



COLORADO

Division of Reclamation, Mining and Safety

Department of Natural Resources

1313 Sherman Street, Room 215
Denver, CO 80203

February 8, 2024

Robert Wagner
RMR Aggregates, Inc.
6200 S. Syracuse Way, Suite 450
Greenwood Village, CO 801111

RE: Mid-Continent LST, File No. M-1982-121 , Technical Revision (TR-6) Adequacy Review-2

Dear Mr. Wagner:

On November 30, 2023, the Division of Reclamation, Mining and Safety (Division) filled your Technical Revision request TR-6 for the Mid-Continent LST, Permit No. **M-1982-121**. During the review of the material submitted by subject matter experts, the Division determined that additional information is needed before the Technical Revision can be considered for approval. Please see the attached memo from Zach Trujillo of the Division.

The items in the Divisions January 3, 2024, Adequacy Review 1 letter have been sufficiently addressed. Please ensure that any further adequacy responses have a non-confidential portion available for the public review. And that only information that falls under Rule 6.4.4(f)(i) is marked as confidential.

Please submit your response(s) to the above listed issue(s) by **Wednesday, February 21, 2024** in order to allow the Division sufficient time for technical review. If you cannot address the above issues by February 21, 2024 please request an extension to the decision due date to ensure adequate time for the Division to review materials. The current decision due date is **March 1, 2024**. If any adequacy issues remain by the decision due date the Division may deny your request.

If you require additional information, or have questions or concerns, please feel free to contact me. Amy Yeldell at the Division of Reclamation, Mining and Safety, Room 215, 1001 E 62nd Ave Denver, CO 80216. Direct contact can be made by phone at 970-210-1272 or via email at amy.yeldell@state.co.us



Sincerely,



Amy Yeldell
Environmental Protection Specialist

Enclosure: Rock Failure Analysis and Stability Report Review by Zach Trujillo-DRMS 2/6/2024

Ec:

Travis Marshall, Senior EPS, DRMS
Russ Means, Minerals Program Supervisor, DRMS
Micheal Cunningham, Acting Division Director
Zach Trujillo, DRMS
Jeff Fugate, AGO
Brittany Cocina, BLM



Date: February 6, 2024

To: Amy Yeldell

CC: Russ Means
Travis Marshall
Amy Eschberger

From: Zach Trujillo

RE: Mid Continent Limestone Quarry, DRMS File No. M-1982-121
Rock Failure Analysis and Stability Report Review

Amy,

As requested I have reviewed the provided geotechnical report, “Rock Failure Analysis and Stability” (Report), conducted by Kilduff Underground Engineering, Inc. (KUE) on behalf of RMR Aggregates, Inc. (RMR) regarding the rock failure event that occurred on January 18, 2023 at the Mid Continent Limestone Quarry (Mine). This memo specifically addresses the updates to the Report along with the response to the Division’s memo dated September 29, 2023 (2023 Memo) as provided under Technical Revision No. 6 (TR-6). For more information regarding the Division’s initial review of the Report, please refer to the Division’s 2023 Memo. Questions and comments regarding the Report to ensure all Rules and requirements are satisfied will be summarized at the end of this memo.

Division’s Comments and/or Questions – 2023 Memo

The following is a summary of the Division’s comments/questions discussed and observed during the 2023 Memo along with KUE’s response provided within TR-6:

Reconnaissance Findings

- **Division:** *In the Report, KUE references borehole logs conducted by Colorado Fuel & Iron in comparison to so their site reconnaissance. The referenced borehole logs were not included within the Report and the Division has no records of the mentioned logs. Please have RMR or KUE provide the borehole logs conducted by CFI for the Division’s review and record.*

KUE: *The relevant borehole logs have been attached to the report within Appendix B.*

After reviewing proposed Appendix B provided in the Report under TR-6, the borehole logs conducted by CFI have been provided for the Division’s review and record. After review, the borehole logs are consistent to the information discussed of the borehole logs in the Report. The Division has no additional comment and this Item has been satisfied.



Failure Mode and Stability Analyses (Current Conditions)

- **Division:** *It is unclear to the Division which material strength properties were used in the stability analyses between the empirical values or post-backanalysis values found under Table 2. Please have KUE provide the Division with clarification on which material strength properties values reported in Table 2 were used within the stability analyses found within Appendix D.*

KUE: *KUE has clarified throughout the report that the models were run using the established empirical values that were corroborated by the backanalysis.*

KUE has provided additional discussion and clarification regarding which material strength property values reported in Table 2 were used within the stability analyses found within Appendix D and Appendix G. For the long-term steady state analysis as well as the mechanical stabilization discussed under Section 6 and Section 9 of the Report, strength parameters are taken from the empirical data. These parameters result in a more conservative approach when analyzing slope stability for long term stabilization in comparison to the values calculated by the back-analysis. The Division has no additional comment and this Item has been satisfied.

KUE Stability Recommendations and Associated Stability Analysis

- **Division:** *Similarly to the comment above, it is unclear to the Division which material strength properties were used in the stability analyses under KUE's recommendations. Please have KUE provide the Division with clarification on which material strength properties values reported in Table 2 were used within the stability analyses found within Appendix D and Appendix G.*

KUE: *KUE has clarified throughout the report that the models were run using the established empirical values that were corroborated by the backanalysis. Appendix G values for joint strength and other joint parameters that dictate stabilization are included in Appendix G.*

Please refer to the Division's previous comment found under the "Failure Mode and Stability Analyses (Current Conditions)" section of this Memo. KUE has provided discussion and clarification regarding which material strength property values were used within the stability analyses found with Appendix D and Appendix G which satisfies this comment from the Division. The Division has no additional comments.

- **Division:** *Within Section 8 of the Report, it is unclear to the Division on what KUE is defining as the [REDACTED] in reference to KUE recommendations to remove said layer. Earlier in the Report, KUE labels the [REDACTED]. It would appear to the Division that when referring to the [REDACTED] under Section 8 of the Report, it is [REDACTED] is part of the [REDACTED] reference. Please have KUE provide additional clarification on whether the recommendation is to remove just the [REDACTED] or the [REDACTED].*

KUE: *This has been clarified in what is now section 9. The [REDACTED] are specifically identified versus the [REDACTED].*

KUE has updated Section 9 (previously Section 8) of the Report and has provided specific language defining the [REDACTED] in relation to their recommendations for slope stabilization. The Division has no additional comment and this Item has been satisfied.

- **Division:** *Under Section 6 of the Report, a long-term static stability analysis was conducted using the post-mining configuration of the [REDACTED] for varying bench slope geometries. A total of three bench slope geometries were analyzed with resulting FOS as provided in Table 4*

of the Report. However only the results from the bench slope geometry for 1.67:1 was provided under Appendix D. Additionally, it appears an error exists in Table 4 for bench slope geometry of 1.67H:1V. The resulting slope stability analysis under Appendix D shows a FOS of 1.66 while Table 4 has a FOS of 1.63. Please have KUE provided a corrected Table 4 (is necessary) and the slope stability analyses for the other bench slope geometries provided under Table 4.

KUE: 5A) Table was misnumbered and has been corrected to Table 6. 5B) Appendix D now includes stability runs for bench geometries of 1:1, 1.4:1 and 1.67:1 for both static and seismic. 5C) Appendix D is correct and the text has been edited.

The Division has reviewed the updated Table 6 (previously labeled Table 4) along with the additional discussion provided under the updated Section 6 of the Report. It is observed that new Factor of Safety (FOS) values have been provided not only with the requested results under seismic conditions but also for static conditions for each bench slope geometry discussed. These values are found to be larger than what was originally provided under the previously submitted Table 6 for static conditions. With that said, rational for the newly provided FOS values have been provided by KUE in the Report.

The newly provided FOS values are the results of the stability analyses for long-term stabilization of the [REDACTED] using the empirical strength parameters. Based on these results, KUE implemented an additional conservative approach to compensate for the potential of unknowns, such as a loss of internal granular cohesion or strength, by using a 70% reduction to empirical limestone cohesion (1,500 psf). The use of this reduced cohesion in the stability analysis for the discussed bench slope geometries resulted in the values reported under the previously submitted Table 6. While not provided under a new table, these values are provided under discussion within Section 6 of the Report for static conditions with the slope geometries of 1.4:1 and 1:1. It should be noted that these analyses and resulting FOS are still applicable regarding the overall slope stability review for TR-6 in relation to the Rules and Regulations.

With that said, discussion of the previously provided FOS result for the static 1:67 slope geometry was not provided as well as all seismic conditions under the reduced cohesion of 1,500 psf within Section 6. While some of the resultant FOS can be found under the associated modeling provided in Appendix D, for clarification and transparency, the associated FOS results for all bench geometries, static/seismic conditions and strength parameters which are discussed in the Report should be provided within the appropriate section. Similarly, all modeling results should be provided as well under the applicable section and or appendix for the Division's review. Please see the "Division's Comments and/or Questions" Section found at the end this Memo for additional comments.

- **Division:** It appears the Division that inconsistencies exist with the material strength input parameters used within the analyses of Appendix G when compared to the values provided under Table 2 of the Report. Additionally, a different failure plane angle was used in comparison to other analyses provided. All models provided (excluding the back-analysis) should be consistent with the documented conditions and parameters representative to the Mine. Please request KUE ensure all input parameters for all provided stability analyses (excluding back-analysis) are consistent with the conditions and parameters associated with the Mine and have KUE provide any updated analyses as necessary.

KUE: 6A) KUE has clarified throughout the report that the models were run using the established empirical values for rock strength. Appendix G values for joint strength and other joint parameters that dictate stabilization are included in Appendix G. 6B) The slope angle has been revised in Appendix G from [REDACTED]. Parameters across the report have been corrected as necessary for consistency.

After reviewing the provided discussion and models within the Report, all input parameters for all the currently provided stability analyses and models are consistent with the conditions and parameters

discussed in the Report and associated with the Mine. The Division has no additional comment and this Item has been satisfied.

- **Division:** *While not discussed in this Memo or in the Report, RMR is approved for blasting per the permit. Please have RMR or KUE address the potential impact blasting may have on the stability of the Mine and have it modeled within the provided active mining and post-mining analyses.*

KUE: *Section 7 Blasting Impacts to Stability has been added to address the potential impact blasting may have on the stability of the Mine.*

To address the associated Division comment, KUE included a new section, Section 7 - Blasting Impacts to Stability, to the Report. In Section 7, KUE analyzes potential seismic loading to the slope from blasting operations based on the results of a study performed by the U.S. Department of Interior, Office of Surface Mining - Structure Response and Damage Produced by Ground Vibrations from Surface Blasting (Blasting Study). This Blasting Study evaluated direct measurements of ground-vibration-produced structure responses and damage from blasting. Using the evaluation of the Blasting Study along with the assumption of proper blast design and site conditions, a design seismic coefficient can be determined. From this, a design seismic coefficient from blasting using site conditions was calculated by KUE and resulted in a value of 0.12 as discussed in the Report. This design seismic coefficient from blasting can be compared to the design seismic coefficient from the peak gravitational acceleration of an applicable maximum considered earthquake. As discussed in Section 7 of the Report, the seismic load resulting from a blast at the Mine is less than that from an applicable maximum considered earthquake. This means that the seismic coefficient from the maximum considered earthquake for a 1,000-year return period will apply a greater seismic load which is a more conservative value to use within the stability analysis for seismic conditions. For more discussion regarding the design seismic coefficient used in the stability analyses within the Report, please refer to discussions associated with the following Item from the Divisions 2023 Memo. The Division has no additional comment and this Item has been satisfied.

- **Division:** *When reviewing the associated stability analysis with mechanical stabilization under Appendix G, it was observed that none of the scenarios provided met the minimum FOS of 1.5 as stated in the Report. Per Section 8.1 of the Report, “[p]otential [redacted] slope heights... were modeled to determine the resisting force required to reach a factor of safety of 1.5.” The West section resultant FOS is 1.45 and resultant FOS for the East section for 10 feet and 15 feet are 1.4 and 1.41 respectively as provided in Appendix G. In order to ensure the minimum criteria of the Division’s Section 30 is met, please have KUE provide updated mechanical stabilization recommendations and associated analyses that meets or exceeds the minimum FOS requirements of 1.5 for static conditions.*

KUE: *Stability models in Appendix G have been revised to achieve a FOS of 1.5 static and 1.3 seismic.*

Based on the Division’s comment, KUE has provided updated analyses for mine stabilization under static and seismic conditions. Discussions regarding the applied seismic coefficient is provided under Section 7 of the Report. When reviewing Section 7, it was observed that the value of the peak ground acceleration for a 1,000-year return period was provided (0.196) however, the actual value of the applied seismic coefficient was not provided along with the methodology in which it was derived from.

While reviewing Appendices D and G, the applied seismic coefficient can be observed within the models as 0.126. Based on the discussed return period, it appears to the Division that KUE used AASHTO LRFD Specifications in determining the appropriate seismic coefficient. AASHTO LRFD Specifications for seismic applications is a widely used and accepted engineering methodology. With this assumption, the Division was able to corroborate the peak gravitational acceleration, site adjustment factors and resulting seismic coefficient provided under Appendices D and G with published information from the USGS Seismic Design Map Web Services. With the applied design seismic coefficient of 0.126, the

resulting FOS for both long-term stabilization of the [REDACTED] and mechanical stabilization meet or exceed the minimum requirement of 1.3. However, additional clarification within Section 7 regarding the design seismic coefficient used along with methodology and rational should be provided in order to determine compliance with Section 30 of the Policies of the Mined Land Reclamation Board. Please see the “Division’s Comments and/or Questions” Section found at the end this Memo for additional comments.

- **Division:** *Per Section 30 of the Policies of the Mined Land Reclamation Board, for generalized, assumed, or single test measurements for critical structures, the minimum recommended FOS is 1.5 for static conditions and 1.3 for seismic conditions. No seismic conditions were provided or evaluated by KUE in the Report. In order to ensure all requirements of Section 30 are satisfied, please have KUE provide stability analyses for the Mine under seismic conditions for all active mining and post-mining scenarios under KUE recommendations.*

KUE: *Long term steady state models for multiple bench geometries and active stabilization models have been run for both static and seismic and are included in Appendix D and G, respectively.*

After reviewing the updated Report and associated appendices, all provided stability analyses have met or exceeded the minimum requirements of Section 30 under static and seismic conditions. However, as discussed earlier in this Memo, not all FOS for every scenario discussed in the Report were provided in the discussions as well as some models not provided under the associated appendix. Please refer to the “Division’s Comments and/or Questions” Section found at the end this Memo for specific scenarios that were not included in either the discussion within the Report or associated appendices for the Division’s review.

Division’s Comments and/or Questions

The following is a summary of the Division’s comments/questions discussed and observed during this Memo.

KUE Stability Recommendations and Associated Stability Analysis

1. During the Division’s review of the applied seismic coefficient, it was observed that the value was not provided within discussion of the Report. Additionally it was unclear as to what methodology was used in determining the applied seismic coefficient. Please have KUE provide additional clarification within Section 7 regarding the design seismic coefficient value used along with the methodology and rational.
2. It was observed that the resulting FOS from multiple scenarios discussed in the Report were not provided in the text of the Report. Additionally, it was also observed that some of the associated models were not provided in the Report for the Divisions review. The resulting FOS and associated models for all scenarios discussed within the Report need to be provided within the associated Section and/or appendices. Please have KUE provide an updated Report including all resulting FOS within the discussions along with all associated models results. The following scenarios were not provided:
 - FOS result for bench slope geometry of 1.67:1 with reduced limestone cohesion (1,500 psf) under static conditions within discussion of Section 6 of the Report.
 - FOS result for bench slope geometries of 1:1, 1.4:1, and 1.67:1 with reduced cohesion (1,500 psf) under seismic conditions within discussion of Section 6 of the Report.
 - Model result for bench slope geometries of 1:1, 1.4:1, and 1.67:1 with reduced cohesion (1,500 psf) under static conditions within Appendix D of the Report.

- Model result for bench slope geometry of 1.67:1 with reduced cohesion (1,500 psf) under seismic conditions within Appendix D of the Report.

This concludes my review of the provided geotechnical report, "Rock Failure Analysis and Stability", conducted by Kilduff Underground Engineering, Inc. on behalf of RMR Aggregates, Inc. regarding the rock failure event that occurred on January 18, 2023 at the Mid Continent Limestone Quarry (Mine). If you have any questions feel free to contact me.

Sincerely,

A handwritten signature in black ink, appearing to read 'ZTJ' with a stylized flourish.

Zach Trujillo
Environmental Protection Specialist
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Zach.Trujillo@state.co.us