Addendum to 2018 Annual Slope Stability Report Per TR0014 DRMS 2006
11/30/18

Re: DRMS Annual Report MLRB 1978-208
From MooresJ
To M Cunningham Sr Environmental Manager, Department Director
Department of Natural Resources
Division of Reclamation Mining and Safety
11/30/18

Sent by email

ADDENDUM TO EARLIER INSPECTION REPORT RESPONSE

INFORMAL Notes and observations regarding the stability and performance of the highwall relative to the original design criteria, and comments on the geological characteristics of the developing deposit beyond the advancing highwall.

I note that you should have in your possession the detail regarding the highwall, the topo and the technical revision with the weed plan, and of course the signage was addressed some time ago, in the possession of the DRMS at this time, these matters arising out of the January 28 2018 inspection earlier this year. I would really appreciate confirmation of those documents together with any comments or approvals to make sure they conform to your expectations. I am happy to send those also, however given the size of the documents (some of the attachments were dating back to the original 1979 drawings) may I offer them in a cloud based format such as drobox? They seem to be a little too large for conventional email

I spent quite a bit of additional time fine tuning the highwall configuration in order to demonstrate the benches present as stipulated in the planned mine design presented to the Division and under the Divisions recommendations approved by the Board in 2006. We have seen a broad degree of success with this geometry and the indications from a brief analysis I conducted recently are that the highwall in performing in excess of the anticipated minimum standards as outlined by Alan Howard, Brierley and Associates, in his 2006 geotechnical report. Much of this can be explained as the competency of the material is significantly improving, as we had anticipated it would, as the highwall advanced through a weathered superficial lawyer of the migmatized granite, into the more solid, competent, homogeneous and structurally consistent, more felsic matrix, and one sees a greater percentage by volume of the Pikes Peak Formation, characterized by a lighter pink matrix, heavily mineralized with well-developed slower cooling quartz crystals which form a strong, durable component.

We further note that there is no apparent structure exposed in advance of nor by the advancing highwall. Any foliated lithology, where this is still chiefly present in the Idaho Springs Formation, is superficial or non-occurring through the complex undulating folds of the complex interface between the two lithology's, and the interstitial matrix is sound, dense and relatively neutral or characteristically very hard, typically moderately to highly abrasive, uniform, free from deleterious mineralization's and other alterations, , resistant to weathering upon its surface exposures, with a less apparent dip/strike as the blocky or laminated character of the deposit to the west s gradually absorbed by the contact area.

In conclusion, we are very happy with the manner in which the highwall has performed based upon the initial design criteria from 2006, and satisfied that the highwall is stable, and not yielding materials in any type of uncontrolled manner based on our observations. We check the stability of the exposed face

several times a week, occasionally daily. . I have photographed the development of the highwall in order to secure a documented record of the exposed face, together with any activity.

This type of deposit is highly satisfactory, given the mining constraints employed, and has performed exceptionally well. Comparatively, the structural component for the final highwall design at Shaffers Crossing has exhibited and performed perhaps with less relative activity and movement, than any other commensurate quarry highwall regionally. Doing so while exposing a mined face that is significantly taller than most of its competitors. This attests to the stability and superior minable characteristics of the underlying lithology that allows this type of configuration to stand so well.
All indications are that this performance with maintain at the current level or improve as the face advances. The benches, while relatively obscure, can be demonstrated to be in place and consistent with the plan as submitted and approved.

Secondly, the nature of the blocky character of the westernmost art of the deposit, exhibits laminations and 'layering' trending NE/SW or close to 0 degrees and dipping in a declining fashion, moderately to variable, to the ESE at between 21 and 39 degrees on average.
The stratigraphic principal trending alignment affords an excellent level of stability as a result of this configuration as the bearing moment tends to be thrust downwards at approximately 90 degrees and obliquely and laterally horizontally and declining back into the hill with somewhat less force. The net results that this has developed a well confined set of strata, uniquely well suited for the direction of the advancing highwall, leaving any exposed face quickly stable with a minimum potential for any spalling or other activity.

This material apparently lends itself very well to the irregular more aesthetically pleasing blasting technicques deliberately employed in order to obtain an a more natural, less artificial appearance commonly found in decouple presplit shots. We believe that this has achieved the desired effect of a more natural, 'softened' appearance for the final highwall, without sacrificing safety and while optimizing both the stability and extraction performance from the final pit limits.

As such and give the deposit is uniform, hard, durable and unremarkable in terms of any structural or chemical deformities or other irregularities, and is characteristized by being routine and unblemished, we are confident that this deposit presents the opportunity todevelop a mined column depth of well in excess of 950 feet, a depthe we are close to approaching at this time, with no exceptional or remarkable comments and a high degree of confidence. We hope very much you will concur.

I am happen to verify my field observations and calculations with a technical expert in this area. I am happy to discuss my observations with experts from the Division at your convenience. I am also happy to provide my shear analysis and rotation calculations at your request

Thank you

Moores, J
Mining Engineer, Business Development Manager
Elk Creek Companies
Shaffers Crossing Quarry
Ref highwall bench development/ design questions
Please feel free to comment and advise

Prepared on behalf of the Operator by Juliet Moores
Elk Creek Sand & Gravel LLC

ADDENDUM TO 2018 ANNUAL DRMS REPORT

Review conducted by Steven Brockman, PE, Civ. Eng.
Re: DRMS Annual Report MLRB 1978-208
From MooresJ
To M Cunningham Sr Environmental Manager, Department Director
Department of Natural Resources
Division of Reclamation Mining and Safety

Sent by email

11/30/18

COLORADO DRMS PERMIT # MLRB 1978-208

Observations and Comments regarding any changes observed from the Previous year to the HIGHWALL including a slope stability analysis and Geotechnical observations, as these relate to the performance of the highwall and how installed relative to the original design criteria, and comments on the GEOLOGICAL CHARACTERISITICS, FEATURES AND LITHOLOGY of the developing deposit beyond the current position of the highwall advancing to the ESE.

PREVIEW NOTE

This ENGIEERING REPORT is compiled and REVIEWED and then submitted in conjunction with, and should be used in connection with, the following reports

- DRMS GRADING COMPLIANCE REPORT – indicates that the grading disturbances on the parcel of land immediately adjacent to the mine permitted property are taking place primarily within the colluvium and decomposed materials that appear to the South and South-west of the primary mining activity and are not connected to the mining activity nor do they impinge on the mining activity in any manner. The excavation depth is typically 2'-0" or less and offers an insight into the limits to which the colluvium and lighter decomposed materials overlay the minable deposit, essentially providing an exposed window in the mining section in the adjacent parcel
- DRMS BENCH COMPLIANCE REPORT – indicates that Benches are in place and constructed in accordance with and in compliance with the mine reclamation plan as submitted to and approved by the Board on the recommendations of the Divisions
- Fox (1978) Geological Report – suggest that the materials are typically of a lower grade in the RQD value and are decomposed; such an analysis is consistent with the authors restrictive exposure to the full potential of the deposit not having the tools to develop a more comprehensive analysis as the harder, more competent material is exposed preferentially in the mined section as the highwall advances to the ESE

- Brierley And Associates (2006) Geotechnical Slope Stability and Geological Report – This report tends to reflect an improvement on the earlier Fox Report but is subject to many of the same limitations, in that the author was forced to draw many of their concludes given only having he limited fresh faces exposed in the active workings, such as existed at the time of the report, and having a higher percentage of poorer quality, lower RQD value materials in the naturally- spalled weathered materials collected from the toe of the slope of the broader joint sets, somewhat opened about 14 to 36 % from weathering as they are closer to the weathered zonae and within the largely biotite rich migmaticitic mafic deposit, the fine grained movement heavy gneiss tends to weather at a slightly faster rate than the more pegmatite felsic rich later injections of quartz and lighter mineralization rich post injection intrusions into the complex contact area.
  This material occurs with a much higher frequency approaching the largely vertical-sub vertical contact one, intruding in roughly hemispherical bubble shaped injection that cool at a slower rate, given the higher percentages of quartz in the liquid, giving raze to a higher percentage (over 60%) of K and Na-rich twinned feldspar crystals and an estimated 42 to 57% of striking well developed lightly stained quartz crystals.
  Biotite rarely appears even within the native Idaho Springs Formation and is largely driven out of the deposit at this point.
  The joint sets rotate from being somewhat oblique to one another immediately parallel subparallel to the existing highwall and ted to be more cubic and at 90 degrees to one another with the primary joint set trending North North East at between 69 degrees and 89 degrees and the second set largely horizontal to sub horizontal. There is increasing levels of situation in the joint sets as the deposit trends through towards the west in general and slightly more to the South.
  All this material has been mined out and this information is based on the direct information by experience of the Operator.
  There is remarkably little deleterious materials and no alteration to speak of through the bulk of the advancing deposit to the east of the existing highwall. This makes sense since observations indicate that due to the slower cooling rates of the largely felsic material, we are seeing classic example of a lighter, typically very hard, somewhat abrasive, light pink or rose colored hue, free of the feldspathc alterations frequently seen elsewhere in norther exposures in local quarries.
  The reason that there is no alteration is that tis deposit is also remarkably free of any structure and thus there is none of the hydrothermal alterations that chiefly characterize the Pikes Peak formation elsewhere, giving rise to the characteristic decomposed granite.
  No this deposit is about as clean and unadulterated as it gets, yielding some breath taking 21 to 54 values on the LA abrasion index at the peak of the deposit
  T nearest structure observed is by reference (CDOT Geotechnical reports 2009, Yen and Assoc., CDOT NH2854-109 Preconstruction geotechnical repot). This is defined as a shear zone trending vertical to sub vertical and essentially following the alignment of the 285 corridor. The pint of contact exposure is immediately under the Southbound lane of SH285 trending east-west roughly and the shear zone is associated with much softer substrate, largely Qu alluvium, some past depositional alteration in the zone immediately adjacent to the structure up to a n offset distance approaching 18 feet in either direction with a zone of influence some 67 to 90 feet in the aggregate
  We further note that there is no apparent structure exposed in advance of nor by the advancing highwall.
  Any foliated lithology, where this is still chiefly present in the Idaho Springs Formation, is superficial or non-occurring through the complex undulating folds of the complex interface between the two lithology's, and the interstitial matrix is sound, dense and relatively neutral or

characteristically very hard, typically moderately to highly abrasive, uniform, free from deleterious mineralization's and other alterations, resistant to weathering upon its surface exposures, with a less apparent dip/strike as the blocky or laminated character of the deposit to the west s gradually absorbed by the contact area.

- In conclusion, we are very happy with the manner in which the highwall has performed based upon the initial design criteria from 2006, and satisfied that the highwall is stable, and not yielding materials in any type of uncontrolled manner based on our observations. We check the stability of the exposed face several times a week, occasionally daily. Have photographed the development of the highwall in order to secure a documented record of the exposed face, together with any activity. (EXHIBIT 3)

- This type of deposit has performed exceptionally well from a slope stability perspective, since the primary dipping angle of the referentially foliated biotite gneiss (now largely all gone) is 'laid back' into the direction of mining and dipping deckling back against it at an angle of between 23 and 46 degrees, this allow the deposit to 'stick;' the overbearing load down against itself, effectively forcing or producing a compounded vertical moment which gives this highwall and deposit its legendary strength.

- The rock itself at this point through the deposit may only be yielding a modular 19.6 to 38 on LAs and still include some mineralization, or did before it was all removed, but the way it lays back into the hill allows it to develop a formidable tensile strength and perform at exceptionally high levels structurally and mechanically, thus precluding the potential for a rotational moment through the crest of the highwall.

- The materials geotechnical characteristics and highly satisfactory, and together with the mining constraints employed, and has performed exceptionally well. Comparatively, all indications are the structural component for the final highwall design at Shaffers Crossing has exhibited and performed perhaps with less relative activity and movement, than any other commensurate quarry highwall regionally. Doing so while exposing a mined face that is significantly taller than most of its competitors. This attests to the stability and superior minable characteristics of the underlying lithology that allows this type of configuration to stand so well.
- All indications are that this performance with maintain at the current level or improve as the face advances. The benches, while relatively obscure, can be demonstrated to be in place and consistent with the plan as submitted and approved.

- Secondly, the nature of the blocky character of the westernmost art of the deposit, exhibits laminations and 'layering' trending NE/SW or close to 0 degrees and dipping in a declining fashion, moderately to variable, to the ESE at between 21 and 39 degrees on average.
- The stratigraphic principal trending alignment affords an excellent level of stability as a result of this configuration as the bearing moment tends to be thrust downwards at approximately 90 degrees and obliquely and laterally horizontally and declining back into the hill with somewhat less force. The net results that this has developed a well confined set of strata, uniquely well suited for the direction of the advancing highwall, leaving any exposed face quickly stable with a minimum potential for any spalling or other activity.

- This material apparently lends itself very well to the irregular more aesthetically pleasing blasting technicques deliberately employed in order to obtain an a more natural, less artificial appearance commonly found in decouple presplit shots. We believe that this has achieved the desired effect of a more natural, 'softened' appearance for the final highwall, without sacrificing safety and while optimizing both the stability and extraction performance from the final pit limits.

- As such and give the deposit is uniform, hard, durable and unremarkable in terms of any structural or chemical deformities or other irregularities, and is characteristized by being routine and unblemished, we are confident that this deposit presents the opportunity to develop a mined column depth of well in excess of 950 feet, a depth we are close to approaching at this time, with no exceptional or remarkable comments and a high degree of confidence. We hope very much you will concur.

- 2013 Colorado Forest Ag Management Plan
- Jefferson Soil Conservation District Notes
- UDFCD Drainage Management Criteria Runoff data
- DAILY WORKPLACE INSPECTION REPORTS: HIGHWALL (3rd QUARTER PROVIDED: June, July, Aug, Sept 2018) Pursuant to 30CFR Part 56/57/58 & Part 62, Subpart B- Ground Control (Federal Metal and Nonmetallic Mine Training, Safety & Health Standards for Surface and Underground Mines) provided by Operator and produced each day in connection with daily safe workplace management practices

I note that you should have in your possession the detail regarding the highwall, the topo and the technical revision with the weed plan, and of course the signage was addressed some time ago, in the possession of the DRMS at this time, these matters arising out of the January 28 2018 inspection earlier this year. I would really appreciate confirmation of those documents together with any comments or approvals to make sure they conform to your expectations. I am happy to send those also, however given the size of the documents (some of the attachments were dating back to the original 1979 drawings) may I offer them in a cloud based format such as drobox? They seem to be a little too large for conventional email

THIS REPORT COMPRISES TWO PARTS AS FOLLOWS

1. A geotechnical, slope stability analysis and engineering report on the highwall – addresses the current condition of the highwall as an annual report requirement as outlined under the technical revision submitted 2006. This arose as the highwall was designed to accommodate a moderately steep angle of repose closer to 70 degrees and criteria established by the Division in establishing the safety factor, or degree of certainty with which the Operator can develop in predicting any likelihood of potential failure, was required which demonstrates that the lithology and its joint subsets can accommodate this geometrical configuration with a strong degree of confidence
2. GEOLOGICAL REPORT – this report addresses changes that have developed to the previously issued geological report arising from the advances in the mining and stabilization of the highwall, cleaning up and exposure of the substrate, indicating lithology types that can be extrapolated with a stronger degree of confidence throughout the adjacent deposit. The

subsurface relationship between control points, allows a moderate to good degree of certainty in determining the lithological characteristics which will predominate during mining and define the behavior of the deposit during extraction, optimizing the pit limits and material availability

Each one of these reports are examined in a little more detail and the data sets derived from field analysis are explored in order to determine the degree of confidence with which concussions can be developed

DATA COLLECTION

Data was collected including joint set data in a variety pf locations throughout the exposed primary face along six (6) data collection points where it was determined that the pit limits had been met or that were representative of this condition. These were fresh faces, not weathered and typically appear in the Idaho Springs formation, a migmatized granite gneiss. The presence of mineralization was declining however joint sets still exit throughout this that are typically representative of the earlier joint sets as described in the earlier reports by Brierley et al (2006)

1. GEOTECHNICAL REPORT, SLOPE STABILITY ANALYSIS AND ENGINEERING REPORT ON HIGHWALL

The Brierley Report (2005) described the site geology as per the original description from the Fox Report prepared by F.M. Fox Associates, Inc. (1878) (1) at the time of original DMG permitting in 1978. A copy of this document is included as Attachment A for reference.

The colluvium described in the Fox Report and Brierley Report no longer exists within the quarry in the active mining area. This has been harvested or mined and 100% of the extracted materials were used.

The Precambrian bedrock, known commonly locally as the Pikes Peak and Idaho Springs Formation is exposed, presenting a clean, hard tight principally mafic formation, free from discontinuities or any type of structural abnormality, alternation , significant moralization or heat alteration (shear) zone.

There is a thin veneer of the hillside colluvium (up to0 several feet), to the East and South of the mining property on the adjacent parcel The colluvium is Pleistocene to Holocene (Recent) Pleistocene alluvium reportedly exists at the extreme western edge of the site, but is not of interest because it is west of the active mining operations.

Mining method is largely a standard block extraction technique with little or no blending required due to the homogeneous nature of the site

Mining takes place typically by blasting in increments of 60,000 to 100,000 tons per shot in a predetermined pattern given the proximity of the shot to any surface weathering or the highwall. The shot has exhibited a high level of efficiency and a low relative powder factor. Non el delays are typically utilized for each shot.

Blasting takes place to maximize removals efficiently however in order to accommodate the 3D renders simulation and other submitted at time of approvals in front of the Board and to the PUD Special Use Application (County) some 'offset' blasting ND other staggering or decoupling techniques allow for the highwall to conform to a more softened appearance arising from the irregular shot pattern proximal to the final pit limits.

The rational for this is that we can definitively indicate that the structural components of the original engineered intent of the configuration are not impaired nor abridged bit these modifications, and as a result the highwall maintains the same engineering values and characteristics preventing a toppling or overturning moment from arising, but he finished appearance of the highwall is slightly more irregular than a conventional highwall in appearance only, thus offering a more natural appearance, encouraging and offering nesting habitat.

The Fox report appears to be based on the Reconnaissance Geologic Map of the Pine Quadrangle (1:24,000) (2). A copy of an excerpt from that map showing the project site area is included as Attachment B to this report. The geologic information included in this reference confirms bedrock consisting of migmatitic biotite gneiss with biotite schist, granitic gneiss and amphibolite. General geologic structure mapped near the quarry includes north to northwesterly striking, easterly to northeasterly dipping foliation and metamorphic compositional layering generally parallel to the

foliation. Dips are shallow to moderately steeply dipping, and generally into the hillside at the quarry site.

The Brierley Report indicates that the site had evolved into a

With respect to the four summary and conclusion items included in the Fox report, Brierley Associates offers the following updated comments:

1. We concur that the site bedrock is composed of compositionally layered metamorphic rocks that include interlayered biotite gneiss, biotite schist, and amphibolite and granite gneiss. These rocks are commonly referred to as the "Idaho Springs Formation" as indicated in the Fox Report, but are referred to as the undifferentiated metamorphic rocks of Precambrian Age (1,700-1,800 m.y.) on the predominant gneiss rocks, irregular bodies of rock composed of granitic lithology also occur within the layered metamorphic rock types.
2. We concur that metamorphic foliation is developed parallel to well-developed metamorphic layering, which generally dips moderately steeply into the hillside. The Fox report indicates an easterly dip. Our mapping efforts indicate an average northeasterly dip as discussed further below.
3. We concur that the rocks presently exposed do not exhibit any prominent faulting. We do find there to be mappable jointing in the rock mass, in addition to the foliation jointing. One could argue this jointing is not "prominent" in that it is not continuous over hundreds of feet, there are jointing trends continuous over tens of feet that could affect slope stability as discussed further below.

1 Preliminary Geologic Evaluation of a Proposed Aggregate Quarry Site at Shaffers Crossing, Jefferson County Colorado; F.M. Fox Associates, Inc.: May 5,1978
2 Reconnaissance Geologic Map of the Pine Quadrangle, Jefferson County, Colorado; by Bruce Bryant; Miscellaneous Field Studies Map MF-598; U.S.Geological Survey; 1974
3 Geologic Map of Colorado; Compiled by Ogden Tweto; U.S. Geological Survey (In Cooperation with The Geological Survey of Colorado);1979

4. We concur that the favorable attitudes of the dominant foliation into the hillside is generally compatible with the originally proposed 1:2 (H:V) slope ratio. Additional discussion about slope stability and proposed steepened slopes is included in the slope stability section below.

Finally, the Geologic Map of Colorado (1:500,000) indicates two northwesterly faults transecting or passing just southwest of the site. These faults would be considered inactive and cut across the both Precambrian metamorphic rocks that occur southeast of U.S. 285 and slightly younger granitic rocks (Silver Plume Quartz Monzonite and Pikes Peak Granite) that occur northwest of the highway.

B. Site Topography (G.1.b)

The site location and topography are discussed in detail in the attached Fox report submitted as part of the original DMG permitting and those details are not repeated herein. Additional comments about site topography for the present rezoning effort include the following:

1. Pre-mining slopes at the site were closer to approximately 2:1 than 2.5:1 as reported in the Fox report.
2. The cut slope along the west side of U.S. 285 across the highway from the quarry is approximately 1:1 overall, and steeper in the lower cut face.
3. Historic mined and reclaimed slopes by others at the site are as steep as 1:2 and appear to be generally stable.

A site topographic map was included in the original DMG permit application. This map is included as Attachment A to this report. The Geologic Map prepared for this report and included in Attachment B also shows the pre-mining topography. In addition, Elk Creek has developed a very detailed site topographic map prepared by Falcon Surveying, Inc. based on a June 2, 2004 field survey. A copy of the new detailed topographic map showing existing conditions (1 in = 40 ft; 1 ft contour interval) is provided elsewhere in the rezoning submittal.

C. Test Borings or Core Samples (G.1.c.)

No test borings were performed and no core samples were obtained as part of original site permitting efforts. Since that time quarry development has occurred and there are ample bedrock exposures at the site to preclude the need for test drilling to identify site lithologies. Topsoil and overburden thickness are negligible, varying from less than a foot to approximately 3 ft thick. There is an upper weathered bedrock zone in which moderately severely weathered to completely weathered bedrock extends approximately 15 to 20 ft into the rock mass. Bedrock exposures at the site have been mapped for geologic structure and these data are included in the slope stability section below.

D. Sites of Special Geologic Interest (G.1.d.)

There are no known or suspected sites of special geologic interest (e.g., fossil beds) at this site. No features of special geologic interest are anticipated to occur because the site is located within an extensive outcrop of Precambrian metamorphic rocks that are prevalent in the Front Range from west of Colorado Springs north to west of Fort Collins.

E. Geologic Hazards (G.1.e and G.1.f)

According to Section 48: G-H of the Jefferson County Zoning, a Geologic Hazard Overlay District has been established to address four (4) types of geologic hazards: slope failure complexes, landslide areas, rockfall areas and subsidence areas. Geologic Hazard Overlay District Zoning Maps have been created to help regulate development in areas susceptible to these geologic hazards.

The Elk Creek Quarry is located in an area well outside (south and west of) any existing Geologic Hazard Overlay District Zoning Maps. Therefore, any concerns about geologic hazards at this site would address unzoned or other geologic hazards. There is no evidence at the site of slope failure, landslide areas or subsidence. Rockfall areas exist as part of the active mining operation within areas that will be completely mined out before establishing final benches and highwalls.

Earthquakes, seismic shaking and liquefaction are not considered to be geologic hazards at the site. The potential for radon gas in this part of the Country is beyond the scope of this geologic report and site radioactivity potential is addressed by Elk Creek in another part of the rezoning application.

F. Slope Stability (G.1.g)

In order to provide an updated evaluation of slope stability at the site, Brierley performed structural geologic mapping of rock mass discontinues exposed at the site, and made generalized stability analyses based on these data. Bedrock exposures at the site primarily reveal foliation jointing's subparallel to metamorphic compositional layering. The foliation strikes northwest and dips from shallow to moderately steeply to the northwest, generally into the hillside that is being mined. Secondary joints that are steeply dipping to sub vertical also occur. Finally, tertiary joints exists that dip northwest to southwest, or generally out of the hillside that is being mined. The foliation joints are persistent across the site. The sub vertical joints are persistent for up to 10 to 25 ft. The tertiary joints that daylight in the cut slopes are only persistent on the scale of several feet based on the exposures to date.

The joint mapping data is summarized in both spreadsheet and stereonet format in Attachment C and the following average joint data are interpreted from these mapping data:

Strike	Dip	Joint Designation	Remarks
N33W	35NE	J-f	Foliation (Primary)
N58W	74NE	J-1	Secondary
N54E	75SE	J-2	Secondary
N38W	77SW	J-3	Secondary
N54e	76NW	J-4	Secondary
N27W	41SW	J-5	Tertiary
N20E	40NW	J-6	Tertiary

Stability evaluations for proposed highwall slopes were preformed using the average joint orientations listed above. There were based mainly on the primary foliation and secondary steeply dipping joints, but also considered the tertiary daylighting joint sets. Because the tertiary joint sets are not very common or persistent, the two sets were averaged into one westerly dipping orientation for the analyses. Also because of the lack of occurrence and persistence of these tertiary features, they are considered to be relevant only to individual highwall, and not overall slope, stability.

The stereonet analysis and summary included in Attachment D shows potential; sliding plane and wedge failures. These all assume continuous, through-going joint features, which is a conservative assumption for this rock mass. Analysis shows potential slope failures if the slope were steepened to 1:4 from originally proposed 1:2 configuration, but acceptable slope conditions for a quarry development if steepened to 1:3 as Elk Creek is presently proposing (12 ft benches by 35 ft highwalls = 1:2.9).

For slope failures to occur, planar or wedge failures must first be kinematically (geometrically) possible or admissible. In addition, for given possible planar or wedge failures mode, the material strength properties of the rock must be low enough for these failures to be mechani9cally possible or admissible. Such analyses were run for all kinematically admissible planes and wedges for both weathered and unweathered rock using internal friction angles of 30 degrees and 40 degrees, respectively.

For the proposed 1:3 slopes, our analyses indicate that sliding failure is kinematically admissible only on the averaged westerly dipping joint set, but that this is mechanically admissible only in the upper weathered rock. Toppling failure is not kinematically admissible for any of the six joint sets analyzed. Of five wedge failures modes identified in the analyses, three are kinematically and mechanically admissible in the upper weathered rock, but not in the general rock mass. Two of the wedges might require spot bolting, but limited individual wedge failure in final highwalls is usually considered acceptable in quarry operations. As an example, DMG permitting for the Morrison Quarry in a similar rock mass assumed up to 15 to 20 percent such failures to be acceptable. The upper weathered rock should be laid back to 1:1 for long term stability.

Part of the slope stability analyses included interpretation of rock mass classification and therefore, strength properties. Summaries of estimated rock mass properties based on rock mass classification

schemes (RQD,RMR and Q) 4 , as well as on general rock mass type summaries that were used in the analyses are also included in Attachment D.

It is important to note that our analyses were based on the rock mass exposures available for viewing in the quarry during July 2004 and the assumptions detailed in this report. Quarry development should occur as an observational approach whereby initial observations and assumptions are verified periodically during final highwall development and if possible, adjustments made in future observations reveal conditions significantly different than those assumes to begin with. It is recommended that the operator make and document such periodic observations, either with their own qualified forces, or by retaining a qualified geotechnical practitioner. Should future exposures reveal differing conditions than those described herein, Brierley should be provided the opportunity to verify analyses, conclusions and recommendations at that time.

CONCLUSSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are provided to summarize the discussions included in this report:

1. The site is underlain by a thin veneer of hillside colluvium (up to several feet) NOT ANYMORE which is in turn underlain by metamorphic rocks varying from schist to granitic gneiss. This gone too
2. General geologic structure mapped near the quarry includes north to northwesterly striking, easterly to northeasterly dipping foliation and metamorphic compositional layering generally parallel to the foliation. Dips are shallow to moderately steeply dipping, and generally into the hillside at the quarry site. That is what it looked like 15 years ago however since then we have substantially mined through that biotite rich lithology and are approaching a more complex intertwined boundary of two clearly identifiable lithologies – vim the Pikes Peak and Idaho Springs as this interface is reached we see the fabric characterized by the foliated material start to give way or relieve itself toe more competent more solid homogeneous pink quartz rich mineralization typical of the P{lies Peak
3. Pre-mining slopes at the site were closer to approximately 2:1 than 2.5:1 as reported in the Fox report. Those days are long gone – we are approaching vertical/sub-vertical the cut slope along the west side of U.S. 285 across the highway from the quarry is approximately 1:1 overall, and steeper in the lower cut face. It's a lot steeper than that now since CDOT took a chunk of it – it is over 69 degrees Historic mined and reclaimed slopes by others at the site are as steep as 1:2 and appear to be generally stable.
4. There is an upper weathered bedrock zone in which moderately severely weathered to completely weathered bedrock extends approximately 15 to 20 ft into the rock mass. Not anymore – I sold it all
5. There are no known or suspected sites of special geologic interest (e.g., fossil beds) at this site. I hoe like Hell there aint

6. The quarry is located in an area well outside any existing Geologic Hazard Overlay District Zoning Maps. There is no evidence at the site of slope failure, landslide areas or subsidence. Rockfall areas exist as part of the active mining operation within areas that will be completely mined out before establishing final benches and highwalls.
7. Bedrock exposures at the site primarily reveal foliation jointing subparallel to metamorphic compositional layering. True so we have A, B sets (almost) The foliation strikes northwest and dips from shallow to moderately steeply to the northeast, generally into the hillside that is being mined. Yes it does Secondary joints that are steeply dipping to sub vertical also occur. Finally, tertiary joints exist that dip northwest to southwest, or generally out of the hillside that is being mined. But they have a relatively minor effect on the overall geotechnical composition of the slope such that this old gal will sit almost vertical. We also employed some innovative out of the box techniques related to the blasting patterns and so on to accomplish a more ragged, 'natural' looking appearance that differs from the more artificial half-casts you typically see in a pre-split pattern, commonly employed n locations attempting to improve recovery ratios.
   We did this because it encouraged a much more natural appearance in the final configuration that allowed and encouraged re-habitation by nesting species and others in the portions of the face that are not being worked – may not want to put this in there. ** ASK FOR HELP HERE

8. Analysis shows potential slope failures if the slope were steepened to 1:4 from the originally proposed 1:2 configuration, but acceptable slope conditions for a quarry development if steepened to 1:3 as Elk Creek is presently proposing (12 ft benches by 35 ft highwalls = 1:2.9). NOTE these went to 40-45 ft benches and the new quarry will have anywhere from 50 to 35 ft benches
9. For the proposed 1:3 slopes, our analyses indicate that sliding failure is kinematically admissible only on the westerly dipping joint set, but that this is mechanically admissible only in the upper weathered rock. WHIH DOESN'T EXIST ANYMORE BOYS AND GIRLS – can you see where we are headed with this thing Toppling failure is not kinematically admissible for any of the six joints analyzed. Several wedge failure modes are kinematically and mechanically admissible in the upper weathered rock, but not in the general rock mass. YAAAAY!!! The upper weathered rock should be laid back to 1:1. There isn't any - however I concur in that I am trying to achieve a slightly more natural aesthetic in this thing a that considers a more of a flute type appearance and has a demonstrable 'flare on the upper echelons, where such moderate weathering does exist or is exposed at any level. So it ends up having a slight Limited individual highwalls is usually considered acceptable in quarry operations.

4 Rock Classification Systems for Engineering Purposes; Louis Kirkaldie, Editor; ASTM STP 984;1988.

Elk Creek Quarry

Input Parameters

q_u	10000 psi
m_i	25
GSI	50
	4.2
	0.0039
	0.5
	-9.22 psi
A	0.74
B	0.72
k	4.52
	39.6
c'	520.0psi
	2212.3 psi

Hoek-Brown Equivalent Mohr-Coulomb Failure Criteria

	0	358	716	1074
	522	4281	6230	7813
	34.7	6.3	4.8	4.1
	17	892	1666	2393
	103	1346	2083	2673
	2.6	-1	-0.8	-0.6
	2	-0.9	-0.7	-0.6
	5.1	0.9	0.5	0.4
	6.6	1.1	0.6	1.4
	0	1532770	4460461	8390669
	0	128164	512656	1153476
	2212	3832	5452	7072
	534	1259	1901	2502

Summary

	GSI = 50
	10000 psi
	39.6
	390 psi
	1659 psi
	9.22 psi

Rock Mass Parameter Summary

	25			
RQD	GSI		(psi)	(psi)
0 to 25	20	31	198	0
25 to 50	30	34	287	2
50 to 75	40	37	332	4
75 to 90	50	40	390	9

				Sum
1432	1790	2148	2506	10024
9205	10475	11657	12774	63056
3.7	3.4	3.2	3	63.3
3087	3758	4410	5047	21270
3182	3636	4049	4431	21502
-0.5	-0.4	-0.4	-0.3	-6.6
-0.5	-0.4	-0.4	-0.4	-5.8
0.3	0.2	0.1	0.1	7.6
0.3	0.2	0.1	0.1	9.4
13181147	18749522	25040161	32012201	103366931
2050624	3204100	4613904	6280036	17942960
8692	10312	11932	13552	
3078	3633	4174	4702	

(psi)	(psi)	(psi)
214160	82369	178467
380837	146476	317364
677235	260475	564362
1204312	463197	1003594

Paste shortcut | to | to | folder | History | Invert selection

ipboard | Organize | New | Open | Select

USB Drive (E:) › STILL TO PRINT › 2018-12-10 SLOPE STABILITY REPORT

Name	Date modified	Type	Size
2004 BRIERLEY REPORT	6/26/2019 8:16 AM	File folder	
2005 tech revision	6/26/2019 8:16 AM	File folder	
2018-3-12 MV-312	6/26/2019 8:16 AM	File folder	
2018-12-1 REV2 Annual highwall eval rep...	6/26/2019 8:16 AM	File folder	
2018-12-7 BENCH COMLIANCE ISSUE	6/26/2019 8:16 AM	File folder	
2018-12-10 RESUBMIT Slope Stab rpt	6/26/2019 8:16 AM	File folder	
2018-12-18 DRAFT 3 SLOPE STAB GEOL G...	6/26/2019 8:16 AM	File folder	
2019-1-10 CONSENT AGENDA ERIC SCOTT	6/26/2019 8:16 AM	File folder	
Schaffer's Crossing Report 190430	5/1/2019 4:26 PM	Microsoft Word D...	2,4

C:)
E:)
(\\192.168.1.13\Users\Server) (S:)
s (\\192.168.1.13) (Y:)
68.1.13) (Z:)
)
GAL SAFE STORAGE
RING
RINT

12/10/18

DRMS SUPPLEMENTAL REPORT: Concerns in re COMPLIANCE RE BENCHING within HIGHWALL

MLRB 1978-208 Shaffers Crossing

12/6/18

2018 Supp. Report by operator in conjunction w/ concerns expressed by staff re benching

REPORT: Notice of Inspection 3/13/18

Inspector Michael Cunningham

Division of Reclamation Mining and Safety

Response from Operator Prepared by MOORESJ, Min. Eng., CSM, BSc. Geol., Geophysics (II), Elk Creek Companies, LLLP. /S/ Elk Creek, Sand & Gravel LLC

Reviewed and Accepted/endorsed by BROCKMAN, S, PE Cave Eng. (license # _____)

Brockman Engineering Inc, Conifer CO 80433

12/7/18

ISSUE

Inspector notified Operator Representative on or around 3/13/18 that there was an issue relating to Inspection conducted in which Inspector indicated a concern that the bench configuration within the confines of the permitted and approved highwall design was not being followed.

The inspector indicated that he had participated in site walk-through and in that walkthrough he made a number of observations: a) signage was insufficient and did not comply with the terms of the Regulations enforced under the Division Rules, b) that a weed control plan was absent from the Operators file or not otherwise sufficient and that the Division was requiring that the Operator provide a technical revision to its permit such that this addressed and conformed to the regulatory requirement under the Rules to include an acceptable weed control plan

c) that the Inspector was unable to visually confirm that the Operator was complying with the stipulated bench configurations, particularly the bench width relative to the bench height, in order to conform to the recommendations presented under the geotechnical report filed om behalf of the Operator in 2006 (the Brierley Geotechnical and Slope Stability Analysis)

This report addresses the issue specificaliy of the HIGHWALL BENCH WIDTH CONFIGURATION such that the specified configuration is an 8'-0" bench no 76 degree angle of repose, and the benches are 12'-0" by 35'-0" in the perpendicular (See exhibit FIGURE 10c 2006 BEI ODP Final USES and Plan PDF) wherein the final Bench design for the highwall submitted to and accepted by DRMS Board, based upon Division recommendations, complies with the calculations and toppling or over turning moment restrictions from the 2006 Geotechnical report

SPECIFIC CONCERN BY DIVISION STAFF

The specific issue that was a concern raised by Vision Staff is that the prescribed bench configuration as indicated, since it did not exist, would have to be implemented in order to bring the highwall into