Mineral Joe Mine Permit Amendment
Permit File No. M-1977-284

Response to Adequacy Review

February 2013

Prepared by Cotter Corporation (N.S.L.)

Cotter Corporation (N.S.L.) (Cotter) submits this response to the December 17, 2012 letter from Stephanie Reigh, Division of Reclamation, Mining and Safety ("DRMS") to Glen Williams, Cotter. The DRMS' comments are in italics and Cotter's responses are in bold.

<u>Mineral Joe Mine, File No. M-1977-284, Amendment (AMI) Application Adequacy Review</u>

1. *Addressing Rule 6.3.3 (1) (f) - On page C-l, the exhibit states that waste rock will be stacked to a height that will not impede grading to 2H: 1V during reclamation. Please provide the Division with the maximum anticipated thickness that waste rock will be placed.*

   The maximum anticipated thickness of the waste rock pile will be 60 feet.

2. *Addressing Rule 6.3.3 (1) (f) - On page C-l, the exhibit states that ore will be piled up to a workable stockpile. Please provide the Division with a maximum anticipated amount of ore to be stockpiled at any given time.*

   No more than 1,700 tons of ore will be stockpiled at any given time.

3. *Addressing Rule 6.3.12 - The mine plan proposes to utilize power supplied by a San Miguel Power Association. Please submit to the Division, either a notarized agreement between Cotter Corp. and SMPA, that Cotter Corp. is to provide compensation for any damage to the power line caused by the mining operation, or a notarized letter, from SMPA on their letterhead, that the proposed mining and reclamation activities will have "no negative effect" on their power line.*

   A copy of the agreement between Cotter Corporation and SMPA is included in Attachment 1

4. *Addressing Rule 6.4.21 (7) - The EPP states that a radiometric survey will be completed prior to mining in order to document baseline conditions at the site. Baseline conditions shall be established as part of this amendment process. Please conduct a radiometric survey of the affected area and submit the results to the Division along with an evaluation of the expected effectiveness of the proposed EPP, which specifically addresses the risks, from uranium, uranium byproducts, and any other radionuclides expected to be encountered during this operation, to human health, property and the environment.*

   The baseline radiometric survey is included as Attachment 2 in this response to DRMS comments. Cotter procedures for separating ore from waste rock are designed to minimize the addition of uranium ore to the waste rock pile—an approach that makes sense from an economic and environmental standpoint. The EPP addressed several issues that evaluate the risks to human health and the environment. The potential of acid mine drainage from the waste rock piles was quantified by the Acid-Base Accounting tests that indicated this was not an issue. Section 5.4.1.8 of the EPP discusses the SPLP results for uranium for the Mineral Joe waste rock which are below the drinking water standards. In this section the high potential for

sequestration of radioactive materials by the Brushy Basin soils surrounding the Mineral Joe Mine waste rock pile is discussed. This fact along with EPP Section 5.4.2 which discusses fate and transport of constituents of potential concern and determines that implementation of the Stormwater Management Plan best management practices will minimize any potential chemical loading to surface water. The hydrogeologic evaluation presented in the EPP showed that factors of low permeability and geochemical conditions restricted potential leachate from the waste rock piles from impacting groundwater resources. A detailed Drainage Design Plan, included as a response to the Division Engineer's comments, routes off-site surface runoff around the waste pile and captures and contains on-site runoff from a 10-year 24-hour precipitation event. As such it appears the risks from uranium, and uranium by-products is minimal.

5. *Addressing Rule 6.4.12 - On page 41, the EPP states that no water is anticipated to be encountered during mining. If groundwater is encountered during mining, more than one (1) gallon per minute or more sustained for ten (10) days. The Operator shall notify Division of encounter. The Operator in consultation with the Division shall work together in addressing steps to evaluate prevailing hydrological balance which may include a well and a monitoring plan. Please commit to this.*

   Cotter commits to notifying the Division if one gallon per minute or more sustained for ten days is encountered. Cotter commits to working with the Division to evaluate the prevailing hydrologic balance in the event that groundwater as referenced is encountered during mining.

6. *Addressing Rule 6.4.21 (14) - On Page 42-43 of the EPP, SPLP tests were conducted in order to characterize the waste rock generated at this site. According to this rule, the ore must also be characterized. Please submit to the Division, a geochemical evaluation of the ore to be mined. Alternatively, if ore samples are not available at this time, commit to submitting this information to the Division, for review and approval, prior to any stockpiling on the surface.*

   Prior to ore being stockpiled on the surface Cotter will submit to DRMS a geochemical evaluation of the ore to be mined for its review and approval.

7. *Addressing Rule 6.4.21 (16) - On page 42, the EPP states that Cotter Corp. will conduct regular inspections of all structures. Please inform the Division of the anticipated minimum inspection frequency interval.*

   Cotter will at a minimum inspect all structures once per week when the mine is active and once per month when the mine is inactive.

8. *Addressing Rule 6.4.21 (18)(b) - Please describe the measures Cotter Corp. intends to take to prevent wildlife from coming into contact with uranium, uranium by-products or any other radionuclides.*

The Colorado Parks and Wildlife (CPW) was informed of Cotter's intent to mine and store uranium onsite. It did not recommend any additional measures to protect wildlife from coming into contact with naturally occurring uranium ore, uranium by-products or any other radionuclides.

9. *This exhibit states that the waste rock will be added, but does not state a method. Please explain how the waste rock will be added and the thickness of the methods to be used.*

The waste rock pile at Mineral Joe will be constructed in lifts approximately one to three feet thick. Each lift will be wheel rolled for compaction.

10. *Please inform the Division of the necessary amount of compaction for the waste rock pile, and the operators plan for insuring that necessary compaction of the waste rock is achieved.*

Cotter considers 84% compaction to be adequate for the waste rock pile. Compaction is only one of the eight parameters used in calculating the angle of internal friction for the soil stability of the waste rock pile. The factor of safety is a function of the angle of internal friction for the soil and the slope angle relative to the horizontal. The factor of safety for the waste rock pile at Mineral Joe was calculated to be 1.678 which is greater than the recommended 1.4 parameter for the safety factor of permanent slopes.

This was a conservative calculation and it is unlikely, even if the degree of compaction is not optimal, that the slope would be unstable at 2H:1V. The method of plug dumping does, however, provide an opportunity for a fair amount of compaction from wheel rolling as the haulage equipment travels on the previously dumped material, and as the equipment spreading out and leveling the material travels over it which will assure a stable slope based on the factor of safety calculation.

The method for ensuring proper construction and compaction of the waste dump will be visual inspection of the maximum lift thickness and observation of wheel rolling each lift by the operator.

11. *Please inform the Division of the maximum anticipated total thickness of the waste rock pile.*

See #1

12. *Please see the Division's Engineer comments in an attach memo dated December 5, 2012 below.*

Attached is the Mineral Joe Mine Drainage Design Plan in response to the Division Engineer's comments.

ATTACHMENT #1

SAN MIGUEL POWER ASSOCIATION AGREEMENT

SAN MIGUEL POWER ASSOCIATION
A Touchstone Energy® Cooperative

Damage Agreement Between
Cotter Corporation
And
San Miguel Power Association, Inc.

Mineral Joe Mine Portal/Vent Hole

This Agreement entered into between Cotter Corp. and San Miguel Power Association, Inc., provides that Cotter Corp. agrees to provide compensation for any damage to the San Miguel Power Association, Inc., power lines caused by the mining operations at the Mineral Joe Mine. This damage agreement is entered into to comply with Rule 6.4.19 of the Colorado Mined Land Reclamation Board regulations dealing with any adverse affect on any significant, valuable or permanent man-made structure located within 200 feet of the affected land. (See attached map)

Cotter Corporation
By Glen Williams
Glen Williams, V.P. of Mining

The foregoing instrument was acknowledged before me this 24th day of January, 2013, by Glen Williams as Vice President of Mining, Cotter Corporation.

Marie G. Daly
Notary Public
My Commission expires: 10/26/2015

San Miguel Power Association, Inc.
By Terry Daley

The foregoing instrument was acknowledged before me this 29th day of January, 2013, by Terry Daley as Engr/Ops Mgr of San Miguel Power Association, Inc.

Marie G. Daly
Notary Public
My Commission expires: 10/26/2015

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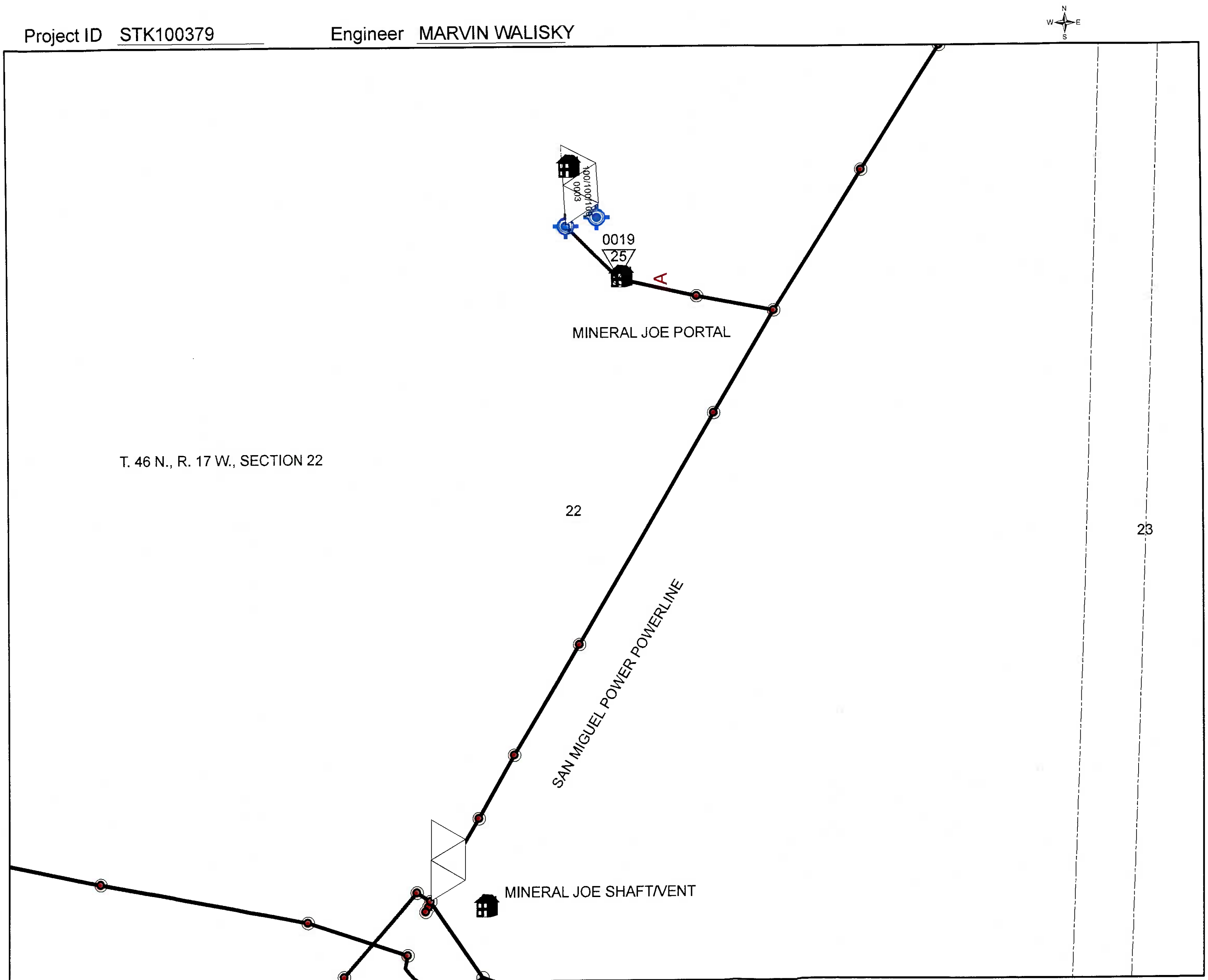
Box 1150, Ridgway, Colorado 81432
970-626-5549 • 970-626-5688 FAX

Project ID STK100379 Engineer MARVIN WALISKY



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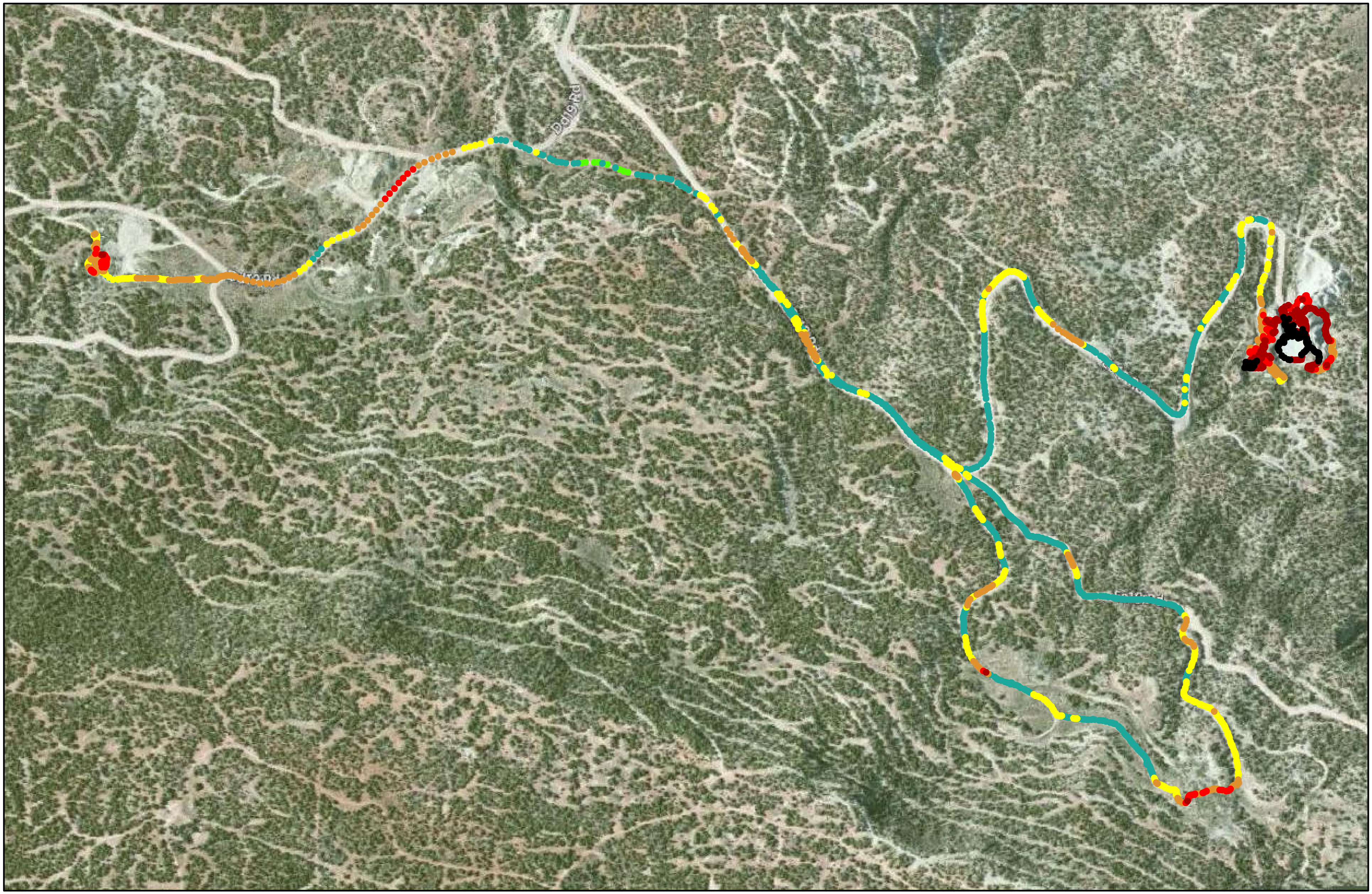
ATTACHMENT #2

RADIOMETRIC SURVEYS



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60 - 100
100 - 150
150 - 300
> 300

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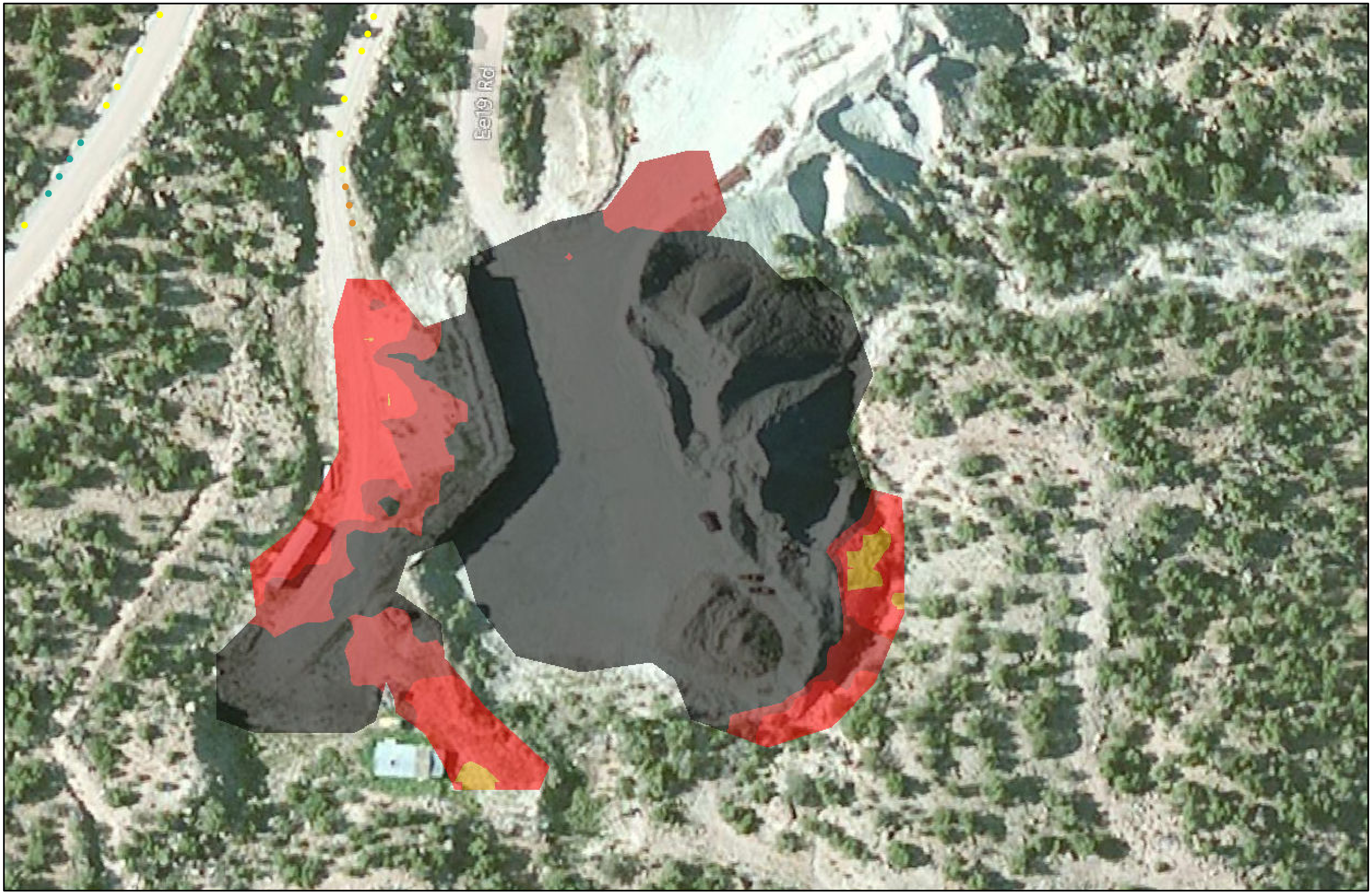
Gamma Scan - Points

Mineral Joe



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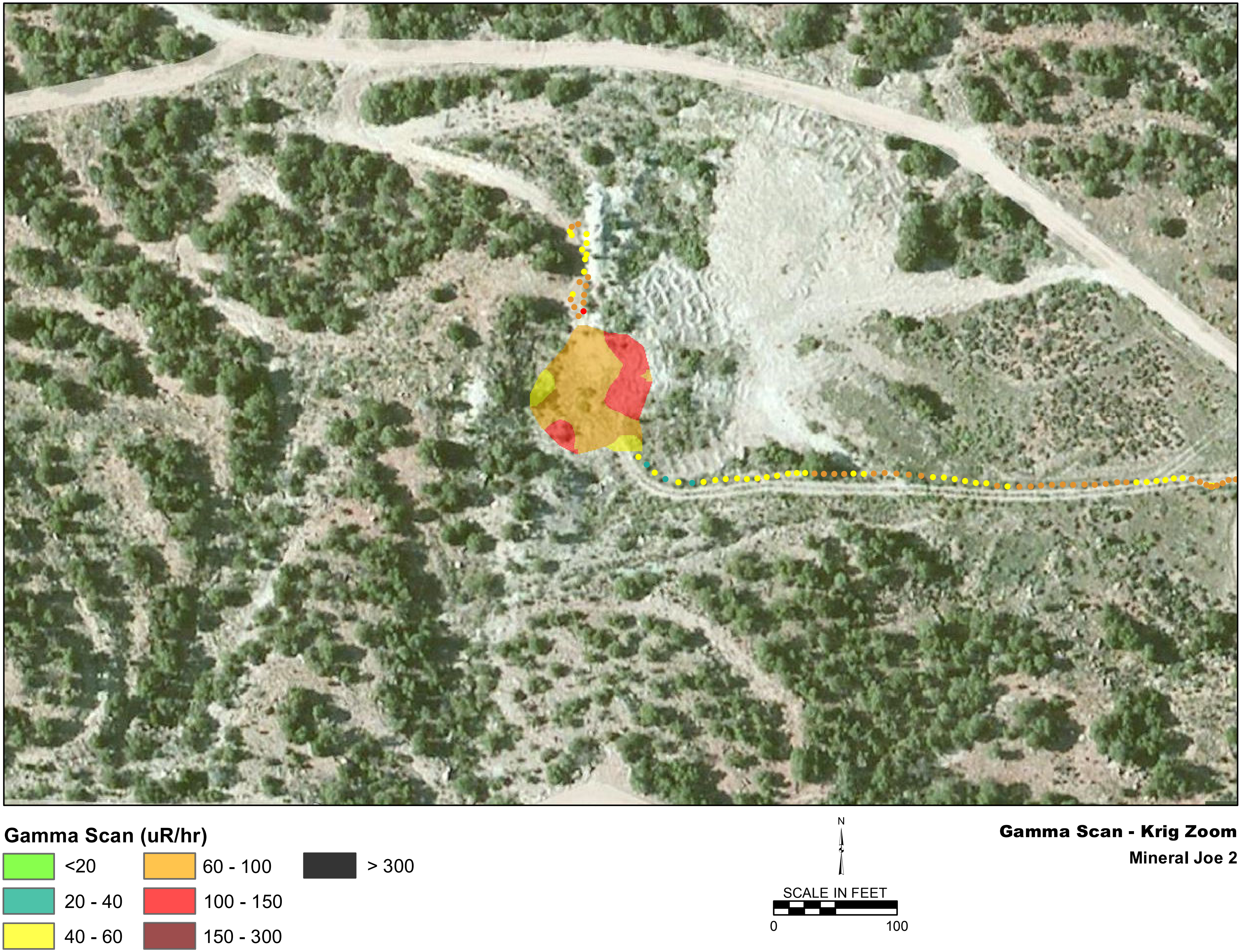
Gamma Scan - Krig Zoom

Mineral Joe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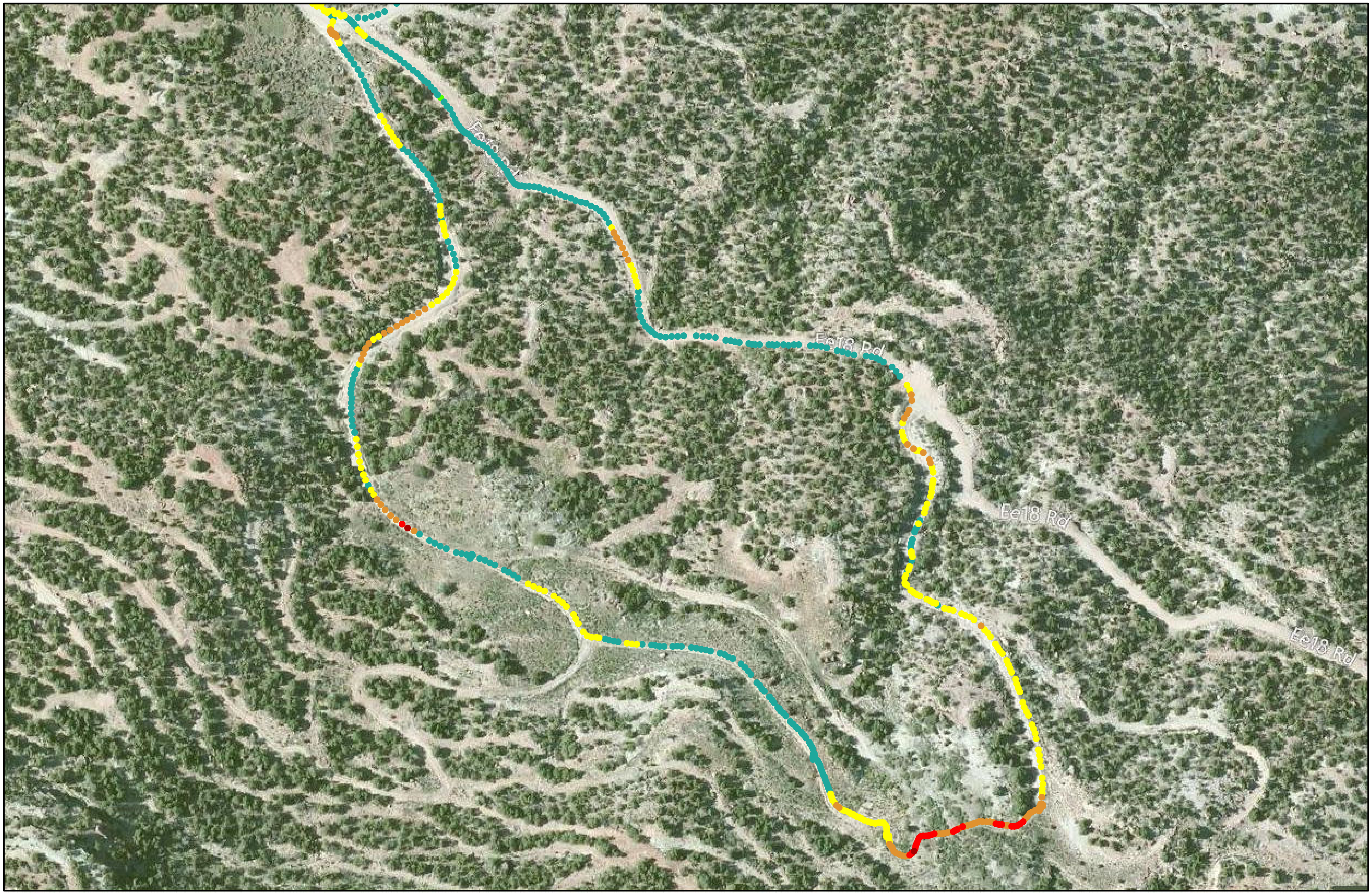
Mineral Joe 2



Gamma Scan (uR/hr)

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- 40 - 60
- 60 - 100
- 100 - 150
- 150 - 300
- > 300

N

SCALE IN FEET

0 300

Gamma Scan - Points

Mineral Joe 12

DRAINAGE DESIGN PLAN
FOR THE
MINERAL JOE MINE

Prepared for

Cotter Corporation (N.S.L.)
West Slope Operations
P.O. Box 700
Nucla, CO 81424

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Document 4148B.130227

February 27, 2013

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1. INTRODUCTION

1.1 Purpose

This Drainage Design Plan presents the design analysis for the stormwater drainage facilities at the Mineral Joe Mine, which is located in Montrose County, Colorado and owned by Cotter Corporation (N.S.L.) ("Cotter"). The plan addresses aspects of stormwater collection, conveyance, and retention design necessary to comply with the Colorado Division of Reclamation Mining and Safety (DRMS) drainage criteria.

1.2 Overview - Runoff Areas and Routing

The Mineral Joe Mine is located below the north-facing escarpment of Monogram Mesa. The permitted mine area (3.64 acres) lies within Sections 21 and 22, T46N, R17W, NMPM, and on the Mineral Joe Claims (MJ-2, MJ-12, MJ-14, MJ-17, MJ-18, and MJ-19, which total 118 acres). Mining activities that have the potential to affect stormwater discharge at the Mineral Joe Mine include the following:

- The waste rock storage pile (2.73 acres)
- Temporary ore stockpile area (0.08 acres)
- Fuel and oil storage area
- Equipment fueling area
- Access road

In addition to the facilities listed above, the Mineral Joe Mine facilities include a vent hole in Area C and an emergency egress portal (at the Mineral Joe 2 Adit) in Area A. The vent hole and associated access road is located off county road EE19. The area surrounding the vent hole has been minimally graded to direct water away from the vent hole, and vegetation is well established. The area surrounding the emergency egress portal is similarly revegetated. The vent hole and the emergency egress portal (Mineral Joe 2 Adit) would have minimal or no effect on stormwater quality.

These facilities occur in two main sub-basins, which are identified as B1 and B2 on Plate 1. Sub-basin B1 occupies 1,205.7 acres and is drained by an unnamed intermittent stream that flows west and northwest into the Paradox Basin (Plate 1).

Sub-basin B2 occupies 296.1 acres and is drained by an unnamed intermittent stream that flows north into the Paradox Basin (Plate 1) and is tributary to East Paradox Creek. The stream is intermittent in its upper reaches and ephemeral on the floor of the Paradox Valley. Sub-basin B2 contains the mine facilities which are the area of primary focus for this Drainage Design Plan. Stormwater is managed to reduce the potential for runoff from upslope to contact disturbed ground in the mine facilities area, as described in detail in the following sections. Runoff from undisturbed surfaces, areas of minor disturbance, and areas not containing designated chemicals or potentially toxic or acid forming materials is considered "non-contact" stormwater because it has not had potential exposure to pollutants.

Table 1. Major Sub-Basin Areas at the Mineral Joe Mine

Sub-Basin	Area (ft2)	Area (acres)	Description
B1	52,519,930	1,205.7	Main sub-basin for underground workings
B2	12,899,050	296.1	Main sub-basin containing WRP, adit, mine facilities area

1.3 Adjacent and Ancillary Facilities

The adjacent JD-6 Mine waste rock pile and JD-6 lease tract are owned/leased by Cotter and are permitted under a separate mining permit (No. M-1977-310) and stormwater permit (COR 040024). The separate claims for the Mineral Joe and JD-6 Mines share a common portal and surface facilities, except for separate vent holes and roads leading to the vent holes. Due to its close proximity to the JD-6 Mine, some of the stormwater management performed at the Mineral Joe Mine site is beneficial to both properties. However, the two sites operate under separate mine permits and stormwater management plans. Specifically, the stormwater diversion structures which are associated with the JD-6 Mine are also beneficial in reducing run-on to the Mineral Joe Mine facilities, while the stormwater retention pond associated with the Mineral Joe Mine collects runoff from the JD-6 waste rock pile.

2. DESIGN CRITERIA & METHODOLOGY

2.1 Design Storms

The magnitudes of design storms for the site are shown in Table 2. The rainfall intensity for 24-hour storms with 2-year to 100-year recurrence intervals were interpolated from the NOAA Atlas 2, Vol. III (USDC, 1973), for the purpose of runoff calculations and engineering design. Per DRMS recommendations, control structures for the Mineral Joe Mine presented in this design report are engineered to contain the 10-year 24-hour storm event and safely pass a 100-year 24-hour storm event.

Table 2. Design Storm Parameters

Recurrence Interval	Duration (Hours)	Storm Magnitude NOAA Atlas (inches)
100-year	24	3.0
50-year	24	2.7
25-year	24	2.4
10-year	24	2.0
5-year	24	1.6
2-year	24	1.2

2.2 Runoff Estimates

2.2.1 Volume

Catchment runoff was estimated using Technical Release 55 (TR-55) developed by the U. S. Department of Agriculture Natural Resources Conservation Service (NRCS, 1986). TR-55 presents simplified procedures to calculate storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for floodwater reservoirs in small watersheds.

Runoff depth (q_d) is calculated in TR-55 by the Curve Number (CN) method, using the following equation:

$$q_d = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

where: q_d = Runoff depth, inches ($q_d = 0$, if $P < 0.2S$),
P = Rainfall depth, inches
S = Potential maximum rainfall retention after runoff begins, inches

This method assumes initial abstraction (losses before runoff begins due to retention in surface depressions, interception by vegetation, evaporation, infiltration etc.) is equal to 0.2S.

The parameter S is related to curve number (CN) by:

$$S = \frac{1000}{CN} - 10$$

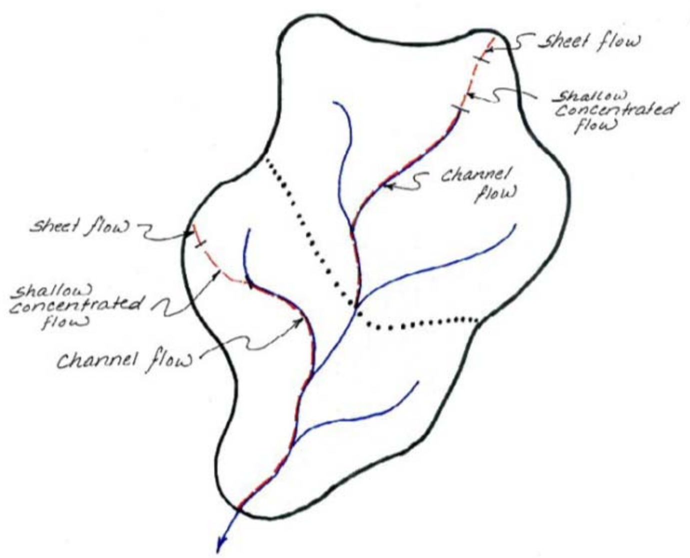
Site soils consist predominantly of Bodot and Ustic Torriorthents, which are listed as hydrologic soil group C in the NRCS Web Soil Survey (NRCS, 2012a, 2012b). Site-specific curve numbers are discussed in Section 3.

Runoff volume (Q) is obtained from : $Q = q_d / 12 \cdot A \cdot 43{,}560$

where: Q = Runoff volume, cubic feet
q_d = Runoff depth, inches
A = Catchment area, acres

2.2.2 Peak Discharge

Peak discharge is calculated using Time of Concentration (T_c) which is the time it takes for runoff to travel from the most hydraulically distant point in the watershed (or sub-basin) to a point of interest. T_c is the sum of travel time for sheet flow (T_{sh}) plus the travel time for shallow concentrated overland flow (T_{sc}) plus the travel time for channel flow (T_{ch}).



Sheet flow occurs over plane surfaces in the "headwaters" or uppermost reaches of the watershed, as shown above. For the Mineral Joe Mine drainage design, sheet flow is assumed to occur in the upper 80 feet of the sub-basin. Sheet flow travel time is calculated using the simplified form of Manning's kinematic solution from Overtop and Meadows (1986) which is Equation 3.3 of TR55 (NRCS, 1986):

$$T_{sh} = \frac{0.007\ (nL)^{0.8}}{P^{0.5} S^{0.4}}$$

where:

T_{sh} = sheet flow travel time (hr)
n = Manning's roughness coefficient for surface flow
L = flow length (ft)

P = 24-hour rainfall (in)
s = land slope (ft/ft)

Shallow concentrated flow has been assumed to occur from the end of sheet flow until the flow path reaches a stream channel mapped as intermittent or a channel with a known or required cross section, such as the diversion or drainage ditch at the Mineral Joe Mine. The travel time for shallow concentrated flow is calculated as:

$$T_{sc} = \frac{L}{3600 \cdot V}$$

where:

T_{sc} = shallow concentrated flow travel time (hr)
L = flow length (ft)
3600= conversion factor for seconds to hours
V = velocity on unpaved surface, interpolated from Figure 3-1 of TR-55 for land slope (ft/s) or calculated using Manning's equation:

$$V = \frac{1.49\, r^{2/3} s^{1/2}}{n}$$

where:

r = hydraulic radius = depth of flow = 0.4 ft
s = slope of the hydraulic grade line (land surface) (ft/ft)
n = Manning's n (roughness coefficient) for open channel flow = 0.05

Simplifying for unpaved conditions:

V= $16.13\, s^{1/2}$

Channelized flow occurs in defined channels or intermittent stream drainages. The travel time for channelized flow is calculated using Manning's equation for channelized flow and the channel-specific geometry and hydraulic characteristics (rather than the simplifying assumptions used for shallow concentrated flow).

Shallow concentrated flow has been assumed to occur from the end of sheet flow until the flow path reaches a stream channel mapped as intermittent or a channel with a known or required cross section, such as diversion or drainage ditch at the Mineral Joe Mine. The travel time for shallow concentrated flow is calculated as:

$$T_{ch} = \frac{L}{3600 \cdot V}$$

where:

T_{ch} = channel flow travel time (hr)
L = flow length (ft)
3600= conversion factor for seconds to hours
V = velocity calculated using Manning's equation for channelized flow:

$$V = \frac{1.49\, r^{2/3} s^{1/2}}{n}$$

where:

r = hydraulic radius = cross sectional area / wetted perimeter (A/Pw)
s = slope of the hydraulic grade line (channel bottom) (ft/ft)
n = Manning's n (roughness coefficient) for open channel flow (as discussed in Section 2.3.1 and Table 3)

Runoff peak discharge is calculated from the TR-55 graphical peak discharge method. This approach graphically generates a unit peak discharge rate (Q_u) based upon the general catchment parameters of curve number (CN), initial abstraction (I_a), precipitation (P) and rainfall distribution type (type II for Colorado) and the individual catchment time of concentration (T_c). The input variables used in determining Q_u using the graphical method were determined as follows:

CN = curve number based soil type, as discussed in Section 3 and Table 6
I_a = initial abstraction, lookup value in Table 4-1 of TR-55 based on CN
P = Precipitation, based on design storms listed in Section 2.1 and Table 2 of this plan
T_c = Time of concentration, calculated as discussed above

Peak discharge (Q_p) for the catchment area is then calculated from:

$$Q_p = Q_u \cdot A_m \cdot q \cdot F_p$$

where: Q_p = Sub-basin peak discharge (cubic feet per second [cfs])
Q_u = Sub-basin unit peak discharge (cfs/mi^2/in [csm/in])
A_m = Sub-basin area (square miles)
q = Runoff (inches)
F_p = Pond and swamp adjustment factor

2.2.3 Computational Method

Runoff volumes and peak discharge were calculated in Excel spreadsheets using the equations provided above. These manual/spreadsheet calculations generally require that the unit peak discharge (Q_u) be determined graphically by interpolating from Figure 4-II of TR-55. The graphical method was used for the initial basin analysis and to check the accuracy of input values to the TR-55 basin model.

Peak discharge was also computed using the NRCS WinTR-55 software (NRCS, 2009). WinTR–55 is a single-event rainfall-runoff, small watershed hydrologic model. The model generates hydrographs from urban, agricultural, and rural areas and at selected points along the stream system. Runoff hydrographs were generated by the model and routed downstream through channels. Multiple sub-areas were modeled within the watershed and routed to the applicable diversion structures to outfalls or to the retention pond.

2.3 Structure Design

2.3.1 Channels

Channel capacity was evaluated with a single section analysis using Manning's Equation. Based on site conditions, channels were assigned a trapezoidal geometry with side slope ratios of 1.5:1 or 2:1.

The value of Manning's n selected for each channel affects channel velocity, conveyance capacity, and peak flows. The most important factors that affect the selection of channel n values are:

1. Type and size of the materials that compose the bed and banks of the channel; and
2. Shape of the channel.

Cowan (1956) developed a procedure for estimating the effects of these factors to determine the value of n for a channel. The value of n may be computed by:

$$n = (n_b + n_1 + n_2 + n_3 + n_4) \cdot m$$

where :

n_b = a base value of n for a straight, uniform, smooth channel in natural materials
n_1 = a correction factor for the effect of surface irregularities
n_2 = a value for variations in shape and size of the channel cross section,
n_3 = a value for obstructions
n_4 = a value for vegetation and flow conditions
m= a correction factor for meandering of the channel

Table 3. Manning's "n" Values Used in Cowan's Method for Channel Roughness

Channel Condition	N Values	Natural Channels	Borrow Ditches	Diversion Ditches	Short Natural Channels
Material Involved	$\mathbf{n_o}$				
Earth	0.02				0.02
Rock cut	0.025	0.022	0.022	0.022	
Fine gravel	0.024				
Coarse gravel	0.028				
Degree of Irregularity	$\mathbf{n_1}$				
Smooth	0				
Minor	0.005			0.005	
Moderate	0.01	0.01	0.01		0.01
Severe	0.02				
Variations of Channel Cross Section	$\mathbf{n_2}$				
Gradual	0				
Alternating occasionally	0.005		0.005	0.005	0.005
Alternating frequently	0.010-0.015	0.01			
Relative Effect of Obstructions	$\mathbf{n_3}$				
Negligible	0				
Minor	0.010-0.015		0.01	0.01	0.01
Appreciable	0.020-0.030	0.02			
Severe	0.040-0.060				
Vegetation	$\mathbf{n_4}$				
Low	0.005-0.010	0.005	0.005	0.005	0.005
Medium	0.010-0.025				
High	0.025-0.050				
Very high	0.050-0.100				
Degree of Meandering	$\mathbf{m_5}$				
Minor	1	1	1	1	1
Appreciable	1.15				
Severe	1.3				
Calculated Manning's n value		0.067	0.052	0.047	0.05

2.3.2 Culverts

Values for hydraulic headwater, tailwater, barrel flow rate and barrel velocity were determined using methods and parameters provided in the Federal Highway Administration (FWHA) document HEC 22 (FWHA 2009) and modeled in the FHWA software program HY-8 Version 7.2 (FWHA, 2012). Although these design calculations indicate that smaller culverts could provide the carrying capacity required in some sub-basins, all culverts installed by Cotter will be 18-inch diameter minimum to reduce the potential of plugging with wind-blown debris and animal denning activities.

2.3.3 Retention Pond and Spillway

The stormwater retention pond has been evaluated to determine its ability to contain the 10-year 24-hour runoff volume with a minimum of 1.0 ft of freeboard, with freeboard reduced to 0.5 ft while passing the 100 yr 24-hour event. A broad crested weir, as described in HEC 22, chapter 8 (FHWA, 2009), was used to establish spillway design parameters and flow through the pond and spillway were evaluated using WinTR55.

2.3.4 Riprap / Granular Bedding / Gravel Mulch

Channel protection requirements, riprap sizing and rip rap grading specifications were evaluated using HEC 15 (FHWA, 2005). The analysis was conducted for the major stormwater conveyance structures (diversion ditches) using the depths, widths, and side slope ratios established for each feature. Where required, channel protection will be placed to the full channel depth listed for each structure.

Riprap will meet the criteria of HEC-15 (FHWA, 2005), including but not limited to:

- The ratio of sizes of D100/D50 and D50/D20 shall fall between 3.0 and 1.5[1].
- Placed thickness should equal the diameter of the largest rock size in the gradation.
- Material shall be durable and angular but not slabby (length:thickness < 3).
- Riprap shall extend 1.0 x flow depth above flow level.

All riprap will be installed with a granular bedding to protect underlying soils per the attached Urban Drainage and Flood Control District specification for gradation and thickness (UDFCD, 2011) in Attachment 1.

Gravel mulch will be “composed of coarse to very coarse gravel, 16 mm to 64 mm (0.6 to 2.5 inch), similar to an AASHTO No. 3 coarse aggregate” (FHWA, 2005). No bedding will be placed between the gravel mulch and bare soil.

[1] The largest rip rap size (D_{100}) shall be no larger than 3 times the median particle size (D_{50}) and no smaller than 1.5 times the median particle size (D_{50}). Similarly, median particle size (D_{50}) shall be no more than 3 times and no less than 1.5 times the D_{20} size. This specification assures an appropriate size gradation for erosion control.

3. HYDROLOGIC CHARACTERISTICS OF SITE SOILS

The dominant soil types in the Mineral Joe Mine facilities area are Bodot and Ustic Torriorthents, which are shown as soil type 23 on Figure 4 of the EPP. Additionally, a thin exposure of rock outcrop – Orthents complex has been mapped along the ridgeline (NRCS, 2012b) in the headwaters of Sub-basin B2. The thin soils that occur on steeper areas of pinyon-juniper woodlands in the vicinity of the Mineral Joe Mine (Unit 23) are classified as fine, montmorillonitic, calcareous, mesic Ustic Torriorthents and are mapped as Hydrologic Soil Group C (Table 4). Rocky outcrop areas are mapped as Group D. These soil groups are defined by the NRCS (2012a) as:

> ***Group C.*** *Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.*
>
> ***Group D.*** *Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.*

Table 4. Soils Types in Vicinity of the Mineral Joe Mine Facilities (Sub-Basin B2)

Map Unit	Soil Name	Taxonomic Classification	Hydro Group	Depth (*in*)	K Sat (micro m/sec)
23	Bodot, dry	Fine, montmorillonitic (calcareous), mesic Ustic Torriorthents	C	0-3	1.41-4.23
				3-30	0.42-1.41
				30-34	0.00-14.11
	Ustic Torriorthents	Ustic Torriorthents		0-4	1.41-4.23
				4-31	1.41-4.23
				31-35	0.42-1.41
88	Rock outcrop	---	D	0-60	0.00-0.03
	Orthents	Orthents	B	0-1	14.11-42.23
				1-14	14.11-42.23
				14-24	1.40-14.00
				24-60	1.40-14.00

The runoff curve numbers for the site were selected based on soil type, land use, and vegetative cover. A curve number of 73 was applied for pinyon-juniper with grass understory, in fair condition (30-70% vegetative cover) and group C soils (Table 5). A curve number of 89 was applied to areas occupied by the gravel access road (County Road EE19). A curve number of 85 was applied to the disturbed ground and waste rock piles in the mine facilities area. For sub-basins containing more than one soil or cover type, a weighted average curve number was calculated based on the relative areas of each CN. Site curve numbers are listed in Table 6 and area-weighted average curve numbers are provided in Attachment 4.

Table 5. Runoff Curve Numbers for Arid and Semi-Arid Rangelands (Table 2-2d of TR-55 [NRCS, 1986])

Cover Description [1]		**Curve Numbers for Hydrologic Soil Group**			
Cover Type	**Hydrologic Condition** [2]	**A**	**B**	**C**	**D**
Herbaceous-mixture of grass, weeds, and low-growing brush, with brush the minor element	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosote bush, blackbrush, bursage, palo verde, mesquite, and cactus	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84
Gravel Road [3]		76	85	89	91

Notes:
(1) Based on average runoff condition, and Ia, = 0.2S.
(2) Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
(3) Source for gravel road CN is Table 2-2a of TR-55 (NRCS 1986)

Table 6. Runoff Curve Numbers for Mineral Joe Mine

Description	**CN**
Pinyon-juniper, grass understory, fair condition, Group C soils	73
Gravel road, Group C soils	89
Disturbed ground, mine facilities area	85

4. STORMWATER ROUTING

Stormwater management at the Mineral Joe Mine focuses on the area of the mine facilities within Sub-basin B2 (shown on Plate 1). Stormwater from upslope is diverted around the mine facilities, as described in Section 4.1 below. Stormwater within the mine facilities area is collected in ditches and/or routed to the stormwater and sediment retention pond, as described in Section 4.5.1 below.

4.1 Sub-Basins Reporting to Upper, Middle, and Lower Diversion Structures

Three main diversion structures currently exist to divert upslope, non-contact stormwater away from mine facilities. The Upper and Middle diversion structures intercept runoff from upslope and convey it eastward into an adjacent sub-basin. As shown in Figure 1, three sub-basins contribute runoff to the Upper Diversion Structure. These sub-basins (N-A through N-C) range from 0.71 to 52.4 acres in size (Table 7). One small sub-basin (N-D, 0.91 acres) contributes runoff to the Middle Diversion Structure. The Middle

Diversion Structure could also collect any over flow that might occur from the eastern half of the Upper Diversion Structure.

The Upper and Middle diversion structures route water into a natural drainage located just east of the Mineral Joe Mine yard (Figure 1). The receiving sub-basin is mapped as an intermittent stream which confluences with the diverted sub-basin approximately 1,300 feet downstream of the diversion structures (Figure 1).

The Lower Diversion Structure (LDS) is in place to divert non-contact stormwater to the east and north, around the Duggan adit and the central mine facilities area. The sub-basins contributing runoff to the LDS are relatively small, as shown in Figure 1. Sub-basin N-E (1.43 acres) contributes runoff to the east-flowing branch of the LDS. Sub-basin N-F (4.19 acres) contributes runoff to the north-flowing branch of the LDS (Table 7).

Table 7. Sub-Basins Contributing to Upper, Middle, and Lower Diversion Structures

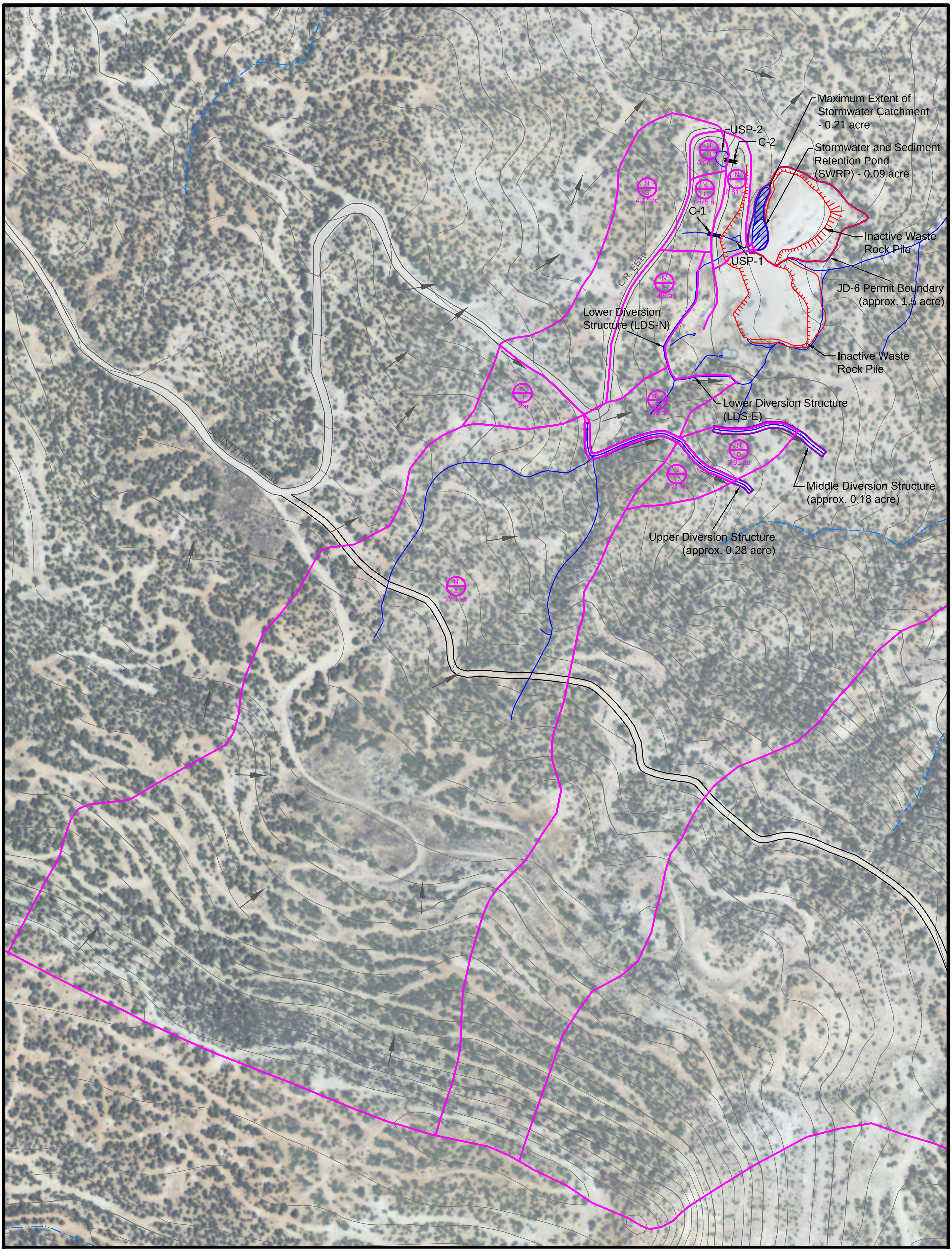
Sub-Basin	Area (ft2)	Area (acres)	Type	Description / Type
N-A	2,282,020	52.4	Non-contact	Main drainage area above Upper Diversion Structure
N-B	52,810	1.21	Non-contact	Small triangular area above west Upper Diversion Structure
N-C	30,830	0.71	Non-contact	Small triangular area above east Upper Diversion Structure
N-D	39,820	0.91	Non-contact	Reports to Middle Diversion Structure
N-E	62,230	1.43	Non-contact	Reports to Lower Diversion Structure, flowing east
N-F	182,680	4.19	Non-contact	Reports to Lower Diversion Structure, flowing north

4.2 Sub-Basin Intercepted by CR EE19

Stormwater from sub-basin N-G is collected in the borrow ditch along County Road EE19. This runoff is derived from upslope (west) of the mine site, in a 4.37-acre sub-basin that extends from the local ridgeline to CR EE19. As shown in Figure 2, stormwater runoff that arrives in the borrow ditch is routed northward into the natural drainage north of the mine. This water does not contact mine facilities and this sub-basin is not included in the WinTR55 model. Montrose County maintains the EE19 road and associated ditches.

Table 8. Sub-Basin Intercepted by EE19 Road

Sub-Basin	Area (ft^2)	Area (acres)	Type	Description / Type
N-G	190,150	4.37	Non-contact	Ridgeline to borrow ditch on County Road EE19



EXPLANATION

- Flow Direction of Stormwater Runoff
- N / A / 52.4 ac — Sub-Basin ID Showing Total Acreage
- Sub-Basin Boundary
- Intermittent Stream
- Stormwater Flowpath
- Upstream Storage Pond (USP)
- Stormwater Retention Pond
- Culvert
- JD-6 Permit Boundary
- Waste Rock Pile
- Road

SCALE 1:3,600

0 300 600 FEET

CONTOUR INTERVAL 20 FEET

N

COLORADO REGISTERED PROFESSIONAL ENGINEER
SUSAN A. WYMAN
34622
2/22/2013

Whetstone Associates	cotter — Cotter Corporation (N.S.L) PO Box 700 Nucla, CO 81424	Mineral Joe Mine Drainage Design Plan	**Figure 1** **Sub-Basins Contributing Non-Contact Stormwater to Upper, Middle and Lower Diversion Structures**
Date: 2/19/2013	Drawn/Checked By: CM/SW	Project No: 4148B	
File: JD7_Reg_Map_R21.dwg		County: Montrose County, CO	

4.3 Sub-Basins Supplying Stormwater Run-on to the Site

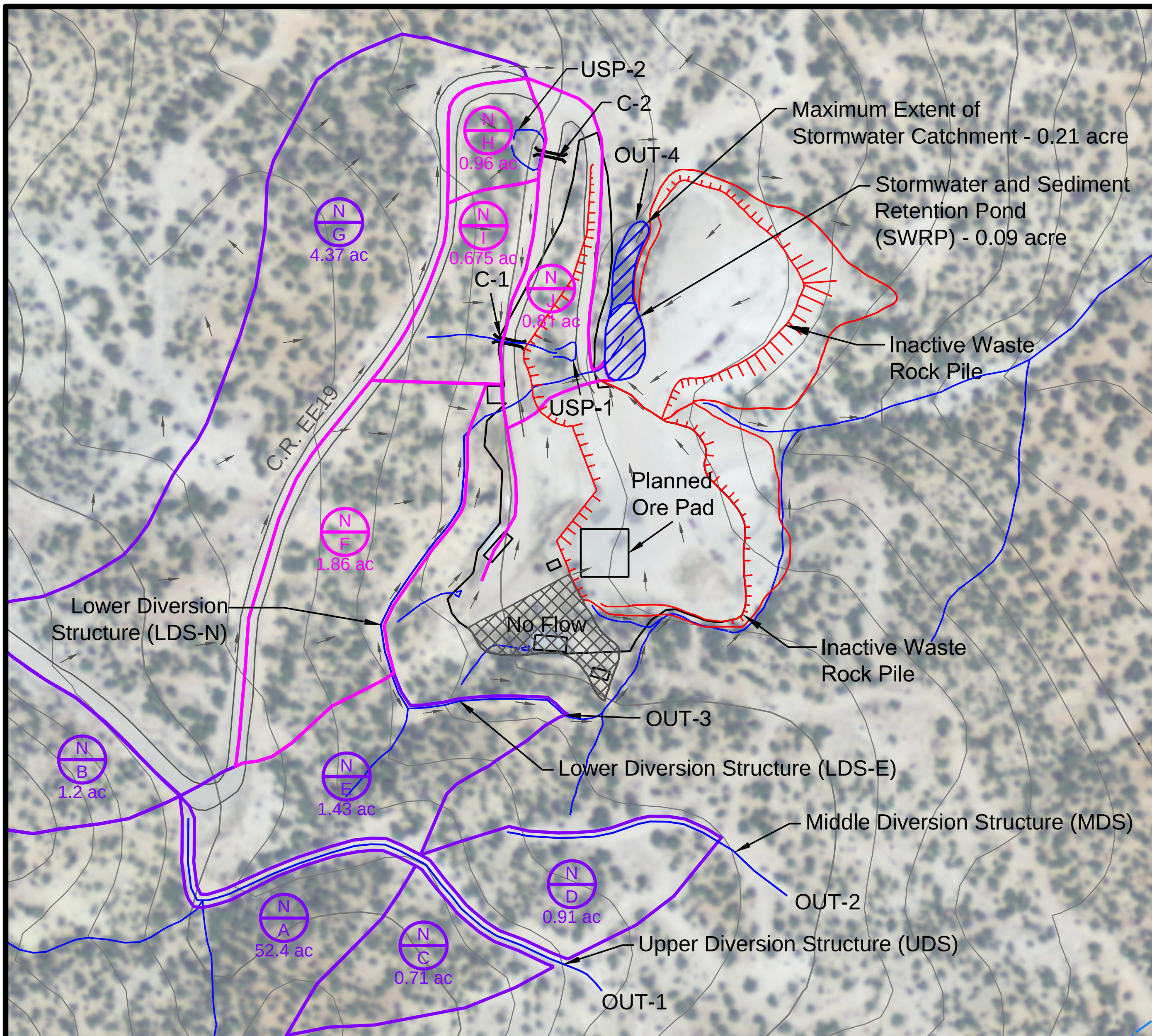
Stormwater from upslope that is not diverted around the site may run on to the site and report to the borrow ditches, channels, and stormwater retention pond in the mine facilities area. Sub-basins have been delineated to identify how run-off flows to individual conveyance structures (culverts or ditches) or to segments of individual drainage structures that receive increasing runoff along their length. The sub-basins contributing runoff to the site are shown in Figure 2 and listed in Table 9.

The largest sub-basin contributing non-contact stormwater to the site is sub-basin N-F (1.86 acres), which contributes runoff to the north-flowing branch of the LDS, which then reports to the stormwater and sediment retention pond. The remaining sub-basins that contribute non-contact stormwater to the mine facilities area range in size from 0.35 acres (sub-basin N-H) to 0.81 acres (sub-basin N-J). Stormwater routing from these sub-basins to the retention pond is discussed in Section 4.6.

Table 9. Sub-Basins Contributing Run-On to Mine Facilities Area

Sub-Basin	Area (ft2)	Area (acres)	Type	Description / Type
N-F	81,040	1.86	Non-contact	Reports to Lower Diversion Structure, flowing north
N-H	15,040	0.35	Non-contact	EE19 Road CL to culvert on switchback
N-I	29,420	0.68	Non-contact	EE19 Road CL to NJ via culvert
N-J	35,210	0.81	Non-contact	Road & slope above stormwater retention pond
MFA	130,990	3.01	Contact	Mine Facilities Area reporting to SWRP

The central facilities area is relatively flat (Figure 3). A perimeter berm around the crest of the waste rock piles prevents stormwater from flowing down the face of the dumps and causing erosion. Snowmelt and precipitation commonly pools at the surface and evaporates. During higher magnitude storms, runoff from the 3.01-acre mine facilities area (Figure 4, Table 9) flows into the stormwater and sediment retention pond (SWRP).



EXPLANATION

N A 52.4 ac — ID of Sub-Basin Diverted Around Site Showing Acreage

N F 4.19 ac — ID of Sub-Basin Contributing to Mine Facilities Area Showing Acreage

Sub-Basin Boundary

Sub-Basin Boundary

Flow Direction of Stormwater Runoff

Flow Direction of Stormwater Runoff

Stormwater Flowpath

Upstream Storage Pond (USP)

Stormwater Retention Pond

Culvert

Mine Facility

Waste Rock Pile

Road

SCALE 1:2,400

0 200 400 FEET

CONTOUR INTERVAL 20 FEET

N

COLORADO REGISTERED SUSAN A. WYMAN 34622 PROFESSIONAL ENGINEER

2/22/2013

Whetstone Associates	cotter	Mineral Joe Mine Drainage Design Plan	*Figure 2* *Site Map Showing Sub-Basins Contributing to Mine Facilities Area*
Date:2/19/2013	Drawn/Checked By: CM/SW	Project No: 4148B	
File: JD7_Reg_Map_R21.dwg		County: Montrose County, CO	

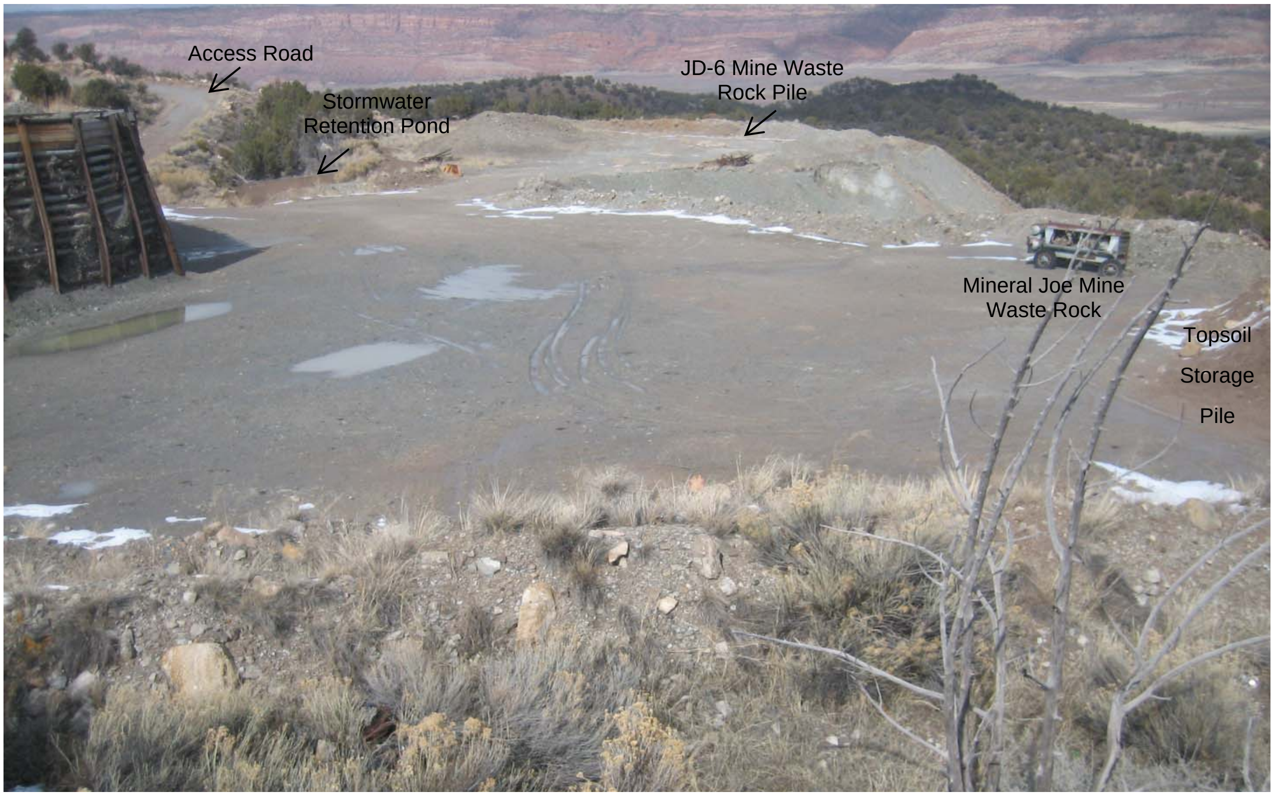
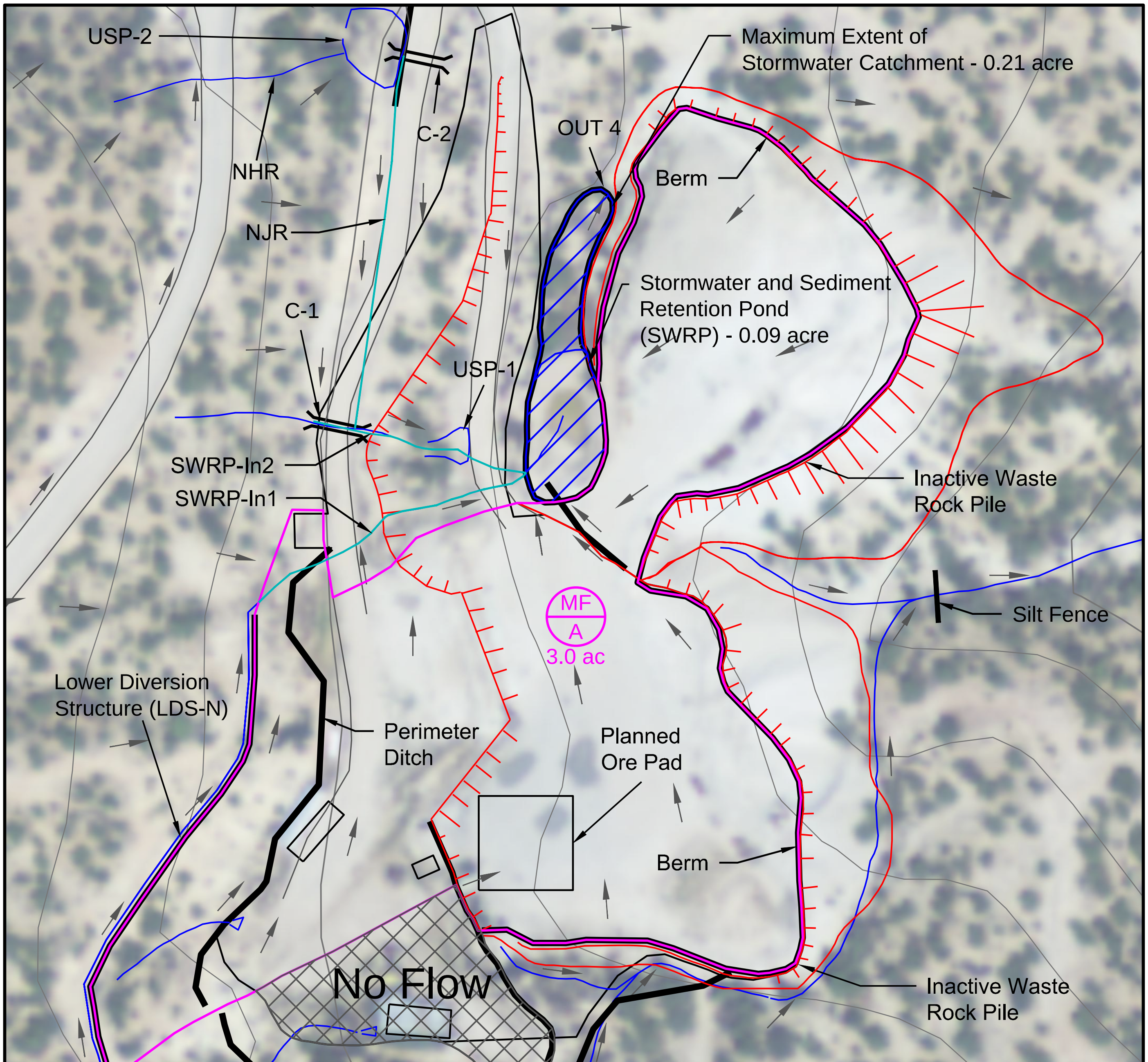


Figure 3. Photograph of Waste Rock Piles and Mine Facilities Area

(Facing North, Overlooking Mineral Joe Waste Rock Pile toward Mineral Joe Waste Rock Pile, Stormwater Retention Pond, and Access Road, February 2012)



EXPLANATION

- MF / A / 3.0 ac — Sub-Basin ID Showing Acreage
- Sub-Basin Boundary
- Stormwater Reach
- Stormwater Control Structure
- Flow Direction of Stormwater Runoff
- No Flow Area
- Stormwater Flowpath
- Upstream Storage Pond (USP)
- Stormwater Retention Pond
- Culvert
- Mine Facility
- Waste Rock Pile
- Road

SCALE 1:1,200

0 100 200 FEET

CONTOUR INTERVAL 20 FEET

N

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PROFESSIONAL ENGINEER
2/22/2013
Susan A. Wyman

Whetstone Associates	cotter	Mineral Joe Mine Drainage Design Plan	*Figure 4* *Detailed Site Map Showing Stormwater Flow Directions in the Mine Facilities Area*
Date:2/19/2013	Drawn/Checked By: CM/SW	Project No: 4148B	
File: JD7_Reg_Map_R21.dwg		County: Montrose County, CO	

4.4 Reach Definition

Stormwater runoff from the sub-basins described above is routed through the site via natural channels, diversion ditches, borrow ditches, and perimeter ditches. The major channels and ditches are entered as reaches in the WinTR55 run-off model. The reaches are shown in Figure 4. The hydraulic parameters, including length, width, slope, and Manning's n, are shown in Table 10.

Table 10. Reach Geometry and Hydraulic Parameters

Reach Identifier	Reach Length (ft)	Reach Manning's n	Friction Slope (ft/ft)	Bottom Width (ft)	Side Slope
UDS	690	0.047	0.088	2	1.5 :1
MDS	384	0.047	0.0933	2	1.5 :1
LDS-E	255	0.05	0.1141	1.5	1.5 :1
LDS-N	335	0.05	0.0794	1.5	1.5 :1
SWRP-In1	194	0.047	0.1907	3	2 :1
SWRP-In2	141	0.047	0.1773	3	2 :1
NJR	240	0.05	0.0443	1.5	1.5 :1
SWRP-Inlet	(This reach is a structure: SWRP)				

4.5 Storage Structures

Storage structures are stormwater management facilities typically designed to impound water, control sediment, and delay downstream flooding. At the Mineral Joe Mine, a stormwater and sediment retention pond (referred to in the TR55 model as "SWRP") collects sediment and runoff from roads and the mine facilities area, as described in Section 4.5.1 below. Upstream storage ponds also work to collect sediment and reduce peak flows, but are not explicitly modeled in TR55 as discussed in Section 4.5.2 below.

4.5.1 Stormwater and Sediment Retention Pond (SWRP)

The stormwater retention pond (SWRP) collects stormwater and sediment that runs off from the mine facilities area (or Duggan Adit staging area) and access road. The SWRP is shown in Figure 5 and its location relative to mine facilities is shown in Figure 4.

The current maximum surface area of the pond is 0.093 acres and the total area designated for the pond is 0.114 acres. Maximum pond surface dimensions are approximately 50 ft by 95 ft feet, currently. The volume of the SWRP was approximated by projecting contours inward from the maximum surface outline of the pond to a depth of 13.3 feet at a slope of 1.5:1. A total pond volume of 23,057 ft^3 (0.529 acre-ft) was calculated using a trapezoidal Riemann sum of the projected contour areas:

$$V = \sum \frac{(A_1 + A_2) \times \text{Contour Interval}}{2}$$

Where:

V = Total Volume
A = Contour Area
Contour Interval = 2 ft

The SWRP is implemented as an in-line storage structure in the WinTR55 model. The TR55 model assumes that the SWRP is a wet detention pond, which is considered an effective BMP for the removal of particulates (the settleable solids fraction of pollutant load) and only minimally effective in the removal of dissolved or colloidal constituents. "Classic" stormwater management practices assume that dry ponds have little documented direct water quality benefits due to scouring of bottom sediments. Wet ponds are designed to facilitate sediment removal and to allow decanted water to pass through the structure via a pipe or spillway. In contrast, the SWRP at the Mineral Joe Mine is designed to fully retain the 10-year 24-hour storm and may retain even larger storms (Section 5.3) and is a dry pond for part of the year. The complete capture and subsequent evaporation results in the JD-6 SWRP being effective for both dissolved, suspended, and colloidal constituents as well as the settleable solids fraction. In the WinTR55 model, however, the SWRP is modeled as a wet storage pond. The pond surface is set to the maximum surface area of the excavated pond, at the height of the spillway (to be constructed). Therefore, the WinTR55 model conservatively predicts the maximum flow over the spillway if the pond structure were full at the beginning of the storm event. Structure parameters are shown in Table 11.

Table 11. Structure Parameters

Reach Identifier	Surface Area @ Crest (ac)	Height Above Crest (ft)	Surface Area @ Ht Above (ac)	Pipe Diameter (in)	Head on Pipe (ft)	Weir Length (ft)
SWRP-Inlet	0.093	1	.101			10
						15
						25

The purpose of the pond is to retain storm water from the 10-year 24-hour storm event and slow its velocity such that any suspended sediment is deposited and contained onsite. The stormwater catchment is currently unlined. It is recommended that the pond remain unlined, to facilitate routine maintenance and sediment removal. Inspections and maintenance are performed in accordance with the Stormwater Management Plan.

Figure 5. Photograph of Stormwater and Sediment Retention Pond (February 2012)

4.5.2 Upstream Storage Ponds (USPs)

"Upstream storage" refers to the storage of storm runoff close to the points of rainfall occurrence, including road embankments, borrow pits, parking lots, property line swales, parks, and on-site basins and ponds (UDFCD DP-17, 2001). Several upstream storage ponds exist at the Mineral Joe Mine, two of which are identified on Figure 2 as USP-1 and USP-2. Additional upstream storage occurs in the perimeter ditch around the mine facilities area (Figure 4) and in small ponds or pools on site. Although this upstream storage is beneficial to reducing stormwater runon to the site, the runoff modeling conservatively neglects to take credit for this storage.

Although the Drainage Criteria Manual published by the Urban Drainage and Flood Control District (UDFCD, 2001) is not directly applicable to the Mineral Joe site, the manual identifies the benefits of upstream storage and the difficulty in quantifying those benefits:

> The difficulty in quantifying the cumulative effects of very large numbers of small (i.e., on-site) detention/retention facilities (Malcomb, 1982; Urbonas and Glidden, 1983) and the virtual impossibility of assurance of their continued long-term performance or existence (Debo, 1982; Prommersberger, 1984) requires the District to recognize in its floodplain management only regional, publicly owned facilities. Nevertheless, upstream storage is encouraged, such as with the "Blue-Green" concept first described in Civil Engineering magazine (Jones, 1967).

The runoff modeling performed for the Mineral Joe Mine using WinTR-55 conservatively neglects to take credit for upstream storage.

4.6 Model Implementation of Stormwater Routing

Stormwater routing from the sub-basins, reaches, and pond described is shown schematically in Figure 6. Although different symbols are used to identify three types of reaches (diversion ditches, borrow or perimeter ditches, and naturally formed channels), the reaches are treated the same in the numerical model.

In the physical system, all of the drainage from the site eventually reports to the same drainage. However, the outflow from the model is broken into four outlets as shown in Figure 6.

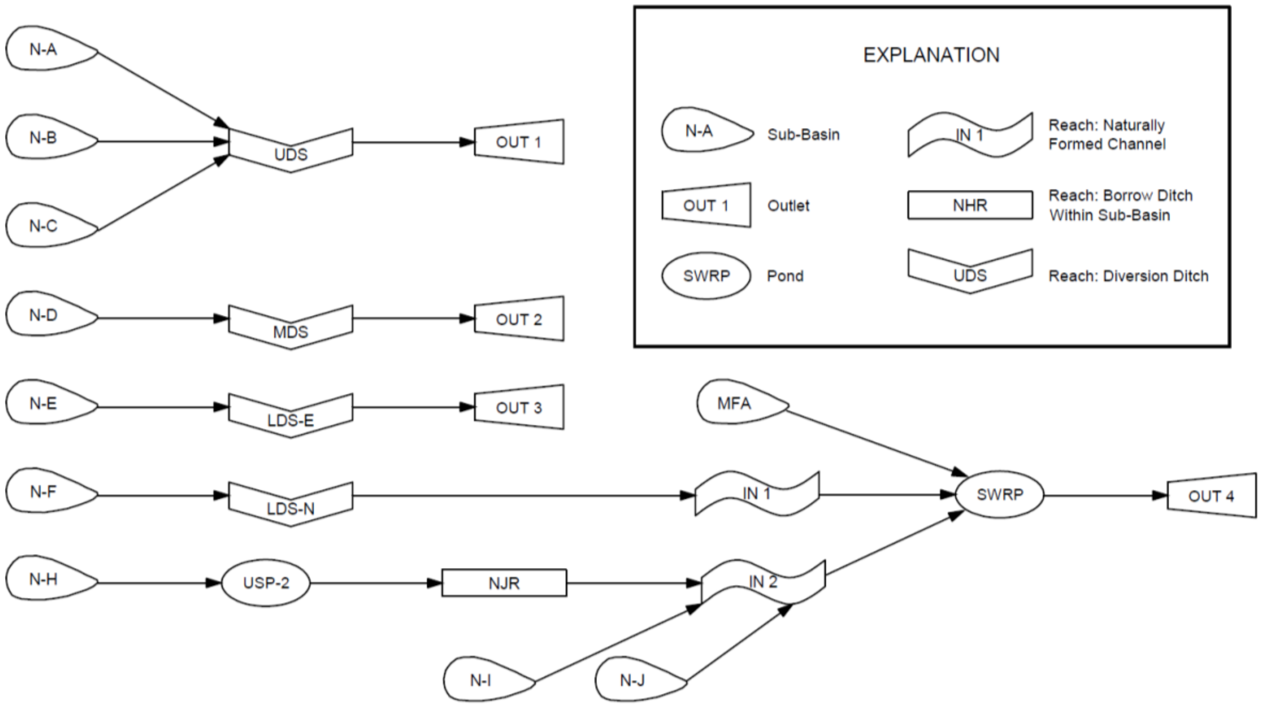

Figure 6. Schematic of Stormwater Routing at the Mineral Joe Mine

Table 12. Sub-Basin Areas, Receiving Reach, Weighted Average Curve Number, and Time of Concentration in TR55 Model

Name	Description	Reach	Area(ac)	RCN	Tc
N-A	Main drainage above UDS	UDS	52.4	73	0.163
N-B+C	Triangle above west UDS	UDS	1.92	73	0.110
N-D	Area below UDS reporting	MDS	0.91	73	0.1
N-E	Area below UDS reporting	LDS-E	1.43	74	0.1
N-F	Road CL to LDS-north	LDS-N	1.86	75	0.1
N-H	Road to culvert on switch	NJR	0.35	76	0.1
N-I	Road to NJ via culvert	SWRP-In2	0.68	74	0.1
N-J	Road & slope above SWRP	SWRP-In2	0.81	81	0.123
MFA	Mine Facilities to SWRP	SWRP-Inlet	3.01	85	0.229

Total area: 63.37 (ac)

Notes: Calculated Tc values of <0.1 hr were converted to 0.1 hr in WinTR55

5. PEAK FLOW MODEL RESULTS

Peak flow rates were calculated for five design storms, including the 10-year 24-hour storm, 25-year 24-hour storm, 50-year 24-hour storm, and 100-year 24-hour storm. As discussed previously, the design criteria for stormwater conveyance structures at the Mineral Joe Mine is the ability to pass the 100-year 24-hour storm. The design criteria for retention structures is the ability to retain the 10-year 24-hour storm and to pass the 100-year 24-hour storm. The flow rates and channel depths associated with these storm events were determined using the WinTR-55 model and the results are described below.

5.1 Peak Flow Rates

The Upper Diversion Structure (UDS) conveys the highest flows at the site. Peak flow through the UDS ranges from 20.14 cfs for the 10-year 24-hour storm to 62.36 cfs for the 100-year 24-hour storm (Table 13). Most of the runoff to the UDS is provided by Sub-Basin N-A, with contributions to peak runoff derived from Sub-basins N-B and N-C (Table 13).

Peak flow into SWRP is calculated to be 5.13 cfs for the 10-year 24-hour storm and 11.40 cfs for 100-year 24-hour storm. Flow rates exiting the structure[2] are delayed and reduced to 4.66 cfs for the 10-year 24-hour storm and 10.86 for 100-year 24-hour storm (Table 13).

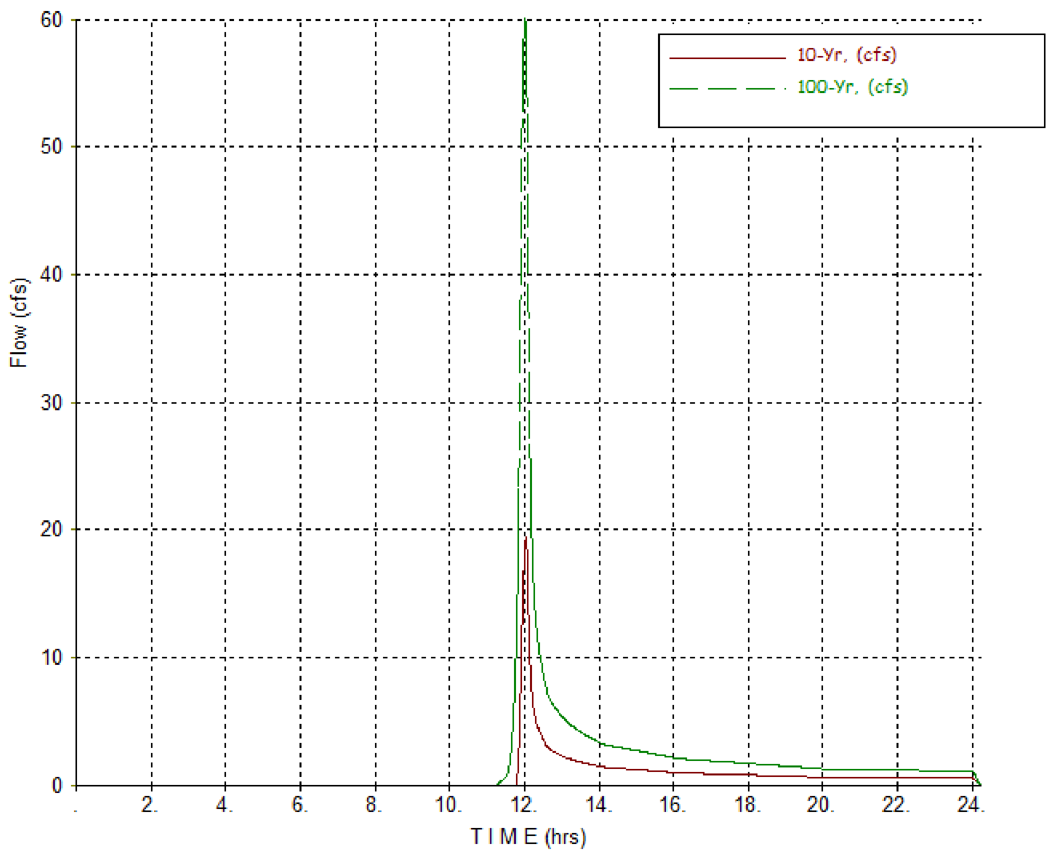

Figure 7. Hydrograph for Upper Diversion Structure

[2] The SWRP is modeled in Win TR55 as a wet detention pond that is full at the beginning of the storm event. Storage capacity of the empty pond is discussed in Section **Error! Reference source not found.**.

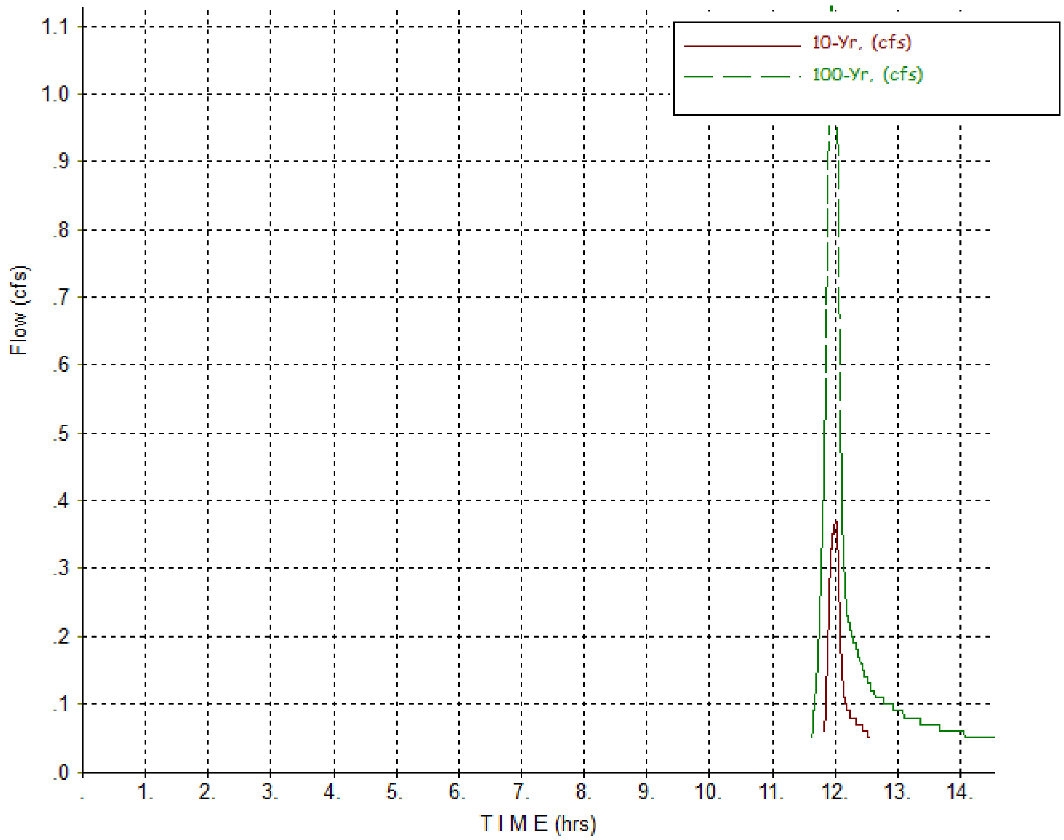

Figure 8. Hydrograph for Middle Diversion Structure

Table 13. Peak Flow (cfs) and Peak Time (hr) by Rainfall Return Period

Sub-Area or Reach	10-Yr (cfs) (hr)	25-Yr (cfs) (hr)	50-Yr (cfs) (hr)	100-Yr (cfs) (hr)	
SUBAREAS					
N-A	19.40	34.13	46.64	60.11	
	12.04	12.02	12.02	12.02	
N-B+C	0.78	1.33	1.80	2.34	
	12.02	12.01	11.96	11.96	
N-D	0.37	0.63	0.87	1.13	
	12.02	12.01	11.95	11.95	
N-E	0.66	1.08	1.48	1.90	
	12.02	11.96	11.95	11.94	
N-F	0.95	1.55	2.08	2.65	
	12.02	11.95	11.94	11.94	
N-H	0.20	0.32	0.42	0.53	
	12.01	11.95	11.94	11.94	
N-I	0.31	0.51	0.70	0.90	
	12.02	11.96	11.95	11.94	
N-J	0.69	1.02	1.29	1.57	
	11.97	11.96	11.96	11.96	
MFA	3.03	4.22	5.16	6.12	
	12.04	12.04	12.03	12.03	
REACHES					
UDS	20.14	35.43	48.41	62.36	
	12.04	12.03	12.02	12.01	
Down	20.11	35.39	48.38	62.34	Out 1
	12.06	12.05	12.04	12.03	
MDS	0.37	0.63	0.87	1.13	
	12.02	12.01	11.95	11.95	
Down	0.37	0.63	0.87	1.13	Out 2
	12.03	12.03	11.96	11.96	
LDS-E	0.66	1.08	1.48	1.90	
	12.02	11.96	11.95	11.94	
Down	0.65	1.08	1.48	1.90	Out 3
	12.03	11.96	11.96	11.96	
LDS-N	0.95	1.55	2.08	2.65	
	12.02	11.95	11.94	11.94	
Down	0.95	1.55	2.08	2.65	
	12.03	11.97	11.96	11.96	
NJR	0.20	0.32	0.42	0.53	
	12.01	11.95	11.94	11.94	
Down	0.20	0.32	0.42	0.53	
	11.89	11.97	11.96	11.96	
SWRP-In1	0.20	0.32	0.42	0.53	
	11.89	11.97	11.96	11.96	
Down	0.20	0.32	0.42	0.53	
	12.04	11.97	11.96	11.96	
SWRP-In2	1.92	3.08	4.06	5.11	
	12.02	11.97	11.96	11.96	
Down	1.92	3.08	4.06	5.11	
	12.02	11.97	11.96	11.96	
SWRP-Inlet	5.13	7.51	9.41	11.40	
	12.03	12.02	12.02	12.01	
Down	4.66	6.91	8.71	10.86	Out 4
	12.07	12.06	12.06	12.05	

5.2 Diversion Structure Capacity

The conveyance capacity of diversion structures is dependent on stage (i.e., flow depth) within the design constraints input to the model (and as constructed on site). Table 14 lists the conveyance capacity in cfs for stages ranging from 0 ft to 5 ft. Interpolating between the stage values shown in Table 14 indicates that the Upper Diversion Structure can pass the 100-year 24-hr peak flow rate (Q_{100}) with a channel depth of 1.83 feet (Table 15). As currently constructed, the UDS has adequate capacity to accommodate flow depths of 1.8 feet or greater (Figure 9). The lower diversion structure LDS-N and borrow ditch NJR will convey the 100-year 24-hr peak flow rate (Q_{100}) with channel depths of 0.29 and 0.08 feet (Table 15).

Table 14. Conveyance Capacity for Diversion Structures

Reach Identifier	Stage (ft)	Flow (cfs)	End Area (sq ft)	Top Width (ft)	Friction Slope (ft/ft)
UDS	0.0	0.000	0	2	0.088
	0.5	6.545	1.4	3.5	
	1.0	23.981	3.5	5	
	2.0	99.073	10	8	
	5.0	792.313	47.5	17	
MDS	0.0	0.000	0	2	0.0933
	0.5	6.740	1.4	3.5	
	1.0	24.692	3.5	5	
	2.0	102.013	10	8	
	5.0	815.824	47.5	17	
LDS-E	0.0	0.000	0	1.5	0.1141
	0.5	5.508	1.1	3	
	1.0	21.128	3	4.5	
	2.0	92.338	9	7.5	
	5.0	788.154	45	16.5	
LDS-N	0.0	0.000	0	1.5	0.0794
	0.5	4.595	1.1	3	
	1.0	17.625	3	4.5	
	2.0	77.028	9	7.5	
	5.0	657.474	45	16.5	
SWRP-In1	0.0	0.000	0	3	0.1907
	0.5	14.537	2	5	
	1.0	52.814	5	7	
	2.0	214.884	14	11	
	5.0	1680.782	65	23	
SWRP-In2	0.0	0.000	0	3	0.1773
	0.5	14.017	2	5	
	1.0	50.925	5	7	
	2.0	207.196	14	11	
	5.0	1620.654	65	23	
NJR	0.0	0.000	0	1.5	0.0443
	0.5	3.432	1.1	3	
	1.0	13.165	3	4.5	
	2.0	57.536	9	7.5	
	5.0	491.100	45	16.5	

Table 15. Channel Stage to Convey 100-year Peak Flow

Channel	100-Yr Peak Stage (ft)
UDS	1.830
MDS	0.084
LDS-E	0.172
LDS-N	0.288
NJR	0.077

Figure 9. Photograph of Upper Diversion Structure (February 2012)

5.3 SWRP Capacity

As discussed in Section 4.5.1, the existing storage capacity of the SWRP is 23,057 ft^3 (0.529 acre-ft). Using methods described in Section 2.2.1 and neglecting stormwater detention by upstream storage (USPs), the volume of stormwater runoff reporting to the SWRP for the 10-year 24-hour storm is 14,404 ft^3 (0.331 acre-ft) as shown in Table 16. These calculations indicate that the current SWRP capacity is 60% greater than the required capacity to retain the 10-year 24-hour storm and 11% greater than the required capacity to retain the 25-year 24-hour storm (20,716 ft^3, 0.476 acre-ft). Additionally, upstream storage at USP-1, USP-2, and in drainage ditches on site is expected to detain a significant fraction of this runoff.

Storage capacity of the SWRP is maintained by routinely excavating sediment from the floor of the pond. Fine sediment is excavated using a backhoe or other equipment and placed on the topsoil stock pile. The nature of this maintenance precludes the use of a liner in the stormwater and sediment retention pond. It is recommended that the pond not be lined, to facilitate continued maintenance and allow for adequate storage capacity within the pond. Maintenance and inspection is performed according to the checklist and schedule provided in the Stormwater Management Plan.

Table 16. Required SWRP Capacity to Contain the 10-year 24-hour Storm

Area	Soil Type	Hydr. Group	Cover Description	Condition	Area (acres)	Curve Number CN	Rainfall P (inches)	Retention S	Runoff q (inches)	Runoff Q (ft^3)
N-F	Bodot / Ustic Torriorthents	C	Sagebrush w/grass understory	Fair	1.86	75	2.00	3.33	0.38	2,572
N-H	Bodot / Ustic Torriorthents	C	Sagebrush w/grass understory	Fair	0.35	76	2.00	3.16	0.41	518
N-I	Bodot / Ustic Torriorthents	C	Sagebrush w/grass understory	Fair	0.68	74	2.00	3.51	0.35	857
N-J	Bodot / Ustic Torriorthents	C	Sagebrush w/grass & roadway	Fair	0.81	81	2.00	2.35	0.60	1,778
MFA	Bodot / Ustic Torriorthents	C	Disturbed ground	Fair	3.01	85	2.00	1.76	0.80	8,679
Total (ft^3)										14,404
Total (acre-ft)										0.331

Peak flow through the SWRP was evaluated using three spillway trial dimensions, 10-ft, 15-ft, and 25-ft (Table 18). Upstream and downstream hydrographs were prepared for Trial #1 (10-ft spillway) using WinTR55[3]. The hydrographs indicate that the arrival time for the 10-year storm occurs at approximately 11.3 hours after rainfall begins, while the 100-year storm arrives at the SWRP approximate 9.9 hours after rainfall begins (Figure 10). Peak flow occurs at 12.01 to 12.07 hours (Table 13).

The spillway was modeled as a weir, which is an appropriate model for natural and excavated earth spillways. As shown in the weir flow rating curve (Table 17, Figure 12), a 10-ft wide spillway can transmit 9.9 cfs at a stage of 0.5 ft above the spillway and 28 cfs at a stage of 1.0 ft. Linear interpolation from the stage-storage table indicates that the SWRP could pass the 100-year 24-hour storm at a stage of 0.54 ft above a 10-ft wide spillway (Table 17). This stage height is shown as H_p in Figure 13 and results in a velocity (v=Q/A) of 2.11 ft/sec over a 10-ft wide spillway.

The existing stormwater pond is constructed without a spillway. A 10-ft wide rock-lined spillway is recommended to pass the peak flows associated with the 100-year 24-hour storm. Cotter will install the recommended spillway upon approval of the Mineral Joe Permit Amendment. It is not necessary that the spillway be placed in the center of the downstream berm. Rather, the spillway will be constructed on the northwest side of the berm, adjacent to the natural slope, to take advantage of the erosion resistance of the hillside. Spillway dimensions are provided in Table 18.

[3] WinTR55 uses the TR20 "engine" to generate a runoff hydrograph equivalent to the TR55 Tabular Method for the SCS Type II precipitation distribution.

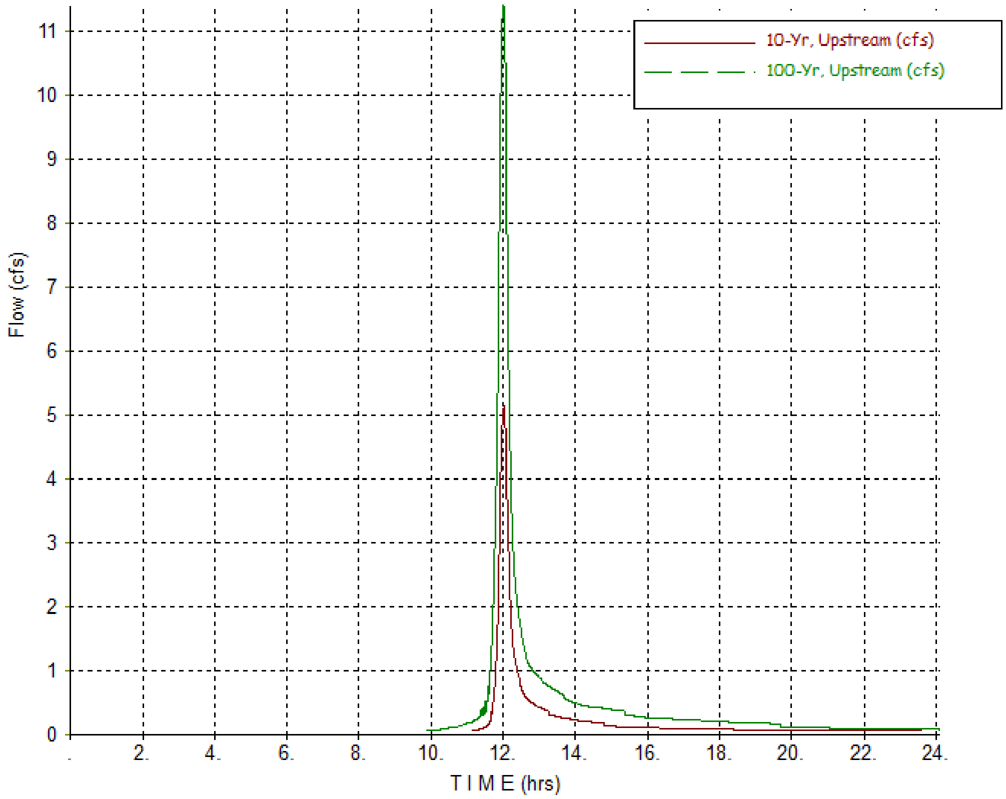

Figure 10. Upstream Hydrograph for SWRP

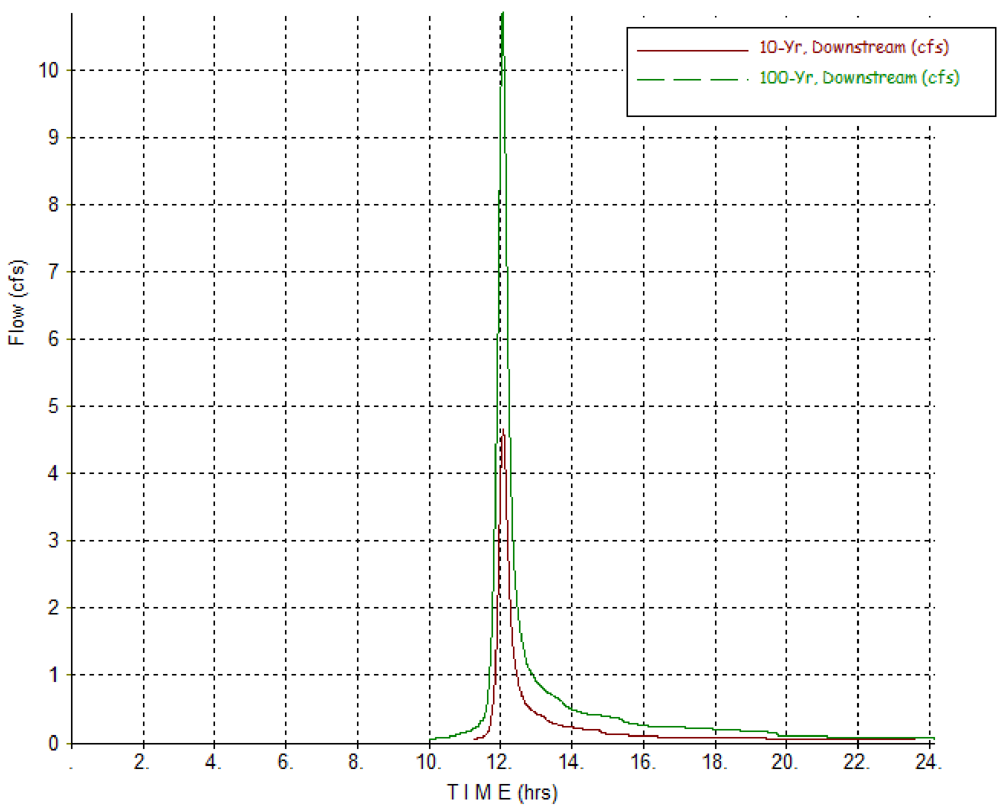

Figure 11. Downstream Hydrograph for SWRP

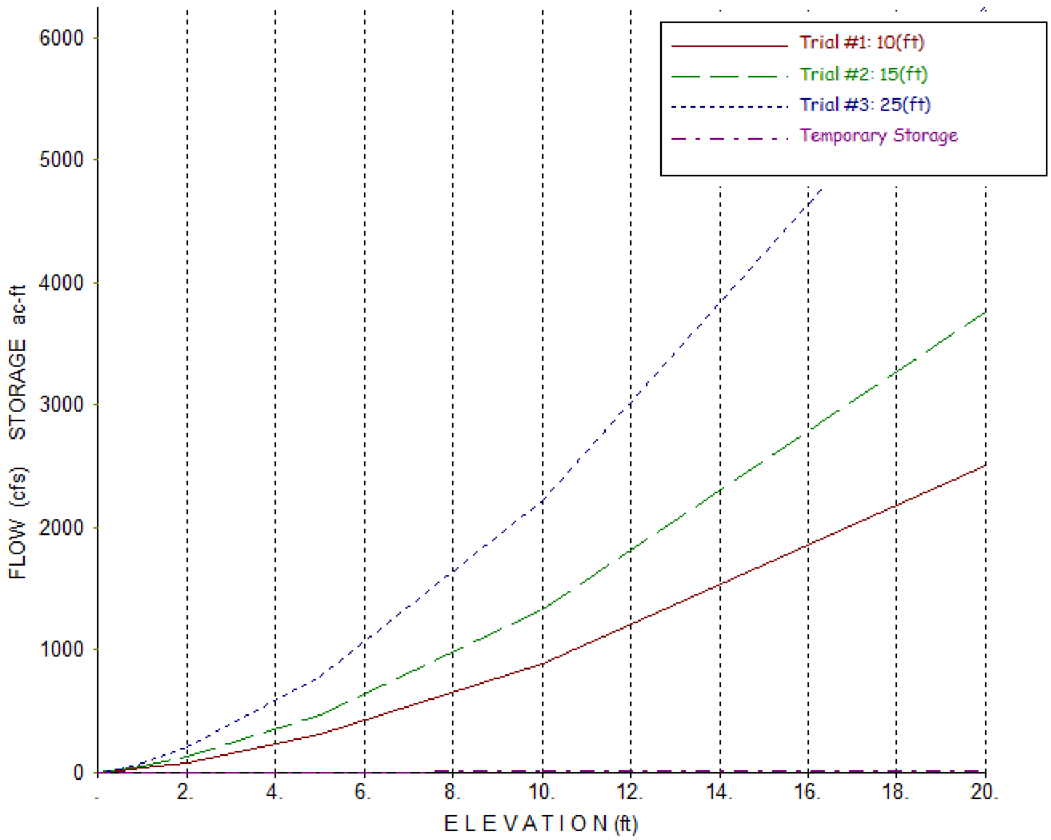

Figure 12. SWRP Flow Rating Curve for 10-ft, 15-ft, and 25-ft Spillway Widths

Table 17. SWRP Stage-Storage Rating Table for 10-ft, 15-ft, and 25-ft Spillway Widths

Stage (ft)	Storage (acft)	Length #1 10 ft	Length #2 15 ft	Length #3 25 ft
0	0	0	0	0
0.5	0.05	9.9	14.8	24.7
1.0	0.10	28.0	42.0	70.0
2.0	0.21	79.2	118.8	198.0
5.0	0.60	313.1	469.6	782.6
Q100 (cfs)		11.40	11.40	11.40
Stage (interpolated)		0.96	0.38	0.23

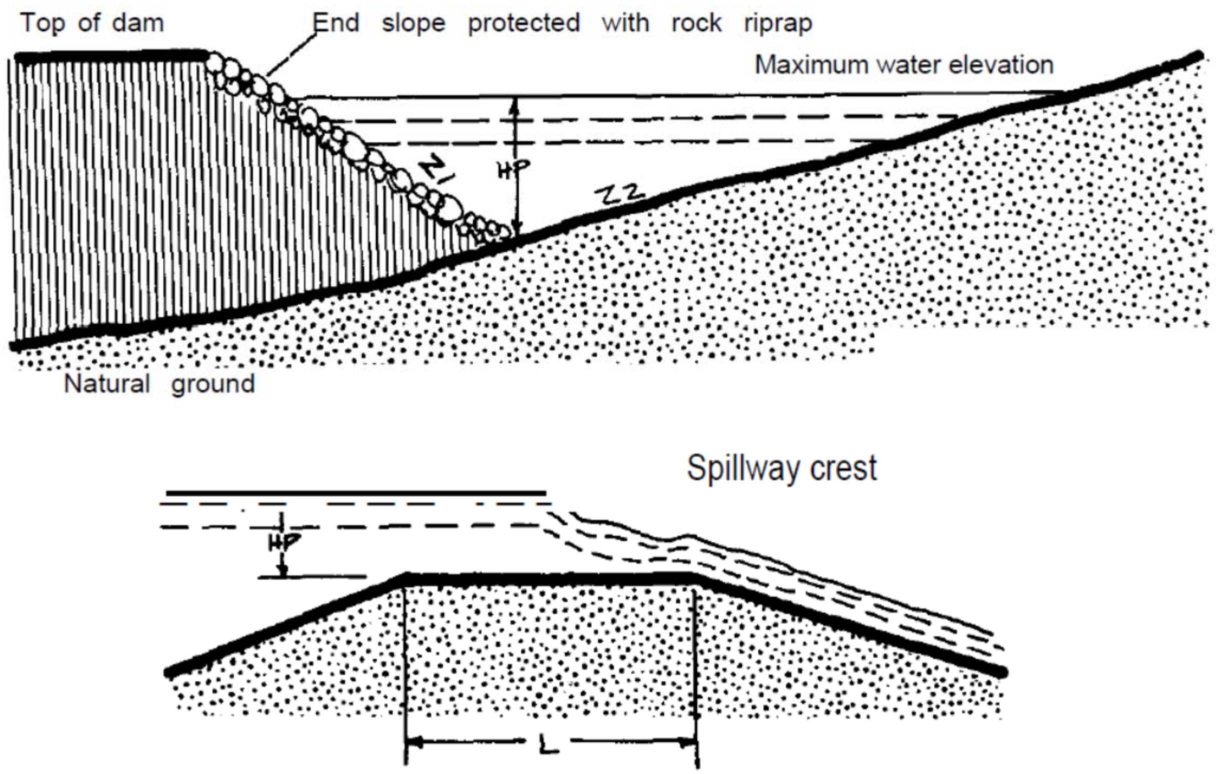

Figure 13. Example Spillway Design Schematic

Table 18. Planned Retention Pond Spillway Dimensions

	SWRP 10-ft Spillway
Design Flow (cfs)	11.40
Spillway Width (ft)	10.0
Spillway Depth (ft)	1.0
Stage (Headwater Depth, H_p) (ft)	0.54
Velocity (ft/s)	2.11
Slope (ft/ft)	0.03
Length (ft)	5.0
Spillway Lining D_{50} (inches)	6

5.4 Culvert Capacity

Culverts were evaluated to determine the size required to convey the 100-year 24-hr peak flow rate (q_{100}) based on the parameters shown in Table 19. As shown in Figure 2, the existing culverts are located on County Road EE 19 and are owned and maintained by Montrose County. Existing culverts are constructed using 18-inch diameter corrugated steel pipe. The capacity was evaluated using HY-8 (FHWA, 2012). On the EE-19 Road, Montrose County installs culverts to fit their requirements.

Any new culverts installed by Cotter within the Mineral Joe mine area will be installed with adequate capacity to convey the 100-year 24-hour storm, and will be a minimum of 18-inch diameter.

Table 19. Culvert Capacity for 100-year 24-hour Storm Event

Parameter	Culvert C-1	Culvert C-2
Contributing Sub-Basin	N-I	N-H
Q10 Design Flow (cfs)	0.31	0.20
Q100 Max Flow (cfs)	0.9	0.53
Channel Depth / Culvert Diameter (ft)	1.5	1.5
Culvert Flow Depth (ft)	0.34	0.25
Tailwater slope	0.191	0.075
Velocity (ft/s)	3.09	2.64
Slope (ft/ft)	0.02	0.02

6. STRUCTURAL CONTROLS AND ADDITIONAL STORMWATER BMPS

6.1 Summary of Existing Structural Controls for Stormwater

The best management practices (BMPs) for stormwater evaluated above include diversion ditches to convey upland runoff around the Mineral Joe Mine site, as well as drainage ditches, berms, and the stormwater retention pond for the capture, control and treatment of runoff. In summary, existing structural controls on stormwater flow are shown in Figure 4 and include the following:

- Upper Diversion Structure (UDS)
- Middle Diversion Structure (MDS)
- Lower Diversion Structure (LDS)
- Stormwater and Sediment Retention Pond (SWRP)
- Crest Berm surrounding the waste rock pile
- Perimeter Ditch surrounding the mine facilities area.
- Silt Fence located in the ephemeral drainage below the waste rock pile

6.2 Sediment and Erosion Prevention

Several practices are employed at the Mineral Joe Mine to reduce erosion and prevent sediment delivery to State waters. Although no perennial streams or springs have been mapped in the Mineral Joe Mine area, these sediment and erosion prevention measures are intended to prevent sediment delivery to ephemeral channels (incised channels that are mostly dry, but may flow temporarily in response to rainfall or snowmelt).

Additional sediment and erosion prevention practices that may be used at the Mineral Joe Mine include the following:

- *Silt Fences*. A silt fence was constructed downslope from the waste rock pile (Figure 4) and is routinely inspected and maintained. Additional silt fencing will be employed where necessary to contain sediment and prevent its migration.

- *Straw Wattles*. Straw wattles are not currently in use at the site, but may be employed to retain sediment during construction activities. Contractors whose onsite activities have the potential to affect stormwater may be required to prepare, submit, and implement a stormwater management plan that addresses the specific site activities. These construction-specific activities may require short-term sediment controls including, but not limited to, straw wattles and silt fences.
- *Ditches and Berms*. Ditches and berms are used to convey stormwater runoff toward catchments and to prevent excess stormwater from entering facilities areas or eroding the waste rock piles. Perimeter berms have been constructed and will be maintained at the crest of the waste rock pile to route water away from the face of the pile and into constructed catchments. Additional ditches or berms may be installed as needed within the permitted affected area during operations.
- *Revegetation*. The waste rock pile will be revegetated as soon as practicable after mining is complete. Revegetation will follow the seed mix and procedures described in the Reclamation Plan and EPP. The establishment of vegetation on the reclaimed facilities will reduce erosion and sedimentation from formerly disturbed areas.
- *Other BMPs*. Additional BMPs may be used as necessary to check or direct water flow and prevent erosion and sediment transport.

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Attachment 1. Rip Rap Granular Bedding Specifications (from UDFCD 2011)

Table MD-11—Gradation for Granular Bedding

U.S. Standard Sieve Size	Percent Weight by Passing Square-Mesh Sieves	
	Type I CDOT Sect. 703.01	Type II CDOT Sect. 703.09 Class A
3 inches	-----	90-100
1½ inches	-----	-----
¾ inches	-----	20-90
³⁄₈ inches	100	-----
#4	95-100	0-20
#16	45-80	-----
#50	10-30	-----
#100	2-10	-----
#200	0-2	0-3

The Type I and Type II bedding specifications shown in Table MD-11 were developed using the T-V filter criteria and the fact that bedding which will protect an underlying non-cohesive soil with a mean grain size of 0.045 mm will protect anything finer. Since the T-V filter criterion provides some latitude in establishing bedding gradations, it is possible to make the Type I and Type II bedding specifications conform with Colorado Division of Highways' aggregate specifications. The Type I bedding in Table MD-11 is designed to be the lower layer in a two-layer filter for protecting fine-grained soils and has a gradation identical to Colorado Department of Transportation's (CDOT's) concrete sand specification AASHTO M-6 (CDOT Section 703.01). Type II bedding, the upper layer in a two-layer filter, is equivalent to Colorado Division of Highways' Class A filter material (Section 703.09 Class A) except that it permits a slightly larger maximum rock fraction. When the channel is excavated in coarse sand and gravel (50% or more of coarse sand and gravel retained on the #40 sieve by weight), only the Type II filter is required. Otherwise, a two-layer bedding (Type I topped by Type II) is required. Alternatively, a single 12-inch layer of Type II bedding can be used, except at drop structures. For required bedding thickness, see Table MD-12. At drop structures, a combination of filter fabric and Type II bedding is acceptable as an alternative to a two-layer filter.

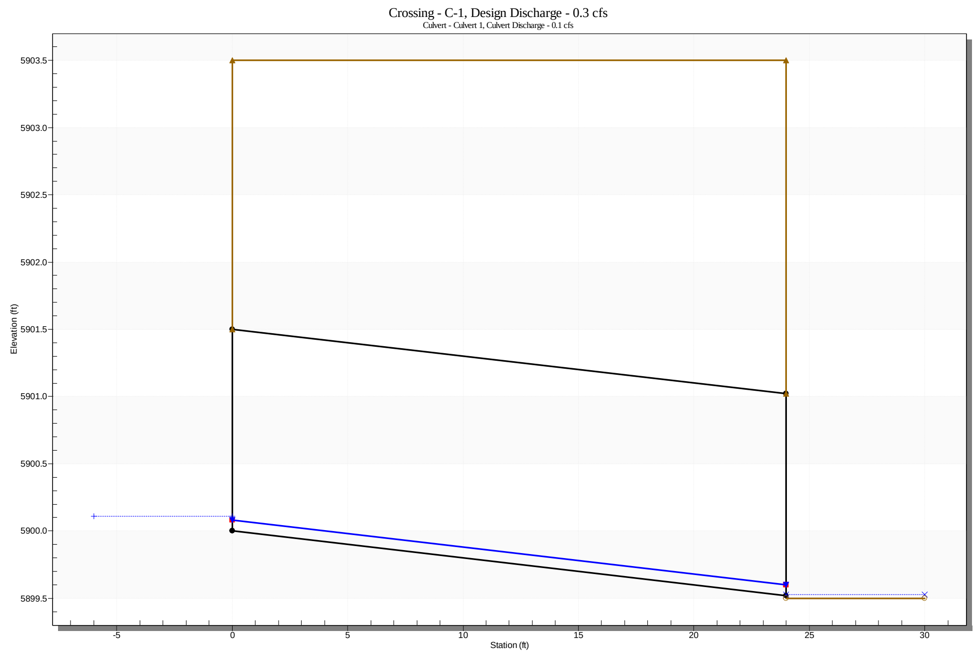
Table MD-12—Thickness Requirements for Granular Bedding

Riprap Designation	Minimum Bedding Thickness (inches)		
	Fine-Grained Soils*		Coarse-Grained Soils**
	Type I	Type II	Type II
VL (d_{50} = 6 in), *L* (d_{50} = 9 in)	4	4	6
M (d_{50} = 12 in)	4	4	6
H (d_{50} = 18 in)	4	6	8
VH (d_{50} = 24 in)	4	6	8

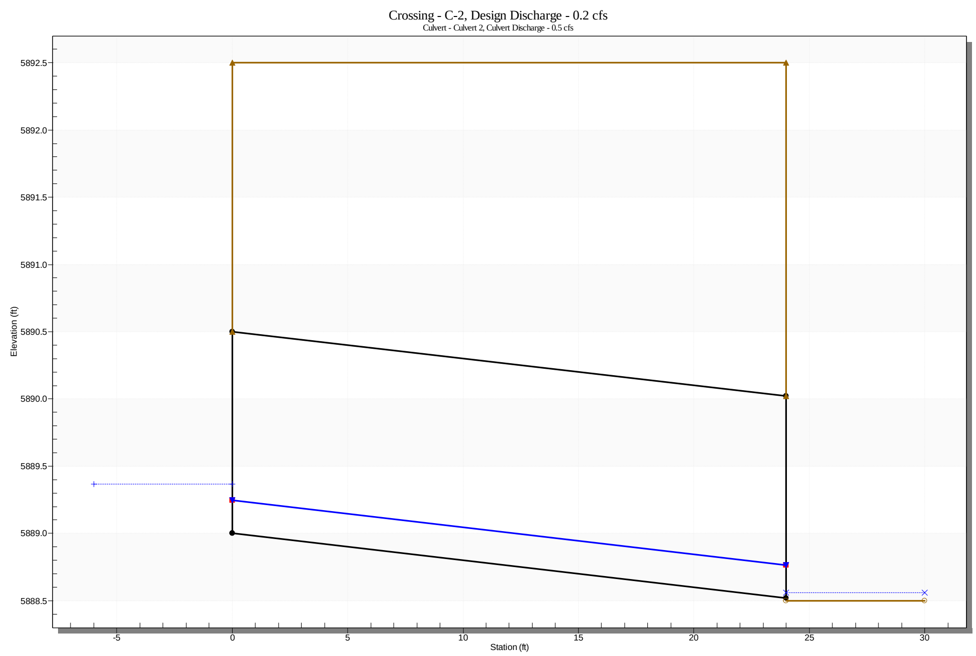
* May substitute one 12-inch layer of Type II bedding. The substitution of one layer of Type II bedding shall not be permitted at drop structures. The use of a combination of filter fabric and Type II bedding at drop structures is acceptable.

** Fifty percent or more by weight retained on the # 40 sieve.

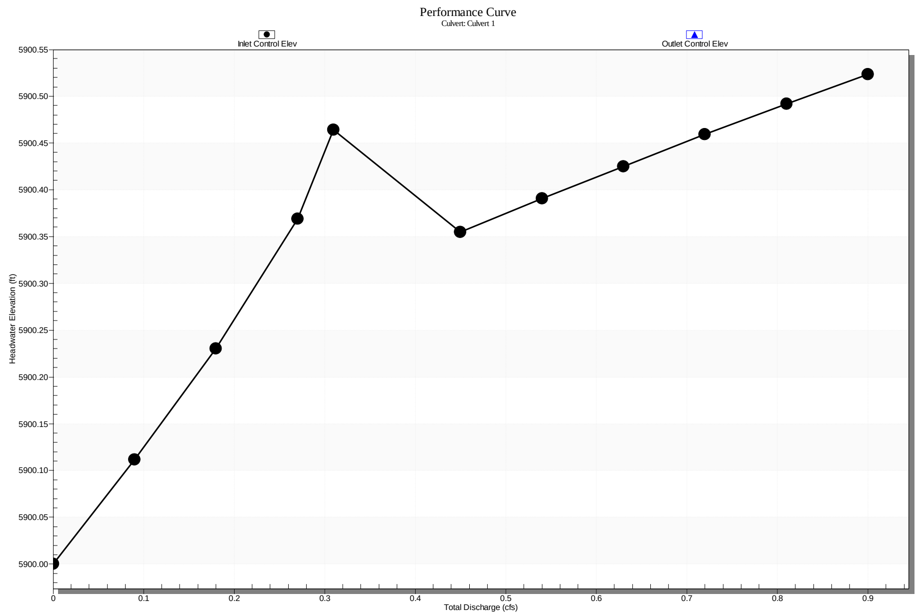
Attachment 2. Culvert Hydraulic Profiles



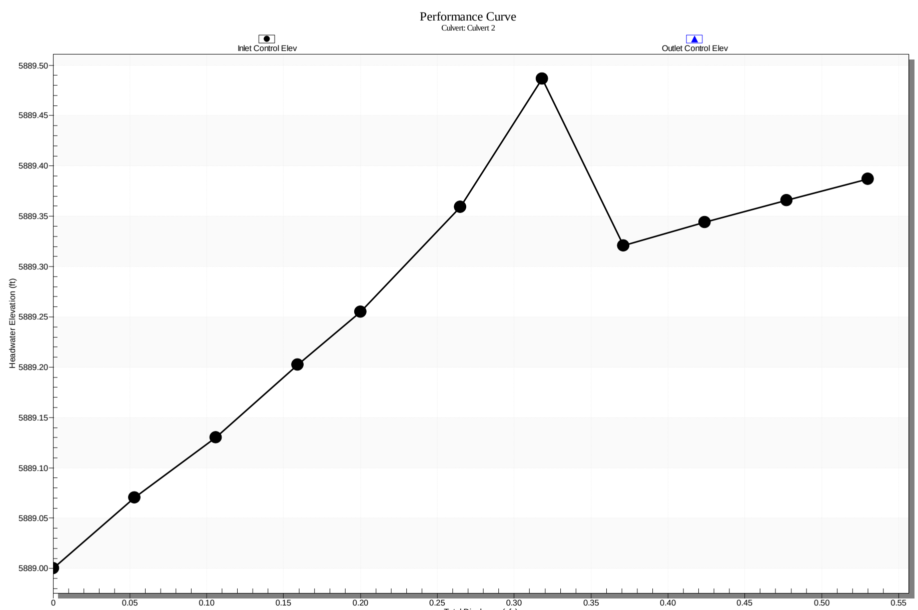
Approximate Hydraulic Profile – Culvert C-1



Approximate Hydraulic Profile – Culvert C-2



Performance Curve – Culvert C-1



Performance Curve – Culvert C-2

Attachment 3. Typical Spillway Design Schematic (from FHWA 2009)

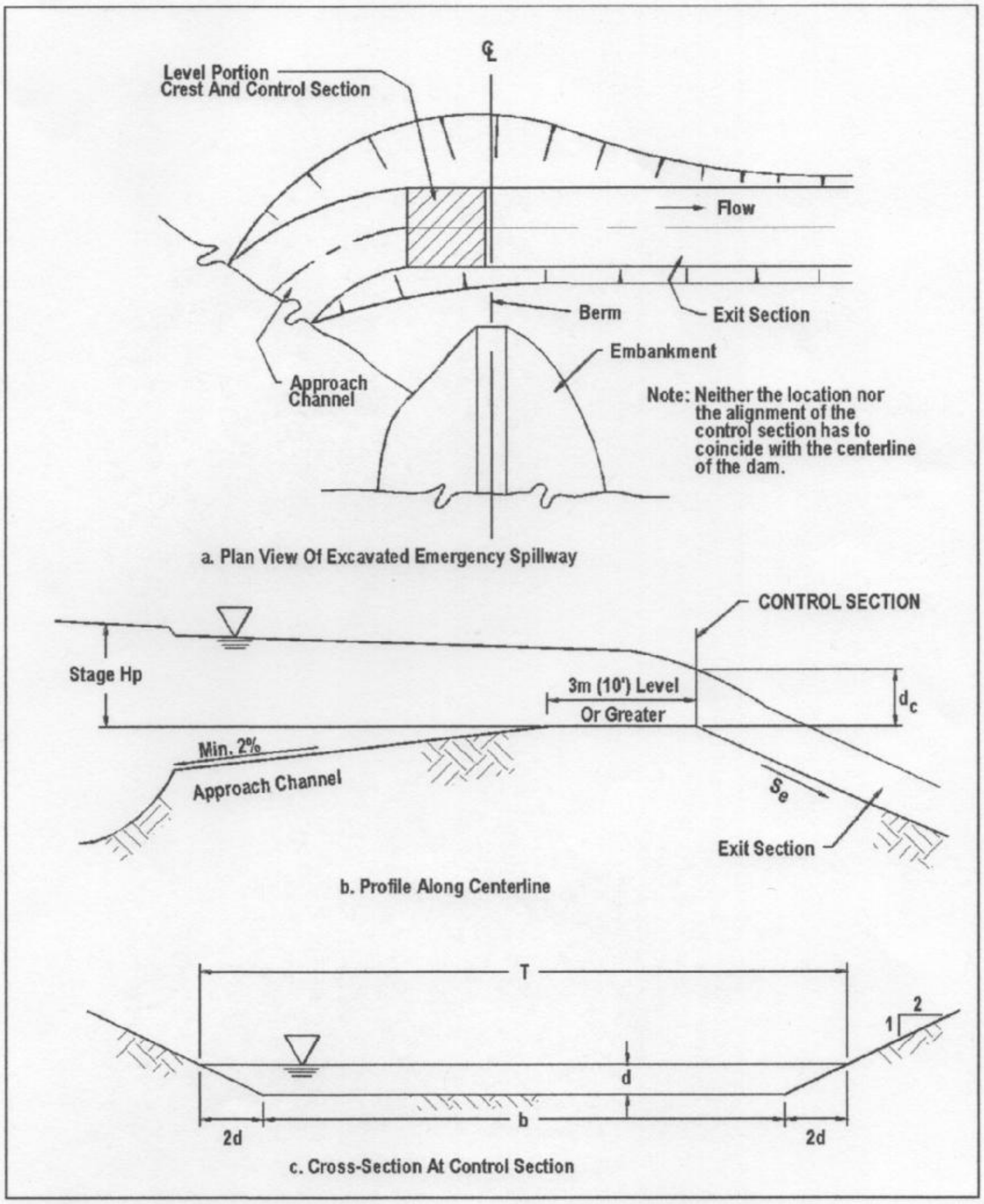


Figure 8-17. Emergency spillway design schematic.

8-31

Attachment 4. WinTR55

WinTR-55 Current Data Description

--- Identification Data ---

User:	Whetstone	Date:	2/20/2013
Project:	JD-6 Mine	Units:	English
SubTitle:	Drainage Design Plan	Areal Units:	Acres
State:	Colorado		
County:	Montrose		

Filename: C:\Users\Susan Wyman\AppData\Roaming\WinTR-55\TR_55_JD6_Mine_Rev05.w55

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
N-A	Main drainage above UDS	UDS	52.4	73	.163
N-B+C	Triangle above west UDS	UDS	1.92	73	.11
N-D	Area below UDS reporting	MDS	0.91	73	0.1
N-E	Area below UDS reporting	LDS-E	1.43	74	0.1
N-F	Road CL to LDS-north	LDS-N	1.86	75	0.1
N-H	Road to culvert on switch	NJR	0.35	76	0.1
N-I	Road to NJ via culvert	SWRP-In2	0.68	74	0.1
N-J	Road & slope above SWRP	SWRP-In2	0.81	81	.123
MFA	Mine Facilities to SWRP	SWRP-Inlet	3.01	85	.229

Total area: 63.37 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
1.2	1.6	2.0	2.4	2.7	3.0	.0

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

JD-6 Mine
Drainage Design Plan
Montrose County, Colorado

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
1.2	1.6	2.0	2.4	2.7	3.0	.0

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

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Watershed Peak Table (Trial #1)

Sub-Area or Reach Identifier	ANALYSIS: (cfs)	Peak Flow by Rainfall Return Period 25-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
SUBAREAS				
N-A	19.40	34.13	46.64	60.11
N-B+C	0.78	1.33	1.80	2.34
N-D	0.37	0.63	0.87	1.13
N-E	0.66	1.08	1.48	1.90
N-F	0.95	1.55	2.08	2.65
N-H	0.20	0.32	0.42	0.53
N-I	0.31	0.51	0.70	0.90
N-J	0.69	1.02	1.29	1.57
MFA	3.03	4.22	5.16	6.12
REACHES				
UDS	20.14	35.43	48.41	62.36
Down	20.11	35.39	48.38	62.34
MDS	0.37	0.63	0.87	1.13
Down	0.37	0.63	0.87	1.13
LDS-E	0.66	1.08	1.48	1.90
Down	0.65	1.08	1.48	1.90
LDS-N	0.95	1.55	2.08	2.65
Down	0.95	1.55	2.08	2.65
SWRP-Inlet	5.13	7.51	9.41	11.40
Down	4.66	6.91	8.71	10.86
SWRP-In1	0.20	0.32	0.42	0.53
Down	0.20	0.32	0.42	0.53
SWRP-In2	1.92	3.08	4.06	5.11
Down	1.92	3.08	4.06	5.11
NJR	0.20	0.32	0.42	0.53
Down	0.20	0.32	0.42	0.53
OUTLET	25.66	43.84	59.17	75.81

Whetstone

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Watershed Peak Table (Trial #2)

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 10-Yr (cfs)	25-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
SUBAREAS				
N-A	19.40	34.13	46.64	60.11
N-B+C	0.78	1.33	1.80	2.34
N-D	0.37	0.63	0.87	1.13
N-E	0.66	1.08	1.48	1.90
N-F	0.95	1.55	2.08	2.65
N-H	0.20	0.32	0.42	0.53
N-I	0.31	0.51	0.70	0.90
N-J	0.69	1.02	1.29	1.57
MFA	3.03	4.22	5.16	6.12
REACHES				
UDS	20.14	35.43	48.41	62.36
Down	20.11	35.39	48.38	62.34
MDS	0.37	0.63	0.87	1.13
Down	0.37	0.63	0.87	1.13
LDS-E	0.66	1.08	1.48	1.90
Down	0.65	1.08	1.48	1.90
LDS-N	0.95	1.55	2.08	2.65
Down	0.95	1.55	2.08	2.65
SWRP-Inlet	5.13	7.51	9.41	11.40
Down	4.90	7.22	9.08	11.03
SWRP-In1	0.20	0.32	0.42	0.53
Down	0.20	0.32	0.42	0.53
SWRP-In2	1.92	3.08	4.06	5.11
Down	1.92	3.08	4.06	5.11
NJR	0.20	0.32	0.42	0.53
Down	0.20	0.32	0.42	0.53
OUTLET	25.93	44.23	59.64	76.12

JD-6 Mine
Drainage Design Plan
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Watershed Peak Table (Trial #3)

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 10-Yr (cfs)	25-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
SUBAREAS				
N-A	19.40	34.13	46.64	60.11
N-B+C	0.78	1.33	1.80	2.34
N-D	0.37	0.63	0.87	1.13
N-E	0.66	1.08	1.48	1.90
N-F	0.95	1.55	2.08	2.65
N-H	0.20	0.32	0.42	0.53
N-I	0.31	0.51	0.70	0.90
N-J	0.69	1.02	1.29	1.57
MFA	3.03	4.22	5.16	6.12
REACHES				
UDS	20.14	35.43	48.41	62.36
Down	20.11	35.39	48.38	62.34
MDS	0.37	0.63	0.87	1.13
Down	0.37	0.63	0.87	1.13
LDS-E	0.66	1.08	1.48	1.90
Down	0.65	1.08	1.48	1.90
LDS-N	0.95	1.55	2.08	2.65
Down	0.95	1.55	2.08	2.65
SWRP-Inlet	5.13	7.51	9.41	11.40
Down	5.04	7.40	9.30	11.28
SWRP-In1	0.20	0.32	0.42	0.53
Down	0.20	0.32	0.42	0.53
SWRP-In2	1.92	3.08	4.06	5.11
Down	1.92	3.08	4.06	5.11
NJR	0.20	0.32	0.42	0.53
Down	0.20	0.32	0.42	0.53
OUTLET	26.08	44.45	59.90	76.44

Whetstone JD-6 Mine

Drainage Design Plan

Montrose County, Colorado

Hydrograph Peak/Peak Time Table (Trial #1)

Sub-Area or Reach Identifier		Peak Flow and Peak Time (hr) by Rainfall Return Period ANALYSIS: (cfs) (hr)	25-Yr (cfs) (hr)	50-Yr (cfs) (hr)	100-Yr (cfs) (hr)
SUBAREAS					
N-A		19.40	34.13	46.64	60.11
		12.04	12.02	12.02	12.02
N-B+C		0.78	1.33	1.80	2.34
		12.02	12.01	11.96	11.96
N-D		0.37	0.63	0.87	1.13
		12.02	12.01	11.95	11.95
N-E		0.66	1.08	1.48	1.90
		12.02	11.96	11.95	11.94
N-F		0.95	1.55	2.08	2.65
		12.02	11.95	11.94	11.94
N-H		0.20	0.32	0.42	0.53
		12.01	11.95	11.94	11.94
N-I		0.31	0.51	0.70	0.90
		12.02	11.96	11.95	11.94
N-J		0.69	1.02	1.29	1.57
		11.97	11.96	11.96	11.96
MFA		3.03	4.22	5.16	6.12
		12.04	12.04	12.03	12.03
REACHES					
UDS		20.14	35.43	48.41	62.36
		12.04	12.03	12.02	12.01
	Down	20.11	35.39	48.38	62.34
		12.06	12.05	12.04	12.03
MDS		0.37	0.63	0.87	1.13
		12.02	12.01	11.95	11.95
	Down	0.37	0.63	0.87	1.13
		12.03	12.03	11.96	11.96
LDS-E		0.66	1.08	1.48	1.90
		12.02	11.96	11.95	11.94
	Down	0.65	1.08	1.48	1.90
		12.03	11.96	11.96	11.96
LDS-N		0.95	1.55	2.08	2.65
		12.02	11.95	11.94	11.94
	Down	0.95	1.55	2.08	2.65
		12.03	11.97	11.96	11.96
SWRP-Inlet		5.13	7.51	9.41	11.40
		12.03	12.02	12.02	12.01
	Down	4.66	6.91	8.71	10.86
		12.07	12.06	12.06	12.05
SWRP-In1		0.20	0.32	0.42	0.53
		11.89	11.97	11.96	11.96
	Down	0.20	0.32	0.42	0.53
		12.04	11.97	11.96	11.96
SWRP-In2		1.92	3.08	4.06	5.11
		12.02	11.97	11.96	11.96

Hydrograph Peak/Peak Time Table (Trial #1) (continued)

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period ANALYSIS: (cfs) (hr)	25-Yr (cfs) (hr)	50-Yr (cfs) (hr)	100-Yr (cfs) (hr)
Down	1.92	3.08	4.06	5.11
	12.02	11.97	11.96	11.96
NJR	0.20	0.32	0.42	0.53
	12.01	11.95	11.94	11.94
Down	0.20	0.32	0.42	0.53
	11.89	11.97	11.96	11.96
OUTLET	25.66	43.84	59.17	75.81

Hydrograph Peak/Peak Time Table (Trial #2)

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 10-Yr (cfs) (hr)	25-Yr (cfs) (hr)	50-Yr (cfs) (hr)	100-Yr (cfs) (hr)
SUBAREAS				
N-A	19.40	34.13	46.64	60.11
	12.04	12.02	12.02	12.02
N-B+C	0.78	1.33	1.80	2.34
	12.02	12.01	11.96	11.96
N-D	0.37	0.63	0.87	1.13
	12.02	12.01	11.95	11.95
N-E	0.66	1.08	1.48	1.90
	12.02	11.96	11.95	11.94
N-F	0.95	1.55	2.08	2.65
	12.02	11.95	11.94	11.94
N-H	0.20	0.32	0.42	0.53
	12.01	11.95	11.94	11.94
N-I	0.31	0.51	0.70	0.90
	12.02	11.96	11.95	11.94
N-J	0.69	1.02	1.29	1.57
	11.97	11.96	11.96	11.96
MFA	3.03	4.22	5.16	6.12
	12.04	12.04	12.03	12.03
REACHES				
UDS	20.14	35.43	48.41	62.36
	12.04	12.03	12.02	12.01
Down	20.11	35.39	48.38	62.34
	12.06	12.05	12.04	12.03
MDS	0.37	0.63	0.87	1.13
	12.02	12.01	11.95	11.95
Down	0.37	0.63	0.87	1.13
	12.03	12.03	11.96	11.96
LDS-E	0.66	1.08	1.48	1.90
	12.02	11.96	11.95	11.94
Down	0.65	1.08	1.48	1.90
	12.03	11.96	11.96	11.96
LDS-N	0.95	1.55	2.08	2.65
	12.02	11.95	11.94	11.94
Down	0.95	1.55	2.08	2.65
	12.03	11.97	11.96	11.96
SWRP-Inlet	5.13	7.51	9.41	11.40
	12.03	12.02	12.02	12.01
Down	4.90	7.22	9.08	11.03
	12.06	12.05	12.05	12.04
SWRP-In1	0.20	0.32	0.42	0.53
	11.89	11.97	11.96	11.96
Down	0.20	0.32	0.42	0.53
	12.04	11.97	11.96	11.96
SWRP-In2	1.92	3.08	4.06	5.11
	12.02	11.97	11.96	11.96

Hydrograph Peak/Peak Time Table (Trial #2) (continued)

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 10-Yr (cfs) (hr)	25-Yr (cfs) (hr)	50-Yr (cfs) (hr)	100-Yr (cfs) (hr)
Down	1.92	3.08	4.06	5.11
	12.02	11.97	11.96	11.96
NJR	0.20	0.32	0.42	0.53
	12.01	11.95	11.94	11.94
Down	0.20	0.32	0.42	0.53
	11.89	11.97	11.96	11.96
OUTLET	25.93	44.23	59.64	76.12

Whetstone

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Drainage Design Plan
Montrose County, Colorado

Hydrograph Peak/Peak Time Table (Trial #3)

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 10-Yr (cfs) (hr)	25-Yr (cfs) (hr)	50-Yr (cfs) (hr)	100-Yr (cfs) (hr)
SUBAREAS				
N-A	19.40	34.13	46.64	60.11
	12.04	12.02	12.02	12.02
N-B+C	0.78	1.33	1.80	2.34
	12.02	12.01	11.96	11.96
N-D	0.37	0.63	0.87	1.13
	12.02	12.01	11.95	11.95
N-E	0.66	1.08	1.48	1.90
	12.02	11.96	11.95	11.94
N-F	0.95	1.55	2.08	2.65
	12.02	11.95	11.94	11.94
N-H	0.20	0.32	0.42	0.53
	12.01	11.95	11.94	11.94
N-I	0.31	0.51	0.70	0.90
	12.02	11.96	11.95	11.94
N-J	0.69	1.02	1.29	1.57
	11.97	11.96	11.96	11.96
MFA	3.03	4.22	5.16	6.12
	12.04	12.04	12.03	12.03
REACHES				
UDS	20.14	35.43	48.41	62.36
	12.04	12.03	12.02	12.01
Down	20.11	35.39	48.38	62.34
	12.06	12.05	12.04	12.03
MDS	0.37	0.63	0.87	1.13
	12.02	12.01	11.95	11.95
Down	0.37	0.63	0.87	1.13
	12.03	12.03	11.96	11.96
LDS-E	0.66	1.08	1.48	1.90
	12.02	11.96	11.95	11.94
Down	0.65	1.08	1.48	1.90
	12.03	11.96	11.96	11.96
LDS-N	0.95	1.55	2.08	2.65
	12.02	11.95	11.94	11.94
Down	0.95	1.55	2.08	2.65
	12.03	11.97	11.96	11.96
SWRP-Inlet	5.13	7.51	9.41	11.40
	12.03	12.02	12.02	12.01
Down	5.04	7.40	9.30	11.28
	12.05	12.04	12.04	12.04
SWRP-In1	0.20	0.32	0.42	0.53
	11.89	11.97	11.96	11.96
Down	0.20	0.32	0.42	0.53
	12.04	11.97	11.96	11.96
SWRP-In2	1.92	3.08	4.06	5.11
	12.02	11.97	11.96	11.96

Hydrograph Peak/Peak Time Table (Trial #3) (continued)

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 10-Yr (cfs) (hr)	25-Yr (cfs) (hr)	50-Yr (cfs) (hr)	100-Yr (cfs) (hr)
Down	1.92	3.08	4.06	5.11
	12.02	11.97	11.96	11.96
NJR	0.20	0.32	0.42	0.53
	12.01	11.95	11.94	11.94
Down	0.20	0.32	0.42	0.53
	11.89	11.97	11.96	11.96
OUTLET	26.08	44.45	59.90	76.44

Structure Output Table

Reach Identifier / Structure Identifier	ANALYSIS:	25-Yr	50-Yr	100-Yr
Reach: SWRP-Inlet				
Weir : SWRP				
10(ft)				
PF (cfs)	4.66	6.91	8.71	10.86
SV (ac ft)	.02	.03	.04	.05
STG (ft)	.24	.35	.44	.53
15(ft)				
PF (cfs)	4.90	7.22	9.08	11.03
SV (ac ft)	.02	.02	.03	.04
STG (ft)	.16	.24	.31	.37
25(ft)				
PF (cfs)	5.04	7.40	9.30	11.28
SV (ac ft)	.01	.01	.02	.02
STG (ft)	.10	.15	.19	.23

Peak Flow (PF), Storage Volume (SV), Stage (STG) by Rainfall Return Period

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Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
N-A	52.40	0.163	73	UDS	Main drainage above UDS
N-B+C	1.92	0.110	73	UDS	Triangle above west UDS
N-D	.91	0.100	73	MDS	Area below UDS reporting
N-E	1.43	0.100	74	LDS-E	Area below UDS reporting
N-F	1.86	0.100	75	LDS-N	Road CL to LDS-north
N-H	.35	0.100	76	NJR	Road to culvert on switch
N-I	.68	0.100	74	SWRP-In2	Road to NJ via culvert
N-J	.81	0.123	81	SWRP-In2	Road & slope above SWRP
MFA	3.01	0.229	85	SWRP-Inlet	Mine Facilities to SWRP

Total Area: 63.37 (ac)

Reach Summary Table

Reach Identifier	Receiving Reach Identifier	Reach Length (ft)	Routing Method
UDS	Outlet	690	CHANNEL
MDS	Outlet	384	CHANNEL
LDS-E	Outlet	255	CHANNEL
LDS-N	SWRP-In2	335	CHANNEL
SWRP-Inlet	Outlet		STRUCTURE(SWRP)
SWRP-In1	SWRP-Inlet	194	CHANNEL
SWRP-In2	SWRP-Inlet	141	CHANNEL
NJR	SWRP-In1	240	CHANNEL

Whetstone

JD-6 Mine
Drainage Design Plan
Montrose County, Colorado

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
N-A							
SHEET	80	0.1875	0.130				0.081
SHALLOW	1262	0.3027	0.050				0.039
CHANNEL	918	0.1553	0.050	1.50	4.24	5.930	0.043
					Time of Concentration		.163
N-B+C							
SHEET	80	0.0900	0.130				0.109
SHALLOW	30	0.3590	0.050				0.001
					Time of Concentration		.11
N-D							
SHEET	80	0.2641	0.130				0.071
SHALLOW	76	0.2064	0.050				0.003
CHANNEL	10	0.1729	0.067	1.50	4.26	2.778	0.001
					Time of Concentration		0.1
N-E							
SHEET	80	0.3413	0.130				0.064
SHALLOW	114	0.1554	0.050				0.005
CHANNEL	223	0.2145	0.067	1.50	4.26	5.162	0.012
					Time of Concentration		0.1
N-F							
SHEET	80	0.2250	0.130				0.076
SHALLOW	94	0.2872	0.050				0.003
					Time of Concentration		0.1
N-H							
SHEET	30	0.1653	0.130				0.039
SHALLOW	102	0.1577	0.050				0.004
					Time of Concentration		0.1
N-I							
SHEET	80	0.2625	0.130				0.071
SHALLOW	47	0.4681	0.050				0.001
					Time of Concentration		0.1
N-J							
SHEET	80	0.1218	0.130				0.097
SHALLOW	100	0.1147	0.050				0.005
CHANNEL	175	0.0443	0.052	0.75	3.26	2.315	0.021
					Time of Concentration		.123

MEA							
SHEET	100	0.0061	0.050				0.178

Sub-Area Time of Concentration Details (continued)

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
SHALLOW	230	0.0061	0.050				0.051
					Time of Concentration		.229
							========

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Montrose County, Colorado

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
N-A	Pinyon - juniper	(fair)	C	52.4	73
	Total Area / Weighted Curve Number			52.4	73
				====	==
N-B+C	Pinyon - juniper	(fair)	C	1.92	73
	Total Area / Weighted Curve Number			1.92	73
				====	==
N-D	Pinyon - juniper	(fair)	C	.91	73
	Total Area / Weighted Curve Number			.91	73
				===	==
N-E	Gravel (w/ right-of-way)		C	.051	89
	Pinyon - juniper	(fair)	C	1.379	73
	Total Area / Weighted Curve Number			1.43	74
				====	==
N-F	Gravel (w/ right-of-way)		C	.227	89
	Pinyon - juniper	(fair)	C	1.633	73
	Total Area / Weighted Curve Number			1.86	75
				====	==
N-H	Gravel (w/ right-of-way)		C	.071	89
	Pinyon - juniper	(fair)	C	.274	73
	Total Area / Weighted Curve Number			.35	76
				===	==
N-I	Gravel (w/ right-of-way)		C	.059	89
	Pinyon - juniper	(fair)	C	.616	73
	Total Area / Weighted Curve Number			.68	74
				===	==
N-J	Gravel (w/ right-of-way)		C	.405	89
	Pinyon - juniper	(fair)	C	.405	73
	Total Area / Weighted Curve Number			.81	81
				===	==
MFA	Natural desert (pervious areas only)		C	3.01	85
	Total Area / Weighted Curve Number			3.01	85
				====	==

Reach Channel Rating Details

Reach Identifier	Reach Length (ft)	Reach Manning's n	Friction Slope (ft/ft)	Bottom Width (ft)	Side Slope
UDS	690	0.047	0.088	2	1.5 :1
MDS	384	0.047	0.0933	2	1.5 :1
LDS-E	255	0.05	0.1141	1.5	1.5 :1
LDS-N	335	0.05	0.0794	1.5	1.5 :1
SWRP-Inlet	(This reach is a structure: SWRP)				
SWRP-In1	194	0.047	0.1907	3	2 :1
SWRP-In2	141	0.047	0.1773	3	2 :1
NJR	240	0.05	0.0443	1.5	1.5 :1

Reach Identifier	Stage (ft)	Flow (cfs)	End Area (sq ft)	Top Width (ft)	Friction Slope (ft/ft)
UDS	0.0	0.000	0	2	0.088
	0.5	6.545	1.4	3.5	
	1.0	23.981	3.5	5	
	2.0	99.073	10	8	
	5.0	792.313	47.5	17	
	10.0	4324.794	170	32	
	20.0	25266.225	640	62	
MDS	0.0	0.000	0	2	0.0933
	0.5	6.740	1.4	3.5	
	1.0	24.692	3.5	5	
	2.0	102.013	10	8	
	5.0	815.824	47.5	17	
	10.0	4453.125	170	32	
	20.0	26015.960	640	62	
LDS-E	0.0	0.000	0	1.5	0.1141
	0.5	5.508	1.1	3	
	1.0	21.128	3	4.5	
	2.0	92.338	9	7.5	
	5.0	788.154	45	16.5	
	10.0	4443.403	165	31.5	
	20.0	26462.485	630	61.5	
LDS-N	0.0	0.000	0	1.5	0.0794
	0.5	4.595	1.1	3	
	1.0	17.625	3	4.5	
	2.0	77.028	9	7.5	
	5.0	657.474	45	16.5	
	10.0	3706.664	165	31.5	
	20.0	22074.865	630	61.5	
SWRP-Inlet	(This reach is a structure: SWRP)				
SWRP-In1	0.0	0.000	0	3	0.1907
	0.5	14.537	2	5	
	1.0	52.814	5	7	
	2.0	214.884	14	11	
	5.0	1680.782	65	23	
	10.0	9060.820	230	43	
	20.0	52522.482	860	83	
SWRP-In2	0.0	0.000	0	3	0.1773
	0.5	14.017	2	5	
	1.0	50.925	5	7	
	2.0	207.196	14	11	
	5.0	1620.654	65	23	
	10.0	8736.682	230	43	

Reach Channel Rating Details (continued)

Reach Identifier	Reach Length (ft)	Reach Manning's n	Friction Slope (ft/ft)	Bottom Width (ft)	Side Slope
	20.0	50643.564	860	83	
NJR	0.0	0.000	0	1.5	0.0443
	0.5	3.432	1.1	3	
	1.0	13.165	3	4.5	
	2.0	57.536	9	7.5	
	5.0	491.100	45	16.5	
	10.0	2768.693	165	31.5	
	20.0	16488.824	630	61.5	

Structure Description - User Entered

Reach Identifier	Surface Area @ Crest (ac)	Height Above Crest (ft)	Surface Area @ Ht Above (ac)	Pipe Diameter (in)	Head on Pipe (ft)	Weir Length (ft)
SWRP-Inlet						
	0.093	1	.104			10
						15
						25

Structure Rating Details - Computed

Reach Idendifier	Stage (ft)	Pool Storage (ac ft)	Flows (cfs) @ Weir Length Length #1 10ft	Length #2 15ft	Length #3 25ft
SWRP	0	0.00	0.000	0.000	0.000
	0.5	0.05	9.899	14.849	24.749
	1	0.10	28.000	42.000	70.000
	2	0.21	79.196	118.794	197.990
	5	0.60	313.050	469.574	782.624
	10	1.48	885.438	1328.157	2213.594
	20	4.06	2504.396	3756.594	6260.990


Monogram Mesa
State Highway 90
East Paradox Creek
88
Affected Area A
(approx 0.28 acre)
Emergency Egress Adit
Affected Area B
(approx 2.73 acres)
Affected Area C
(approx 0.62 acre)
Waste Rock Dump
Middle Diversion Structure
Upper Diversion Structure
Mineral Joe
Vent Shaft
MJ 2
MJ 12
MJ 14
MJ 17
MJ 18
MJ 19
B 3 363.3 ac
B 2 296.1 ac
B 1 543 ac
EXPLANATION
Flow Direction of Stormwater Runoff
Sub-Basin ID Showing Total Acreage
B 1 543 ac
Sub-Basin Boundary
Intermittent Stream
Spring
Stormwater Flowpath
Stormwater Retention Pond
Mineral Joe Boundary
Mineral Joe Permit Boundary
Waste Rock Pile
Road
Mine Adit
Vent Shaft
SCALE 1:9,600
0
800
1,600 FEET
N
CONTOUR INTERVAL 20 FEET
Whetstone Associates
Cotter Corporation (N.S.L)
PO Box 700
Nucla, CO 81424
cotter
Mineral Joe Mine
Drainage Design Plan
Date: 2/7/2013
Drawn/Checked By: CM/SW
Project No: 4148B
File: JD7_Reg_Map_R21.dwg
County: Montrose County, CO
Plate 1
Mine Drainage Basins, Lease Boundary,
Vent Holes, and Mine Facilities