STATE OF COLORADO

Eschberger - DNR, Amy <amy.eschberger@state.co.us>

Adequacy Review #3 / TR-05 / Lyons Quarry / M-1977-141

Snyder, Travis <Travis.Snyder@hdrinc.com> Tue, Jun 29, 2021 at 5:20 PM
To: "Eschberger - DNR, Amy" <amy.eschberger@state.co.us>, Kimberly DENNIS <kimberly.dennis@lafargeholcim.com>
Cc: Chance ALLEN <chance.allen@lafargeholcim.com>, "Cazier - DNR, Tim" <tim.cazier@state.co.us>, "Cunningham - DNR, Michael" <michaela.cunningham@state.co.us>

Good afternoon Amy,

Attached is Technical Revision 5, Version 3 for your review. As in previous submittals, Attachment E-1, the Kleinfelder Stability Report, is not included due to its file size. The crosswalk spreadsheet will help identify the changes that were made to the document. We hope this revision satisfies the Division's concerns but please review and let us know if you have any follow up questions.

Thanks.

Travis Snyder

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From: Eschberger - DNR, Amy <amy.eschberger@state.co.us>
Sent: Wednesday, June 23, 2021 10:21 AM
To: Kimberly DENNIS <kimberly.dennis@lafargeholcim.com>
Cc: Snyder, Travis <Travis.Snyder@hdrinc.com>; Chance ALLEN <chance.allen@lafargeholcim.com>; Cazier - DNR, Tim <tim.cazier@state.co.us>; Cunningham - DNR, Michael <michaela.cunningham@state.co.us>
Subject: Adequacy Review #3 / TR-05 / Lyons Quarry / M-1977-141

Hi Kim,

I'm attaching our adequacy review #3 letter for TR-05.

The current decision date for this revision is set for 7/5. We'll need at least a few days to review your response prior to the decision date, and will be out that Monday, 7/5 for the July 4th holiday. Therefore, if you don't think you'll be able to get us a response by the end of next Tuesday, 6/29, please go ahead and submit an extension request.

Feel free to reach out with any questions.

Thanks,

Amy Eschberger

Environmental Protection Specialist

[Quoted text hidden]

2 attachments

Reclamation Permit Technical Revision No.5_Rev. 3_FINALwATT_210629.pdf
20532K

TR5 DRMS Adequacy Review #1,2,3 Crosswalk and Revisions 210629.xlsb.pdf
111K

Item #	DRMS Comment	Aggregate Response	Reference Section
1	Rock Anchors: The response was not adequate. Additional clarification is required. There are numerous references to the 2008 Kleinfelder report in TR-05 which provided two options for stabilizing the dacite highwall: backfill or install rock bolts/anchors and shotcrete. The adequacy response infers a third option, not included in the Kleinfelder report using wire mesh in lieu of shotcrete. This approach is not explicitly stated (mentioned only in technical specification 31 72 16), nor is there any design analysis provided to demonstrate wire mesh is an acceptable alternative to the previously proposed shotcrete. The DRMS understands detailed design of the proposed rock anchor system will not be completed until the rock scaling phase of the construction is finished. Please address the following:		
i.	Analysis: Provide an analysis or critical narrative demonstrating wire mesh is a feasible alternative to the Kleinfelder shotcrete option.	Revise text in Section 5.1, Item 7. Use GeoBrugg Minax 80/4 product for justification of twisted wire mesh vs. shotcrete. Update with Nick's latest comments and any Andrew revisions.	Section 5.1, Item 7
ii.	Wire mesh substitute: Section 5.1, Item 7, Ground Control needs to be revised to explicitly state wire mesh is to be substituted for shotcrete.	Revise text in Section 5.1, Item 7	Section 5.1, Item 7
iii.	Welded wire: Other engineering applications using wire mesh, such as gabion basket construction, generally prefer twisted wire mesh over welded wire mesh due to the potential for welds to break. Why in this case is welded wire (specification 31 72 16) indicated over twisted wire?	Specification will changed to twisted wire Geobrugg Minax 80/4	Section 5.1, Item 7
iv.	Welded wire cost: Item 7.2 in the Exhibit L table provides a unit cost of$7,000 per installed anchor. Does this cost include the wire mesh?	TR5 AR#2 response added $500 per bolt to cover costs of additional mesh and split set bolts (From original $6,500 to $7000) per RR#10. This is stated in the Measure of Payment of the Ground Control specs. An addtional $500 will be added to cover the more expensive Minax 80/4 making each rock bolt $7,500. Check costs.	Section 5.1, Item 7 + Attachment D
v	Rock scaling: As rock scaling is an integral part of the reclamation plan, it would seem appropriate to include notes to perform rock scaling in accordance with project specifications on Sheet 01C-02, Site Grading Plan and/or Sheet 01C-03, Sections C, D and E.	Add notes for rock scaling to Sheets 01C-02 and 03	Sheets 01C-02 and 03
vi.	Rock anchors: The new note on Sheet 01C-02 does not completely reflect the inferred intent. The drawing note “Area to receive rock anchors as needed” should be revised to “Area to receive rock anchors as determined by engineer after rock scaling is completed and in accordance with project specifications”. A callout referencing the new as yet unnamed detail on Sheet 01C-07 (Detail 6?) should also be added.	Call-out and revised note will be added to Sheets 01C-02 and 03. Add note to TR5 that an addendum will be added to the TR5 once the scaling of the highwall has been performed and a more thorough design of the rock bolt layout can be performed.	Sheets 01C-02 and 03. Section 5.1, Item 7
vii.	Final configuration of highwall: Section 5.1, Item 7 states “Details C, D and E show the proposed final configuration of the dacite highwalls” on Sheet 01C-03. These three sections are of a small scale using a dashed line and do not differentiate between the Fountain formation sandstone and the dacite. The “Remaining High Wall” should be revised to “Remaining Dacite High Wall” with references to “See Note 1” addressing the rock reinforcement.	Revise detail name , add call-out. Delineator will be added to the profile sections starting at crest of dacite and running in to hillside.	Sheet 01C-03 and new 04
viii.	Rock anchor Bolt Split Set & Wire Mesh Detail: As stated in Comment vi above, this detail on Sheet 01C-07 should be labeled as Detail 6(?) and provided with the proper symbology indicating it is called out from Sheet 01C-02.	Add call-out and detail for rock reinforcement on new page 01C-04.	New Sheet 01C-04
ix	Anchor bolt detail: The DRMS would expect a rock anchor detail is not premature at this time given the stereonets and rock strengths in the Kleinfelder report. An additional detail similar to the FHWA detail below should be included as well	Add call-out and detail for rock reinforcement on new page 01C-04.	New Sheet 01C-05
2	Site Grading Plans: The response was not adequate. Additional clarification is required with respect to maintenance. Given wire mesh is inferred to be substituted for shotcrete, the DRMS and the landowner should be made aware of the rock anchor system inspection points and potential for maintenance of the same. Please address the following:		
a)	A long-term catchment berm maintenance plan: Please update the Lyons Quarry Catchment Basin Operation and Maintenance (O&M) Plan to include the rock anchor system; addressing inspection points in Table 2-1, estimating the expected Life Span in Section 2.5, and other sections as appropriate.	The catchment basin O&M plan will be updated to include discussion of the rock bolt/mesh O&M. Inspection points identified in Maintenance section added to plan (see new Table 2-1). Inspections of highwall, benches and crest areas already considered under Table 2-2 annual frequequency of occurrance. Added process/description of installation and maintenence for the rock bolts.	Attachment I
b)	Determination of the responsible entity… The DRMS understands this entity to be Aggregate Industries until we release the permit and Boulder County thereafter. If this is the case, no additional response is necessary.	Aggregate will be listed as the responsible entity for this specific O&M. Noted in Section 1.2 of O&M Plan.	Attachment I
c)	Areas that will be reinforced… the incorporation of Comments 1.i through ix should address the remaining concerns with respect to the grading plan and reclamation plans.		
3	Northeast HIghwall Catchment Berm: The response was adequate.		
4	Catchment Berm Stability: The response was adequate.		
5	Increasing Berm Functionality Factor of Safety: The response was adequate.		
6	Swale Berm Culvert: The response was adequate.		
7	Quarry 2 Swale: The response was adequate.		
8	Northwest HIghwall Catchment Berm: The response was adequate.		
9	Drawings and Maps: Pursuant to Rule 6.2.1(2)(b), all drawings and maps are required to be signed and dated. Please sign and date revised drawings and maps.	Andrew to sign and date drawings	Drawing plan set
10	Professional Engineer Seal: As part of the review of the response, it was noted the original hard copy professional engineer seal for Andrew Little in Attachment F, Grading Plan Verification Letter was signed but not dated. Pursuant to Rule 1.5.A.3 4 CCR 730-1, the signature and date of signature shall appear through the seal. Please resubmit the letter in accordance with Colorado rules governing professional engineer seals.	Andrew to provide signature and date for seal.	Attachment F
11	Rock Anchor Inspections: This is a reminder the DRMS will periodically inspect the rock anchor system and catchment berms until the Lyons Quarry (M-1977-141) is released from reclamation liability. No response is necessary.		

Aggregate Industries - WCR, Inc.

Lyons Quarry

112d Reclamation Permit Operations Technical Revision

Boulder County, Colorado

June 2021

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Contents

Attachments

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1 Introduction

1.1 Purpose and Objectives

The purpose of this document is to support the request to the Colorado Division of Reclamation Mining and Safety (DRMS) for a Technical Revision (TR) to the 112c Reclamation Permit Operations for Lyons Quarry (File number M-1977-141). The objectives of this document are to provide a narrative and updated Exhibits that explain the requested revisions to the approved Reclamation Plan based on changes in the mining operations at Lyons Quarry. Revised Exhibits include the following:

Exhibit E – Reclamation Plan

Exhibit F – Reclamation Plan Map

Exhibit L – Reclamation Costs

Rule 6.5 – Geotechnical Stability Exhibit

The purpose for executing this effort is to allow for revised slope configurations of the quarry highwall areas to be in compliance with the standards set forth in the DRMS Mineral Rules and Regulations for the Extraction of Construction Materials (July 15, 2019); Section 3.1.2 which states in part:

> *(3.1.2.1) Grading shall be carried on so as to create a final topography appropriate to the final land use selected in the Reclamation Plan.*
>
> *(3.1.2.3) All grading shall be done in a manner to control erosion and siltation of the affected lands, to protect areas outside the affected land from slides and other damage. If not eliminated, all highwalls shall be stabilized.*
>
> *(3.1.2.7) Maximum slopes and slope combinations shall be compatible with the configuration of surrounding conditions and selected land use* (OMLR, 2019)*.*

Specifically, Aggregate Industries requests to grade and stabilize the highwall areas to meet the slope stability and surrounding topography requirements by excavating, processing and either backfilling or exporting the overburden sandstone material from the site. The dacite highwalls will be stabilized by scaling and using rock bolts to allow for appropriately distanced and protected, public viewing of this unique geologic formation as well as provide suitable habitat for avian and bat nesting areas. This revised plan will not go beyond the already disturbed mining boundary and will dramatically reduce the amount of blasting and extensive material handling required by the current approved plan (M-1977-141 Technical Revision #2); which specifies stabilizing the highwall by backfilling against the near-vertical slopes.

A summary of the approved design in M-1977-141 Technical Revision #2 involves a backfill buttress against the dacite formation to blend with the cut slopes in the overburden sandstone. The sandstone would be excavated using drill and blast methods to achieve overall 1.5H:1V (horizontal:vertical) slopes. Fill slopes in the pit highwall area would be placed and compacted to

achieve 50-foot-high benches and sloped at 2H:1V with 15-foot wide benches. In an effort to establish the final grading, the anticipated cut/fill quantities for the Technical Revision #2 grading plan would be approximately balanced at 364,700 CY.

1.2 Background

Aggregate Industries operated the Lyons Quarry mine located 3 miles southwest of the town of Lyons, Colorado, in the South St. Vrain canyon area. Quartz monzonite was extracted from the mine between 1977 and 2008. While the mining permit for the quarry is still under active status with DRMS, the quarry is currently inactive and in the process of closure and reclamation in accordance the rules and regulations of DRMS. A timeline of the approved Mining Plan and Reclamation Plan for the project, as described in the Lyons Quarry Colorado DMG File M-1977-141 (2004), is provided in **Table 1** below.

Table 1 - Mine Permit Activity for Lyons Quarry

Year	Description
1977	Original Permit Application
1984	Revised Permit Application
2003	AM01 – Permit Amendment Approved
2008	Cessation of Mining Activity
2011	Hall Ranch Open Space, including Lyons Quarry, is sold to Boulder County
2016	TR01 – Technical Revision Approved for Weed Control Plan
2017	TR02 – Technical Revision Approved for Revised Reclamation Plan for Area 1 (Quarry)
2018	TR03 – Technical Revision Approved for Importing Fill to Quarry 2
2020	TR04 – Technical Revision Under Review for Revised Reclamation Plan for Area 2 (Permitted Non-Mining Disturbance Area)

Changes in the mining operations at Lyons Quarry resulted in much less mining (removal of quartz monzonite) than was originally planned. The reduction in mining activities resulted in less removal and stockpiling of overburden materials than were originally planned to support reclamation. Without the available stockpiled overburden materials for placement and re-grading at the site, extensive excavation will be required in the overburden sedimentary rocks to achieve a balance of the cut and fill quantities to re-grade the mined areas.

In 2013, flooding of South St. Vrain Creek destroyed several structures on the site and displaced stockpiled materials within the floodplain area. Access to the site was restored via construction of a new bridge and road improvements in 2017. In 2018, the remains of the structures, equipment and

miscellaneous surface debris were removed from the floodplain area by Aggregate Industries; however, several areas impacted by the displacement of stockpiled site materials remain.

In response to the 2013 flooding, Boulder County has initiated development of restoration plans for the 3.2 mile stretch of South St. Vrain Creek, from the forest service boundary in the canyon to the Old Saint Vrain Bridge off Highway 7. These restoration plans are currently at the 30% Design phase and include the floodplain area located between South St. Vrain Creek and the mined high walls at Lyons Quarry. Reclamation of this floodplain area (Area 2) by Aggregate Industries is addressed in Technical Revision #4 which was approved by DRMS in December 2020.

2 Project Location and Description

2.1 Location

Lyons Quarry is located southwest of Lyons, Colorado in Boulder County. **Attachment A - Figure 1,** shows the Lyons Quarry site just south of South St. Vrain Creek, along Colorado State Highway 7 in Sections 25 and 26 of Township 3 North, Range 71 West of the 6th Principle Meridian.

2.2 Recent Flooding

The floods in September 2013 changed the low-lying areas of the Lyons Quarry as up to 17 inches of rain fell over a three-day span raising the levels of the South St. Vrain Creek to 100 and 500-year floodplains (Boulder County's average annual precipitation is 18 inches by comparison). The flooding washed away the Site access bridge that crossed South St. Vrain Creek from Highway 7. **Attachment A - Figure 2 and Figure 3,** display the pre- and post-flood conditions of the site as aerial images from October 7, 2012 and October 6, 2013, respectively. The extent of the flood destruction and change in creek alignment especially at the east end of the site is shown on these images.

Boulder County Parks and Open Space, the current property owner, contracted a design group to develop restoration plans for the 3.2 mile stretch of South St. Vrain Creek, from the Forest Service boundary in the canyon to the Old Saint Vrain Bridge off Highway 7. These restoration plans include the floodplain area located between South St. Vrain Creek and the mined high walls at Lyons Quarry. Restoration of South St. Vrain Creek downstream of the site was completed in 2017. During this work, approximately 29,000 cubic yards (CY) of cobble material from impacted reaches of South St. Vrain Creek downstream of the site were allowed to be disposed of within Quarry #2 of the Lyons Quarry as document in Technical Revision #3. This saved the restoration project both time and transportation costs. The preliminary designs for the floodplain area adjacent to the Quarry call for realignment of the creek. This realignment will be a consideration for the reclamation design of both the floodplain and quarry area.

2.3 Lyons Quarry

Lyons Quarry is located southwest of Lyons, Colorado approximately 10 miles north of Boulder, Colorado. According to records from the 2002 permit Technical Revision #1, the total reclamation area (Project) covers 71 acres (55 acres have been disturbed) of the approximately 266-acre

property lease area. The area of disturbance extends from South St. Vrain Creek on the north, to the south approximately 1,500 feet. The limits of affected land make up the east and west perimeters of the site reclamation with the east boundary adjacent to the lease property line. A mining map is shown in **Attachment A - Figure 4**.

The site is further described as having a surface elevation (El.) of 5,508 feet near the northeastern entrance of the site to above El. 6,000 feet at the south end of the site. The existing natural slopes in sedimentary rock strata are as steep as 1.75H:1V, where the sedimentary strata are capped by the Lyons Sandstone. Where the sedimentary rocks are not capped by the Lyons Sandstone, slopes ranged from 2H:1V to 4H:1V. The mining plan splits the operation up into two quarries as shown in **Attachment A - Figure 5**. Quarry 1 is at the east end and at the base of the 300-foot tall high wall. Quarry 1 is bounded on the south and west by the highwall protrusion and on the east and northeast by backfill material. A constructed swale allows access into Quarry 1 between the backfill and an access road ramp that leads to Quarry 2 to the west. The horseshoe-shaped Quarry 2 is in the southwest corner of the operation and is bounded on the east, south and west by quarry highwalls. Quarry 2 was partially backfilled in 2017 but still has highwalls approximately 100 feet in height.

The flattest measured slopes were in areas mapped as landslides. Existing natural slopes in the dacite are nearly vertical where the dacite is exposed along the north side of South St. Vrain Creek. Where the dacite outcrops in the drainage along the west side of the site, the existing natural slopes range from 0.3H:1V to 2.2H:1V. This large range in the natural slope was measured along west-facing slopes over a span of approximately 300 feet.

Vegetation is generally absent in the leveled and mined areas. Vegetation over the remainder of the site consists of grasses, forbs, and shrubs/brush with various cottonwoods, willows, Virginia creeper and golden currant found along the drainages.

Surface water is present along the north edge of the site, in South St. Vrain Creek. Groundwater is present, ponded in low areas and observed as wet areas along the base of the highwall. Groundwater is also anticipated perched above siltstone and shale layers in the Fountain Formation.

Under the current reclamation plan, the existing sedimentation pond on the east end of the site will be utilized for dust control, earthen fill moisture conditioning, and watering vegetation as needed. The pond will then be backfilled (requiring approximately 2,200 CY) at the end of construction to blend with the surrounding topography, unless alternatives for future land use dictate otherwise. The final contours will be graded toward South St. Vrain Creek.

3 Exhibit E – Reclamation Plan

The post-mining use has come under consideration recently with the purchase of the site by BCPOS. Original plans involved the land being reclaimed to cattle range and pastureland in the production, stockpile and pit floor areas. With these land uses in mind, a Reclamation Plan developed in the 2016 Technical Revision #2 addressed the areas within the quarry, known as Lyons Quarry Reclamation Area 1 (LQRA1 as noted in Technical Revision #4). The plan included re-grading the high walls, backfilling the pit areas, installing runoff erosion control structures around the site perimeter and revegetating approximately 81% of the LQRA1 total 37-acre area. The remaining

19% of the area includes steep slopes that would either be covered by talus riprap or remain open for nesting birds. The design for Technical Revision #2 is based on recommendations made in the Kleinfelder Summary Report of Engineering Stability Analysis for Lyons Quarry (dated February 2008).

Recent discussions with BCPOS have proposed using the property for public recreation purposes as well. During the adequacy review period for Technical Revision #2, it was the request of BCPOS that the revised plan's construction approach leave as much natural slope variability to the site as possible; therefore, keeping the dacite formation exposed for geologic interpretation. Aggregate Industries and their consultant, HDR Engineering, developed a 30% conceptual design in October 2020 to present to the BCPOS to meet the following objectives:

- Meet the requests of BCPOS for slope variability and preserve a section of the exposed dacite walls for biological and geological interpretation purposes,
- Minimize risk to reclamation earthmoving contractors working at the base of the highwall area during backfill operations,
- Minimize the amount of blasting and material handling required to backfill the northeast facing slope of the highwall,
- Keep the reclamation operations within the current footprint of the disturbed mining area.

A meeting was held on November 12, 2020 between BCPOS, Aggregate Industries and HDR to discuss comments and concerns with the revised plan. Many of the questions centered on the floodplain reclamation areas and were either addressed during the Technical Revision #4 development or will be addressed during construction activities. Questions about the maintenance of the reclamation components (rock bolts, catchment berms, etc.) will be addressed during the final design development. Generally, there was overall consensus that the revised plan was acceptable, and that the revised grading plan design development should continue.

The revised reclamation plan's construction approach will require the following components:

- Excavation and backfill of earthen material,
- Construction of rockfall catchment areas at the base of the highwalls,
- Scaling and stabilization of the remaining highwall slopes,
- Soil conditioning and revegetation, and
- Installation of stormwater drainage and erosion control infrastructure.

The Site Grading Plan, **Attachment B**, shows the proposed cut and fill slopes and final grading. Exhibit F – Reclamation Plan Map, **Attachment C**, shows the planned reclamation areas and the types of reclamation proposed in Area 1, based on a slope analysis of the final grading. Section 5.1 provides more detail of the proposed Reclamation Plan and Scope of Work developed for estimating the costs for Exhibit L – Reclamation Cost, **Attachment D**. Unless otherwise noted, unit costs for Attachment D are based on bid tabulation results from a 2019 contractor bidding opportunity for the Lyons Quarry Reclamation. Rule 6.5-Geotechnical Stability Exhibit, **Attachment E**, provides the basis for the Site Grading Plan based on analysis and recommendations from the Kleinfelder Summary Report of Engineering Stability Analysis (Attachment E-1) and the Colorado Rockfall Simulation Program (CRSP) Evaluation Report (Attachment E-2). The Geotechnical Stability Exhibit limitations include a 3-year limit on the use of the report due to possible changes over time in land use, site conditions, regulations, or other factors. As stated in Attachment F of Technical Revision

#2, these conditions were last confirmed in February 2017 by the engineer of record for the Kleinfelder report. A site visit with the engineering team was performed on January 8, 2021 to confirm that existing conditions of the site were consistent with those described in the Kleinfelder report. This reclamation plan is based on the premise that the conditions described in the geotechnical report for the analyses performed and the conclusions and recommendations presented still exist at the site and should remain valid for the duration of the planned reclamation. The Grading Plan Verification Letter, signed and sealed by a registered professional engineer (**Attachment F**), verifies that the slopes and configurations shown on the Grading Plan meet the specifications of the Geotechnical Stability Exhibit. The 90% Design Technical Specifications and Drawing Plan Set are included as **Attachments G and H** respectively.

Table 2 shows the proposed reclamation schedule with planned reclamation phases, sequence, and estimated durations for each phase. The proposed schedule for Area 2 can be found in Technical Revision #4 and would attempt to coincide with the Area 1 schedule in order to prevent multiple mobilization efforts.

Table 2 – Reclamation Schedule for Area 1

Phase	Duration
Final Design and Construction Documents – Completed by March 2021	3 months
Aggregate Industries Mobilization Planning Activities – Completed March 2021	2 months
Mobilization, Site Prep. and Earthwork Construction	12 months
Revegetation Test Plot Monitoring	12 months
Revegetation	6 months

As a first step toward final reclamation, and prior to mobilization, an updated topographical survey of the site will be conducted to establish the site perimeters and slope staking. An inventory will be taken of existing structures, utilities, and remaining equipment, if any, to be demobilized and/or disposed of. A project safety plan will be developed to be consistent with applicable MSHA and OSHA requirements prior to initiation of field activities. Utility locates will be conducted prior to any earthwork.

A number of permits and notices are required for construction within the quarry area. The following permits have either been retained by Aggregate Industries since mining activities ceased or will be applied for prior to commencement of reclamation activities within the quarry area (upland of the floodplain):

- Boulder County Grading Permit
- Boulder County Floodplain Development Permit
- Boulder County Stormwater Quality Permit
- CDPHE Dewatering Permit
- CDPHE Stormwater Discharge Permit

Erosion control Best Management Practices (BMPs) and dust control measures will be established prior to any site grading to restrict sediment transport from the site and control dust generation during construction activities. BMPs will be established in accordance with the Boulder County Storm Drainage Criteria Manual that requires the design of BMPs be consistent with the guidance in the Colorado Department of Transportation (CDOT) Erosion Control and Stormwater Quality Guide (CDOT, 2006) or the Mile High Flood District (MHFD), Urban Storm Drainage Criteria Manual Volume 3 (UDFCD, 2016).

Appropriate measures will be taken to ensure areas outside of the affected land are protected and any refuse associated with the flood-impacted area, or any identified hazardous materials, are disposed of properly. At this time there are no known hazardous materials on site and the construction documents will include specifications that require the contractor to stop work immediately and notify Aggregate Industries and the State if any hazardous materials are encountered. Once the site controls are installed, the grading plan will be implemented.

3.1 Excavation of the Fountain Formation

The overburden Fountain Formation will be graded back to a slope of 2H:1V. Excavation, either via heavy equipment or blasting, will be required for the overburden sandstone material of the highwall crest area, from the northeast corner of Quarry 2 to the eastern extent of Quarry 1. The excavated overburden Fountain Formation slope will not exceed the 1.5H:1V profile described in the Kleinfelder report Section 7.1.1 – Slope Template I (**Attachment A Figure 6**).

In place of the talus cover that is proposed in the current M-1977-141, Technical Revision #2 reclamation plan for slopes steeper than 2H:1V, these slopes will be graded back to a minimum 2H:1V slope, as shown in Attachment B.

Excavated material from the Fountain Formation sandstone will be segregated into riprap or fill material onsite with the fill material either being sent to Quarry 2 for backfill or transported down to the swale at the entrance to Quarry 1. The riprap rock material will be sized, and the largest gradation will be used for the scour berm at the base of the quarry. Smaller riprap will be used for lining the drainage channels. If there are excess materials remaining after these features have been completed, a beneficial re-use of the material offsite could be assessed. Aggregate Industries and BCPOS have had active communication about the ability to re-use site materials specifically for municipal and State projects in the area around Lyons Quarry. If the material cannot be exported from the site, the spoils will be placed along a section of the eastern slope of the quarry as shown in the grading plan.

3.2 Quarry 2

To meet objectives of staying within the current footprint of site disturbance, Aggregate Industries proposes to reconfigure the reclaimed slope grading so that the Quarry 2 is backfilled to form a natural swale as this area originally had prior to mining activity. Fill slopes in the Quarry 2 area will be placed and compacted to achieve 50-foot-high benches, sloped at 2H:1V, with 15-foot wide benches. As referenced in the Background section, this area has already been partially backfilled by 29,000 CY of excess material obtained from a downstream reclamation project. Permit M-1977-141, Technical Revision #4 for the Area 2 floodplain references continuing backfill of this area with

crusher fines from four areas of the floodplain. Any additional backfill material needed to bring the slopes up to a 2H:1V grade will be bladed down from the overburden soils at the top of the highwall.

This operation will make use of nuisance crusher fines from the floodplain area, will stay within the quarry footprint, and require minimal, if any, blasting. The re-creation of a swale formation, shown in Attachment B – Grading Plan Sheet 01C-02 and 01C-03, Details A and B, will allow runoff collected within the re-contoured swale to be conveyed down to the large catchment basin of Quarry 1. This basin will allow for the settlement of potential suspended sediments and channel runoff water to South St. Vrain Creek through a new culvert installed within the catchment berm.

3.3 Rockfall Prevention

After the Fountain Formation sandstone at the crest of the highwall has been excavated, the dacite highwall in Quarry 1 (northeast facing) as well as the dacite highwall between Quarry 1 and Quarry 2 (northwest facing), will be scaled to remove any loose rock that accumulated on the highwall naturally or is deposited during excavation of the Fountain Formation. Attachment B – Grading Plan, Sheet 01C-03, Details C, D and E show the proposed configuration of the dacite highwalls along the northwest and northeast faces of Quarry 1.

Scaling of the dacite highwalls removes potential high risk (removable) rocks as well as cleans and exposes the highwall to be evaluated for rock bolting. Where rock bolts will be needed to stabilize the highwall areas, efforts will be made to minimize the visual impacts of the rock bolts in order to preserve the exposed rock face to the extent possible. The Project team reviewed the options proposed in the Kleinfelder report to meet the objectives of maximizing slope variability while minimizing risk to the reclamation contractor and reducing the amount of material required for excavation.

Section 7.1.1 of the Kleinfelder report recommends, “reinforcing potential wedge failures on the northeast facing slopes using rock anchors and shotcrete; or alternately constructing soil fills against the dacite on the northeast facing slopes”. Permit M-1977-141, Technical Revision #2 recommended buttressing the dacite in this area with fill instead of using rock bolts as stabilization.

The Kleinfelder report also notes, “The consequence of failure of a small rock wedge from the dacite on the northeast facing slopes is a rapid block slide that may cause undercutting of the Fountain Formation. These types of failures should be effectively mitigated by analyses during construction and rock bolt support utilizing adequate safety factors” (Kleinfelder, 2008). As mentioned in Section 3.2, the northeast-facing slopes in Quarry 2 will be backfilled for stabilization. Aggregate Industries proposes to perform as-needed rock reinforcement accompanied by twisted wire mesh and split-set stabilizers to areas of the exposed dacite formation in place of backfilling along the northeast and northwest-facing slopes of Quarry 1. More information on the scaling and rock reinforcement of the dacite highwall can be found in Section 5.1, Item 7 and Attachment G.

3.4 Rockfall Catchment Basin and Berms

Scaling and rock bolting as mentioned above will remove or stabilize the highest risk blocks within the dacite highwalls. However, due to the columnar jointing of the dacite formation, the potential for development of rock blocks to fall out of the highwalls will always remain. As a result, an

appropriately sized rockfall catchment basin and/or berm coupled with restricted access to the toe areas of the highwalls are necessary. The joint orientations and spacings in the dacite presented in the Kleinfelder report indicate a high potential to form elongated blocks that could range in size from about 2 to 6 feet in all dimensions, based on the reported spacing of the joint sets.

Aggregate Industries proposes to connect the existing backfill at the east end of Quarry 1 with the ramp that leads to Quarry 2. This will require backfilling of the existing swale that allows access to Quarry 1, creating a 30-foot high berm across the swale as shown in **Attachment A - Figure 7**. By filling this swale, a large rockfall catchment basin will be formed at the toe of the northeast-facing highwall in Quarry 1. An updated rockfall evaluation using a Colorado Rockfall Simulation Program (CRSP) model (Jones et al., 2000) was used to verify that the catchment basin shown in **Attachment A - Figure 7** is adequate to catch 100% of the modeled potential rockfall from both the dacite and Fountain Formation sandstone with an adequate factor of safety meeting or exceeding the MLRB Policy No.30 requirement of 1.5. The CRSP evaluation report is included as Attachment E-2.

The Fountain Formation sandstone was modeled as excavated to a 2H:1V slope as discussed above; however, for conservatism the 20-foot wide bench at the sandstone/dacite contact was not included in the evaluation. The northeast-facing dacite highwall was modeled as-is based on the updated topographic survey conducted in September 2020 by Aggregate Industries. Section A, shown on **Attachment A - Figure 7**, was selected as the most critical section for the highwall and used to generate the slope configuration. Using the current condition of the slope is conservative because the scaling work discussed above will reclaim some of the benches that exist in the dacite that were formed during the quarrying process, which will provide rockfall containment on the highwall until they fill with collected material.

The results of the evaluation indicate that along the critical Section A, either a 170-foot long run-out area with no berm, or a 30-foot long run-out area with a 9-foot high catchment berm, is necessary to catch 100% of all rock sizes modeled. Spherical sandstone blocks up to 12 feet in diameter were modeled, although these blocks are deemed highly unlikely to be generated by the quarry slope, providing a factor of safety. The 30-foot long runout area was selected because it corresponds to the eastern end of the northeast dacite highwall where the runout area is narrowest but has an opposite-facing slope at 1H:1V across from the 30-foot runout area. The slope height of 50 feet at this location provides a factor of safety of over five times the necessary slope height of 9 feet to catch all rock sizes simulated with a 30-foot runout and an opposite slope of 1H:1V. The area with the lowest opposite berm height is the western end of the northeast-facing dacite highwall where the runout area is 130 feet long and the opposite facing berm is 20 feet high, which is well within the limits of the evaluation results. An additional factor of safety can be assumed since the critical section is applied to the entire highwall. With the catchment basin in Quarry 1 as described above, observation of the northeast-facing dacite highwall can only be made from a significant distance.

A rockfall evaluation was also conducted for the northwest-facing dacite highwall with the critical Section B shown on **Attachment A - Figure 7**, to evaluate the necessary height of a catchment berm to be constructed at the highwall toe. The results of the evaluation indicate that with a runout length of 30 feet, an 8-foot high berm constructed with 2H:1V slopes will catch 100% of all rock sizes modeled, which includes the spherical sandstone blocks up to 12 feet in diameter (which are highly unlikely) providing a factor of safety. The runout length of 30 feet was selected for evaluation as the

narrowest available area at the western extent of the highwall. Increasing the berm height to 12 feet will provide a factor of safety of at least 1.5 at the south end where the runout length is shortest and higher along the remaining alignment where the runout length increases from 30 to 60 feet.

According to the Kleinfelder report; “Rockfall events could also result in a dangerous condition to structures or people who happen to be located at the base of the slope during a rockfall event. This potential hazard should be effectively mitigated by adequate limitation of access to areas of potential rockfall” (Kleinfelder, 2008). Aggregate Industries proposes to install appropriate land use controls, such as fences and signage, around a buffer zone restricting public access to any areas of potential rockfall or fall hazards. The alignment of this proposed fencing is shown in Attachment B and Chain Link Fence specifications for the land use controls have been developed using Mile High Flood District Technical Specifications. These specifications can be found in Attachment G.

3.5 Stormwater and Erosion Control Features

With the proposed changes to the site grading plan, corresponding revisions to the approved Technical Revision #2 plan for channeling stormwater runoff and controlling erosion will be necessary. As with the original plan, slopes equal to or less than 2H:1V will be stabilized with appropriate Best Management Practices (BMP’s) including straw wattles and/or silt fencing. Slopes steeper than 2H:1V may not be feasible to install BMPs but will be channeled to the rockfall catchment basin and a secondary earthen berm around the scour berm to capture potentially suspended sediments.

The runoff control channel that ran along the west perimeter of the quarry will be realigned to convey drainage through the reconstructed swale of Quarry 2 into the catchment basin of Quarry 1 (shown in Attachment B). Channelizing and capturing surface runoff within the quarry area would further reduce impacts to areas outside of the already impacted mining activity. Flow will then be directed through the swale and scour berm in Quarry 1 via a 24-inch reinforced concrete pipe (RCP) culvert. This culvert was sized to convey the peak discharge from a 10-year storm event. The culvert outlet will tie into the drainage channel at the toe of the scour berm and direct flow to the east. The culvert is necessary to prevent the retention of water within the catchment basin. Aggregate does not propose to impound water in the catchment basin and all areas will be graded to positively drain through the RCP outlet.

The runoff control channel on the east perimeter of the quarry will remain as previously designed in Technical Revision #2, running along the existing access road grade and tying in with the scour berm toe drainage channel before discharging through a 24-inch RCP culvert running under the site access road to South Saint Vrain Creek. This culvert would represent a new discharge point for the site but is needed to convey stormwater under the site access road.

3.6 Scour Berm Realignment

The toe areas of fill slopes that extend into the low-lying areas and the floodway of South St. Vrain Creek will be protected from scour by future flood events by the construction of a “self-launching” riprap scour berm. The self-launching term refers to the ability of the riprap comprising the scour berm to fill in undermined sections that may be impacted during a flood event. The scour protection is designed to withstand a minimum 100-year flood event. The riprap gradation for the scour berm

has a D_{50} of 28 inches and a maximum stone size of 42 inches. The compressive strength specifications of the riprap will allow for the white sandstone layers of Lyons Quarry to be used as sources.

The scour berm feature specified in M-1977-141, Technical Revision #2 to protect the base of the quarry at the floodplain boundary would, for the most part, remain in place as part of this revised reclamation plan. Sections in M-1977-141, Technical Revision #2 where the berm becomes a stand-alone trapezoidal shape would be moved to the south and would be built against the new swale berm in Quarry 1 (Attachment B). Relocating this section of the scour berm would greatly reduce the amount of required riprap material and maintain the existing parking area of Lyons Quarry for public use in the future.

Aggregate proposes to leave the current parking area, located within the floodplain reclamation area LQRA 4 (Attachment B, Sheet 01C-02), in place for future BCPOS maintenance use. This area is currently covered with a layer of crusher fines and Aggregate will use reclaimed crusher fines to develop a parking area approximately 1.7 acres as shown on Sheet 01C-01 in the design drawings (Attachment H).

3.7 Site Restoration

As specified in Technical Revision #2, slopes for the revised plan that are steeper than 2H:1V will be revegetated either by using straw mulch and crimping or hydro mulching methods while also receiving an appropriate seed mix and necessary organic amendments (Attachment C). Slopes steeper than 2H:1V will mostly consist of rock faces that will not support vegetation; therefore, these slopes will not be revegetated. Available onsite topsoil sources will be utilized where needed but any nuisance fine sediment material, such as layers of crusher fines identified within the floodplain area, would be assessed for utilizing offsite at municipal or State projects. Aggregate will not remove any material from the site that could potentially be used for reclamation of the affected lands until all appropriate stakeholders have approved this export.

The focus of revegetation will be native plant species, adapted to the area climate, that require no irrigation. A native plant seed mix was developed in consultation with a BCPOS ecologist for elevations from 5,500 to 7,000 feet above mean sea level. Areas of revegetation will be maintained for up to one growing season to control weed infestation.

The sedimentation pond would be utilized during construction for dust control, fill moisture conditioning and watering vegetation as needed. Mining Permit M-1977-141, Technical Revision #2 calls for the 0.3-acre sedimentation pond at the eastern end of the site to be backfilled following all reclamation operations. Grading will blend with surrounding topography and be sloped towards South St. Vrain Creek (Attachment B). Recent correspondence with BCPOS indicates that they do not have augmentation water rights available and to proceed with filling the pond as part of the reclamation.

3.8 Proposed Restoration of Reclamation Area 2

As noted in an April 2021 DRMS site inspection report, “TR-4 (and the associated bond estimate) only addressed reclamation of the four discreet areas located within Reclamation Area 2 where

stockpiled materials or crusher fines remained after the 2013 flooding, covering a total of 5.15 acres. Based on the Division's estimate of 17 acres disturbed in Reclamation Area 2, re-topsoiling and revegetation of the remaining 11.85 acres of disturbance in this area will need to be addressed in TR-5".

Aggregate Industries proposes to work with a contractor performing highway rehabilitation for the Colorado Department of Transportation in the near vicinity of Lyons Quarry. The highway project calls for borrow material import of 8,000 to 12,000 cubic yards of inert soil material. In April 2021, test plots were excavated in Area 2 of the Lyons Quarry specifically in floodplain areas outside of proposed South St. Vrain Restoration project. The results of the test pit program show a layer of crusher fines remaining that is 1-3 feet thick and free of organic material. Aggregate proposes to reclaim this area (approximately 3.7 acres) by scraping the alluvium aside with a bulldozer, removing the crusher fines and stockpiling any organic material that can be salvaged down to the water table. The alluvium would then be replaced, and the stockpiled organic material would cover the alluvium in a 1-foot thick layer. Material would be transported off site with over-the-road haul trucks to the CDOT Highway 7 project. Aggregate estimates 10,000 CY of material export for this operation as shown in the volume quantities chart in Attachment B.

Aggregate proposes this re-use of the cobble and alluvium material would also be applied to LQRA4 and LQRA5 (as shown in Attachment B) to replace the proposed imported soil riprap described in Technical Revision #4. By substituting the angular rock of the soil riprap with rounded cobble there are likely to be less issues with exposed soil fines and potential realignment of the creek during restoration work. Soil conditioning and re-vegetation of all floodplain restoration would follow the same requirements for Area 2 described in Technical Revision #4.

Adding the 3.7 acres for this restoration along with the 5.15 acres proposed in Technical Revision #4, approximately half (8.85 of the 17 acres) of Area 2 would be restored. Considering the remaining 8.15 acres: the scour berm is planned to cover 1.26 acres, the South St. Vrain's re-alignment through the northeast corner of the site covers another 1.15 acres and the South St. Vrain Realignment project will likely disturb the remaining 5.74 acres by creating three separate channels through the floodplain area. To avoid the potential of site restoration being disturbed by this realignment work in the near future, and considering that many of these areas have re-established vegetation since the 2013 flood, Aggregate proposes to keep this remaining 5.74 acres as is.

4 Exhibit F – Reclamation Plan Map

The Reclamation Plan Map is provided as Attachment C.

5 Exhibit L – Reclamation Costs

Estimated reclamation costs for each of the major work items described below are summarized and presented in Exhibit L – Reclamation Costs, Attachment D.

5.1 Planned Reclamation Scope of Work

The following tasks are specific to the reclamation work to be performed in the Lyons Quarry Area 1 (LQRA1) location and do not include tasks to be performed within the reclamation of the floodplain areas (LQRA2-LQRA5) which are covered in Technical Revision #4.

Item 1.0 – Mobilization/Demobilization

This item includes all costs necessary and incidental to move equipment and supplies onto the project area, perform minimal road improvements, if required, move equipment within the project area during the course of the project, and any other requirements necessary for the successful completion of this project. The operator will maintain such temporary works and equipment throughout the period of construction. This item also includes all labor, equipment, and costs associated with demobilization and clean-up of the project site following the completion of the project. For the scope of work proposed, Aggregate assumes that the following equipment will be mobilized to the site:

- (1) Front-end wheel loader with 4.5 CY bucket (Caterpillar 950 or equivalent)
- (1) Track-mounted excavator (Caterpillar 349 or equivalent)
- (1) Bulldozer (Caterpillar D9 or equivalent)
- (2) Articulating haul truck (Caterpillar 740 or equivalent)
- (1) Skid steer tracked loader (Caterpillar 262 or equivalent)
- (1) Rock Screen for Type M riprap

This equipment will most likely be provided by the selected contractor; however, the equipment can also be rented from Wagner Rents – Caterpillar Rental, 1317 E Mulberry St, Fort Collins, CO 80524.

Item 2.0 – Project Safety Plan and Implementation

The project will involve working around inactive quarry slopes and associated hazards, and the contractor must comply with all OSHA regulations. This task includes all of the operator's and sub-contractor's expenses for employee time, labor, materials, and safety equipment and safety training necessary for preparing and executing a job safety plan.

Item 3.0 – Erosion, Sedimentation, and Dust Control Plan

This item covers the design, installation, maintenance, and removal of temporary erosion, sedimentation, and dust control features. The operator will be required to install these sediment control features prior to any ground disturbing activities and maintain them throughout the duration of the project. The work to reclaim areas within the floodplain is anticipated to be performed during low flow conditions on South St. Vrain Creek to minimize the impacts of snowmelt runoff within the work areas. The installed temporary erosion and sediment control features assume BMP's in accordance with the Boulder County Storm Drainage Criteria Manual, including but not limited to Temporary Embankment Protectors, Silt Barriers and Sediment Control Logs.

Dust generated from the project area during work and off-work periods will be controlled and kept to a minimum. The operator will be required to develop and implement a Dust Control Plan, including Wind Erosion/Dust Control BMP's and dust suppression of working areas during working and non-working periods, including weekends, throughout the duration of the project.

Item 4.0 – Site Survey

This task consists of performing all surveys, measurements, and computations required by the specifications to accurately track that the materials are imported and exported according to the design drawings.

Item 5.0 – Disposal of Excavated Materials

This item covers off-site disposal of debris materials that may be encountered during excavation of the floodplain areas. While most of the mining infrastructure has been accounted for, the potential for deposition of debris from upstream sources following the 2013 flood remains.

Item 6.0 – Earthwork

Item 6.1 – Excavation and Blasting

Once the site controls are installed, the grading plan will be implemented. All areas will be appropriately marked to protect vegetation and structures. The work areas will then be cleared and grubbed prior to excavation and backfilling. Topsoil sources will be stripped and appropriately stockpiled.

As described in the Geotechnical Stability Exhibit, Attachment E, cut slopes in the overburden sedimentary rock will be excavated using heavy equipment or drill and blast methods to achieve overall 2H:1V slopes. Excavated material from the Fountain Formation sandstone will be segregated into riprap or fill material onsite with the fill material either being sent to Quarry 2 for backfill or transported down to the swale at the entrance to Quarry 1. The CAT 349 excavator and CAT D9 dozer will perform the majority of excavation with the excavator and wheel loader loading the CAT 740 haul trucks.

The riprap rock material will be screened and sized with the largest gradation used for constructing the scour berm at the base of the quarry. Smaller riprap (Type M) will be used for lining the drainage channels. As shown in **Table 3** the estimated aggregate excavation volume to establish the final grading for the Quarry 1 area is approximately 245,080 CY. Excavation and fill requirements for the floodplain (Area 2), which are covered in Technical Revision #4, are included for reference. Technical Specifications, including blasting requirements, for Excavation are included in Section 31 23 16 of Attachment G.

Table 3 – Estimated Excavate-Fill Quantities

Item	Excavate (CY)	Fill (CY)
Area 1 – Quarry Slope Grading[1]	245,080	125,300
Northeast Catchment Berm		14,278
Northwest Catchment Berm		21,133
Sedimentation Pond Fill		2,222
Scour Berm		19,033
Total Area 1	**245,080**	**181,966**
Area 2 – Floodplain Soil Removal	23,300	13,685
Area 2 – Floodplain Soil Export[2]	10,000	
Total Area 2	**33,300**	**13,685**
Total Project	**278,380**	**195,651**
Excavate-Fill Balance[3]	**72,729**	

1. Area 1 quantities include Quarry 1 and Quarry 2
2. See Section 3.8 for description of Floodplain Soil Export
3. Excludes 10,000 CY Floodplain Soil Export

Item 6.2 – Fill

Fill slopes in the Quarry 2 highwall area will be placed and compacted to achieve 50-foot-high benches, sloped 2H:1V, with 15-foot wide benches. Compaction will be performed with tracked equipment (D9 dozer) a minimum number of passes to achieve specified densities. Including Quarry 1 and 2, filling the sediment pond and building catchment berms, the estimated aggregate fill volume to establish the final grading for Area 1 is approximately 181,966 CY. Fill materials will consist of overburden materials that are uniformly graded continuously from boulder size to silt size, with a maximum particle size equal to two-thirds of the lift thickness and maximum 45 percent fines in the minus 3-inch fraction.

Benches will be constructed 15-feet-wide at 50-foot contour intervals and will be sloped from west to east at grades no steeper than 10H:1V. The bench width will be adjusted to achieve an overall 150-foot-high slope with a stability factor of safety greater than 1.5. All fill will be placed as follows:

- Placed in horizontal lifts not to exceed 3 feet thick, based on the maximum particle size of the fill materials
- Compacted to achieve greater than 90% of the maximum dry density determined in accordance with ASTM D698
- Placed in a manner that allows for a moisture content within 3% of optimum based on ASTM D698

Additional Technical Specifications for Fill are included in Section 31 23 23 of Attachment G. The average push distance for the majority of fill activities (Quarry 2) is 300 feet. The average haul distance for the catchment berm construction is 0.55 miles.

Item 6.3 - Riprap for Drainage Channels and Scour Berm

The toe areas of fill slopes that extend into the low-lying areas and the flood way of South St. Vrain Creek will be protected from scour by future flood events by the construction of a riprap scour berm as shown in Attachment B. The riprap gradation for the scour berm has a D_{50} of 28 inches and a maximum stone size of 42 inches. The riprap gradation for the drainage channels will meet Type M requirements. Riprap material sourcing and placement will need to meet the following specifications:

A. Onsite, hard, durable, broken, quarried sandstone or igneous rock. Free from fractures, bedding planes, siltstone or shale layers, pronounced weathering, and earth or other adherent coatings.

B. Elongation: Minimum dimension not less than 1/3 maximum dimension.

C. Unconfined compressive strength: Minimum 4,000 psi in accordance with ASTM D 7012 on drilled core specimen.

D. Relative Density: Minimum 2.5 in accordance with ASTM C 127

E. Gradation: The size, gradation, and weight of riprap shall conform to the requirements of the Technical Specifications Section 31 37 00 included in Attachment G.

As shown in **Table 3** the total volume of riprap for the Scour Berm and Drainage Channels is estimated to be 20,000 CY. This estimate could vary slightly, depending on the final alignment of the drainage channels. Riprap will be placed using CAT 740 haul trucks and the CAT 349 excavator.

Item 6.4 – Final Grading

Final Grading of all fill slopes, benches, crest areas, and toe areas will ensure that water is not allowed to pond on or adjacent to the fill slopes. Grading will be performed to the proposed slope gradients shown in the Grading Plan (Attachment B). Final subgrades will be developed using survey equipment from Item 4.0 and a CAT D9 dozer or CAT 349 excavator. Final grades with organic material included will be developed using an excavator or tracked skid-steer to lightly spread out the material and prevent compaction.

Item 7.0 – Ground Control

After the Fountain Formation sandstone at the crest of the highwall has been excavated, the dacite highwall in Quarry 1 (northeast facing) as well as the dacite highwall between Quarry 1 and Quarry 2 (northwest facing), will be scaled to remove any loose rock that accumulated on the highwall naturally or is deposited during excavation of the Fountain Formation. Attachment B – Grading Pan, Sheet 01C-03, Details C, D and E show the proposed final configuration of the dacite highwalls along the northwest and northeast faces of Quarry 1. Ground Control work will be performed

according to Technical Specifications Section 31 72 16 included in Attachment G. This work includes:

- Rock slope scaling: The Work consists of removing loose rock and debris in areas shown on the Plans prior to placement of Rock Reinforcement (Number 10) or as directed by the Engineer.

- Rock bolt installation: This Work consists of furnishing and installing Rock Reinforcement (Number 10), split set stabilization and twisted wire mesh as shown on the Plans.

Submittals for the Ground Control will include a qualifications statement, Scaling Work Plan, Construction Materials submittals, Rock Reinforcement Shop Drawings, a narrative of the testing procedures and application of anchoring materials, and drilling and testing forms.

The crew performing Rock Scaling shall remove or stabilize loose, hanging, or potentially dangerous or unstable rocks and soil debris on rock cut slopes using manual scaling techniques. Rock scaling will be required for any areas that are to receive Rock Reinforcement (Number 10) described below to provide to remove the weathered surface of rock prior to split set, mesh and Rock Reinforcement installation. The crew shall scale by hand methods using a standard steel mine-scaling rod or similar device, or by mechanical tools that can be hand operated (i.e. jack hammers). In addition to hand scaling techniques other measures such as hydraulic wedges, air pillow, or other mechanical means may be used if demonstrated to be effective and approved in writing by the Engineer.

Rock Reinforcement may be needed for stabilization where large blocks are evident in the bedrock. Locations for Rock Reinforcement will be determined by the on-site Engineer after scaling operations are complete. Based on these field observations, the Engineer may increase, reduce, delete, or otherwise alter the Rock Reinforcement as necessary to address actual field conditions. This is anticipated to be addressed in an amendment to this Technical Revision once the slope has been cleared and a formal design of the Rock Reinforcement alignment, placement and depth is determined. The Rock Reinforcement will be installed according to specification found in Section 31 72 16 – Ground Control and will consist of #10 thread bars installed into the dacite face and anchored with cement grout installed in two phases. A bearing plate, washer and nut will be installed to tension the bolt to the rock surface.

To prevent the fractured surface of the dacite face from becoming loose and falling away from the area immediately around the Rock Reinforcement, and prior to the #10 thread bar installation, Aggregate will install split set stabilizers (Type SS-33 or equivalent) and twisted wire mesh over the previously-scaled area. Three split-set stabilizers, each 48 inches long, shall be placed a maximum of 4 (four) feet from the main Rock Reinforcement position in a triangular pattern. Drilling for Type SS-33 split set stabilizers shall be with a hydraulic or percussive drill with a bore diameter of 2-5/8 inches. Aggregate will use a manufacturer-provided driver tool attached to a drill chuck to install the split set stabilizers and bearing plate over the twisted wire mesh.

The GeoBrugg Minax 80/4 twisted wire mesh used for quarry highwall applications as a replacement for the shotcrete noted in the Kleinfelder report (Figure 6), is specified for use. Minax mesh with a wire tensile strength of at least 1,770 N/mm2 is able to withstand substantially higher static and dynamic loads than conventional reinforcement nets and enables higher levels of rockburst energy

to be absorbed. According to the Federal Highway Administration (FHWA) – Context Sensitive Rock Slope Design Solutions, while shotcrete "adds a small amount of structural support for small blocks" it is used more for "ongoing loss of eroded areas" and requires proper drainage behind/through the shotcrete (Andrew, et. al, 2011). In the case of Lyons Quarry, the Rock Reinforcement (Number 10) is intended to provide the necessary stabilization of the dacite highwall where required and be supported by the split sets and twisted wire mesh installed on a fresh, scaled rock face. Twisted wire mesh provides a free-draining system requiring minimal maintenance compared to shotcrete that may spall or crack, and the mesh is "used to apply active retention force to retain rocks and soil on a slope". The mesh along with the split sets and Rock Reinforcement will be hot-dip galvanized to provide corrosion protection and an approximate lifespan of at least 50 years.

Each group of three split set stabilizers will retain a minimum of 16 square feet of welded twisted wire mesh centered around each Rock Reinforcement (Number 10). Split set anchor plates will be installed with uniform contact made with both the rock face and the wire mesh, such that the wire mesh is held securely against the rock face. Split sets that do not make sufficient contact between the plate and rock face will be removed and replaced.,

For the costs estimated for the Ground Control task, the most conservative unit rates from the CDOT 2018 US Hwy 24 Rockfall Mitigation project were used. For Lyons Quarry it is assumed that up to 144 hours of rock scaling will be required at a cost of $500 per hour due to the complexity of the highwall configuration. An assumed total of 20 Rock Reinforcements each with a drilled length of 30 feet will be needed for reclamation at a cost of $7,500 per Rock Reinforcement location.

Item 9.0 – Restoration - Test Plots, Soil Conditioning and Revegetation

Reclamation areas will be restored depending on their proximity to the current channel alignment and whether backfill material is required as shown on Exhibit F- Reclamation Plan Map, Attachment C.

9.1 – Test Plots

The final reclamation topsoil/growth medium, seeding, fertilization, and revegetation will be determined based on the results of Test Plots developed during the Quarry reclamation work using the soil types and slopes planned for reclamation to assist in determining the appropriate types and methods for reclamation.

The actual location of the restoration test plots will be determined by the Quarry reclamation sub-contractor and based on the operator's earthwork schedule and re-grading plan. The specifications will require that the sub-contractor develops test plots with similar elevations and aspects as the planned reclamation. The test plots will have 30-foot x 30-foot dimensions with two variables per plot, or two 15-foot x 30-foot subplots. There would be a total of four (4) test plots, or eight (8) total subplots. The test plots will be seeded in the spring of 2021 once the ground surface is exposed and there is sufficient moisture to obtain germination.

The test plots will be monitored periodically throughout the reclamation of the Quarry. The plots and plants would be photographed, and a vegetative survey conducted to include plant type, plant height, plant density, overall, vegetation density, and presence of weeds. Monitoring would also include general observations such as evidence of erosion and pest issues. Soil samples would be collected in the fall for routine soil nutrient assessment, including major plant nutrients and

micronutrients. Aggregate Industries may also conduct a bench-scale study that could allow the start of reclamation activities sooner than the proposed 12-month schedule. The bench-scale study would supplement the field plot information. By growing indoors, faster germination and vegetative growth can be achieved.

9.2 – Soil Conditioning

All reclamation areas within the floodplain will be reclaimed in a manner that allows for livestock grazing. These areas will be backfilled as described above, then covered with a layer of growth medium material. The growth medium material will be developed from a blend of any available topsoil stockpiled on site and material available from the excavation and breakdown of the fine-grained sedimentary overburden rock, supplemented as needed by imported topsoil, biosolids, or compost, then blended, scarified, seeded and mulched.

The materials will be transported using front end wheel loaders or articulating haul trucks. This material will then be uniformly spread and mixed with conventional earthmoving equipment, such as dozer rippers or the teeth of an excavator bucket, into the top 12 inches of the subsoil. For the Area 1 reclamation it is anticipated that the soil conditioning area covers approximately 33.9 acres.

For purposes of estimating costs for Attachment D, Aggregate estimates that the top six inches from 5 acres along the top of the highwall will provide an assumed 4,033 CY of topsoil. To provide 6 inches of topsoil cover for the remaining 28.9 acres, Aggregates estimates importing 23,312 CY of organic material meeting the requirements below. This number is reduced from the 31,460 CY assumed in Technical Revision #2 due to the reduced amount of fill areas in Quarry 1 that would require revegetation. The costs of utilizing topsoil sources onsite versus imported soil growth medium have been broken out as separate lines in the estimated costs table of Attachment D.

Imported soil amendments shall be from a local source of material to be generated during test plot development and reclamation. Caked or lumpy soil amendments will not be accepted. If selected as the preferred source, manure shall be dry cow, horse or sheep manure that has been stockpiled a minimum of one (1) year. Manure shall not be so caked or lumpy that it cannot be spread uniformly. Compost manure shall be stabilized through at least one heating cycle (120 to 140 F degrees), turned at least once, and windrowed for at least 45 days and stockpiled for a least 2 months. Biosolids or compost biosolids, containing municipal biosolids, shall meet Colorado Department of Public Health and Environment Water Quality Control Commission 5 CCR 1002-64 Biosolids Regulation No. 64, including permitting and regulatory approval procedures. Soil amendments shall not contain pathogens or toxic materials harmful to human health or vegetation growth.

For the additional restoration of the floodplain area, soil conditioning requirements would follow the specifications detailed in Technical Revision #4. Aggregate Industries estimates this area to cover approximately 7.02 acres of the west end of the floodplain.

9.3 – Revegetation

It is anticipated that the revegetation of Area 1 covers approximately 33.9 acres. Seeding of the reclaimed areas assumes a native seed mix comprised of the species and mixtures recommended by Boulder County Parks and Open Space with updates provided in December 2019 by Senior Plant Ecologist David Hirt. This seed mix incorporates species that have performed well. **Table 4** shows the native seed mix recommended for 5,500 to 7,000 feet elevation (reclaimed areas at the site

range in elevation from 5,500 to 5,820 feet). The listed quantities and application rates are shown in pounds of pure live seed per acre (#PLS/Acre). Assumed application rates have been doubled to account for broadcast seeding. The seeding is anticipated to be completed from March - April 15, 2022. If any areas must be prepared in the summer, fall, or winter, then the topsoil will be mulched at that time and seeded the following spring.

Table 4 – Native Seed Mixes 5,500 Feet to 7,000 Feet Elevation

Common Name	Species Name	Variety	%of Mix	#PLS/ Acre
Canada Wildrye	*Elymus canadensis*	Mandan	12	3.64
Blue Grama	*Bouteloua gracilis*	Native, Alma, or Hachita	14	0.59
Slender Wheatgrass	*Elymus trachycaulus*	San Luis or First Strike	10	2.19
Squirrel Tail	*Elymus elymoides*	Pueblo	12	2.18
Thickspike Wheatgrass	*Elymus trachycaulus*	Critana	10	2.26
Sandberg Bluegrass	*Poa secunda*	Colorado Plateau	5	0.38
Switchgrass	*Panicum virgatum*	Blackwell or Nebraska 28 or BOCO	9	0.81
Green Needlegrass	*Stipa viridula*	Lodorm or Native	8	1.54
Fringed Sage	*Artemesia frigida*	VNS	4	0.03
Hairy Golden Aster	*Heterotheca viliosa*	VNS	5	0.20
Rocky Mtn. Bee Plant	*Cleome serrulata*	VNS	4	2.12
Rabbitbrush	*Ericameria nuaseousus*	VNS	7	0.61
		Totals:	**100**	**16.55**

Fertilization assumes a minimum of 300 pounds (lbs.) of available nitrogen and 50 lbs. of available phosphorous per acre will be supplied after seeding and not included with the seeding. A soil analysis will be performed as part of the Test Plots to determine the fertilizer needs. Immediately following the seeding and fertilizing, the area will be lightly scarified and mulched using various application processes, based on the final grade, soil conditions, and equipment access. These may include:

- Long-stemmed native prairie hay, (4000 lbs./acre) and a tackifier emulsion (150 gal/acre hydro mulched. It is assumed that hydro mulch will be applied to slopes 2H:1V or steeper (unless prohibited by access or topography) (See Exhibit F – Reclamation Plan). Based on the revised grading plan, at least 31.5 acres of Areas 1 and 2 are in this slope range.
- Long-stemmed native prairie straw (4000 lbs/acre) mechanically crimped into the soil a minimum of 2”. It is assumed mulching and crimping will be applied to all reclaimed slopes

flatter than 2H:1V (See Exhibit F – Reclamation Plan). The slope analysis indicates approximately 11.1 acres are in this slope range.

10.0 – Perimeter Fencing

To further mitigate against unauthorized access into the high wall area, Aggregate Industries proposes to install appropriate land use controls, such as fences and signage, around a buffer zone restricting public access to any areas of potential rockfall or fall hazards. The alignment of this proposed fencing is shown in Attachment B and Perimeter Fence specifications for the land use controls have been developed using the Colorado Department of Transportation's M-607-4 Deer Fence specifications. The mesh fence will be installed using 12-gauge zinc-coated steel fabric with 6-inch mesh spacing. The fence will be a minimum of 8 feet in height and have 5-inch timber line posts spaced at 10-foot intervals with a tension line at the top. The line posts will be set in concrete. As shown in Attachment D, Aggregate is proposing to install 3,366 linear feet of perimeter fence including gates.

Aggregate proposes to install two gates in to the fence line: one at the east end of the swale berm of Quarry 1 to allow maintenance equipment access in the catchment basin; and another at the top of the access road along the east end of the site to allow maintenance access to the top of the highwall area (see Attachments B and H). The gates will provide an access path of 12-feet in width and be able to swing 90 degrees in and out. The gates will be secured with a brass padlock with keys provided to the appropriate agencies unless otherwise directed by the appropriate stakeholders. Costs for this line item were based off of a similar scope under a 2020 CDOT highway project which included over 6,000 linear feet of deer fence installation at approximately $23 per linear foot.

6 References

Andrew, R.D., Bartingale, R. and Hume, H. (2011) *Context Sensitive Rock Slope Design Solutions* (Report No. FHWA-CFL/TD-11-002). Federal Highway Administration. https://www.fhwa.dot.gov/clas/ctip/context_sensitive_rock_slope_design/

CDOT, 2018. Tabulation of Bids - US 24 Rockfall Mitigation from MM 289 to 301. Colorado Department of Transportation. May 3, 2018. Accessed at https://www.codot.gov/business/bidding/bid-tab-archives/2018-bid-tabs/stm-0242-081-21450 February 12, 2021.

Jones, Christopher L., Jerry D. Higgins, and Richard D. Andrew. "MI-66 Colorado Rockfall Simulation Program, Version 4.0." Rockfall Simulation Program. Miscellaneous MI-66. Denver, CO: Colorado Geological Survey, Division of Minerals and Geology, Department of Natural Resources, March 2000. https://coloradogeologicalsurvey.org/publications/colorado-rockfall-simulation-program.

Kleinfelder, 2008. Summary Report of Engineering Stability Analysis - Lyons Quarry, Boulder County, Colorado. Submitted by Kleinfelder West, Inc., February 2008

OMLR, 2019. Mineral Rules and Regulations of the Colorado Mined Land Reclamation Board for the Extraction of Construction Materials. Prepared by the Office of Mined Land Reclamation. Effective July 15, 2019.

A

Attachment A. Figures

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Figure 1 – Site Map and Location

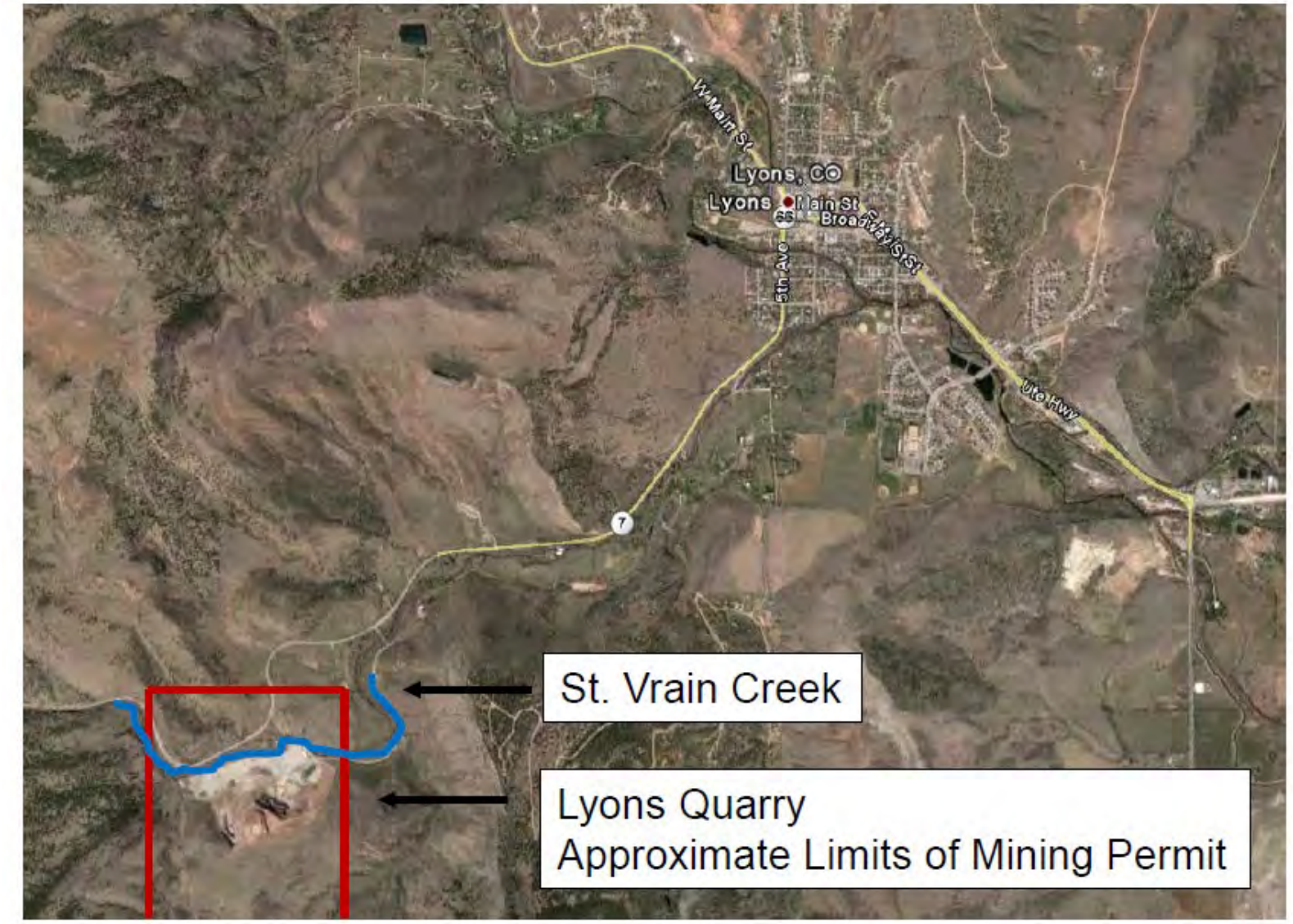


Figure 2 – Pre-Flood Satellite Image
October 6, 2012

Figure 3 – Post-Flood Satellite Image
October 7, 2013

Figure 4 – Andesite Quarry Mining Map

Figure 5 – Lyons Quarry during mining activities looking south (pre-2009)

Figure 6 - Kleinfelder Report - Template I, Section D'-D', (Kleinfelder, 2008)

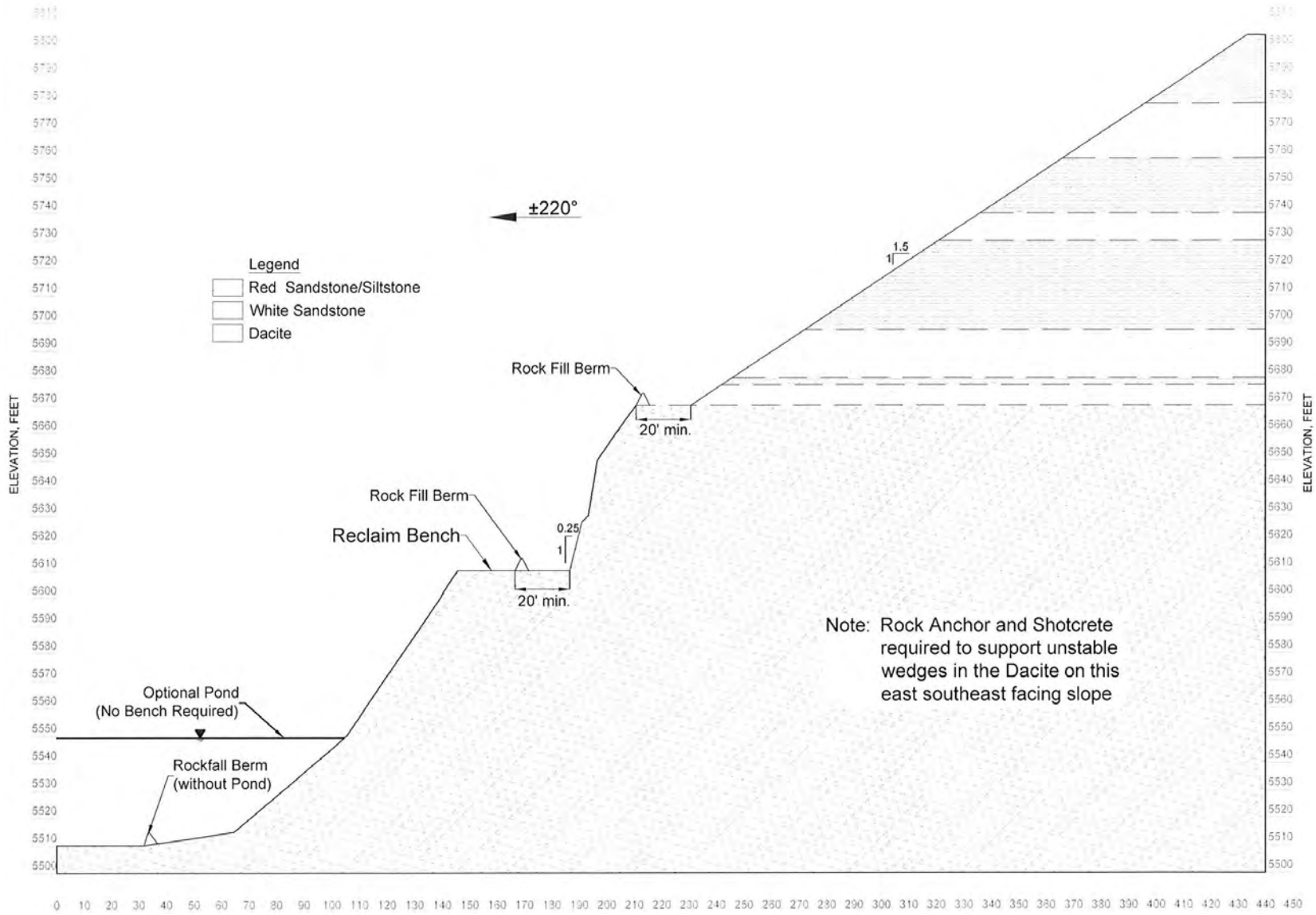
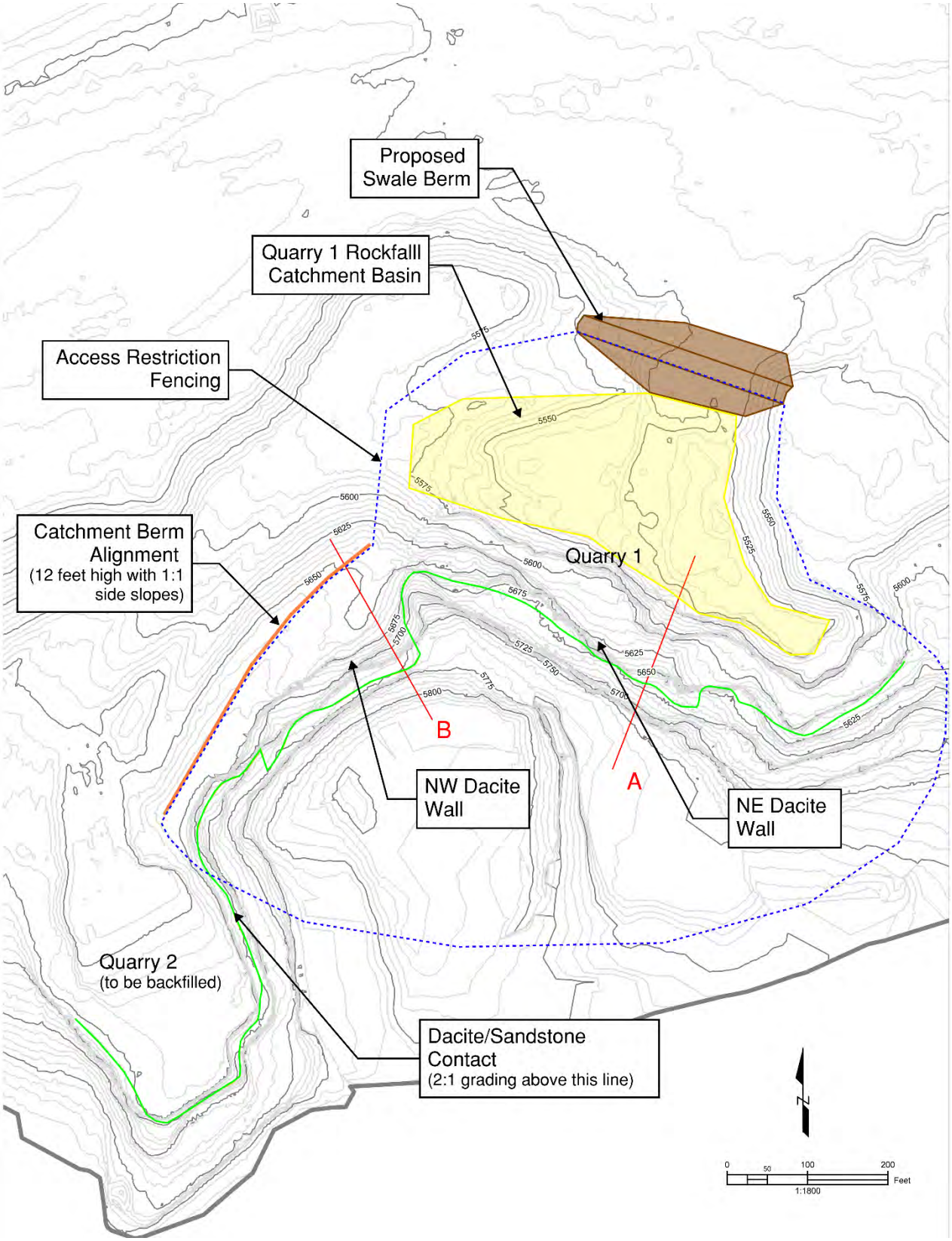


Figure 7 – Rockfall Catchment Basins and Berms, (Attachment E-2, Figure 1)



B

Attachment B.
Site Grading Plan

June 2021

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QUANTITIES TABLE		
ITEM	CUT (CU. YD.)	FILL (CU. YD.)
SLOPE GRADING	245,080	125,300
CATCHMENT BERM	-	14,278
NORTHWEST BERM	-	21,133
SEDIMENTATION POND	-	2,222
SCOUR BERM	-	19,033
FLOODPLAIN SOIL REMOVAL	23,300	13,685
FLOODPLAIN SOIL EXPORT	10,000	-
NET CUT/FILL: 82,729 CU. YD. (CUT)		

LEGEND

- PROPOSED SCOUR BERM
- PROPOSED DRAINAGE CHANNEL
- PROPOSED FILL SLOPE
- EXCESS SPOIL MATERIAL
- PROPOSED MAJOR CONTOUR (5700)
- PROPOSED MINOR CONTOUR
- LIMITS OF DISTURBANCE
- PROPOSED FENCE
- PROPOSED GATE
- PROPOSED CULVERT
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR

NOTES:
1. PERFORM ROCK SCALING IN ACCORDANCE WITH GROUND CONTROL SPECIFICATIONS (SECTION 31 72 16).
2. SOIL RIPRAP BACKFILL SHALL BE PLACED IN HORIZONTAL LIFTS NOT EXCEEDING 12 INCHES IN THICKNESS, DEPENDING OF THE FILL MATERIALS.
3. FINAL GRADING OF ALL FILL SLOPES, BENCHES, CREST AREAS, AND TOE AREAS SHOULD ENSURE THAT WATER IS NOT ALLOWED TO POND ON OR ADJACENT TO THE FILL SLOPES.

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100%	4/16/2021	FINAL DESIGN
90%	2/12/2021	PRE-FINAL DESIGN
60%	01/22/2021	INTERMEDIATE DESIGN PACKAGE

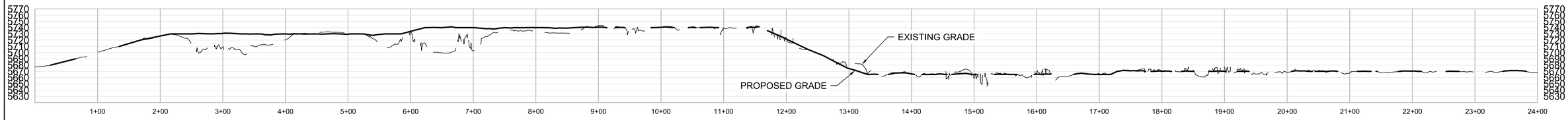
PROJECT MANAGER TRAVIS SNYDER
DRAWN BY R. NALLEY
PROJECT NUMBER 10092468

COLORADO LICENSED
RYAN W. TIMOTH
53410
PROFESSIONAL ENGINEER

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

CIVIL
FLOODPLAIN SOIL REMOVAL AND SITE GRADING PLAN

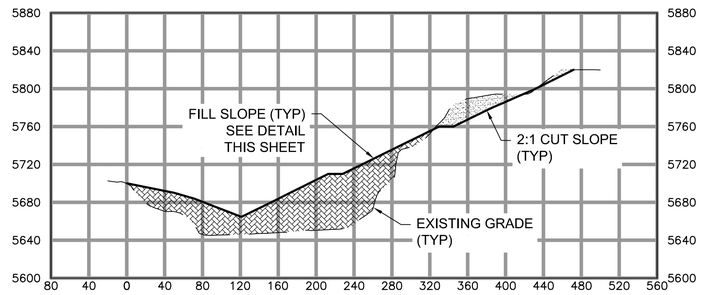
FILENAME 01C-02.dwg
SCALE AS NOTED
SHEET 01C-02



STATION EXCAVATION BASE PROFILE

1" = 80'

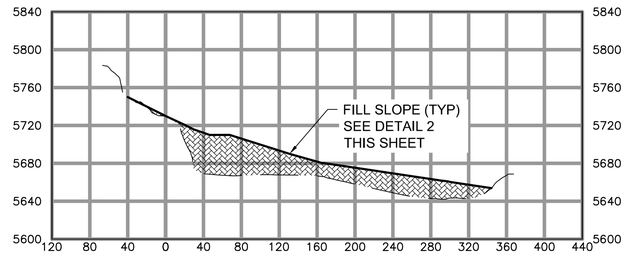
01C-02



STATION 1+00

SECTION A 01C-02

1" = 80'



STATION 5+24

SECTION B 01C-02

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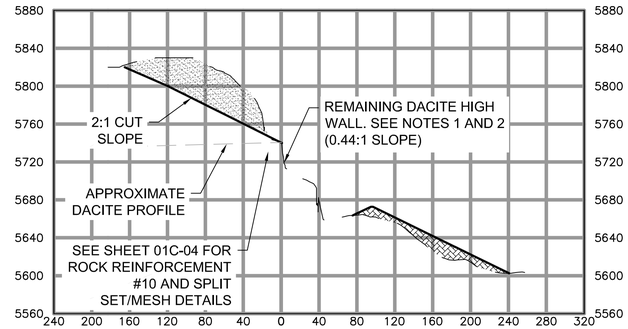


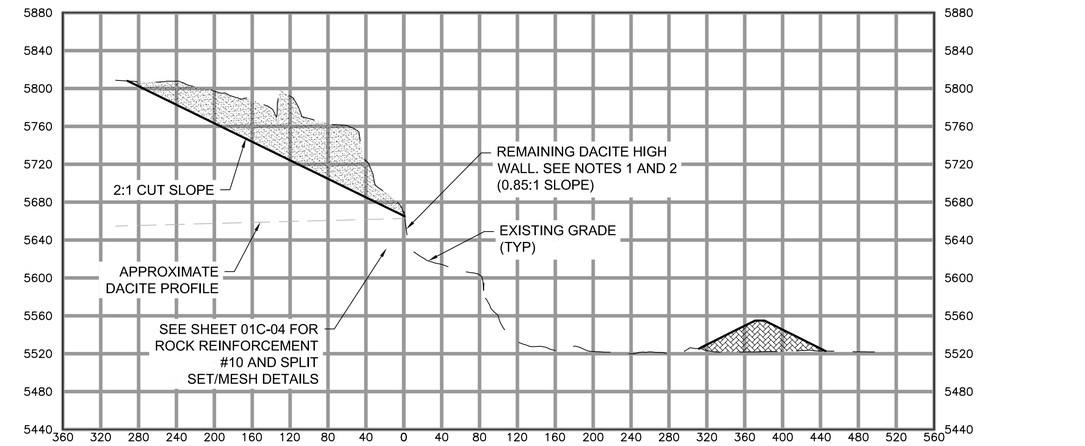
STATION 10+75

SECTION C 01C-02

1" = 80'

NOTES:

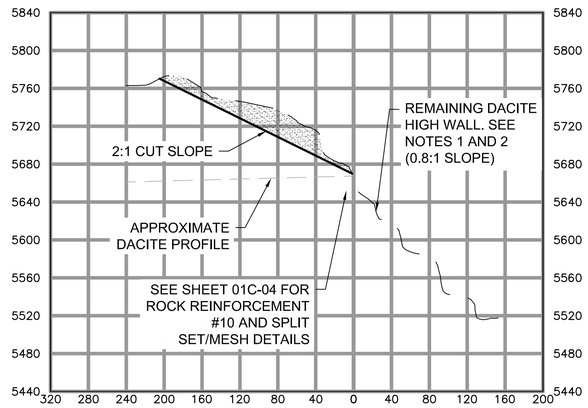
1. ROCK REINFORCEMENT MAY BE NEEDED FOR STABILIZATION WHERE LARGE BLOCKS ARE EVIDENT IN THE BEDROCK. LOCATIONS TO BE DETERMINED BY ON-SITE ENGINEER AFTER SCALING.
2. PERFORM ROCK SCALING IN ACCORDANCE WITH GROUND CONTROL SPECIFICATIONS (SECTION 31 72 16).



STATION 16+00

SECTION D 01C-02

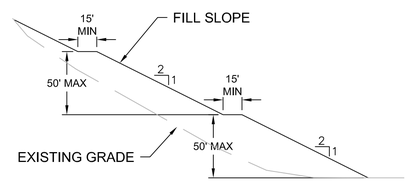
1" = 80'



STATION 19+50

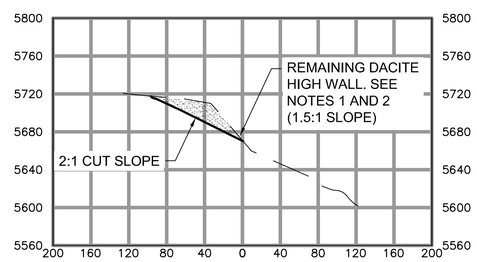
SECTION E 01C-02

1" = 80'



FILL SLOPE DETAIL 1 01C-03

1" = 60'



STATION 22+00

SECTION F 01C-02

1" = 80'

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SCALE IN FEET

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90%	2/12/2021	PRE-FINAL DESIGN
60%	01/22/2021	INTERMEDIATE DESIGN PACKAGE

PROJECT MANAGER	TRAVIS SNYDER
DRAWN BY	R. NALLEY
PROJECT NUMBER	10092468

COLORADO LICENSED TRAVIS W. SNYDER 53410 PROFESSIONAL ENGINEER 4/16/2021

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

CIVIL
FINAL GRADING PROFILE, SECTION, & DETAILS

FILENAME 01C-03.dwg
SCALE AS NOTED

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C

Attachment C.
Exhibit F –

Reclamation Plan Map

June 2021

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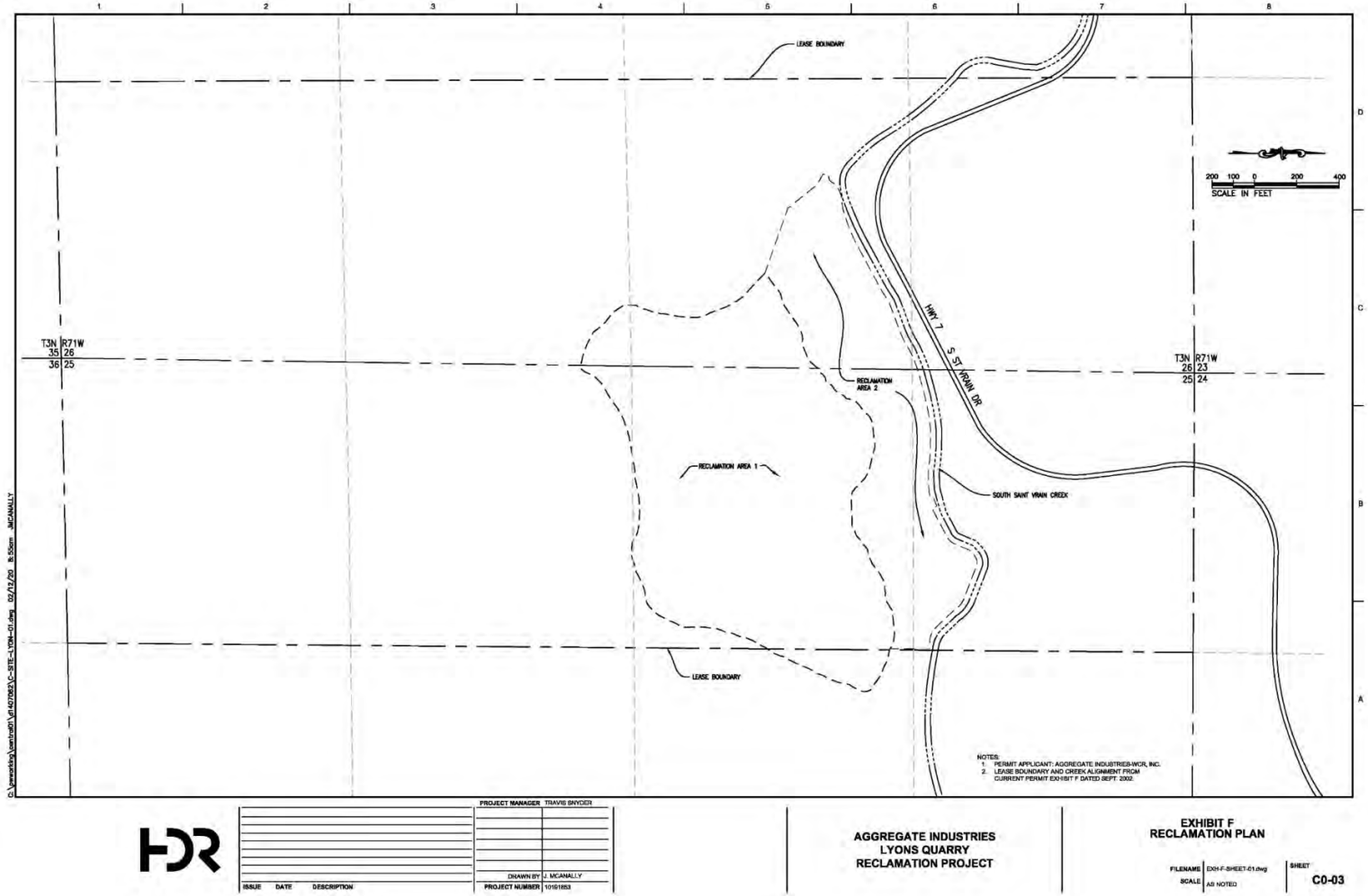
Figure C-1 – Reclamation Plan Map – Exhibit F



SLOPE	RECLAMATION DESCRIPTION	SYMBOL	PLAN AREA
VARIES	MULCH		31.5 ACRES
2.0H:1V	HYDRO MULCH		11.1 ACRES
>3.0H:1V	TYPE L SOIL RIPRAP WITH STAKED COIR MATTING		2.9 ACRES
VARIES	TYPE M RIPRAP		1.0 ACRES

N

LQRA2 LQRA3 LQRA4 LQRA5

POINT1 POINT2 POINT3

100 50 0 100 200
SCALE IN FEET

NOTES:
1. PERMIT APPLICANT: AGGREGATE INDUSTRIES-WCR, INC.
2. PERMIT BOUNDARY FROM CURRENT PERMIT EXHIBIT F DATED SEPT. 2002.
3. AREAS OF RE-VEGETATION AS SHOWN ARE APPROXIMATE. RE-VEGETATION AREAS WILL BE BASED OFF OF FINAL TOPOGRAPHIC SURVEY.

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90%	2/12/2021	PRE-FINAL DESIGN
60%	01/22/2021	INTERMEDIATE DESIGN PACKAGE

PROJECT MANAGER TRAVIS SNYDER
DRAWN BY R. NALLEY
PROJECT NUMBER 10092468

COLORADO LICENSED TIMOTHY J. SNYDER 37410 PROFESSIONAL ENGINEER 6/21/21

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

CIVIL
OVERALL RECLAMATION PLAN & DETAILS

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SHEET 01C-09

D

Attachment D.
Exhibit L –

Reclamation Costs

June 2021

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Exhibit L – Reclamation Costs

Lyons Quarry Area 1 Reclamation Cost Estimate					
Item No.	**Description**	**Unit**	**Estimated Quantity**	**Unit Price**	**Total Cost**
1.0	Mobilization/Demobilization	Job	1	N/A	$225,000.00
2.0	Project Safety Plan	Job	1	N/A	$55,000.00
3.0	Erosion Control	Job	1	N/A	$125,000.00
4.0	Survey	Job	1	N/A	$65,000.00
5.0	Debris Removal (10 ton/load)	Load	5	$1,600.00	$8,000.00
6.1	Excavation & Blasting	CY	245,080	$5.35	$1,311,178.00
6.2	Fill and Compaction (includes excess cut/fill from Table 3)	CY	181,966 + 72,729 = 254,695	$2.20	$560,329.00
6.3	Scour Berm/Drainage Riprap	CY	20,000	$28.00	$560,000.00
6.4	Final Grading	Acre	40.35	$1,000.00	$40,350.00
7.1	Rock Scaling	Hour	144	$500.00	$72,000.00
7.2	Rock Reinforcement	Each	20	$7,500.00	$150,000.00
8.1	Install Runoff Channels	LF	4,120	$33.00	$135,960.00
8.2	24” Class V RCP	LF	165	$550.00	$90,750.00
9.1	Soil Test Plots	Each	4	$14,901.00	$59,604.00
9.2	Soil Conditioning (includes floodplain export area)	Acre	40.35	$10,986.41	$443,302.00
	Scarify & Blend Amendments	Acre	40.35	$1,000.00	$33,900.00
	Utilize Onsite Topsoil Sources	CY	4,033	$5.00	$20,165.00
	Import Soil Growth Medium	CY	32,549	$13.00	$423,137.00
9.3	Re-vegetation	Acre	40.35	$4,403.27	$177,672.00
	Seeding	#PLS	667.8	$120.00	$80,136.00
	Fertilizing	Lbs.	14,123	$3.00	$42,369.00
	Scarifying	Acre	40.5	$864.00	$34,992.00
	Mulching (Mulch and Crimp)	Acre	29.25	$500.00	$14,625.00
	Mulching (Hydromulch)	Acre	11.1	$500.00	$5,550.00
10.0	Perimeter Fencing	LF	3,366	$25.00	$84,150.00
	Total of Items 1.0-10.0				**$4,163,295.00**

E

Attachment E.
Rule 6.5 –

Geotechnical Stability Exhibit

Attachment E-1: Kleinfelder – Summary Report of Engineering Stability Analysis

Attachment E-2: HDR – Lyons Quarry CRSP Evaluation Report

June 2021

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1.0 OBJECTIVE:

The objective of this Updated Rockfall Evaluation of Lyons Quarry is to use the Colorado Rockfall Simulation Program (CRSP) (Jones et al, 2000) to simulate rocks falling down the dacite highwall design appropriate mitigation measures, and evaluate the required size of rockfall catchment areas and height of catchment berms.

The dacite highwall at Lyons Quarry has two main faces as shown in Figure 1; the northeast (NE) and northwest (NW) facing highwalls. Section A was selected as the critical slope for the northeast-facing slope based on highwall height, steepness and lack of benches. This location coincides with Section D-D' from the 2008 Kleinfelder report (Kleinfelder, 2008). This section was evaluated to find the necessary runout area to catch 100% of rocks falling from the slope and to evaluate the effect of a catchment berm at the end of the runout area. Section B was selected as the critical slope for the northwest-facing wall based on height and steepness and was evaluated to find the necessary height of a catchment berm to be placed along the northwest side of the bench as shown in Figure 1.

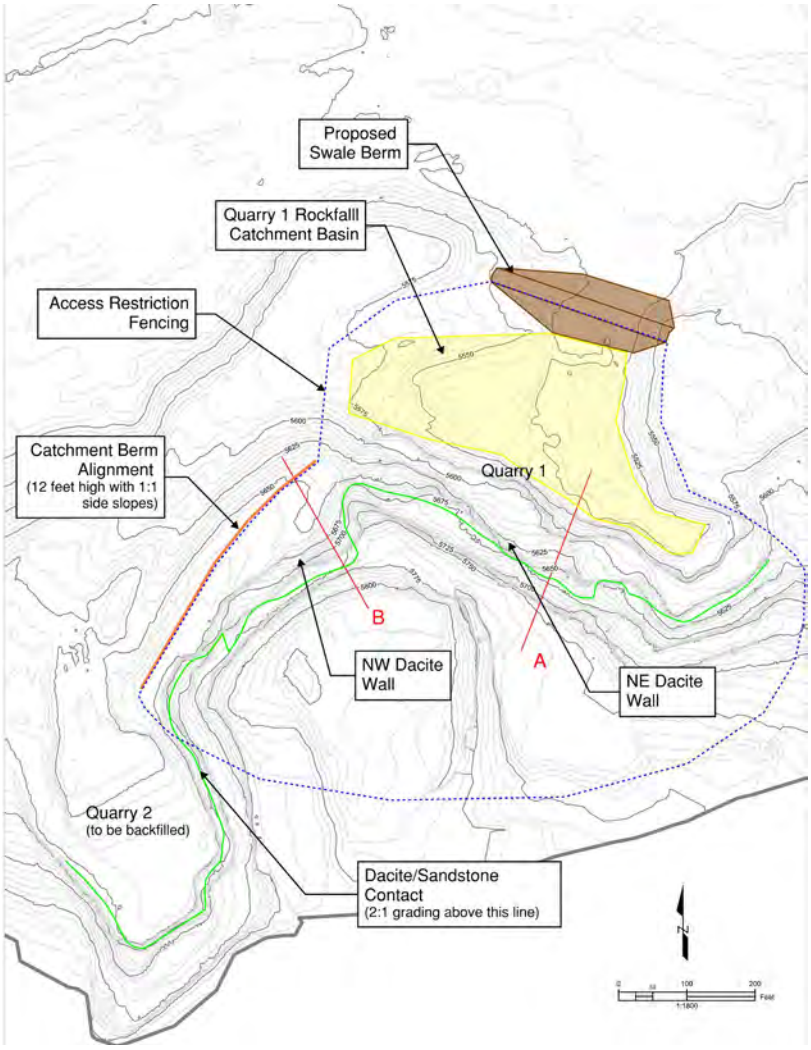

Figure 1. Plan view of Lyons Quarry showing dacite walls and proposed rockfall mitigation

2.0 INPUTS:

The program requires several inputs which are each described below. For more detailed explanation of the program refer to the CRSP Manual in Appendix A of this memo.

- *Surface Roughness:* is a function of the size of the rock and the irregularity of the slope surface. Surface roughness is an estimation of how much the slope angle may vary within the radius of the rock.

- *Tangential Coefficient:* of frictional resistance determines how much the component of the rock's velocity parallel to the slope is slowed during impact. Vegetation and, to a lesser extent, slope material influence the tangential coefficient.

- *Normal Coefficient:* of restitution is a measure of the change in the velocity normal to the slope after impact, compared to the normal velocity before the impact. The normal coefficient is determined by the rigidity of the slope surface.

- *Rock Density:* varies according to rock type.

- *Rock Shape:* can be selected from "spherical", "cylindrical", or "dischoidal". Spherical is typically used for analysis and is the most conservative, as this shape provides the most mass concentration for a given radius. However other shapes are provided for when the discontinuities in the rock mass tend to create blocks of varying shapes.

- *Rock Size:* is given by diameter when "spherical" is selected, length and diameter when "cylindrical" is selected, and thickness and diameter when "dischoidal" is selected.

The slope configuration is based on the most recent survey of the existing ground conducted by Aggregate Industries in September, 2020. The proposed reclamation plan includes excavating the sandstone above the dacite highwalls back at a 2H:1V (horizontal:vertical) slope ratio. The 2H:1V Fountain Formation sandstone slope exceeds stability requirements laid out in the Kleinfelder report (Kleinfelder, 2008), and should not contribute significantly to rockfall; however, for conservatism the sandstone was still simulated as a rockfall source. The dacite/sandstone contact is shown as a yellow line on Figure 1. The slope topography is simplified into cells and each cell is assigned a set of coefficients based on the material properties of the slope. All catchment berms evaluated are assumed to have 1H:1V side slopes. No site-specific data was collected for this evaluation; such as measured surface roughness, amount of vegetation (tangential coefficient), elastic properties of the dacite or sandstone (normal coefficient) or rock density. Therefore judgment was used in selecting conservative values for the coefficients based on the guidance in the CRSP manual (Appendix A) and Kleinfelder (2008). For simplicity, the slope cells were divided into five slope types based on material and slope angle and assigned the set of coefficients shown in Table 1.

Due to the sandstone and dacite having different unit weights and rock shapes, each rock type was simulated separately with the source of rocks being isolated to the individual rock type only. The inputs used for each rock type are shown in Table 2. It should be noted that based on the discontinuity data and historic performance, rock sizes above 6 feet in any dimension are unlikely or rare, although they were evaluated to provide a factor of safety. For each simulation 1,000 rocks were rolled and the percent of rocks stopping before the analysis point was evaluated.

Table 1 – Coefficient values by slope type			
Slope Type	**Surface Roughness**	**Tangential Coefficient**	**Normal Coefficient**
Sandstone 2:1 cut slope	0.35	0.85	0.3
Dacite Wall	0.25	0.9	0.25
High Angle Talus	0.8	0.85	0.25
Low Angle Talus	1	0.8	0.2
Catchment Area (Soil)	0.5	0.8	0.15

Table 2 – Rock Input Properties			
Rock Type	**Density**	**Shape**	**Rock Sizes Simulated** (feet)
Sandstone	150	Spherical	2,4, 6, 8, and 12 foot diameter
Dacite	180	Cylindrical	1x4, 2x4, 2x6, 3x6, and 6x12 (diameter x length)

3.0 RESULTS:

Northeast Facing Dacite Wall

Since the swale berm shown in Figure 1 was already part of the reclamation plan regardless of rockfall potential, results of this evaluation were used to determine whether the catchment berm that is created will be adequate to catch 100% of all modeled rock sizes as listed in Table 2. Section A, shown in Figure 2, was evaluated for the northeast-facing dacite wall as the critical section because it is the highest and steepest slope. The first step was to evaluate the necessary length of the runout area without a berm. Several iterations were simulated with the analysis point at various distances from the toe of the slope. The results shown in Table 3 indicate that a runout length of 170 feet will catch 100% of even the largest rock sizes simulated.

The eastern extent of the northeast highwall has only about 30 feet of runout length available at the toe but has an opposite facing slope at 1H:1V across the runout area. To evaluate the maximum height along the slope that would stop 100% of all modeled rock sizes the location of the analysis point was varied. The results are shown in Table 4 and indicate that 100% of all rock sizes will be caught at a height of 9 feet along the opposite facing slope. The opposite slope at the east end of the highwall is 50 feet high which provides a factor of safety of 5.6 relative to the slope height, as in actual slope height divided by required slope height.

These two evaluations bracket all situations. The lowest height of an opposite slope within the catchment basin is 20 feet which has a runout length of about 130 feet. The catchment berm as planned will catch 100% of all modeled rock sizes with a factor of safety.

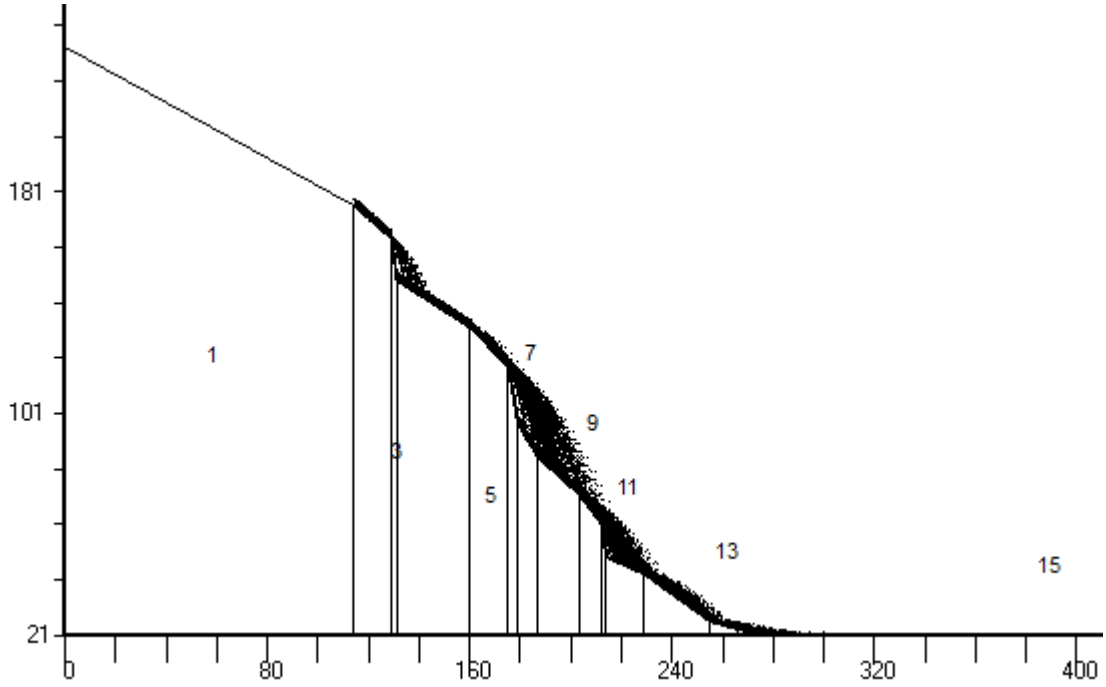

Figure 2. Section A, northeast facing dacite wall

Table 3 – Section A Runout Evaluation

Rock Type	Rock Size (ft)	% Caught by Runout Length (ft)		
		160	165	170
Dacite	1x4	100	100	100
	2x4	100	100	100
	2x6	100	100	100
	3x6	100	100	100
	6x12	100	100	100
Sandstone	2	100	100	100
	4	100	100	100
	6	99.3	100	100
	8	98.5	99.9	100
	12	99.9	100	100

Table 4 – Section A Berm Height Evaluation

Rock Type	Rock Size (ft)	% Caught by Berm Height (ft)		
		7	8	9
Dacite	1x4	100	100	100
	2x4	100	100	100
	2x6	99.9	100	100
	3x6	99.9	100	100
	6x12	99.8	100	100
Sandstone	2	99.9	100	100
	4	100	100	100
	6	98.6	99.9	100
	8	97.8	99.7	100
	12	99.6	100	100

Northwest Facing Dacite Wall

At the toe of the northwest-facing wall is backfill from previous reclamation work that creates a flat runout area ranging from about 80 feet wide in the north to about 30 feet wide at the south end. A catchment berm along the north side of this flat area would be required to catch the rockfall from the northwest-facing dacite wall. Section B, shown in Figure 3, was selected as the critical section for this slope because of the slope height and steepness. A catchment berm with a 1H:1V slope was added 30 feet from the toe of the slope to represent the shortest runout area available at the south end of the highwall. Placing the berm 30 feet from the toe provides a factor of safety, because at Section B (which is the highest slope), a longer runout area is available and at the south end where the runout area is only 30 feet the actual quarry slope height is much lower. The results are shown in Table 5 and indicate that an 8 ft high catchment berm would catch 100% of all rock sizes simulated. In addition to the inherent factor of safety built into the evaluation as stated above a berm height of 12 feet high would provide an additional factor of safety of 1.5 relative to berm height.

4.0 LIMITATIONS

The rockfall evaluation presented herein, while useful, has some limitations in practical application. Site-specific field data was not taken to determine the input coefficients to CRSP such as surface roughness, amount of vegetation (tangential coefficient), elastic properties of the highwall (normal coefficient), or rock densities. These parameters were conservatively assigned based on judgment and previous project experience and analyses. Additional field data would improve the accuracy and confidence of the evaluation. The physics of a rock falling down an irregular natural slope are complicated and are subject to multiple interactive factors. The CRSP program is an attempt to provide statistical analysis based on empirical relations and an algorithm which has been field calibrated. The CRSP program is not intended to be an exact predictor of rock behavior, therefore a factor of safety should be included in the mitigation design to account for model uncertainties. Additionally, the program utilizes a two-dimensional analysis whereas rockfall behavior is actually a three-dimensional phenomenon.

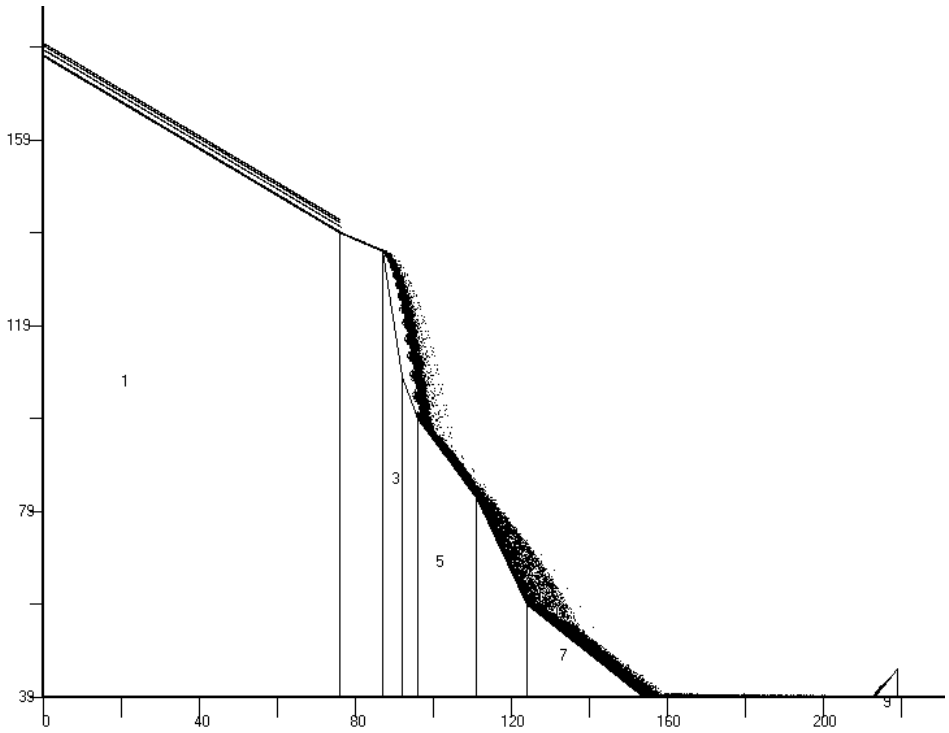

Figure 3. Section B, northwest facing dacite wall

Table 5 – Section B Berm Height Evaluation

Rock Type	Rock Size (ft)	% Caught by Berm Height (ft)		
		6	8	10
Dacite	1x4	99.8	100	100
	2x4	99.6	100	100
	2x6	98.9	100	100
	3x6	98.8	100	100
	6x12	99.1	100	100
Sandstone	2	100	100	100
	4	99.3	100	100
	6	95.2	100	100
	8	97.1	100	100
	12	100	100	100

5.0 CONCLUSIONS:

According to the results of the rockfall evaluation described herein, the proposed berm across the opening at the base of the northeast quarry highwall along with the natural topography will create a catchment basin that will be adequate with a factor of safety to catch dacite and sandstone rocks falling from the northeast-facing highwall. The factor of safety could be increased by filling the catchment area with water and maintaining a pond at the base of the highwall or placing a layer of loose sand or pea gravel at the base of the highwall to reduce the rockfall energy. The evaluation of the northwest-facing wall shows a 30 foot runout area and an 8 foot high berm are necessary to catch 100% of rockfall. A factor of safety of 1.5 added to the berm height results in a 12 foot high berm with 1H:1V side slopes to catch all rockfall from the northwest facing dacite slope.

6.0 REFERENCES:

Jones, C.L., Higgins, J.D., and Andrew, R.D., 2000, Colorado Rockfall Simulation Program (CRSP), Version 4.0, Colorado Department of Transportation, Colorado Geological Survey, Colorado School of Mines, March

Kleinfelder West, Inc., 2008, Summary Report of Engineering Stability Analysis, Lyons Quarry, Boulder County Colorado, Submitted to Aggregate Industries, February 13th

F

Attachment F. Grading Plan Verification Letter

June 2021

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June 4, 2021

Amy Eschberger
Environmental Protection Specialist
Colorado Division of Reclamation, Mining and Safety
1313 Sherman Street, Room 215
Denver, CO 80203

RE: Lyons Quarry; DRMS File No. M-1 977-141; Technical Revision No. 5; Verification of Grading Plan

Dear Ms. Eschberger,

This letter is to verify that the slopes and overall configuration shown on the Final Grading Plan presented in Technical Revision No. 5 meet the geotechnical specifications of the 2008 Kleinfelder Summary Report of Engineering Stability Analysis (Kleinfelder Report) or that additional analysis has been performed to show that conservative factors of safety have been met.

The Kleinfelder Report states that where the highwall and rock slopes will remain exposed, the final reclamation slopes can have the following configuration:

- Dacite left at existing slope angle with loose rock scaled from the face of the dacite.
- Fountain Formation laid back to a single overall slope angle of 1.5H:1V (33 degrees from the horizontal).
- Rockfall catchment berm on minimum 20-foot-wide bench, constructed at the toe of the Fountain Formation and on top of the dacite sill at the contact of the two units.
- Rockfall catchment berm on minimum 20-foot-wide bench, reclaimed or constructed at existing benches and at the toe of the dacite unit.

Technical Revision No. 5 includes technical specifications covering scaling of loose rock from the dacite highwall as well as a provision for rock reinforcement to be installed where necessary for stability at the discretion of the on-site geotechnical engineer overseeing construction. The Fountain Formation will be laid back to a single overall slope angle of 2H:1V (26.5 degrees) which is less steep than the Kleinfelder Report requirement. Due to the change to the Fountain Formation slope angle, restricted access to the rockfall catchment area, and additional analysis using the Colorado Rockfall Simulation Program (CRSP) using an updated slope configuration, a bench and berm at the toe of the Fountain Formation as well as a berm along the reclaimed bench within the dacite are not necessary for public safety. At Quarry 1 a minimum 30-foot-high berm will be constructed to connect the existing slopes opposite of the highwall to create a large catchment basin for any rockfall from either the dacite or the laid-back Fountain Formation with a conservative factor of safety. At Quarry 2 backfill will be placed against the dacite highwall as discussed below. At the base of the dacite highwall between Quarry 1 and Quarry 2 a minimum 12-foot-high catchment berm will be constructed a minimum of 30 feet from the toe of the highwall.

Quarry 2 has been partially backfilled as noted in Technical Revision No. 3. Technical Revision No. 5 provides for the completion of backfilling Quarry 2 up to the contact of the dacite with the Fountain Formation, above which the Fountain Formation will be laid back to 2H:1V, along the east slope. The south and west slopes of Quarry 2 will be filled up to the crest of the Fountain Formation to create a natural swale that existed pre-mining. The grading will extend to the north as a base for the catchment

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berm, described above, at the base of the northwest facing dacite highwall. The Kleinfelder Report states that the existing highwall and rock slopes can be left in place with no modifications where they will be completely covered by stable fill slopes. Regarding the fill slopes, the summary report states that existing fill slopes and future constructed fill slopes can be graded to a final configuration as follows:

- Bench Slope Angle of 26.5 degrees or 2H:1V
- Maximum Bench Height of 50 feet
- Minimum Bench Width of 15 feet
- Maximum Overall Slope Height of 150 feet

A site visit was conducted on January 8th, 2021 during which visual verification was made of the continuity of slope conditions from what was included in the Kleinfelder Report to the present conditions.

Sincerely,
HDR

Andrew Little, PG PE
Project Geological Engineer

G

Attachment G.

Lyons Quarry 90% Design – Technical Specifications

June 2021

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DIVISION 02

EXISTING CONDITIONS

SECTION 02 21 13
SITE SURVEY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Underground utility locate.
   2. Measurement and mapping of all local site features, easements, utility locates and legal monuments.
   3. Photography of local property features and legal monuments.
   4. Mapping of all property easements.
   5. Placement of local control for site development.
   6. Placement of soil boring locations for geotechnical investigation.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 23 16 – Excavation
   4. Section 31 23 23 – Fill
   5. Section 31 37 00 - Riprap

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Society of Professional Surveyors:
      a. Minimum Standard Detail Requirements for ALTA/NSPS Land Title Surveys, 2/16.
   2. Building code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.
   3. General:
      a. Furnish all necessary equipment, materials, and labor to effectively measure the site in accordance with these specifications. Additional local surveying requirements for local platting, mapping, etc., shall be researched and followed by the surveyor.
      b. The Contractor shall be responsible for all damage to public and private property resulting from the operations of its employees.
      c. The Contractor shall be responsible for gaining permission to access any site(s) required for surveying. Any site-specific training to access the property shall be the responsibility of the Contractor.

1.3 DEFINITIONS

A. “Contractor” shall mean person, firm, or corporation with whom Owner may enter into contract for execution of work specified relating to the Survey of the site.

1.4 SUBMITTALS

A. Topographical Survey:
   1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Submit to the Owner complete CAD files within one week after field visit.
   3. CAD file shall be AutoCAD Civil 3D files with 3D points and TIN (Triangulated Irregular Network) surfaces of topography included. All site features shall be drawn and included within CAD file. Contractor shall receive Owner approval to use different CAD software.
   4. TIN surface(s) shall be exported as individual .XML format files. XML files shall be delivered with CAD files.

5. Point files of all field survey data, including control shall be delivered in .csv format. Any point code description data sets shall be included with point files.
6. Submit PDF of the completed topography survey to the Owner.

B. Site Photos:
   1. Field survey photos shall be included with the topographical survey.

C. Site Staking:
   1. Provide site control staking as required for site development. Work with the Owner to determine amount of staking to be completed.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 INITIAL SURVEY

A. An initial survey shall be performed to document existing grade prior to excavation, fill (where fill is planned), and riprap placement as shown on the drawings.

B. Results of the initial survey shall be submitted to Engineer at least seven days prior to commencement of any excavation activities. The initial survey shall be conducted within a single one week period.

3.2 AS-BUILT FINAL SURVEY

A. The following shall be included in the final topography survey:
   1. Survey datum and units: the vertical and horizontals datum shall meet state and local guidelines. The datum and units shall be provided with the survey, including coordinate system, foot units (international, U.S. survey), ground conversion factors (as applicable), etc.
      a. All surveys shall be spatially tied in and geo-referenced. A datum specific only to the development area shall not be used.
      b. The contractor shall provide all digital source data (i.e., for Trimble equipment, the .job file) and the RTK survey report.
   2. Site topography including but not limited to:
      a. Existing ground topography shall be recorded with a maximum grid spacing of 100 FT. Topography shall be presented in 5 FT intervals unless otherwise noted.
      b. Grade breaks, including but not limited to: bench crests and toe limits, berms (tops and toes), depressions, ditches, swales, drainages, hills, rock piles, steep hill faces, road centerlines, waterlines, wetlands, trees, shrubs, storm water ponds and flow lines.
      c. All roads surrounding public and private roads shall be surveyed, including centerline, edge of asphalt, intersections, shoulder, culverts, and borrow ditches. Private access roads shall be provided, including two tracks (both tracks to allow for rebuilding if needed).
      d. Adjacent property topography information shall be provided up to 100 FT past the proposed development area, unless otherwise noted by the Owner. Additional topography past the initial development area shall include any utilities (road, storm water, electric) that may need updating due to proposed development.

B. Easements: All utility, property, landscape, road, road right-of-way, floodplain, and public and private easement information shall be included and displayed with the survey file for plat and/or site development. Road centerlines shall be provided for structure setback requirements.
   1. Research of site easements shall be the Contractor's responsibility prior to site surveying.
      a. Title reports shall be requested as needed by the Contractor.

C. Monuments: All monuments shall be clearly surveyed and labeled within survey file. All section corners and existing property pins shall be located. Section corners (minimum of three) shall be located or established for development of new property parcels. Research of monuments shall be the responsibility of the Contractor prior to site visit.

D. Control shall be clearly established on the site. Contractor will be responsible for establishing a minimum of three control points that can be located within the site development area. Control shall be clearly established in an area that will preserve the horizontal and vertical information. Marked rebar (12 IN minimum depth) shall be used for control points.

E. Underground utilities shall be located and surveyed in via ["Call before you dig 811"] locate services. All private and public underground utilities shall be located. Utilities survey information shall include the name of the corresponding utility company with the field marking.

F. Power and electrical utilities shall be located and surveyed. All power poles, anchors, electrical structures, etc., shall be surveyed. Overhead electric lines crossing the survey site shall have the next adjacent pole(s) in all directions surveyed in. Utility owner information shall be provided with survey.

G. Any additional surface utilities, including but not limited to: manholes, light structures, storm drains, fiber optics, railroads, inlets, utility boxes, hydrants, and valves shall be provided. Research of site utilities shall be completed prior to field survey visit.

H. All visible site structures, including but not limited to: buildings, fences, gates, junk piles, signs, mailboxes, concrete structures (top and bottom of concrete), walk paths, and cattle guards shall be surveyed.

I. Culverts shall be located and surveyed; inlets and outlet elevation shall be provided along with culvert size and type.

J. A 3D TIN surface shall be developed with the approved CAD software. Contractor shall review and prepare a 3D TIN surface to be used for grading and volume calculations.

K. Survey notes and legend information shall be included in survey deliverables.

L. Site photos shall include site features, including but not limited major structure, utilities or any additional items that may require removal to allow for site development. Adjacent roads, structures, property boundaries, etc., shall be photographed. All storm drains, culverts, and storm structures shall be clearly photographed.

3.3 WORKMANSHIP AND METHODS

A. Provide equipment capable of recording horizontal and vertical measurements within 1/100 FT degree of accuracy.

B. Contractor is responsible for meeting local surveying best practices and plat recording requirements.

C. Contractor is responsible for providing additional survey equipment if needed when GPS equipment may not be suitable.

D. Aerial surveys are not to be used unless requested and approved by the Owner.

END OF SECTION

SECTION 02 81 13
DISPOSAL OF EXCAVATED MATERIALS

PART 1 - GENERAL

1.2 WORK INCLUDES

A. Transportation and disposal of excavated earth materials.

B. Transportation and disposal of demolished infrastructure.

1.3 RELATED SECTIONS

A. Section 32 90 00: Restoration and Seeding.

B. Section 31 23 16: Excavation

C. Section 31 23 23: Fill

1.4 DEFINITIONS

A. Earth materials – rock, soil, sludge or sediment that does not meet the specification for Backfill.

B. Existing debris – any solid material that is not rock, soil, sludge or sediment (e.g. electrical conduit, concrete, rebar, timbers, tires, etc.).

1.5 SUBMITTALS

A. Provide identity of the proposed landfill to receive debris materials 14 days prior to transportation to the landfill.

B. Manifests or other documentation of waste disposal including photo documentation of the material before and after loading on to the truck.

PART 1 - PRODUCTS

NOT USED

PART 2 - EXECUTION

1.6 GENERAL

A. Disposal of non-contaminated earthen materials will be to an existing on-site repository.

B. Disposal of debris encountered during excavation will be sent to a controlled landfill.

1.7 TRANSPORTATION AND DISPOSAL REQUIREMENTS

A. Earth materials placed in the on-site repository will require restoration and seeding in accordance with Section 32 90 00 – Restoration and Seeding.

B. It is assumed that all earth materials requiring transportation or on-site disposal will not be considered to contain hazardous contaminated substances or hazardous waste. If hazardous materials are encountered during reclamation, the CONTRACTOR will stop work immediately and notify OWNER. The OWNER will then notify the appropriate response agencies.

C. Debris encountered during excavation will be transported and disposed of in a controlled landfill.

END OF SECTION

DIVISION 31

EARTHWORK

SECTION 31 10 00
SITE CLEARING

PART 1- GENERAL

1.1 WORK INCLUDES

A. Site clearing in the work areas for excavation or fill.

B. Temporary erosion- and sedimentation-control measures.

C. Protecting existing vegetation to remain.

D. Removing existing vegetation, clearing and grubbing, stripping and stockpiling topsoil.

1.2 RELATED SECTIONS

A. Section 31 25 00: Erosion Protection and Sedimentation Control

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site.
   1. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in- place surface soil and is the zone where plant roots grow.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
   1. Use sufficiently detailed photographs or videotape.
   2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

1.5 QUALITY ASSURANCE

A. Pre-Construction Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant protection measures are in place.

B. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.

6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

C. Do not direct vehicle or equipment exhaust towards protection zones.

D. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

E. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

1.7 SCHEDULING AND SEQUENCING

A. Begin site clearing and grubbing only after erosion and sediment control provisions are in place.

B. Haul roads, access roads, and additional staging areas needed by CONTRACTOR not shown on the Drawings may be cleared upon approval of OWNER and after CONTRACTOR submits and implements a revised Erosion and Sediment Control Plan to the OWNER for approval.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Wrap a l-inch blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.
1. Restore damaged improvements to their original condition, as acceptable to OWNER.

3.2 PROTECTION

A. Protect trees and plants remaining on-site.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by OWNER.

3.3 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Do not saw cut trees >12” and <48” diameter. Use excavator or equivalent machine to loosen root mass and push over existing trees designated for removal. Remove all branches from trunk. Keep root ball intact with tree trunk and stockpile in designated area.
3. Use only hand methods for grubbing within protection zones.
4. Mulch tree branches to be used for restoration.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

3.4 TOPSOIL STRIPPING

A. Strip topsoil to a depth of 6 inches, or as approved by OWNER, in a manner to prevent intermingling with underlying subsoil or other waste materials.
1. Remove non-soil materials from topsoil, including gravel and other objects more than 3 inches in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
1. Limit height of topsoil stockpiles to 10 feet

2. Do not stockpile topsoil within protection zones.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Excavation of reclamation slopes.

1.2 RELATED SECTIONS

A. Section 31 10 00: Site Clearing

B. Section 31 25 00: Erosion Protection and Sedimentation Control.

1.3 REFERENCES

A. The following is a list of Standards which apply to this Section:
   1. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR, Part 1926, Subpart P, Excavation Standards
   2. IME (Institute of Makers of Explosives) Safety Library Publications (SLPs).

1.4 DEFINITIONS

A. Common Excavation: Excavation in all earth materials including soil, weathered rock, and fractured unweathered rock.

B. Rock Excavation: Excavation in any earth materials that can not be performed with modern earth work equipment, special attachments, pre-drilling, or other excavation technology or methods and requires controlled blasting excavation methods.

C. Controlled Blasting: Use of explosives in a carefully controlled manner to facilitate excavation of hard, cemented materials. Controlled blasting requires control of various elements of the blast, including hole size, position, alignment, depth, spacing, burden, charge size, and distribution and delay sequences to excavate rock materials to the desired lines while maintaining ground vibrations and air-overpressure within specified maximum limits. Preshearing, cushion blasting, and line drilling are all forms of controlled blasting.

D. Air-Overpressure: Temporary changes in ambient air pressure caused by blasting.
   1. Air-overpressure is expressed in units of psi or dB or dBL (linear decibel scale). Measurements for blasting are made with microphones having a flat frequency response for over-pressure in the 2 to 200 Hz range. A- weight or C-weight microphones shall not be used for these measurements.

E. Blaster-in-Charge or Blasting Supervisor: The single designated and licensed person with complete responsibility and total authority over all decisions involving safe handling, use and site storage of explosives. The Blaster-in-Charge and Blasting Supervisor may be the same person.

F. Charge-per-Delay: For vibration control, any charges firing within any 8-millisecond time period are considered to have a cumulative effect on vibration and air-overpressure effects. Therefore, the maximum charge-per-delay (W) is the sum of the weight of all charges firing within any 8-millisecond time period. For example, if two 10-lb. Charges fire at 100 ms and one 15-lb charge fires at 105 ms, the maximum charge per delay would be 35lbs.

G. Delay: A distinct pause of pre-determined time between detonations of single charges or groups of charges

H. Occupied Building: Structure on or off construction limits that is occupied by humans or livestock.

I. Peak Particle Velocity (PPV): The maximum of the three ground vibration velocities measured in the vertical, longitudinal and transverse directions. Velocity units are expressed in inches-per-second (ips).

J. Primary Initiation: The method whereby the blaster initiates the blast(s) from a remote and safe location. Primary initiation systems use pneumatic tubing or shock-tubes to convey firing energy from blasters to blast locations.

K. Production Holes: Blast holes in the main body of the rock mass being removed by drilling and blasting.

L. Prohibited Persons: Persons prohibited from handling or possessing explosive materials as defined by the seven categories described in Section 555.11 of 27 CFR (ATF Rules).

M. Residential Building: Includes single and multiple family dwellings, hotels, motels and any other structure containing sleeping quarters.

N. Scaled Distance: A factor describing relative vibration energy based on distance and charge-per-delay. For ground vibration control and prediction purposes, Scaled Distance (Ds) is obtained by dividing the distance of concern (D) by the square root of the charge-per-delay (W), $Ds = D/(W)^{0.5}$. Minimum scaled distance limits are used to establish charge weights and the units of scaled distance (Ds) are ft-lb-0.5.

O. Stemming: Crushed stone, tamped clay or other inert earth material placed in the unloaded collar area of blastholes for the purpose of confining explosive charges and limiting rock movement and air-overpressure (airblast).

P. Sub-drilling: The portion of the blasthole that is drilled below or beyond the desired excavation depth or limit. Subdrilling is generally required to prevent the occurrence of high or tight areas of unfractured rock between blastholes.

Q. Top Soil: Sufficient in nitrogen, phosphorus, potassium, calcium and magnesium to support normal plant life. This soil contains organic material unsuitable as fill or backfill.

R. Unsuitable Foundation Soils: Soils that display yielding, excessive rutting, excessive water content, or have desiccated; soft clays, loose sands, and open or narrowly graded gravels.

1.5 SUBMITTALS

A. Shop Drawings:
   1. Excavation Plan: Include the following information as a minimum:
      a. Methods and sequencing of excavation in the various excavation areas.
      b. Numbers, types and sizes of equipment proposed to perform excavations.
      c. Anticipated difficulties and proposed resolutions.
      d. Conceptual plans and sections showing sloping or shoring of temporary slopes as necessary for construction.
      e. Proposed locations of stockpiled excavated material.

B. Pre-Blast Survey:
   1. At least 14 days prior to the commencement of any work involving explosives, conduct a pre-blast condition survey to thoroughly document the condition of all permanent man-made structures which have the potential to be impacted by blasting operations.
   2. The pre-blast survey shall include a photographic or videotape record of all exposed facilities, including structures, utilities, wells, buried cables, and other man made features within 1500 feet of the blast area.
   3. Submit three (3) copies of all pre-blast survey reports, including photographs or video recordings, to OWNER.
   4. Within 14 days following completion of all blasting activities, complete post-blast surveys and submit three (3) copies of post-blast survey reports, including photographs or video recordings, to OWNER.

C. Blasting Safety Plan:
   1. No drilling or blasting work shall be performed until the CONTRACTOR's Safety Plan and Blasting Control Plan for such operations has been submitted and approved by the OWNER.
   2. At a minimum of 14 days prior to the commencement of any work involving explosives, submit a complete Safety Plan For The Use Of Explosives. A Blasting Safety Plan simply stating: “all regulations will be followed” will not be acceptable. Blasting Safety Plan shall include:
      a. A complete list of all authorities having jurisdiction over operations involving the transportation, storage, handling and use of explosives.
      b. Copies of all required blasting permits regarding explosive use, possession, transportation (if applicable) and storage.
      c. Copies of Colorado Type I Licenses, with construction blasting or special operations endorsements for the type of work involved, for all blasters overseeing blasting operations.
      d. A complete description of the clearing and guarding procedures that will be employed to ensure personnel, staff, visitors, and all other persons are at safe locations during blasting. This information shall include details regarding visible warning signs or flags, audible warning signals, method of determining blast areas (all areas affected by any potentially harmful blast effects), access blocking methods, guard placement and guard release procedures, primary initiation method, and the system by which the blaster-in-charge will communicate with site guards, and the method to notify other CONTRACTORs, visitors, or project personnel on-site of a scheduled blast.
      e. A detailed description of how explosives will be:
         1) Stored on site, and
         2) transported and used at the various project work areas.
         3) Plans shall explain how day-storage magazines and explosive transport vehicles will satisfy all applicable ATF, OSHA, federal, Colorado and local regulations.
         4) This plan shall also indicate how explosives will be inventoried, secured and guarded to prevent theft or unauthorized use and shall have Table of Distance calculations for storage areas.
      f. Include Material Safety Data Sheets (MSDS) and technical data sheets for all products and specific details about hazard communication programs for employees.
      g. Equipment that will be used to monitor the approach of lightning storms and in the event of such, evacuation and site security plans.
      h. Detailed contingency plans for handling of misfires caused by cutoffs or other causes.

D. Blast Reports:
   1. Submit a Blast Report to the OWNER within 24 hours of each blast event. Maintain copies of Blast Reports onsite in a three-ring binder and available for immediate review by OWNER. The Blast Reports shall include:
      a. Location, date and time of blast.
      b. Name, signature, and license number of blaster-in-charge.
      c. Identification, direction and distance in feet, from the nearest blast hole to the nearest potentially affected structure, such as any dwelling, school, church, or community or institutional building either:
         1) Not located in permit area; or
         2) Not owned nor leased by the person who conducts the mining operations.
      d. Weather conditions, including temperature, wind direction, and approximate velocity.
      e. Type of material blasted.
      f. Sketches of the blast pattern including number of holes, burden, spacing, and delay pattern. Sketches shall also show decking, if holes are decked to achieve different delay times within a hole.
      g. Diameter and depth of holes.
      h. Types of explosives used.

i. Total weight of explosives used per hole and maximum weight of explosives per 8-millisecond period.
j. Initiation system.
k. Type and length of stemming.
l. Mats or other protections used.
m. Type of delay detonator and delay periods used.
n. Number of persons in the blasting crew; and
o. Seismographic and air-overpressure records, including:
    1) Type of instrument, sensitivity, and the calibration signal of the gain setting or certification of annual calibration.
    2) Exact location of instrument and the date, time and distance from the blast.
    3) Name of the person and firm taking the reading.
    4) Name of the person and firm analyzing the seismographic and air-overpressure record.
    5) The vibration and air-overpressure levels recorded.
p. Summary report of all complaints including complaints regarding blasting-related damage.

E. Permits:
1. Submit copies of all required blasting or explosives related permits.

1.6 QUALITY ASSURANCE

A. Qualifications
1. A blasting supervisor licensed by the State of Colorado, Division of Oil and Public Safety, and acceptable to the OWNER shall be on the site, and in immediate charge of the blasting operations. The license of the supervising blaster(s) shall contain endorsements for construction blasting or a special operations endorsement applicable to the type of blasting on this project.
2. Blasting supervisor shall have no less than three years of experience in controlled blasting on projects of similar character. A written description of the education and experience of this supervisor shall be submitted. The description shall be specific and include references who are able to verify the details. The blasting supervisor may act as Blaster-in-Charge.
3. A list of at least three previous projects of similar character performed by the Blaster in Charge, successfully completed. List shall include contact names and phone numbers of the owner's responsible project manager or engineer.
4. All persons engaged in handling explosives shall have had an Employee Possessor background check submitted to BATFE. Prohibited persons not having been granted a relief from disability shall not handle explosives.

B. Regulatory Requirements
1. Comply with the applicable rules, regulations and standards established by Federal, State and Local Regulatory Agencies, including rules and regulations for storage, transportation, and use of explosives.
2. Whenever blasting operations are in progress, explosives shall be stored, handled and used as provided in: the Federal Occupational Safety and Health Act of 1970 and the Construction Safety Act of 1969, as amended; Safe Explosives Act, Title XI, Subtitle C of Public Law 107-296, Interim Final Rule; and Organized Crime Control Act of 1970, Title XI, Public Law 91-452, Approved October 15, 1970, as amended.
3. Ensure that all explosive deliveries to work sites are done in compliance with recent rules and regulations issued by the Department of Transportation (DOT) and the Transportation Security Administration (TSA) on commercial transportation of explosives pursuant to the mandates of the USA PATRIOT ACT of 2001. Under TSA rules, commercial drivers with hazardous materials endorsement shall undergo a personal background records check, training and testing.
4. Comply with all the applicable provisions of OSHA of 1970, 29 U.S.C., Section 651 et seq., including safety and health regulations for construction.

5. U.S. Code of Federal Regulations (CFR)
    a. CFR 27, U.S. Department of Justice, Alcohol, Tobacco, Firearms and Explosives Division (ATF). 27 CFR Part 555, Implementation of the Safe Explosives Act, Title XI, Subtitle C of Public Law 107-296; Interim Final Rule.
    b. Organized Crime Control Act of 1970, Title XI, Public Law 91-452, Approved October 15, 1970, as amended.
    c. CFR 49, Parts 100-177 (DOT RSPA); 301-399 (DOT FHA).
    d. Federal Occupational Safety and Health Act of 1970, as amended.
    e. Construction Safety Act of 1969, as amended.
6. State Agencies: Compliance with the following, as administered by the Colorado Department of Labor and Employment.
    a. Colorado Code of Regulations (7 CCR 1101-9)
    b. Colorado Revised Statutes (Title 9, Articles 6 & 7)

PART 2 - PRODUCTS

2.1 BLAST MONITORING

A. Blast Monitoring Seismographs:
    1. Requires 3-axis velocity transducer, air-overpressure transducer, and data acquisition and storage device.
    2. Flat frequency response between 2 and 250 Hz.
    3. Air over-pressure maximum level of 148 dB.

PART 3 - EXECUTION

3.1 GENERAL

A. Excavate to lines, grades, and dimensions shown on the Drawings, and as necessary to accomplish Work.

B. Excavate soil and rock to within a tolerance of ±0.1 and ±0.5 foot, respectively except where dimensions or grades are shown on the Drawings as maximum or minimum.

C. Do not over-excavate without the OWNER's written authorization.

D. Take precautions to preserve material below the limit of excavation and repair damage to material below the limit of excavation to the satisfaction of OWNER.

E. Stockpile topsoil removed during excavation that is to be applied after backfill operations.

F. Selectively process and stockpile materials as necessary to yield suitable types and sufficient quantities of the various fill materials required for construction of the Work.

G. Maintain excavations in the dry until fill is placed.

H. Provide adequate survey control to avoid unauthorized overexcavation.

3.2 BLASTING

A. Blast only between the hours of 9 a.m. and 3 p.m. during any workday (Monday-Friday), unless special circumstances warrant another time or day and special approval is granted in writing by the OWNER.

B. Controlled blasting shall be employed. Take all necessary precautions to preserve the material below and beyond the established limits of excavation.

C. Control blasting such that maximum peak particle velocities at the nearest edge of any completed structure within one mile of the blast location shall not exceed 1.0 inch per second and air over-pressure shall not exceed 133 dB.

D. Monitor blast vibrations by conducting seismic monitoring.
   1. Locate seismographs south of St. Vrain Creek and at the north, east and west limits of the site.
   2. Seismic monitoring equipment shall be 4-channel units capable of measureing air-overpressure and vertical, longitudinal, and transverse directions of ground vibration velocities.
   3. Peak partical velocity shall be the largest of the three measured ground vibration velocities.

E. Control fly rock to prevent damage to persons, structures, existing improvements, or vegetation.
   1. Use burden and stemming requirements as required to control flyrock.
   2. Use blasting mats in developed areas.

F. Fifteen minutes prior to each blast, sound an audible siren or horn capable of being heard within one-half mile of the blasting site.

G. Blasting operations may be suspended by the OWNER for any one or more of the following:
   1. Safety precautions are inadequate.
   2. Existing structural conditions are aggravated or adjacent improvements are damaged as a result of blasting.
   3. Blasting methods adversely impact the stability of intact rock outside the prescribed limits of excavation.
   4. Skilled operators and/or licensed foreman are not present.

H. Blasting operations shall not resume until modifications have been made to correct the conditions that resulted in the suspension.

I. Repair or replace any damage caused by blasting. Repair or replace any damage resulting from possession or use of explosives for the Work.

J. A blasting supervisor licensed by the State of Colorado, Division of Oil and Public Safety, and acceptable to the OWNER shall be on the site, and in immediate charge of the blasting operations.
   1. The license of the supervising blaster(s) shall contain endorsements for construction blasting or a special operations endorsement applicable to the type of blasting on this project.
   2. Such supervisor shall have no less then three years of continuous experience in controlled blasting on projects of similar character.
   3. The blasting supervisor and the blaster-in-charge may be the same person.

3.3 STOCKPILING EXCAVATED MATERIAL

A. When necessary, stockpile excavated material that is waiting for disposal or use as fill.

B. Confine stockpiles to within approved work areas.

C. Do not stockpile excavated material adjacent to trenches and other excavations unless excavation sideslopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

D. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce settlement.

END OF SECTION

SECTION 31 23 19
DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Dewatering system.
2. Surface water control system.
3. Monitoring wells.
4. System operation and maintenance.
5. Water disposal.

B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 31 23 16 - Excavation .
4. Section 31 23 23 - Fill
5. Section 31 23 33 – Trenching, Backfilling, and Compacting for Utilities
6. Section 31 25 00 - Erosion Protection and Sedimentation Control.
7.

1.2 QUALITY ASSURANCE

1.3 DEFINITIONS

A. Dewatering:
1. Lowering of groundwater table and intercepting horizontal water seepage to prevent groundwater from entering [excavations, trenches and shafts.]
2. Disposing of removed water.

B. Surface Water Control:
1. Removal of surface water within open excavations or ponding areas.

C. Foundations:
1. Footings, base slabs, foundation walls, mat foundations, grade beams, piers and any other support placed directly on soil or rock.

1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Dewatering plan design data and Drawings including the following:
a. Proposed type of dewatering system with complete description of equipment and instrumentation to be used.
b. Arrangement, locations, and depths of system components.
c. Pipe sizes and capacities.
d. Filter types and sizes.
e. Water disposal method and location.
f. Surface water control devices.
g. System operation, monitoring, and maintenance procedures.
h. Method of monitoring water quality.
i. Signed and sealed by professional engineer.
3. Product technical data including:
a. Dewatering pump data including the following:
1) Size, capacity, and means of operation [of engine and motor].

b. Pumping equipment for control of surface water within excavation.

1.5 PROJECT CONDITIONS

PART 2 - PRODUCTS

2.1 DEWATERING EQUIPMENT

A. Select dewatering equipment to meet specified performance requirements.

PART 3 - EXECUTION

3.1 PROTECTION

A. Erosion Control:
   1. See Specification Section 31 25 00.
   2. Clean paved roadways daily of any spillage of dirt, rocks or debris from vehicles and equipment entering or leaving site.
   3. Conduct work to minimize erosion of site. Remove eroded material washed off site.
      a. If necessary or requested by OWNER, construct stilling areas to settle and detain eroded material.

B. Protect existing surface and subsurface features on-site and adjacent to site as follows:
   1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.
   2. Protect and maintain benchmarks, monuments or other established reference points and property corners.
      a. If disturbed or destroyed, replace at own expense to full satisfaction of OWNER and controlling agency.
   3. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed.
      a. Protect new and existing structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
      b. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition.
      c. All repairs to be made and paid for by CONTRACTOR.
   4. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by OWNER to prevent serious interruption of travel.

3.2 DEWATERING

A. Review Geotechnical investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.

3.3 SURFACE WATER CONTROL SYSTEMS

A. Provide ditches, berms, and other devices to divert and collect surface pond water from reaching the Scour Berm 18” RCP drainage pipe. Use necessary erosion control BMPs as specified in Specification Section 31 25 00.

B. If necessary, divert surface water and seepage water within excavation areas into sumps and pump water into drainage channels, storm drains and settling basins in accordance with requirements of the agencies having jurisdiction.

C. Control and remove unanticipated water seepage into excavation and fill areas.

END OF SECTION

SECTION 31 23 23
FILL

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Fill placement and compaction for reclamation slopes.

B. Fill for backfill of sediment pond.

C. Miscellaneous fill or backfill not specifically covered in other sections.

1.2 RELATED SECTIONS

A. Section 31 10 00: Site Clearing

B. Section 31 23 16: Excavation

C. Section 31 25 00: Erosion Protection and Sedimentation Control

1.3 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Society for Testing and Materials (ASTM):
      a. ASTM C 117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
      b. ASTM C 136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates
      c. ASTM D 75, Standard Practice for Sampling Aggregates.
      d. ASTM D 422, Test Method for Particle-Size Analysis of Soils.
      e. ASTM D 698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m.3)).
      f. ASTM D 4318, Standard Test Method for Liquid Limit, Plastic Limit, Plasticity Index of Soils.
      g. ASTM D 6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth).

1.4 DEFINITIONS

A. Backfill: Fill materials placed in trenches, excavations, and around structures, pipes and other facilities.

B. Borrow Material: Fill or backfill material from required excavations or from designated borrow areas on the site.

C. Certified/Certification: Review, approved, stamped, and signed by a Professional Engineer registered in the State of Colorado.

D. Completed Course: A course or layer that is ready for next layer or next phase of Work.

E. Coverage: One coverage is defined as the requirement for successive trips of a piece of compaction equipment, which by means of sufficient overlap, will ensure contact on the entire surface of the layer by the equipment.

F. Deleterious Materials: Organic matter, trash, rubbish, debris, oversize materials, and soluble materials.

G. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

H. Fill: All materials used to raise existing grade where not defined as backfill.

I. Fines: Material passing the No. 200 sieve as determined in accordance with ASTM D 422.

J. Imported Material: Material obtained from sources off site.

K. Lift: Loose (uncompacted) layer of material.

L. Optimum Water Content: Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

M. Oversize Materials: Soil particles, soil clods, sedimentary fragments, rocks, and other materials having a maximum dimension in excess of the specified limits.

N. Particle Size: The size of a particle before compaction measured parallel to its longest dimension.

O. Period of Inactivity or Extended Shutdown: Four days.

P. Relative Compaction:
1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D 698.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by OWNER.

Q. Well-Graded:
1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed or coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1.5 SUBMITTALS

A. Shop Drawings:
1. Fill Placement Plan to include:
   a. Planned sequence for construction.
   b. Fill placement rates and planned equipment spread for material processing, hauling, placement and compaction.
   c. Protection of completed fill during shutdowns, and preparation methods prior to resuming placement after shutdowns.
2. Catalog and manufacturer's data sheets for all equipment to be used to compact fill and backfill.
3. Sources of imported materials.

B. Samples:
1. For all imported materials; taken at source.

C. Quality Control Submittals:
1. Certified test results documenting conformance with all Specification requirements for:
   a. Imported materials.
   b. Borrow materials

1.6 QUALITY ASSURANCE

A. Certified quality control test results for all imported material. Submit prior to importing materials. CONTRACTOR is responsible for scheduling and performing tests as specified during production.

B. Perform water content, field density, gradation, and other tests during borrow materials development and fill placement as needed to develop and manage operations and produce consistent embankment fill and backfill meeting Specification requirements.

C. Notify OWNER when any of the following occur:

1. Embankment fill is about to be placed or fill operations are about to be resumed after a period of inactivity.
2. Structures are ready for backfilling, or backfilling operations are about to be resumed after a period of inactivity.
3. Soft or loose surface is encountered where fill or backfill is to be placed.
4. Materials appear to be deviating from the Specifications.
5. Initial sampling of imported material is to be conducted or importing of a material to the site is about to begin.
6. Borrow excavation is about to be shifted from one area to another, or a change in borrow materials is encountered.

1.7 SCHEDULING AND SEQUENCING

A. Complete applicable Work specified in Sections 31 10 00, Site Clearing, 31 23 16, Excavation, and Section 31 25 00: Erosion Protection and Sedimentation Control as required prior to placing fill or backfill.

B. Place fill only during daylight hours.

PART 2 - PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Source(s) of imported material must be approved by OWNER before material is imported to the site.

B. Samples:
1. Provide one 50-pound sample of each imported material, collected in accordance with ASTM D 75.
2. Clearly mark to show source of material and intended use.
3. Provide certified test results to document conformance with Specification requirements.

C. Tests:
1. As necessary to locate acceptable sources of imported material and to develop and manage borrow areas.
2. During production of imported and on-site fill materials, perform gradation test and Atterberg limits tests in accordance with ASTM C 117, ASTM C 136, and ASTM D 4318.
3. Provide gradation test results to OWNER within 48 hours of sampling; provide all other test results to OWNER upon test completion.

2.2 EARTH FILL

A. Well graded select or processed on-site bedrock or overburden materials consisting of hard igneous or sedimentary rock fragments, gravel, sand, and fines.

B. Allowable USCS classifications: SW, SP, SM, SC, SC-SM, GW, GP, GM, GC, and GC-GM.

C. Gradation: Graded uniformly and continuously from boulder size to silt size, maximum particle size equal to two-thirds of the lift thickness, maximum 45 percent fines in the minus 3-inch fraction.

D. Moisture Content – Within 3 percent of optimum based on ASTM D 698.

2.3 MOISTURE CONDITIONING EQUIPMENT

A. Provide water trucks and other supplemental equipment necessary to uniformly apply water in borrow areas, stockpiles, or to loose lifts of material for proper compaction.

B. Watering equipment shall be equipped with pressurized distributor bars or other means necessary to assure uniform application or water.

C. Provide blades, discs, and other supplemental equipment necessary to process borrow materials and pulverize residual bedrock into acceptable size particles, blend non-uniform fill and backfill materials, and for aerating and drying out wet materials.

2.4 COMPACTION EQUIPMENT

A. Provide dedicated compaction equipment of suitable type, capable of achieving the requirements of the Specifications, and which provide a satisfactory uniform, homogeneous fill.

B. Hauling or placement equipment shall not be considered compaction equipment.

C. Provide hand-operated equipment for use in confined areas not accessible to regular compaction equipment or where regular compaction equipment might damage structures or piping. Compaction equipment shall be subject to the approval of OWNER.

PART 3 - EXECUTION

3.1 GENERAL

A. Keep placement surfaces free of water, ice, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness in a manner that avoids segregation.

C. Compact each lift at the specified moisture content, using the specified equipment, and to specified densities, prior to placing succeeding lifts.

D. Slope lifts only as necessary to keep placement surfaces drained of water.

E. The maximum allowable particle size delivered in the fill and backfill at placement location and prior to any compaction shall be no larger than the maximum specified in Part 2.

F. Process by blading, disking, harrowing, or other methods as necessary to provide sufficient disaggregation and blending of fill and backfill. Processing of material to achieve the required particle size shall occur in the borrow areas.

G. Maintain moisture content of delivered materials within the range specified and compact materials in the lift to produce the specified fill characteristics.

H. Do not place fill or backfill if fill or backfill material is frozen, contains ice, or if surface upon which fill or backfill is to be placed is frozen. Remove frozen materials as needed to resume placement operations.

3.2 MOISTURE CONDITIONING AND PROCESSING

A. Moisture condition and process material prior to and during borrow excavation so that material is within the specified moisture content and particle size limits at the time it is delivered to the placement location.

B. Provide supplemental sprinkling on the fill to keep material within specified moisture content limits throughout the placement and compaction process, and to preserve moisture in completed courses until placement of overlying courses.

C. Blend material by disking, blading, or harrowing to maintain uniform moisture content throughout the lift.

D. Do not attempt to compact material that contains excessive moisture. Material that becomes too wet shall be removed or reworked. Aerate material by blading, disking, harrowing, or other methods to hasten the drying process.

E. Provide suitable types and numbers of watering and blending equipment to keep pace with fill and backfill placement activities, Provide additional equipment or restrict material placement rates if watering and blending equipment cannot keep pace with fill and backfill placement.

F. Maintain moisture conditions of the fill surface during nights, weekends, holidays, and other periods of temporary work stoppage.

3.3 COMPACTION

A. Compact all material by mechanical means. If tests indicate that compaction or moisture content is not as specified, or if compaction equipment being used is not as specified, terminate material placement and take corrective action prior to resuming material placement.

B. Operate compaction equipment in accordance with manufacturer's instructions and recommendations. Maintain equipment in such condition that it will deliver the manufacturer's rated compactive effort.

C. Operate Sheepsfoot and tamping foot rollers at a speed less than 5 miles per hour, and vibratory drum roller at a speed less than 3 miles per hour.

D. Operate sheepsfoot and tamping foot rollers to maintain the spaces between the individual feet clear of adherent materials that impair the effectiveness of the roller.

E. Where a minimum number of coverages is specified, provide a minimum 20 percent overlapping roller passes for each complete roller coverage per lift.

F. Provide suitable quantity of equipment to keep pace with fill and backfill placement activities. Restrict material placement rates if compaction equipment cannot keep pace with fill and backfill placement.

3.4 EARTH FILL

A. Construct fill to the lines and grades shown.

B. Where the surface under the fill is steeper than 4 horizontal to 1 vertical, excavate benches in the slope equal to the lift height to expose firm, moist, dense surfaces just prior to placing the next lift of fill.

C. Maintain the soil fill surfaces, including sloping the surfaces to drain, preventing or repairing gullies, and maintaining surfaces free of weeds or other vegetation, until final completion and acceptance of all Work.

D. Protect soil fill during periods of inactivity or extended shutdown. Grade surfaces to facilitate runoff and wheel roll or compact with a smooth drum roller to reduce infiltration and softening.

E. A temporary cover or loose lift of soil fill can be placed to protect the fill during periods of frost provided the loose lift is removed or properly moisture conditioned and compacted in accordance with these Specifications prior to placing additional fill.

F. After periods of inactivity or extended shutdowns, prepare the fill surface by moisture conditioning and re-compacting prior to resumption of fill and backfill activities:

G. Fill Placement:
   1. Maximum Lift Thickness:
      a. Thirty-six (36) inches for fill placed along reclaimed slopes.
      b. Nine (9) inches for embankment material, drainage swales, and in areas near pipes, utilities, and structures.
   2. Compaction: Not less than 90 percent relative compaction (ASTM D 698).
   3. Moisture Content: Within 3 percent of optimum (ASTM D 698).

3.5 FIELD QUALITY CONTROL

A. Field Testing and Inspections:

1. Initial laboratory compaction, gradation, and Atterberg limit tests are required prior to placement of any fill or backfill materials; additional tests are required during construction at the specified frequency and whenever material variation occurs such that existing information is not representative. Testing shall also be performed at locations as requested by the OWNER where minimum frequencies are unrepresentative for variable materials or inconsistent construction operations, and to retest previously failed materials after corrective actions have been implemented.
2. Laboratory Compaction Tests:
    a. Prior to placement of fill and backfill, a minimum of four laboratory compaction density tests in accordance with ASTM D 698 for each different soil and weathered bedrock material used.
    b. Rock corrections applied to density and moisture content determinations for oversize materials larger than 3/4-inch.
3. Gradation and Atterberg Limit Tests:
    a. Prior to placement of fill and backfill, four gradation tests and four Atterberg limit tests for each different soil material used; tests shall correspond with samples used for initial laboratory compaction and minimum/maximum density tests. Gradation test shall be performed in accordance with ASTM D 422, and Atterberg limits test shall be performed in accordance with ASTM D 4318.
4. In-Place Density and Moisture Content measurements:
    a. During fill and backfill placement, in-place density testing shall be performed in accordance with ATSM D 6938.
    b. One test shall be performed for each lift of fill placed.
5. Test Reporting:
    a. Written copies of all Field Tests shall be available on site at all times.
    b. Corrective Actions: Where testing of in-place materials fails to meet these Specifications, the questionable materials shall be removed or retested after corrective measures have been implemented. Retests will reference the prior failing test number.

END OF SECTION

SECTION 31 23 33
TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavation, trenching, backfilling and compacting for all drain piping.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 23 16 Excavation
   4. Section 33 05 16 - Precast Concrete Structures.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C33/C33M, Standard Specification for Concrete Aggregates.
      b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT^3 (600 kN-M/M^3)).
      c. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
      d. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

B. Qualifications: Hire an independent soils laboratory to conduct in-place moisture-density tests for backfilling to assure that all work complies with this Specification Section.

1.3 DEFINITIONS

A. Excavation: All excavation will be defined as unclassified.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Submit respective pipe or conduit manufacturer's data regarding bedding methods of installation and general recommendations.
   4. Submit sieve analysis reports on all granular materials.

B. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Trench shield (trench box) certification if employed:
      a. Specific to Project conditions.
      b. Re-certified if members become distressed.
      c. Certification by registered professional structural engineer, registered in the state where the Project is located.
      d. Engineer is not responsible to, and will not, review and approve.

1.5 SITE CONDITIONS

A. Avoid overloading or surcharge a sufficient distance back from edge of excavation to prevent slides or caving.

B. Protect and maintain benchmarks, monuments or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of Owner and controlling agency.

C. Verify location of existing underground utilities

PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill Material:
   1. As approved by OWNER.
      a. Free of rock cobbles, roots, sod or other organic matter, and frozen material.
      b. Moisture content at time of placement: ±3 PCT of optimum moisture content as specified in accordance with ASTM D698.

B. Bedding Materials:
   1. As approved by the OWNER.
   2. Granular bedding materials:
      a. ASTM C33/C33M, gradation 67 (3/4 IN to No. 4 sieve) defined below:

Sieve Size	1 IN	3/4 IN	3/8 IN	No. 4	No. 20
Percent Passing by Weight	100	90-100	20-55	0-10	0

      1) Well-graded crushed stone.
      2) Well graded crushed gravel.
      3) Well graded gravel.

PART 3 - EXECUTION

3.1 GENERAL

A. Remove and dispose of unsuitable materials as directed by Geotechnical Engineer.

3.2 EXCAVATION

A. Unclassified Excavation: Remove rock excavation, clay, silt, gravel, hard pan, loose shale, and loose stone as directed by OWNER.

B. Excavation for Appurtenances:
   1. 12 IN (minimum) clear distance between outer surface and embankment.
   2. See Specification Section 31 23 16 for applicable requirements.

C. Groundwater Dewatering:
   1. Where groundwater is, or is expected to be, encountered during excavation, install a dewatering system according to Section 31 23 19 to prevent softening and disturbance of subgrade to allow pipe, bedding and backfill material to be placed in the dry, and to maintain a stable trench wall or side slope.
   2. Groundwater shall be drawn down and maintained at least 2 FT below the bottom of any trench or manhole excavation prior to excavation.
   3. Review soils investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.
      a. Employ dewatering specialist for selecting and operating dewatering system.
   4. Keep dewatering system in operation until dead load of pipe, structure and backfill exceeds possible buoyant uplift force on pipe or structure.

5. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
6. Install groundwater monitoring wells as necessary.
7. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.
8. Cost of groundwater dewatering shall be included in the lineal foot unit price of the pipe installation

D. Trench Excavation:
1. Excavate trenches by open cut method to a minimum depth of 6 IN below bottom exterior surface of the pipe.
2. Any trench or portion of trench, which is opened and remains idle for seven calendar days, or longer, as determined by the OWNER, may be directed to be immediately refilled, without completion of work, at no additional cost to OWNER.
   a. Said trench may not be reopened until OWNER is satisfied that work associated with trench will be prosecuted with dispatch.
3. Observe following trenching criteria:
   a. Trench size:
      1) Excavate width to accommodate free working space.
      2) Maximum trench width at top of pipe or conduit may not exceed outside diameter of utility service by more than the following dimensions:

OVERALL DIAMETER OF UTILITY SERVICE	EXCESS DIMENSION
33 IN and less	18 IN
more than 33 IN	24 IN

      3) Cut trench walls vertically from bottom of trench to 1 FT above top of pipe.
      4) Keep trenches free of surface water runoff.
         a) Include cost in Bid.
         b) No separate payment for surface water runoff pumping will be made.
4.

3.3 PREPARATION OF FOUNDATION FOR PIPE LAYING

A. Over-Excavation:
1. Backfill and compact to 90 PCT of maximum dry density per ASTM D698.
2. Backfill with granular bedding material as option.

B. Rock Excavation:
1. Excavate minimum of 12 IN below bottom exterior surface of the pipe.
2. Backfill to grade with suitable earth or granular material.
3. Form bell holes in trench bottom.

C. Subgrade Stabilization:
1. Stabilize the subgrade when directed by the OWNER.
2. Observe the following requirements when unstable trench bottom materials are encountered.
   a. Notify OWNER when unstable materials are encountered.
   b. Remove unstable trench bottom caused by CONTRACTOR failure to dewater, rainfall, or CONTRACTOR operations.
      1) Replace with subgrade stabilization with no additional compensation.

D. Pipe Bedding
1. Pipe bedding shall be furnished and placed in accordance with the requirements in these Specifications.
2. Pipe shall be placed on a firm layer of bedding material and shall be bedded uniformly throughout its length.

a. The bearing shall be achieved by shaping the bedding or by lightly “bouncing” the pipe to set it into the bedding.
b. Pipe bedding material shall be placed at a minimum thickness of 6 IN.

3.4 BACKFILLING METHODS

A. Carefully Compacted Backfill:
1. Furnish where specified for trench embedment conditions and for compacted backfill conditions at a minimum up to the springline of the pipe.
2. Comply with the following:
a. Place backfill in lifts not exceeding 8 IN (loose thickness).
b. Hand place, shovel slice, and pneumatically tamp all carefully compacted backfill.
c. Observe specific manufacturer's recommendations regarding backfilling and compaction.
d. Compact each lift to specified requirements.

B. Common Trench Backfill:
1. Perform in accordance with the following:
a. Place backfill in lift thicknesses capable of being compacted to densities specified.
b. Observe specific manufacturer's recommendations regarding backfilling and compaction.
c. Avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion.

C. Water flushing for consolidation is not permitted.

3.5 COMPACTION

A. General:
1. Place and assure bedding, backfill, and fill materials achieve an equal or higher degree of compaction than undisturbed materials adjacent to the work.
2. In no case shall degree of compaction below minimum compactions specified be accepted.

B. Compaction Requirements:
1. Unless noted otherwise on Drawings or more stringently by other Specification Sections, comply with following minimum trench compaction criteria.
a. Bedding material:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All locations	Cohesionless soils	75 PCT relative density by ASTM D4253 and ASTM D4254

b. Carefully compacted backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All applicable areas	Cohesive soils	95 PCT of maximum dry density by ASTM D698
	Cohesionless soils	75 PCT relative density by ASTM D4253 and ASTM D4254

c. Toe drain bedding and backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All locations	Cohesionless soils	60 PCT relative density by ASTM D4253 and ASTM D4254

d. Common trench backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
Under pavements, roadways, surfaces within highway right-of-ways	Cohesive soils	95 PCT of maximum dry density by ASTM D698
	Cohesionless soils	60 PCT of relative density by ASTM D4253 and ASTM D4254
Under turfed, sodded, plant seeded, nontraffic areas	Cohesive soils	85 PCT of maximum dry density by ATM D698
	Cohesionless soils	40 PCT of relative density by ASTM D4253 and ASTM D4254

3.6 FIELD QUALITY CONTROL

A. Testing:
   1. Perform in-place moisture-density tests as directed by the Owner.
   2. Perform tests through recognized testing laboratory approved by Owner.
   3. Costs of "Passing" tests paid by Owner.
   4. Perform additional tests as directed until compaction meets or exceeds requirements.
   5. Cost associated with "Failing" tests shall be paid by Contractor.
   6. Reference to Engineer in this Specification Section will imply Geotechnical Engineer when employed by Owner and directed by Engineer to undertake necessary inspections as approvals as necessary.
   7. Assure Owner has immediate access for testing of all soils related work.
   8. Ensure excavations are safe for testing personnel.

END OF SECTION

SECTION 31 25 00
EROSION PROTECTION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Design, install, maintain, and remove all necessary erosion protection and sediment controls.

1.2 DEFINITIONS

A. Best Management Practices (BMP's): Techniques, processes, activities, and structures used in combination to reduce pollutant discharges in stormwater. BMP's include source control practices (non-structural BMPs) and engineered structures designed to treat runoff based on site-specific conditions before, during, and after construction.

B. Sediment and Erosion Control devices as defined herein shall mean silt fences, hay bales, erosion control logs, sandbag cofferdams, sediment ponds, sediment traps, or other devices approved by OWNER.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Stormwater Management Plan (SWMP) consisting of SWMP Plan and Report developed in accordance with Urban Drainage and Flood Control District (UDFCD), Urban Storm Drainage Criteria Manual Volume 3 (UDFCD, 2016).
   2. Wind Erosion and Dust Control Plan. The SWMP must contain wind erosion and dust control BMPs to keep soil particles from entering the air, during working and non-working periods, as a result of land disturbing construction activities.

1.4 REFERENCES

A. Boulder County Storm Drainage Criteria Manual (Boulder County, 2016).

B. Urban Drainage and Flood Control District (UDFCD), Urban Storm Drainage Criteria Manual Volume 3 (UDFCD, 2016).

PART 2 - PRODUCTS

2.1 EROSION CONTROL BMPS

A. Erosion control BMPs include Earth Dikes and Drainage Swales and other similar temporary source controls used to limit erosion of soil. These are typically surface treatments that limit erosion by redirecting flows or reducing velocities of concentrated flow. Earth dikes and drainage swales control the flow path of runoff at a construction site by diverting runoff around areas prone to erosion, such as steep slopes. Earth dikes and drainage swales may also be constructed as temporary conveyance features. This will direct runoff to additional sediment control treatment BMPs, such as sediment traps or basins.

2.2 SEDIMENT CONTROL BMPS

A. Sediment control BMPs include silt fences, sediment control logs, and other similar temporary soil sediment control measures that limit transport of sediment off-site to downstream properties and receiving waters. These are generally treatment processes that either provide filtration through a permeable media or that slow runoff to allow settling of suspended particles.
   1. Silt fence is a woven geotextile fabric attached to wooden posts and trenched into the ground. It is designed as a sediment barrier to intercept sheet flow runoff from disturbed areas.

2. Sediment control logs are a linear roll made of natural materials used as a sediment barrier to intercept sheet flow runoff from disturbed areas. Sediment control logs also are used as check dams in small drainage ditches.
    a. Made from natural materials such as straw, coconut fiber, or compost and free from any noxious weed seeds or defects.
    b. Minimum 9 inches diameter.

2.3 SEDIMENT BASIN

A. Use existing sediment pond in conjunction with other BMP's for sediment control.

PART 3 - EXECUTION

3.1 PREPARATION

A. Identify required lines, levels, contours, and datums for the construction of erosion control facilities.

3.2 SEDIMENT AND EROSION CONTROLS

A. Install necessary sediment and erosion control measures prior to any ground disturbing activities, including site clearing, stripping and stockpiling topsoil, excavation, fill placement and grading.

B. The BMPs shown on the drawings are the minimum sediment and erosion controls required. Install additional or alternate BMPs as necessary to address conditions encountered during the work.

3.3 EROSION CONTROL MEASURES

A. Earth Dikes and Drainage Swales (ED/DS)
    1. Install ED/DS to divert runoff around areas of disturbance.
    2. Install ED/DS as temporary conveyance features to direct runoff to additional sediment control treatment BMPs, such as sediment traps or basins.
    3. Place and compact earth dike embankments to 90 percent of maximum density and within 2 percent of optimum moisture content according to ASTM D 698.
    4. Where construction traffic must cross a swale, install a temporary culvert with 12 inch minimum diameter.

B. Wind Erosion and Dust Control
    1. Use wind erosion and dust control BMPs to keep soil particles from entering the air as a result of land disturbing construction activities.
    2. BMPs include site watering, seeding and mulching, or other practices that provide prompt surface cover.

3.4 SEDIMENT CONTROL MEASURES

A. Silt Fence
    1. Install silt fence for sediment control around stockpiles located outside constructed sediment and erosion control measures.
        a. Imbed silt fence posts a minimum depth of 18 inches and at least 3 feet from the toe of the slope. There should be no sag
        b. Burry a minimum 10 inch tail of silt fence at a minimum depth of 6 inches in a 6'x4' anchor trench on the upslope side of the silt fence.
        c. Maintain silt fence during construction. Replace damaged sections and remove accumulated sediment before it reaches 6 inches in depth.

B. Sediment Control Log (SCL)
    1. Install SCLs for sediment control associated with sheet flow runoff from diversion ditches and as check dams in the ditches.
        a. Properly trench and stake SCLs to prevent undercutting, bypassing and displacement.
        b. Trench SCLs to a depth of one-third of the SCL diameter.

c. Stake SCLs with a minimum 4 foot spacing and embed stakes a minimum depth of 6 inches below the bottom of the trench.,
d. Maintain SCLs during construction. Replace damaged sections and remove accumulated sediment before it reaches one-half the height of the sediment control log.

C. Sediment Basin
1. Use the existing sediment basin to capture eroded or disturbed soil transported in storm runoff prior to discharge from the site.
2. To the extent practical, divert flows from undisturbed and/or off-site areas around the sediment basin to prevent "clean" runoff from mixing with runoff from disturbed areas.

3.5 MATERIALS MANAGEMENT CONTROL MEASURES

A. Stockpile Management
1. Use Stockpile management when soils or other erodible materials are stored at the construction site.
2. Locate stockpiles away from all drainage system components and, where practical, at locations that will remain undisturbed for the longest period of time as construction progresses.
3. Stockpiles shall be constructed to a maximum height of 15 feet with side slopes no steeper than 2H:1V.
4. For stockpiles located outside constructed sediment and erosion control measures, install sediment control BMPs around the perimeter of the stockpile, such as sediment control logs, silt fence, straw bales or sand bags. If perimeter protection must be moved to access stockpile, replace perimeter controls by the end of the workday.
5. For stockpiles in active use, provide a stabilized designated access point on the up gradient side of the stockpile. Stabilize the stockpile surface with surface roughening, erosion control blankets, or soil binders.
6. Soils stockpiled for an extended period (typically for more than 60 days) shall be seeded and mulched with a temporary grass cover.

3.6 INSPECTION AND MAINTENANCE

A. Conduct daily spot checks and weekly/post-storm full inspections of BMP's to ensure that they are in place and operating effectively and in accordance with SWMP Plans and Report.

B. Maintain and repair sediment and erosion controls during course of construction.

3.7 REMOVAL OF TEMPORARY FACILITIES

A. Do not remove erosion control facilities without written approval from OWNER.

B. All erosion control facilities will be the property of CONTRACTOR, and shall be removed and disposed of offsite after all Work is complete.

END OF SECTION

SECTION 31 23 23
FILL

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Fill placement and compaction for reclamation slopes.

B. Fill for backfill of sediment pond.

C. Miscellaneous fill or backfill not specifically covered in other sections.

1.2 RELATED SECTIONS

A. Section 31 10 00: Site Clearing

B. Section 31 23 16: Excavation

C. Section 31 25 00: Erosion Protection and Sedimentation Control

1.3 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Society for Testing and Materials (ASTM):
      a. ASTM C 117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
      b. ASTM C 136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates
      c. ASTM D 75, Standard Practice for Sampling Aggregates.
      d. ASTM D 422, Test Method for Particle-Size Analysis of Soils.
      e. ASTM D 698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m.3)).
      f. ASTM D 4318, Standard Test Method for Liquid Limit, Plastic Limit, Plasticity Index of Soils.
      g. ASTM D 6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth).

1.4 DEFINITIONS

A. Backfill: Fill materials placed in trenches, excavations, and around structures, pipes and other facilities.

B. Borrow Material: Fill or backfill material from required excavations or from designated borrow areas on the site.

C. Certified/Certification: Review, approved, stamped, and signed by a Professional Engineer registered in the State of Colorado.

D. Completed Course: A course or layer that is ready for next layer or next phase of Work.

E. Coverage: One coverage is defined as the requirement for successive trips of a piece of compaction equipment, which by means of sufficient overlap, will ensure contact on the entire surface of the layer by the equipment.

F. Deleterious Materials: Organic matter, trash, rubbish, debris, oversize materials, and soluble materials.

G. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

H. Fill: All materials used to raise existing grade where not defined as backfill.

I. Fines: Material passing the No. 200 sieve as determined in accordance with ASTM D 422.

J. Imported Material: Material obtained from sources off site.

K. Lift: Loose (uncompacted) layer of material.

L. Optimum Water Content: Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

M. Oversize Materials: Soil particles, soil clods, sedimentary fragments, rocks, and other materials having a maximum dimension in excess of the specified limits.

N. Particle Size: The size of a particle before compaction measured parallel to its longest dimension.

O. Period of Inactivity or Extended Shutdown: Four days.

P. Relative Compaction:
1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D 698.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by OWNER.

Q. Well-Graded:
1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed or coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1.5 SUBMITTALS

A. Shop Drawings:
1. Fill Placement Plan to include:
   a. Planned sequence for construction.
   b. Fill placement rates and planned equipment spread for material processing, hauling, placement and compaction.
   c. Protection of completed fill during shutdowns, and preparation methods prior to resuming placement after shutdowns.
2. Catalog and manufacturer's data sheets for all equipment to be used to compact fill and backfill.
3. Sources of imported materials.

B. Samples:
1. For all imported materials; taken at source.

C. Quality Control Submittals:
1. Certified test results documenting conformance with all Specification requirements for:
   a. Imported materials.
   b. Borrow materials

1.6 QUALITY ASSURANCE

A. Certified quality control test results for all imported material. Submit prior to importing materials. CONTRACTOR is responsible for scheduling and performing tests as specified during production.

B. Perform water content, field density, gradation, and other tests during borrow materials development and fill placement as needed to develop and manage operations and produce consistent embankment fill and backfill meeting Specification requirements.

C. Notify OWNER when any of the following occur:

1. Embankment fill is about to be placed or fill operations are about to be resumed after a period of inactivity.
2. Structures are ready for backfilling, or backfilling operations are about to be resumed after a period of inactivity.
3. Soft or loose surface is encountered where fill or backfill is to be placed.
4. Materials appear to be deviating from the Specifications.
5. Initial sampling of imported material is to be conducted or importing of a material to the site is about to begin.
6. Borrow excavation is about to be shifted from one area to another, or a change in borrow materials is encountered.

1.7 SCHEDULING AND SEQUENCING

A. Complete applicable Work specified in Sections 31 10 00, Site Clearing, 31 23 16, Excavation, and Section 31 25 00: Erosion Protection and Sedimentation Control as required prior to placing fill or backfill.

B. Place fill only during daylight hours.

PART 2 - PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Source(s) of imported material must be approved by OWNER before material is imported to the site.

B. Samples:
1. Provide one 50-pound sample of each imported material, collected in accordance with ASTM D 75.
2. Clearly mark to show source of material and intended use.
3. Provide certified test results to document conformance with Specification requirements.

C. Tests:
1. As necessary to locate acceptable sources of imported material and to develop and manage borrow areas.
2. During production of imported and on-site fill materials, perform gradation test and Atterberg limits tests in accordance with ASTM C 117, ASTM C 136, and ASTM D 4318.
3. Provide gradation test results to OWNER within 48 hours of sampling; provide all other test results to OWNER upon test completion.

2.2 EARTH FILL

A. Well graded select or processed on-site bedrock or overburden materials consisting of hard igneous or sedimentary rock fragments, gravel, sand, and fines.

B. Allowable USCS classifications: SW, SP, SM, SC, SC-SM, GW, GP, GM, GC, and GC-GM.

C. Gradation: Graded uniformly and continuously from boulder size to silt size, maximum particle size equal to two-thirds of the lift thickness, maximum 45 percent fines in the minus 3-inch fraction.

D. Moisture Content – Within 3 percent of optimum based on ASTM D 698.

2.3 MOISTURE CONDITIONING EQUIPMENT

A. Provide water trucks and other supplemental equipment necessary to uniformly apply water in borrow areas, stockpiles, or to loose lifts of material for proper compaction.

B. Watering equipment shall be equipped with pressurized distributor bars or other means necessary to assure uniform application or water.

C. Provide blades, discs, and other supplemental equipment necessary to process borrow materials and pulverize residual bedrock into acceptable size particles, blend non-uniform fill and backfill materials, and for aerating and drying out wet materials.

2.4 COMPACTION EQUIPMENT

A. Provide dedicated compaction equipment of suitable type, capable of achieving the requirements of the Specifications, and which provide a satisfactory uniform, homogeneous fill.

B. Hauling or placement equipment shall not be considered compaction equipment.

C. Provide hand-operated equipment for use in confined areas not accessible to regular compaction equipment or where regular compaction equipment might damage structures or piping. Compaction equipment shall be subject to the approval of OWNER.

PART 3 - EXECUTION

3.1 GENERAL

A. Keep placement surfaces free of water, ice, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness in a manner that avoids segregation.

C. Compact each lift at the specified moisture content, using the specified equipment, and to specified densities, prior to placing succeeding lifts.

D. Slope lifts only as necessary to keep placement surfaces drained of water.

E. The maximum allowable particle size delivered in the fill and backfill at placement location and prior to any compaction shall be no larger than the maximum specified in Part 2.

F. Process by blading, disking, harrowing, or other methods as necessary to provide sufficient disaggregation and blending of fill and backfill. Processing of material to achieve the required particle size shall occur in the borrow areas.

G. Maintain moisture content of delivered materials within the range specified and compact materials in the lift to produce the specified fill characteristics.

H. Do not place fill or backfill if fill or backfill material is frozen, contains ice, or if surface upon which fill or backfill is to be placed is frozen. Remove frozen materials as needed to resume placement operations.

3.2 MOISTURE CONDITIONING AND PROCESSING

A. Moisture condition and process material prior to and during borrow excavation so that material is within the specified moisture content and particle size limits at the time it is delivered to the placement location.

B. Provide supplemental sprinkling on the fill to keep material within specified moisture content limits throughout the placement and compaction process, and to preserve moisture in completed courses until placement of overlying courses.

C. Blend material by disking, blading, or harrowing to maintain uniform moisture content throughout the lift.

D. Do not attempt to compact material that contains excessive moisture. Material that becomes too wet shall be removed or reworked. Aerate material by blading, disking, harrowing, or other methods to hasten the drying process.

E. Provide suitable types and numbers of watering and blending equipment to keep pace with fill and backfill placement activities, Provide additional equipment or restrict material placement rates if watering and blending equipment cannot keep pace with fill and backfill placement.

F. Maintain moisture conditions of the fill surface during nights, weekends, holidays, and other periods of temporary work stoppage.

3.3 COMPACTION

A. Compact all material by mechanical means. If tests indicate that compaction or moisture content is not as specified, or if compaction equipment being used is not as specified, terminate material placement and take corrective action prior to resuming material placement.

B. Operate compaction equipment in accordance with manufacturer's instructions and recommendations. Maintain equipment in such condition that it will deliver the manufacturer's rated compactive effort.

C. Operate Sheepsfoot, bulldozer tracking and tamping foot rollers at a speed less than 5 miles per hour, and vibratory drum roller at a speed less than 3 miles per hour.

D. Operate sheepsfoot, bulldozer tracking and tamping foot rollers to maintain the spaces between the individual feet clear of adherent materials that impair the effectiveness of the roller.

E. Where a minimum number of coverages is specified, provide a minimum 20 percent overlapping passes for each complete coverage per lift.

F. Provide suitable quantity of equipment to keep pace with fill and backfill placement activities. Restrict material placement rates if compaction equipment cannot keep pace with fill and backfill placement.

3.4 EARTH FILL

A. Construct fill to the lines and grades shown.

B. Where the surface under the fill is steeper than 4 horizontal to 1 vertical, excavate benches in the slope equal to the lift height to expose firm, moist, dense surfaces just prior to placing the next lift of fill.

C. Maintain the soil fill surfaces, including sloping the surfaces to drain, preventing or repairing gullies, and maintaining surfaces free of weeds or other vegetation, until final completion and acceptance of all Work.

D. Protect soil fill during periods of inactivity or extended shutdown. Grade surfaces to facilitate runoff and wheel roll or compact with a smooth drum roller to reduce infiltration and softening.

E. A temporary cover or loose lift of soil fill can be placed to protect the fill during periods of frost provided the loose lift is removed or properly moisture conditioned and compacted in accordance with these Specifications prior to placing additional fill.

F. After periods of inactivity or extended shutdowns, prepare the fill surface by moisture conditioning and re-compacting prior to resumption of fill and backfill activities:

G. Fill Placement:
   1. Maximum Lift Thickness:
      a. Thirty-six (36) inches for fill placed along reclaimed slopes.
      b. Nine (9) inches for embankment material, drainage swales, and in areas near pipes, utilities, and structures.
   2. Compaction: Not less than 90 percent relative compaction (ASTM D 698).
   3. Moisture Content: Within 3 percent of optimum (ASTM D 698).

3.5 FIELD QUALITY CONTROL

A. Field Testing and Inspections:

1. Initial laboratory compaction, gradation, and Atterberg limit tests are required prior to placement of any fill or backfill materials; additional tests are required during construction at the specified frequency and whenever material variation occurs such that existing information is not representative. Testing shall also be performed at locations as requested by the OWNER where minimum frequencies are unrepresentative for variable materials or inconsistent construction operations, and to retest previously failed materials after corrective actions have been implemented.
2. Laboratory Compaction Tests:
    a. Prior to placement of fill and backfill, a minimum of four laboratory compaction density tests in accordance with ASTM D 698 for each different soil and weathered bedrock material used.
    b. Rock corrections applied to density and moisture content determinations for oversize materials larger than 3/4-inch.
3. Gradation and Atterberg Limit Tests:
    a. Prior to placement of fill and backfill, four gradation tests and four Atterberg limit tests for each different soil material used; tests shall correspond with samples used for initial laboratory compaction and minimum/maximum density tests. Gradation test shall be performed in accordance with ASTM D 422, and Atterberg limits test shall be performed in accordance with ASTM D 4318.
4. In-Place Density and Moisture Content measurements:
    a. During fill and backfill placement, in-place density testing shall be performed in accordance with ATSM D 6938.
    b. One test shall be performed for each lift of fill placed.
5. Test Reporting:
    a. Written copies of all Field Tests shall be available on site at all times.
    b. Corrective Actions: Where testing of in-place materials fails to meet these Specifications, the questionable materials shall be removed or retested after corrective measures have been implemented. Retests will reference the prior failing test number.

END OF SECTION

SECTION 31 72 16
GROUND CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Rock slope scaling: The work consists of removing loose rock and debris in areas shown on the plans prior to placement of Rock Reinforcement (Number 10) or as directed by the ENGINEER.

B. Rock bolt installation: This Work shall consist of furnishing and installing Rock Reinforcement (Number 10) as shown in the Plans.

1.2 RELATED SECTIONS

A. Section 31 23 16: Excavation

1.3 REFERENCES

A. The following is a list of Standards which apply to this Section:
   1. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR, Part 1926,
         1) Subpart I, Tools-Hand and Power
         2) Subpart M, Fall Protections
         3) Subpart P, Excavation Standards
   2. ASTM International (ASTM):
      a. ASTM A 29, Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought
      b. ASTM A36, Standard Specification for Carbon Structural Steel
      c. ASTM A47, Standard Specification for Ferritic Malleable Iron Castings
      d. ASTM A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
      e. ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
      f. ASTM A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
      g. ASTM A536, Standard Specification for Ductile Iron Castings
      h. ASTM A722, Standard Specification for High-Strength Steel Bars for Prestressed Concrete
      i. ASTM A775, Standard Specification for Epoxy-Coated Steel Reinforcing Bars
      j. ASTM C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens)
      k. ASTM C150, Standard Specification for Portland Cement
      l. ASTM D7803, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Powder Coating
      m. ASTM F436, Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
      n. ASTM F432-95, Standard Specification for Roof and Rock Bolts and Accessories
   3. American Association of State Highway Transportation Officials (AASHTO):
      a. AASHTO M85, Standard Specification for Portland Cement
   4. Federal Specification 595B - COLORS USED IN GOVERNMENT PROCUREMENT

1.4 DEFINITIONS

A. Scaling Supervisor: The CONTRACTOR's designated representative responsible for facilitation and coordination of all rock scaling activities on this project.

B. Rock Scaler: An individual who is engaged in accessing and removing unconsolidated materials using hand tools at locations which require high scaling techniques.

C. Rock Reinforcement (Number 10): The use of grouted, threaded bars installed into a rock mass with the purpose of strengthening the rock mass so that the rock supports itself. The bar shall be grouted in two phases, the first phase in the bond length and the second phase in the free stressing length. All Rock Reinforcement (Number 10) bars will be tested and locked off to the loads shown in the Plans or as directed by the ENGINEER.

1.5 SUBMITTALS

A. Qualifications: The CONTRACTOR performing the scaling work on this subsection shall submit
   1. Proof of at least three (3) projects completed during the past three (3) years that have involved high scaling (in excess of 100 feet vertically) from ropes and/or man baskets.
   2. Proof of Scaling Supervisor's American Red Cross "Basic First Aid Course" certification or equivalent
   3. Proof that all crew members that will perform rock scaling shall be familiar with rock climbing techniques, radio operation, and work site safety.
   4. Proof that all work requiring rope access is in accordance with the Code of Federal Regulations (CFR) 1926.501 B15. The Englewood, Colorado Area Office of the Occupational Safety and Health Administration can be contacted at (303) 843-4515 for an interpretation of these regulations as they apply to the work.

B. Scaling Work Plan: A detailed work plan for each rock slope to be scaled. The Scaling Work Plans shall be submitted to the ENGINEER at least 10 working days prior to beginning the rock scaling work.

C. The Scaling Work Plans shall provide the following:
   1. Proposed construction sequence and schedule.
   2. Types and number of machinery and tools to be used for scaling.
   3. Number of scaling crews required for the project.
   4. Protection plan to be implemented by the CONTRACTOR during scaling to protect personnel.

D. Construction Submittals: The following submittals shall be made to the ENGINEER at least 10 working days prior to beginning the rock reinforcement work.
   1. One sample each of the various thread bar types to be used shall be submitted to the ENGINEER from the normal stock of the manufacturer. Samples of Rock Reinforcement materials, including anchorage hardware and couplers, and centralizers shall be submitted together with mill reports indicating tensile yield point and elongation results at no additional expense to the OWNER.
   2. Certificates stating that samples for testing are from normal stock, which will be used in the work.
   3. Certificate of Calibration from an independent testing laboratory for each combination of stressing ram, jack, and gauge to be used for testing of the Rock Reinforcement. The stressing ram assembly shall be calibrated specifically for this project within 30 days of the initial testing.

E. Rock Reinforcement Shop Drawings: The CONTRACTOR shall furnish shop drawings as specified in Section 01 33 00, except as noted herein. Shop drawings shall include the following:
   1. Applicable literature for the threaded bars, anchorage hardware, grout, and field epoxy coating repair including color sample. The manufacturer's recommended installation, storage procedures and recommended working temperature ranges for thread bars and grout shall be included.

2. A brief narrative describing the CONTRACTOR's Rock Reinforcement installation procedures, including a description of all drilling equipment and methods. The procedure for spanning open voids and debris-filled discontinuities in the rock shall be discussed and shall minimize grout loss during installation.
3. A brief narrative describing the Rock Reinforcement testing procedures and equipment. The submittal shall include calibration graphs to correlate the pressure indicator to applied load for each combination of stressing ram, jack, and pressure indicator to be used in the Work. The serial number of each component of the stressing equipment shall be clearly indicated on each calibration graph.
4. A narrative describing the materials and procedures for application of epoxy on the anchorage hardware.
5. Drilling Forms. The CONTRACTOR shall maintain daily records of Rock Reinforcement work. These reports shall, as a minimum, include the quantities, lengths and location of the reinforcement, and testing information and any unusual occurrences on a form that has been pre-approved by the ENGINEER. Daily records shall be provided to the ENGINEER within 24 hours of the day they are recorded

1.6 QUALITY ASSURANCE

A. Qualifications
   1. Scaling Supervisor: The Scaling Supervisor shall have a minimum of three years of experience in high scaling operations, shall be current in the American Red Cross "Basic First Aid Course" or equivalent, and shall have experience or training in the use of emergency remote rescue techniques.
   2. Rock Scaler: Rock scalers shall have either a minimum of six months experience in high scaling operations or shall have attended a training course conducted by an individual who qualifies as a supervisor under this specification.

B. Proof Testing
   1. All Rock Reinforcement (Number 10) bars will be proof tested as described in Subsection 3.3.G and locked off at the loads as directed by the ENGINEER.

PART 2 - PRODUCTS

A. Rock Reinforcement (Number 10) shall be Grade 150 thread bar and shall conform to the requirements of ASTM A722. The thread bar shall be of size and dimension as shown on the Plans or as directed by the ENGINEER. Each bar shall be furnished with appropriate anchorage hardware. Coupling of bars shall be as approved by the ENGINEER. All Rock Reinforcement bars shall be epoxy coated in accordance with ASTM A775 to a minimum coating thickness of 12 mils.

B. Nuts shall be heavy duty conforming to the requirements of ASTM A108 (Grade 75) or ASTM A29 (Grade 150) and appropriately sized for the threaded bar specified. Nuts shall develop an ultimate strength of not less than 125 percent of the minimum yield strength of the bar. Nuts shall be hot dip galvanized in accordance with ASTM A153 and powder coated in accordance with ASTM D7803. Exposed nuts shall be powder coated grey-beige color RAL 1019 as shown in the plans or as approved by the ENGINEER.

C. Washers shall be made of hardened steel, and conform to the requirements of ASTM A47, F436, or A536 and appropriately sized for the threaded bar specified. Washers may be flat, beveled, or spherical seat as required to adequately seat and load the Rock Reinforcement system without bending the bar, and shall be placed between the plate and the nut. Washers shall be hot dip galvanized in accordance with ASTM A153 and powder coated in accordance with ASTM D7803 or as approved by the ENGINEER.

D. Bearing Plates shall conform to ASTM A36 and shall be galvanized in accordance with ASTM A123 and powder coated in accordance with ASTM D7803. Exposed bearing plates shall be powder coated or as approved by the ENGINEER.

E. Centralizers and Spacers. Centralizers and spacers shall be fabricated from any type of material, except wood, that is not deleterious to the thread bar and shall be appropriate for the thread bar diameter and the drill hole diameter.

F. Cement grout shall be neat-cement or sand-cement and shall consist of a pumpable mixture of Type II or III Portland cement conforming to AASHTO M85/ASTM C 150 and water. Cement shall be fresh and shall not contain lumps or other indications of hydration. Chloride-containing grouts or other grouts, which in the opinion of the ENGINEER may be detrimental, are not permitted. The grout shall be capable of reaching cube strength of 3,000 pounds/square inch (psi) in three (3) days when tested in accordance with ASTM C109. The grout shall have a water-cement ratio of 0.40 to 0.60. The mixed grout shall be free of lumps and undispersed cement.

G. Split Set anchors (International Rollforms, Inc. – Split-set stabilizer model SS-33 or equivalent) shall meet ASTM F 432-95 requirements providing a load capacity of 10 tons (9.1 metric tons). The stabilizer tube shall be 48 inches long and 1.3 inches in diameter and shall consist of galvanized steel. The domed plate for each stabilizer shall be 6 x 6 x 0.16 inches thick and galvanized. Galvanizing shall meet Specification ASTMA123/A123M for hot-dip galvanized coating on iron-steel products.

H. Twisted wire mesh shall be Twisted Wire Reinforcement:
   1. Smooth wire flat sheets.
   2. Conforming to ASTM A1064.
   3. Wire size conforming to ASTM A82 for steel wire with minimum 0.192” diameter.
   4. Mesh openings shall be maximum 4-inches on center.
   5. Meet specification ASTMA123/A123M for hot-dip galvanized coating on iron-steel products

PART 3 - EXECUTION

3.1 GENERAL

A. Safety of the work shall be the responsibility of the CONTRACTOR. The work shall be performed in a manner to minimize hazards and exposure of the public, construction personnel, and equipment to hazardous and potentially hazardous conditions. Placement of Rock Reinforcement (Number 10) shall be scheduled so as to ensure safety.

B. The CONTRACTOR shall be responsible for protecting the roadway and all appurtenances from any damage resulting from CONTRACTOR activities. The CONTRACTOR shall be responsible for repairing any damage resulting from scaling or other construction activities as determined by the ENGINEER.

3.2 ROCK SCALING

A. The crew shall remove or stabilize loose, hanging, or potentially dangerous or unstable rocks and soil debris on rock cut slopes using manual scaling techniques. The crew shall scale by hand methods using a standard steel mine-scaling rod or similar device, or by mechanical tools that can be hand operated (i.e. jack hammers).

B. In addition to hand scaling techniques other measures such as hydraulic wedges, air pillow, or other mechanical means may be used if demonstrated to be effective and approved in writing by the ENGINEER.

3.3 ROCK REINFORCEMENT

A. All epoxy coated bar surfaces shall be free of sludge, grease, or any other deleterious matter which might inhibit the bonding ability. The CONTRACTOR shall exercise special care to prevent damage to the epoxy coating during handling and installation. Thread bars shall be rejected or recoated as directed by the ENGINEER if the epoxy coating and/or outer sections are damaged.

B. Rock Reinforcement shall be placed as directed by the ENGINEER. Locations, orientations, lengths, and quantities for Rock Reinforcement shown in the Plans are approximate. The ENGINEER may increase, reduce, delete, or otherwise alter the Rock Reinforcement as necessary to address actual field conditions.

C. Additional Rock Reinforcement installed without the approval of the ENGINEER shall be at the CONTRACTOR's expense.

D. Drill holes required for the installation of the Rock Reinforcement shall be constructed according to the following requirements:

1. Diameter, Length and Alignment. Drill hole diameter for each thread bar shall be uniform for the entire length of the hole unless otherwise approved by the ENGINEER. The drilling equipment shall be capable of drilling a straight hole to the depth required and shall be equipped to inject air into the hole through the bit. The drill hole diameter shall be compatible with the thread bar and grout to be used. Over-drilling beyond the final installed position of the rock reinforcement shall not exceed six inches. Ground conditions encountered as construction progresses may require the lengths of the Rock Reinforcement to be greater than the minimum length shown on the Plans and lengths shall be varied as directed by the ENGINEER. Where the varied lengths are to be utilized, the use of couplers (or other approved methods as recommended by the manufacturer) will be permitted as approved by the ENGINEER.
2. Orientation. Holes shall be drilled at the orientations and inclinations shown on the plans or as directed by the ENGINEER. Deviation from those orientations and inclinations shall not exceed five degrees. The CONTRACTOR shall use an angle-measuring device to ensure the required inclinations.
3. Cleaning of Drill Holes. Each hole shall be cleaned of all drill cuttings, sludge, and debris by means of compressed air introduced at the back of the hole prior to placement of the grout.
4. A minimum of three centralizers shall be placed on each bar to position the thread bar within one inch of the center of the drill hole. The centralizers shall be placed within two feet from the top and bottom of the drill hole. The maximum center-to-center spacing of the centralizers shall be ten feet. The centralizers shall be attached securely to the thread bars so they will not shift during handling or insertion into the drill hole yet will still allow grout tremie pipe insertion to the bottom of the drill hole and allow grout to flow freely up the hole. After the drill hole is cleaned and the thread bar is properly placed in the hole, Rock Reinforcement (Number 10) which shall be grouted in two phases. The first phase of grouting shall be limited to the bond length; the second phase of grouting shall be the free stressing length. Grouting of the free stressing length shall not be performed until after the Rock Reinforcement (Number 10) is load tested and locked-off at the design load. The CONTRACTOR shall promptly remove any excess grout from the rock face.
5. Thread bars used for the installation of rock reinforcement shall be extended through the bearing plate to ensure a sufficient bar length for installation of the anchorage hardware. A flat washer shall be placed between the bearing plate and nut. Where necessary, additional beveled washers shall be used to ensure uniform bearing between the nut and the bearing plate.
6. Split-set wedge anchors and wire mesh will be placed around each anchor rock bolt.

a. Three split-set anchors, each 48 inches long, shall be placed a maximum of 4 (four) feet from the main anchor bolt position in a triangular pattern. Drilling length forType SS-33 stabilizer split set shall be with a hydraulic or percussive drill with a bore diameter of 2-5/8 inch operating at 90 psig to have sufficient impact. Drill each borehole at least 2 -inches beyond the length of the split set. Use manufacturer-provided driver tool attached to drill chuck to install the split set and bearing plate.

b. Each group of three split set anchors will retain a minimum of 16 square feet of twisted wire mesh centered around the anchor bolt to keep fractured rock on the exposed surface from raveling out from under the anchor bolt plate. Split set anchor plates are to be installed with uniform contact made with both the rock face and the wire mesh, such that the wire mesh is held securely against the rock face. Split sets that do not make sufficient contact between the plate and rock face shall be removed and replaced.

E. The CONTRACTOR shall perform all testing of Rock Reinforcement as specified, or as directed by the ENGINEER and as required for the safe prosecution of the work. At least one (1) set of three (3) grout cubes shall be made for each grout pump and each work shift or as directed by the ENGINEER. Compression tests shall be performed at three (3) days according to ASTM C109. Test locations shall be determined by the ENGINEER.

F. Testing and Stressing Equipment.

1. Testing equipment shall include stressing jack, hydraulic pump, pressure gage, and a reaction frame. The CONTRACTOR shall furnish at least one set of laboratory calibrated stressing equipment for use in conducting these tests. Each set of stressing equipment shall consist of a suitably sized hydraulic ram, hydraulic pump (hand or electric) with pressure indicator (either a digital indicator, or analog pressure gauge with maximum 100-psi graduations), two dial gauges or displacement indicators capable of reading an increment of 0.001 inch over a range of 2 inches, an extension bar and couplers, and associated hardware for testing the Rock Reinforcement.
2. The hydraulic pump shall be calibrated by an independent laboratory as a system with the stressing jack and pressure indicator prior to field use. The stressing equipment shall be calibrated every 90 days throughout the duration of the Work. A calibrated master pressure indicator shall be kept on the site to periodically check the test pressure indicator.
3. The stressing jack, bearing plates, and reaction frame shall be aligned with the Rock Reinforcement such that unloading and repositioning of the stressing equipment will not be required during the test. The stressing equipment shall be placed over the Rock Reinforcement system in such a manner that the stressing jack, bearing plates, and anchorage are axially aligned with the Rock Reinforcement and the Rock Reinforcement is centered within the equipment.
4. Required test data shall be recorded by the CONTRACTOR. Testing and stressing shall not be conducted until the grout has attained at minimum the specified 3-day compressive strength. Required Rock Reinforcement testing shall be conducted within 30 days of installation or as approved by the ENGINEER.
5. After a Rock Reinforcement has been accepted by the ENGINEER, the unneeded portion beyond the anchorage may be cut, if not otherwise required for use in re-testing. Cutting shall be done according to the bar manufacturer's recommendations and as approved by the ENGINEER. Care shall be taken not to damage the thread bar. The Rock Reinforcement shall not be cut using a torch or other device which in the opinion of the ENGINEER might affect the tensile strength of the thread bar. The exposed end, including bearing plate, shall be coated with epoxy paint prior to grouting.

6. Pull Testing for the SS-33 shall be performed using equipment (cylinder, gage, pump, hose, adapters, etc.) specifically designed for connecting to the split set. For SS-33 stabilizer split sets, with the bushing removed, the claw adapter is slid over the pull collar which has been installed with the stabilizer. When the housing and cylinder are raised, the bushing can be inserted between the nut and the cylinder. The nut is then tightened to take up slack. The pump is then actuated to raise cylinder pressure, pulling the stabilizer slightly out of the hole through the bearing plate. Maximum gage reading at slip indicates the holding force. The device can be used for slip loads up to 12 US tons (10.9 metric tons).

G. Testing - Rock Reinforcement (Number 10). All Rock Reinforcement (Number 10) shall be proof tested as described in this special provision. Testing to be performed at a frequency of 1 out of every 4 of the Rock Reinforcement (Number 10) installed.

1. Proof Test.
   a. At load increments other than maximum test load, the load shall be held long enough to obtain a stable reading.
   b. Incremental loading for proof tests shall be in accordance with the following loading schedule.

PROOF TEST LOADING SCHEDULE

Load	Hold Time
AL	Obtain Reading
0.25DL	Obtain Reading
0.50DL	Obtain Reading
0.75DL	Obtain Reading
1.00DL	Obtain Reading
1.20DL	Obtain Reading
1.33DL	Obtain Reading
Creep test	2 min
	3 min
	4 min
	5 min
	6 min
	10 min
AL DL	1 min Lock-off

AL – Alignment Load
DL – Design (Lock-off) Load
1.33DL – Maximum Test Load

   c. The Rock Reinforcement movement shall be measured and recorded to the nearest 0.001 inch at each load increment and at the specified time intervals for the creep phase. The alignment load (AL) should be the minimum load required to align and stabilize the stressing equipment and should not exceed five percent of the Design Load (DL). The lock-off load shall be as directed by the ENGINEER.
   d. Depending on the observed test performance, either a 10-minute or 60-minute creep test shall be performed at the maximum test load of 1.33 DL.
      1) The creep period shall start as soon as the maximum test load of 1.33DL is applied and the Rock Reinforcement movement shall be measured and recorded at 1 minute, 2, 3, 4, 5, 6 and 10 minutes.

2) If the Rock Reinforcement movement between 1 minute and 10 minutes exceeds 0.04 inch based on the average of the two dial gauges or displacement indicators, the maximum test load of 1.33 DL shall be maintained an additional 50 minutes and movement shall be recorded at 15 minutes, 20, 25, 30, 45, and 60 minutes.

2. Proof Test Rock Reinforcement Acceptance Criteria. Proof test results shall be submitted to the ENGINEER for review. A Rock Reinforcement will be considered acceptable when the following conditions are met for the proof test:
   a. Total creep movement is less than 0.04 inch measured between the 1 and 10 minute readings or total creep movement of less than 0.08 inch is measured between the 6 and 60 minute readings.
   b. The total measured movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the test reinforcement free stressing length.
   c. Pullout failure does not occur at the maximum test load of 1.33DL.
      1) Pullout failure is defined as the load at which attempts to further increase the test load simply result in continued pullout movement of the Rock Reinforcement.
      2) The pullout failure load shall be recorded as part of the test data.
   d. Successful tested Rock Reinforcements meeting the above proof test acceptance criteria may be incorporated as production Rock Reinforcements.
3. Proof Test Rock Reinforcement Rejection. If the ENGINEER determines that the pullout failure of the Rock Reinforcement was caused by the installation methods or materials, the ENGINEER may require the CONTRACTOR to replace some or all of the installed production Rock Reinforcements between a failed proof test Rock Reinforcement and the adjacent passing proof test Rock Reinforcement.
   a. Alternatively, the ENGINEER may require the installation and proof testing of additional Rock Reinforcements.

H. Installation and testing of additional proof test Rock Reinforcements or installation of additional or modified Rock Reinforcements as a result of proof test failure will be at no additional cost to the OWNER.

3.4 METHOD OF MEASUREMENT

A. Rock scaling: Rock scaling will be measured by the total number of hours spent on this bid item that are not incidental to any other bid item. Paid hours shall be the amount of time spent for the following activites:
   1. Removal of material from the slope as shown in the plans or as directed by the ENGINEER,
   2. Setting required safety anchors
   3. Setting up equipment related to the use of “air bags” for scaling (including air compressors)
   4. Time spent on the slope and roadway for the clearing of traffic
   5. The time to ascend to and descend from the access point for the work area to be scaled will not be measured and paid separately, but shall be considered incidental to the work, unless approved by the ENGINEER.

B. Rock Reinforcement installation: Rock Reinforcement (Number 10) will be measured by each reinforcement installed, tested and accepted. Included in this item is the twisted wire mesh and 3 split set stabilizers for each Rock Reinforcement installed.
   1. All testing for Rock Reinforcement will not be measured and paid for separately but shall be included in the work.

3.5 BASIS OF PAYMENT

A. Rock scaling:
   1. Payment will be made under:
      a. Pay Item: Rock Scaling
      b. Pay Unit: Hour

2. Payment for Rock Scaling will be only for the work that is as shown on the plans and as otherwise directed by the ENGINEER. Scaling to stabilize and improve CONTRACTOR safety in rock excavation areas will not be paid, but is included in the item Rock Excavation (Special).
3. All tools and equipment required to complete Rock Scaling work, including air compressor or air canisters and other equipment required for using air bags, including the air bags, shall be included in the Pay Item – Rock Scaler. Payment will not be made for equipment usage, but all equipment usage will be included in the cost of the work.
4. Payment will not be made for Rock Scaling conducted in areas outside those shown on the plans or areas not approved by the ENGINEER.
5. Payment will not be made for Rock Scaling performed solely for the purpose of worker safety, unless approved by the ENGINEER.
6. Scaling Supervisor hours will not be measured and paid for separately but shall be included in the work.

B. Rock Reinforcement installation
1. The accepted quantity of work will be paid for at the contract price per unit of measurement for the pay items listed below. Payment will be made under:
   a. Pay Item: Rock Reinforcement
   b. Pay Unit: Each
2. All labor, equipment, materials, and testing including jacking ram, dial gauges, chairs, grout, and any other item included in providing Rock Reinforcement (Number 10), split set stabilizer or twisted wire mesh will not be measured and paid for separately but shall be included in the work.
3. All materials including bearing plates, washers, nuts, centralizers or spacers, couplers, grout, epoxy coating, paint, lifting equipment and any other items necessary for the installation of Rock Reinforcement (Number 10) thread bar systems, split set anchors or twisted wire mesh will not be measured and paid for separately but shall be included in the work.

END OF SECTION

DIVISION 32

EXTERIOR IMPROVEMENTS

SECTION 32 90 00
RESTORATION AND SEEDING

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Establishing Test Plots to support reclamation activities including:
   1. Assessing soil chemistry of growth medium materials to determine fertilizer and amendment needs.
   2. Assessing different mixtures of growth medium materials by evaluating success in establishing vegetation in the test plots.

B. Reclaiming disturbed areas within the limits of site disturbance. Disturbed areas include:
   1. Excavation cut slopes.
   2. Fill slopes.
   3. Regraded slopes.
   4. Areas disturbed as a result of the installation of the erosion protection and sediment control measures.
   5. Sediment pond.

1.2 RELATED SECTIONS

A. SECTION 31 10 00 SITE CLEARING.

B. SECTION 31 25 00: EROSION PROTECTION AND SEDIMENTATION CONTROL.

1.3 DEFINITIONS

A. Reclaiming disturbed areas shall mean regrading, hauling, placing and spreading growth medium materials; applying fertilizers, soil amendments and seed; applying mulch and/or mulch stabilizers and maintaining all seeded areas.

B. Subsoils shall mean onsite existing fill or overburden, consisting of fine-grained soils or weathered, fine-grained, residual sedimentary rock materials.

C. Soil amendments shall mean a local source of peat, manure, compost, biosolids or other organic materials as approved by the OWNER.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Reclamation Plans showing sequence and limits of site reclamation.
   2. Test Plot Plan showing location, layout, plans and details of test plots.

B. Products:
   1. Tags from all seed and soil amendment materials shall be provided to and approved by the OWNER.
   2. Certificate of analysis and weight for all commercial fertilizers.

C. Samples:
   1. Onsite subsoils proposed for reclamation.
   2. Soil amendments proposed for reclamation, taken at the source.

D. Soil Testing:
   1. Soil testing results from Colorado State University Soil, Water and Plant Testing Laboratory:
      a. Onsite subsoils.
      b. Soil amendments.

1.5 QUALITY ASSURANCE

A. Qualifications: Demonstrate CONTRACTOR or SUBCONTRACTOR education, training, and experience in revegetation, reclamation, and satisfactory performance on three similar projects within the past five years or as approved by the OWNER.

1.6 PROTECTION

A. Protect from erosion damage caused by other construction.

B. Reclaim any disturbance of vegetation or native ground outside of the limits of site disturbance.

PART 2 - PRODUCTS

2.1 SUBSOIL

A. Subsoil shall be as defined in this specification.

B. Subsoil shall be from on-site stockpiles representative of material to be generated during test plot development and reclamation. Subsoils shall be consistent with on site materials observed supporting vegetation.

C. Subsoil shall not contain toxic materials harmful to vegetation growth.

D. Subsoil used for test plots shall be stockpiled and thoroughly mixed prior to placement in the four plots, to provide uniform, consistent, materials for all plots.

2.2 SOIL AMENDMENTS

A. Soil amendments shall be as defined in this specification.

B. Soil amendments shall be from a local source of material to be generated during test plot development and reclamation.

C. Caked or lumpy soil amendments will not be accepted.

D. Manure shall be dry cow, horse or sheep manure that has been stockpiled a minimum of one (1) year. Manure shall not be so caked or lumpy that it cannot be spread uniformly.

E. Compost manure shall be stabilized through at least one heating cycle (120 to 140 F degrees), turned at least once, and windrow for at least 45 days and stockpile for a least 2 months.

F. Biosolids or compost biosolids, containing municipal biosolids, shall meet Colorado Department of Public Health and Environment Water Quality Control Commission 5 CCR 1002-64 Biosolids Regulation No. 64, including permitting and regulatory approval procedures.

G. Soil amendments shall not contain pathogens or toxic materials harmful to human health or vegetation growth.

2.3 INORGANIC FERTILIZERS

A. Commercial grade nitrogen, phosphorus, or other inorganic based fertilizer.

B. Free flowing, suitable for application with hydraulic- or pneumatic-type equipment or fertilizer spreaders and conforming to applicable Colorado State Fertilizer laws.

C. Fertilizer types and application rates to be determined base on soil testing results.

2.4 SEED

A. Weeds classified by Colorado Department of Agriculture as noxious weeds in accordance with the Noxious Weed Act:
   1. List A and List B noxious weed species: None
   2. List C weed species: 0.5 percent maximum, by weight.

B. Seed containers: Sealed and labeled to comply with Colorado State Seed Laws and Regulations or in accordance with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act, if shipped in Interstate Commerce.
   1. Identify seed origin on label. Each delivery shall be accompanied by seed bag tags or equivalent. Tags shall show the guaranteed percentages of purity, weed content germination, net weight, date of seed testing, and date of shipment.
   2. Seed Mixture:
      a. Purity: 85 percent minimum.
      b. Germination:
         1) 85 percent minimum
         2) Germination test less than 1 year old at time of seeding.
      c. Uniform mixture shown in
      d. Table 32 90 00.1 – Upland Seed Mixture.

TABLE 32-90 00.1 – NATIVE SEED MIXTURE – 5,500 - 7,000 FEET ELEVATION

Common Name	Species Name	Variety	% of Mix	#PLS/ Acre
Canada Wildrye	*Elymus canadensis*	Mandan	12	3.64
Blue Grama	*Bouteloua gracilis*	Native, Alma, or Hachita	14	0.59
Slender Wheatgrass	*Elymus trachycaulus*	San Luis or First Strike	10	2.19
Squirrel Tail	*Elymus elymoides*	Pueblo	12	2.18
Thickspike Wheatgrass	*Elymus trachycaulus*	Critana	10	2.26
Sandberg Bluegrass	*Poa secunda*	Colorado Plateau	5	0.38
Switchgrass	*Panicum virgatum*	Blackwell or Nebraska 28 or BOCO	9	0.81
Green Needlegrass	*Stipa viridula*	Lodorm or Native	8	1.54
Fringed Sage	*Artemesia frigida*	VNS	4	0.03
Hairy Golden Aster	*Heterotheca viliosa*	VNS	5	0.20
Rocky Mtn. Bee Plant	*Cleome serrulata*	VNS	4	2.12
Rabbitbrush	*Ericameria nuaseousus*	VNS	7	0.61
		Totals:	**100**	**16.55**

2.5 MULCHES

A. Mulch shall consist of native grass hay:
   1. Certified noxious weed free.
   2. Approximately 30 percent by weight of the mulch material shall be ten inches (10") in length or longer.
   3. Rotted, caked, decayed or moldy material will not be accepted.

PART 3 - EXECUTION

3.1 TEST PLOTS

A. Develop test plots using the soil types and slopes anticipated for reclamation. The test plots shall be seeded in the fall and maintained for a minimum of two seasons.

B. Test Plot Size:
   1. Test Plots shall be 30 by 30 foot plots, subdivided into two 15 ft. X 30 ft. subplots, allowing testing of two variables per plot.

C. Test Plot Location and Orientation:
   1. To facilitate reclamation schedule considerations, test plots shall be located such that they do not interfere with reclamation earthwork. Test plots shall be located as near to the reclamation area as practical. Test plots shall be established at the same elevation and aspect (northeast facing slopes and northwest facing slopes) as the reclamation slopes.

D. Test Plot Protection
   1. Secure test plots with wire fencing (minimum 10 feet height) to keep wildlife out. The fence will have a gate for access.

E. Test Plots Setup:
   1. Developed four test plots with two subplots per test plot (8 total subplots) (Table 32 90 00.2 – Test Plot Setup).
   2. Select soil amendments. Use only a single soil amendment type in a subplot. Soil amendment types shall not be mixed.
   3. Test plots treatments are as follows:
      a. All treatments require placement of on-site subsoil representative of material to be generated during reclamation and consistent with the material observed supporting vegetation at the site.
      b. Treatment 1 (T1) – 12 inches of subsoil only.
      c. Treatment 2 (T2) – 12 inches of subsoil with 5 percent by volume amendments. Amendment source will be either compost or biosolids.
      d. Treatment 3 (T3) – 12 inches of subsoil with 15 percent by volume amendments
      e. Treatment 4 (T4) – 12 inches of subsoil with inorganic fertilizer
   4. Soil amendments shall be thoroughly and uniformly mixed with subsoil.
   5. Determine inorganic fertilizer types and application rates based on subsoil test results from Colorado State University.
   6. Fertilizer will only be added to T4 plots. However, if soil test reports recommend other soil amendments (e.g. addition of lime), OWNER will evaluate the need for adding amendments to all plots at same rate.

F. Test Plot Preparation and Seeding
   1. Following placement of subsoil and amendments, surface shall be lightly scarified to allow for suitable surface bed for receiving seeds.
   2. Seeds shall be broadcast using a calibrated hand spreader or similar calibrated seed spreading device and applied at recommended rates.
   3. Mulch using native grass hay (certified noxious weed-free). The mulch will be applied so it is dense enough to shade the soil and prevent wind desiccation, but not so dense as to retard grass seedling emergence. Properly applied hay mulch should form a porous layer with some soil still visible. This thickness of mulch should correspond to an application rate of 2 tons per acre. Any type of hay or straw will be crimped into the soil to minimize loss of hay by wind or water erosion.

4.

TABLE 32-90 01 – TEST PLOT SETUP

Test Plot	1		2		3		4	
Subplot	1A	1B	2A	2B	3A	3B	4A	4B
Subsoil (inches)	12	12	12	12	12	12	12	12
Amendments (Percent by volume)	None	5	15	None	None	15	5	None
Inorganic fertilizer	None	None	None	None	Per Recom.	None	None	Per Recom.
Treatment	T1	T2	T3	T1	T4	T3	T2	T4

Treatments:
T1 – 12 in. of subsoil only, subplots 1A and 2B
T2 – 12 in. of subsoil with 5 percent volume amendments, subplots 1B and 4A
T3 – 12 in. of subsoil with 15 percent volume amendments, subplots 2A and 3B
T4 – 12 in. of subsoil with inorganic fertilizer 2A and 4B

Volume Calculations:

1 foot thick subsoil on 15 X 30 ft. plot is 450 ft^3 or 17 yd^3 per subplot. 17 yd^3 X 8 subplots = **136 yd^3 total subsoil**
5 percent amendments = 0.05 X 17 yd^3 = 0.9 yd^3 per subplot X 2 subplots = 1.8 yd^3
15 percent amendments = 0.15 X 17 yd^3 = 2.6 yd^3 per subplot X 2 subp0lots = 5.2 yd^3
Total amendments volume = 1.8 + 5.2 yd^3 = **7 yd^3 total amendments**

G. Test Plot Irrigation
   1. No irrigation is required if seeding is done in fall (a spring seeding is feasible only if ground is wet and there is sufficient moisture to obtain germination).

H. Test Plot Monitoring
   1. Test plots shall be monitored twice per year, spring and fall. Monitoring activities include:
      a. Photographs of plots and plants
      b. Vegetative survey that includes identification of plant types, plant heights, plant density, overall vegetation density, presences of weeds.

I. Test Plot Soil Testing
   1. Samples shall be collected in the fall for each plot and tested for routine soil nutrient assessment by Colorado State University including major plant nutrients and micronutrients.

3.2 GENERAL

A. The general order of execution shall be:
   1. Test plot development and soil amendment determination
   2. Amended subsoil placement
   3. Seedbed preparation
   4. Seed application
   5. Mulch application
   6. Maintenance

B. Seeding shall be accomplished between September 1 and May 1. No seeding shall take place when soils are frozen, snow covered, or excessively wet or dry, or when wind velocities prevent uniform application of the materials.

C. Grade all areas to drain. The maximum slope steepness shall be 2H:1V unless otherwise shown on the Drawings or approved in writing by OWNER.

D. Remove all CONTRACTOR'S equipment, debris, office, temporary fences or gates, and all other CONTRACTOR'S properties.

E. Eliminate uneven areas and low spots. Remove debris, roots, branches and stones in excess of 3-inch size.

F. Scarify and loosen subgrade soil to a minimum depth of 3 inches where amended subsoil is required. Scarify and loosen areas to receive seed that have been disturbed or compacted by equipment.

3.3 PLACING SUBSOIL

A. Place subsoil over all areas disturbed during construction.

B. Spread subsoil evenly over the disturbed area, or as required by OWNER.

C. Do not place subsoil in water or while frozen or muddy conditions exist.

D. Grade final surface of the amended subsoil to a relatively smooth surface using mechanical or hand raked methods. There shall not be any localized low spots that will allow water to accumulate.

3.4 FERTILIZERS AND SOIL AMENDMENTS

A. Immediately prior to seedbed preparation, fertilizers and amendments shall be uniformly applied over the areas designated for seeding and immediately incorporated into the soil by tilling methods as discussed below. Commercial fertilizer and soil amendments shall be applied at the rates indicated by the results of the test plots.

B. Cultivate soil amendments into top 6-inches of soil.

C. Organic Compost Soil Amendment shall be applied at a maximum rate of three (3) cubic yards per one-thousand (1,000) square feet. Actual application rates will be deterimined by the results of the test plots.

D. Commercial Fertlizer Amendment shall be applied at a maximum rate of three-hundred (300) lbs. per acre. Actual application rates will be deterimined by the results of the test plots.

3.5 SEED BED PREPARATION

A. The seedbed shall be firm and any trash, weeds or other debris that could interfere with seeding operations shall be removed and disposed of as approved by OWNER.

B. Where equipment can operate, the seedbed shall be adequately loosened four to six inches (4" to 6") deep and smoothed. Chiseling, discing, harrowing or cultipacking may be required. Work shall be done on the contour where practicable.

C. Where equipment cannot operate, the seedbed shall be hand raked or otherwise prepared by hand by scarifying to a minimum depth of one inch (1") to provide a roughened surface so that seed will stay in place.

D. Seedbed preparation shall be suspended when soil moisture conditions are not suitable for the preparation of a satisfactory seedbed as determined by OWNER.

3.6 SEED APPLICATION

A. Apply seed by broadcast seeding within 10 days following soil preparation.
   1. Apply seed mixture at rate specified in Table 32 90 00 – Seed Mixture.

B. Broadcast seeding:
   1. Mechanical broadcasting:
      a. Equipment:
         1) Centrifugal type.
         2) Pull type similar to fertilizer spreader.
      b. Designed and regulated to apply seed uniformly at proper rate per acre.

2. Hand Broadcasting:
    a. By hand broadcaster.
    b. By hand.
    c. Uniformly applied.
3. Cover seed with soil to depth of ¼-inch to ½-inch immediately after broadcasting.
    a. Use hand rake or float.
    b. Do not use log chain or similar device.

3.7 MULCHING

A. Native grass hay mulch shall be applied uniformly at the rate of two (2) tons per acre over seeded areas. Hydromulch (with 150 gal/acre tackifier emulsion) shall be applied at the rate of one and a half (1-1/2) tons per acre. Mulch shall be applied to the designated areas immediately after seeding and not later than 24 hours after seeding has been performed. Mulching shall not be done when the wind velocity exceeds fifteen (15) miles per hour.

3.8 STABILIZING MULCH

A. On areas flatter than 3H:1V, unless prohibited by access or topography, a mulch crimper shall be used to stabilize or anchor the mulch into the soil after mulch has been spread. The crimper shall be equipped with scrapers to keep the blades clean. Spacing of crimper blades shall not exceed nine inches (9").

B. On areas steeper than 3H:1V, hydromulch shall be applied.

C. On areas where access or topography prohibits machine mulching or hydromulching, crimping shall be achieved by hand with a suitable tool, such as a spade, on 18" centers, or the mulch shall be tied down with properly anchored jute netting.

3.9 IRRIGATION

A. No irrigation is proposed assuming seeding is done in fall (a spring seeding may be feasible if done when ground is wet and there is sufficient moisture to obtain germination).

B. The sedimentation pond is to remain in place until the end of reclamation in order to provide irrigation if deemed necessary.

C. If irrigation is determined to be necessary for germination success, the estimated amount of water necessary to water planted grasses would be 0.2 to 0.8 acre feet to establish vegetation with the goal of no watering once plants are established. The focus of revegetation is native plant species adapted to area climate. The water would be pumped from the existing pond at rates of 40 to 80 gallons per minute, depending upon the irrigation system setup, season, and weather conditions.

3.10 MAINTENANCE AND PROVISIONAL ACCEPTANCE

A. The CONTRACTOR shall keep all seeded areas in good condition during the construction season, reseeding and mulching if and when necessary until growth is established over the entire area seeded, CONTRACTOR shall maintain these areas in an approved condition until provisional acceptance.

B. On slopes, the CONTRACTOR shall prevent washouts by an approved method. Any washout which occurs shall be regraded and reseeded at no additional expense to OWNER. Maintain seeded area until vegetation is established.

C. The OWNER will inspect all work for provisional acceptance during the following construction season, upon the written request of the CONTRACTOR, received at least 10 days before the anticipated date of inspection.

D. An area will be considered to be satisfactorily reclaimed when:
1. Soil erosion resulting from the operation has been stabilized.
2. A vegetative cover has been established.

E. The inspection by the OWNER will determine whether maintenance shall continue in any area or manner.

F. After all necessary corrective work and clean-up has been completed, the OWNER will certify in writing the provisional acceptance. The CONTRACTOR'S responsibility for maintenance shall cease on receipt of provisional acceptance.

3.11 GUARANTEE PERIOD AND FINAL ACCEPTANCE

A. All seeded areas shall be guaranteed by the CONTRACTOR for not less than 1 full year from the time of final project acceptance.

B. At the end of the guarantee period, inspection will be made by the OWNER upon written request submitted by the CONTRACTOR at least 10 days before the anticipated date. Areas not demonstrating satisfactory reclamations as outlined above, as determined by the OWNER, shall be renovated, reseeded, and maintained meeting all requirements as specified herein.

C. After all necessary corrective work has been completed, the OWNER shall certify in writing the final acceptance.

END OF SECTION

SECTION 33 40 00
STORM DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Storm drainage pipe.
   2. Inlets and flared end sections.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. M36, Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains (Equivalent ASTM A760/A760M).
      b. M190, Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches.
   2. ASTM International (ASTM):
      a. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   3. Standard Specifications for Road and Bridge Construction for the State of Colorado:
      a. Standard Details.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Certifications.
   4. Test reports.
   5. Submit all tests and certification in a single coordinated submittal.
      a. Partial submittals will not be accepted.

B. Submit schedules and details for structures and joints.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforced Concrete Pipe (RCP):
   1. Reinforced concrete culvert, storm drain and sewer pipe: ASTM C76, Classes III, IV, and V as specified in the project drawings.

B. RCP Joint Sealer:
   1. Rubber gasket: ASTM C361.

C. Flared End Sections:
   1. Conform to State of Colorado Specifications.
   2. Bituminous coated: AASHTO M190, Type A.
   3. Jointing: Same as pipe.

D. Concrete and Reinforcement for Inlets, Manholes, Junction Boxes, Headwalls, and Flumes:
   1. Conform to Drawings and Details.

E. Concrete and Reinforcement for Concrete Flared End Sections:
   1. Conform to Drawings and Details.
      a. Precast reinforced concrete end sections shall have at least one line of reinforcement conforming to the requirements of AASHTO M 170 equivalent to the square inches per linear foot for elliptical reinforcement in circular pipe, Class II, Wall B.

PART 3 - EXECUTION

3.1 PREPARATION

A. Comply with manufacturer's instructions.

B. Comply with Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

A. Verify and coordinate installation.

B. Infiltration Test:
   1. If at any time prior to expiration of the correction or warranty period infiltration exceeds 200 GAL/IN of nominal diameter/mile/day, locate the leaks and make repairs.

C. In case of conflict, do not relocate piping without prior approval from the Engineer.

END OF SECTION

SECTION 32 31 13
CDOT DEER FENCE AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. CDOT Deer fencing and gates. This section shall consist of furnishing and installing new fence and/or removing and salvaging existing fence and restoring the same in conformance with the lines and grades and requirements shown on the DRAWINGS. Wherever the materials to be removed are not in good condition, as judged by the ENGINEER, or wherever CONTRACTOR has damaged the materials during the process of removal, equal or better quality fencing materials than the existing shall be furnished and installed by CONTRACTOR.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 23 00 - Earthwork.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   The following is a list of standards which may be referenced in this section:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. M111M/M111, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. M133, Standard Specification for Preservatives and Pressure Treatment Processes for Timber.
      c. M232M/M232, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      d. M281, Standard Specification for Steel Fence Posts and Assemblies, Hot-Wrought.
   2. ASTM International (ASTM):
      a. A116, Standard Specification for Metallic-Coated, Steel-Woven Wire Fence Fabric.
      b. F537, Standard Specification for Design, Fabrication, and Installation of Fences Constructed of Wood and Related Materials
   3. Federal Specification (FED): FCGS-02-1, Fencing, Wire and Post, Metal (Chain-link Fence Posts, Top Rails and Braces).

B. Qualifications:
   1. Installer bonded and licensed in the Project state.
   2. Installer shall have a minimum two years' experience installing similar fencing.
   3. Utilize only AWS certified welders.

1.3 DEFINITIONS

A. NPS: Nominal pipe size, in inches.

B. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
    1. Acknowledgement that products submitted meet requirements of standards referenced.
    2. Manufacturer's installation instructions.
3. Scaled plan layout showing spacing of components, accessories, fittings, and post anchorage.
4. Mill certificates.
5. Source quality control test results.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
    1. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Welded Wire Fabric:
1. Fabric type:
    a. Conform to AASHTO M 279 (ASTM A116)Design # 2096-6-12.5, Grade 60, Coating type ZA, Coating Class 80.
2. Wire gage: 12.5
3. Mesh size: 6 IN.

B. Concrete:
1. ASTM C150 Type I.
2. 1 IN maximum size aggregate (ASTM C33).
3. Clean water.
4. Minimum 28-day compressive strength of 2500 PSI.
5. Not less than four sacks of cement per cubic yard.
6. 3 IN minimum slump.
7. 2 to 4 PCT entrained air.

C. Line Post:
1. Treated 5 in diameter timber

D. Corner or Terminal Posts:
1. Treated 6 in diameter timber

E. Tension Wire:
1. Top of fabric:
    1. Continuous line wire shall be high tensile (175 K min), Fixed know 13 gauge wire (60K min.) shall connect line wire with vertical stay wire.

F. Fence Fittings (Post and Line Caps, Rail and Brace Ends, Sleeves-Top Rail, Tie Wires and Clips, Tension and Brace Bands, Tension Bars, Truss Rods):
1. ASTM F626.

G. Swing Gate:
1. ASTM F900.
2. Materials as specified for fence framework and fabric.
3. Hardware:
    1. Galvanized per ASTM A153/A153M.
    2. Hinges to permit 90 DEG in and out gate opening.
    3. Provide heavy duty brass padlock with 2 keys.

2.2 SOURCE QUALITY CONTROL

A. Test related fence construction materials to meet the following standards:
   1. Posts and rails: ASTM F1043, Heavy Industrial.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with:
   1. Manufacturer's instructions.
   2. Lines and grades shown on Drawings.
   3. ASTM F567.

B. Do not start fence installation before final grading is complete and finish elevations are established.

C. Drill holes in firm, undisturbed or compacted soil.

D. Place fence with bottom edge of fabric at maximum clearance above grade, as shown on Drawings.
   1. Correct minor irregularities in earth to maintain maximum clearance.

E. Line brace posts shall be spaced at 400 ft. Intervals, where fencing is continuous and where end, corner & line brace posts are not specified.

F. Space line posts at equal intervals not exceeding 10 FT OC.

G. Provide post braces for each gate, corner, pull and terminal post and first adjacent line post.

H. Install tension bars full height of fabric.

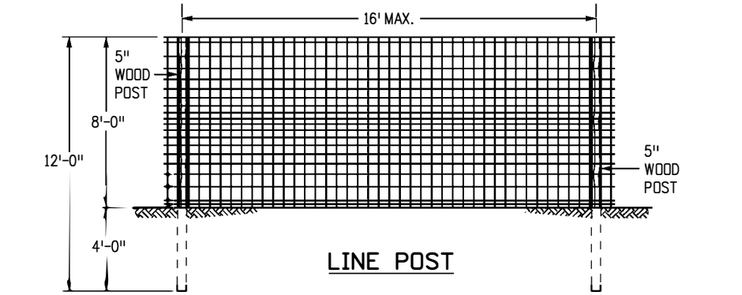
I. All fence wire ties, brace wires, staples and other wire appurtenances shall be galvanized in conformance with MSHTD M 23 2.

J. Pull fabric taut and secure to posts and rails.
   1. Secure so that fabric remains in tension after pulling force is released.
   2. Secure to posts at not over 15 IN OC, and to tension wire at not over 24 IN OC.
   3. Bend ends of wire to minimize hazards to persons or clothing.

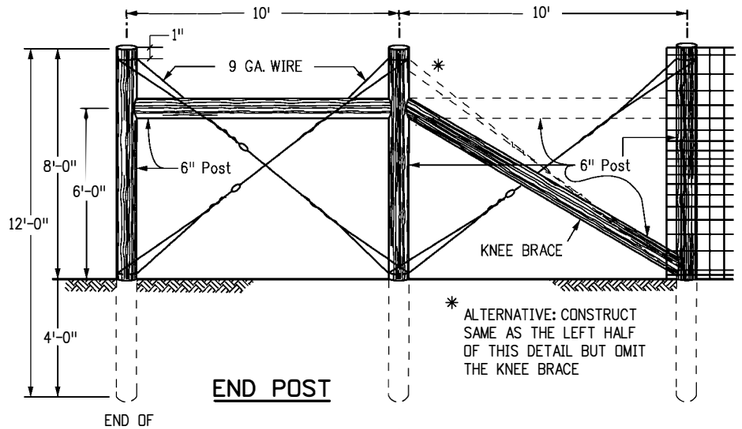
K. Install post top at each post.

L. Gates:
   1. Construct with fittings or by welding.
   2. Provide rigid, weatherproof joints.
   3. Assure right, non-sagging, non-twisting gate.
   4. Coat welds with rust preventive paint, color to match pipe.

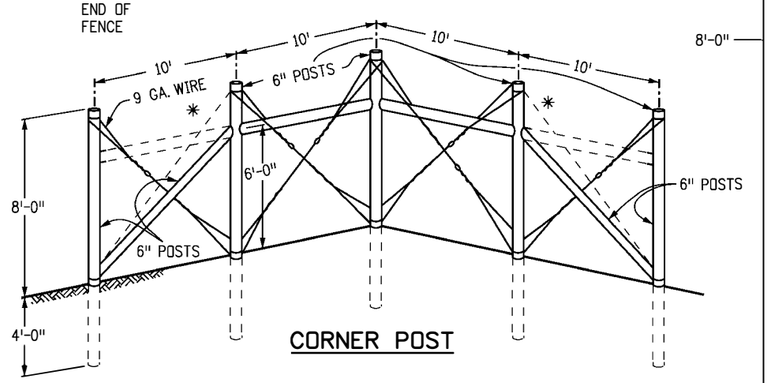
END OF SECTION



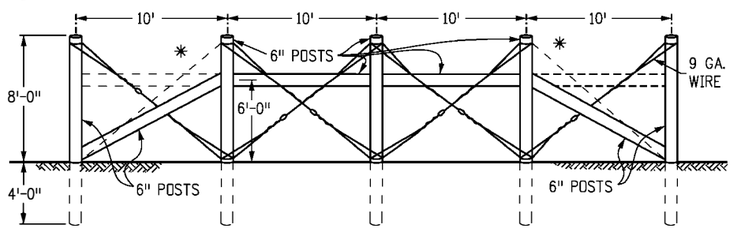
LINE POST



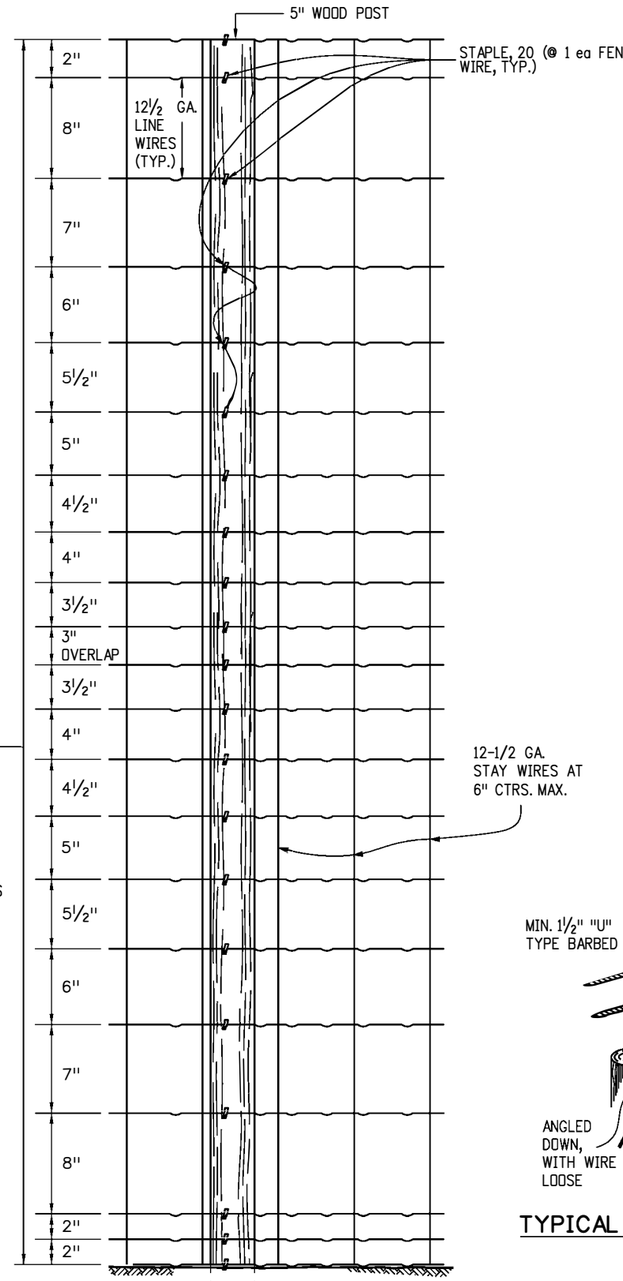
END POST



CORNER POST



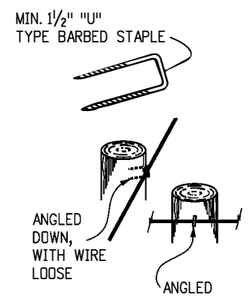
LINE BRACE POST



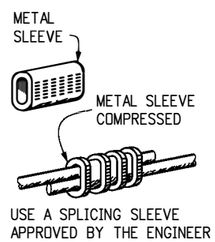
DEER FENCE WIRE FABRIC

GENERAL NOTES

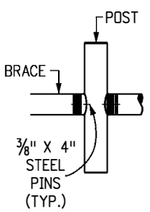
1. AT EACH LOCATION WHERE AN ELECTRIC TRANSMISSION, DISTRIBUTION OR SECONDARY LINE CROSSES A BARRIER FENCE, THE CONTRACTOR SHALL FURNISH AND INSTALL A GROUND CONFORMING TO ARTICLE 250 OF THE NATIONAL ELECTRICAL CODE. THE GROUND ROD SHALL BE A MINIMUM DIAMETER OF ½ IN. AND 8 FT. IN LENGTH, AND DRIVEN AT LEAST 7½ FT. INTO THE GROUND. THE ROD SHALL BE CONNECTED TO EACH WIRE WITH A MINIMUM AWG NO. 8 STRANDED COPPER WIRE. GROUNDING WILL NOT BE PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE WORK.
2. END POST, CORNER POST, AND LINE BRACE POST SHALL BE ASSEMBLED BY THE UNIT AND PAID FOR AS SUCH. ALL WORK AND MATERIAL ASSOCIATED WITH EACH ASSEMBLY, SHALL BE INCLUDED IN THE UNIT PRICE FOR THAT ASSEMBLY.
3. LINE BRACE POSTS SHALL BE SPACED AT 400 FT. INTERVALS, WHERE FENCING IS CONTINUOUS AND WHERE END, CORNER & LINE BRACE POSTS ARE NOT SPECIFIED.
4. ALL LINE POSTS SHALL BE 5 IN. MIN. DIAMETER AND 12 FT. LONG. ALL END, CORNER AND LINE BRACE POSTS SHALL BE 6 IN. MIN. DIAMETER AND 12 FT. LONG. ALL POSTS AND BRACES SHALL BE TREATED IN ACCORDANCE WITH SUBSECTION 710.07.
5. FENCE WIRE MAY BE PLACED ON EITHER THE ROAD SIDE OR THE FIELD SIDE OF POSTS, DEPENDING ON LOCAL CONDITIONS; i.e., ON CURVES, THE WIRE SHOULD BE PLACED ON THE SIDE WHICH WOULD RESULT IN THE LEAST AMOUNT OF TENSION ON THE STAPLES. THIS ALSO APPLIES WHERE WIND DRIFT OR OTHER CONDITIONS WOULD EXERT UNUSUAL PRESSURE AGAINST THE WIRE.
6. WHERE CONCRETE STRUCTURES ARE USED AS A DEER PASS, THE FENCE SHALL END AT EYEBOLTS IN WINGS OF THE STRUCTURE. EYEBOLTS IN FRESH CONCRETE SHALL BE MADE OF ½ IN. ROUND BARS AND EMBEDDED A MINIMUM OF 6 IN. WITH A HOOKED OR BENT END. IN EXISTING CONCRETE, THE ½ IN. ROUND BARS SHALL BE DEFORMED AND GROUTED INTO DRILLED HOLES. EYEBOLTS SHALL HAVE A MINIMUM OF 1 IN. INSIDE EYE DIAMETER AND SHALL BE FURNISHED AND INSTALLED BY THE CONTRACTOR. COST OF EYEBOLTS SHALL BE INCLUDED IN THE CONTRACT PRICE FOR FENCING.
7. WOVEN WIRE FENCE FABRIC SHALL CONFORM TO AASHTO M 279 (ASTM A 116). DESIGN NO. 2096-6-12½, GRADE 60, COATING TYPE ZA, COATING CLASS 80.
8. ALL FENCE WIRE TIES, BRACE WIRES, STAPLES AND OTHER WIRE APPURTENANCES SHALL BE GALVANIZED IN CONFORMANCE WITH AASHTO M 232.
9. THE CONTRACTOR SHALL RE-ESTABLISH DISTURBED OR DESTROYED SURVEY MONUMENTS TO THE APPROPRIATE ACCURACY IN ACCORDANCE WITH SUBSECTION 625.08 OF THE STANDARD SPECIFICATIONS.
10. CONTINUOUS LINE WIRE SHALL BE HIGH TENSILE (175 K MIN.). CONTINUOUS STAY WIRE SHALL BE MID-TENSILE (125 K MIN.). FIXED KNOT 13 GAUGE WIRE (60K MIN.) SHALL CONNECT LINE WIRE WITH THE VERTICAL STAY WIRE.
11. DEER GATE AND TOP BRACES SHALL BE PAINTED WITH GREEN PAINT ACCORDING TO SUBSECTION 708.03 AND COLOR NO. 14109 OF FEDERAL STANDARD 595B.



TYPICAL STAPLING



WIRE SPLICE



BORE A ⅜" X 2" HOLE IN EACH BRACE AND POST TO RECEIVE THE PINS. WRAP THE ENDS OF THE BRACES WITH SEVERAL TURNS OF 12-½ GAGE SMOOTH GALV. WIRE TO PREVENT SPLITTING. OR: NOTCH POST AND NAIL WITH 40d COMMON NAILS

CROSS BRACE DOWELING

Computer File Information		Sheet Revisions	
Creation Date: 07/04/12 Initials: DLM		Date:	Comments
Last Modification Date: 04/30/15 Initials: LTA	(R-X)	04/30/15	Created new M Standard: M-607-4 - Deer Fence, Gates, and Game Ramps
Full Path: www.coloradodot.info/business/designsupport	(R-X)		
Drawing File Name: 607040105.dgn	(R-X)		
CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English	(R-X)		

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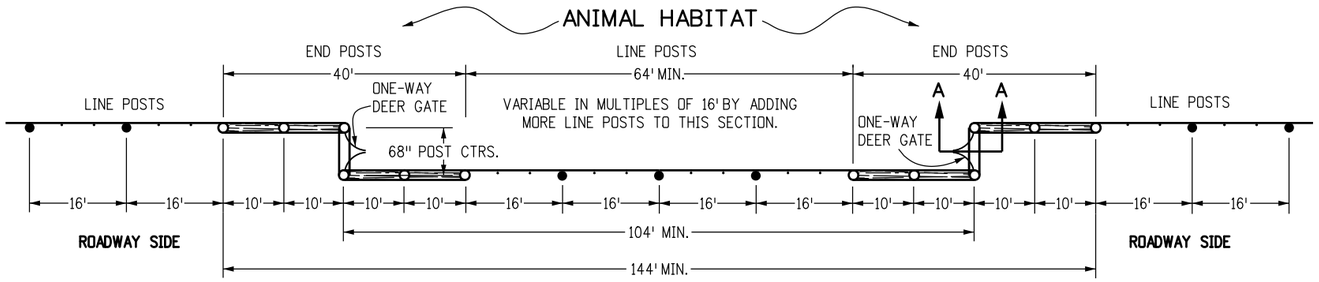
DEER FENCE, GATES, AND GAME RAMPS

Issued By: Project Development Branch March 4, 2015

STANDARD PLAN NO.

M-607-4



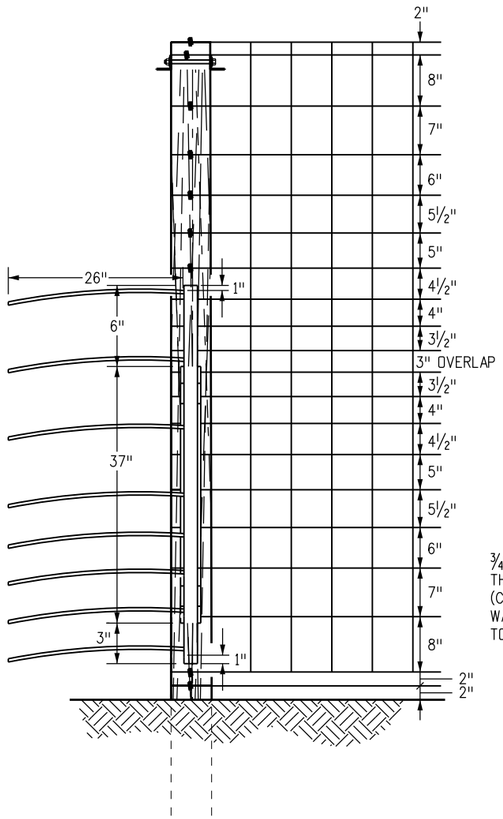
PLAN VIEW - TYPICAL DEER GATE INSTALLATION

LEGEND

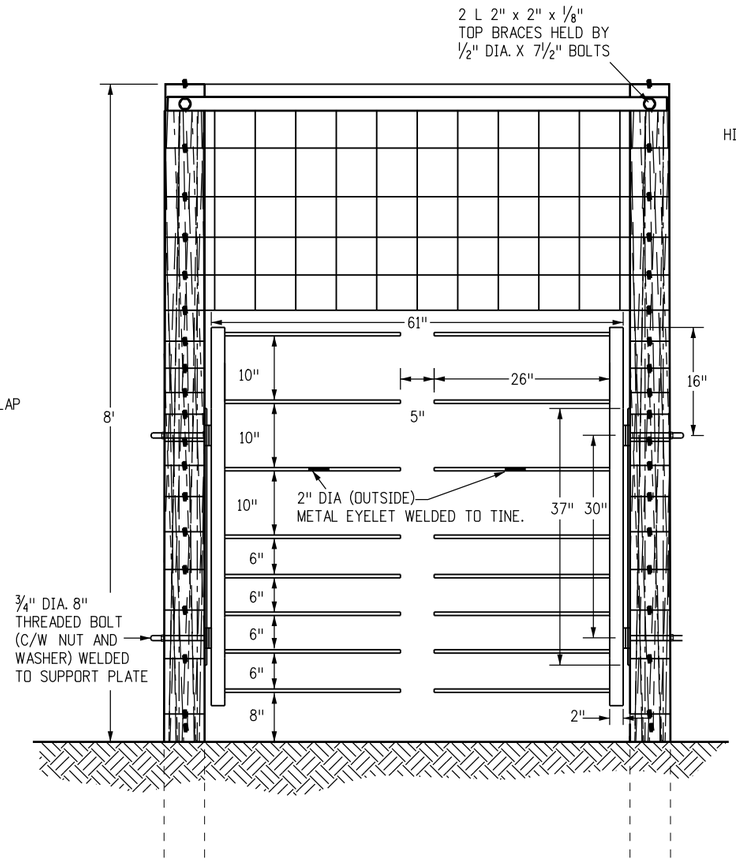
- =LINE POST
- =WOODEN STAY
- =END POST
- =BRACE

NOTES

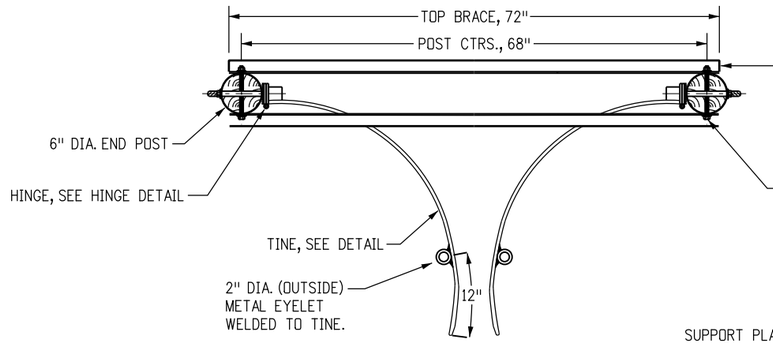
1. SIX IN. DOUBLE ACTING SPRING DOOR HINGE WITH FLAT BUTTON TIPS CUT IN TWO SHALL BE USED AS A SINGLE SWING HINGE AND BE PROVIDED WITH A GREASING NIPPLE AND WELDED TO SUPPORT PLATE.
2. TINES SHALL BE MOLDED IN ONE PIECE OF STEEL (AASHTO M 169, GRADE 1050), WITH NO WELDS ALLOWED.



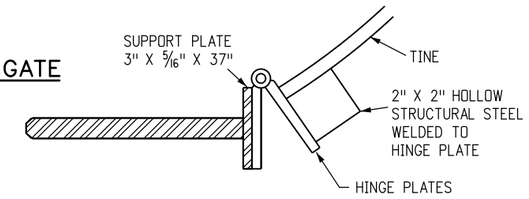
SECTION A-A



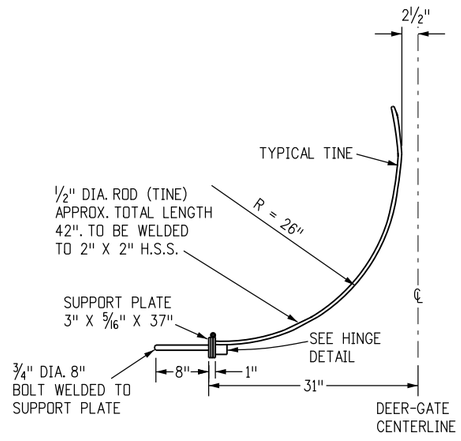
FRONT VIEW - DEER GATE



TOP VIEW - DEER GATE



TYPICAL HINGE DETAIL



TYPICAL TINE DETAIL

Computer File Information		Sheet Revisions	
Creation Date: 07/04/12 Initials: DLM		Date:	Comments
Last Modification Date: 04/30/15 Initials: LTA	(R-X)	04/30/15	Created new M Standard: M-607-4 - Deer Fence, Gates, and Game Ramps
Full Path: www.coloradodot.info/business/designsupport	(R-X)		
Drawing File Name: 607040205.dgn	(R-X)		
CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English	(R-X)		

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Denver, CO 80222
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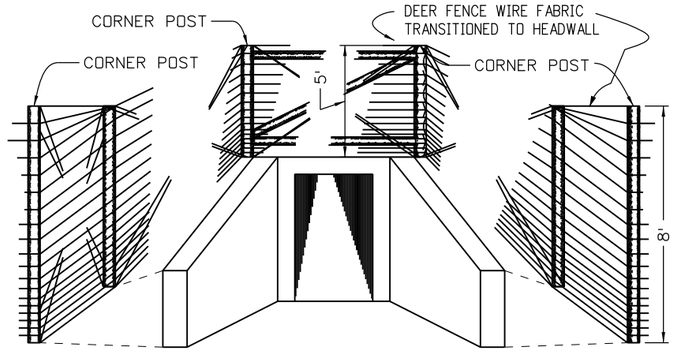
Division of Project Support DLM/LTA

DEER FENCE, GATES, AND GAME RAMPS

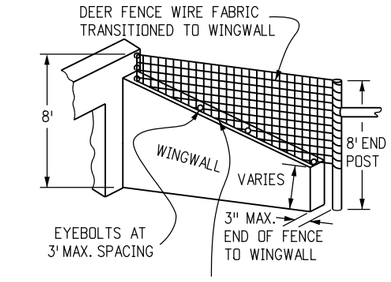
Issued By: Project Development Branch March 4, 2015

STANDARD PLAN NO.
M-607-4



FENCE DEER (SPECIAL) OVER CONCRETE BOX CULVERT

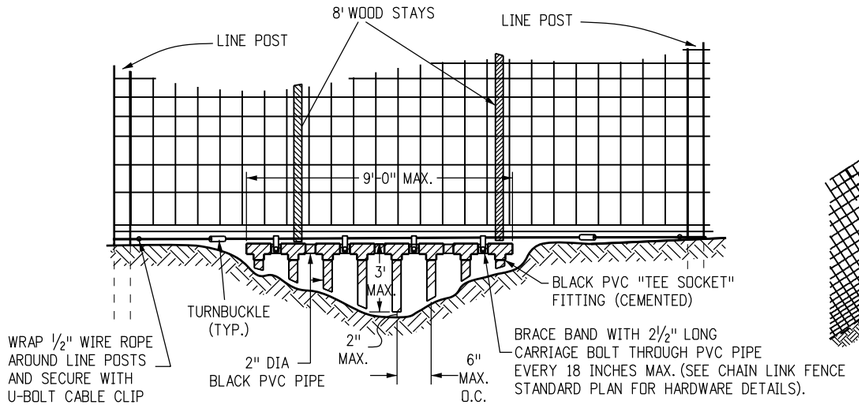
FIVE FOOT POSTS AND WIRE FABRIC SHALL BE INSTALLED WHERE THE FENCE PASSES OVER A CBC AT LOCATIONS SHOWN IN THE PLANS. THIS WORK WILL BE PAID FOR AS FENCE DEER (SPECIAL).

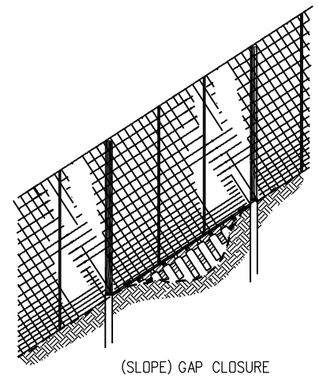


INSTALL 9 GA. WIRE THROUGH EYEBOLTS AND ATTACH FENCE FABRIC TO WIRE AT 1 FT. INTERVALS

NOTES

1. LOCATIONS OF DEER FENCE IN THE CLEAR ZONE SHALL BE SHOWN IN THE PLANS.
2. POSTS WITHIN THE CLEAR ZONE SHALL BE DRILLED.
3. DRILL HOLES PERPENDICULAR TO THE ROADWAY.
4. KNEE BRACE SHALL BE OMITTED FROM ANY END POST OR CORNER POST WITHIN THE CLEAR ZONE.

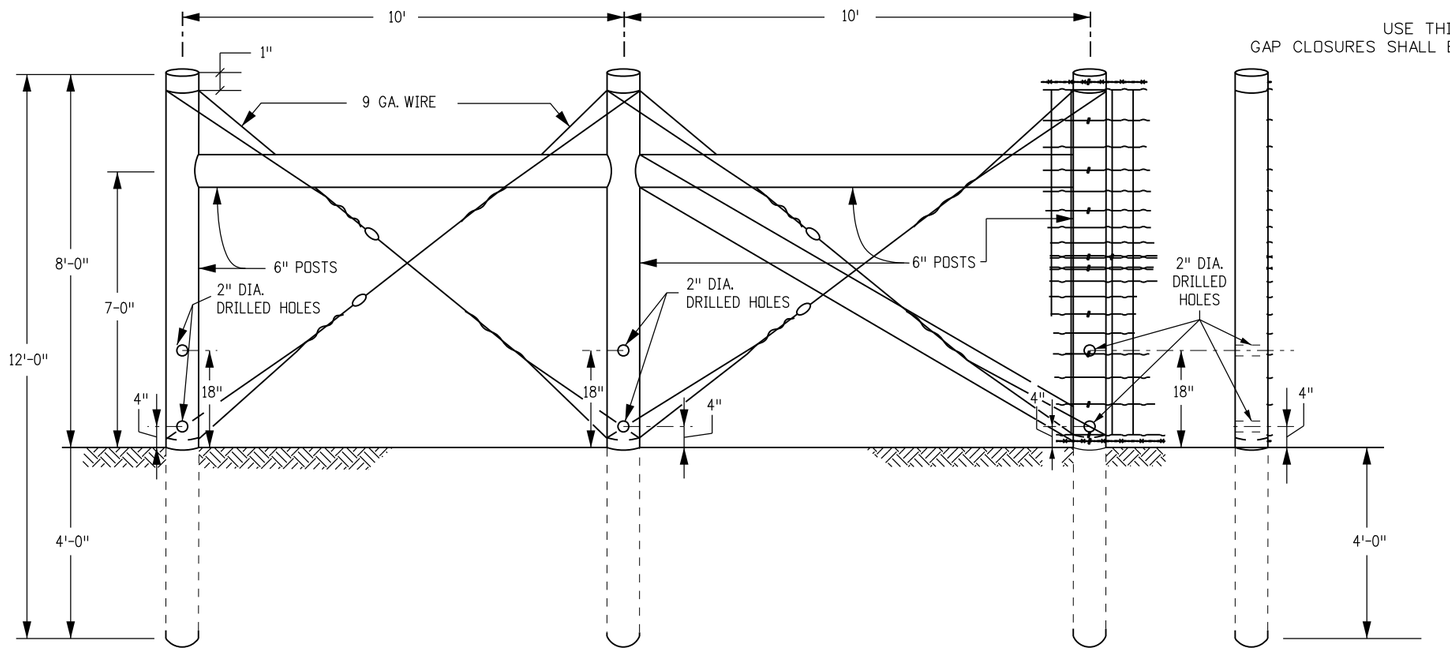




(SLOPE) GAP CLOSURE

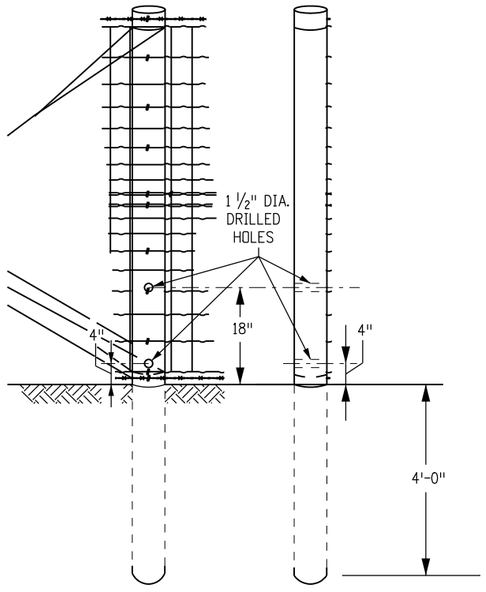
GAP CLOSURE

USE THIS DETAIL TO CLOSE ALL GAPS BEWTEEN 6 INCHES AND 3 FEET.
GAP CLOSURES SHALL BE INCLUDED IN THE PRICE OF THE FENCE AND NOT BE PAID FOR SEPARATELY.



END POST AND CORNER POST

SIDE VIEW



FRONT VIEW SIDE VIEW

5 IN. LINE POST

MODIFIED FOR PLACEMENT WITHIN ROADWAY CLEAR ZONE

Computer File Information		Sheet Revisions	
Creation Date: 07/04/12 Initials: DLM		Date:	Comments
Last Modification Date: 04/30/15 Initials: LTA	(R-X)	04/30/15	Created new M Standard: M-607-4 – Deer Fence, Gates, and Game Ramps
Full Path: www.coloradodot.info/business/designsupport	(R-X)		
Drawing File Name: 607040305.dgn	(R-X)		
CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English	(R-X)		

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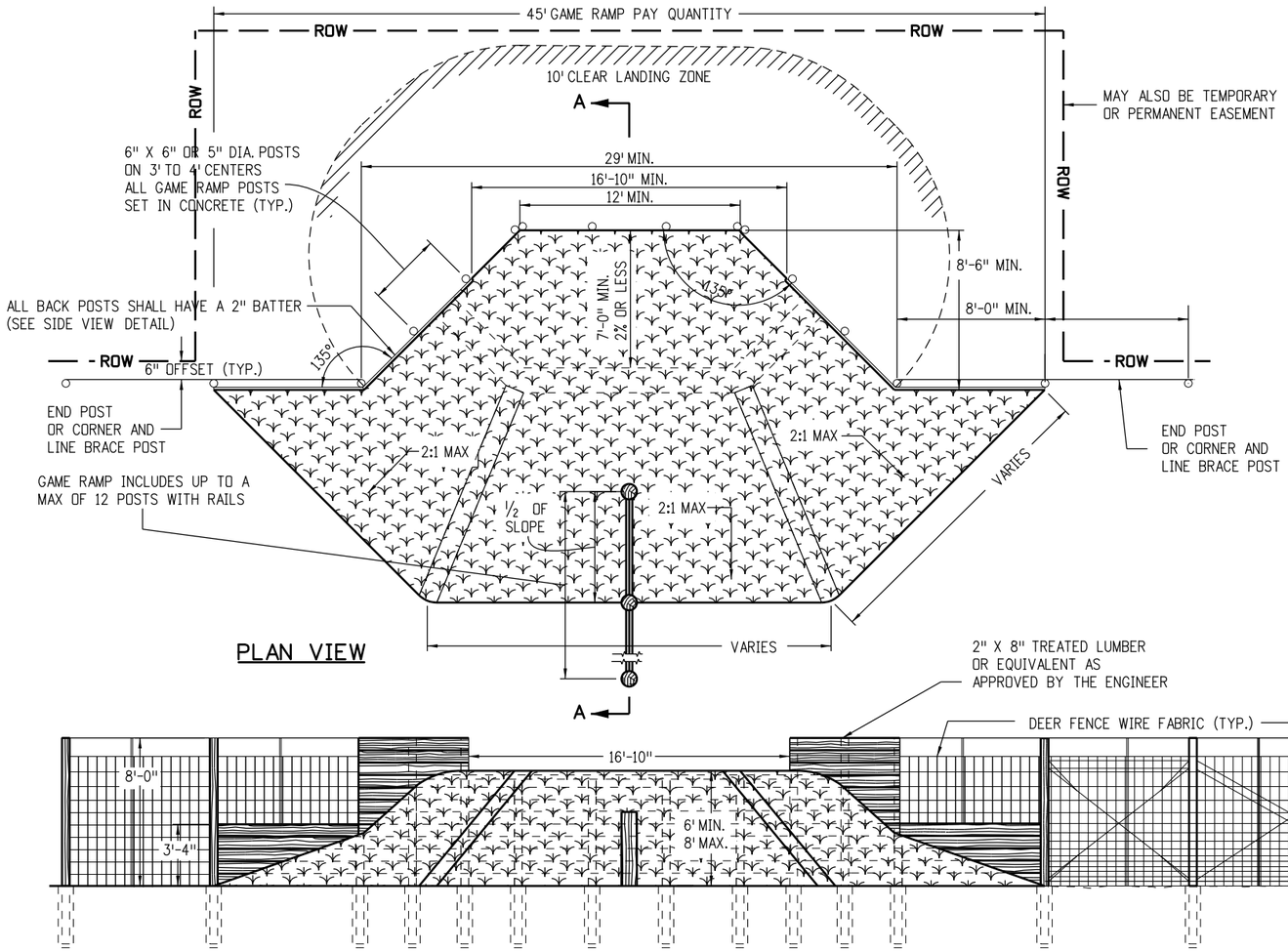
DEER FENCE, GATES, AND GAME RAMPS

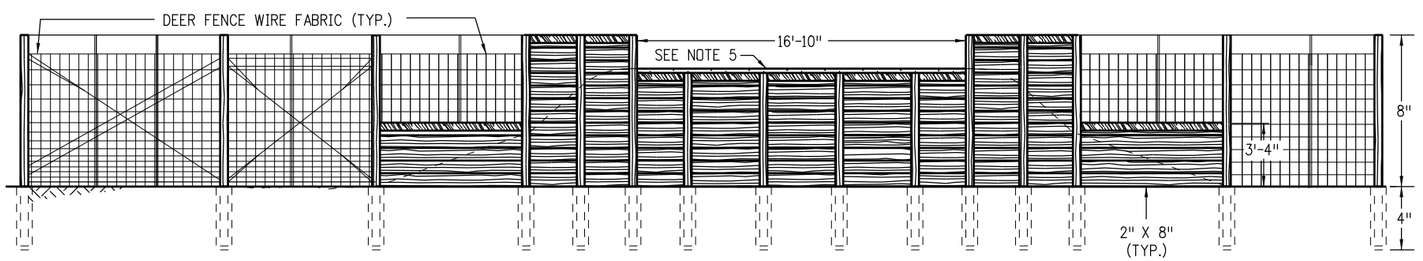
Issued By: Project Development Branch March 4, 2015

STANDARD PLAN NO.
M-607-4



PLAN VIEW

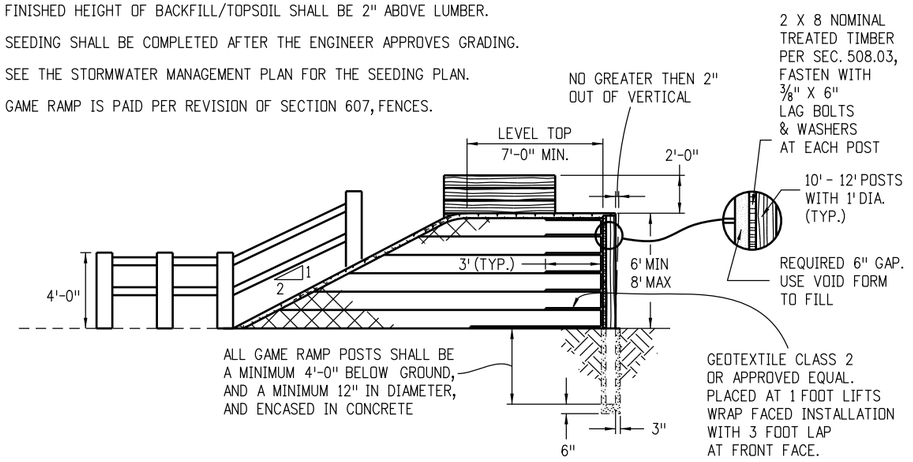
FRONT ELEVATION VIEW



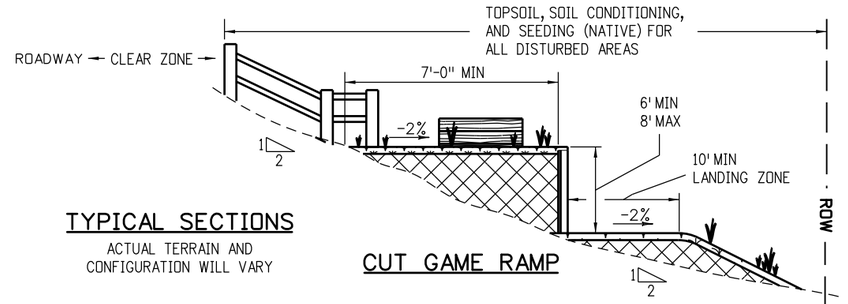
REAR ELEVATION VIEW

NOTES

1. THE LANDING ZONE SHALL BE FLAT, STABLE, AND EARTHEN. THE AREA SHALL BE VOID OF OBJECTS THAT MAY HINDER OR ENDANGER WILDLIFE. THE ENGINEER MAY ADJUST THE GAME RAMP LOCATION AS NEEDED.
2. THERE SHALL BE NO DISTURBANCE BEYOND THE ROW OR TEMPORARY/PERMANANT EASETMENTS.
3. FILL MATERIAL SHALL BE STRUCTURE BACKFILL (CLASS 2) AND MEET THE REQUIREMENTS OF SECTION 206 WITH A MINIMUM COMPACTION OF 90%.
4. FOUR INCHES OF TOPSOIL SHALL BE PLACED IN ACCORDANCE WITH SECTION 207.
5. FINISHED HEIGHT OF BACKFILL/TOPSOIL SHALL BE 2" ABOVE LUMBER.
6. SEEDING SHALL BE COMPLETED AFTER THE ENGINEER APPROVES GRADING.
7. SEE THE STORMWATER MANAGEMENT PLAN FOR THE SEEDING PLAN.
8. GAME RAMP IS PAID PER REVISION OF SECTION 607, FENCES.



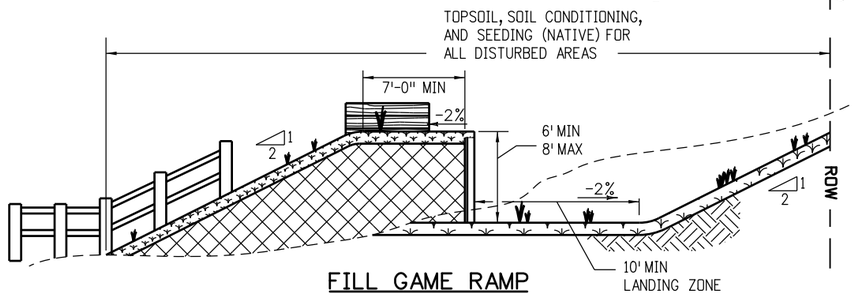
SECTION A-A



TYPICAL SECTIONS

ACTUAL TERRAIN AND CONFIGURATION WILL VARY

CUT GAME RAMP



FILL GAME RAMP

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Last Modification Date: 04/30/15 Initials: LTA	(R-X)	04/30/15	Created new M Standard: M-607-4 - Deer Fence, Gates, and Game Ramps
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Drawing File Name: 607040405.dgn	(R-X)		
CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English	(R-X)		

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DEER FENCE, GATES, AND GAME RAMPS

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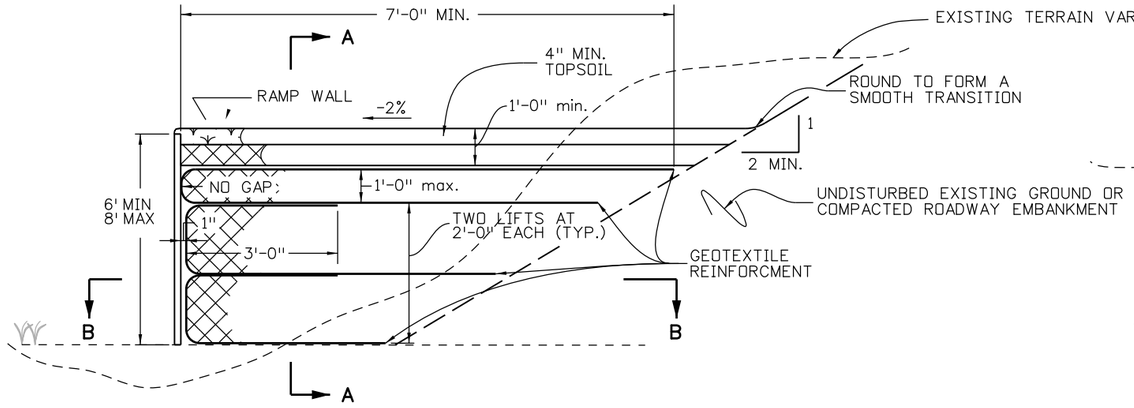
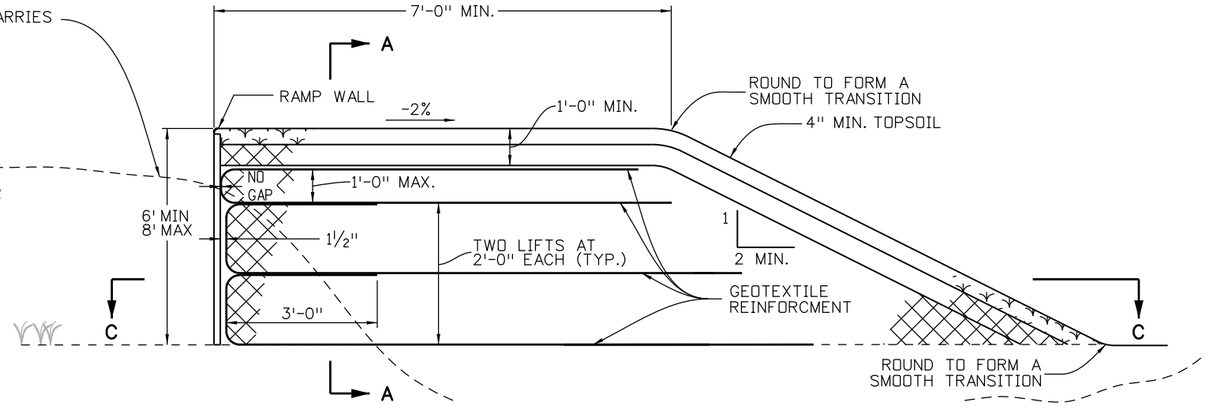
STANDARD PLAN NO.

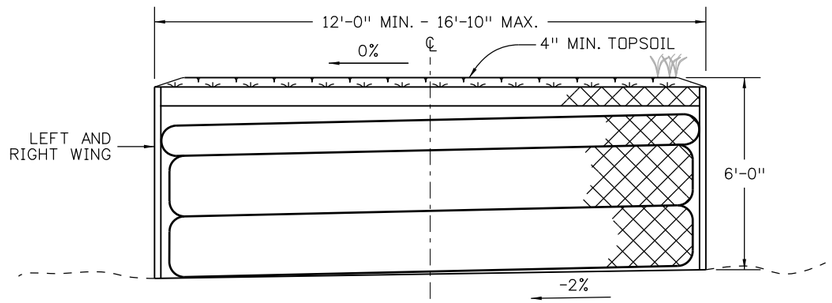
M-607-4



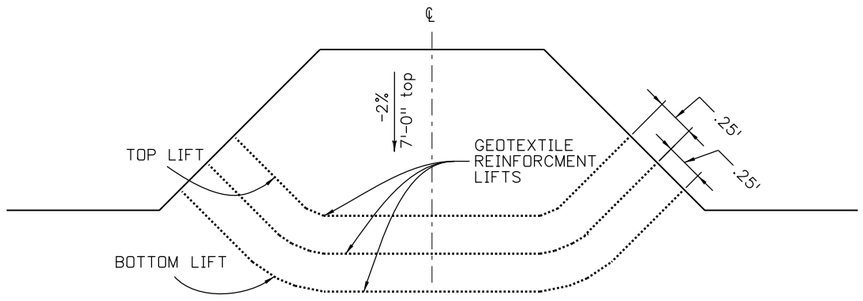
CUT SECTION PERPENDICULAR TO GAME RAMP



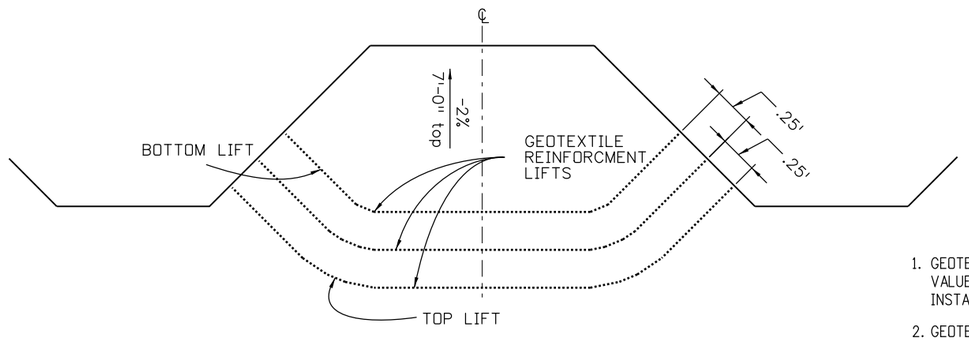
FILL SECTION PERPENDICULAR TO GAME RAMP



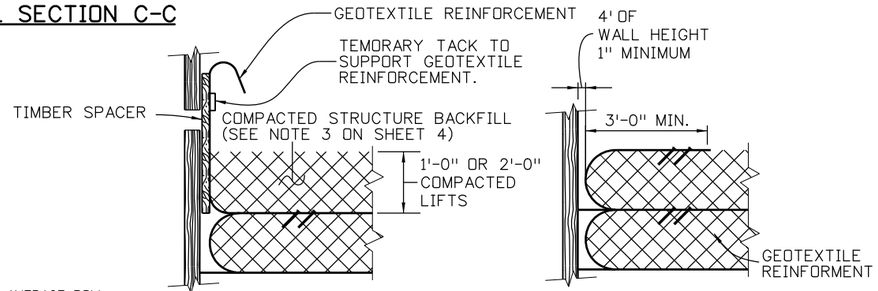
SECTION A-A



FILL SECTION C-C



CUT SECTION B-B



GAP DETAIL STEP 1

GAP DETAIL STEP 2

NOTES

1. GEOTEXTILE REINFORCEMENT SHALL BE WOVEN FABRIC WITH A MINIMUM AVERAGE ROLL VALUE OF 4800 LB/FT FOR INSTALLATIONS WITH A GAP AND 2400 LB/FT FOR INSTALLATIONS WITHOUT A GAP BASED ON ASTM D4595.
2. GEOTEXTILE REINFORCEMENT SHALL BE PLACED BY ALTERNATING MACHINE DIRECTION (MD) WITH CROSS MACHINE DIRECTION (XD) FROM LAYER TO LAYER.
3. THE GEOTEXTILE REINFORCEMENT WRAP AT BACK FACE OF GAME RAMP SHALL BE PULLED BACK SLACK FREE WITH ITS END ANCHORED TO SOIL UNDERNEATH WITH STAPLES OR PINS.
4. MINIMUM SPLICE OF ALL GEOTEXTILE SHALL CONSIST OF 1 FOOT OF OVERLAP.
5. GEOTEXTILE REINFORCEMENT WRAP AT BACK FACE OF GAME RAMP WALL SHALL BE TEMPORARILY HUNG WITH A SPACER BOARD AND TACK STRIP. AFTER REACHING A TOTAL OF 2'-0" COMPACTED LIFT, THE TACK STRIP SHALL BE REMOVED AND GEOTEXTILE REINFORCEMENT SHALL BE PULLED BACK SLACK FREE WITH ITS END ANCHORED TO SOIL UNDERNEATH WITH STAPLE OR PINS BEFORE THE SPACER BOARD IS PULLED.
6. DO NOT USE SPACER FOR THE TOP LIFT (FINAL LIFT). TOP LIFT SHALL ABUT THE GAME RAMP WALL.

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Last Modification Date: 04/30/15 Initials: LTA	R-X	04/30/15	Created new M Standard: M-607-4 - Deer Fence, Gates, and Game Ramps
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Drawing File Name: 607040505.dgn	R-X		
CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English	R-X		

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DEER FENCE, GATES, AND GAME RAMPS

Issued By: Project Development Branch March 4, 2015

STANDARD PLAN NO.
M-607-4
Sheet No. 5 of 5

H

Attachment H.

Lyons Quarry Final Design – Drawings

June 2021

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AGGREGATE INDUSTRIES

LYONS QUARRY
RECLAMATION PROJECT

INDEX OF DRAWINGS

PROJECT VICINITY
SCALE: NTS

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ISSUE	DATE	DESCRIPTION
REV 1	6/29/2021	FINAL DESIGN
100%	4/16/2021	FINAL DESIGN
90%	2/12/2021	PRE-FINAL DESIGN
60%	1/22/2021	INTERMEDIATE DESIGN PACKAGE

PROJECT MANAGER	TRAVIS SNYDER
DRAWN BY	R. NALLEY
PROJECT NUMBER	10092468

COLORADO LICENSED
TRAVIS W. TIMOTHY
45410
PROFESSIONAL ENGINEER

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

GENERAL
COVER &
DRAWING INDEX

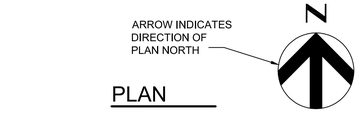
FILENAME 00G-01.dwg
SCALE AS NOTED

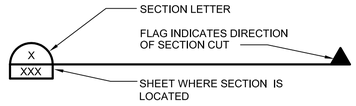
SHEET
00G-01

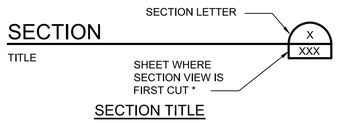
MATERIALS IN PLAN/SECTION

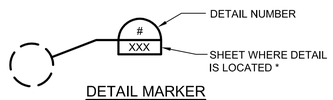
- ASPHALT (PLAN OR SMALL-SCALE SECTION)
- CONCRETE (PLAN AND/OR SECTION)
- DEMOLITION (PLAN AND/OR SECTION)
- EARTH (SECTION)
- BEDROCK
- GRANULAR FILL (SECTION)
- GROUT (SECTION)
- METAL (SECTION)
- PLYWOOD (LARGE-SCALE SECTION)
- PRECAST CONCRETE (PLAN AND/OR SECTION)
- RIPRAP (PLAN AND/OR SECTION)
- ROCK FALL DEBRIS/MUCK
- SAND (SECTION)
- ITEMS BEYOND

GENERAL SYMBOLOGY









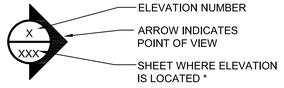
FOR REFERENCING DETAILS INCLUDED IN DRAWING SET.

XXXXXXXXX

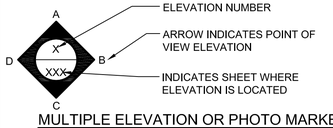
DETAIL MARKER

FOR REFERENCING DETAILS BOUND IN SPECIFICATIONS OR SEPARATE VOLUME.

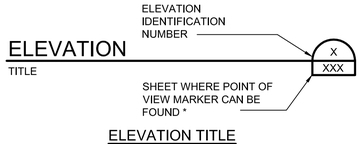
DETAIL TITLE



SINGLE ELEVATION OR PHOTO MARKER



MULTIPLE ELEVATION OR PHOTO MARKER



ELEVATION TITLE

* EXCEPTIONS WHERE THE SHEET NUMBER IS REPLACED BY A DASH (-).
1) FOR COMMON DETAILS, SECTIONS, ELEVATIONS OR DETAILS THAT ARE CUT OR CALLED OUT ON MULTIPLE SHEETS.
2) SECTIONS, ELEVATIONS OR DETAILS THAT ARE LOCATED ON THE SAME SHEET THEY ARE CUT OR CALLED OUT ON.

- MINING
- US HIGHWAY SYMBOL
- INTERSTATE HIGHWAY SYMBOL
- CENTERLINE
- PROPERTY LINE
- EMBANKMENT SLOPE (CUT)
- EMBANKMENT SLOPE (FILL)
- SOIL SURFACE
- BEDROCK SURFACE
- BREAKLINE
- WATER LEVEL IN SECTION/PROFILE
- CULVERT
- BRIDGE
- SEDIMENT CONTROL LOG
- STRAW BALE BARRIER
- SLOPE LABEL (2 / 1)
- DIMENSION (CIVIL - EARTHWORKS) (1.5')
- DIMENSION (CIVIL - CONCRETE STRUCTURES) (1'-6")
- CONTROL POINT

BARSCALE

GENERAL LINE SYMBOLOGY

- EXISTING CONTOUR (MINOR)
- EXISTING CONTOUR W/ELEVATION (MAJOR) (25)
- NEW CONTOUR (MINOR)
- NEW CONTOUR (MAJOR) (25)
- ROADS (UNIMPROVED)
- ROADS (PAVED)
- CENTERLINE
- HIDDEN LINE
- PHANTOM LINE (NOT IN SECTION)
- PROPERTY LINE
- MATCH LINE
- RAILROAD
- WATERLINE/SURFACE DRAINAGE
- HDPE / LDPE LINER
- GEOTEXTILE
- GEOCOMPOSITE
- POWER LINE ALIGNMENT
- GAS LINE ALIGNMENT
- WATER LINE ALIGNMENT
- STORM WATER LINE ALIGNMENT
- FENCELINE (X)
- LIMITS OF DISTURBED AREA (LDA)
- EARTH DIKE & DRAINAGE SWALE
- SILT FENCE (SF SF SF)

GENERAL NOTES:

1. THIS IS A STANDARD SHEET SHOWING COMMON SYMBOLOGY. ALL SYMBOLS ARE NOT NECESSARILY USED ON THIS PROJECT.
2. SCREENING OR SHADING OF WORK IS USED TO INDICATE EXISTING COMPONENTS OR TO DE-EMPHASIZE PROPOSED IMPROVEMENTS TO HIGHLIGHT SELECTED TRADE WORK. REFER TO CONTEXT OF EACH SHEET FOR USAGE.

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ISSUE	DATE	DESCRIPTION
100%	4/16/2021	FINAL DESIGN
90%	2/12/2021	PRE-FINAL DESIGN
60%	1/22/2021	INTERMEDIATE DESIGN PACKAGE

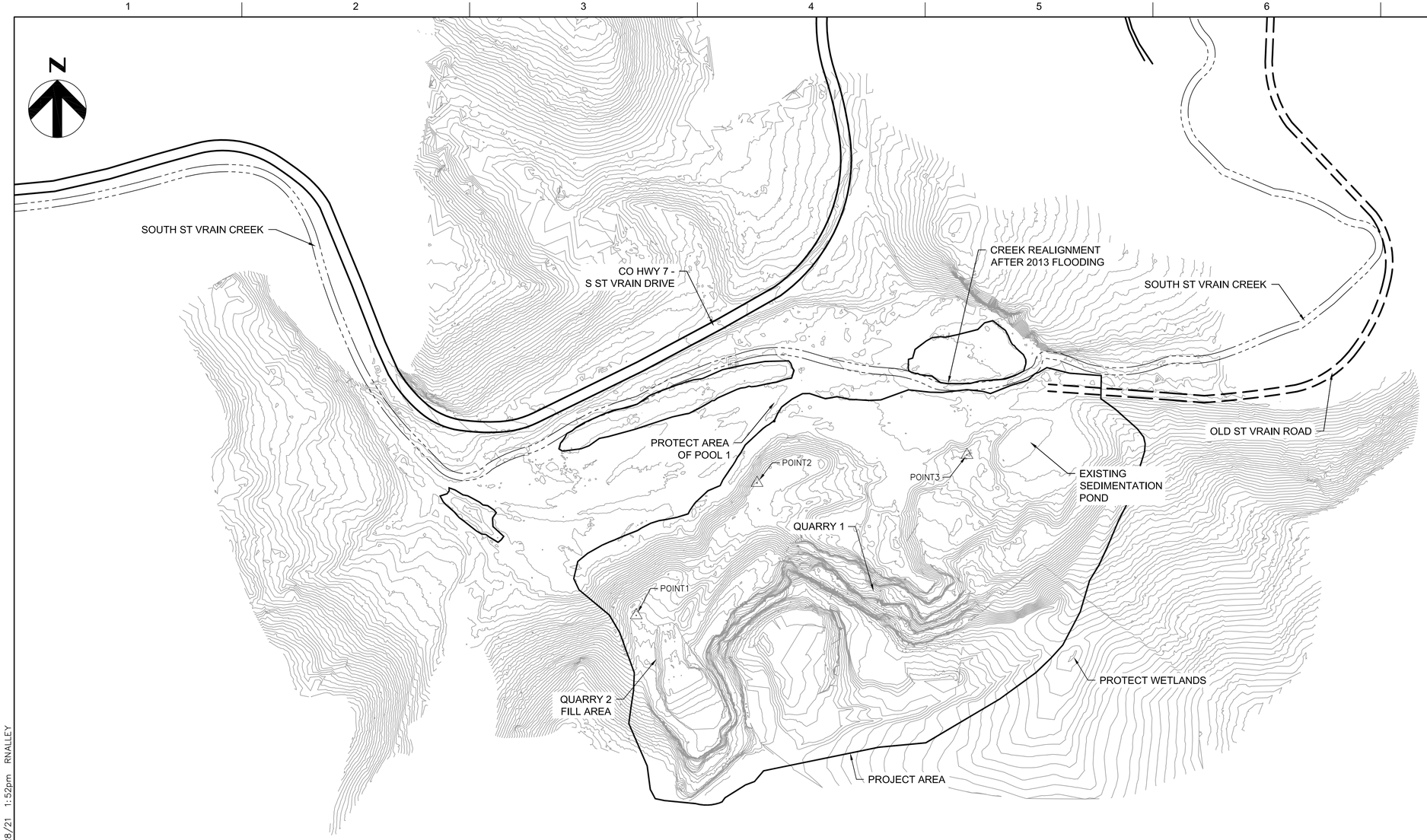
PROJECT MANAGER	TRAVIS SNYDER
DRAWN BY	R. NALLEY
PROJECT NUMBER	10092468

COLORADO LICENSED TIMOTHY M. 53410 PROFESSIONAL ENGINEER 2/12/21

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

GENERAL NOTES & LEGEND

FILENAME	00G-02.dwg
SCALE	AS NOTED
SHEET	00G-02



SURVEY CONTROL POINT TABLE				
POINT NO.	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	1315538.88	3055208.16	5655.33	POINT1
2	1315997.87	3055627.15	5582.42	POINT2
3	1316094.89	3056355.29	5539.47	POINT3

NOTES:

1. AREA OF POOL 1 IS DEPICTED IN LETTER FROM BOULDER COUNTY PARKS AND OPEN SPACE TO COLORADO DIVISION OF RECLAMATION MINING AND SAFETY DATED SEPTEMBER 6, 2016, REGARDING NORTHERN LEOPARD FROGS AND BAT SPECIES: HISTORIC AND CURRENT USE OF RETENTION POND AND POOLS AT AGGREGATE MINE SITE ON HAUL II.

200 100 0 200 400
SCALE IN FEET

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ISSUE	DATE	DESCRIPTION
100%	4/16/2021	FINAL DESIGN
90%	2/12/2021	PRE-FINAL DESIGN
60%	1/22/2021	INTERMEDIATE DESIGN PACKAGE

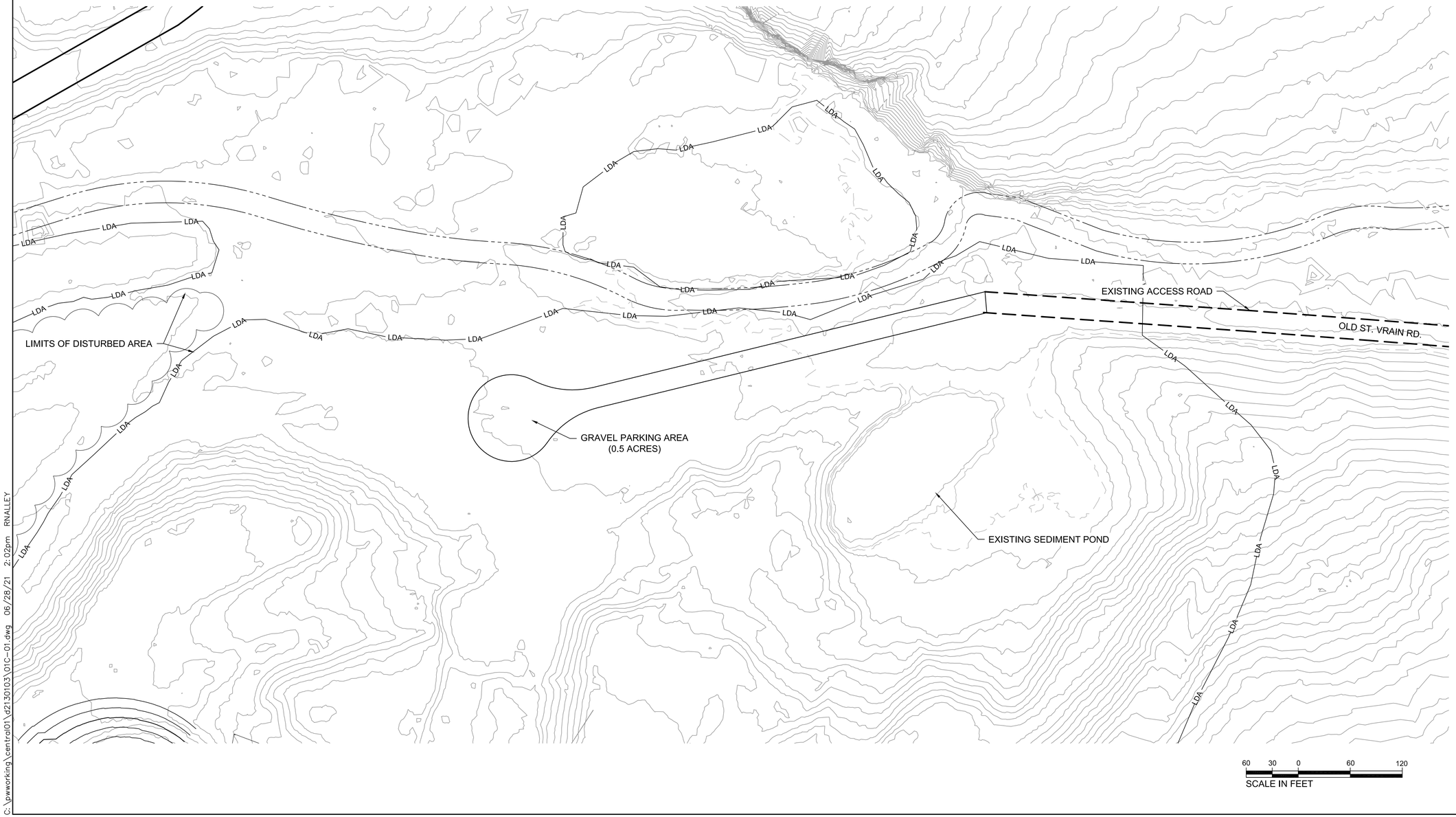
PROJECT MANAGER TRAVIS SNYDER
DRAWN BY R. NALLEY
PROJECT NUMBER 10092468

COLORADO LICENSED TIMOTHY J. [illegible] 33410 PROFESSIONAL ENGINEER

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

GENERAL PLAN OF EXISTING CONDITIONS & SURVEY CONTROL

FILENAME 00G-03.dwg
SCALE AS NOTED
SHEET **00G-03**



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ISSUE	DATE	DESCRIPTION
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60%	01/22/2021	INTERMEDIATE DESIGN PACKAGE

PROJECT MANAGER	TRAVIS SNYDER
DRAWN BY	R. NALLEY
PROJECT NUMBER	10092468

COLORADO LICENSED
TRAVIS W. SNYDER
35410
PROFESSIONAL ENGINEER

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

CIVIL
SITE ACCESS &
STAGING AREAS

FILENAME 01C-01.dwg
SCALE AS NOTED

SHEET
01C-01

QUANTITIES TABLE		
ITEM	CUT (CU. YD.)	FILL (CU. YD.)
SLOPE GRADING	245,080	125,300
CATCHMENT BERM	-	14,278
NORTHWEST BERM	-	21,133
SEDIMENTATION POND	-	2,222
SCOUR BERM	-	19,033
FLOODPLAIN SOIL REMOVAL	23,300	13,685
FLOODPLAIN SOIL EXPORT	10,000	-
NET CUT/FILL: 82,729 CU. YD. (CUT)		

LEGEND

- PROPOSED SCOUR BERM
- PROPOSED DRAINAGE CHANNEL
- PROPOSED FILL SLOPE
- EXCESS SPOIL MATERIAL
- PROPOSED MAJOR CONTOUR (5700)
- PROPOSED MINOR CONTOUR
- LIMITS OF DISTURBANCE
- PROPOSED FENCE
- PROPOSED GATE
- PROPOSED CULVERT
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR

NOTES:
1. PERFORM ROCK SCALING IN ACCORDANCE WITH GROUND CONTROL SPECIFICATIONS (SECTION 31 72 16).
2. SOIL RIPRAP BACKFILL SHALL BE PLACED IN HORIZONTAL LIFTS NOT EXCEEDING 12 INCHES IN THICKNESS, DEPENDING OF THE FILL MATERIALS.
3. FINAL GRADING OF ALL FILL SLOPES, BENCHES, CREST AREAS, AND TOE AREAS SHOULD ENSURE THAT WATER IS NOT ALLOWED TO POND ON OR ADJACENT TO THE FILL SLOPES.

100 50 0 100 200
SCALE IN FEET

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REV	DATE	DESCRIPTION
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100%	4/16/2021	FINAL DESIGN
90%	2/12/2021	PRE-FINAL DESIGN
60%	01/22/2021	INTERMEDIATE DESIGN PACKAGE

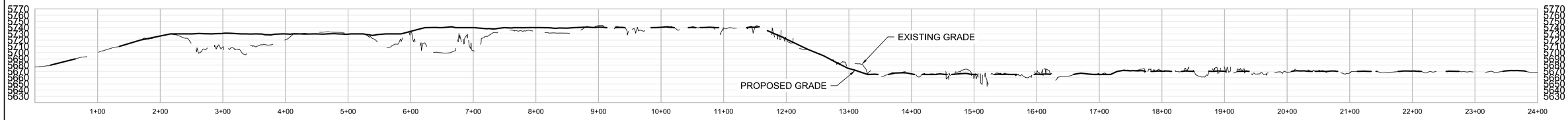
PROJECT MANAGER TRAVIS SNYDER
DRAWN BY R. NALLEY
PROJECT NUMBER 10092468

COLORADO LICENSED
RYAN W. TIMOTH
53410
PROFESSIONAL ENGINEER

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

CIVIL
FLOODPLAIN SOIL REMOVAL AND SITE GRADING PLAN

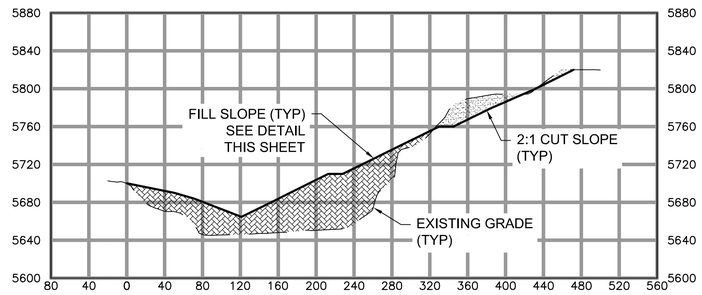
FILENAME 01C-02.dwg
SCALE AS NOTED
SHEET 01C-02



STATION EXCAVATION BASE PROFILE

1" = 80'

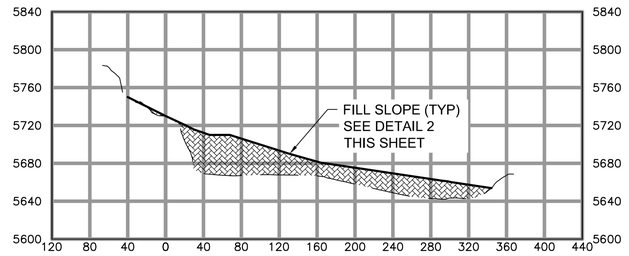
01C-02



STATION 1+00

SECTION A 01C-02

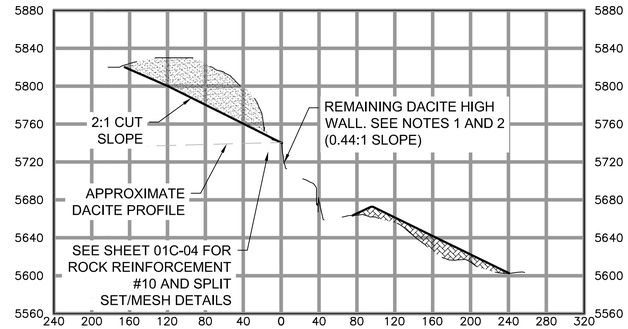
1" = 80'



STATION 5+24

SECTION B 01C-02

1" = 80'



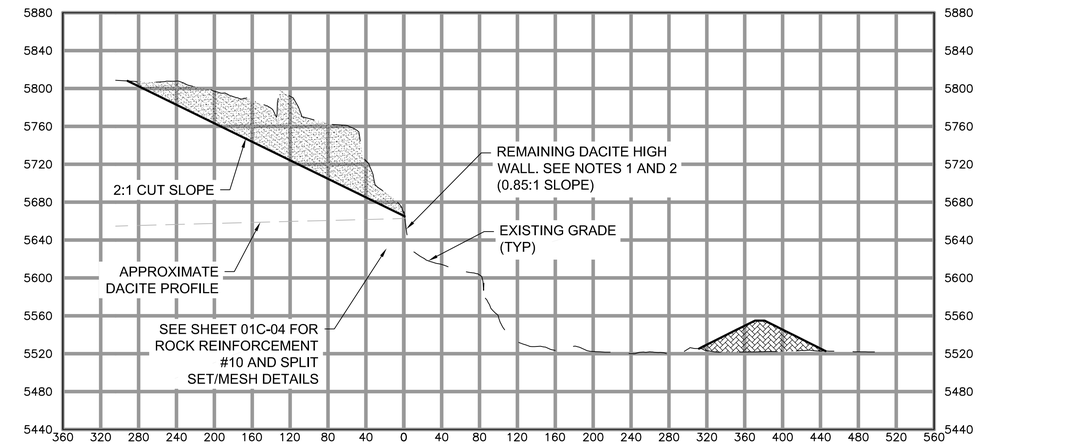
STATION 10+75

SECTION C 01C-02

1" = 80'

NOTES:

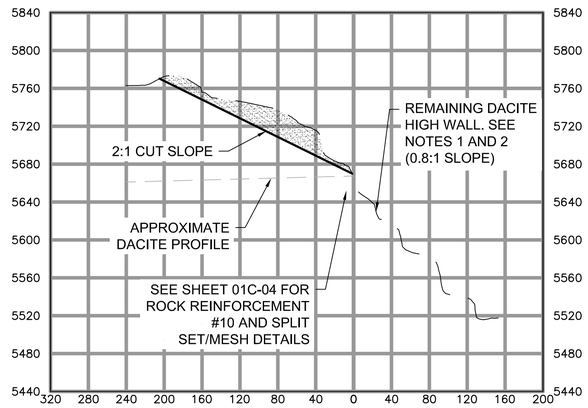
1. ROCK REINFORCEMENT MAY BE NEEDED FOR STABILIZATION WHERE LARGE BLOCKS ARE EVIDENT IN THE BEDROCK. LOCATIONS TO BE DETERMINED BY ON-SITE ENGINEER AFTER SCALING.
2. PERFORM ROCK SCALING IN ACCORDANCE WITH GROUND CONTROL SPECIFICATIONS (SECTION 31 72 16).



STATION 16+00

SECTION D 01C-02

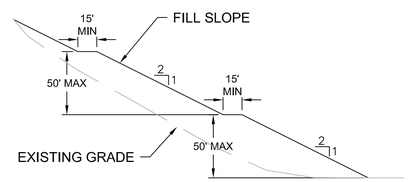
1" = 80'



STATION 19+50

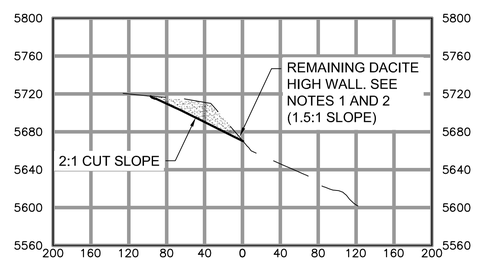
SECTION E 01C-02

1" = 80'



FILL SLOPE DETAIL 1 01C-03

1" = 60'



STATION 22+00

SECTION F 01C-02

1" = 80'

80 40 0 80 160

SCALE IN FEET

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ISSUE	DATE	DESCRIPTION
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90%	2/12/2021	PRE-FINAL DESIGN
60%	01/22/2021	INTERMEDIATE DESIGN PACKAGE

PROJECT MANAGER	TRAVIS SNYDER
DRAWN BY	R. NALLEY
PROJECT NUMBER	10092468

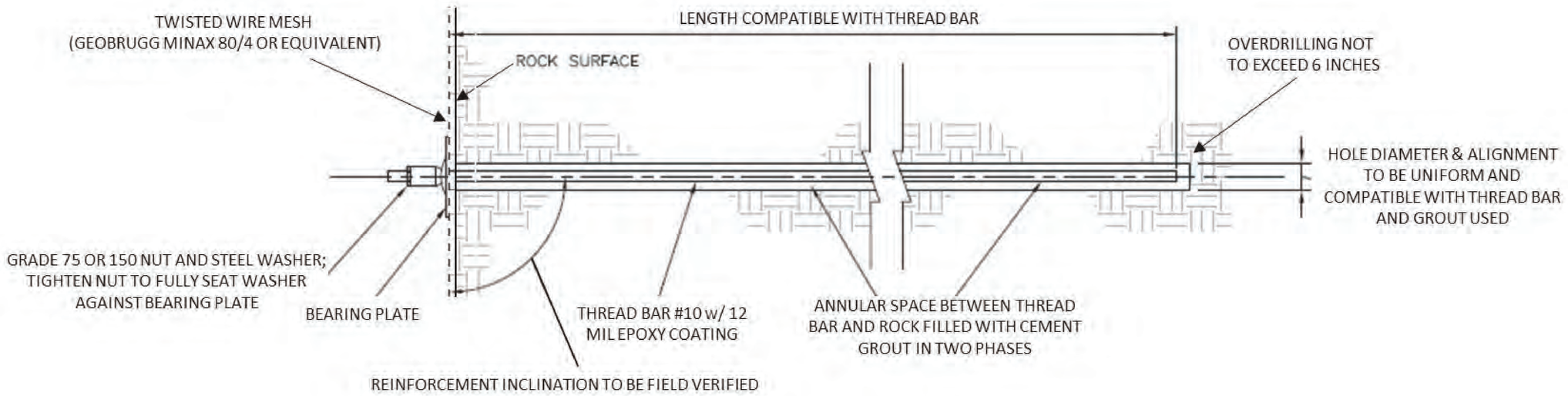
COLORADO LICENSED TRAVIS W. SNYDER 53410 PROFESSIONAL ENGINEER 4/16/2021

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

CIVIL
FINAL GRADING PROFILE, SECTION, & DETAILS

FILENAME 01C-03.dwg
SCALE AS NOTED

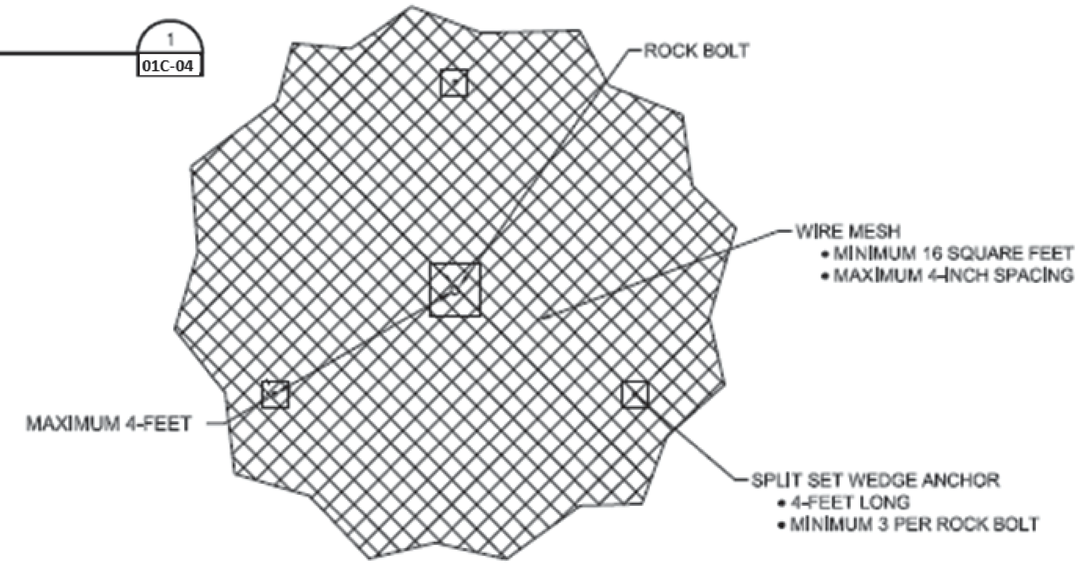
SHEET **01C-03**



DETAIL 1

TYPICAL ROCK REINFORCEMENT (NUMBER 10) DETAIL

01C-04



DETAIL 2

TYPICAL ROCK DOWEL DETAIL

01C-04

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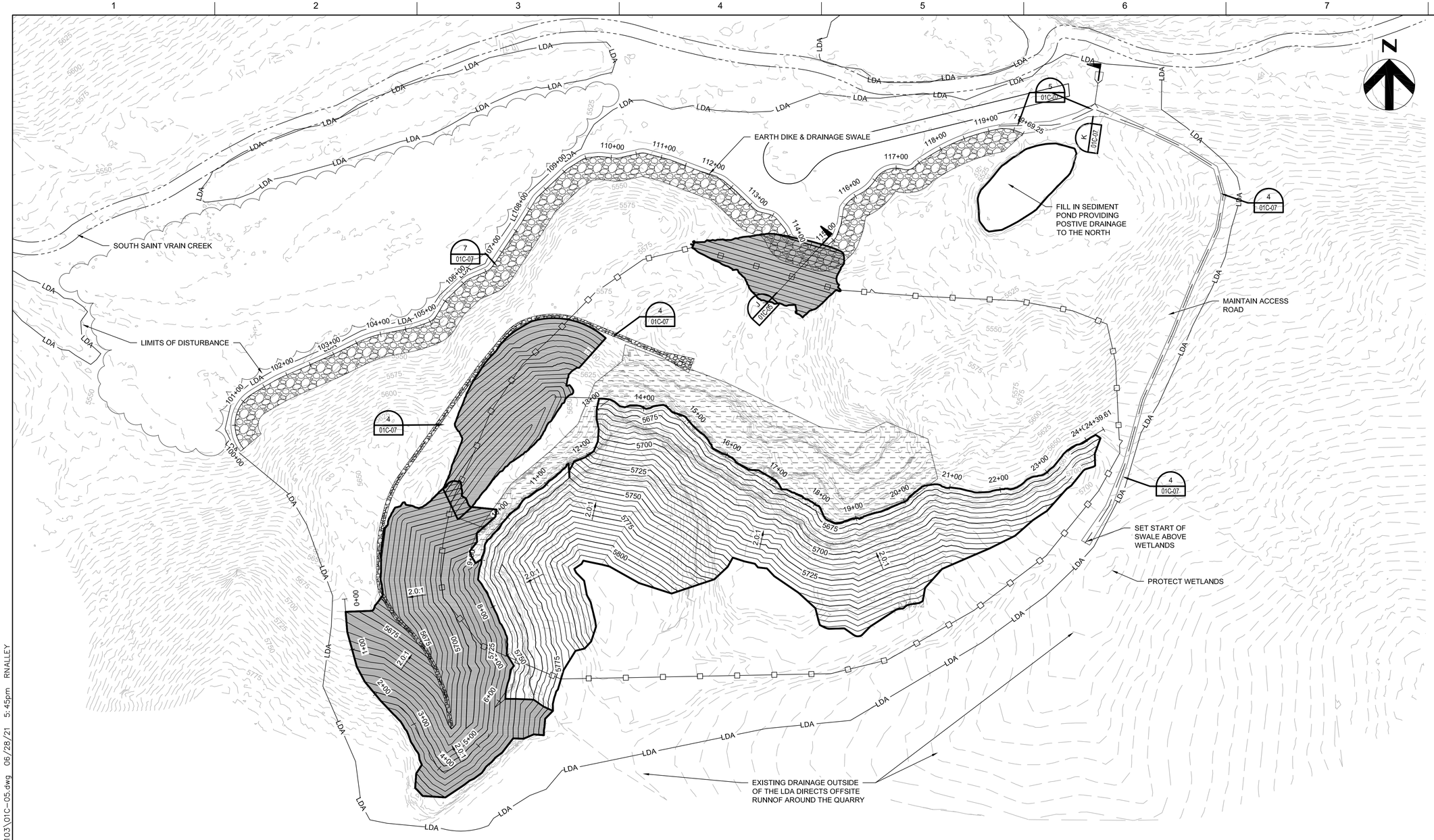
ISSUE	DATE	DESCRIPTION
REV 1	06/29/2021	FINAL DESIGN

PROJECT MANAGER TRAVIS SNYDER
DRAWN BY R. NALLEY
PROJECT NUMBER 10092468

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

CIVIL
ROCK REINFORCEMENT DETAILS

FILENAME 01C-04.dwg
SCALE NTS
SHEET 01C-04



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90%	2/12/2021	PRE-FINAL DESIGN
60%	01/22/2021	INTERMEDIATE DESIGN PACKAGE

PROJECT MANAGER TRAVIS SNYDER

DRAWN BY R. NALLEY

PROJECT NUMBER 10092468

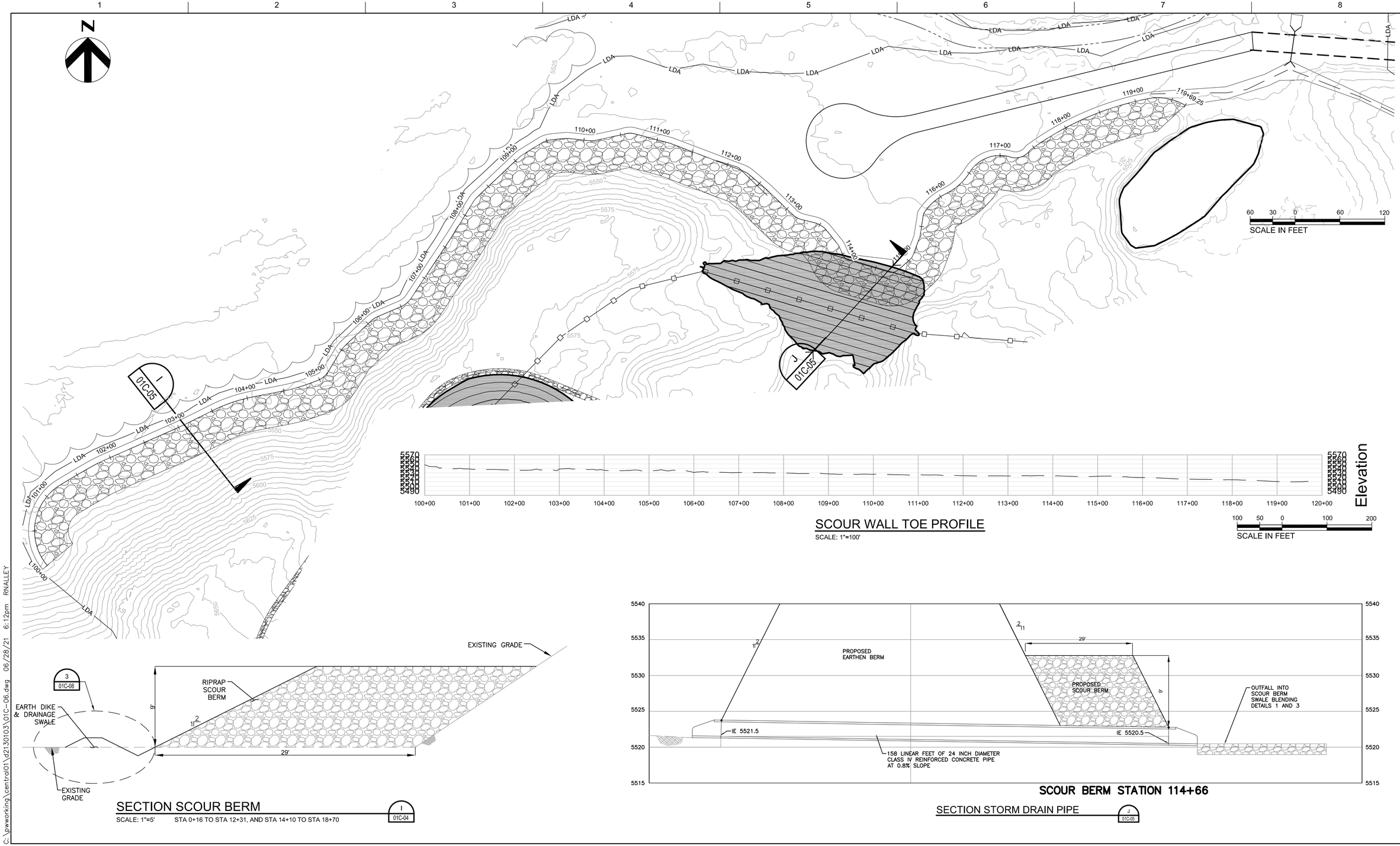
COLORADO LICENSED TIMOTHY J. [illegible] 33410 PROFESSIONAL ENGINEER

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

CIVIL
DRAINAGE & EROSION CONTROL PLAN

FILENAME 01C-05.dwg
SCALE AS NOTED

SHEET 01C-05



SCOUR WALL TOE PROFILE

SCALE: 1"=100'

SECTION SCOUR BERM

SCALE: 1"=5' STA 0+16 TO STA 12+31, AND STA 14+10 TO STA 18+70

I 01C-04

SCOUR BERM STATION 114+66

SECTION STORM DRAIN PIPE

J 01C-05

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ISSUE	DATE	DESCRIPTION
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100%	4/16/2021	FINAL DESIGN
90%	2/12/2021	PRE-FINAL DESIGN
60%	01/22/2021	INTERMEDIATE DESIGN PACKAGE

PROJECT MANAGER TRAVIS SNYDER

DRAWN BY R. NALLEY

PROJECT NUMBER 10092468

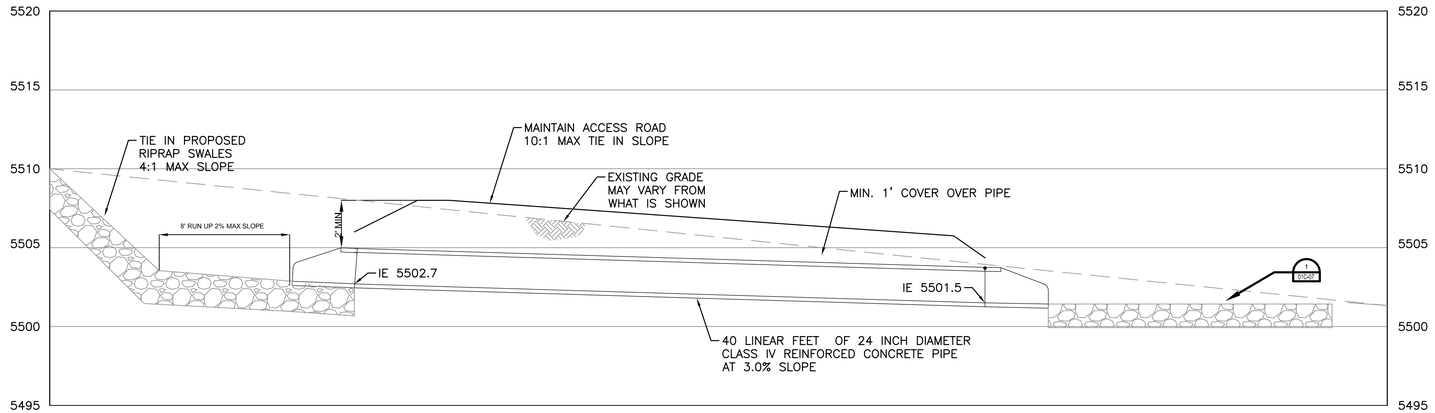
COLORADO LICENSED
TRAVIS J. SNYDER
35410
PROFESSIONAL ENGINEER

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

CIVIL
SCOUR BERM
SECTION & DETAILS

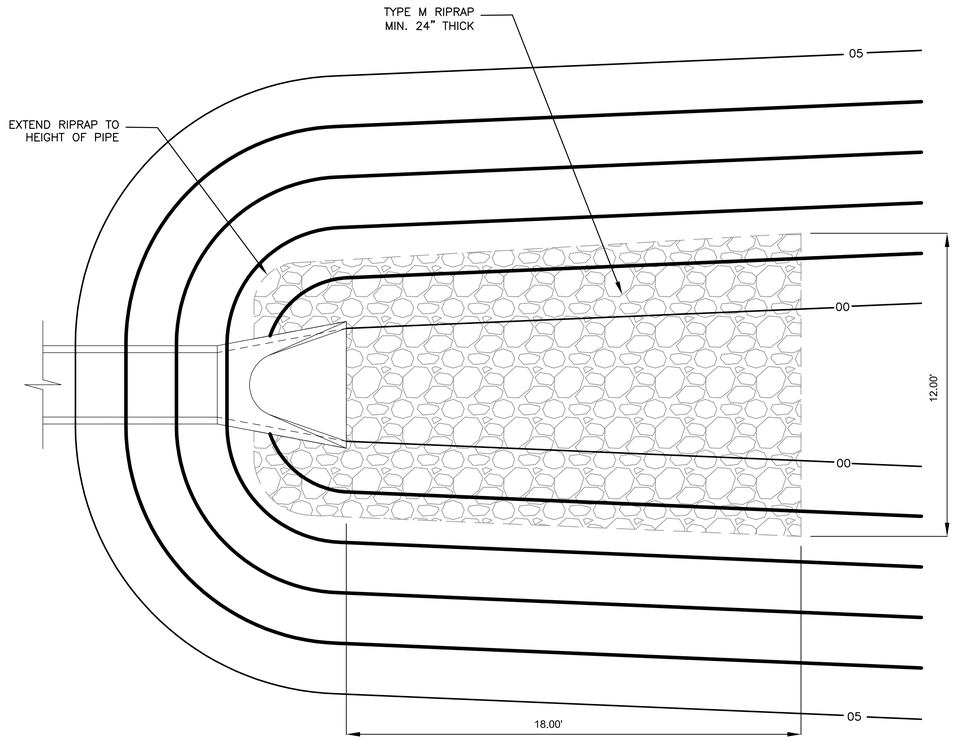
FILENAME 01C-06.dwg
SCALE AS NOTED

SHEET
01C-06



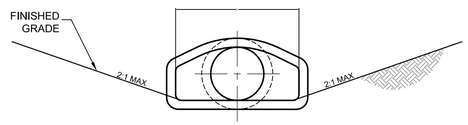
SECTION STORM DRAIN PIPE

K
01C-06

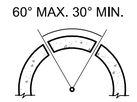


DETAIL
STORM DRAIN OUTFALL PROTECTION

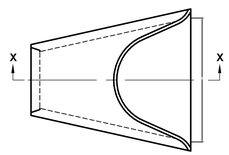
1
01C-05/07



END VIEW

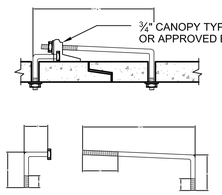


¾" GALVANIZED ANCHOR BOLTS, NUTS, AND WASHERS, MILD STEEL, ASTM A 307.
ROD LUG SHALL BE GALVANIZED OR APPROVED EQUAL.



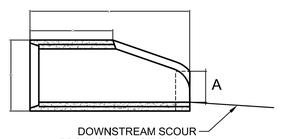
PLAN

PIPE I.D.	DIMENSIONS			
	A	C	L	E
	INCHES			
18	10	48	78	36
24	12	48	78	48
30	14	36	96	60
36	18	36	96	72
42	24	36	96	78
48	28	24	96	84
54	USE HEADWALL / WINGWALL			
60				
72				



PIPE DIAMETER	F
INCHES	
18 - 30	5
36 - 42	6
48 - 60	7
72 - 84	9

CONCRETE JOINT FASTENER
(TWO PER JOINT)
NTS



SECTION X-X

GENERAL NOTES:

1. DIMENSIONS OF END SECTIONS MAY VARY SLIGHTLY FROM THOSE SHOWN ON THE TABLES DUE TO DIFFERENT MANUFACTURERS' CONFIGURATIONS.
2. CONCRETE END SECTIONS SHALL BE FURNISHED WITH TONGUE OR GROOVE AS REQUIRED.
3. THE INSIDE CONFIGURATION AND THE JOINT OF CONCRETE END SECTION AND PIPE SHALL MATCH.
4. CONCRETE PIPE JOINT FASTENERS SHALL BE INSTALLED SO THAT A MINIMUM OF 20 LINEAR FEET OF THE OUTLET END OF THE PIPE ARE MECHANICALLY LOCKED TOGETHER. END SECTION LENGTHS WHEN USED, SHALL BE INCLUDED IN THE 20 LF REQUIREMENT.
5. PLASTIC END SECTIONS SHALL NOT BE USED.

DETAIL
REINFORCED CONCRETE PIPE END SECTION
NOT TO SCALE

2
01C-05/07

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ISSUE	DATE	DESCRIPTION
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100%	4/16/2021	FINAL DESIGN
90%	2/12/2021	PRE-FINAL DESIGN
60%	01/22/2021	INTERMEDIATE DESIGN PACKAGE

PROJECT MANAGER TRAVIS SNYDER
DRAWN BY J. MCANALLY
PROJECT NUMBER 10092468

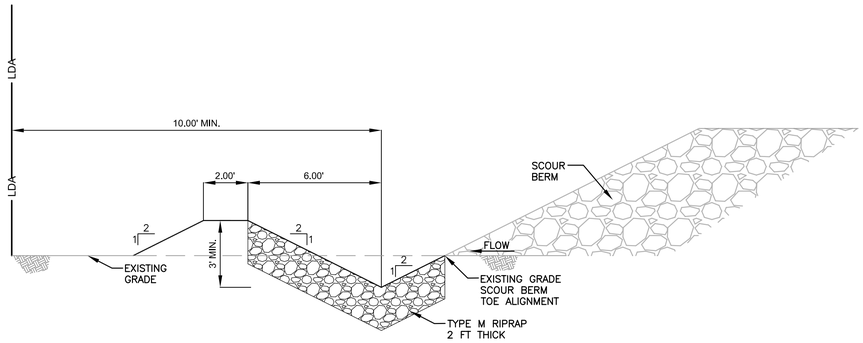
COLORADO LICENSED
TIMOTHY M. KNAPP
21410
PROFESSIONAL ENGINEER

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

CIVIL
DRAINAGE & EROSION CONTROL DETAILS

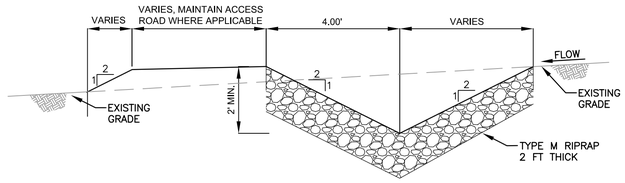
FILENAME 01C-07.dwg
SCALE 1"=3'

SHEET
01C-07



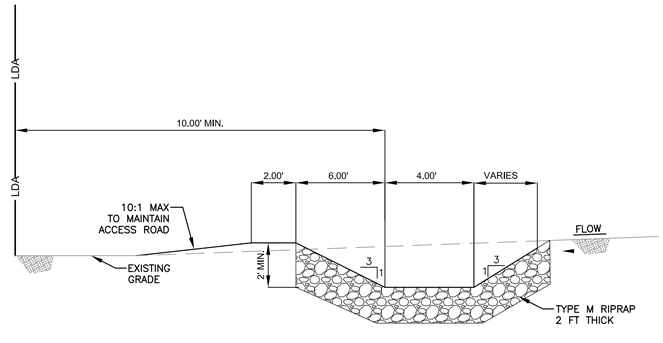
DETAIL 3 01C-05

EARTH DIKE & DRAINAGE SWALE
(CONVEYANCE BELOW SCOUR BERM)



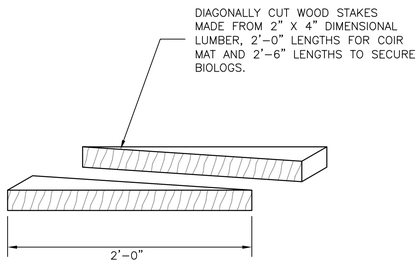
DETAIL 4 01C-05

EARTH DIKE & DRAINAGE SWALE
(DIVERSION AROUND DISTURBED AREAS)

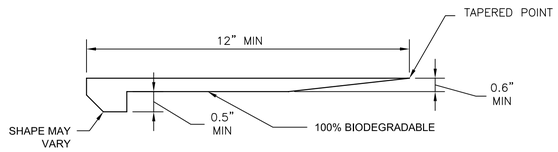


DETAIL 5 01C-06

EARTH DIKE & DRAINAGE SWALE
BETWEEN SCOUR BERM AND CULVERT



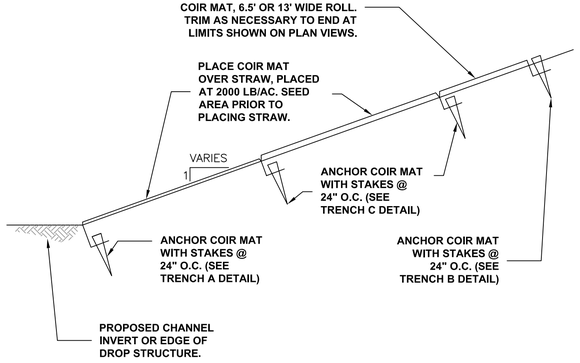
CUT WOOD



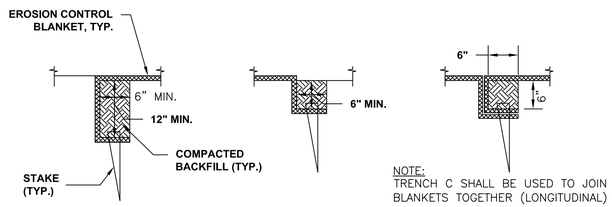
PROPRIETARY

NOTES
1. PLACE STAKES 1'–6" O.C. TO 3' ABOVE WATER, THEN 2' O.C. TO UPPER LIMIT OF FABRIC.

STAKES



COIR MAT PLACEMENT DETAIL



TRENCH A TRENCH B TRENCH C

ANCHOR TRENCH DETAILS FOR EROSION CONTROL BLANKETS

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ISSUE	DATE	DESCRIPTION
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90%	2/12/2021	PRE-FINAL DESIGN
60%	01/22/2021	INTERMEDIATE DESIGN PACKAGE

PROJECT MANAGER TRAVIS SNYDER
DRAWN BY J. MCANALLY
PROJECT NUMBER 10092468

COLORADO LICENSED
TRAVIS J. SNYDER
25410
PROFESSIONAL ENGINEER

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

CIVIL
DRAINAGE & EROSION CONTROL DETAILS

FILENAME 01C-08.dwg
SCALE NTS

SHEET
01C-08

SLOPE	RECLAMATION DESCRIPTION	SYMBOL	PLAN AREA
VARIES	MULCH		31.5 ACRES
2.0H:1V	HYDRO MULCH		11.1 ACRES
>3.0H:1V	TYPE L SOIL RIPRAP WITH STAKED COIR MATTING		2.9 ACRES
VARIES	TYPE M RIPRAP		1.0 ACRES

N

LQRA2 LQRA3 LQRA4 LQRA5

POINT1 POINT2 POINT3

100 50 0 100 200
SCALE IN FEET

NOTES:
1. PERMIT APPLICANT: AGGREGATE INDUSTRIES-WCR, INC.
2. PERMIT BOUNDARY FROM CURRENT PERMIT EXHIBIT F DATED SEPT. 2002.
3. AREAS OF RE-VEGETATION AS SHOWN ARE APPROXIMATE. RE-VEGETATION AREAS WILL BE BASED OFF OF FINAL TOPOGRAPHIC SURVEY.

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ISSUE	DATE	DESCRIPTION
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90%	2/12/2021	PRE-FINAL DESIGN
60%	01/22/2021	INTERMEDIATE DESIGN PACKAGE

PROJECT MANAGER TRAVIS SNYDER
DRAWN BY R. NALLEY
PROJECT NUMBER 10092468

COLORADO LICENSED TIMOTHY J. SNYDER 37410 PROFESSIONAL ENGINEER 6/21/21

AGGREGATE INDUSTRIES
LYONS QUARRY
RECLAMATION PROJECT

CIVIL
OVERALL RECLAMATION PLAN & DETAILS

FILENAME 01C-09.dwg
SCALE AS NOTED
SHEET 01C-09

Attachment I.

Lyons Quarry – Catchment Basin O&M Plan (Draft)

June 2021

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Lyons Quarry Catchment Basin Operation and Maintenance (O&M) Plan

1 Introduction and General Information

1.1 Facility Information

This plan serves to outline the procedures for operation and maintenance of the proposed rockfall and sediment catchment basins for Lyons Quarry (Boulder County Parcel # 120125000007). Aggregate Industries operated the Lyons Quarry mine located 3 miles southwest of the town of Lyons, Colorado, in the South St. Vrain canyon area. Quartz monzonite was extracted from the mine between 1977 and 2008. While the mining permit for the quarry is still under active status with the Colorado Division of Reclamation, Mining and Safety (DRMS), the quarry is currently inactive and in the process of closure and reclamation in accordance the rules and regulations of DRMS.

Reclamation for Lyons Quarry is proposed to occur in two Phases. Phase 1 includes all areas above the historic 100-year floodplain area such as the quarry pit #1 in the center of the site, quarry #2 in the southwest corner of the site (Figure 1 below), associated fill areas as well as the high wall and crest (top) of the quarry to the south. Phase 2 would include the toe of the quarry area and the floodplain north to South St. Vrain Creek. The east and west boundaries of the mine permit are the approximate extents of reclamation for the floodplain. If necessary, this O&M Plan may be revised at the completion of the Phase 1 and Phase 2 reclamation plan activities.

Figure 1 - Lyons Quarry Pit Configuration

1.2 Organization Responsible for O&M

Aggregate Industries-WCR will be completing reclamation of the Site in 2022 to meet requirements of the State of Colorado 112d mine permit# M-1977-141. Aggregate Industries will be responsible for the O&M of all features of the site until the mine permit is released by DRMS. At this point, Boulder County Parks and Open Space will assume responsibility for the Site O&M. Boulder County Parks & Open Space (located at 5201 St Vrain Rd Bldg. 1, Longmont, CO 80503 [303.678.6200]), purchased the property known as the Hall Ranch Open Space in 2011 with proceeds from an open space tax passed by voters. Aggregate Industries and Boulder County have been working together over the years to transfer the site and enhance the final configuration for the proposed future land use.

Boulder County has been working on plans for how to manage the property for public recreational and natural resource conservation purposes following the completion of reclamation by Aggregate Industries, which is scheduled for February 2022. Boulder County wants to maintain this schedule so that the public may begin to enjoy the benefit of the substantial investment it made in this property.

1.3 Facility Overview

The site is described as having a surface elevation (El.) of 5,508 feet near the northeastern entrance of the site to above El. 6,000 feet at the south end of the site. The existing natural slopes in sedimentary rock strata are as steep as 1.75H:1V, where the sedimentary strata are capped by the Lyons Sandstone. Where the sedimentary rocks are not capped by the Lyons Sandstone, slopes ranged from 2H:1V to 4H:1V. The mining plan splits the operation up into two quarries as shown in Attachment A - Figure 5 of Technical Revision 5. Quarry 1 is at the east end and at the base of the 300-foot tall high wall. Quarry 1 is bounded on the south and west by the highwall protrusion and on the east and northeast by backfill material. A constructed swale allows access into Quarry 1 between the backfill and an access road ramp that leads to Quarry 2 to the west. The horseshoe-shaped Quarry 2 is in the southwest corner of the operation and is bounded on the east, south and west by quarry highwalls. Quarry 2 was partially backfilled in 2017 but still has highwalls approximately 100 feet in height.

The flattest measured slopes were in areas mapped as landslides. Existing natural slopes in the dacite are nearly vertical where the dacite is exposed along the north side of South St. Vrain Creek. Where the dacite outcrops in the drainage along the west side of the site, the existing natural slopes range from 0.3H:1V to 2.2H:1V. This large range in the natural slope was measured along west-facing slopes over a span of approximately 300 feet. Surface water is present along the north edge of the site, in South St. Vrain Creek. Groundwater is present, ponded in low areas and observed as wet areas along the base of the highwall. Groundwater is also anticipated perched above siltstone and shale layers in the Fountain Formation.

Rockfall and Sediment Catchment Basins

The proposed plan for construction of the rockfall catchment basins along the northeast and northwest-facing high walls of the quarry can be found in the DRMS Mine Permit Technical Revision #5 – Section 3.8 for Lyons Quarry. With the proposed changes to the site grading plan, corresponding revisions to the 2017 approved plan for channeling stormwater runoff and controlling erosion will be necessary. As with the original plan, slopes equal to or less than 2H:1V will be stabilized with appropriate Best Management Practices (BMP's) including straw wattles and/or silt fencing. Slopes steeper than 2H:1V may not be feasible to install BMPs but will be channeled to the rockfall catchment basin located within

the main pit of the quarry, and a secondary earthen berm around the scour berm at the toe of the quarry to capture potentially suspended sediments.

The runoff control channel that ran along the west perimeter of the quarry will be realigned to convey drainage through the reconstructed swale of Quarry 2 into the catchment basin of Quarry 1 (shown in Attachment A of this O&M Plan). Channelizing and capturing surface runoff within the quarry area would further reduce impacts to areas outside of the already impacted mining activity. Flow will then be directed through the swale and scour berm in Quarry 1 via a 24-inch reinforced concrete pipe (RCP) culvert. This culvert was sized to convey the peak discharge from a 10-year storm event. The culvert outlet will tie into the drainage channel at the toe of the scour berm and direct flow to the east. The culvert is necessary to prevent the retention of water within the catchment basin. Aggregate does not propose to impound water in the catchment basin and all areas will be graded to positively drain through the RCP outlet.

The runoff control channel on the east perimeter of the quarry will remain as previously designed in Technical Revision #2, running along the existing access road grade and tying in with the scour berm toe drainage channel before discharging through a 24-inch RCP culvert running under the site access road to South St. Vrain Creek. This culvert would represent a new discharge point for the site but is needed to convey stormwater under the site access road.

Highwall Stabilization

After the Fountain Formation sandstone at the crest of the highwall has been excavated, the dacite highwall in Quarry 1 (northeast facing) as well as the dacite highwall between Quarry 1 and Quarry 2 (northwest facing), will be scaled to remove any loose rock that accumulated on the highwall naturally or is deposited during excavation of the Fountain Formation. Technical Revision 5, Attachment B – Grading Plan, Sheet 01C-03, Details C, D and E show the proposed configuration of the dacite highwalls along the northwest and northeast faces of Quarry 1.

Scaling of the dacite highwalls removes potential high risk (removable) rocks as well as cleans and exposes the highwall to be evaluated for rock reinforcement. Where rock reinforcement will be needed to stabilize the highwall areas, efforts will be made to minimize the visual impacts of the rock bolts, wire mesh and hardware in order to preserve the exposed rock face to the extent possible.

As mentioned in Section 3.2 of Technical Revision 5, the northeast-facing slopes in Quarry 2 will be backfilled for stabilization. Aggregate Industries proposes to perform as-needed rock reinforcement accompanied by twisted wire mesh and split-set stabilizers to areas of the exposed dacite formation in place of backfilling along the northeast and northwest-facing slopes of Quarry 1. More information on the scaling and rock reinforcement of the dacite highwall can be found in Section 5.1, Item 7, and the Technical Specifications in Attachment G.

2 Operations and Maintenance

2.1 Operating Procedures

Normal operating procedures for facility function, including any seasonal modifications or adjustments.

The catchment basins (shown in Figure 2 below) were designed to provide the necessary runout area to capture 100% of potential rockfall from the sandstone and dacite slopes that would remain exposed along the northwest and northeast-facing slopes of Lyons Quarry. The proposed berm across the opening at the base of the northeast quarry highwall along with the natural topography will create a catchment basin that will be adequate with a factor of safety to catch dacite and sandstone rocks falling from the northeast-facing highwall. The evaluation of the northwest-facing wall shows a 30-foot runout area and an 8-foot-high berm are necessary to catch 100% of rockfall. A factor of safety of 1.5 added to the berm height results in a minimum 12-foot-high berm with 2H:1V side slopes to catch all rockfall from the northwest facing dacite slope. No seasonal modifications or adjustments are anticipated outside of monitoring for erosion or buildup of material within the catchment basin.

Figure 2 - Catchment Basin and O&M Stockpile Area

The combination of the Rock Reinforcement anchors, wire mesh and split set stabilizers are designed to provide stabilization where large blocks are evident in the dacite bedrock. Locations for Rock Reinforcement will be determined by the on-site Engineer after scaling operations are complete. Based on these field observations, the Engineer may increase, reduce, delete, or otherwise alter the Rock Reinforcement as necessary to address actual field conditions. This is anticipated to be addressed once

the slope has been cleared and a formal design of the Rock Reinforcement alignment, placement and depth is determined. The Rock Reinforcement will consist of #10 thread bars installed into the dacite face and anchored with cement grout installed in two phases. A bearing plate, washer and nut will be installed to tension the bolt to the rock surface.

The Rock Reinforcement (Number 10) is intended to provide the necessary stabilization of the dacite highwall where required and be supported by the split sets and twisted wire mesh installed on a fresh, scaled rock face. To prevent the fractured surface of the dacite face from becoming loose and falling away from the area immediately around the Rock Reinforcement, and prior to the #10 thread bar installation, Aggregate will install split set stabilizers (Type SS-33 or equivalent) and twisted wire mesh over the previously-scaled area.

Three split-set stabilizers, each 48 inches long, shall be placed a maximum of 4 (four) feet from the main Rock Reinforcement position in a triangular pattern. Twisted wire mesh provides a free-draining system requiring minimal maintenance compared to shotcrete that may spall or crack, and the mesh is used to apply active retention force to retain rocks and soil on a slope. GeoBrugg Minax 80/4 twisted wire mesh used for quarry highwall applications is specified for use. The mesh along with the split sets and Rock Reinforcement will be hot-dip galvanized to provide corrosion protection and an approximate lifespan of at least 50 years.

2.2 Regular Maintenance

The proposed catchment basins rock reinforcements are designed to require as minimal maintenance as possible. The large basin that is proposed at the base of Quarry 1 is oversized to allow for additional rockfall material. The existing rockfall in this area and on the quarry benches will be scaled during construction so the end product will be a relatively clean basin. Based on the amount of rockfall that has occurred since mining ceased in 2008, and that the overlying sandstone slopes will be graded back, it is estimated that this catchment basin will not fill up for many years, possibly decades.

The catchment berm along the northwest facing slope creates a much smaller basin than the Quarry 1 berm; however, this vertical slope is much shorter as the highwall has already been partially backfilled. The dacite in this area is also much more stable than the northeast-facing dacite. Overall, this area should receive minimal rockfall. *A better estimate for the potential amount of rockfall to expect for both of these catchment basins over a given timeframe will be developed at the end of reclamation once the highwalls have been scaled and stabilized.*

The following measures are recommended in the Federal Highway Administration (FHWA) – Context Sensitive Rock Slope Design Solutions 2011 report which discusses the use of rock anchors and wire mesh as stabilization features. All cut slopes and their attendant stabilization and protection systems must be monitored for damage, weathering, stability, and rock accumulation. Periodic maintenance will be needed to uphold safety (Andrew, et. al. 2011).

Table 2-1 – Maintenance Procedures for Highwall Stabilization and Mitigation Measures

MAINTAINED ITEM	MAINTENANCE PROCEDURE
STABILIZATION MEASURES	
Cut Slope	Periodic scaling (every 2 to 10 years) to remove loosened and/or unstable material.
Rock Bolts	Check to ensure hex nuts and bearing plates are flush with rock face. Tighten any loosened hex nuts to appropriate load.
Injectable Resin/Epoxy	Maintenance of resin/epoxy is not needed after injection. If rockfall or stability problems persist after injection, additional stabilization or protection measures may be needed.
Wire Mesh (Anchored)	Remove any accumulated material suspended in mesh or at slope base. If mesh is damaged, repair or replace damaged section(s).
PROTECTION MEASURES	
Earthen Berms	Clear accumulated material periodically. Repair any damaged section(s) of berm.
Ditches	Clear accumulated material periodically.

2.3 Inspections

Required inspection frequency to verify facilities are being maintained and functioning as designed.

All components of the remedy shall be inspected at least once per year during the Annual Inspection. Additional inspections may be performed as necessary to respond to reports from observers, or to inspect maintenance activities. The following paragraphs describe required inspections. Table 2-2 summarizes the inspections relevant to the catchment basins.

Annual Inspections

Annual Inspections will be conducted by the landowner, Boulder County Parks and Open Space. Table 2-2 summarizes he annual inspections that are required. Inspectors shall provide adequate noting and reporting of changes in hazardous conditions since the last inspection or maintenance was performed including photographic logs to show the progression of the hazard since the last inspection.

Table 2-2 – Summary of Inspection Requirements

#	Component to be Inspected	Minimum Frequency	Maintenance Issues to be Identified
1	General Site Inspection	Annual	Evidence of vandalism, trespassing around gates, storm/flood damage
2	Site Vegetation	Annual	Erosion where vegetation is absent or where vegetation is restricting flow through stormwater conveyances
3	Northeast Quarry 1 Catchment Basin and Berm	Annual	Erosion along berm side slopes. Catchment basin is nearing 50% capacity.
4	Northwest Quarry 2 Catchment Basin and Berm	Annual	Erosion along berm side slopes. Catchment basin is nearing 50% capacity.
5	Quarry Highwall, Benches, and Crest Areas	Annual	Noting major signs of loose ground, cracking, spalling, large and potentially hazardous rocks, or sloughing. Rock bolt/split-set hardware is tight against rock surface. Mesh does not have excessive bulging from loose rock.
6	Drainage Channels and Stormwater Conveyance Through Northeast Catchment Berm	Annual	Clearing of sediment and other debris riprap drainage channels, culverts, water bars, etc.

The Colorado DRMS office will review and approve long-term monitoring/management plans for this permitted site during the reclamation planning process. Once the site has been reclaimed in accordance with the approved reclamation plan and the permit is released from DRMS jurisdiction, no further reporting to the DRMS office is required. Following transfer of the site to Boulder County Parks and Open Space, it is up to the landowner to maintain the site and ensure compliance with all state and local requirements.

2.4 Maintenance Standards.

Minimum standards that are required for the sediment and rock catchment basins to produce desired results and maintenance actions when the minimum standards are not met.

For the catchment basins to retain their effectiveness, periodic cleanout may be required if the basins reach 50% of their capacity according to the estimated volumes for each basin shown in Table 2-2.

Quarry #	Total Base Area (sf)	Average Depth (ft)	Total Capacity (CY)	50% Capacity for Maintenance (CY)
1	59,836	30	66,484	33, 242
2	16,638	12	7,394	3,697

Material removed from the catchment basins shall be transported to the designated stockpile area (Figure 2) located where the current site sedimentation pond is scheduled to be backfilled. This area is outside of the historic 100-year floodplain and is proposed to have 20,000-40,000 CY capacity before the lower section of the basin area is filled. Fill could continue above the basin area at a 3H:1V grade to the south and east, providing additional capacity as needed.

To reduce maintenance of vegetation that could decrease the capacity of the basin or potentially constrict drainage through the swale berm, these areas will not be revegetated at the end of reclamation. If vegetation does become established to the point that these components are affected, the vegetation shall be removed.

Scaling is used to reshape slopes and to stabilize existing slopes and mitigate rockfall. Scaling will be completed immediately after the initial slope construction and periodically thereafter to remove any loosened rocks. Following construction activities, hand scaling is more likely to be needed than mechanical excavation. For hand scaling, workers rappel from the top of the slope or work out of a crane or man lift basket and use steel pry bars or air bags (also known as pneumatic pillows) to remove any loosened rocks. In most cases, several workers are scaling a slope at one time. Hand scaling is effective on slopes that are accessible by workers and that have rocks that are not too big to be removed manually.

As noted in Table 2-1, maintenance activities for the rock reinforcement activities are anticipated to be minimal but could include checking to ensure hex nuts and bearing plates are flush with rock face. Tighten any loosened hex nuts to appropriate load. A scaling bar of adequate length (6-8 feet long) shall be used to sound or strike the rock bolt base plates. A high-pitched “ping” sound indicates the bolt is likely tensioned tight against the rock face and no action is needed. A hollow or dull sound, or visible movement of the plate, indicates the plate may not be making solid contact with the rock face and the bolt should be tensioned. Loose bolts should be photographed, and their locations noted in the annual inspection report. Loose rock bolts should be tensioned whenever major maintenance events are being performed. During these events efforts should be made to remove any accumulated material suspended in the wire mesh or at slope base. If the mesh is damaged, repair or replace as needed.

2.5 Lifespan

Expected lifespan of the facility components.

Due to the catchment basins being constructed of natural, durable soils and rock, the expected lifespan of the rockfall and sediment catchment basin structures is at least 50 years. The life expectancy of the concrete pipe culverts is also assumed to be 50 to 75 years.

For the highwall stabilization features, the Minax twisted wire mesh along with the split sets and Rock Reinforcement (Number 10) anchors will be hot-dip galvanized to provide corrosion protection and an approximate lifespan of at least 50 years. The #10 thread bars and connecting hardware will receive an additional epoxy coating appropriate for their application (12 mil thickness specified).

3 HEALTH AND SAFETY CONSIDERATIONS

This section lists and describes safety and health hazards that may be present while performing O&M activities at the Site.

This section does not constitute a site-specific health and safety plan nor is it intended to relieve any entity performing services or work pursuant to this O&M Plan from following applicable Occupational Safety and Health Administration (OSHA) requirements. The entity performing operation and maintenance activities is required to meet current OSHA requirements, with the exception of State and local government workers, who are outside the jurisdiction of OSHA regulations.

Because requirements change over time and hazards are specific to activities, this information should only be used as a guide. Each time an entity performs work or services at this Site, a site-specific project health and safety plan should be developed.

3.1 Potential Hazards

- **Remote Site Safety:** This project will require work activities in a remote location. The primary hazards associated with working in remote locations are (1) isolation from public rescue services; (2) limited means of communication; (3) exposure to adverse severe weather; and (4) exposure to violence or crime. The potential hazards associated with each remote site visit must be evaluated and mitigated prior to the team departing for the field.
- **Mining Safety:**

Ground instabilities can cause falling rock. Using heavy equipment can crumble highwalls and/or send falling rock onto work areas. Failure to control rockfall with rock-fall fences or barriers may result in injuries and highwall disintegration. If rock debris is not contained or removed, the workplace may become unsafe.

Safe mine operations need to be in place and followed. To ensure the integrity of highwalls, early detection of failing highwalls is key. The design for the Lyons Quarry highwall was developed with preventative measures against potential destruction of expensive equipment or loss of life, but the contractors performing the necessary maintenance should follow the best management practices listed below before and during their work.

These best management practices include:

- Training employees to recognize and report highwall hazards.
- Conducting thorough examinations before beginning work around highwalls
- Noting changing weather conditions and inspecting highwall for major signs of loose ground, cracking, spalling, large potentially hazardous rocks, or sloughing.
- Noting and reporting changes in hazardous conditions since the last maintenance was performed.
- Positioning equipment so it swings away from the highwall.
- Making sure slope spotting occurs regularly while maintenance within the basin is ongoing.

In general, if a single bench or rock ledge is fifty feet high, mining employees are advised to stay fifty feet from the wall. There are no exceptions to this rule. In the case of a double ledge or bench of a hundred feet, it is advised that no one goes nearer than a hundred feet from those benches.

If a maintenance employee notices movement or spots a discontinuity, they are to report their observation to a superior immediately. There is to be no picking up of any rocks along the highwall.

- **Slip, Trip, & Fall Prevention:** Each year, physical injuries due to common slips, trips, and falls while walking account for a significant percentage of all reportable accidents nationwide. Most of these accidents are preventable through proper housekeeping, correct walking surfaces/footwear and simple precautions.
- **Biological Hazards:** Virtually every project site affords the possibility of harboring some form of biological hazard. Biological hazards include wild, domesticated or feral mammals, snakes, spiders, mites, insects, arachnids, noxious plants or harmful bacteria, viruses, fungi – any living organism that can cause injury or illness. These hazards can cause a variety of health effects, including bite trauma, envenomation, skin irritation, allergies, infections or illness, paralysis and death. Due to the nature and location of the project assignments, exposure to biological hazards may be unavoidable.
- **Heat Stress:** Fieldwork conducted during periods of high temperatures and/or humidity can result in heat-related disorders. While there is no specific OSHA standard addressing heat stress, guidelines are available in the publication, *Threshold Limit Values for Chemical Substances and Physical Agents* (latest year), published by the American Conference of Governmental Industrial Hygienists.
- **Cold Stress**: It is much more likely that Site workers incur a cold-induced illness than a heat disorder, as cold stress can occur very rapidly at higher elevations. Preventative steps should be followed during periods of cold weather, especially when combined with high winds and/or precipitation.

4 Attachments

4.1 Lyons Quarry Reclamation Project – 100% Final Design Site Drawings

4.2 Lyons Quarry Reclamation Project - Final Site Drawings – As-Builts *(to be developed)*

5 References

Andrew, R.D., Bartingale, R. and Hume, H. (2011) Context Sensitive Rock Slope Design Solutions (Report No. FHWA-CFL/TD-11-002). Federal Highway Administration.
https://www.fhwa.dot.gov/clas/ctip/context_sensitive_rock_slope_design/