverage.

Permafrost typically exhibits higher strength than unfrozen soils due to its increased cohesion, however, slope creep can occur when building overtop of permafrost slopes, especially if thawing begins to occur. Excess pore-water pressure can build up along the thaw interface in a frozen soil if the rate of thaw exceeds the rate of consolidation, reducing the effective shear strength of a soil. The relative rates of the generation and drainage of excess pore fluids is referred to as the thaw-consolidation ratio (Smith, 1996). Shallow flow slope failures most commonly occur where the thaw-consolidation ratio exceeds 0.3, which is typically observed in saturated, fine-grained clayey silts and clays (Smith, 1996).

Permeable, coarse grained soils (such as those observed within the Class B Storage Facility, Class C Storage Facility, and Overburden Stockpile foundations) typically consolidate at the same rate that thawing occurs (Smith, 1996). Therefore, ultimately, the stability of a thawing slope on coarse-grained soils is dependent on the shear strength parameters of the unfrozen soil.

Shallow flow slope failure and slope creep caused by permafrost are not anticipated beneath the Class B Storage Facility, Class C Storage Facility, and Overburden Stockpiles for the following reasons:

- Permafrost was not observed within the Class B Storage Facility foundation area.
- Available data indicates permafrost is limited in coverage, occurring within the Overburden Stockpile and northern Class C Storage Facility areas.
- The Class C Storage Facility is placed in a confined valley with a shallow basin grade, thus limiting the potential for movement.
- The piles and stockpile foundations typically consist of sand and gravel soils with some silt. These soils are expected to consolidate at the same rate as thawing occurs, therefore exhibiting an effective shear strength similar to unfrozen soils during any thawing. Additionally, the stability model conservatively assumes fully saturated conditions for the foundation materials, which accounts for any buildup of fluid within the soil pores during thawing.

CONSTRUCTION AND OPERATION CONSIDERATIONS

The following are generally recommended methods of construction and operation to ensure ongoing stability and performance of the piles and stockpile. These methods may be updated and revised, as necessary, based on field observations and performance monitoring during the initial stages of waste and stockpile construction.

The pre-production phase should include the following tasks

- Determine temporary run-off and erosion controls for construction. These controls are applied on an as-needed basis. Controls may include run-off collection channels, settlement ponds, silt fences etc. and can be decommissioned once operations begin.
- Construct the permanent diversion channels and run-off collections ponds, as shown on Drawing C300.
- Topsoil should be stockpiled on site if revegetation of the storage facilities is required for closure and reclamation. The storage facility foundation areas should be cleared and grubbed vegetated areas prior to placement of rock fill.

General operations considerations are as follows:

- Rock fill and overburden materials will be transported from the pit using haul trucks. The material may be end dumped over the face or spread by dozers over the crest of the storage facilities.
- Trial sections may be constructed in the field during the initial stages of development to monitor rock fill pile stability and foundation performance. The various rock fill materials may be sampled for characterization and for durability test work to confirm the design parameters.
- Rock fill material shall be end dumped over the crest to allow for maximum segregation of the coarser material at the base of each bench. For overburden materials, end dumping short of the crest and dozing over may be required.

Detailed construction and operation guidelines will be developed during future design phases.

RECLAMATION

Reclamation of the Class B and C facilities will be required for mine closure. As much as practical the reclamation will be carried out concurrent with mine operations. It is anticipated reclamation of the Class B and C facilities will begin as sectors become inactive. Reclamation will be conducted in conjunction with on-going environmental monitoring to ensure that sediment control and water quality objectives are met.

The closure of the piles will include the resloping of the pile faces to facilitate the placement of soil and revegetation and to allow for water breaks. The final waste pile bench crests will be rounded and the faces sloped to improve the long-term erosion stability of the waste piles.

The Class B Storage Facility will have a low permeability capping layer placed over the surface to prevent the ingress of water and subsequent acid generation and leaching. The capping layer is assumed to be glacial till at this time, sourced from the overburden stockpile. The Class C facility will be capped with the remaining overburden and contoured to resemble the natural topography.

On-going monitoring of the Class B and C facilities will be required for mine closure. The design of the post-closure monitoring program will be developed over the mine life as experience is gained during the construction and operation of the two facilities. On-going monitoring will be defined in the closure design for the Class B and C facilities. The preliminary closure requirements for the Class B and C facilities are expected to include:

- On-going monitoring of surface and groundwater quality and flow rates
- Regular periodic inspection of the waste piles, and
- Deformation monitoring.

CONCLUSIONS AND RECOMMENDATIONS

PFS rock fill storage facilities and overburden stockpile designs have been completed for the Kudz Ze Kayah Project. These designs include the following key elements:

- Storage facility and stockpile location assessment and sizing for the Class B Storage Facility, Class C Storage Facilities, and Overburden Stockpile
- Geotechnical characterization of foundation conditions at each location
- Geotechnical characterization of storage facility and stockpile materials
- Failure hazard classification using the Waste Pile Stability Rating Scheme
- Static and seismic (for the 1 in 2,475-year earthquake event) limit equilibrium stability analyses for each facility, and
- Assessment of slope creep or slope failure potential due to influence of permafrost.

The Class B and C facilities were modelled to have 3H1:1V slopes and the overburden stockpile was modelled to have a 2.2H:1V slope. The stability analyses determined that each facility meets or exceeds the target FOS of 1.5 for static and 1.1 for seismic conditions.

The stockpile and storage facilities were rated according to the Waste Pile Stability Rating Scheme presented by the BC Mine Waste Rock Pile Research Committee. Each facility was determined to have a Moderate failure hazard level. The committee recommendations for investigation, design, and construction of moderate level facilities include detailed phased site investigations, lab testing, and detailed stability analyses.

It is recommended additional site investigation work is completed during future design phases. The 1996, 2015, and 2016 site investigations completed to date provide sufficient data for a pre-feasibility level study. However, there is a lack of test pit or drilling data along the upper slopes of the overburden stockpile and Class B Storage Facility. It is recommended that additional test pitting or soil drilling be completed throughout the upslope areas of these facilities in order to confirm or disprove the presence of permafrost. Additional soil samples should be collected for laboratory testing in future programs to provide data to better characterize the facility foundations.

The presence of permafrost within the facility footprints should be re-assessed once the installed thermistors reach equilibrium with ground temperatures and all logged data is collected.

The geotechnical model and material characteristics should be updated after additional geotechnical data is collected. The stability analyses should be updated using the new data during future design phases.

REFERENCES

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Yours truly,
Knight Piésold Ltd.

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. I. D. MAGOON # 36097 — Jan 23, 2017

Prepared: Greg Magoon, P.Eng.
Intermediate Engineer

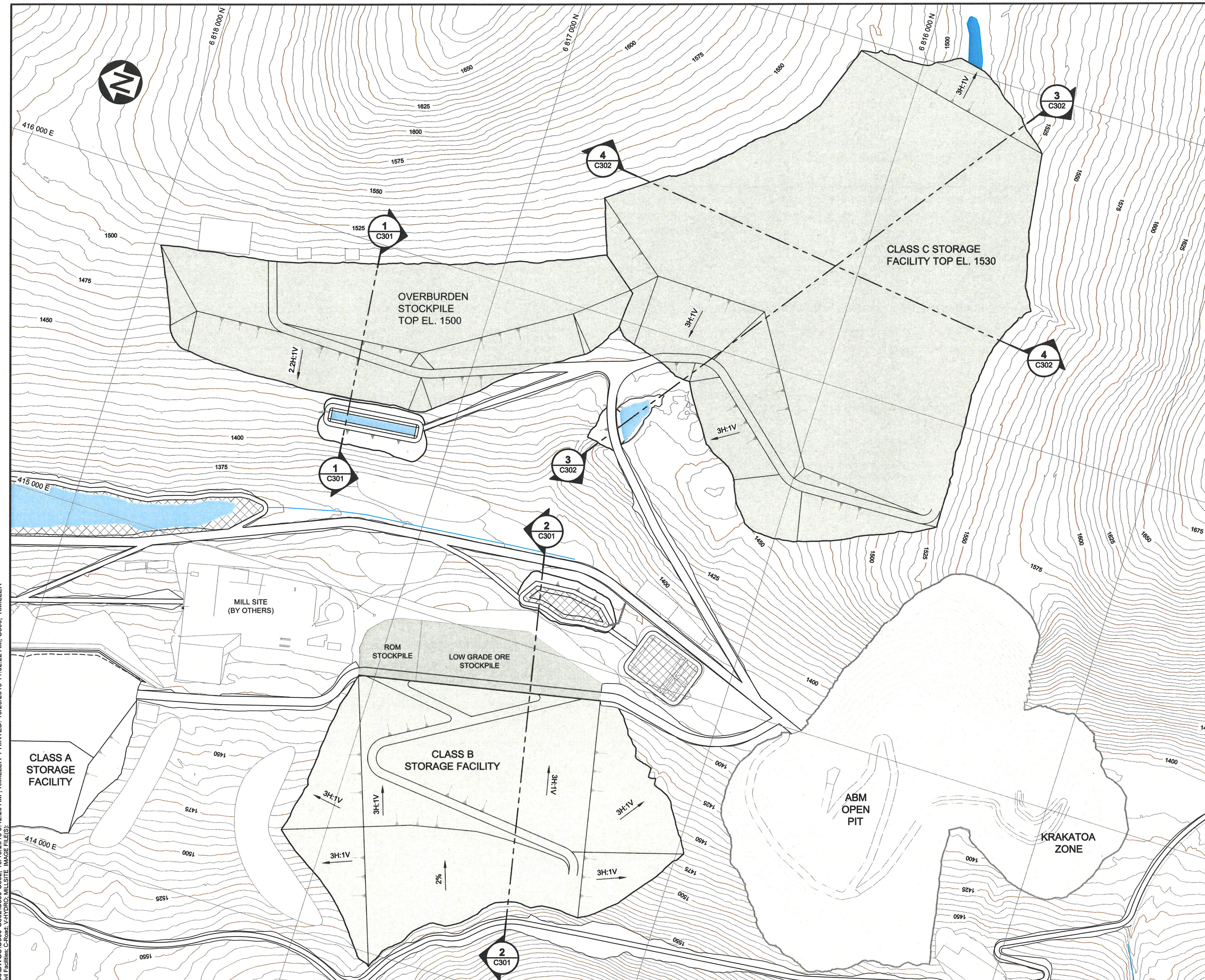
PROFESSIONAL ENGINEER — YUKON TERRITORY — L.J. GALBRAITH — Jan 23/17

Reviewed: Les Galbraith, P.Eng.
Senior Engineer | Associate

Approval that this document adheres to Knight Piésold Quality Systems: LJG

Attachments:

Drawing C300 Rev 0	Overburden Stockpile, Class B and Class C Storage Facilities – Plan
Drawing C301 Rev 0	Overburden Stockpile and Class B Storage Facility – Section 1 and 2
Drawing C302 Rev 0	Class C Storage Facility – Section 3 and 4
Appendix A	Waste Pile Stability Rating Scheme



PLAN
SCALE A

NOTES:

1. COORDINATE GRID IS UTM NAD 83 9N.
2. TOPOGRAPHIC DETAIL BASED ON INFORMATION PROVIDED BY BMC FEBRUARY 02, 2016.
3. CONTOUR INTERVAL IS 5 METRES.
4. ALL ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

SCALE A 120 60 0 120 240 360 480 600 m

PROFESSIONAL ENGINEER
YUKON TERRITORY
L.J. GALBRAITH
Oct 20/16

Knight Piésold
CONSULTING

BMC MINERALS (NO. 1) LTD.

KUDZ ZE KAYAH PROJECT

OVERBURDEN STOCKPILE, CLASS B AND CLASS C STORAGE FACILITIES PLAN

P/A NO.	DRAWING NO.	REVISION
VA101-640/2	C300	0

REFERENCE DRAWINGS

DRG. NO.	DESCRIPTION
C302	CLASS C STORAGE FACILITY - SECTIONS 3 & 4
C301	OVERBURDEN STOCKPILE AND CLASS B STORAGE FACILITY - SECTIONS 1 & 2

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	21OCT'16	ISSUED WITH REPORT	MAP	KJM		

SAVED: M:\1\01\00640\02\A\Acad\DWGS\C300-C302\C300-C302, 10/19/2016 9:42:20 AM , KMILLER PRINTED: 10/20/2016 11:02:22 AM, C300, KMILLER
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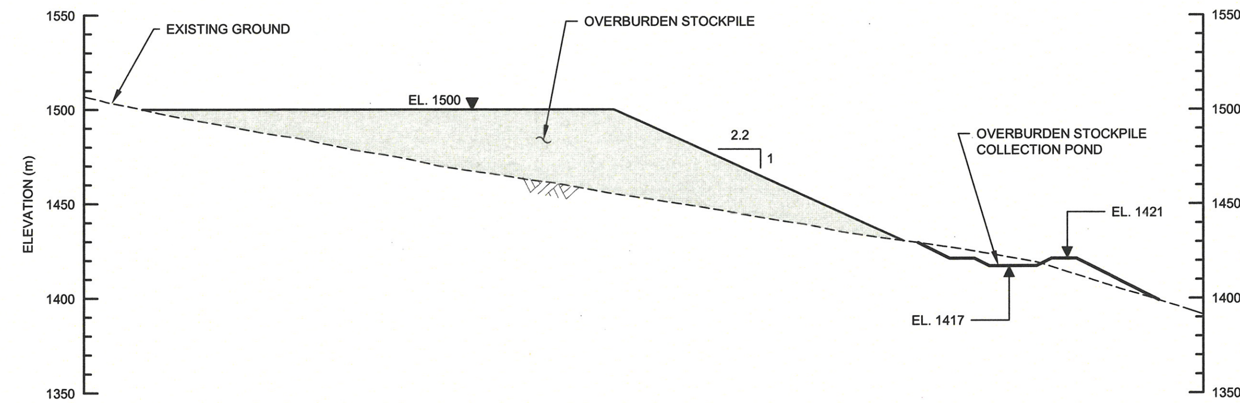
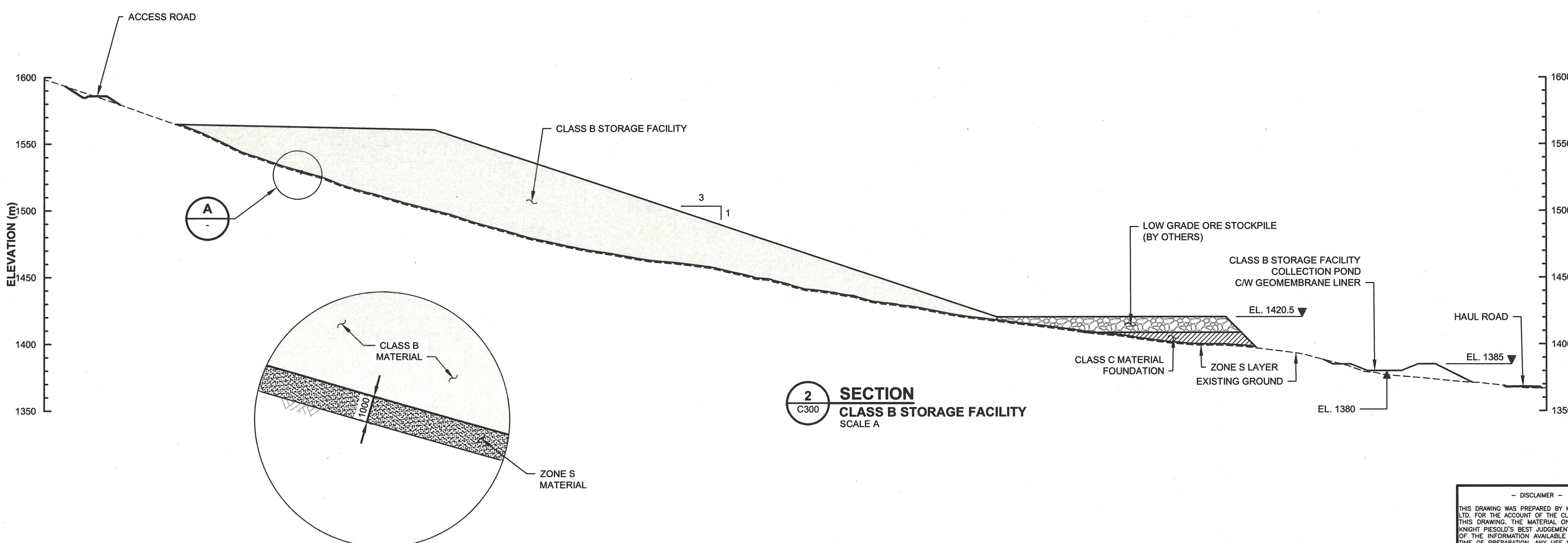


1 SECTION (C300)
OVERBURDEN STOCKPILE
SCALE A



2 SECTION (C300)
CLASS B STORAGE FACILITY
SCALE A

A DETAIL
NTS

LEGEND:

- CLASS B MATERIAL
- DRAIN ROCK
- ZONE S (BEDDING LAYER)
- CLASS C MATERIAL

SCALE A 40 20 0 40 80 120 160 200 m

NOTES:

1. ALL ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. BENCHES NOT SHOWN.

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PROFESSIONAL ENGINEER — YUKON TERRITORY — L.J. GALBRAITH — Oct 20/16

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KUDZ ZE KAYAH PROJECT

OVERBURDEN STOCKPILE AND CLASS B STORAGE FACILITY SECTION 1 AND 2

P/A NO.	DRAWING NO.	REVISION
VA101-640/2	C301	0

REFERENCE DRAWINGS

DRG. NO.	DESCRIPTION
C300	OVERBURDEN STOCKPILE, CLASS B AND CLASS C STORAGE FACILITIES - PLAN

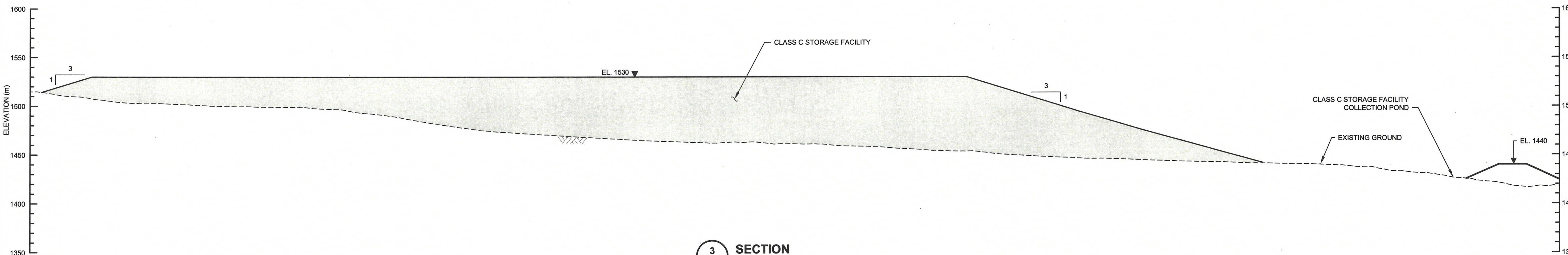
REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

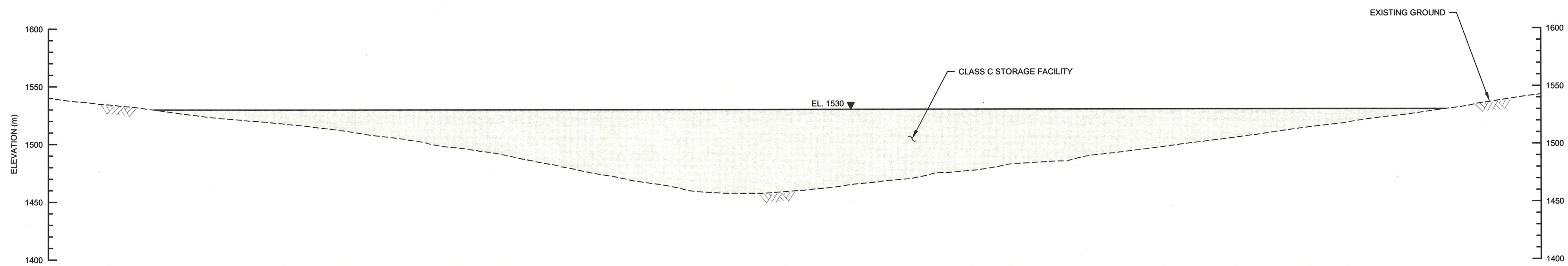
REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	21OCT'16	ISSUED WITH REPORT	MAP	KJM		

SAVED: M:\1\01\00640\02\A\Acad\DWGS\C300-C302\C300-C302, 10/19/2016 9:42:20 AM , KMILLER PRINTED: 10/20/2016 11:03:00 AM, C301, KMILLER
XREF FILE(S): V-TOPO-CONT-5.0m; Civil Facilities; C-Road; V-HYDRO; MILLSITE IMAGE FILE(S):



3 / C300 **SECTION**
CLASS C STORAGE FACILITY
SCALE A



4 / C300 **SECTION**
CLASS C STORAGE FACILITY
SCALE A

SCALE A 40 20 0 40 80 120 160 200 m

NOTES:

1. ALL ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. BENCHES NOT SHOWN.

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

DRG. NO.	DESCRIPTION
C300	OVERBURDEN STOCKPILE, CLASS B AND CLASS C STORAGE FACILITIES - PLAN

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	21OCT'16	ISSUED WITH REPORT	MAP	KJM		

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PROFESSIONAL ENGINEER — YUKON TERRITORY — L.J. GALBRAITH — Oct 20/16

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KUDZ ZE KAYAH PROJECT

CLASS C STORAGE FACILITY
SECTION 3 AND 4

P/A NO.	DRAWING NO.	REVISION
VA101-640/2	C302	0

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XREF FILE(S): V:TOPO-CONT-5.0m; Civil Facilities; C-Road; V-HYDRO; MILLSITE IMAGE FILE(S):

APPENDIX A

WASTE PILE STABILITY RATING SCHEME

(Pages A-1 to A-4)

TABLE 5.1

DUMP STABILITY RATING SCHEME

KEY FACTORS AFFECTING STABILITY	RANGE OF CONDITIONS OR DESCRIPTION		POINT RATING
DUMP CONFIGURATION		< 50m	0
		50m - 100m	50
DUMP HEIGHT		100m - 200m	100
		> 200m	200
DUMP VOLUME	Small	< 1 million BCM's	0
	Medium	1 - 50 million BCM's	50
	Large	> 50 million BCM's	100
DUMP SLOPE	Flat	< 26°	0
	Moderate	26° - 35°	50
	Steep	> 35°	100
FOUNDATION SLOPE	Flat	< 10°	0
	Moderate	10° - 25°	50
	Steep	25° - 32°	100
	Extreme	> 32°	200
DEGREE OF CONFINEMENT	Confined	-Concave slope in plan or section -Valley or Cross-Valley fill, toe butressed against opposite valley wall -Incised gullies which can be used to limit foundation slope during development	0
	Moderately Confined	-Natural benches or terraces on slope -Even slopes, limited natural topographic diversity -Heaped, Sidehill or broad Valley or Cross-Valley fills	50
	Unconfined	-Convex slope in plan or section -Sidehill or Ridge Crest fill with no toe confinement -No gullies or benches to assist development	100
FOUNDATION TYPE	Competent	-Foundation materials as strong or stronger than dump materials -Not subject to adverse pore pressures -No adverse geologic structure	0
	Intermediate	-Intermediate between competent and weak -Soils gain strength with consolidation -Adverse pore pressures dissipate if loading rate controlled	100
	Weak	-Limited bearing capacity, soft soils -Subject to adverse pore pressure generation upon loading -Adverse groundwater conditions, springs or seeps -Strength sensitive to shear strain, potentially liquefiable	200
DUMP MATERIAL QUALITY	High	-Strong, durable -Less than about 10% fines	0
	Moderate	-Moderately strong, variable durability -10 to 25% fines	100
	Poor	-Predominantly weak rocks of low durability -Greater than about 25% fines, overburden	200

Continued..

TABLE 5.1 (Continued)
DUMP STABILITY RATING SCHEME

KEY FACTORS AFFECTING STABILITY		RANGE OF CONDITIONS OR DESCRIPTION	POINT RATING
METHOD OF CONSTRUCTION	Favourable	-Thin lifts (<25m thick), wide platforms -Dumping along contours -Ascending construction -Wrap-arounds or terraces	0
	Mixed	-Moderately thick lifts (25m - 50m) -Mixed construction methods	100
	Unfavourable	-Thick lifts (> 50m), narrow platform (sliver fill) -Dumping down the fall line of the slope -Descending construction	200
PIEZOMETRIC AND CLIMATIC CONDITIONS	Favourable	-Low piezometric pressures, no seepage in foundation -Development of phreatic surface within dump unlikely -Limited precipitation -Minimal infiltration into dump -No snow or ice layers in dump or foundation	0
	Intermediate	-Moderate piezometric pressures, some seeps in foundation -Limited development of phreatic surface in dump possible -Moderate precipitation -High infiltration into dump -Discontinuous snow or ice lenses or layers in dump	100
	Unfavourable	-High piezometric pressures, springs in foundation -High precipitation -Significant potential for development of phreatic surface or perched water tables in dump -Continuous layers or lenses of snow or ice in dump or foundation	200
DUMPING RATE	Slow	-< 25 BCM's per lineal metre of crest per day -Crest advancement rate < 0.1m per day	0
	Moderate	-25 - 200 BCM's per lineal metre of crest per day -Crest advancement rate 0.1m - 1.0m per day	100
	High	-> 200 BCM's per lineal metre of crest per day -Crest advancement > 1.0m per day	200
SEISMICITY	Low	Seismic Risk Zones 0 and 1	0
	Moderate	Seismic Risk Zones 2 and 3	50
	High	Seismic Risk Zones 4 or higher	100

MAXIMUM POSSIBLE DUMP STABILITY RATING: 1800

TABLE 5.2

DUMP STABILITY CLASSES AND RECOMMENDED LEVEL OF EFFORT

DUMP STABILITY CLASS	FAILURE HAZARD	RECOMMENDED LEVEL OF EFFORT FOR INVESTIGATION, DESIGN AND CONSTRUCTION	RANGE OF DUMP RATING (DSR)
I	Negligible	-Basic site reconnaissance, baseline documentation -Minimal lab testing -Routine check of stability, possibly using charts -Minimal restrictions on construction -Visual monitoring only	< 300
II	Low	-Thorough site investigation -Test pits, sampling may be required -Limited lab index testing -Stability may or may not influence design -Basic stability analysis required -Limited restrictions on construction -Routine visual and instrument monitoring	300-600
III	Moderate	-Detailed, phased site investigation -Test pits required, drilling or other subsurface investigations may be required -Undisturbed samples may be required -Detailed lab testing, including index properties, shear strength and durability likely required -Stability influences and may control design -Detailed stability analysis, possibly including parametric studies, required -Stage II detailed design report may be required for approval/permitting -Moderate restrictions on construction (eg. limiting loading rate, lift thickness, material quality, etc.) -Detailed instrument monitoring to confirm design, document behaviour and establish loading limits	600-1200
IV	High	-Detailed, phased site investigation -Test pits, and possibly trenches, required -Drilling, and possible other subsurface investigations probably required -Undisturbed sampling probably required -Detailed lab testing, including index properties, shear strength and durability testing probably required -Stability considerations paramount. -Detailed stability analyses, probably including parametric studies and full evaluation of alternatives probably required -Stage II detailed design report probably required for approval/permitting -Severe restrictions on construction (eg. limiting loading rates, lift thickness, material quality, etc.) -Detailed instrument monitoring to confirm design, document behaviour and establish loading limits	> 1200

TABLE 6.4

INTERIM GUIDELINES FOR MINIMUM DESIGN FACTOR OF SAFETY [1]

STABILITY CONDITION	SUGGESTED MINIMUM DESIGN VALUES FOR FACTOR OF SAFETY	
	CASE A	CASE B
STABILITY OF DUMP SURFACE		
–Short Term (during construction)	1.0	1.0
–Long Term (reclamation – abandonment)	1.2	1.1
OVERALL STABILITY (DEEP SEATED STABILITY)		
–Short Term (static)	1.3 – 1.5	1.1 – 1.3
–Long Term (static)	1.5	1.3
–Pseudo–Static (earthquake) [2]	1.1 – 1.3	1.0

CASE A:
- Low level of confidence in critical analysis parameters
- Possibly unconservative interpretation of conditions, assumptions
- Severe consequences of failure
- Simplified stability analysis method (charts, simplified method of slices)
- Stability analysis method poorly simulates physical conditions
- Poor understanding of potential failure mechanism(s)

CASE B:
- High level of confidence in critical analysis parameters
- Conservative interpretation of conditions, assumptions
- Minimal consequences of failure
- Rigorous stability analysis method
- Stability analysis method simulates physical conditions well
- High level of confidence in critical failure mechanism(s)

NOTES: 1. A range of suggested minimum design values are given to reflect different levels of confidence in understanding site conditions, material parameters, consequences of instability, and other factors.

2. Where pseudo–static analyses, based on peak ground accelerations which have a 10% probability of exceedance in 50 years, yield F.O.S. < 1.0, dynamic analysis of stress–strain response, and comparison of results with stress–strain characteristics of dump materials is recommended.