Attachment C
Drainage Report for Daneros Mine

DRAINAGE REPORT
FOR
DANEROS MINE,
SAN JUAN COUNTY, UTAH

Prepared for:

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Acronyms

ac	acres
ARC	antecedent runoff condition
BLM	U.S. Bureau of Land Management
cfs	cubic feet per minute
CN	curve number
cy	cubic yards
D	depth
DRA	development rock area
ft	feet
ft/s	feet per second
FHWA	Federal Highway Administration
HSG	hydrologic soil group
in	inches
in/hr	inches per hour
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
SCS	Soil Conservation Service
sq-mi	square miles
T_c	time of concentration
UDOGM	Utah Division of Oil, Gas and Mining
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey

Section 1 Introduction

This report presents the design analysis for the storm water drainage facilities at the Daneros Mine operated by Energy Fuels Resources (USA) Inc. (Energy Fuels). This report analyses three portal areas located within the Daneros Mine including:

- Daneros Portal Area;
- Proposed Bullseye Portal Area; and
- Proposed South Portal Area.

The scope of the report covers aspects of storm water collection, conveyance, and retention design necessary to comply with U.S. Department of Interior, Bureau of Land Management (BLM) requirements for the mine site including Title 43 Code of Federal Regulations Section 3809 (43 CFR §3809.401(2)(iii)), and the Utah Division of Oil, Gas, and Mining requirements including Utah Administrative Code Title R647 Natural Resources; Oil, Gas and Mining; Non-Coal, and Utah Code Title 40 Chapter 08 Utah Mined Land Reclamation Act. Detailed hydrologic and hydraulic calculations are provided in the report appendices.

1.1 Site Location

The Daneros Mine is located southwest of Fry Canyon, Utah, in San Juan County. It is located in Bullseye Canyon within the central portion of the Colorado Plateau in southeastern Utah. The locations of the three portal areas that comprise the Daneros Mine are shown in Figure 1.

1.2 Report Organization

This report is organized as follows:

- Section 1: Introduction
- Section 2: Daneros Portal Area Drainage Control Design
- Section 3: Proposed Bullseye Portal Area Drainage Control Design
- Section 4: Proposed South Portal Area Drainage Control Design
- Section 5: Conclusions and Recommendations
- Section 6: References

Section 2 Daneros Portal Area Drainage Control Design

This section discusses the drainage control approach and procedures used to design the drainage facilities components, identify existing drainage conditions, and the overall drainage design approach for the Daneros Portal Area. As described below, the Daneros Portal Area drainage facilities are illustrated in Exhibit A.

2.1 Drainage Control Approach

The following approach was used to design the drainage facilities components:

1. The peak discharge was estimated for a selected storm return interval using drainage basin characteristics from available topographic data and aerial photographs.

2. Channels were designed to convey the peak discharge.

3. The channel lining was designed for the estimated flow condition.

4. Catchment berms were designed to retain water within the disturbed area for the design storm.

5. Temporary sediment ponds were sized to capture and retain runoff from the disturbed area.

The design of storm water collection, conveyance, and retention facilities components for the Daneros Portal Area is provided below.

2.2 Existing Drainage Conditions

The Daneros Portal Area is situated in a drainage area of approximately 6.6 acres which encompasses the 1.8-acre surface mine permit area. Two existing drainage channels are located within the existing permit area; one drains west to east along the north edge of the permit boundary and into the Bullseye Canyon drainage located in the middle of the permit area, and another channel collects the DRA runoff and drains east to west into a temporary sediment pond. There are three 60 inch culverts installed under the county road allowing Bullseye Canyon to pass through the Daneros Portal Area.

2.3 Drainage Basins

Energy Fuels proposes to extended the existing DRA to the north. Three drainage basins were delineated based on the topography and proposed mine surface as illustrated in Exhibit A:

Basin 1 – The offsite surface water runoff area from north of the extended DRA (2.67 acres)

Basin 2 – The existing and extended DRA (3.40 acres)

Basin 3 – The existing ore storage area and the offsite surface water runoff area north and south of the existing ore storage area (2.56 acres)

2.4 Peak Discharge Estimate

The point precipitation frequency estimate for the 100-year, 24-hour storm, obtained from National Oceanic and Atmospheric Association (NOAA) Atlas 14, Volume 1 for Utah (NOAA, 2004) is 2.80 inches, and was selected as the design storm return interval for surface water control structure design. CDM Smith estimated the peak discharge using the graphical peak discharge method from the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Urban Hydrology for Small Watersheds TR-55 (USDA, 1986). The peak discharge estimated using the NRCS TR-55 is based on hydrologic characteristics of the mine area including estimated precipitation and runoff, soil type, basin slope, time of concentration and travel time. These hydrologic characteristics are described in detail below.

CDM Smith used the Soil Conservation Service (SCS) runoff equation to estimate runoff from the 2.80 inch design storm. The SCS runoff equation is:

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

Where:

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in)

S is related to the soil and cover conditions of the watershed through the Curve Number (CN). CN has a range of 0 to 100, and S is related to CN by:

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

According to the NRCS TR 55 (USDA, 1986), the major factors that determine the CN include the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). CDM Smith determined HSG of the Daneros Portal Area based on USDA, NRCS soil map (see Appendix A). The soil type of the Daneros Portal Area is classified as "Strych-Skos-Badland complex", which has a moderately high to high rate of water transmission (0.57–1.98 inches per hour [in/hr]). Therefore, based on the soil type and soil drainage class, CDM Smith classified the mine area as HSG "A". However, based on site reconnaissance and communication with Utah Division of Oil, Gas and Mining (UDOGM), it was determined that the mine area consists of 55% of HSG "B" and 45% of HSG "D".

For Basin 1, the CN for desert shrub (poor hydrologic condition), average ARC, and HSG of "B" is 77. Also, the CN for desert shrub (poor hydrologic condition), average ARC, and HSG of "D" is 88. Therefore, the area-weighted average of these two values is 82. For P equal to 2.80 inches and CN equal to 82, S equals 2.195 and Q equals 1.22 inches (refer to Appendix B).

For Basins 2 and 3, the CN for newly graded areas, average ARC, and HSG of "B" is 86. Also, the CN for newly graded areas, average ARC, and HSG of "D" is 94. Therefore, the area-weighted average of these two values is 90. For P equal to 2.80 inches and CN equal to 90, S equals 1.111 and Q equals 1.80 inches.

For drainage Basins 1 and 2, the time of concentration and travel times for each basin were estimated, since they are needed to size Diversion Channel 1 and Collection Channel 2. Different flow segments were used to accurately predict the time of concentration; sheet flow, shallow concentration flow, and channel flow. The addition of the travel times for each flow segment determines the time of concentration, which is the time it takes runoff to reach the central drainage destination from the hydraulically most distant point of the basin. The time of concentration (T_c) equation is (USDA, 1986):

$$T_c = T_{t1} + T_{t2} + T_{t3}$$

T_{t1} is the travel time of sheet flow. Based on the NRCS TR-55 (USDA, 1986), sheet flow is less than or equal to 300 feet. The sheet flow travel time equation is:

$$T_{t1} = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} S^{0.4}}$$

Where:

n = Manning's roughness coefficient

L = flow length in feet (considering the maximum sheet flow length of 300 feet)

P_2 = 2-year, 24-hour rainfall in inches (1.24 inches from NOAA Precipitation-Frequency Atlas 14 Maps for Utah)

S = land slope in ft/ft (Measured from the USGS topographic map)

T_{t2} is the travel time of shallow concentrated flow. The shallow concentration flow travel time equation is (USDA, 1986):

$$T_{t2} = \frac{L}{3600V}$$

Where:

V = average velocity in feet per second (ft/sec) (based on Figure 3-1 (USDA, 1986))

L = estimated from the existing topographic map

T_{t3} is the travel time of channel flow. The channel flow travel time equation is (USDA, 1986):

$$T_{t3} = \frac{L}{3600V}$$

Where:

V = average velocity in ft/sec (based on Figure 3-1 (USDA, 1986))

L = estimated from the existing topographic map

Based on the previous calculations, the graphical peak discharge method is calculated using the following equations:

$$q_p = q_u A_m Q$$

Where,

q_p = peak discharge in cfs (based on Exhibit 4-II (USDA, 1986))

q_u = unit peak discharge (csm/in)

A_m = drainage area in square miles

Q = runoff in inches

These equations were used to determine the peak discharge for Basins 1 and 2; detailed calculations are provided in Appendix B. The 100-year, 24 hour peak discharges for each basin are summarized in Table 2-1.

Table 2-1 100-year Peak Discharges for Daneros Portal Area Basins

Basin	Area		100-year Peak Discharge
	(ac)	(sq-mi)	(cfs)
1	2.67	0.0042	2.4
2	3.40	0.0053	5.3
3	Not Applicable – Catchment Berm Utilized (see Section 2.5.2)		

2.5 Surface Water Control Structure Design

Diversion Channel 1 was designed to route offsite surface from Basin 1 to a natural drainage. Collection Channel 2 was designed to collect runoff from Basin 2 and route it to the temporary sediment pond (see Exhibit A).

2.5.1 Channel Design

Each channel was sized to convey the 100-year peak discharge. For the 100-year 24-hour storm events, the design discharge used for each channel is the peak discharge described in Section 2.4 that corresponds to the conveyed runoff for each channel. The following equations (Chow, 1973) were used to calculate the flow velocity and depth in the channels. Input values (listed in Table 2-2) into the equations include 100-year peak discharge, cross section geometry, slope, and Manning's n value.

$$Q = VA$$

$$A = \frac{1}{2}(2b + (z_1 + z_2)h)h$$

$$R = \frac{A}{\left(b + h\left(\sqrt{1 + z_1^2} + \sqrt{1 + z_2^2}\right)\right)}$$

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

Where:

Q = discharge in cfs
V = velocity in ft/sec
z_1 : 1 = side slope (left)
z_2 : 1 = side slope (right)
A = flow area in ft^2
b = bottom width of the cross section in ft
h = flow depth in ft
S = channel slope in ft/ft
n = Manning's roughness coefficient

Table 2-2 Input values for Channels

Channel	**S (ft/ft)**	**n**	**z_1 (ft/ft)**	**z_2 (ft/ft)**	**B (ft)**	**100-year Peak Discharge (cfs)**
Diversion Channel 1(1)	0.2379	0.035	1	6	8	2.4
Collection Channel 2(2)	0.0159	0.035	1.5(3)	33.33(4)	0	5.3

1)Located at north edge of the exploration drilling road (see Exhibit A)
2)Located at north edge of the access road (see Exhibit A)
3)Slope of DRA
4)Side slope (camber) of the access road (3%)

CDM Smith used the Urban Drainage and Flood Control Department (UDFCD) Drainage Criteria (UDFCD, 2005) to determine the appropriate channel lining for the drainage channels. UDFCD (2005) recommends flow velocity be less than 5 ft/sec for grass-lined channels and less than 12 ft/sec for riprap channels.

After adding 1 foot of freeboard to the calculated flow depth (refer to Table 2-3) to prevent channel overtopping, CDM Smith recommends using 1.5 ft as the design depth for each of the two channels.

Table 2-3 Calculation Summary of Channels

Channel	Design Depth			Design Velocity (ft/s)
	Calculated (ft)	Freeboard (ft)	Design (ft)	
Diversion Channel 1	0.08	1	1.5	3.7
Collection Channel 2	0.41	1	1.5	1.8

Even though the flow velocity is less than 5 ft/sec in Collection Channel 2, CDM recommends placing riprap at the toe of the DRA for permanent protection.

2.5.2 Catchment Berm Design

Runoff from Basin 3 will be captured by the existing berm located south of the access road and a rollover berm designed across the access road (see Exhibit A).

The minimum height of the existing berm to capture runoff from Basin 3 was calculated to contain runoff from the 100-year, 24-hour storm event (NOAA, 2004). The total runoff volume from Basin 3 was calculated by multiplying the basin area by the design runoff (1.80 inches). Then the calculated total runoff volume was divided by the available retention area within the access road to calculate the minimum required height of the berm. The calculated minimum height of the existing berm is 2.5 feet, which includes 1-foot of freeboard. Details for these calculations are shown in Table 2-4.

Table 2-4 Calculation Summary for Catchment Berms

Berm	Basin Area (ac)	100-yr, 24-hr Storm (in)	Runoff (in)	Runoff Volume (cu-ft)	Retention Area (sq-ft)	Berm Height		
						Calculated (ft)	Freeboard (ft)	Design (ft)
Exist	2.56	2.80	1.80	16,727	11,000	1.5	1	2.5

2.5.3 Temporary Sediment Pond Design

A temporary sediment pond will be utilized to capture and retain surface water runoff from Basin 2. The temporary sediment pond was sized to retain the runoff volume associated with Basin 2. The total runoff volume from Basin 2 was calculated by multiplying the basin area by the design runoff (1.80 inches). Although a rectangular surface area was assumed for the sediment pond, it is recommended that the shape of the pond be adjusted to minimize the cut/fill required, while maintaining the capacity of the pond. The total volume of the sediment pond was calculated based on 1.5H:1V side slopes along the perimeter of the pond. Details for this calculation are shown in Table 2-5.

Table 2-5 shows that the maximum capacity of the temporary sediment pond (27,904 cu-ft) is 5,688 cu-ft or 26 percent greater than the total calculated runoff volume (22,216 cfs).

Table 2-5 Calculation Summary for Temporary Sediment Pond

Basin	Basin Area (ac)	100-yr, 24-hr Storm (in)	Runoff (in)	Runoff Volume (cu-ft)	Sediment Pond Volume (cu-ft)	Sediment Pond Dimensions		
						Top Length (ft)	Top Width (ft)	Height (ft)
2	3.40	2.8	1.80	22,216	27,904	100	50	8

Section 3 Bullseye Portal Area Drainage Control Design

This section discusses the drainage control approach and procedures used to design the drainage facilities components, identify existing drainage conditions, and the overall drainage design approach for the Bullseye Portal Area. As described below, the Bullseye Portal Area drainage facilities are presented in Exhibit B.

3.1 Drainage Control Approach

The following approach was used to design the drainage facilities components:

1. The peak discharge was estimated for a selected storm return interval using drainage basin characteristics from available topographic data and aerial photographs.

2. Channels were designed to convey the peak discharge.

3. The channel lining was designed for the estimated flow condition.

4. Catchment berms were designed to retain water within the disturbed area for the design storm.

The design of storm water collection, conveyance, and retention facilities components for the Bullseye Portal Area are provided below.

3.2 Existing Drainage Conditions

The Bullseye Portal Area is situated in a drainage area of approximately 19.1 acres which encompasses the 8.0-acre surface mine permit area. Bullseye Canyon Drainage, running northeast to southwest, is located within the planned disturbance.

3.3 Drainage Basins

Five drainage basins were delineated based on the topography and proposed mine surface as illustrated in Exhibit B:

Basin 1 – The offsite surface water runoff area northwest of the DRA (2.55 acres).

Basin 2 – The offsite surface water runoff area northwest of the DRA (1.91 acres).

Basin 3 – The offsite surface water runoff area east of the surface mine facilities (1.12 acres).

Basin 4 – DRA (4.92 acres).

Basin 5 – The mine facilities surface area (1.01 acres).

3.4 Runoff Volume Estimate

The point precipitation frequency estimate for the 100-year, 24-hour storm, obtained from NOAA Atlas 14, Volume 1 for Utah (NOAA, 2004) is 2.80 inches, and was selected as the design storm return interval for surface water control structure design. CDM Smith estimated the peak discharge using the graphical peak discharge method from the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Urban Hydrology for Small Watersheds TR-55 (USDA, 1986). The peak discharge estimated using the NRCS TR-55 is based on hydrologic characteristics of the mine area including estimated precipitation and runoff, soil type, basin slope, time of concentration and travel time. These hydrologic characteristics are described in detail below.

CDM Smith used the Soil Conservation Service (SCS) runoff equation to estimate runoff from the 2.80 inches of design storm. The SCS runoff equation is:

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

Where:

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in)

S is related to the soil and cover conditions of the watershed through the Curve Number (CN). CN has a range of 0 to 100, and S is related to CN by:

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

According to the NRCS TR 55 (USDA, 1986), the major factors that determine the CN include the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). CDM Smith determined HSG of the Bullseye Portal Area based on USDA, NRCS soil map (see Appendix A). The soil type of the Bullseye Portal Area is classified as "Strych-Skos-Badland complex", which has a moderately high to high rate of water transmission (0.57–1.98 inches per hour [in/hr]). Therefore, based on the soil type and soil drainage class, CDM Smith classified the mine area as HSG "A". However, based on site reconnaissance and communication with UDOGM, it was determined that the mine area consists of 55% of HSG "B" and 45% of HSG "D".

For Basins 1 through 3, the CN for desert shrub (poor hydrologic condition), average ARC, and HSG of "B" is 77. Also, the CN for desert shrub (poor hydrologic condition), average ARC, and HSG of "D" is 88. Therefore, area-weighted average of these two values is 82. For P equal to 2.80 inches and CN equal to 82, S equals 2.195 and Q equals 1.22 inches (refer to Appendix C). For Basins 4 and 5, the CN for newly graded areas, average ARC, and HSG of "B" is 86. Also, the CN for newly graded areas, average ARC, and HSG of "D" is 94. Therefore, area-weighted average of these two values is 90. For P equal to 2.80 inches and CN equal to 90, S equals 1.111 and Q equals 1.80 inches. CDM Smith used 1.22 inches as the design runoff for the peak discharge calculations for Basins 1 through 3, and 1.80 inches for Basins 4 and 5.

For drainage Basins 1 through 3, the time of concentration and travel times for each basin were estimated. Different flow segments were used to accurately predict the time of concentration; sheet flow, shallow concentration flow, and channel flow. The addition of the travel times for each flow segment determines the time of concentration, which is the time it takes runoff to reach the central drainage destination from the hydraulically most distant point of the basin. The time of concentration (T_c) equation is (USDA, 1986):

$$T_c = T_{t1} + T_{t2} + T_{t3}$$

T_{t1} is the travel time of sheet flow. The sheet flow travel time equation is:

$$T_{t1} = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5}S^{0.4}}$$

Where:

n = Manning's roughness coefficient

L = flow length in feet (considering the maximum sheet flow length of 300 feet)

P_2 = 2-year, 24-hour rainfall in inches (1.24 inches from NOAA Precipitation-Frequency Atlas 14 Maps for Utah)

S = land slope in ft/ft (Measured from the USGS topographic map)

T_{t2} is the travel time of shallow concentrated flow. The shallow concentration flow travel time equation is (USDA, 1986):

$$T_{t2} = \frac{L}{3600V}$$

Where:

V = average velocity in feet per second (ft/sec) (based on Figure 3-1 (USDA, 1986))

L = estimated from the existing topographic map

T_{t3} is the travel time of channel flow. The channel flow travel time equation is (USDA, 1986):

$$T_{t3} = \frac{L}{3600V}$$

Where:

V = average velocity in ft/sec (based on Figure 3-1 (USDA, 1986))

L = estimated from the existing topographic map

Based on the previous calculations, the graphical peak discharge method is calculated using the following equations:

$q_p = q_u A_m Q$

Where,

q_p = peak discharge in cfs (based on Exhibit 4-II (USDA, 1986))

q_u = unit peak discharge (csm/in)

A_m = drainage area in square miles

Q = runoff in inches

These equations were used to determine the peak discharge for Basins 1 through 3; detailed calculations are provided in Appendix C. The 100-year, 24 hour peak discharges for each basin are summarized in Table 3-1.

Table 3-1 100-year Peak Discharges for Bullseye Portal Area Basins

Basin	Area		100-year Peak Discharge
	(ac)	(sq-mi)	(cfs)
1	2.55	0.0040	2.1
2	1.91	0.0030	1.6
3	1.12	0.0018	1.0
4	Not Applicable – Catchment Berm Utilized (see Section 3.5.2)		
5	Not Applicable – Catchment Berm Utilized (see Section 3.5.2)		

3.5 Surface Water Control Structure Design

Three diversion channels (Channels 1 through 3) were designed to route offsite surface water run-on from Basins 1, 2 and 3 to the Bullseye Canyon Drainage (see Exhibit B). Storm water runoff from Basin 4 and 5 will be captured by earthen berms.

3.5.1 Channel Design

Each diversion channel was sized to convey the 100-year peak discharge described in Section 3.4 that corresponds to the conveyed runoff for each channel. The following equations (Chow, 1973) were used to calculate the flow velocity and depth in the diversion channels. Input values (listed in Table 3-2) into the equations include 100-year peak discharge, cross section geometry, slope, and Manning's n value.

$$Q = VA$$

$$A = (b + zh)h$$

$$V = \frac{1.49}{n}\left[\frac{(b+zh)h}{b+2h\sqrt{1+z^2}}\right]^{2/3} S^{1/2}$$

Where:

Q = discharge in cfs
V = velocity in ft/sec
z : 1 = side slope
A = flow area in ft^2
b = bottom width of the cross section in ft
h = flow depth in ft
S = channel slope in ft/ft
n = Manning's roughness coefficient

Table 3-2 Input values for Channels

Channel	S (ft/ft)	n	Z (ft/ft)	B (ft)	100-year Peak Discharge (cfs)
Diversion Channel 1	0.0263	0.035	3	0	2.1
Diversion Channel 2A	0.0219	0.035	3	0	1.6
Diversion Channel 2B	0.2083	0.035	3	0	1.6
Diversion Channel 3	0.0192	0.035	3	0	1.0

CDM Smith used the Urban Drainage and Flood Control Department (UDFCD) Drainage Criteria (UDFCD, 2005) to determine the appropriate channel lining for the drainage channels. UDFCD (2005) recommends flow velocity be less than 5 ft/sec for grass-lined channels and less than 12 ft/sec for riprap channels.

As shown in Table 3-3, because the calculated maximum flow velocity of Diversion Channel 2B is greater than 5 ft/sec, Diversion Channel 2B will require riprap protection. The riprap sizing was calculated for Diversion Channel 2B using the USACE riprap sizing program, CHANLPRO version 2.0. Per program output, D100 of 18 inches and D50 of 12 inches are recommended for the riprap sizing.

After adding 1 foot of freeboard to the calculated flow depth (refer to Table 3-3) to prevent channel overtopping, CDM Smith recommends using the design depth of 1.5 ft for all the diversion channels.

Table 3-3 Calculation Summary of Channels

Channel	Design Depth			Design Velocity (ft/s)
	Calculated (ft)	Freeboard (ft)	Design (ft)	
Diversion Channel 1	0.5	1	1.5	2.7
Diversion Channel 2A	0.5	1	1.5	2.3
Diversion Channel 2B	0.3	1	1.5	5.5
Diversion Channel 3	0.4	1	1.5	2.0

3.5.2 Catchment Berm Design

Earthen berms will be utilized to capture surface water runoff from Basins 4 and 5 (see Exhibit B).

The catchment berms were designed to contain runoff from Basins 4 and 5 for the 100-year, 24-hour storm event (NOAA, 2004). The total runoff volume was calculated by multiplying the basin area by the design runoff (1.80 inches). Then the calculated total runoff volume was divided by the available retention area to calculate the minimum required berm height. The calculated minimum height of Berm 1 within Basin 4 is 3.0 feet, which includes 1-foot of freeboard. The calculated minimum required height of Berm 2 within Basin 5 is 1.5 feet, which includes 1-foot of freeboard. Details for these calculations are shown in Table 3-4.

Table 3-4 Calculation Summary for Catchment Berms

Berm	Basin Area (ac)	100-yr, 24-hr Storm (in)	Runoff (in)	Runoff Volume (cu-ft)	Retention Area (sq-ft)	Berm Height		
						Calculated (ft)	Freeboard (ft)	Design (ft)
1	5.06	2.80	1.80	33,077	14,743	2.2	1	3.0
2	1.01	2.80	1.80	6,611	16,284	0.4	1	1.5

3.6 Culvert Design

Culverts were designed at two proposed crossing locations (see Exhibit B). Currently, three 60-inch culverts are installed at the Daneros Portal Area which is reasonably close and upgradient to the Bullseye Portal Area. Therefore, three 60-inch culverts were designed at those two crossing locations.

Sizing of the culverts to match the existing culverts upgradient is reasonable because these access roads are for mine use and public access is restricted. CDM Smith recommends that these access roads be continually monitored during the life of the mine, be maintained if damaged as a result of a large storm event, and be removed after mining.

Section 4 South Portal Area Drainage Control Design

This section discusses the drainage control approach and procedures used to design the drainage facilities components, identify existing drainage conditions, and the overall drainage design approach for the proposed South Portal Area. As described below, the South Portal Area drainage facilities are presented in Exhibit C.

4.1 Drainage Control Approach

The following approach was used to design the drainage facilities components:

1. The peak discharge was estimated for a selected storm return interval using drainage basin characteristics from available topographic data and aerial photographs.

2. Channels were designed to convey the peak discharge.

3. The channel lining was designed to convey the peak discharge.

4. Catchment berms were designed to retain water within the disturbed area for the design storm.

5. Temporary sediment ponds were sized to capture and retain runoff from the mine surface facility and DRA.

The design of storm water collection, conveyance, and retention facilities components for the South Portal Area are provided below.

4.2 Existing Drainage Conditions

Currently, historic mine-relate disturbance exists in the proposed location of the South Portal Area. There is an existing drainage channel running north to south through the proposed mine area.

4.3 Drainage Basins

Six drainage basins were delineated based on the topography and existing mine surface as illustrated in Exhibit C:

Basin 1 – The offsite surface water runoff area north of the DRA; west side (1.03 acres).

Basins 2a/2b/2c – The offsite surface water runoff area north of the DRA; east side (14.27, 0.65, and 4.87 acres, respectively).

Basin 3 –DRA (6.27 acres)

Basin 4 – North mine facilities surface area (1.22 acres)

Basins 5a/5b – South mine facilities surface area (4.71 and 3.33 acres, respectively)

Basin 6 – Ore stockpile area (2.45 acres)

4.4 Peak Discharge Estimate

The point precipitation frequency estimate for the 100-year, 24-hour storm, obtained from NOAA Atlas 14, Volume 1 for Utah (NOAA, 2004) is 2.80 inches, and was selected as the design storm return interval for surface water control structure design. CDM Smith estimated the peak discharge using the graphical peak discharge method from the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Urban Hydrology for Small Watersheds TR-55 (USDA, 1986). The peak discharge estimated using the NRCS TR-55 is based on hydrologic characteristics of the mine area including estimated precipitation and runoff, soil type, basin slope, time of concentration and travel time. These hydrologic characteristics are described in detail below.

CDM Smith used the Soil Conservation Service (SCS) runoff equation to estimate runoff from the 2.80 inches of design storm. The SCS runoff equation is:

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

Where:

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in)

S is related to the soil and cover conditions of the watershed through the Curve Number (CN). CN has a range of 0 to 100, and S is related to CN by:

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

According to the NRCS TR 55 (USDA, 1986), the major factors that determine the CN include the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). HSG of the South Portal Area was determined based on USDA, NRCS soil map (see Appendix A). The soil type of the mine area is classified as “Skos-Rock outcrop complex”, which has a moderately low to moderately high rate of water transmission (0.06–0.20 inches per hour [in/hr]). Therefore, based on the soil type and soil drainage class, the mine area was classified as HSG “C”.

For Basins 1, 2a, 2b, and 2c, the CN for desert shrub (poor hydrologic condition), average ARC, and HSG of “C” is 85. For P equal to 2.80 inches and CN equal to 85, S equals 1.765 and Q equals 1.42 inches (refer to Appendix D). For Basins 3, 4, 5a, 5b, and 6, the CN for newly graded areas, average ARC, and HSG of “C” is 91. For P equal to 2.80 inches and CN equal to 91, S equals 0.989 and Q equals 1.89 inches.

For drainage Basins 1, 2a, 2b, 2c, and 3, the time of concentration and travel time were estimated, as it is required to size the channels. Different flow segments were used to accurately predict the time of concentration; sheet flow, shallow concentration flow, and channel flow. The addition of the travel times for each flow segment determines the time of concentration, which is the time it takes runoff to reach the central drainage destination from the hydraulically most distant point of the basin. The time of concentration (T_c) equation is (USDA, 1986):

$$T_c = T_{t1} + T_{t2} + T_{t3}$$

T_{t1} is the travel time of sheet flow. Based on the NRCS TR-55 (USDA, 1986), sheet flow is less than or equal to 300 feet. The sheet flow travel time equation is:

$$T_{t1} = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5}S^{0.4}}$$

Where:

n = Manning's roughness coefficient

L = flow length in feet (considering the maximum sheet flow length of 300 feet)

P_2 = 2-year, 24-hour rainfall in inches (1.24 inches from NOAA Precipitation-Frequency Atlas 14 Maps for Utah)

S = land slope in ft/ft (Measured from the USGS topographic map)

T_{t2} is the travel time of shallow concentrated flow. The shallow concentration flow travel time equation is (USDA, 1986):

$$T_{t2} = \frac{L}{3600V}$$

Where:

V = average velocity in feet per second (ft/sec) (based on Figure 3-1 (USDA, 1986))

L = estimated from the existing topographic map

T_{t3} is the travel time of channel flow. The channel flow travel time equation is (USDA, 1986):

$$T_{t3} = \frac{L}{3600V}$$

Where:

V = average velocity in ft/sec (based on Figure 3-1 (USDA, 1986))

L = estimated from the existing topographic map

Based on the previous calculations, the graphical peak discharge method is calculated using the following equations:

$q_p = q_u A_m Q$

Where,

q_p = peak discharge in cfs (based on Exhibit 4-II (USDA, 1986))

q_u = unit peak discharge (csm/in)

A_m = drainage area in square miles

Q = runoff in inches

These equations were used to determine the peak discharge for Basins 1, 2a, 2b, 2c, and 3; detailed calculations are provided in Appendix D. The 100-year, 24 hour peak discharge is summarized in Table 4-1.

Table 4-1 100-year Peak Discharges for South Portal Area Basins

Basin	Area		100-year Peak Discharge
	(ac)	(sq-mi)	(cfs)
1	1.03	0.0016	1.2
2a	14.27	0.0223	17.1
2b	0.65	0.0010	0.9
2c	4.87	0.0076	5.3
3	3.14 1)	0.0049	7.3
4	Not Applicable – Catchment Berm Utilized (see Section 4.5.2)		
5a/5b	Not Applicable – Catchment Berm Utilized (see Section 4.5.2)		
6	Not Applicable – Catchment Berm Utilized (see Section 4.5.2)		

1) A half of the basin area used for the peak discharge calculation

4.5 Surface Water Control Structure Design

Diversion Channels 2 and 3 were designed to route offsite surface water run-on from Basins 2a, 2b and 2c to the existing drainage channel (see Exhibit C). Collection Channel 1 will be used to convey the runoff from Basin 1 and 3. Offsite surface water run-on from Basin 2b will be captured and diverted west by an earthen berm surrounding Basin 4, and into Diversion Channel 2. Storm water runoff from Basin 3 will be diverted into two directions and captured by the sediment ponds; i.e., 1) east to Portal Area Sediment Pond through Collection Channel 1, and 2) west to West Facility Area Sediment Pond along an earthen berm surrounding Basin 3 and through a culvert under the county road (see Exhibit C). 80% of the runoff from Basin 3 is assumed to drain to the Portal Area Sediment Pond and the West Facility Sediment Pond to allow for the drainage of Basin 3 as the DRA is built out.

Storm water runoff from Basins 4, 5a, 5b, and 6 will be captured and retained by earthen berms along the edges of the basins.

4.5.1 Channel Design

Each channel was sized to convey the 100-year peak discharge described in Section 4.4 that corresponds to the conveyed runoff for the channel. The following equations (Chow, 1973) were used to calculate the flow velocity and depth in the channels. Input values (listed in Table 4-2) into the equations include 100-year peak discharge, cross section geometry, slope, and Manning's n value.

$$Q = VA$$

$$A = (b + zh)h$$

$$V = \frac{1.49}{n}\left[\frac{(b+zh)h}{b+2h\sqrt{1+z^2}}\right]^{2/3} S^{1/2}$$

Where:

- Q = discharge in cfs
- V = velocity in ft/sec
- $z : 1$ = side slope
- A = flow area in ft^2
- b = bottom width of the cross section in ft
- h = flow depth in ft
- S = channel slope in ft/ft
- n = Manning's roughness coefficient

Table 4-2 Input values for Channels

Channel	S (ft/ft)	n	Z (ft/ft)	B (ft)	100-year Peak Discharge (cfs)
Collection Channel 1	0.0867	0.035	3	4	8.5[1)]
Diversion Channel 2	0.0500	0.035	3	4	18.0[2)]
Diversion Channel 3	0.0313	0.035	3	4	5.3[3)]

1) Sum of 100-yr peak discharges of Basins 1 and 3 (see Table 4-1)
2) Sum of 100-yr peak discharges of Basins 2a and 2b (see Table 4-1)
3) 100-yr peak discharges of Basins 2c (see Table 4-1)

CDM Smith used the Urban Drainage and Flood Control Department (UDFCD) Drainage Criteria (UDFCD, 2005) to determine the appropriate channel lining for the drainage channels. UDFCD (2005) recommends flow velocity be less than 5 ft/sec for grass-lined channels and less than 12 ft/sec for riprap channels.

As shown in Table 4-3, the calculated maximum flow velocities of Collection Channel 1 and Diversion Channel 2 are greater than 5 ft/sec but less than 5.4 ft/sec. Therefore, it is expected that grass lined channels function as designed even during a 100-yr event.

After adding 1 foot of freeboard to the calculated flow depths (refer to Table 4-3) to prevent channel overtopping, CDM Smith recommends using the design depths of 1.5 ft for these three channels.

Table 4-3 Calculation Summary of Channels

Channel	Design Depth			Design Velocity (ft/s)
	Calculated (ft)	Freeboard (ft)	Design (ft)	
Collection Channel 1	0.3	1	1.5	5.2
Diversion Channel 2	0.6	1	1.5	5.4
Diversion Channel 3	0.3	1	1.5	3.2

4.5.2 Catchment Berm Design

Earthen berms will be utilized to capture surface water runoff from Basins 3, 4, 5a, 5b, and 6.

Berm 1 will be utilized along the west edge of Basin 3 to keep the storm water runoff within Basin 3 before reaching West Facility Area Sediment Pond (see Exhibit C). Considering that the minimum required height of Berm 2 is 1.5 ft, 1.5 ft is recommended for the minimum height of Berm 1, because Berm 1 does not have to be designed to contain the 100-year storm runoff.

Runoff in Basins 5a and 5b will be captured by Berm 2 surrounding the basin. Runoff in Basin 6 will be captured by Berm 3 along the edge of the ore stockpile area. Also, runoff in Basin 4 will be captured by Berm 4 surrounding the portal area (see Exhibit C).

The catchment berms were designed to contain runoff from the 100-year, 24-hour storm event (NOAA, 2004). The total runoff volume from each basin was calculated by multiplying the basin area by the design runoff (1.89 inches). Then the calculated total runoff volume was divided by the available retention area within the basin to calculate the minimum required height of the berm. The calculated minimum required berm heights are 1.5, 2.5, and 1.5 feet for Berms 2, 3, and 4 respectively. Details for these calculations are shown in Table 4-4.

Table 4-4 Calculation Summary for Catchment Berms

Berm	Basin Area (ac)	100-yr, 24-hr Storm (in)	Runoff (in)	Runoff Volume (cu-ft)	Retention Area (sq-ft)	Berm Height		
						Calculated (ft)	Freeboard (ft)	Design (ft)
2	8.05	2.80	1.89	55,229	220,915	0.3	1	1.5
3	2.45	2.80	1.89	16,809	10,672	1.6	1	2.5
4	1.22	2.80	1.89	8,370	44,395	0.2	1	1.5

4.5.3 Temporary Sediment Pond Design

In addition to the catchment berms, temporary sediment ponds will be utilized to capture and retain surface water runoff from Basins 1, 3, 4, 5a, and 5b. Three ponds were designed; 1) West Facility Area Sediment Pond, 2) East Facility Area Sediment Pond, and 3) Portal Area Sediment Pond. These ponds were designed to capture the runoff from the basins as follows:

- Runoff from Basin 5a and up to 80% of Basin 3 captured by West Facility Sediment Pond
- Runoff from Basin 5b captured by East Facility Sediment Pond
- Runoff from Basin 4, up to 80% of Basin 3, and Basin 1 captured by Portal Area Sediment Pond

The volumes of these sediment ponds were compared to the runoff volume from the basins (see Table 4-5).

Table 4-5 Calculation Summary for Temporary Sediment Ponds

Temporary Sediment Pond		Captured Basin Characteristics				
Name	**Design Capacity (cu-ft) (1)**	**Basin ID**	**Basin Area (ac)**	**100-yr, 24-hr Storm (in)**	**Runoff (in)**	**Runoff Volume (cu-ft)**
West Facility Area Sediment Pond	95,307	3 (80%)	5.02	2.80	1.89	34,413
		5a	4.71	2.80	1.89	32,314
					Total Runoff	**66,727**
East Facility Area Sediment Pond	36,865	5b	3.33	2.80	1.89	22,846
					Total Runoff	**22,846**
Portal Area Sediment Pond	62,319	1	1.03	2.80	1.42	5,309
		3 (80%)	5.02	2.80	1.89	34,413
		4	1.22	2.80	1.89	8,370
					Total Runoff	**48,092**

(1) The volume estimated with 1-ft freeboard.

4.5.4 Culvert Design

Culverts were designed at three proposed crossing locations (see Exhibit C).

Culvert sizing calculation was performed using Bentley's FlowMaster program for the 100-yr, 24-hour storm (see Appendix E). Based on this calculation, a single 24-inch culvert is recommended at all these three crossings.

Section 5 Conclusions and Recommendations

This section provides a summary of the conclusions and recommendations for drainage control structures to route offsite surface flow around the surface mine area and retain the 100-year, 24-hr storm event within the onsite berms for the three portal areas of Daneros Mine.

5.1.1 Daneros Portal Area

CDM Smith recommends installation of the following storm water drainage controls for the Daneros Portal Area:

1. Diversion Channel 1 and Collection Channel 2 according to the configuration and design criteria illustrated in Exhibit A. During mining, inspection and maintenance is recommended after large storm events to maintain channels as illustrated in Exhibit A.

2. Catchment Berm 1 to retain runoff flow from Basin 2 according to the configuration and design criteria illustrated in Exhibit A.

3. Existing berm located south of the access road and rollover berm across the access road that are used to retain runoff flow from Basin 3 according to the configuration and design criteria that is illustrated in Exhibit A. The minimum height of the existing berm should be 2.5 feet.

4. Temporary sediment pond to retain runoff from Basin 2 according to the configuration and design criteria illustrated in Exhibit A.

5.1.2 Bullseye Portal Area

CDM Smith recommends installation of the following storm water drainage controls for the Bullseye Portal Area:

1. Diversion Channels 1, 2A, 2B, and 3 according to the configuration and design criteria illustrated in Exhibit B. During mining, inspection and maintenance is recommended after large storm events to maintain channels as illustrated in Exhibit B. Riprap lining (D100 of 18 inches and D50 of 12 inches) is recommended for Diversion Channel 2B.

2. Catchment Berms 1 and 2 to retain runoff flow from Basins 4 and 5 according to the configuration and design criteria illustrated in Exhibit B.

3. Three 60-inch culverts at each of the two proposed crossings along the Bullseye Canyon Drainage. Inspection and maintenance is recommended after large storm events to maintain integrity of the stream crossing during mining. The culvert crossings need to be removed after reclamation.

5.1.3 South Portal Area

CDM Smith recommends installation of the following storm water drainage controls for the South Portal Area storm:

1. Collection Channel 1 and Diversion Channels 2 and 3 according to the configuration and design criteria illustrated in Exhibit C. During mining, inspection and maintenance is recommended after large storm events to maintain the channel as illustrated in Exhibit C.

2. Catchment Berms 1, 2, 3, and 4 to retain runoff flow from Basins 3, 5, 6, and 4, respectively, according to the configuration and design criteria illustrated in Exhibit C.

3. Three temporary sediment ponds to retain surface water runoff from Basins 1, 3, 4, 5a, and 5b, according to the configuration and design criteria illustrated in Exhibit C.

Section 6 References

Chow, V.T. (1973). Open Channel Hydraulics.

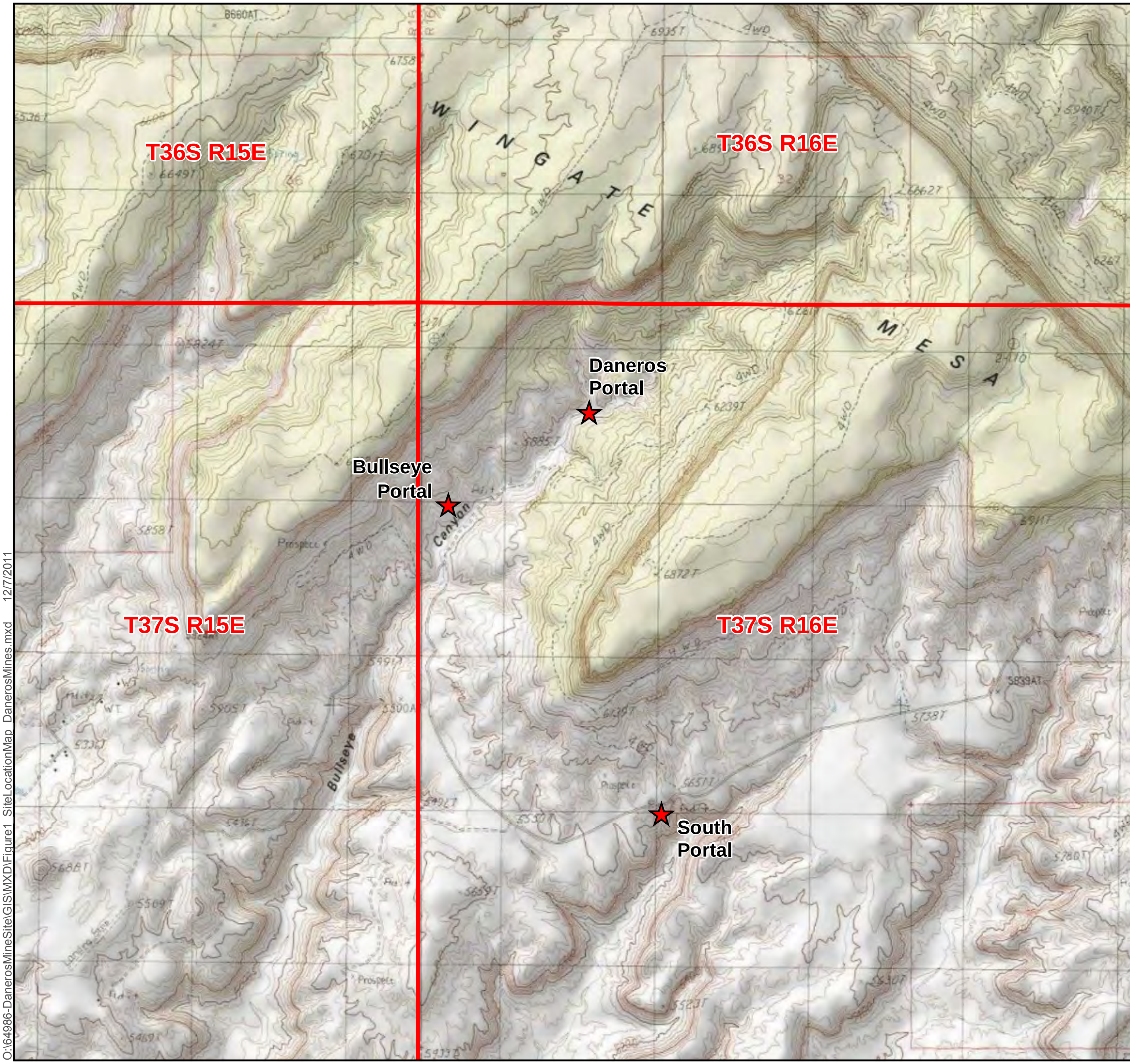
National Oceanic and Atmospheric Administration. (NOAA). 2004. Precipitation Frequency Atlas of the United States, NOAA Atlas 14, Volume IV.

Urban Drainage and Flood Control District. (UDFCD). 2005. Urban Storm Drainage Criteria Manual.

U.S. Department of Agriculture. (USDA). 1986. Urban Hydrology for Small WaterSheds, Technical Release 55. June.

U.S. Department of Interior, Bureau of Land Management (BLM). (1999). 43 CFR Part 3800 Mining Claims Under the General Mining Laws: Surface Management; Proposed Rule.

Figures



Legend

★ Portal Location

N
W E
S

Scale of Feet

0 3,000 6,000

1 inch = 3,000 feet

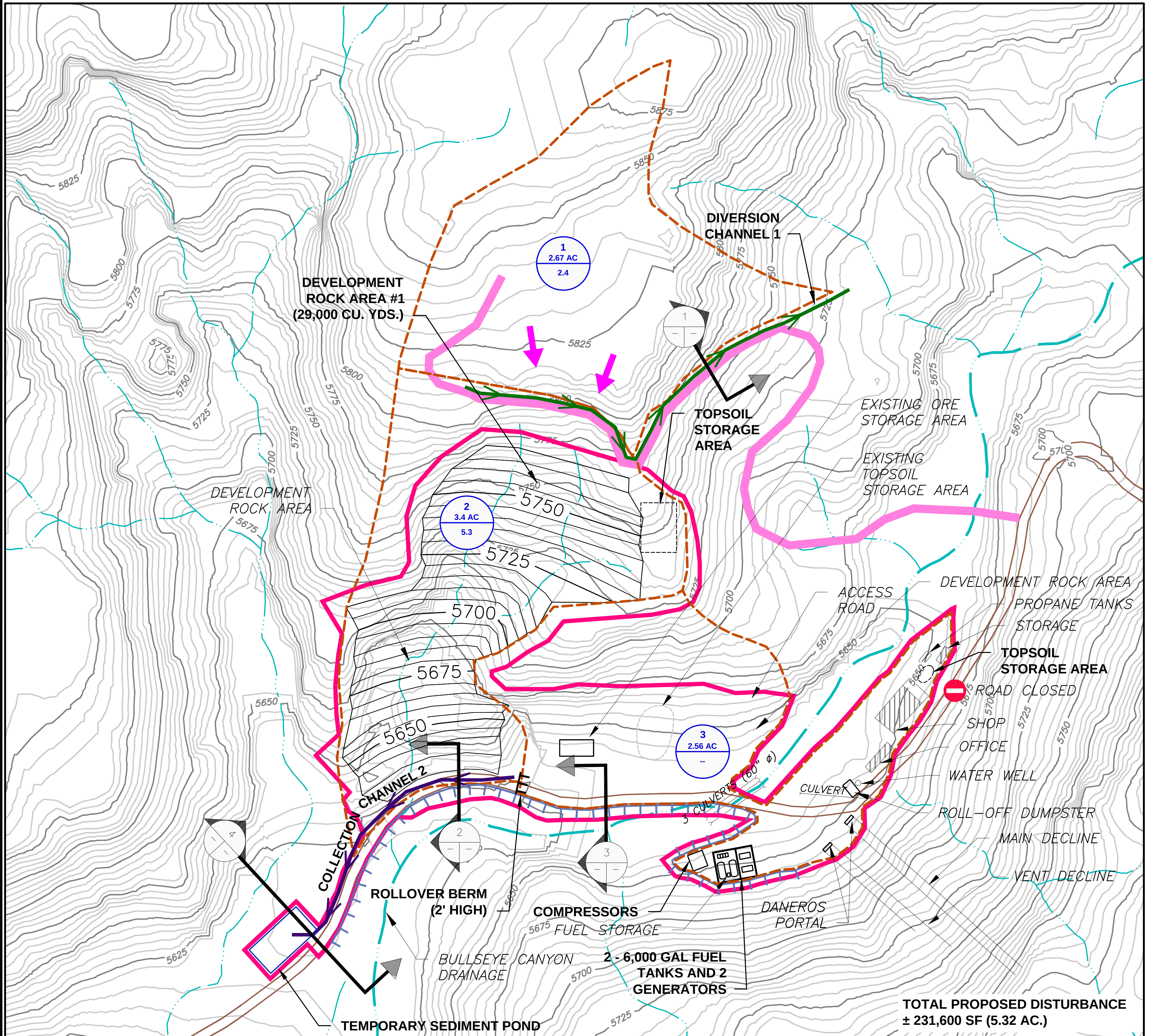
Figure 1
Site Location Map
Daneros Mine
Denison Mines (USA) Corp.

San Juan County, Utah

Source: USGS Fry Spring Quadrangle Map

CDM

Exhibits



0 150' 300'

SCALE IN FEET

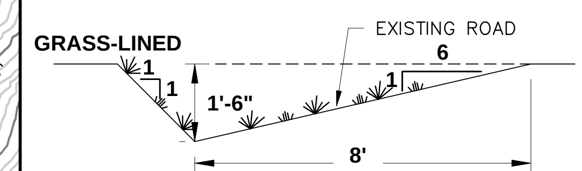
TOWNSHIP 37S
RANGE 16E
SECTION 6

N

LEGEND

- EXISTING EXPLORATION DRILLING ROAD
- PROPOSED LIMIT OF DISTURBED AREA
- EXISTING CATCHMENT BERM
- ROLLOVER BERM
- PROPOSED DIVERSION CHANNEL 1
- PROPOSED COLLECTION CHANNEL 2
- EXISTING DRAINAGE
- SURFACE WATER FLOW DIRECTION DURING MINING
- DRAINAGE BASIN BOUNDARY
- EXISTING CONTOUR INTERVAL (25 FT.)
- EXISTING CONTOUR INTERVAL (5 FT.)
- PROPOSED CONTOUR INTERVAL (25 FT.)
- PROPOSED CONTOUR INTERVAL (5 FT.)
- ROAD
- SEDIMENT POND

1 / 2.21 AC / 0.4 — BASIN ID; BASIN AREA (acres); 100-YEAR Q (cfs)



COLLECTION CHANNEL 1 CROSS-SECTION
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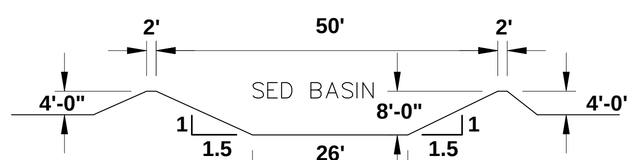

SEDIMENT BASIN CROSS-SECTION
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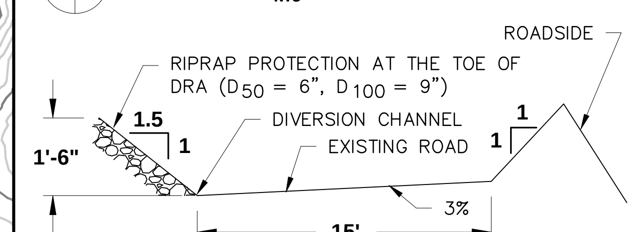

DIVERSION CHANNEL 2 CROSS-SECTION
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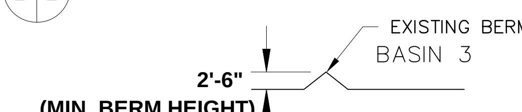


CATCHMENT AND DRAINAGE BERM CROSS-SECTION
NTS

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. EOM
DRAWN BY: J. HUMPHREY
SHEET CHK'D BY: T. BRAGDON
CROSS CHK'D BY:
APPROVED BY:
DATE: SEPTEMBER 2013

CDM Smith
CDM Federal Programs Corporation
555 17th Street, Suite 1100
Denver, CO 80202
Tel: (303) 383-2300

ENERGY FUELS RESOURCES (USA) INC
SAN JUAN COUNTY, UTAH

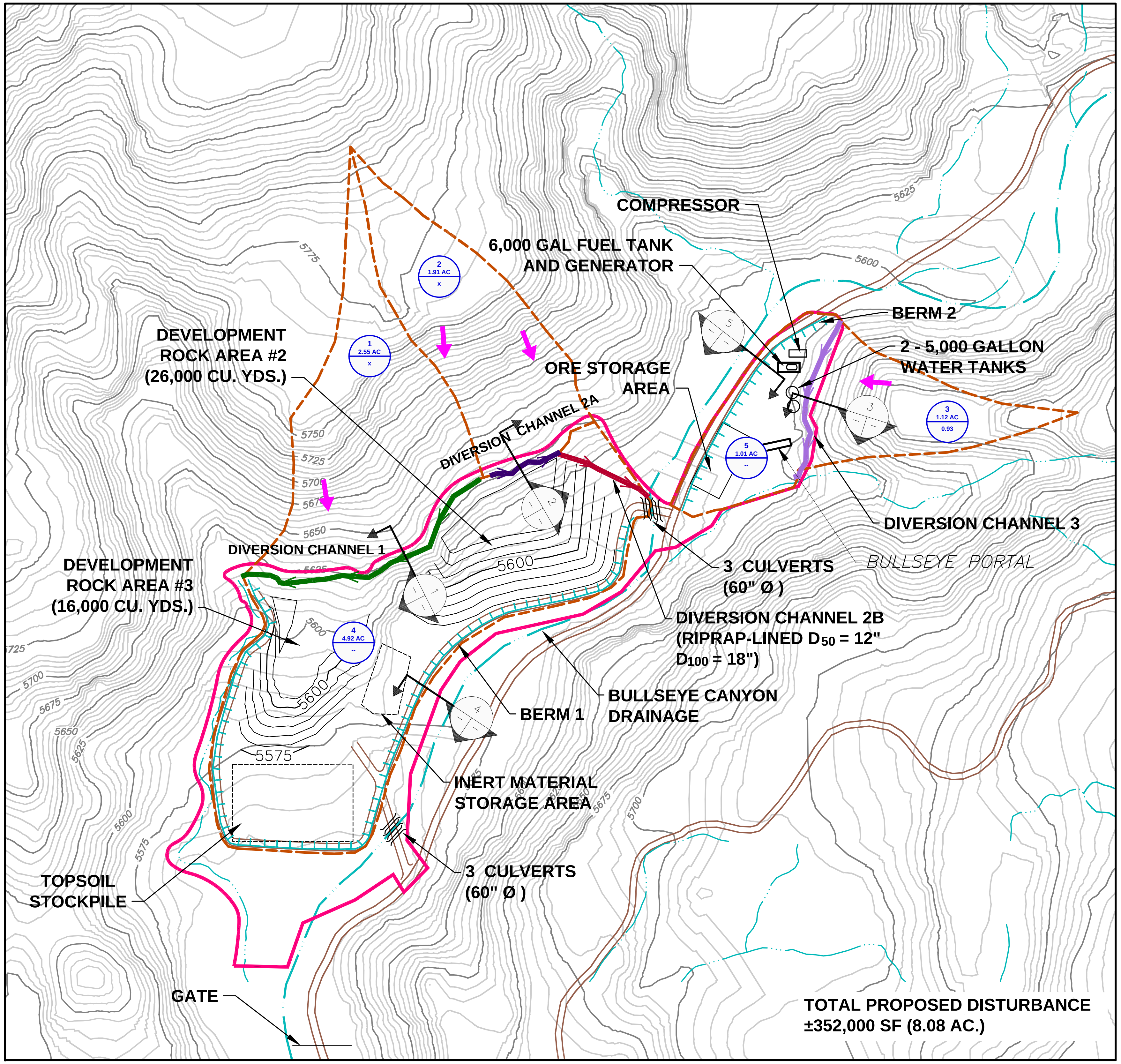
DANEROS MINE SITE

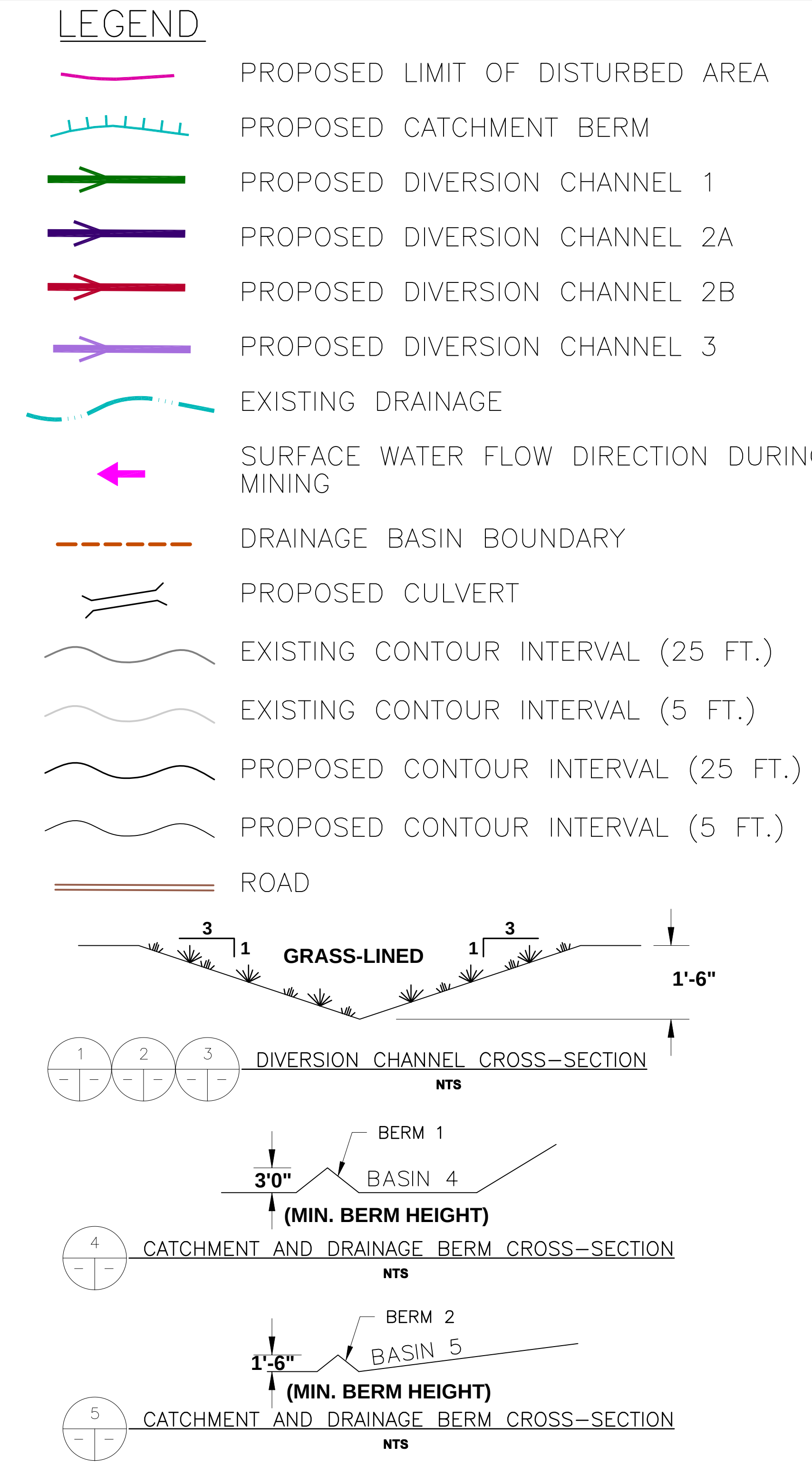
DANEROS PORTAL AREA DRAINAGE PLAN AND DETAILS

PROJECT NO. 64986
FILE NAME:
EXHIBIT
A

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

X:\64986-Denison Mines\DANEROS\EXHIBIT\ EXHIBIT_A





0 200' 400'

SCALE IN FEET

TOWNSHIP 37S
RANGE 16E
SECTION 6

BASIN ID
BASIN AREA (acres)
100-YEAR Q (cfs)

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. EOM
DRAWN BY: J. HUMPHREY
SHEET CHK'D BY: T. BRAGDON
CROSS CHK'D BY:
APPROVED BY:
DATE: SEPTEMBER 2013

CDM Smith
CDM Federal Programs Corporation
555 17th Street, Suite 1100
Denver, CO 80202
Tel: (303) 383-2300

ENERGY FUELS RESOURCES (USA) INC
SAN JUAN COUNTY, UTAH

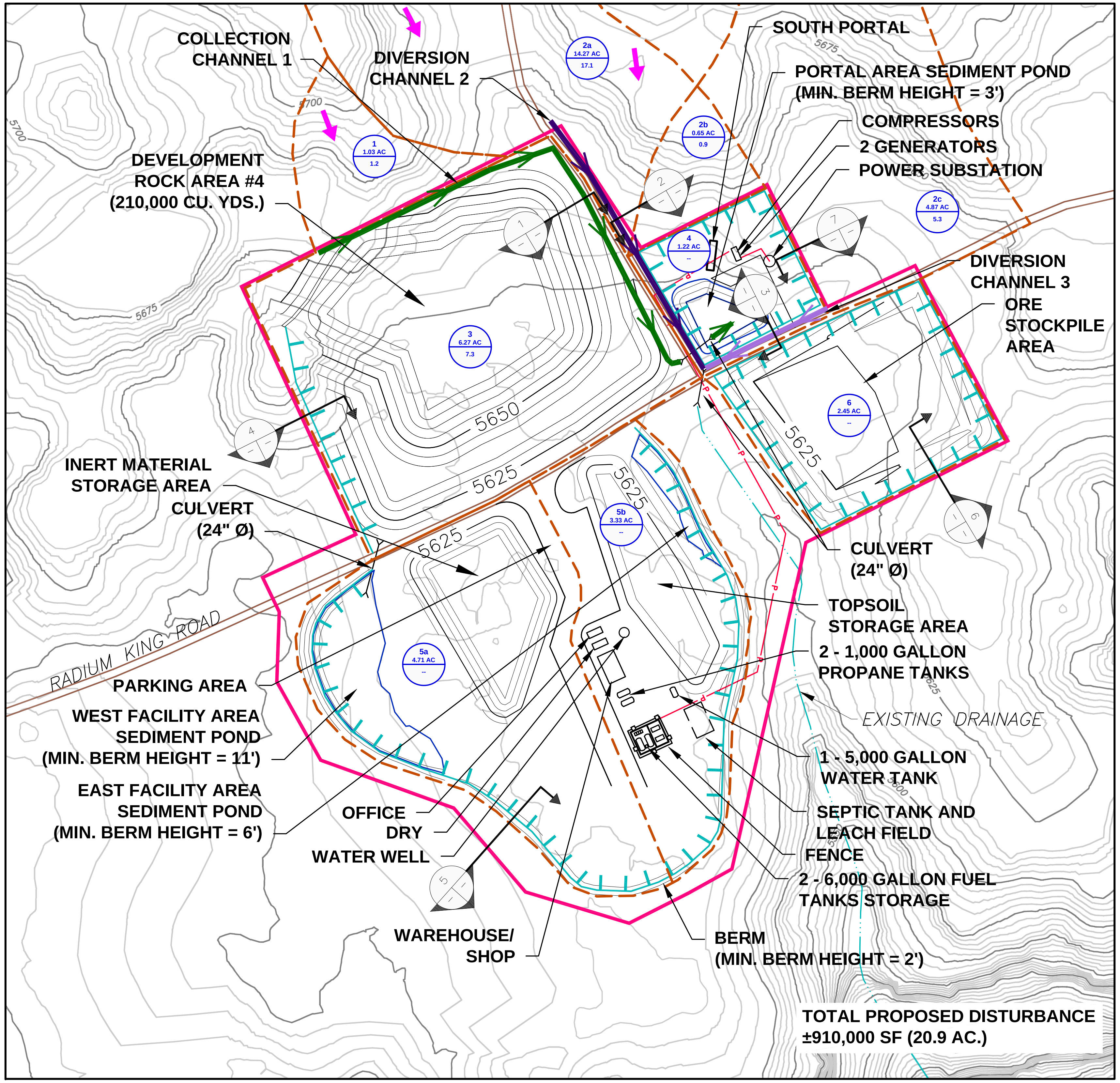
DANEROS MINE SITE

BULLSEYE PORTAL AREA DRAINAGE PLAN AND DETAILS

PROJECT NO. 64986
FILE NAME:
EXHIBIT
B

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

X:\64986-Denison Mines\Doneros Mine\CIVL\ EXHIBIT_B 07/17/2012



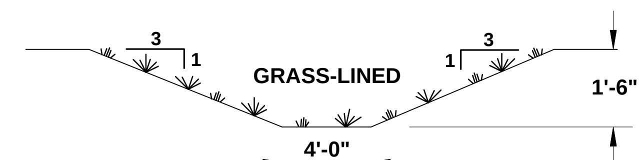
N

LEGEND

- PROPOSED LIMIT OF DISTURBED AREA
- PROPOSED CATCHMENT BERM
- PROPOSED COLLECTION CHANNEL 1
- PROPOSED DIVERSION CHANNEL 2
- PROPOSED DIVERSION CHANNEL 3
- EXISTING DRAINAGE
- SURFACE WATER FLOW DIRECTION DURING MINING
- DRAINAGE BASIN BOUNDARY
- FENCE
- SEDIMENT POND
- POWER LINE
- EXISTING CONTOUR INTERVAL (25 FT.)
- EXISTING CONTOUR INTERVAL (5 FT.)
- PROPOSED CONTOUR INTERVAL (25 FT.)
- PROPOSED CONTOUR INTERVAL (5 FT.)
- ROAD

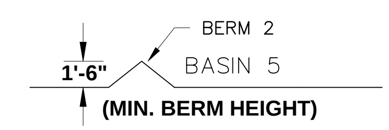
NOTES:

1. DURING CONSTRUCTION OF THE PORTAL AREA POND AND BERM, STORMWATER STORAGE CAPACITY WILL BE VERIFIED TO EXCEED 48,092 CU–FT WITH A MINIMUM OF 1 FOOT OF FREE BOARD.
2. DURING CONSTRUCTION OF THE WEST FACILITY AREA AND EAST FACILITY AREA PONDS, , STORMWATER STORAGE CAPACITY WILL BE VERIFIED TO EXCEED 66,727 CU–FT AND 22, 846 CU–FT WITH A MINIMUM OF 1 FOOT OF FREE BOARD, RESPECTIVELY.



* CROSS SECTION 3 IS FOR DIVERSION CHANNEL 3

1 2 3 DIVERSION CHANNEL CROSS–SECTION
NTS



5 CATCHMENT AND DRAINAGE BERM CROSS–SECTION
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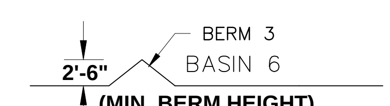

6 CATCHMENT AND DRAINAGE BERM CROSS–SECTION
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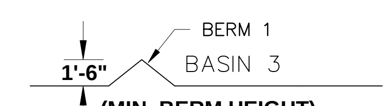

4 CATCHMENT AND DRAINAGE BERM CROSS–SECTION
NTS

7 CATCHMENT AND DRAINAGE BERM CROSS–SECTION
NTS

TOWNSHIP 37S
RANGE 16E
SECTION 18

0 200' 400'
SCALE IN FEET

BASIN ID
BASIN AREA (acres)
100-YEAR Q (cfs)

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. EOM
DRAWN BY: J. HUMPHREY
SHEET CHK'D BY: T. BRAGDON
CROSS CHK'D BY:
APPROVED BY:
DATE: SEPTEMBER 2013

CDM Smith
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Denver, CO 80202
Tel: (303) 383-2300

ENERGY FUELS RESOURCES (USA) INC
SAN JUAN COUNTY, UTAH

DANEROS MINE SITE

SOUTH PORTAL AREA DRAINAGE PLAN AND DETAILS

PROJECT NO. 64986
FILE NAME:

EXHIBIT C

PRELIMINARY DESIGN - NOT FOR CONSTRUCTION

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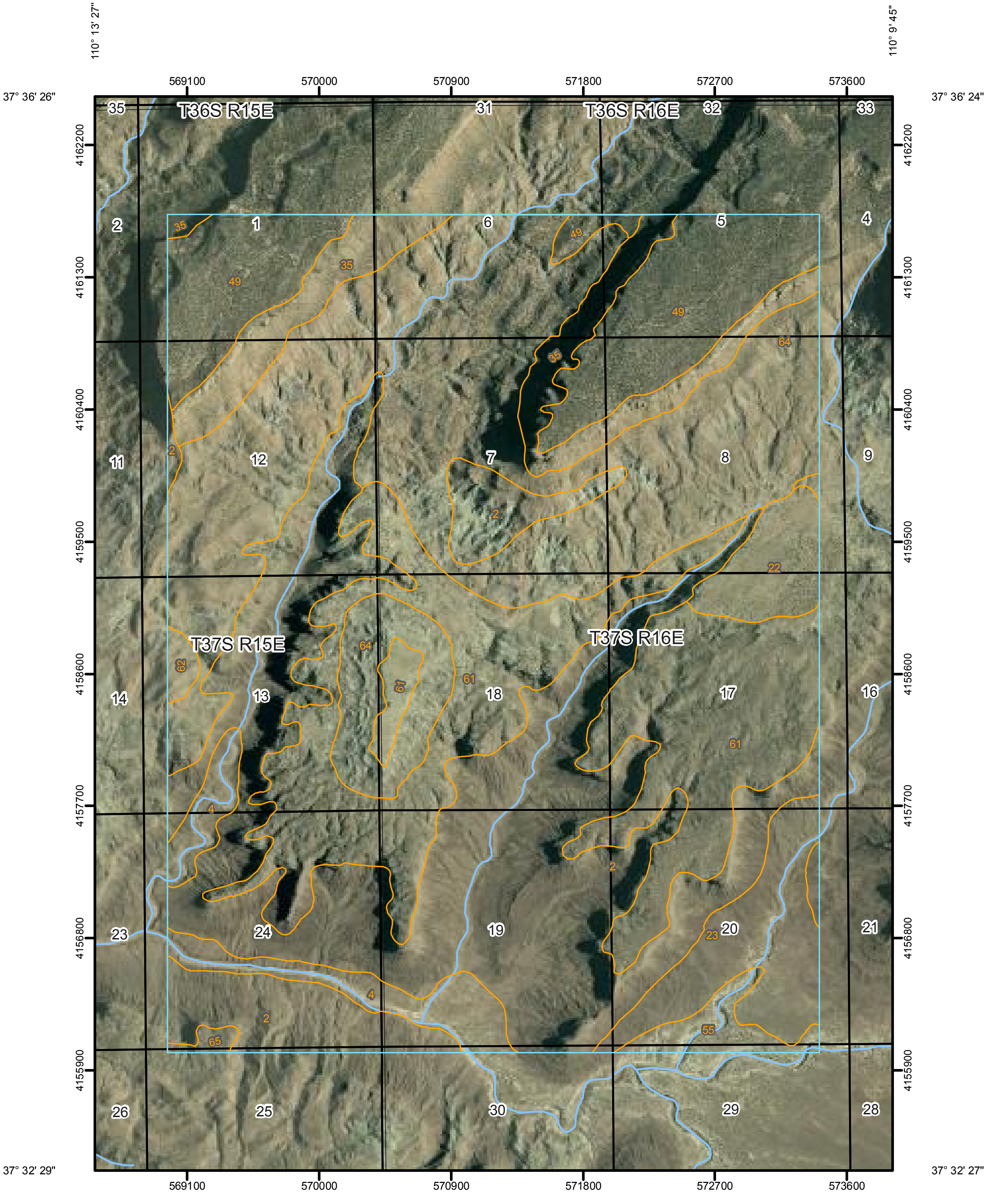
Appendix A
NRCS Soil Map and Soil Type Description for Daneros Mine

CDM Smith



Map Scale: 1:34,900 if printed on A size (8.5" x 11") sheet.

Meters: 0, 300, 600, 1,200, 1,800

Feet: 0, 1,000, 2,000, 4,000, 6,000

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

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

Gully

Short Steep Slope

Other

Political Features

Cities

PLSS Township and Range

PLSS Section

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

MAP INFORMATION

Map Scale: 1:34,900 if printed on A size (8.5" × 11") sheet.

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 12N NAD83

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

Soil Survey Area: San Juan County, Utah, Central Part
Survey Area Data: Version 7, Oct 6, 2010

Date(s) aerial images were photographed: 7/14/2006

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

San Juan County, Utah, Central Part (UT638)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
2	Badland-Rock outcrop complex	1,772.5	28.3%
4	Bankard family-Sheppard complex	188.4	3.0%
22	Mido-Rock outcrop-Arches complex	126.7	2.0%
23	Milok fine sandy loam, 1 to 6 percent slopes	256.7	4.1%
35	Myton family-Skos-Rock outcrop association	337.0	5.4%
49	Rizno-Rock outcrop complex	563.3	9.0%
55	Rock outcrop-Piute-Skos association	72.6	1.2%
61	Skos-Rock outcrop complex	1,192.4	19.0%
62	Skos,warm-Rock outcrop complex	20.2	0.3%
64	Strych-Skos-Badland complex	1,721.3	27.5%
65	Strych, warm-Skos, warm-Badland complex	13.7	0.2%
Totals for Area of Interest		**6,264.8**	**100.0%**

San Juan County, Utah, Central Part

64—Strych-Skos-Badland complex

Map Unit Setting

Elevation: 5,400 to 6,200 feet
Mean annual precipitation: 8 to 12 inches
Mean annual air temperature: 48 to 53 degrees F
Frost-free period: 120 to 150 days

Map Unit Composition

Strych and similar soils: 40 percent
Skos and similar soils: 35 percent
Badland: 15 percent

Description of Strych

Setting

Landform: Structural benches
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium derived from sandstone and shale and/or colluvium derived from sandstone and shale

Properties and qualities

Slope: 30 to 50 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 4.3 inches)

Interpretive groups

Land capability (nonirrigated): 7s
Ecological site: Semidesert Stony Loam (Shadscale) (R035XY242UT)

Typical profile

0 to 3 inches: Very stony sandy clay loam
3 to 60 inches: Very cobbly fine sandy loam

Description of Skos

Setting

Landform: Structural benches
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex

Across-slope shape: Convex
Parent material: Colluvium derived from interbedded sandstone and shale and/or residuum weathered from interbedded sandstone and shale

Properties and qualities

Slope: 30 to 50 percent
Depth to restrictive feature: 4 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Very low (about 1.6 inches)

Interpretive groups

Land capability (nonirrigated): 7s
Ecological site: Semidesert Shallow Sandy Loam (Shadscale) (R035XY230UT)

Typical profile

0 to 4 inches: Channery loam
4 to 14 inches: Very channery clay loam
14 to 18 inches: Unweathered bedrock

Description of Badland

Setting

Landform: Ridges on structural benches
Landform position (three-dimensional): Nose slope
Down-slope shape: Convex
Across-slope shape: Convex

Data Source Information

Soil Survey Area: San Juan County, Utah, Central Part
Survey Area Data: Version 7, Oct 6, 2010

San Juan County, Utah, Central Part

61—Skos-Rock outcrop complex

Map Unit Setting

Elevation: 4,700 to 6,600 feet
Mean annual precipitation: 8 to 12 inches
Mean annual air temperature: 49 to 54 degrees F
Frost-free period: 140 to 160 days

Map Unit Composition

Skos and similar soils: 80 percent
Rock outcrop: 10 percent

Description of Skos

Setting

Landform: Structural benches, breaks
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Colluvium derived from interbedded sandstone and shale and/or residuum weathered from interbedded sandstone and shale

Properties and qualities

Slope: 4 to 30 percent
Depth to restrictive feature: 4 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Very low (about 0.6 inches)

Interpretive groups

Land capability (nonirrigated): 7s
Ecological site: Semidesert Shallow Sandy Loam (Shadscale) (R035XY230UT)

Typical profile

0 to 3 inches: Channery sandy loam
3 to 6 inches: Very channery sandy clay loam
6 to 10 inches: Unweathered bedrock

Description of Rock Outcrop

Setting

Landform: Cliffs, ledges

Data Source Information

Soil Survey Area: San Juan County, Utah, Central Part
Survey Area Data: Version 7, Oct 6, 2010

Appendix B
Peak Discharge Estimate Calculation Brief for Daneros Portal Area

CDM

PROJECT:	Daneros Site	COMPUTED BY :	Eom M.	CHECKED BY:	
JOB NO.:		DATE :	8/1/2013	DATE CHECKED:	
CLIENT:	Denison Mine			PAGE NO. :	1 of 2

Description: These sheets show the calculation of time of concentration for the subwatersheds listed, as described in USDA Natural Resources Conservation Service - Construction and Engineering Division Technical Release 55

Basin 1

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: Group B (55%) and Group D (45%)

P 100 yr 24 hr (in)	2.8	
P 2yr 24hr (in)	1.24	
CN	82	(for desert shrub, poor hydrologic condition, average ARC, and HSG of B (55%) and D (45%); weighted average)
S	2.195	
Q (inches) eq 2-3	1.22	

TR-55 Time of Concentration

Sheet Flow		Shallow Conc Flow		
n	0.4	s (ft/ft)	0.19	
L (ft)	300	L (ft)	150	
P 2yr 24hr (in)	1.24	V (ft/s)	7	(Figure 3-1)
s (ft/ft)	0.19			
Tt (hr)	0.56	Tt (hr)	0.01	

Tc (hr)	0.57	
Am (drainage area, mi2)	0.0042	2.67 ac
Q (runoff, in)	1.22	
Ia (Table 4-1)	0.439	
Ia/P	0.16	
qu (csm/in) (Exhibit 4-II)	470	
Peak discharge (cfs), eq 4-1	2.4	

Basin 2

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: Group B (55%) and Group D (45%)

P 100 yr 24 hr (in)	2.8	
CN	90	(for newly graded areas, average ARC, and HSG of B (55%) and D (45%); weighted average)
S	1.111	
Q (inches) eq 2-3	1.80	

TR-55 Time of Concentration

Sheet Flow		Shallow Conc Flow		
n	0.4	s (ft/ft)	0.31	
L (ft)	300	L (ft)	310	
P 2yr 24hr (in)	1.24	V (ft/s)	9	(Figure 3-1)
s (ft/ft)	0.31			
Tt (hr)	0.46	Tt (hr)	0.01	

Tc (hr)	0.47	
Am (drainage area, mi2)	0.0053	3.40 ac
Q (runoff, in)	1.80	
Ia (Table 4-1)	0.222	
Ia/P	0.08	
qu (csm/in) (Exhibit 4-II)	550	
Peak discharge (cfs), eq 4-1	5.3	

Source: USDA NRCS TR-55

CDM

PROJECT:	Daneros Site	COMPUTED BY :	Eom M.	CHECKED BY:	Christine M.
JOB NO.:		DATE :	8/1/2013	DATE CHECKED:	12/12/2011
CLIENT:	Denison Mine			PAGE NO. :	2 of 2

Basin 3

Assumptions:

-100 yr-24hr preciptation at Daneros Mine site = 2.80 in

-Soil type: Group B (55%) and Group D (45%)

P 100 yr 24 hr (in)	2.8	
CN	90	(for newly graded areas, average ARC, and HSG of B (55%) and D (45%); weighted average)
S	1.111	
Q (inches) eq 2-3	1.80	

Source: USDA NRCS TR-55

Appendix C
Peak Discharge Estimate Calculation Brief for Bullseye Portal Area

CDM Smith

CDM

PROJECT:	Bullseye Site	COMPUTED BY :	Eom M.	CHECKED BY:	Christine M.
JOB NO.:		DATE :	12/9/2011	DATE CHECKED:	12/12/2011
CLIENT:	Denison Mine			PAGE NO. :	1 of 2

Description: These sheets show the calculation of time of concentration for the subwatersheds listed, as described in USDA Natural Resources Conservation Service - Construction and Engineering Division Technical Release 55

Basin 1

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: Group B (55%) and Group D (45%)

P 100 yr 24 hr (in)	2.8	
P 2yr 24hr (in)	1.24	
CN	82	(for desert shrub, poor hydrologic condition, average ARC, and HSG of B (55%) and D (45%); weighted average)
S	2.195	
Q (inches) eq 2-3	1.22	

TR-55 Time of Concentration

Sheet Flow		Shallow Conc Flow		
n	0.4	s (ft/ft)	0.40	
L (ft)	300	L (ft)	342	
P 2yr 24hr (in)	1.24	V (ft/s)	3.2	(Figure 3-1)
s (ft/ft)	0.12			
Tt (hr)	0.68	Tt (hr)	0.03	

Tc (hr)	0.71	
Am (drainage area, mi2)	0.0040	2.55 ac
Q (runoff, in)	1.22	
Ia (Table 4-1)	0.439	
Ia/P	0.16	
qu (csm/in) (Exhibit 4-II)	425	
Peak discharge (cfs), eq 4-1	2.1	

Basin 2

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: Group B (55%) and Group D (45%)

P 100 yr 24 hr (in)	2.8	
P 2yr 24hr (in)	1.24	
CN	82	(for desert shrub, poor hydrologic condition, average ARC, and HSG of B (55%) and D (45%); weighted average)
S	2.195	
Q (inches) eq 2-3	1.22	

TR-55 Time of Concentration

Sheet Flow		Shallow Conc Flow		
n	0.4	s (ft/ft)	0.50	
L (ft)	300	L (ft)	544	
P 2yr 24hr (in)	1.24	V (ft/s)	3.6	(Figure 3-1)
s (ft/ft)	0.13			
Tt (hr)	0.65	Tt (hr)	0.04	

Tc (hr)	0.69	
Am (drainage area, mi2)	0.0030	1.91 ac
Q (runoff, in)	1.22	
Ia (Table 4-1)	0.439	
Ia/P	0.16	
qu (csm/in) (Exhibit 4-II)	425	
Peak discharge (cfs), eq 4-1	1.6	

Basin 3

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: Group B (55%) and Group D (45%)

P 100 yr 24 hr (in)	2.8	
P 2yr 24hr (in)	1.24	
CN	82	(for desert shrub, poor hydrologic condition, average ARC, and HSG of B (55%) and D (45%); weighted average)
S	2.195	
Q (inches) eq 2-3	1.22	

TR-55 Time of Concentration

Sheet Flow		Shallow Conc Flow		
n	0.4	s (ft/ft)	0.59	
L (ft)	300	L (ft)	126	
P 2yr 24hr (in)	1.24	V (ft/s)	4	(Figure 3-1)
s (ft/ft)	0.18			
Tt (hr)	0.58	Tt (hr)	0.01	

Tc (hr)	0.58	
Am (drainage area, mi2)	0.0018	1.12 ac
Q (runoff, in)	1.22	
Ia (Table 4-1)	0.439	
Ia/P	0.16	
qu (csm/in) (Exhibit 4-II)	470	
Peak discharge (cfs), eq 4-1	1.0	

Basin 4

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: Group B (55%) and Group D (45%)

P 100 yr 24 hr (in)	2.8	
CN	90	(for newly graded areas, average ARC, and HSG of B (55%) and D (45%); weighted average)
S	1.111	
Q (inches) eq 2-3	1.80	

Basin 5

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: Group B (55%) and Group D (45%)

P 100 yr 24 hr (in)	2.8	
CN	90	(for newly graded areas, average ARC, and HSG of B (55%) and D (45%); weighted average)
S	1.111	
Q (inches) eq 2-3	1.80	

Source: USDA NRCS TR-55

Appendix D
Peak Discharge Estimate Calculation Brief for South Portal Area

CDM Smith

CDM			
PROJECT: South Site	COMPUTED BY : Eom M.	CHECKED BY:	
JOB NO.:	DATE : 8/1/2013	DATE CHECKED:	
CLIENT: Denison Mine		PAGE NO. : 1 of 2	

Description: These sheets show the calculation of time of concentration for the subwatersheds listed, as described in USDA Natural Resources Conservation Service - Construction and Engineering Division Technical Release 55

Basin 1

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: 61 - rate of water transmission: moderately low to moderately high (0.06 to 0.20 in/hr) --> Group C

P 100 yr 24 hr (in)	2.8	
P 2yr 24hr (in)	1.24	
CN	85	(for desert shrub, poor hydrologic condition, average ARC, and HSG of C)
S	1.765	
Q (inches) eq 2-3	1.42	

TR-55 Time of Concentration

Sheet Flow

n	0.4	
L (ft)	270	
P 2yr 24hr (in)	1.24	
s (ft/ft)	0.22	
Tt (hr)	0.49	
Tc (hr)	0.49	
Am (drainage area, mi2)	0.0016	1.03 ac
Q (runoff, in)	1.42	
Ia (Table 4-1)	0.353	
Ia/P	0.13	
qu (csm/in) (Exhibit 4-II)	540	
Peak discharge (cfs), eq 4-1	1.2	

Basin 2a

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: 61 - rate of water transmission: moderately low to moderately high (0.06 to 0.20 in/hr) --> Group C

P 100 yr 24 hr (in)	2.8	
P 2yr 24hr (in)	1.24	
CN	85	(for desert shrub, poor hydrologic condition, average ARC, and HSG of C)
S	1.765	
Q (inches) eq 2-3	1.42	

TR-55 Time of Concentration

Sheet Flow			Shallow Conc Flow		
n	0.4		s (ft/ft)	0.20	
L (ft)	300		L (ft)	1276	
P 2yr 24hr (in)	1.24		V (ft/s)	7.25	(Figure 3-1)
s (ft/ft)	0.33				
Tt (hr)	0.45		Tt (hr)	0.05	
Tc (hr)	0.50				
Am (drainage area, mi2)	0.0223	14.27 ac			
Q (runoff, in)	1.42				
Ia (Table 4-1)	0.353				
Ia/P	0.13				
qu (csm/in) (Exhibit 4-II)	540				
Peak discharge (cfs), eq 4-1	17.1				

Source: USDA NRCS TR-55

Basin 2b

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: 61 - rate of water transmission: moderately low to moderately high (0.06 to 0.20 in/hr) --> Group C

P 100 yr 24 hr (in)	2.8	
P 2yr 24hr (in)	1.24	
CN	85	(for desert shrub, poor hydrologic condition, average ARC, and HSG of C)
S	1.765	
Q (inches) eq 2-3	1.42	

TR-55 Time of Concentration

Sheet Flow

n	0.4
L (ft)	202
P 2yr 24hr (in)	1.24
s (ft/ft)	0.22
Tt (hr)	0.38
Tc (hr)	0.38

Am (drainage area, mi2)	0.0010	0.65 ac
Q (runoff, in)	1.42	
Ia (Table 4-1)	0.353	
Ia/P	0.13	
qu (csm/in) (Exhibit 4-II)	600	
Peak discharge (cfs), eq 4-1	0.9	

Basin 2c

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: 61 - rate of water transmission: moderately low to moderately high (0.06 to 0.20 in/hr) --> Group C

P 100 yr 24 hr (in)	2.8	
P 2yr 24hr (in)	1.24	
CN	85	(for desert shrub, poor hydrologic condition, average ARC, and HSG of C)
S	1.765	
Q (inches) eq 2-3	1.42	

TR-55 Time of Concentration

Sheet Flow		Shallow Conc Flow		
n	0.4	s (ft/ft)	0.12	
L (ft)	300	L (ft)	500	
P 2yr 24hr (in)	1.24	V (ft/s)	7.25	(Figure 3-1)
s (ft/ft)	0.20			
Tt (hr)	0.55	Tt (hr)	0.02	
Tc (hr)	0.57			

Am (drainage area, mi2)	0.0076	4.87 ac
Q (runoff, in)	1.42	
Ia (Table 4-1)	0.353	
Ia/P	0.13	
qu (csm/in) (Exhibit 4-II)	490	
Peak discharge (cfs), eq 4-1	5.3	

Source: USDA NRCS TR-55

Basin 3

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: 61 - rate of water transmission: moderately low to moderately high (0.06 to 0.20 in/hr) --> Group C

P 100 yr 24 hr (in)	2.8	
P 2yr 24hr (in)	1.24	
CN	91	(for newly graded areas, average ARC, and HSG of C)
S	0.989	
Q (inches) eq 2-3	1.89	

TR-55 Time of Concentration

Sheet Flow

n	0.4	
L (ft)	127	
P 2yr 24hr (in)	1.24	
s (ft/ft)	0.39	
Tt (hr)	0.21	
Tc (hr)	0.21	
Am (drainage area, mi2)	0.0049	3.14 ac
Q (runoff, in)	1.89	
Ia (Table 4-1)	0.353	
Ia/P	0.13	
qu (csm/in) (Exhibit 4-II)	790	
Peak discharge (cfs), eq 4-1	7.3	

Source: USDA NRCS TR-55

Basin 4, 5, 6

Assumptions:
-100 yr-24hr preciptation at Daneros Mine site = 2.80 in
-Soil type: 61 - rate of water transmission: moderately low to moderately high (0.06 to 0.20 in/hr) --> Group C

P 100 yr 24 hr (in)	2.8	
CN	91	(for newly graded areas, average ARC, and HSG of A)
S	0.989	
Q (inches) eq 2-3	1.89	

Source: USDA NRCS TR-55

Appendix E
Culvert Sizing Calculation for South Portal Area

Worksheet for Basin 3_West

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.06250	ft/ft
Normal Depth	1.17	ft
Diameter	1.17	ft
Discharge	7.30	ft³/s

Results

Diameter	1.17	ft
Normal Depth	1.17	ft
Flow Area	1.07	ft²
Wetted Perimeter	3.67	ft
Hydraulic Radius	0.29	ft
Top Width	0.00	ft
Critical Depth	1.07	ft
Percent Full	100.0	%
Critical Slope	0.05443	ft/ft
Velocity	6.81	ft/s
Velocity Head	0.72	ft
Specific Energy	1.89	ft
Froude Number	0.00	
Maximum Discharge	7.85	ft³/s
Discharge Full	7.30	ft³/s
Slope Full	0.06250	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Worksheet for Basin 3_West

GVF Output Data

Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.17	ft
Critical Depth	1.07	ft
Channel Slope	0.06250	ft/ft
Critical Slope	0.05443	ft/ft

Worksheet for Basin 3_East

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.04700	ft/ft
Normal Depth	1.90	ft
Diameter	1.90	ft
Discharge	23.30	ft³/s

Results

Diameter	1.90	ft
Normal Depth	1.90	ft
Flow Area	2.85	ft²
Wetted Perimeter	5.98	ft
Hydraulic Radius	0.48	ft
Top Width	0.00	ft
Critical Depth	1.71	ft
Percent Full	100.0	%
Critical Slope	0.04149	ft/ft
Velocity	8.18	ft/s
Velocity Head	1.04	ft
Specific Energy	2.94	ft
Froude Number	0.00	
Maximum Discharge	25.06	ft³/s
Discharge Full	23.30	ft³/s
Slope Full	0.04700	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Worksheet for Basin 3_East

GVF Output Data

Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.90	ft
Critical Depth	1.71	ft
Channel Slope	0.04700	ft/ft
Critical Slope	0.04149	ft/ft

Worksheet for Div Chan 2&3

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.10000	ft/ft
Normal Depth	1.13	ft
Diameter	1.13	ft
Discharge	8.50	ft³/s

Results

Diameter	1.13	ft
Normal Depth	1.13	ft
Flow Area	1.01	ft²
Wetted Perimeter	3.56	ft
Hydraulic Radius	0.28	ft
Top Width	0.00	ft
Critical Depth	1.09	ft
Percent Full	100.0	%
Critical Slope	0.08720	ft/ft
Velocity	8.44	ft/s
Velocity Head	1.11	ft
Specific Energy	2.24	ft
Froude Number	0.00	
Maximum Discharge	9.14	ft³/s
Discharge Full	8.50	ft³/s
Slope Full	0.10000	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Worksheet for Div Chan 2&3

GVF Output Data

Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.13	ft
Critical Depth	1.09	ft
Channel Slope	0.10000	ft/ft
Critical Slope	0.08720	ft/ft