Quarry 5 Reclamation Plan

GCC Rio Grande, Inc.

Tijeras Mine and Mills

February 28th, 2025

Table of Contents

1. Introduction

GCC Rio Grande, Inc. (GCC Rio Grande) owns and operates the Tijeras Mine and Mill, consisting of a Portland cement plant and multiple surface limestone quarries, located near the Village of Tijeras, New Mexico.

GCC Rio Grande is submitting the Quarry 5 Reclamation Plan to the New Mexico Energy, Minerals and Natural Resources Department, Mining and Minerals Division ("MMD") as per MMD Permit #BE001RE, which authorizes mining and reclamation activities on the site. Approval of this plan is required prior to the implementation of reclamation activities in the Quarry 5 area. This plan has been prepared by GCC Rio Grande to meet the requirements of the New Mexico Mining Act, § 69-36-11, New Mexico Statutes Annotated (NMSA) and its implementing regulations including 19.10.5.506, New Mexico Administrative Code (NMAC).

The objective of this plan is to provide for the reestablishment of a "self-sustaining ecosystem" that is consistent with the surrounding area and post-mining land use. This plan describes the measures that will be taken to reclaim the identified disturbances area, establish a self-sustaining ecosystem, and meet environmental standards.

2. Project Description

GCC Rio Grande, Inc. (GCC) proposes to reclaim a portion of Quarry 5 consisting of 44 acres shown in Appendix A Figure 1. The following reclamation description follows the standards of the approved 2019 Mine Closeout Plan. GCC is using a phased approach to execute the reclamation. The target data of completion for the reclamation is 2030. The post mining land use for Quarry 5 is reactional and wildlife habitat.

3. Quarry 5 Engineering Design

GCC will use the Quarry 5 Engineered design from Water & Earth Technologies (WET). Design provides the sloping and contouring for reclaiming the proposed area. The summary also provides information on drainage channels and how those will be lined and incorporated. Stormwater will still be captured by the sediment pond onsite until all operations have ceased.

All reclaimed areas will be stable and exhibit none of the following characteristics:

- Large rills or gullies (greater than 3 inches wide or deep)
- Perceptible soil movement or head cutting in any drainages
- Slope instability on or adjacent to the reclaimed area

See the attached Summary for Quarry 5 Post-Mining Topography (PMT) Design at GCC Tijeras Plant in Appendix B for additional information of the reclamation design.

4. Reclamation Activities

4.1 Reclamation Preparation

To prepare for the approval of the overall reclamation plan. GCC has been in the process of removing the slide failure in Quarry 5 to provide additional material to use in the reclamation process. Overall Reclamation of Quarry 5 will occur as follows:

- Surface Re-contouring and Seedbed Preparation
    - Backfill of excavated areas with stockpiled subsurface overburden materials
    - Contouring of reclaimed subsurface to 3H:1V or flatter
    - Even placement of stockpiled topsoil over area to be reclaimed
    - Harrowing of final topsoil grade for seedbed preparation
- Seeding and Mulching
    - Seed application by broadcast or drill seeding (preferred)
    - Application of mulch
    - Stabilizing mulch through punching or crimping
- Monitoring
    - Monitoring will follow the approved method per the 2019 Mine Closeout Plan

4.2 Surface Re-contouring

Excavated areas will be backfilled with stockpiled subsurface materials only; topsoil will not be placed as backfill. Subsurface soils will then be contoured (graded) to match design plan closely as practicable, with no slopes exceeding 3H:1V. The material needed to complete the contouring will be obtained primarily from Quarry 5. If the material in Quarry 5 is not sufficient, GCC has determined Quarry 7 will be the additional source of material. The material that will be used are limestone and Redbed material. GCC will be using dozers and excavators for the primary contouring work. The facilities Stormwater BMP's will remain in place while the reclamation is in progress.

4.3 Seed Bed Preparation

The geomorphic methods described in Section 5.3.1 of the 2019 Mine Closeout Plan result in range of slopes reflective of the original pre-mining topography with a two-foot deep Redbed topdressing. The 2008 test plot study indicated that the application of fertilizer or organic amendments is not cost effective and that the native Redbed soils is a suitable, effective plant growth medium (Habitat Management 2009). Thus, the re-contoured surface will be conditioned only by surface roughening. A rough final surface facilitates seed entrapment, moisture retention, and erosion control. Surface roughening operations can be conducted either immediately before (contour furrowing) or after (land imprinting) broadcast seeding. Seed will be adequately covered and the seedbed firmed up through the land imprinting process. Localized and natural sloughing, and movement of the soil will also assist in "setting" the seedbed if contour furrowing is used. All sites with a final geomorphic grade will be scarified using a bulldozer equipped with small harrowers. Scarification will be done in two perpendicular passes with the final pass on the contour for added erosion control.

4.4 Seeding

Seed will be sowed across the mine reclamation areas using broadcast. Seed will be as locally sourced as possible and weed-free certified, with each seed bag tagged and labeled with certification information. If primary plant species are not available at time of purchase, replacement species will also be native to the area. All revegetation areas will be broadcast seeded as soon as practicable after Redbed materials have been prepared for planting with three native seed mixtures at a rate of forty pure live seeds per square foot Due to seed size variability and slope variability, most areas will be hand-seeded. Rice hulls will be used as a seed extender to allow for the even application of the seed. Smooth, medium, and large sized seeds that are easily broadcast will be placed in one sub-mixture. Species with small seeds will be placed in their own sub-mixture to avoid differential settling during planting. This sub-mixture will be applied separately (different broadcasters or at different times) from sub-mixtures 1 and 2 in an effort to ensure the even distribution of plant seeds across the reclamation areas. Seed will be applied during the summer before monsoon rains establish, likely in June. A second window of opportunity exists in early November to seed.

GCC will use the approved seed mixture from the 2019 Mine Closeout Plan shown in Table 1.

Table 1- Reclamation Seed Mixture

Species	Common Name	Desired %	PLS/ SqFt	Lbs. PLS/ Acre
	Grasses			
Pascopyrum smithii	Western wheatgrass	5	1	.396
Pseudoroegneria spicata	bluebunch wheatgrass	5	2	0.622
Andropogon hallii	sand bluestem	5	1	0.385
Bouteloua curtipendula	sideoats grama	5	2	0.456
Bouteloua gracilis	blue grama	5	2	0.106
Pleuraphis jamesii	James's galleta	5	1	0.274
Achnatherum hymenoides	Indian ricegrass	5	1	0.309
Sporobolus cryptandrus	sand dropseed	5	2	0.016
Stipa neomexicana	New Mexican feathergrass	5	1	0.379
	Grass Total	**45**	**9**	**2.94**
	Forbs			
Achillea millifolium	western yarrow	3.5	2	0.031
Dalea purpurea	Purple Prairie Clover	3.5	1	0.207
Gaillardia aristata	Indian blanket flower	3.5	1	0.104
Linum lewisii	Lewis (Blue) flax	3.5	2	0.66
Lupinus argenteus	silver mountain lupine	3.5	2	4.760
Fallugia paradoxa	Apache Plume	3.5	2	0.224
Penstemon angustifolia	narrow-leaf penstemon	3.5	2	0.224
Ratibida columnifera	coneflower	3.5	1	0.0354
Sphaeralcea coccinea	scarlet globemallow	3	2	0.174
	Forb Total	**31**	**6.2**	**6.49**
	Shrubs			
Atriplex canescens	four-wing saltbush	3	1	0.837
Krascheninnikovia lanata	winterfat	3	1	0.768
Cercocarpus montanus	mountain mahogany	3	2	1.476
Ericameria nauseosa	rubber rabbitbrush	3	1	0.109

Chrysothamnus viscidiflorus	yellow rabbitbrush	3	1	0.056
Purshia mexicana	New Mexico cliffrose	3	2	1.348
Purshia tridentata	antelope bitterbrush	3	2	5.808
Rosa woodsii	Wood's rose	3	2	1.923
	Shrub Total	**24**	**4.8**	**12.326**
	Seed Mixture Total	**100**	**40**	**21.764**

Notes: pure live seeds = PLS; % = percent

4.4 Revegetation Monitoring

Revegetation monitoring will occur throughout the bonding period.

4.5 Monitor Method

GCC will follow the approved monitoring method per the 2019 Mine Closeout Plan.

4.5 Evaluation of Success Criteria

Per the 2019 Mine Closeout Plan at the beginning in the 10th year after seeding, revegetation success will be evaluated against the approved performance standard. The parameters to be measured on the reclaimed sites shall be equal to or greater than the approved performance standard. The appropriate test is a one-tailed *t* test with a 90% confidence interval. The test statistic is:

$$t = \frac{X_r - 0.90\,(x_h)}{\frac{S_r}{\sqrt{n_r}}}$$

Where

x_r	is the reclamation mean
x_h	is the approved performance standard
s_r	is the reclamation standard deviation
n_r	is the reclamation sample size

If the mean values of the sample parameters from the reclaimed sites are equal to or greater than those of the historical record with the appropriate confidence level, the revegetation shall be deemed successful. To use the above test, the assumptions must be valid that the data is drawn from a normal population. Fortunately, the *t* test remains relatively valid for non-normal populations which possess a mound shaped probability distribution.

5. Bond Release

Once the FA bond period is attained and the re-vegetation has been deemed successful by meeting the standards. GCC will prepare and submit a letter requesting the release of GCC from fiscal responsibility for the reclaimed area.

Appendix A Maps

TABLE 1. QUARRY 5 SUMMARY OF RECLAMATION	
Reclamation Activity	**Area (ac)**
Passively Reclaimed	13.1
Partial Reclamation Operations	1.9
Revegetation Operations	3.2
Comprehensive Reclamation Operations	15.9
Safety Berm (to reclaim with Quarry 7)	1.6
Undisturbed	4.2
TOTAL QUARRY 5 AREA	39.9

REVISIONS

NO.	BY	CKD	DATE	DESCRIPTION

LEGEND

- GEOMORPHIC GRADING BOUNDARY
- V-CHANNEL
- ROCKY BOTTOM CHANNEL
- EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- RIDGE CENTERLINE
- UNDISTURBED CHANNEL
- PASSIVELY RECLAIMED
- PARTIAL RECLAMATION OPERATIONS
- REVEGETATION OPERATIONS
- COMPREHENSIVE RECLAMATION OPERATIONS

WATER & EARTH TECHNOLOGIES

Habitat Management
Environmental & Natural Resource Services

GCC

GCC TIJERAS
11783 NM 337
TIJERAS, NM 87059-8619
(505) 286-6081

SEAL
RYAN T. WADE
NEW MEXICO
20564
PROFESSIONAL ENGINEER
Ryan Wade 2-14-25

DWG TITLE
QUARRY 5 RECLAMATION PLAN OVERVIEW

PLAN SET: Q5 RECLAMATION
DWG. NO.: 1
DATE: 2/10/2025
DESIGNED BY: RTW
FILEPATH: GCC_Quarry 5/AutoCAD/Q5 Design_West_Final.dwg
PAPER SIZE: ANSI D - 34" X 22"

PARTIAL RECLAMATION OPERATIONS

Notes:
1. Topdressing shall be applied across the treatment area with a target depth of 1-foot.
2. Topdressing shall contain at least 10% coarse fragments after application.
3. Topdressing shall be deep ripped, along the contour, with a dozer-mounted 3-gang ripper.
4. Topdressing will be seeded with shrub species following deep ripping activities.
5. Topdressing quantity (1-foot application depth) = 2,886 CY.

REVISIONS				
NO.	BY	CKD	DATE	DESCRIPTION

LEGEND

- GEOMORPHIC GRADING BOUNDARY
- V-CHANNEL
- ROCKY BOTTOM CHANNEL
- EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- UNDISTURBED CHANNEL
- PASSIVELY RECLAIMED
- PARTIAL RECLAMATION OPERATIONS
- REVEGETATION OPERATIONS
- COMPREHENSIVE RECLAMATION OPERATIONS

WATER & EARTH TECHNOLOGIES

Habitat Management Environmental & Natural Resource Services

GCC

GCC TIJERAS
11783 NM 337
TIJERAS, NM 87059-8619
(505) 286-6081

SEAL: RYAN T. WADE NEW MEXICO 20564 PROFESSIONAL ENGINEER — Ryan Wade 2-14-25

DWG TITLE: QUARTO 5 PARTIAL RECLAMATION OPERATIONS

PLAN SET: Q5 RECLAMATION

DWG. NO.: 2

DATE: 2/10/2025

DESIGNED BY: RTW

FILEPATH: GCC_Quarry 5/AutoCAD/Q5 Design_West_Final.dwg

PAPER SIZE: ANSI D - 34" X 22"

QUARRY 5 EARTHWORK SUMMARY			
Reclamation Area by Activity	Area (ac)	Cut (CY)	Fill (CY)
Passively Reclaimed	13.1	-	-
Partial Reclamation Operations	1.9	166	3,047
Revegetation Operations	3.2	-	-
Comprehensive Reclamation Operations	15.9	19,251	45,243
Total Topdressing Import Volume	-	-	28,873

Earthwork Zone	Area (ac)	Cut (CY)	Fill (CY)	Cut-Fill Balance (CY)	Notes:
Zone 1	2.2	1,511	4,975	3,464 (Net Fill)	Import 3,464 CY of Topdressing.
Zone 2	2.6	2,712	6,797	4,085 (Net Fill)	Import 4,085 CY of Topdressing.
Zone 3	2.0	5,232	4,737	495 (Net Cut)	Export 3,580 CY to Zone 4. Import 3,085 CY of Topdressing.
Zone 4	5.6	7,903	21,543	13,640 (Net Fill)	Import 3,580 CY from Zone 3 and Import an additional 10,045 CY of Topdressing.
Zone 5	1.3	845	2,859	2,014 (Net Fill)	Import 2,014 CY of Topdressing.
Zone 6	0.9	593	1,870	1,277 (Net Fill)	Export 145 CY to Zone 7 and Import 1,422 CY of Topdressing.
Zone 7	0.9	357	1,862	1,505 (Net Fill)	Import 145 CY from Zone 7 and Import 1,370 CY of Topdressing.
Zone 8	0.3	98	600	502 (Net Fill)	Import 502 CY of Topdressing.
Zone 9	1.8	-	2,886	2,886 (Net Fill)	Import 2,886 CY of Topdressing.
Zone 10	0.1	166	161	5 (Net Cut)	No Topdressing Import Required.

REVISIONS

NO.	BY	CKD	DATE	DESCRIPTION

LEGEND

- GEOMORPHIC GRADING BOUNDARY
- V-CHANNEL
- ROCKY BOTTOM CHANNEL
- EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- UNDISTURBED CHANNEL
- EARTHWORK ZONE
- PASSIVELY RECLAIMED
- PARTIAL RECLAMATION OPERATIONS
- REVEGETATION OPERATIONS

WATER & EARTH TECHNOLOGIES

Habitat Management
Environmental & Natural Resource Services

GCC

GCC TIJERAS
11783 NM 337
TIJERAS, NM 87059-8619
(505) 286-6081

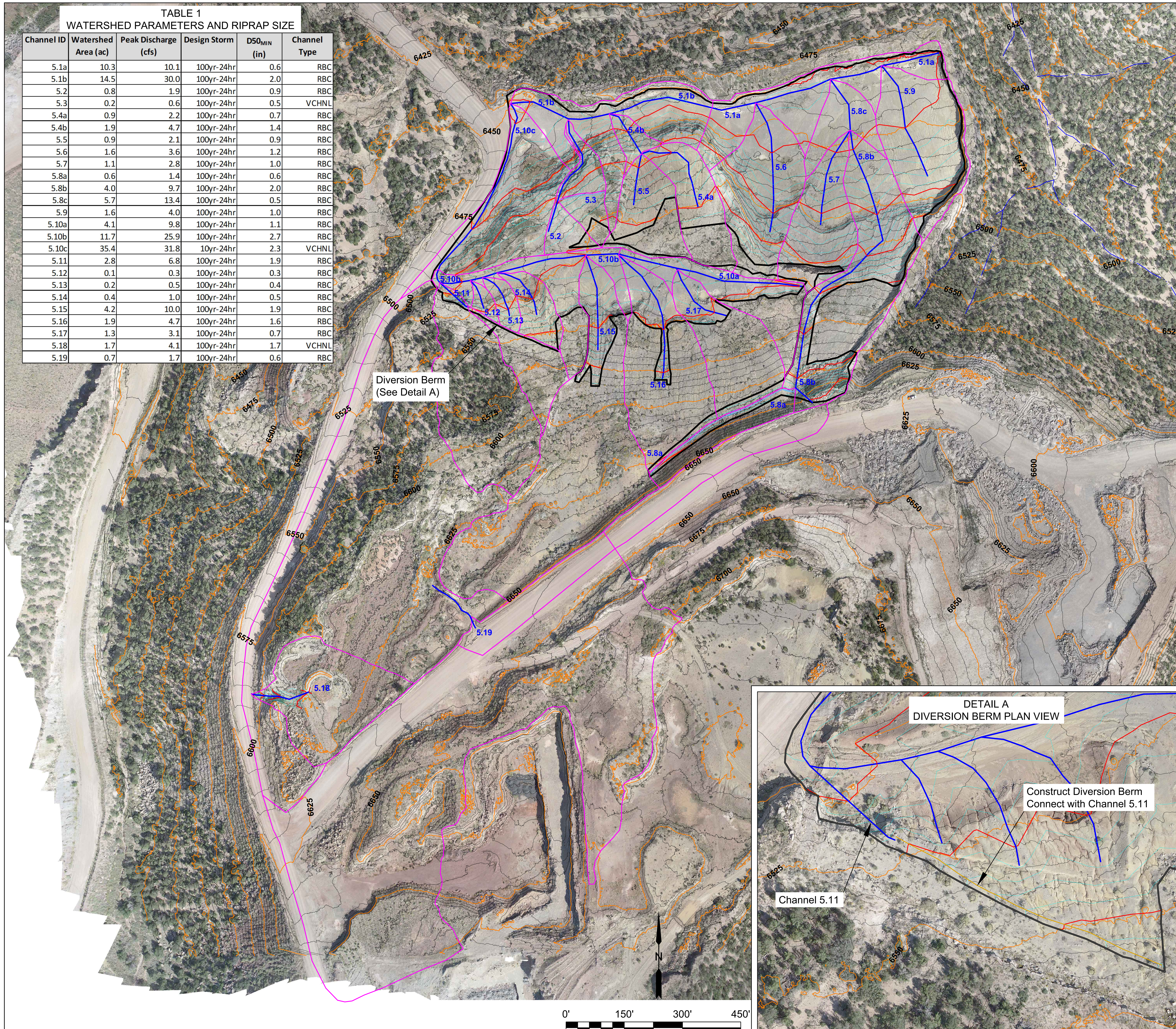
SEAL
RYAN T. WADE
NEW MEXICO
20564
PROFESSIONAL ENGINEER
2-14-25

DWG TITLE
QUARRY 5 COMPREHENSIVE RECLAMATION OPERATIONS GRADING QUANTITIES

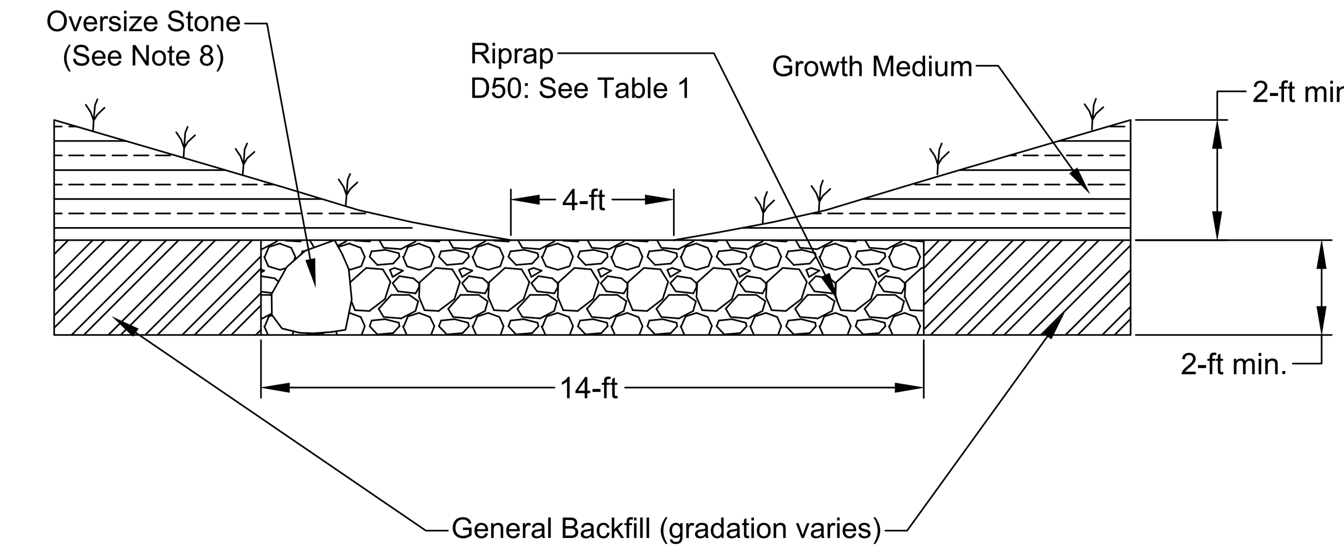
PLAN SET: Q5 RECLAMATION
DWG. NO.: 3
DATE: 2/10/2025
DESIGNED BY: RTW
FILEPATH: GCC_Quarry 5/AutoCAD/Q5 Design_West_Final.dwg
PAPER SIZE: ANSI D - 34" X 22"

TABLE 1
WATERSHED PARAMETERS AND RIPRAP SIZE

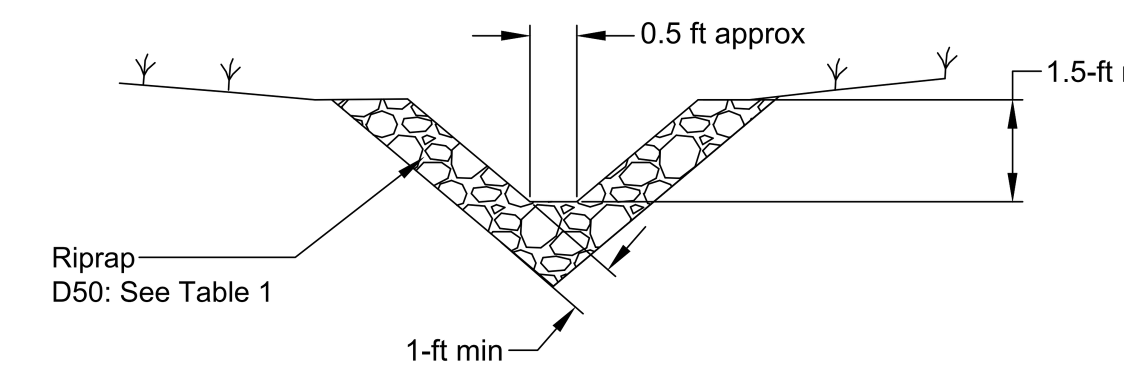
Channel ID	Watershed Area (ac)	Peak Discharge (cfs)	Design Storm	$D50_{MIN}$ (in)	Channel Type
5.1a	10.3	10.1	100yr-24hr	0.6	RBC
5.1b	14.5	30.0	100yr-24hr	2.0	RBC
5.2	0.8	1.9	100yr-24hr	0.9	RBC
5.3	0.2	0.6	100yr-24hr	0.5	VCHNL
5.4a	0.9	2.2	100yr-24hr	0.7	RBC
5.4b	1.9	4.7	100yr-24hr	1.4	RBC
5.5	0.9	2.1	100yr-24hr	0.9	RBC
5.6	1.6	3.6	100yr-24hr	1.2	RBC
5.7	1.1	2.8	100yr-24hr	1.0	RBC
5.8a	0.6	1.4	100yr-24hr	0.6	RBC
5.8b	4.0	9.7	100yr-24hr	2.0	RBC
5.8c	5.7	13.4	100yr-24hr	0.5	RBC
5.9	1.6	4.0	100yr-24hr	1.0	RBC
5.10a	4.1	9.8	100yr-24hr	1.1	RBC
5.10b	11.7	25.9	100yr-24hr	2.7	RBC
5.10c	35.4	31.8	10yr-24hr	2.3	VCHNL
5.11	2.8	6.8	100yr-24hr	1.9	RBC
5.12	0.1	0.3	100yr-24hr	0.3	RBC
5.13	0.2	0.5	100yr-24hr	0.4	RBC
5.14	0.4	1.0	100yr-24hr	0.5	RBC
5.15	4.2	10.0	100yr-24hr	1.9	RBC
5.16	1.9	4.7	100yr-24hr	1.6	RBC
5.17	1.3	3.1	100yr-24hr	0.7	RBC
5.18	1.7	4.1	100yr-24hr	1.7	VCHNL
5.19	0.7	1.7	100yr-24hr	0.6	RBC



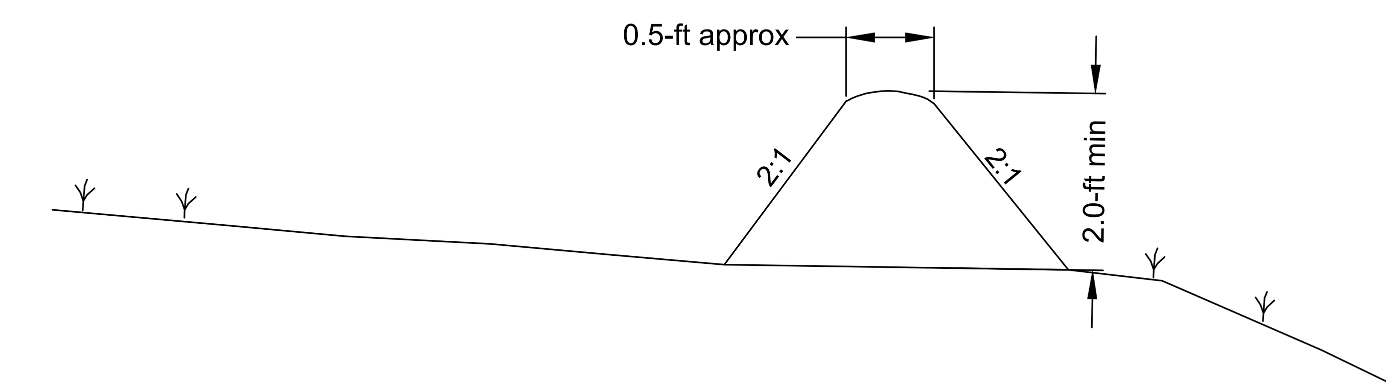
TYPICAL ROCKY BOTTOM CHANNEL (RBC)
CROSS-SECTION VIEW



TYPICAL V-CHANNEL (VCHNL)
CROSS-SECTION VIEW



TYPICAL DIVERSION BERM (DBERM)
CROSS-SECTION VIEW



NOTES

1. FINAL SURFACE TOPOGRAPHY SHOWN. THIS INCLUDES A MINIMUM 2-FOOT COVER OF TOPDRESSING.
2. THE TYPICAL ROCKY BOTTOM CHANNEL AND V CHANNEL SHALL BE CONSTRUCTED FROM RIPRAP.
3. THE RIPRAP WILL BE HARD, ANGULAR, AND HIGHLY WEATHER-RESISTANT.
4. CALCAREOUS SHALE, AND OTHER NON WEATHER-RESISTANT STONE ARE NOT PERMITTED IN THE RIPRAP.
5. THE RIPRAP SHALL CONSIST OF A WELL-GRADED MIXTURE OF STONE. LARGER STONE SHALL PREDOMINATE, WITH SUFFICIENT SMALLER SIZES TO FILL VOIDS BETWEEN STONES.
6. THE RIPRAP MAY INCLUDE UP TO 35 PERCENT SOIL BY VOLUME, WITH THE REMAINING 65 PERCENT COMPOSED OF STONE.
7. THE RIPRAP GRADATION IS DEFINED BY THE D50 SIZE, AND SHALL BE AT LEAST AS LARGE AS THE MINIMUM D50 SPECIFIED IN TABLE 1. IF THE RIPRAP CONTAINS A SOIL FRACTION (UP TO 35 PERCENT), THE MINIMUM D50 SIZE APPLIES TO THE STONE FRACTION ONLY.
8. THE RIPRAP MAY INCLUDE MINOR AMOUNTS OF OVERSIZE STONE (LARGER THAN 6 INCHES). OVERSIZE STONES ARE ALLOWED IN THE RIPRAP PROVIDED THAT:
   - 8.1. STONES ARE LESS THAN 2-FEET IN DIAMETER,
   - 8.2. DO NOT CREATE SIGNIFICANT VOIDS ,
   - 8.3. DO NOT PROTRUDE ABOVE THE TOP OF THE RIPRAP LAYER,
   - 8.4. DO NOT EXCEED 10 PERCENT OF THE RIPRAP VOLUME, AND
   - 8.5. MUST BE SCATTERED AND NOT BE GROUPED TOGETHER.

REVISIONS				
NO.	BY	CKD	DATE	DESCRIPTION

LEGEND

- GEOMORPHIC GRADING BOUNDARY
- 5.3 V-CHANNEL WITH CHANNEL ID
- 5.1 ROCKY BOTTOM CHANNEL WITH CHANNEL ID
- EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- UNDISTURBED CHANNEL
- SUBWATERSHED BOUNDARY
- DIVERSION BERM (DBERM) CENTERLINE

WATER&EARTH TECHNOLOGIES
Habitat Management
Environmental & Natural Resource Services

GCC
GCC TIJERAS
11783 NM 337
TIJERAS, NM 87059-8619
(505) 286-6081

SEAL
RYAN T. WADE
NEW MEXICO
20564
PROFESSIONAL ENGINEER
Ryan Wade 2-14-25

DWG TITLE	PLAN SET
QUARRY 5 DRAINAGE STRUCTURES & WATERSHED BOUNDARIES	Q5 RECLAMATION
	DWG. NO. 4
	DATE 2/10/2025
DESIGNED BY RTW; FILEPATH GCC_Quarry 5/AutoCAD/Q5 Design_West_Final.dwg	PAPER SIZE ANSI D - 34" X 22"

Appendix B Quarry 5 Design Summary

GCC Tijeras Mine and Mill
Quarry 5 Reclamation Plan

February 14, 2025

Prepared for:

GCC Rio Grande Inc.

11783 Highway 337 South

Tijeras, New Mexico 87123

Prepared by:

Water & Earth Technologies, Inc.

40504 Weld County Road 17

Severance, Colorado 80524

And:

Habitat Management Inc.

14 Inverness Drive East Suite A-100

Englewood, Colorado 80112

I, Ryan Wade, state that the information presented in this report entitled "GCC Tijeras Mine and Mill Quarry 5 Reclamation Plan" was prepared by me or a person(s) under my supervision and is correct to the best of my knowledge and information. I have personally inspected the Quarry 5 reclamation site.

RYAN T. WADE
NEW MEXICO
20564
PROFESSIONAL ENGINEER

Ryan Wade 2-14-25

CONTENTS

FIGURES

PHOTOGRAPHS

TABLES

APPENDICES

DRAWINGS

RECLAMATION PLAN INTRODUCTION

GCC Rio Grande, Inc. (“GCC”) will reclaim Quarry 5 located within the Tijeras Plant and Limestone Quarry as described in this plan. This reclamation plan includes a Geomorphic Topography Design (“GTD”), hydrology and hydraulics analyses, topdressing specifications, and reclamation performance standards. The plan has been developed and is designed to reclaim a stable landform that is self-sustaining and capable of supporting the approved post-mining land use.

Quarry 5 is located immediately south of the cement plant and offices (Photograph 1: Quarry 5 Reclamation Boundary (Outlined in Green)). It is comprised of approximately 40 acres with about 36 acres of disturbance and 4 acres of undisturbed land. Quarry 5 is a moderately steep landform with northerly aspects. Slope gradients generally range from 10 to 33 percent. A minor amount of off-site stormwater flows onto Quarry 5 (1.6 acres). Currently, there is a small pit in the northeast corner of Quarry 5. GCC personnel have observed that long-term ponding does not occur in this pit; nonetheless, this reclamation plan involves backfilling the small pit in northeastern Quarry 5 to establish positive drainage to the west.

This plan enhances and accelerates Quarry 5 reclamation by:

- Preserving passively reclaimed areas that are already sufficiently stable with well-developed cover consisting of suitable, primarily native vegetation.
- Specifying partial reclamation operations for those areas that are nearing suitable surface stability and have significant amounts of native vegetation growth.
- Requiring comprehensive reclamation operations for land affected by mining where no reclamation operations have been performed to date.

An overview of the reclamation plan is presented on Drawing 1: Quarry 5 Reclamation Plan

GEOFLUVIAL POST-MINING TOPOGRAPHY DESIGN

The GTD incorporates state-of-the-art geomorphic design principles and drainage features/structures using currently accepted models, methods and environmental data. The GTD establishes positive drainage that routes stormwater runoff from Quarry 5 eventually into Sediment Pond 1. Currently stormwater runoff from Quarry 5’s watershed runs into two main locations; a low area in the northeast corner of the quarry (that has the potential to impound stormwater runoff) and the northwestern corner of the quarry. The eastern portion of the quarry is about one-third of the watershed and the western portion about two-thirds of the watershed. The GTD requires backfilling and grading of cut and fill materials to create positive drainage from the northeastern corner to the northwestern corner of the disturbed area. Stormwater runoff is routed from this northwestern corner through existing drainage structures to Sediment Pond 1.

Photograph 1: Quarry 5 Reclamation Boundary (Outlined in Green)

RECLAMATION OPERATIONS AREAS

Under this plan disturbed land in Quarry 5 is separated into four reclamation operations categories:

- Passively Reclaimed–Previously backfilled and graded, sufficiently stable and revegetated, requiring no further reclamation operations.
- Partial Reclamation Operations–Requires limited finish grading, topdressing placement, surface roughening and limited seeding.
- Revegetation Operations – Requires revegetation operations only (seeding/mulching).
- Comprehensive Reclamation Operations–Requires full reclamation operations.

Reclamation operations for disturbance categories is detailed below.

PASSIVELY RECLAIMED AREA

Passively reclaimed land is located primarily in the southwestern region of Quarry 5, with narrower bands extending along the eastern and northern edges and a 1.8-acre inclusion in the south-central portion of the disturbed area. A review of historic aerial photographs reveals that redbed soils were backfilled and spread beginning in 2012 and ending by 2020. This area was not seeded by GCC, but instead was passively colonized with native seeds and propagules.

Passive reclaimed areas were initially identified on aerial photography and ground-truthed through several field observations. New Mexico Mining and Minerals Division (MMD) personnel observed these areas May 10th, 2024, and generally agreed on their level of reclamation suitability. Passively reclaimed lands have well-developed vegetation composed primarily of native grasses, forbs and woody species (Photograph 2: Reclaimed Land in Quarry 5 Colonized with Mature Vegetation).

Photograph 2: Reclaimed Land in Quarry 5 Colonized with Mature Vegetation

Woody species include both shrubs and coniferous trees. The establishing community is permanent and capable of self-generation. The reclaimed vegetation community will be capable of supporting the post-mining land use. Passively reclaimed lands are stable with respect to soil erosion. There is one isolated gulley that has eroded due to concentrated flow that enters this area from an opening in the safety berm. The gulley feature will be stabilized with rock riprap (See Drawings).

PARTIAL RECLAMATION OPERATIONS AREA

Partial reclamation operation areas were previously rough backfilled and graded (Drawing 2: Partial Reclamation Operations). Backfilling and grading operations consisted of parallel dozer pushes down the slope. Finish grading was performed non-uniformly. Evidence of surface roughening isn't currently present. Currently numerous rills and small gullies are present and scattered throughout this 1.8-acre area. The rills and gulleys coincide with the dozer pattern, and likely resulted from flow concentrations created by small ruts and windrows created by bulldozer tracks. This area has medium to low density vegetation cover.

Partial reclamation operations include the following components either singly or in combination:

- Spread topdressing over portions of the area where the plant growth medium is inadequate in depth or of unsuitable quality.
- Roughen topdressing placement areas along the contour with a bulldozer mounted ripper.
- Alleviate compacted areas along the contour with a bulldozer equipped with a ripper.
- Contour rip areas with excessive rills or soil erosion.
- Perform seeding and mulching on disturbed areas, areas treated during Quarry 5 reclamation operations and areas where vegetation cover development is substandard.

A permanent channel will be constructed at the top of the slope that diverts stormwater runon eastward to a reclaimed channel.

REVEGETATION OPERATIONS AREA

This portion of Quarry 5 has been disturbed by mining and then passively reclaimed. However, during Quarry 5 reclamation, heavy equipment access will result in incidental re-disturbance of these areas. Significant dozer ruts and windrows shall be blended to the surrounding terrain, the surface will be roughened (preferably through contour ripping) and followed by revegetation operations.

COMPREHENSIVE RECLAMATION OPERATIONS AREA

This portion of Quarry 5 has been disturbed by mining and to date reclamation operations have not been performed. The PMT is characterized by complex topography created with a series of ridges and valleys. The low part of the pit in the northeast corner of Quarry 5 will be backfilled and graded to establish positive drainage to the northwest corner of the quarry. Stormwater from the entire quarry will converge at the northwest corner, as it currently does, and then flow in a haul road ditch northwesterly towards Sediment Pond 1. Cut and fill zones and their respective volumetrics are detailed on Drawing 3: Comprehensive Reclamation Operations Grading Quantities. The GTD includes the following geomorphic reclamation concepts:

- Concave channel profiles and hillslopes.
- Drainage density equal to or greater than adjacent similar gradient undisturbed lands.

- Complex topography with a variety of slope aspects.
- Slope lengths are limited by their gradients to control soil erosion.

Highwalls that bound the east and north sides of Quarry 5 will be retained as wildlife habitat. The highwalls will be scaled as necessary to remove loose rock that historically has resulted in cavities and ledges that serve as wildlife habitat. Scaling activities will also produce talus below the reconstructed bluff base. This talus serves to control erosion and provide additional wildlife habitat.

Following backfilling and grading, and drainage feature construction, topdressing will be placed on the disturbed area as described below (see TOPDRESSING & REVEGETATION). After topdressing placement, the surface will be roughened (preferably through contour ripping) followed by revegetation operations.

DRAINAGE STRUCTURES-TEMPORARY & PERMANENT

Quarry 5 reclamation includes both temporary and permanent channels, and one diversion berm that will direct sheet flow away from a steep and erosion-prone hillslope (Drawing 4: Quarry 5 Drainage Structures). Designs for temporary and permanent channels are discussed in the following subsections, respectively. Design cross-sections for these drainage structures are shown on Drawing 4. Hydrologic analyses supporting channel designs are presented in Section 5.

TEMPORARY CHANNEL

Channel 5.10c is an existing drainage ditch. It is on the eastern side of the haul road that accesses quarries 3, 5 and 7. This channel will remain a temporary diversion while this haul road is in use. Per the recent Mine Closeout Plan, this haul road will be retained at the end of mine life, but with a significantly narrower road width. A permanent channel design will be developed after mining is completed in the areas it serves.

Channel 5.10c was designed to safely pass the 10-year, 24-hour storm, with a 7 percent increase in precipitation to account for future climate change. This channel is routinely maintained during haul road maintenance. The PMT design does not increase the watershed area reporting to this channel; therefore, erosion or sedimentation problems are not anticipated for this temporary diversion.

PERMANENT CHANNELS

This reclamation plan has a dendritic channel pattern with a moderately high drainage density of 187 ft/acre. The proposed channel network routes stormwater to the northwest corner. From the northwest corner of Quarry 5, stormwater flows to the northwest in a haul road ditch that discharges into Sediment Pond 1.

All but two permanent channels are designed as a trapezoidal Rocky Bottom Channels (RBC); there are two permanent V-shaped channels (V-CHNL). The RBC’s generally have a concave channel centerline profile (slope decreases in the downstream direction) that are free of severe nick points.

The RBC's will be constructed with a rock riprap channel bottom; however, riprap will not extend up the sideslopes as with traditional riprap channels. Instead, the rock riprap will be placed 2-feet deep in a 15-ft wide trench. Growth medium will then be spread over the riprap on both sides of the channel to create a natural channel shape. The resulting channel will have a riprap channel bottom and sideslopes composed of topdressing. The riprap bottom will resist incision. RBC sideslopes will support vegetation which prevents significant lateral migration. This RBC channel design was evaluated in Quarry 1 reclamation and has performed well to date.

The riprap D50 size was calculated to resist incipient motion for peak discharge from the 100-year, 24-hour storm, and is considered a minimum D50. It is expected that some reclaimed channels within Quarry 5 will be sufficiently rocky, with a D50 larger than the minimum D50 size. Where this occurs importation of additional riprap will not be required.

Both V-CHNL's (Channel 5.8a and Channel 5.3) are designed to intercept sheet flow and route stormwater into an RBC. Channel 5.8a intercepts sheet flow runoff from the safety berm at the southern boundary of Quarry 5 (which is causing erosion to the partially reclaimed slope below) and routes stormwater eastward into an RBC. The other V-CHNL, Channel 5.3, intercepts sheet flow above a steep, rocky slope and is routed into Channel 5.2.

DIVERSION BERM

A diversion berm will be constructed that intercepts sheet flow and routes it into Channel 5.11. Currently, runoff sheet flows across a rocky area which then transitions to redbed soils with a severe down gradient nick point. The effect of sheet flow runoff flowing over erodible redbed soils with a nick point has led to significant rills and gulleys that are not likely to self-stabilize. This diversion berm will stabilize the area by:

1. Diverting stormwater runon and sheet flow away from the erodible redbed soils (sheet flow will be confined to a stable rocky surface).
2. Regrading the eroded redbed soils into a geomorphic surface with a series of ridges and channels that removes the nick points.
3. Routing stormwater through the reclaimed land in designed drainage structures.

HYDROLOGY

There are 19 stormwater channels in this reclamation plan, including one temporary diversion channel and eighteen permanent channels, all of which are ephemeral. The stormwater channels have relatively small watershed areas with correspondingly small times of concentration (considerably less than six hours). The Bernalillo County design storm is the 100-year, 6-hour storm; however, MMD criteria for these drainage structures is the 100-year, 24-hour storm which results in significantly larger peak discharge. This reclamation plan uses the MMD design storm since it results in the largest peak discharge.

Permanent stormwater channels were designed to safely pass runoff from the 100-year, 24-hour storm event, with a 7 percent increase in the current NOAA Atlas 14 (Bonnin, et al, 2011) rainfall depth to account for future climate change (DNR, 2020). The temporary channel (Channel 5.8c) is designed to safely pass the 10-year, 24-hour storm, and the 10-year rainfall was increased by 7 percent to account for future climate change. Peak discharges were then input into a riprap sizing equation (Abt & Johnson, 1991) to compute the minimum riprap D50 size.

HEC-HMS software was used to calculate peak discharge for 9 watershed sizes ranging from 0.1 acres up to 26.4 acres. The SCS Curve Number method was used to determine excess rainfall (stormwater runoff), and a curve number of 77 was used, consistent with previous hydraulic structure design at the Tijeras mine.

The Clark Unit hydrograph was used as the transform method, and Time of Concentration (Tc) and the R-value were calculated from physical watershed parameters measured from the as-built Quarry 1 topography including watershed area, longest flow path length and slope, and centroidal flow path length (Table 1. Watershed Clark Unit Hydrograph Parameters).

Table 1. Watershed Clark Unit Hydrograph Parameters

Subbasin	Area (ac)	Area (sq mi)	Longest Flowpath (mi)	Longest Flowpath Slope (ft/mi)	Centroidal Flowpath Length (mi)	TC (hrs)	R (hrs)	Q100 (cfs)
Sub-0.1	0.1	0.00016	0.02	1,410	0.013	0.03	0.01	0.2
Sub-0.4	0.4	0.00063	0.05	1,014	0.028	0.05	0.02	1.0
Sub-1.0	1.0	0.00156	0.07	1,362	0.039	0.07	0.02	2.5
Sub-3.0	3.0	0.00469	0.12	898	0.066	0.11	0.03	7.3
Sub-5.0	5.0	0.00781	0.20	1,056	0.118	0.14	0.05	11.9
Sub-10.0	10.0	0.01563	0.25	676	0.090	0.17	0.05	23.4
Sub-15.0	15.0	0.02344	0.32	428	0.153	0.23	0.07	30.7
Sub-17.2	17.2	0.02688	0.39	533	0.181	0.25	0.08	34.7
Sub-26.4	26.4	0.04125	0.31	476	0.196	0.25	0.08	53.3

Peak discharges for the selected watersheds were plotted (Figure 1: Watershed Area vs Peak Discharge for the 100-Year, 24-Hour Storm). This shows that peak discharge for the 100-year, 24-hour storm event increases almost linearly for this range of watershed areas. Another hydrologic model was completed for the entire Quarry 5 watershed (50.3 acres) that included hydraulic routing for multiple sub-watersheds. Supporting documentation for hydrologic modeling is provided in Appendix A.

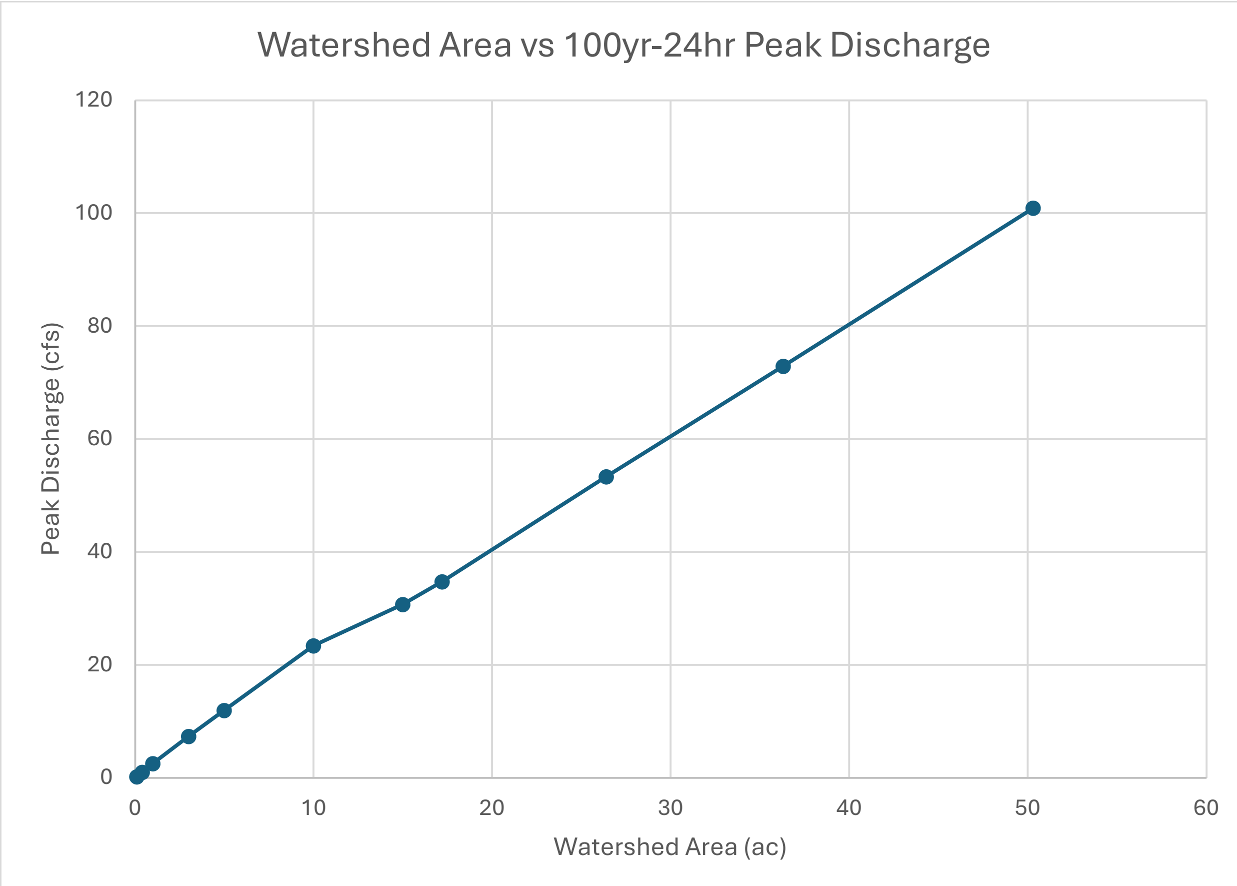


Figure 1: Watershed Area vs Peak Discharge for the 100-Year, 24-Hour Storm

Riprap Sizing Analyses

D50 riprap size was calculated using the Abt & Johnson (1991) method. The Abt and Johnson (1991) riprap equation is based on flume testing at Colorado State University, specifically for steep chute channels which are representative of the reclaimed channels at Quarry 5. The Abt and Johnson riprap size equation is shown below.

$$\mathbf{D50 = 5.23 * S^{0.43} * q_d^{0.56}}$$

Where:

D50 = median stone size (in)

S = bed slope (ft/ft)

q_d = unit discharge (ft^2/s)

Watershed areas were delineated from the PMT for the 19 channels. The 100-year, 24-hour peak discharge was calculated for watershed by linearly interpolating the data in Figure 1. Unit discharge (q_d) was calculated by dividing channel width into the 100-year, 24-hour peak discharge. The steepest bed slope (S) measured from the PMT was used in the riprap equation. The riprap $D50_{min}$ sizes were then calculated for each channel location and are summarized in Table 2.

Table 2. Channel Watershed Characteristics and Riprap Size

Channel ID	Watershed Area (ac)	Peak Discharge (cfs)	Design Storm*	$D50_{MIN}$ (in)	Channel Type
5.1a	10.3	10.1	100yr-24hr	0.6	RBC
5.1b	14.5	30.0	100yr-24hr	2.0	RBC
5.2	0.8	1.9	100yr-24hr	0.9	RBC
5.3	0.2	0.6	100yr-24hr	0.5	VCHNL
5.4a	0.9	2.2	100yr-24hr	0.7	RBC
5.4b	1.9	4.7	100yr-24hr	1.4	RBC
5.5	0.9	2.1	100yr-24hr	0.9	RBC
5.6	1.6	3.6	100yr-24hr	1.2	RBC
5.7	1.1	2.8	100yr-24hr	1.0	RBC
5.8a	0.6	1.4	100yr-24hr	0.6	RBC
5.8b	4.0	9.7	100yr-24hr	2.0	RBC
5.8c	5.7	13.4	100yr-24hr	0.5	RBC
5.9	1.6	4.0	100yr-24hr	1.0	RBC
5.10a	4.1	9.8	100yr-24hr	1.1	RBC
5.10b	11.7	25.9	100yr-24hr	2.7	RBC
5.10c	35.4	31.8	10yr-24hr	2.3	VCHNL
5.11	2.8	6.8	100yr-24hr	1.9	RBC
5.12	0.1	0.3	100yr-24hr	0.3	RBC
5.13	0.2	0.5	100yr-24hr	0.4	RBC
5.14	0.4	1.0	100yr-24hr	0.5	RBC
5.15	4.2	10.0	100yr-24hr	1.9	RBC
5.16	1.9	4.7	100yr-24hr	1.6	RBC
5.17	1.3	3.1	100yr-24hr	0.7	RBC
5.18	1.7	4.1	100yr-24hr	1.7	VCHNL
5.19	0.7	1.7	100yr-24hr	0.6	RBC

*Design storm precipitation is increased by 7 percent to account for future climate change as previously approved by the MMD.

TOPDRESSING & REVEGETATION

Topdressing will be placed at a target depth of 2-feet in the comprehensive reclamation operation areas, except directly in drainage channel bottoms. If suitable growth medium at targeted replacement depth is already present when final grade is achieved, then imported topdressing is not required.

Topdressing will be placed on partial reclamation areas at a target depth of 1-foot. After placement topdressing will be ripped along the contour. This operation will improve water harvesting, alleviate compaction and minimize slippage of topdressing at the subsoil interface.

Where redbed is used as a suitable plant growth medium revegetation operations will be performed. Soil amendments will be applied as needed based on soil analyses. Prior to reseeding operations, the redbed soils will be decompacted and the surface roughened. Following seedbed preparations seeding with the approved permanent reclamation seed mixture will be performed.

GRADING TOLERANCES

GCC will use earth-moving equipment with machine control software to achieve the subgraded and final graded surfaces. Tolerance for the final grade is plus or minus 2-feet. This is critical to achieving designed slope lengths and gradients, and of particular importance to construction a smooth channel profile. Deviations outside of the grading tolerance must be approved by a site engineer that is a New Mexico registered Professional Engineer (P.E.).

Additionally, small rocky “islands” (with less than 2-ft of growth medium) may be included in the reclaimed surface. The rocky islands must be stable, and individual rocky islands will be less than 0.2-acre in size. Lastly, the total cumulative area of rocky islands within Quarry 5 will be less than 2 acres (5 percent of the 39.5-ac Quarry 5 area). The rocky islands will function similarly to other undisturbed land at GCC Tijeras, with revegetation likely to favor woody species and cacti (Photograph 3: Example of Rocky Undisturbed Land at Tijeras Mine).

Grading deviations will be documented including the magnitude of elevation change relative to the approved design, as well as justification (ie. Avoiding bedrock, rock too large to move with equipment, etc.). Upon completion of reclamation grading at Quarry 5, GCC will survey the final-graded surface and submit as-built documentation to MMD. The as-built documentation will include topography of the final-graded surface and highlight grading deviations from the approved plan.

Photograph 3: Example of Rocky Undisturbed Land at Tijeras Mine

PERFORMANCE STANDARDS

The performance standards presented here will be used to determine when, and if, repairs are necessary on reclaimed land. The performance standards consider both hillslope stability and channel stability. Repair work, including the method of repair and urgency of repair will be discussed and agreed upon with MMD prior to implementation. In the early years following final reclamation (years 1 through year 5), it may be permissible to observe erosion and determine if vegetation is able to mature and stabilize the area without additional management inputs, if determined appropriate by a site Engineer and MMD.

1. If a hill slope contains numerous parallel rills and gullies, at least 6 inches deep, that are clearly systemic with no vegetation colonizing the rilled area, then repairs will become necessary. Isolated rills and gullies will not require repair unless they threaten the integrity of the overall landform.
2. If a significant vertical incision occurs in the channels at the reach scale (i.e., greater than 1-foot deep) then repairs will become necessary. The reach scale is defined as a distance equal to 10 times the channel width, measured at the peak water surface elevation for the 100-year, 24-hour storm.
3. If significant lateral erosion occurs in the channels such that the channel migrates outside of the riprap apron (at least 4.5 feet of channel migration from the center-line) and begins to downcut, then repairs will become necessary.

CONCLUSION

This reclamation plan details GTD, channel locations and design, topdressing requirements and performance standards. There are already significant portions of Quarry 5 that have been topdressed and are stabile with mature vegetation. These areas, identified as passively reclaimed land, will be preserved. Some of the passively reclaimed lands will be disturbed during reclamation construction and will be subsequently revegetated.

There are partially reclaimed lands that are topdressed, but with sparse vegetation and elevated erosion rates. Partially reclaimed lands will be stabilized by diverting stormwater runon and importing salvaged topdressing that will be ripped along the contour to alleviate decompaction, promote water harvesting and to minimize the potential for topdressing slippage at the subsoil interface.

The disturbed land will be graded into a geomorphic landform that consists of numerous ridges and channels. Hydrologic and hydraulic analyses were conducted for all reclaimed channels in Quarry 5. All permanent channels are designed to safely pass the 100-year, 24-hour storm event, and one temporary channel was designed to safely pass the 10-year, 24-hour storm. Precipitation amounts for both design storms were increased by 7 percent to account for anticipated future climate change impacts. As the reclaimed area matures and vegetation becomes established, the landform is expected to function as a self-sustaining ecosystem.

REFERENCES

Abt, S.R. and T.L. Johnson. 1991. Riprap design for overtopping flow. Journal of Hydraulic Engineering.

Bonnin M. Geoffrey, Martin Deborah, Lin Bingzhang, Parzybok Tye, Yekta Michael, Riley David. NOAA Atlas 14 Precipitation-Frequency Atlas of the United States, Volume 1 Version 5.0: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah). Revised 2011. National Oceanic and Atmospheric Administration.

State of Colorado. Department of Natural Resources. Division of Water Resources. Office of the State Engineer. January 21, 2020. Guidelines for the Use of Regional Extreme Precipitation Study (REPS) Rainfall Estimation Tools.