Illustration 61
Analysis of 1 Right Dewatering System (DW-1R)
Runoff Control Structures

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DESERADO MINE
BLUE MOUNTAIN ENERGY

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Introduction

Blue Mountain Energy plans to dewater the B-seam underground working with a submersible pump in a new well named DW-1R. The well location was primarily determined by the end of the workings in the 1-Right set of entries, which is the lowest point within the active mine. The well will discharge to a small new sediment pond (DW-1R-Pond) located approximately 1100 feet to the south of the well through a 6-inch HDPE pipe laid on the surface. The DW-1R-Pond is located on the north bank of a tributary to Red Wash. The location was chosen to place the pond on flatter slopes and as close as possible to the tributary to minimize the amount of rip-rap channel that would need to be constructed.

There will be two separate small areas of disturbance. The well pad for DW-1R will be within disturbance boundaries. The new DW-1R-Pond and a short access road and discharge channel will be new disturbance.

The outfall from the DW-1R pond has been submitted to the Colorado Department of Public Health and Environment Water Quality Control Division as Outfall 033A. Discharge from the pond will not happen until the discharge permit is approved. Dewatering of the mine can continue in its current configuration and discharge point until Outfall 033A is approved. If the outfall permit approval is delayed significantly, another option will be to run a 6" HDPE pipe along existing roads to already approved Outfall 029.

Flow from the well will be about 400 gpm (0.89 cfs) but will fluctuate a little with mine water levels and pump wear. Initially, the pump will operate on short intervals where the pump will be on for a short time and off for a short time. As mining proceeds, more volume will become available underground and pumping intervals will lengthen. Total flow from the well will be recorded by a flow meter with a totalizer. A flow meter is an important part of monitoring the performance of the pump, so no other flumes or flow measurement devices are proposed.

Hydrology

As mentioned previously, there will be two separate small areas of disturbance – the well pad and the discharge pond. Runoff from both areas were modeled with SEDCAD.

Hydrologic data including rainfall, soil type, and curve numbers can be found in Appendix A.

Well Pad

The well pad is approximately 0.25 acres and will be almost flat. Because vegetation cannot be allowed on the well pad, a small retention pond or trench was included off the low end of the pad to capture sediment runoff from the pad during a 10-year storm. Settleable solids will be reduced from 5 ml/l to 0.24 ml/l. This is half of the permitted level of 0.5 ml/l. No embankment will be constructed with the well pad trench. It will be cut below existing grade and will simply fill up and discharge to the same location and elevation it currently does. The 100-year storm was also modeled to verify the outlet to the existing grade is sufficient. SEDCAD calculations for the well pad area can be found in Appendix B

Discharge Pond

BME has historically included a small settling pond on similar dewatering facilities even though the water is typically clean and free of sediment. The purpose of the pond is to allow reaction time and settling in the unlikely event that sediment makes its way to the pump intake. Though small, the pond is much larger than it needs to be and reduces the settleable solids concentration to effectively 0.0 ml/l.

The outlet of the discharge pond will be a simple broad crested weir with a width of three feet. Side slopes of 3:1 will result in a slightly lower peak elevation than calculated by SEDCAD. Again, SEDCAD does not have a way to include a base flow, so the pumped flow rate of 0.89 cfs must be added to the 100 -Year runoff rate of 3.36 cfs for a total of 4.25 cfs. Interpolating from the stage vs. discharge table yields a peak pond elevation of 5532.58. SEDCAD Calculations for the discharge pond area can be found in Appendix C.

Sedimentology

The particle size distribution used in the model is the same as has been used in our SEDCAD models for more than 20 years. The author is not sure where it came from. A retired SEDCAD modeler was called, and his recollection is that a soil sample was sent to the University of Kentucky for analysis and the particle size distribution was a result of that analysis.

Sedimentology was modeled for the 10 Year storm. Both well pad sediment trap and the pond reduce the settleable solids concentration well below the permitted level of 0.5 ml/L.

Additional Rip Rap Considerations

It is the author's experience that SEDCAD calculates a rip rap size that is either too small or too large depending on the method used when compared to other methods. Smaller is acceptable on long stretches of perimeter ditches, but near outlets and dams, the author prefers to use other methods. Calculations using other methods can be found in Appendix D. The SEDCAD channel calculations can be found in Appendices B and C.

References

OSMRE. *Guidelines for the Use of the Revised Universal Soil Loss Equation on Mined Lands, Construction Sites, and Reclaimed Lands.* Version 1.06. August 1998.

USDA NRCS Conservation Engineering Division. *Technical Release 55 (TR-55).* June 1986.

USDA NRCS. *Web Soil Survey.* https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

NOAA National Weather Service. *Precipitation Frequency Data Server.* https://hdsc.nws.noaa.gov/hdsc/pfds/

Appendix A – Rainfall Data, Soil Map, and Curve Number

Precipitation Frequency Data Server

NOAA Atlas 14, Volume 8, Version 2
Location name: Rangely, Colorado, USA*
Latitude: 40.1919°, Longitude: -108.7203°
Elevation: 6725.82 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.142 (0.111-0.183)	0.167 (0.131-0.215)	0.216 (0.168-0.279)	0.265 (0.205-0.344)	0.345 (0.264-0.452)	0.416 (0.308-0.586)	0.495 (0.353-0.718)	0.584 (0.399-0.873)	0.715 (0.469-1.10)	0.824 (0.521-1.27)
10-min	0.209 (0.163-0.268)	0.245 (0.191-0.315)	0.317 (0.247-0.409)	0.388 (0.301-0.504)	0.506 (0.386-0.706)	0.609 (0.451-0.858)	0.725 (0.517-1.05)	0.855 (0.584-1.28)	1.05 (0.688-1.61)	1.21 (0.764-1.87)
15-min	0.254 (0.199-0.327)	0.298 (0.233-0.384)	0.386 (0.301-0.499)	0.474 (0.367-0.615)	0.616 (0.471-0.861)	0.742 (0.550-1.05)	0.884 (0.631-1.28)	1.04 (0.713-1.56)	1.28 (0.837-1.97)	1.47 (0.931-2.28)
30-min	0.331 (0.259-0.425)	0.388 (0.304-0.500)	0.502 (0.391-0.648)	0.614 (0.476-0.797)	0.796 (0.608-1.11)	0.958 (0.709-1.36)	1.14 (0.812-1.65)	1.34 (0.915-2.00)	1.64 (1.07-2.52)	1.88 (1.19-2.91)
60-min	0.405 (0.317-0.520)	0.474 (0.370-0.609)	0.606 (0.472-0.783)	0.735 (0.569-0.954)	0.939 (0.716-1.31)	1.12 (0.826-1.57)	1.32 (0.938-1.90)	1.54 (1.05-2.29)	1.86 (1.22-2.86)	2.12 (1.34-3.28)
2-hr	0.478 (0.378-0.607)	0.559 (0.442-0.710)	0.711 (0.560-0.906)	0.855 (0.670-1.10)	1.08 (0.831-1.48)	1.28 (0.954-1.77)	1.50 (1.08-2.13)	1.73 (1.19-2.54)	2.08 (1.38-3.15)	2.38 (1.51-3.60)
3-hr	0.532 (0.423-0.670)	0.616 (0.489-0.777)	0.771 (0.611-0.976)	0.918 (0.723-1.17)	1.15 (0.884-1.55)	1.34 (1.01-1.84)	1.56 (1.13-2.19)	1.79 (1.24-2.60)	2.13 (1.42-3.20)	2.41 (1.55-3.64)
6-hr	0.644 (0.518-0.801)	0.743 (0.597-0.926)	0.919 (0.736-1.15)	1.08 (0.856-1.35)	1.32 (1.02-1.74)	1.51 (1.14-2.03)	1.72 (1.26-2.38)	1.96 (1.38-2.78)	2.27 (1.62-3.34)	2.53 (1.65-3.76)
12-hr	0.795 (0.647-0.977)	0.917 (0.745-1.13)	1.13 (0.912-1.39)	1.31 (1.05-1.62)	1.57 (1.23-2.04)	1.79 (1.36-2.36)	2.01 (1.48-2.73)	2.25 (1.59-3.15)	2.58 (1.75-3.72)	2.84 (1.87-4.16)
24-hr	0.959 (0.789-1.16)	1.11 (0.908-1.34)	1.35 (1.11-1.65)	1.57 (1.27-1.92)	1.87 (1.49-2.39)	2.12 (1.63-2.74)	2.37 (1.76-3.16)	2.64 (1.88-3.63)	3.00 (2.05-4.26)	3.29 (2.19-4.74)
2-day	1.11 (0.926-1.33)	1.28 (1.07-1.54)	1.57 (1.30-1.89)	1.82 (1.50-2.20)	2.17 (1.74-2.74)	2.46 (1.92-3.15)	2.76 (2.08-3.63)	3.08 (2.21-4.17)	3.51 (2.43-4.90)	3.85 (2.59-5.46)
3-day	1.21 (1.01-1.43)	1.40 (1.17-1.68)	1.72 (1.43-2.05)	2.00 (1.66-2.39)	2.40 (1.93-3.00)	2.72 (2.13-3.45)	3.06 (2.31-3.99)	3.41 (2.47-4.58)	3.90 (2.71-5.40)	4.29 (2.90-6.02)
4-day	1.28 (1.08-1.52)	1.49 (1.25-1.76)	1.84 (1.54-2.18)	2.14 (1.78-2.55)	2.57 (2.08-3.19)	2.92 (2.30-3.68)	3.28 (2.50-4.25)	3.67 (2.67-4.89)	4.20 (2.93-5.77)	4.61 (3.13-6.43)
7-day	1.48 (1.26-1.74)	1.71 (1.46-2.01)	2.10 (1.78-2.47)	2.44 (2.06-2.88)	2.93 (2.39-3.60)	3.32 (2.64-4.14)	3.73 (2.86-4.77)	4.16 (3.05-5.47)	4.74 (3.34-6.43)	5.20 (3.57-7.16)
10-day	1.66 (1.42-1.93)	1.91 (1.63-2.22)	2.33 (1.98-2.71)	2.69 (2.27-3.15)	3.29 (2.62-3.89)	3.61 (2.89-4.46)	4.04 (3.11-5.12)	4.48 (3.31-5.85)	5.09 (3.61-6.84)	5.56 (3.84-7.59)
20-day	2.17 (1.88-2.48)	2.46 (2.13-2.82)	2.95 (2.54-3.39)	3.36 (2.88-3.88)	3.93 (3.25-4.69)	4.37 (3.53-5.30)	4.82 (3.76-6.00)	5.28 (3.94-6.76)	5.90 (4.23-7.78)	6.37 (4.44-8.55)
30-day	2.58 (2.25-2.93)	2.92 (2.55-3.33)	3.48 (3.03-3.97)	3.94 (3.40-4.51)	4.57 (3.80-5.39)	5.04 (4.10-6.04)	5.52 (4.32-6.79)	6.00 (4.50-7.59)	6.62 (4.77-8.63)	7.09 (4.97-9.41)
45-day	3.10 (2.72-3.49)	3.51 (3.08-3.96)	4.18 (3.65-4.73)	4.72 (4.10-5.36)	5.43 (4.54-6.33)	5.97 (4.87-7.07)	6.49 (5.11-7.89)	7.00 (5.28-8.75)	7.65 (5.54-9.85)	8.13 (5.74-10.7)
60-day	3.53 (3.11-3.96)	4.02 (3.54-4.51)	4.79 (4.21-5.39)	5.41 (4.72-6.11)	6.22 (5.21-7.19)	6.81 (5.59-8.01)	7.39 (5.84-8.90)	7.94 (6.01-9.85)	8.63 (6.28-11.0)	9.13 (6.48-11.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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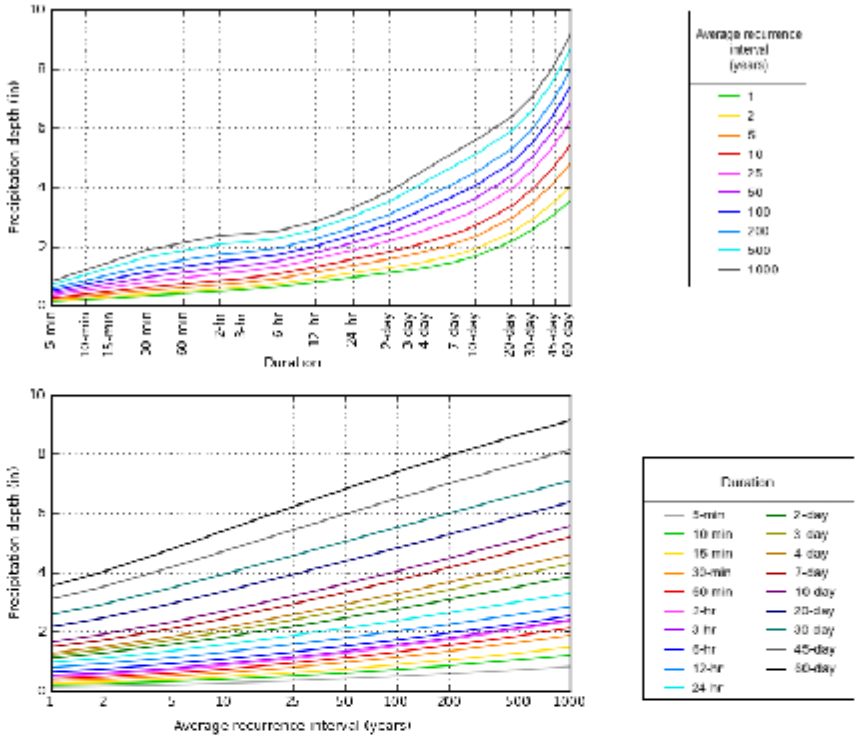
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 40.1919°, Longitude: -108.7203°



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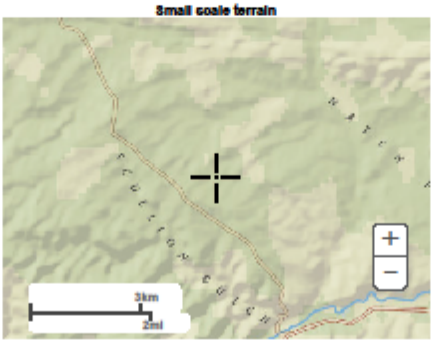
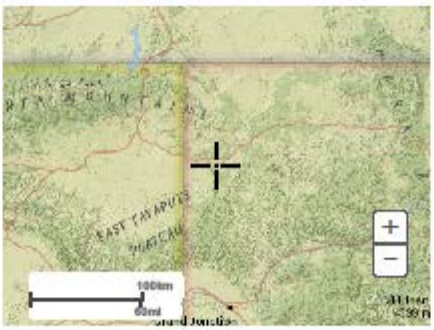
Maps & aerials

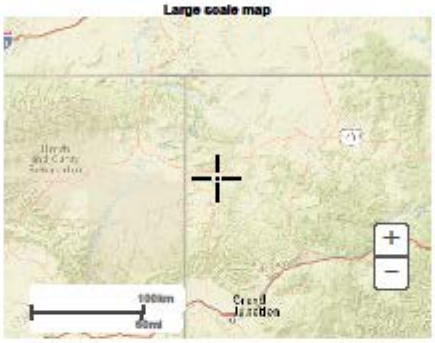
Small scale terrain



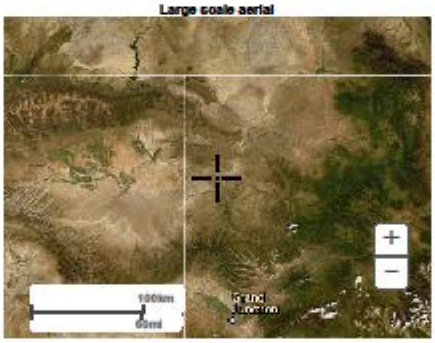
Large scale terrain



Large scale map



Large scale aerial



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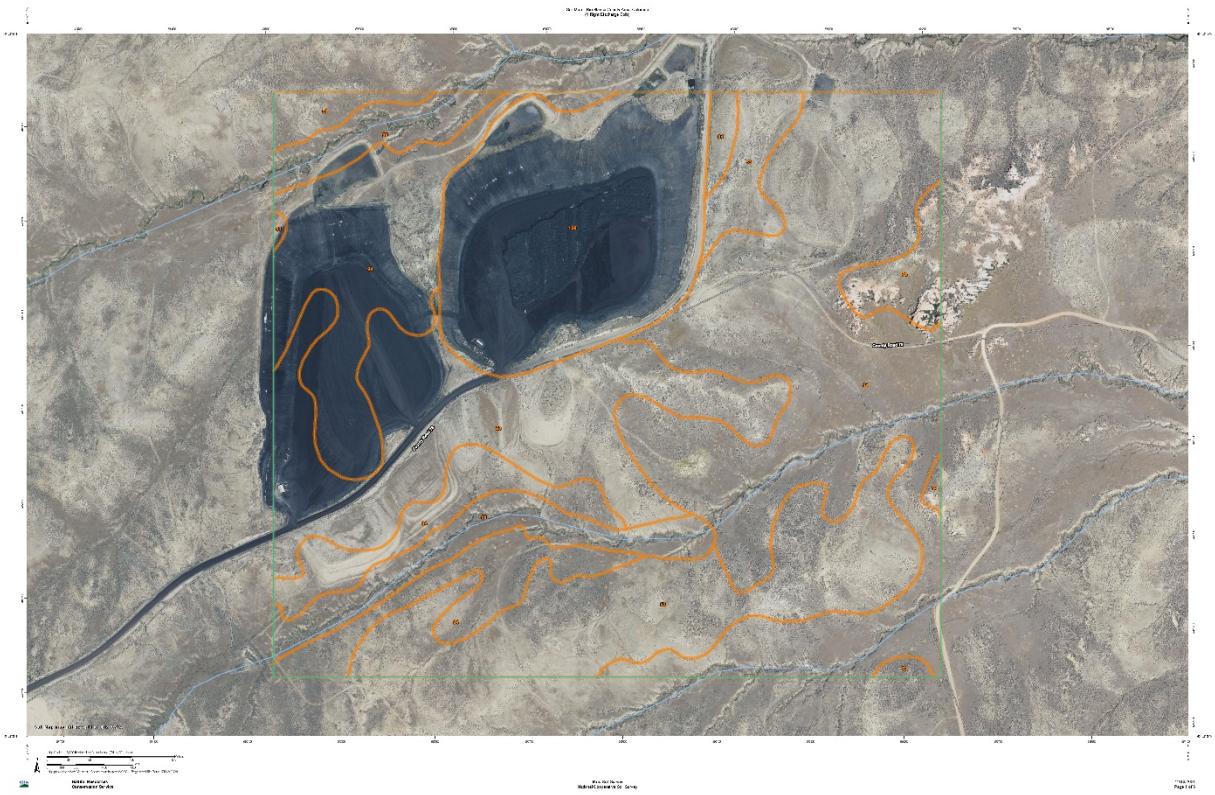


MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Rio Blanco County Area, Colorado
Survey Area Data: Version 16, Sep 2, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 23, 2020—Jul 5, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
53	Moyerson stony clay loam, 15 to 65 percent slopes	136.7	31.3%
78	Rock outcrop	8.7	2.0%
90	Torrifluvents, gullied	28.3	6.5%
94	Turley fine sandy loam, 3 to 8 percent slopes	193.8	44.4%
130	Miscellaneous water	69.5	15.9%
Totals for Area of Interest		**437.0**	**100.0%**

Hydrologic Soil Group and Surface Runoff

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

Report—Hydrologic Soil Group and Surface Runoff

Absence of an entry indicates that the data were not estimated. The dash indicates no documented presence.

Hydrologic Soil Group and Surface Runoff–Rio Blanco County Area, Colorado			
Map symbol and soil name	**Pct. of map unit**	**Surface Runoff**	**Hydrologic Soil Group**
53—Moyerson stony clay loam, 15 to 65 percent slopes			
Moyerson	90	Very high	D

Hydrologic Soil Group and Surface Runoff–Rio Blanco County Area, Colorado			
Map symbol and soil name	Pct. of map unit	Surface Runoff	Hydrologic Soil Group
78—Rock outcrop			
Rock outcrop	90	Very high	D
90—Torrifluvents, gullied			
Torrifluvents, gullied	90	Very low	A
94—Turley fine sandy loam, 3 to 8 percent slopes			
Turley	85	Medium	C
130—Miscellaneous water			
Water	100	—	—

Data Source Information

Soil Survey Area: Rio Blanco County Area, Colorado
Survey Area Data: Version 16, Sep 2, 2021

JT

1 Right Dewatering
Well Pad Curve Number
Rio Blanco County, Colorado

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
Well Pad	Newly graded area (pervious only)		D	.25	94
	Total Area / Weighted Curve Number			.25	94
				===	==
Pond Area	Sagebrush (w/ grass understory)	(poor)	C	.76	80
	Sagebrush (w/ grass understory)	(poor)	D	2.28	85
	Total Area / Weighted Curve Number			3.04	84
				====	==

Appendix B – Well Pad SEDCAD Calculations

Jason Tuttle

General Information

Storm Information:

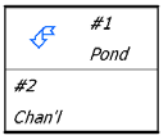
Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.570 inches

Particle Size Distribution:

Size (mm)	Standard
1.0000	100.000%
0.5600	95.000%
0.3500	90.000%
0.1500	80.000%
0.0500	60.000%
0.0250	40.000%
0.0095	20.000%
0.0001	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	#2	0.000	0.000	
Channel	#2	==>	End	0.000	0.000	



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	In	0.250	0.250	0.25	0.02	0.1	8,368	5.02	3.40
	Out			0.25	0.02	0.0	2,728	0.24	0.13
#2		0.000	0.250	0.25	0.02	0.0	2,727	0.24	0.13

Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In	Out
1.0000	100.000%	100.000%
0.5600	100.000%	100.000%
0.3500	100.000%	100.000%
0.1500	93.880%	100.000%
0.0500	70.410%	100.000%
0.0250	46.940%	100.000%
0.0095	23.470%	88.230%
0.0001	0.000%	0.000%

Structure #2:

Size (mm)	In/Out
1.0000	100.000%
0.5600	100.000%
0.3500	100.000%
0.1500	100.000%
0.0500	100.000%
0.0250	100.000%
0.0095	88.230%
0.0001	0.000%

Structure Detail:

Structure #1 (Pond)

Pond Inputs:

Initial Pool Elev:	5,603.50 ft
Initial Pool:	0.00 ac-ft
*Sediment Storage:	0.00 ac-ft
Dead Space:	0.00 %

**No sediment capacity defined*

Broad-crested Weir

Weir Width (ft)	Spillway Elev (ft)
8.00	5,603.50

Pond Results:

Peak Elevation:	5,603.52 ft
H'graph Detention Time:	0.01 hrs
Pond Model:	CSTRS
Dewater Time:	0.12 days
Trap Efficiency:	73.40 %

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
5,602.00	0.000	0.000	0.000		Top of Sed. Storage
5,602.25	0.000	0.000	0.000		
5,602.50	0.001	0.000	0.000		
5,602.75	0.002	0.001	0.000		
5,603.00	0.004	0.001	0.000		
5,603.25	0.005	0.002	0.000		
5,603.50	0.006	0.004	0.000		Spillway #1
5,603.52	0.006	0.004	0.247	3.00	Peak Stage
5,603.75	0.008	0.006	3.087		
5,604.00	0.009	0.008	8.731		

Detailed Discharge Table

Elevation (ft)	Broad-crested Weir (cfs)	Combined Total Discharge (cfs)
5,602.00	0.000	0.000
5,602.25	0.000	0.000
5,602.50	0.000	0.000
5,602.75	0.000	0.000
5,603.00	0.000	0.000
5,603.25	0.000	0.000
5,603.50	0.000	0.000
5,603.75	3.087	3.087
5,604.00	8.731	8.731

Structure #2 (Erodible Channel)

Trapezoidal Erodible Channel Inputs:

Material: Graded silts to cobbles when colloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	3.0:1	3.0:1	5.5	0.0300	0.50			4.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.25 cfs	
Depth:	0.04 ft	0.54 ft
Top Width:	5.23 ft	8.23 ft
Velocity:	1.30 fps	
X-Section Area:	0.19 sq ft	
Hydraulic Radius:	0.037 ft	
Froude Number:	1.18	

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	0.250	0.046	0.046	0.146	94.000	TR55	0.25	0.016
	Σ	**0.250**						**0.25**	**0.016**
#2	Σ	**0.250**						**0.25**	**0.016**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.320	118.00	0.50	1.0000	1.0000	1	0.1	9,814	6.12	4.15
	Σ							**0.1**	**8,368**	**5.02**	**3.40**
#2	Σ							**0.0**	**2,727**	**0.24**	**0.13**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	0.50	0.58	118.00	0.700	0.046
#1	**1**	**Time of Concentration:**					**0.046**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	0.50	0.58	118.00	0.700	0.046
#1	**1**	**Muskingum K:**					**0.046**

Jason Tuttle

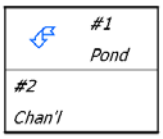
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 24 hr
Rainfall Depth:	2.370 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	#2	0.000	0.000	
Channel	#2	==>	End	0.000	0.000	



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	In	0.250	0.250	0.41	0.03
	Out			0.41	0.03
#2		0.000	0.250	0.41	0.03

Structure Detail:

Structure #1 (Pond)

Pond Inputs:

Initial Pool Elev:	5,603.50 ft
Initial Pool:	0.00 ac-ft

Broad-crested Weir

Weir Width (ft)	Spillway Elev (ft)
8.00	5,603.50

Pond Results:

Peak Elevation:	5,603.53 ft
Dewater Time:	0.25 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
5,602.00	0.000	0.000	0.000		
5,602.25	0.000	0.000	0.000		
5,602.50	0.001	0.000	0.000		
5,602.75	0.002	0.001	0.000		
5,603.00	0.004	0.001	0.000		
5,603.25	0.005	0.002	0.000		
5,603.50	0.006	0.004	0.000		Spillway #1
5,603.53	0.006	0.004	0.409	6.00	Peak Stage
5,603.75	0.008	0.006	3.087		
5,604.00	0.009	0.008	8.731		

Detailed Discharge Table

Elevation (ft)	Broad-crested Weir (cfs)	Combined Total Discharge (cfs)
5,602.00	0.000	0.000
5,602.25	0.000	0.000
5,602.50	0.000	0.000
5,602.75	0.000	0.000
5,603.00	0.000	0.000
5,603.25	0.000	0.000
5,603.50	0.000	0.000
5,603.75	3.087	3.087
5,604.00	8.731	8.731

Structure #2 (Erodible Channel)

Trapezoidal Erodible Channel Inputs:

Material: Graded silts to cobbles when colloidal

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
5.00	3.0:1	3.0:1	5.5	0.0300	0.50			4.0

Erodible Channel Results:

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.41 cfs	
Depth:	0.05 ft	0.55 ft
Top Width:	5.30 ft	8.30 ft
Velocity:	1.56 fps	
X-Section Area:	0.26 sq ft	
Hydraulic Radius:	0.049 ft	
Froude Number:	1.24	

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	0.250	0.046	0.046	0.146	94.000	TR55	0.41	0.031
	Σ	**0.250**						**0.41**	**0.031**
#2	Σ	**0.250**						**0.41**	**0.031**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	0.50	0.58	118.00	0.700	0.046
#1	**1**	**Time of Concentration:**					**0.046**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	0.50	0.58	118.00	0.700	0.046
#1	**1**	**Muskingum K:**					**0.046**

Appendix C – Discharge Pond SEDCAD Calculations

Jason Tuttle

General Information

Storm Information:

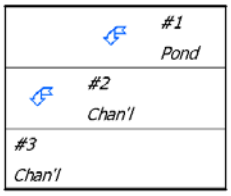
Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.570 inches

Particle Size Distribution:

Size (mm)	Standard
1.0000	100.000%
0.5600	95.000%
0.3500	90.000%
0.1500	80.000%
0.0500	60.000%
0.0250	40.000%
0.0095	20.000%
0.0001	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	#2	0.000	0.000	
Channel	#2	==>	#3	0.001	0.469	
Channel	#3	==>	End	0.000	0.000	



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	9. Small streams flowing bankfull	8.20	10.00	121.95	25.77	0.001
#2	**Muskingum K:**					**0.001**

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	In	3.040	3.040	1.59	0.12	0.4	4,856	3.03	1.45
	Out			0.40	0.12	0.0	44	0.00	0.00
#2		0.000	3.040	0.40	0.12	0.0	44	0.00	0.00
#3		0.000	3.040	0.40	0.12	0.0	44	0.00	0.00

Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In	Out
1.0000	100.000%	100.000%
0.5600	95.000%	100.000%
0.3500	90.000%	100.000%
0.1500	80.000%	100.000%
0.0500	60.000%	100.000%
0.0250	40.000%	100.000%
0.0095	20.000%	100.000%
0.0001	0.000%	0.000%

Structure #2:

Size (mm)	In/Out
1.0000	100.000%
0.5600	100.000%
0.3500	100.000%
0.1500	100.000%
0.0500	100.000%
0.0250	100.000%
0.0095	100.000%
0.0001	0.000%

Structure #3:

Size (mm)	In/Out
1.0000	100.000%
0.5600	100.000%
0.3500	100.000%
0.1500	100.000%
0.0500	100.000%
0.0250	100.000%
0.0095	100.000%
0.0001	0.000%

Structure Detail:

Structure #1 (Pond)

Pond Inputs:

Initial Pool Elev:	5,532.00 ft
Initial Pool:	0.46 ac-ft
*Sediment Storage:	0.00 ac-ft
Dead Space:	20.00 %

**No sediment capacity defined*

Broad-crested Weir

Weir Width (ft)	Spillway Elev (ft)
1.00	5,532.00

Pond Results:

Peak Elevation:	5,532.19 ft
H'graph Detention Time:	1.07 hrs
Pond Model:	CSTRS
Dewater Time:	0.58 days
Trap Efficiency:	98.54 %

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
5,529.00	0.123	0.000	0.000		Top of Sed. Storage
5,529.50	0.133	0.064	0.000		
5,530.00	0.144	0.133	0.000		
5,530.50	0.154	0.208	0.000		
5,531.00	0.165	0.287	0.000		
5,531.50	0.176	0.373	0.000		
5,532.00	0.188	0.463	0.000		Spillway #1
5,532.19	0.192	0.499	0.404	14.00	Peak Stage
5,532.50	0.199	0.560	1.091		
5,533.00	0.211	0.663	3.087		
5,533.50	0.224	0.772	5.671		
5,534.00	0.236	0.887	8.731		

Detailed Discharge Table

Elevation (ft)	Broad-crested Weir (cfs)	Combined Total Discharge (cfs)
5,529.00	0.000	0.000
5,529.50	0.000	0.000
5,530.00	0.000	0.000
5,530.50	0.000	0.000
5,531.00	0.000	0.000
5,531.50	0.000	0.000
5,532.00	0.000	0.000
5,532.50	1.091	1.091
5,533.00	3.087	3.087
5,533.50	5.671	5.671
5,534.00	8.731	8.731

Structure #2 (Riprap Channel)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
1.00	2.0:1	2.0:1	8.2	1.00		

Riprap Channel Results:

Simons/OSM Method - Mild Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	0.40 cfs	
Depth:	0.19 ft	1.19 ft
Top Width:	1.76 ft	5.76 ft
Velocity:	1.55 fps	
X-Section Area:	0.26 sq ft	
Hydraulic Radius:	0.141 ft	
Froude Number:	0.71	
Manning's n:	0.0346	
Dmin:	2.00 in	
D50:	6.00 in	
Dmax:	9.00 in	

Structure #3 (Vegetated Channel)

Trapezoidal Vegetated Channel Inputs:

Material: Bermuda grass

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.00	2.0:1	2.0:1	6.6	D, B	1.00			7.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	0.40 cfs		0.40 cfs	
Depth:	0.23 ft	1.23 ft	0.51 ft	1.51 ft
Top Width:	1.92 ft	5.92 ft	3.05 ft	7.05 ft
Velocity:	1.20 fps		0.39 fps	
X-Section Area:	0.34 sq ft		1.04 sq ft	
Hydraulic Radius:	0.166 ft		0.316 ft	
Froude Number:	0.51		0.12	
Roughness Coefficient:	0.0955		0.4562	

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	3.040	0.035	0.000	0.000	84.000	TR55	1.59	0.116
	Σ	**3.040**						**1.59**	**0.116**
#2	Σ	**3.040**						**0.40**	**0.116**
#3	Σ	**3.040**						**0.40**	**0.116**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.320	120.00	5.50	0.0420	1.0000	1	0.4	4,856	3.03	1.45
	Σ							**0.4**	**4,856**	**3.03**	**1.45**
#2	Σ							**0.0**	**44**	**0.00**	**0.00**
#3	Σ							**0.0**	**44**	**0.00**	**0.00**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	6.54	5.00	76.45	2.040	0.010
		6. Grassed waterway	5.90	20.00	338.98	3.640	0.025
#1	**1**	**Time of Concentration:**					**0.035**

Jason Tuttle

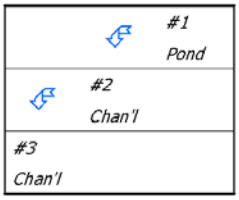
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 24 hr
Rainfall Depth:	2.370 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	#2	0.000	0.000	
Channel	#2	==>	#3	0.001	0.469	
Channel	#3	==>	End	0.000	0.000	



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#2	9. Small streams flowing bankfull	8.20	10.00	121.95	25.77	0.001
#2	**Muskingum K:**					**0.001**

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	In	3.040	3.040	3.37	0.26
	Out			2.04	0.26
#2		0.000	3.040	2.04	0.26
#3		0.000	3.040	2.04	0.26

Structure Detail:

Structure #1 (Pond)

Pond Inputs:

Initial Pool Elev:	5,532.00 ft
Initial Pool:	0.46 ac-ft

Broad-crested Weir

Weir Width (ft)	Spillway Elev (ft)
3.00	5,532.00

Pond Results:

Peak Elevation:	5,532.31 ft
Dewater Time:	0.54 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
5,529.00	0.123	0.000	0.000		
5,529.50	0.133	0.064	0.000		
5,530.00	0.144	0.133	0.000		
5,530.50	0.154	0.208	0.000		
5,531.00	0.165	0.287	0.000		
5,531.50	0.176	0.373	0.000		
5,532.00	0.188	0.463	0.000		Spillway #1
5,532.31	0.195	0.524	2.043	12.85	Peak Stage
5,532.50	0.199	0.560	3.274		
5,533.00	0.211	0.663	9.261		
5,533.50	0.224	0.772	17.014		
5,534.00	0.236	0.887	26.194		

Detailed Discharge Table

Elevation (ft)	Broad-crested Weir (cfs)	Combined Total Discharge (cfs)
5,529.00	0.000	0.000
5,529.50	0.000	0.000
5,530.00	0.000	0.000
5,530.50	0.000	0.000
5,531.00	0.000	0.000
5,531.50	0.000	0.000
5,532.00	0.000	0.000
5,532.50	3.274	3.274
5,533.00	9.261	9.261
5,533.50	17.014	17.014
5,534.00	26.194	26.194

Structure #2 (Riprap Channel)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
1.00	2.0:1	2.0:1	8.2	1.00		

Riprap Channel Results:

Simons/OSM Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	2.04 cfs	
Depth:	0.21 ft	1.21 ft
Top Width:	1.86 ft	5.86 ft
Velocity*:		
X-Section Area:	0.31 sq ft	
Hydraulic Radius:	0.156 ft	
Froude Number*:		
Manning's n*:		
Dmin:	3.00 in	
D50:	9.00 in	
Dmax:	11.25 in	

Velocity and Manning's n calculations may not apply for this method.

Structure #3 (Vegetated Channel)

Trapezoidal Vegetated Channel Inputs:

Material: Bermuda grass

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
1.00	2.0:1	2.0:1	6.6	D, B	1.00			7.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	2.04 cfs		2.04 cfs	
Depth:	0.44 ft	1.44 ft	0.80 ft	1.80 ft
Top Width:	2.75 ft	6.75 ft	4.21 ft	8.21 ft
Velocity:	2.49 fps		0.98 fps	
X-Section Area:	0.82 sq ft		2.09 sq ft	
Hydraulic Radius:	0.278 ft		0.455 ft	
Froude Number:	0.80		0.24	
Roughness Coefficient:	0.0653		0.2314	

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	3.040	0.035	0.000	0.000	84.000	TR55	3.37	0.257
	Σ	**3.040**						**3.37**	**0.257**
#2	Σ	**3.040**						**2.04**	**0.257**
#3	Σ	**3.040**						**2.04**	**0.257**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	6.54	5.00	76.45	2.040	0.010
		6. Grassed waterway	5.90	20.00	338.98	3.640	0.025
#1	**1**	**Time of Concentration:**					**0.035**

Appendix D – Additional Rip Rap Calculations

Project Name:	1 Right Discharge Pond
Number:	TR-73
Calculated by:	Jason Tuttle
Date:	12/15/21
Location:	Spillway Slope

Channel Geometry

Bottom Width (ft)	1.00
Slope(ft/ft)	0.082
Side Slope(_H:1V)	2.00
Side Slope(_H:1V)	2.00
Mannings n	0.060
Depth (ft)	0.58

Specific Depth Values

Area (ft^2)	1.25
Wetted Perimeter	3.59
Hydraulic Radius	0.35
Capacity (cfs)	4.40
Velocity (fps)	3.51

Capacity at Range of Depths

Depth (ft)	Area (ft^2)	Wetted Perimter (ft)	Hyrdraulic Radius (ft)	Capacity (cfs)	Velocity (ft/s)
0.1	0.12	1.45	0.08	0.16	1.35
0.2	0.28	1.89	0.15	0.56	1.98
0.3	0.48	2.34	0.20	1.18	2.47
0.4	0.72	2.79	0.26	2.07	2.88
0.5	1.00	3.24	0.31	3.24	3.24
0.6	1.32	3.68	0.36	4.72	3.58
0.7	1.68	4.13	0.41	6.54	3.89
0.8	2.08	4.58	0.45	8.72	4.19
0.9	2.52	5.02	0.50	11.28	4.48
1	3.00	5.47	0.55	14.25	4.75
1.1	3.52	5.92	0.59	17.65	5.02
1.2	4.08	6.37	0.64	21.51	5.27
1.3	4.68	6.81	0.69	25.84	5.52
1.4	5.32	7.26	0.73	30.66	5.76
1.5	6.00	7.71	0.78	36.01	6.00
1.6	6.72	8.16	0.82	41.89	6.23
1.7	7.48	8.60	0.87	48.33	6.46
1.8	8.28	9.05	0.91	55.34	6.68
1.9	9.12	9.50	0.96	62.96	6.90
2	10.00	9.94	1.01	71.19	7.12

Project: TR-73
Calculated By: Jason Tuttle
Date: 12/15/2021
Location: 1 Right Discharge Pond Spillway Slope

Rip Rap Calculations

Given Equation 734*

$$V = 3(d_{50})^{0.5}(S - 1)/S^{0.17}$$

Solve For d50

$$d_{50} = \left(\frac{V \cdot S^{0.17}}{3(S_s - 1)}\right)^2$$

V (mean velocity):	3.51
S (Channel Slope ft/ft):	0.082
Ss (Rock Specific Gravity):	2.5
d50(ft):	**0.26**

Using Equation 735*

$$d_{50} = 0.010V^{2.44}$$

d50(ft): **0.21**

* Equations from Clark County Nevada Drainage Manual