Attachment R

100-Year Flood Evaluation

Weaver Consultants Group

7340 E. CALEY AVENUE, SUITE 110
CENTENNIAL, COLORADO 80111
PHONE: (720) 529-0132
FAX: (720) 529-0137

MEMORANDUM

To: Mike Neumann *(via email)*
Energy Fuels Resources (USA) Inc.

Date: June 1, 2016

From: Ryan Ellis, P.E. RE
Weaver Consultants Group

Project #: 4275-548-34-00-02

Re: 100-Year Floodplain Analysis
Daneros Mine

As the Daneros Mine has progressed through the environmental assessment process with the Bureau of Land Management, Energy Fuels Resources (USA) Inc. (EFR) determined that there was a need to evaluate the extent of the floodplain caused by the base flood event (100-year, 24-hour) within Bullseye Canyon. EFR requested that Weaver Consultants Group (WCG) conduct this evaluation within Bullseye Canyon adjacent to the existing and planned facilities associated with the Daneros Mine.

BACKGROUND

There are three portal areas planned at the Daneros Mine, including Daneros, Bullseye, and the South Portal Areas. These areas were included in the 2014 Drainage Report prepared by CDM Smith, which evaluated the onsite stormwater controls needed to contain and pass the stormwater flows resulting from the 100-year storm event. EFR requested that WCG delineate the floodplain resulting from the base flood within Bullseye Canyon to help refine their facility designs. WCG utilized the United States Department of Agriculture's (USDA) Urban Hydrology for Small Watersheds – TR-55 method for establishing the peak flow within Bullseye Canyon.

PEAK FLOW DETERMINATION

Basin Area (Am) – The drainage basin was delineated using the United States Geological Survey (USGS) Quad map as well as an aerial image. The resulting area is 2,185 acres or 3.41 square miles.

Time of Concentration (Tc) – The Tc was calculated using the two main branches of Bullseye Canyon. The longest reach resulted in a Tc of 0.76 hours. The next longest reach resulted in a Tc of 0.48 hours. The Tc of 0.48 hours was selected because it was more representative of the typical start of the drainage basin and is a more conservative approach.

Curve Number (CN) – The soils within the drainage basin are categorized by the USDA and are available electronically through the Web Soil Survey (http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx).

The Web Soil Survey specifies the soil types, percent of the drainage basin, and hydraulic soil condition for the soils found within the drainage basin. This information is not based on site specific testing. The Web Soil Survey output is presented in Attachment A. These soil definitions along with Table 2-2a and 2-2d from the TR-55 manual were used to define the CN for the drainage basin. A CN of 88 was selected based on weighted average percentage of soils with Type A, B, and D hydrologic soil group classification and the cover type. The cover type selected was a combination of bare ground and desert shrub with poor ground cover. All the tables used from the TR-55 Manual are presented in Attachment B.

Precipitation (P) – The precipitation quantity for the 100-year, 24-hour event for the area of the Daneros Mine is 2.80 inches. This was obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 website. The precipitation data is presented in Attachment C.

Ponding Factor (Fp) – A ponding factor of 1.0 was used since there are no known ponds within the drainage basin.

Initial Abstraction (Ia) – Using the CN of 88 and Table 4-1 from TR-55, the Ia is 0.237. Ia/p was computed to be 0.085

Unit Peak Discharge (Qu) – The qu value of 550 was selected using the CN and Ia/P from Exhibit 4-II.

Runoff (Q) – Runoff was interpolated to be 1.65 inches from Table 2-1 using the rainfall and CN.

Peak Discharge (Qp) – The Peak Discharge Qp, measured in cubic feet per second (CFS), was calculated using the formula:

Qp = Qu * Am * Q * Fp.

The result is **3,100 CFS** = 550 * 3.41 square miles * 1.65 inches * 1.0

FLOODPLAIN DELINEATION

As part of this floodplain delineation effort, Bullseye Canyon was surveyed within the area of the Daneros Portal Area and the Bullseye Portal Area. Six cross sections selected near each portal area were used to delineate the boundaries of the floodplain. These cross sections are shown in the attached figures. The Manning's equation was used to define the flow depth and velocity at each of the 12 cross sections caused by a peak flow of 3,100 CFS. Once the flow depth was determined for each cross section, the boundaries were interpolated between each cross section to delineate a continuous floodplain near each portal area.

CHANNEL ASSUMPTIONS

Wetted Perimeter and Area – These parameters were measured in AutoCAD from the current survey of the channel. Iterations were calculated to arrive at the correct channel depth and peak flow of 3,100 CFS.

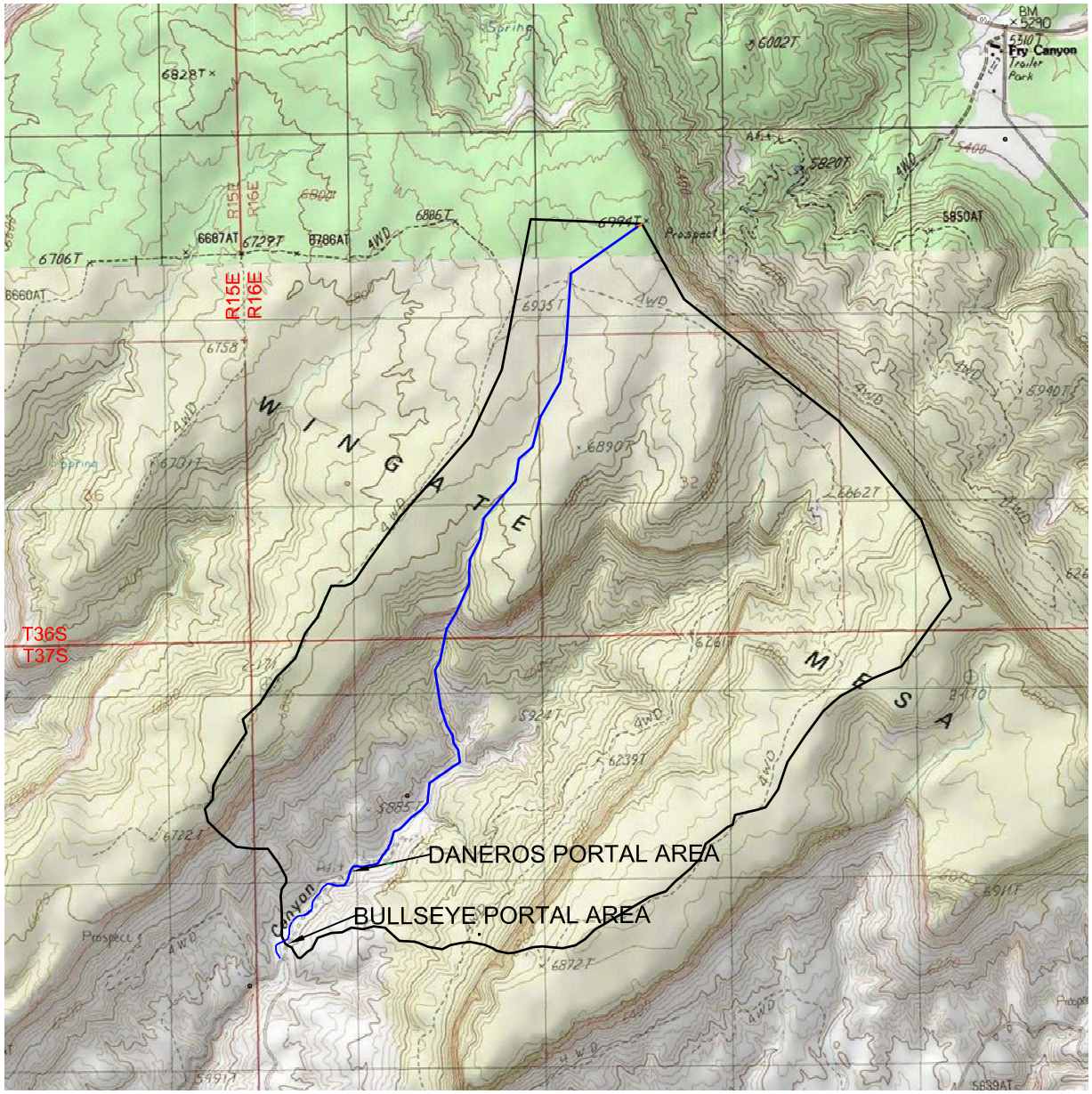
Manning's Roughness coefficient (N) – There are segments within the Bullseye Canyon that range from 0.04 to 0.07 depending on the concentration of boulders. The Manning's N value of 0.07 was selected based on the fact that the location of the boulders will change, and it is possible for any reach to have that roughness at some point in the future. This future condition also assumes no channel maintenance. This is a conservative approach since the channel roughness is varied and there are segments that will be lower than a 0.07 roughness factor.

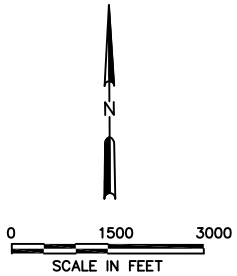
Channel Slope – The slope was measured for each of the 12 cross sections from the surveyed topography within the channel. The slopes varied from 0.019 to 0.057 ft/ft.

If you should have any questions or require additional information, please do not hesitate to contact us.

Attachments

FIGURES





LEGEND:

BULLSEYE CANYON DRIANAGE

DRAINAGE BASIN (3.41 SQUARE MILES)

☐ DRAFT
☒ FOR PERMITTING PURPOSES ONLY
☐ ISSUED FOR CONSTRUCTION

PREPARED FOR
ENERGY FUELS RESOURCES (USA) INC.

DATE: 5/2016
FILE: 3401-661-34-34-00
CAD: FLOODPLAIN ANALYSIS.DWG

DRAWN BY: RE
DESIGN BY: RE
REVIEWED BY: DO

REVISIONS

NO.	DATE	DESCRIPTION
1	6/1/2016	ISSUED FOR PERMIT

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

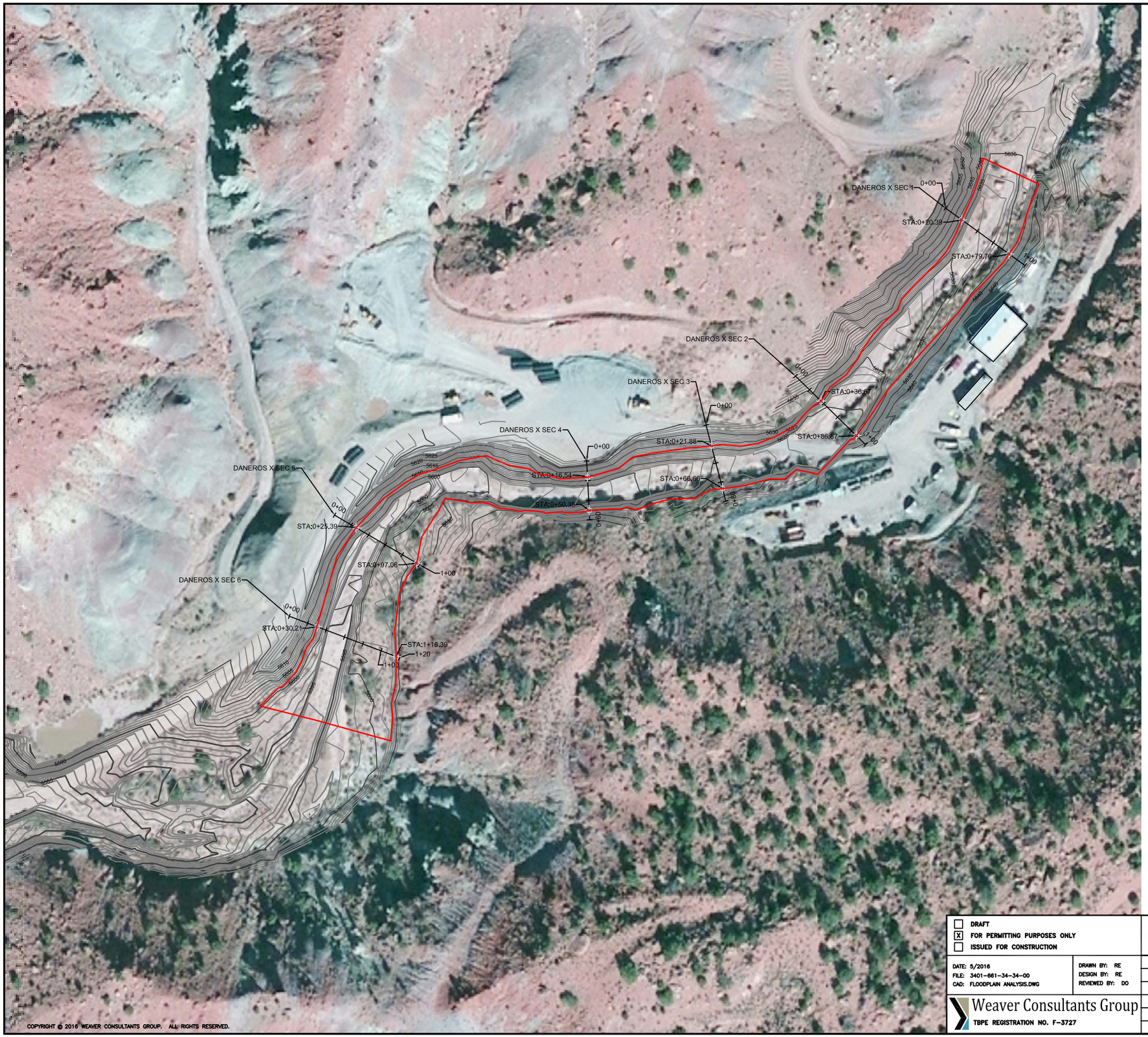
DRAINAGE BASIN

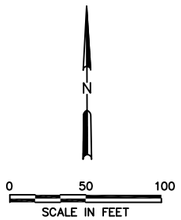
DANEROS MINE
SAN JUAN COUNTY, UTAH

WWW.WCGRP.COM

FIGURE 1

g:\projects\energy fuels\daneros\floodplain\2016\floodplain analysis_recover.dwg figure 1 rellis





LEGEND:

- EXISTING 5' CONTOUR
- EXISTING 1' CONTOUR
- 100-YEAR FLOODPLAIN
- CHANNEL CROSS SECTION (0+00 – 1+00)

COPYRIGHT © 2016 WEAVER CONSULTANTS GROUP. ALL RIGHTS RESERVED.

g:\projects\energy fuels\daneros\floodplain\2016\floodplain analysis_recover.dwg figure 2 reils

- [ ] DRAFT
- [x] FOR PERMITTING PURPOSES ONLY
- [ ] ISSUED FOR CONSTRUCTION

DATE: 5/2016
FILE: 3401-661-34-34-00
CAD: FLOODPLAIN ANALYSIS.DWG

DRAWN BY: RE
DESIGN BY: RE
REVIEWED BY: DO

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
ENERGY FUELS RESOURCES (USA) INC.

REVISIONS

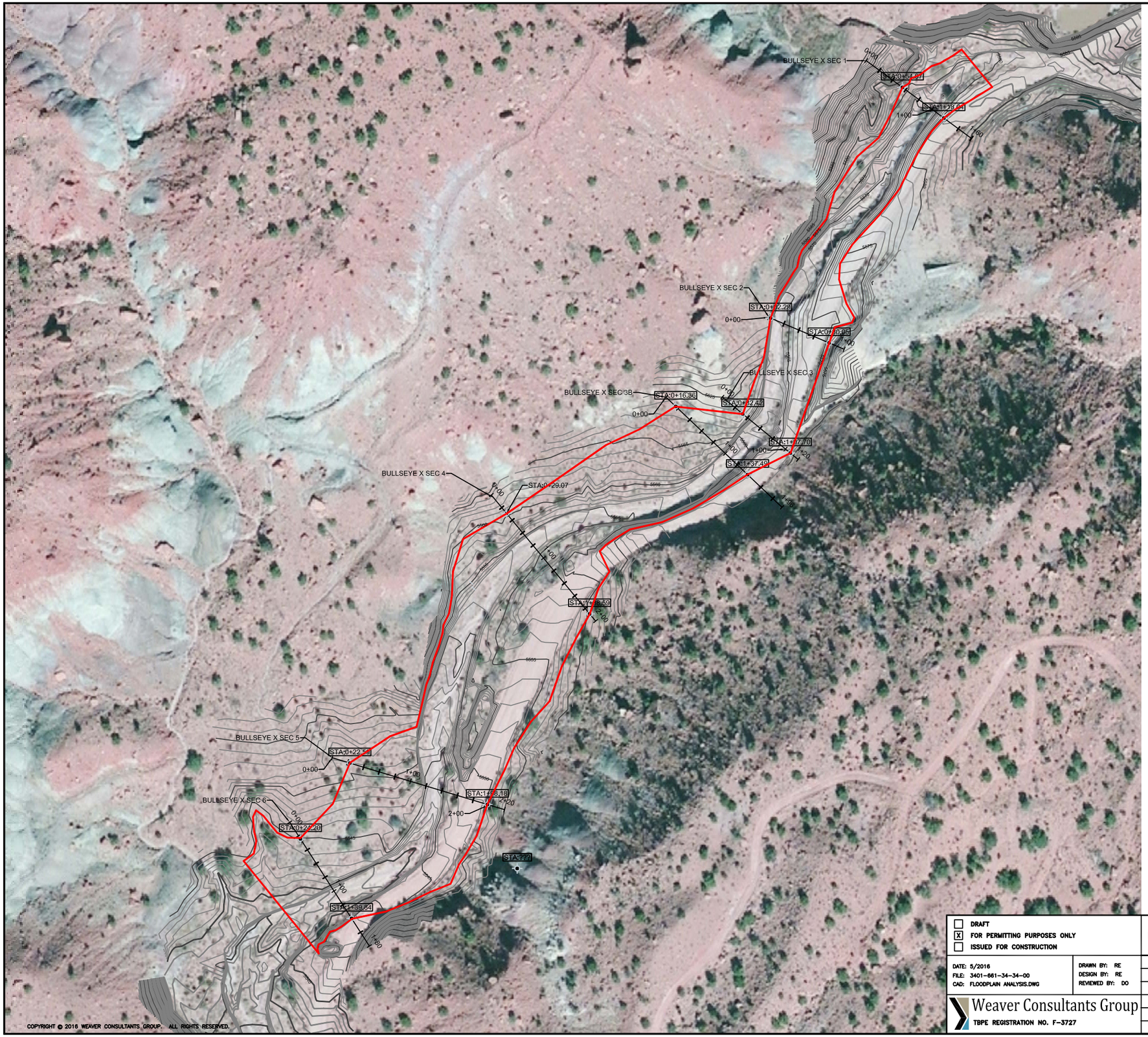
NO.	DATE	DESCRIPTION
1	6/1/2016	ISSUED FOR PERMIT

DANEROS PORTAL AREA
SITE PLAN

DANEROS MINE
SAN JUAN COUNTY, UTAH

WWW.WCGRP.COM

FIGURE 2



COPYRIGHT © 2016 WEAVER CONSULTANTS GROUP. ALL RIGHTS RESERVED.

N

0 60 120
SCALE IN FEET

LEGEND:

2920 — EXISTING 5' CONTOUR

EXISTING 1' CONTOUR

100-YEAR FLOODPLAIN

0+00 1+00 — CHANNEL CROSS SECTION

- [ ] DRAFT
- [x] FOR PERMITTING PURPOSES ONLY
- [ ] ISSUED FOR CONSTRUCTION

DATE: 5/2016
FILE: 3401-661-34-34-00
CAD: FLOODPLAIN ANALYSIS.DWG

DRAWN BY: RE
DESIGN BY: RE
REVIEWED BY: DO

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
ENERGY FUELS RESOURCES (USA) INC.

REVISIONS

NO.	DATE	DESCRIPTION
1	6/1/2016	ISSUED FOR PERMIT

BULLSEYE PORTAL AREA
SITE PLAN

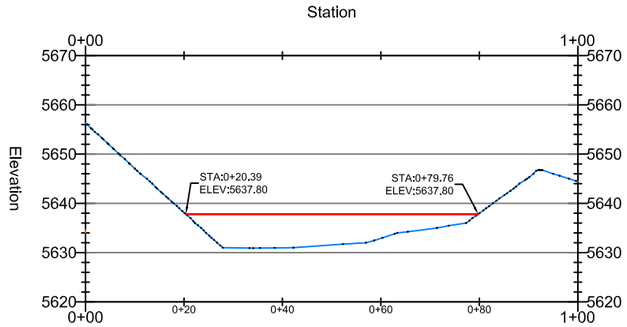
DANEROS MINE
SAN JUAN COUNTY, UTAH

WWW.WCGRP.COM

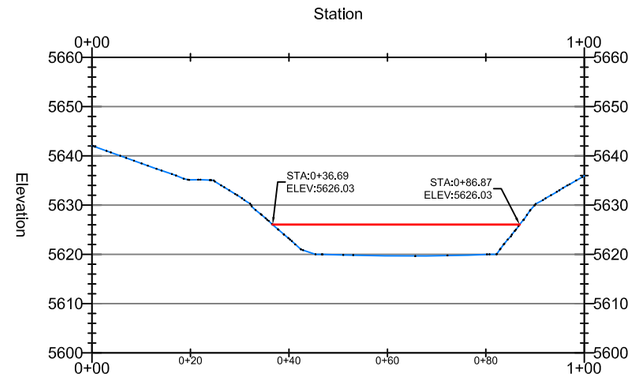
FIGURE 3

g:\projects\energy fuels\daneros\floodplain\2016\floodplain analysis_recover.dwg figure 3 reills

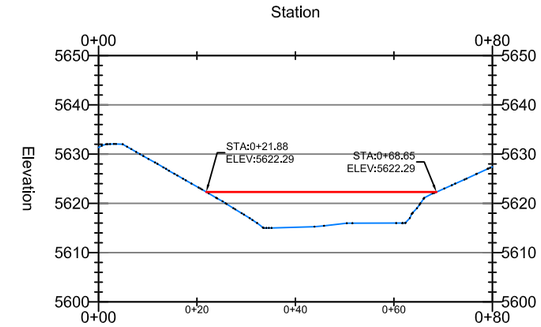
DANEROS X SEC 1



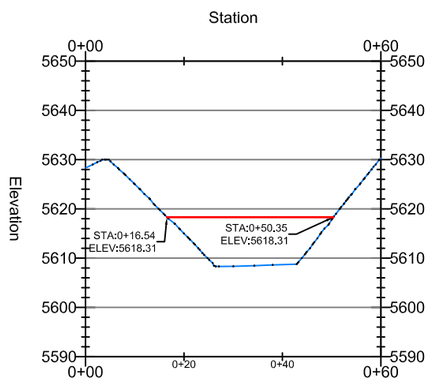
DANEROS X SEC 2



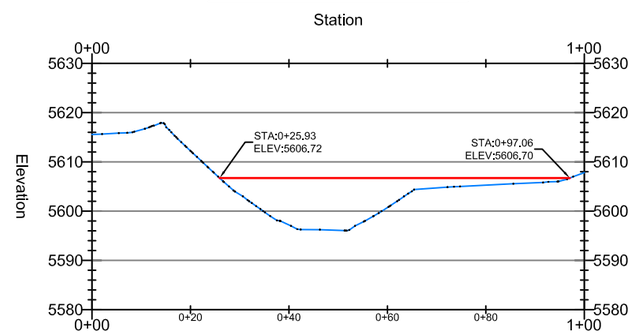
DANEROS X SEC 3



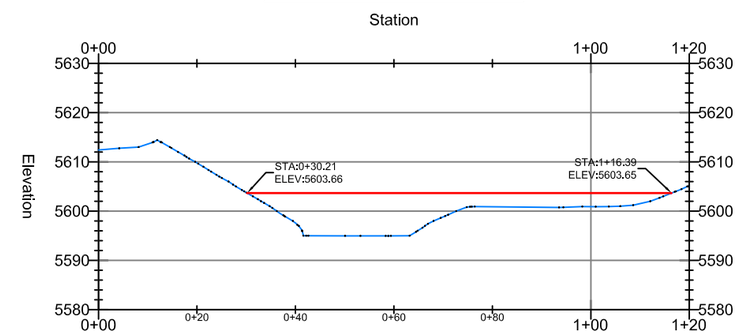
DANEROS X SEC 4



DANEROS X SEC 5



DANEROS X SEC 6



BASE FLOOD ELEVATION
100-YEAR 24 HOUR (3,100 CFS)

g:\projects\energy fuels\daneros\floodplain\2016\floodplain analysis_recover.dwg figure 4 rella

COPYRIGHT © 2016 WEAVER CONSULTANTS GROUP. ALL RIGHTS RESERVED.

- [ ] DRAFT
- [x] FOR PERMITTING PURPOSES ONLY
- [ ] ISSUED FOR CONSTRUCTION

DATE: 5/2016
FILE: 3401-661-34-34-00
CAD: FLOODPLAIN ANALYSIS.DWG

DRAWN BY: RE
DESIGN BY: RE
REVIEWED BY: DO

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
ENERGY FUELS RESOURCES (USA) INC.

REVISIONS

NO.	DATE	DESCRIPTION
1	6/1/2016	ISSUED FOR PERMIT

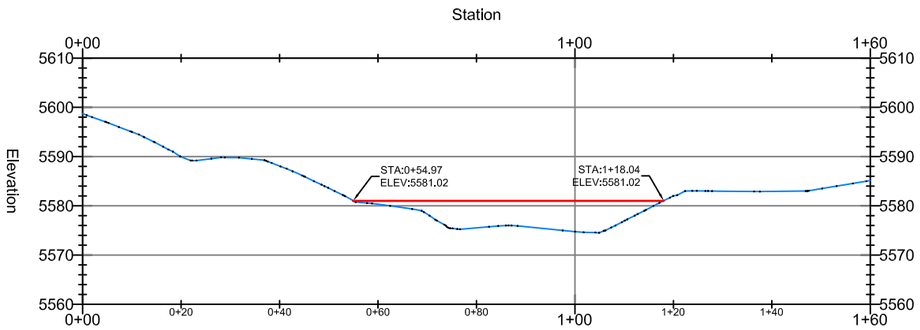
DANEROS PORTAL AREA
CROSS SECTIONS

DANEROS MINE
SAN JUAN COUNTY, UTAH

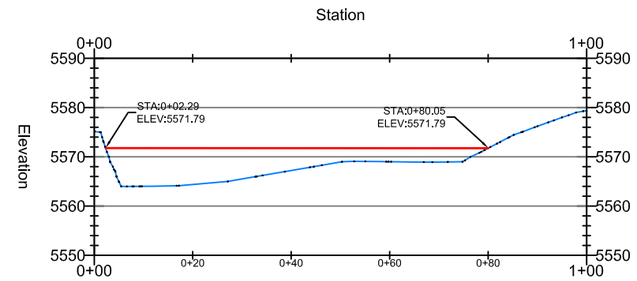
WWW.WCGRP.COM

FIGURE 4

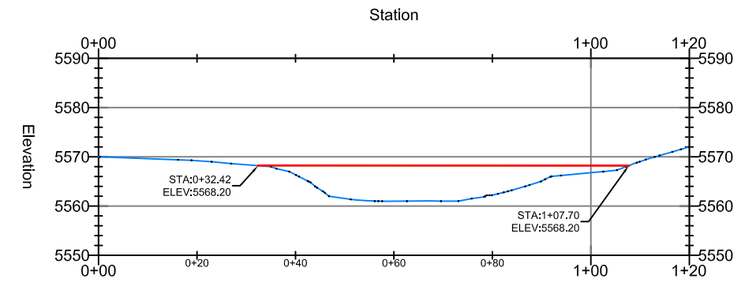
BULLSEYE X SEC 1



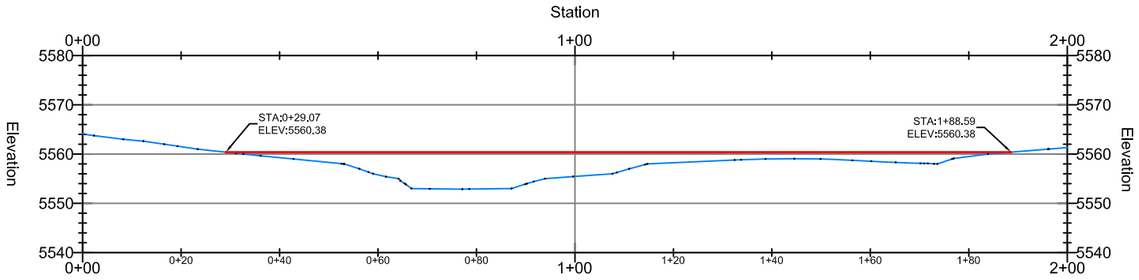
BULLSEYE X SEC 2



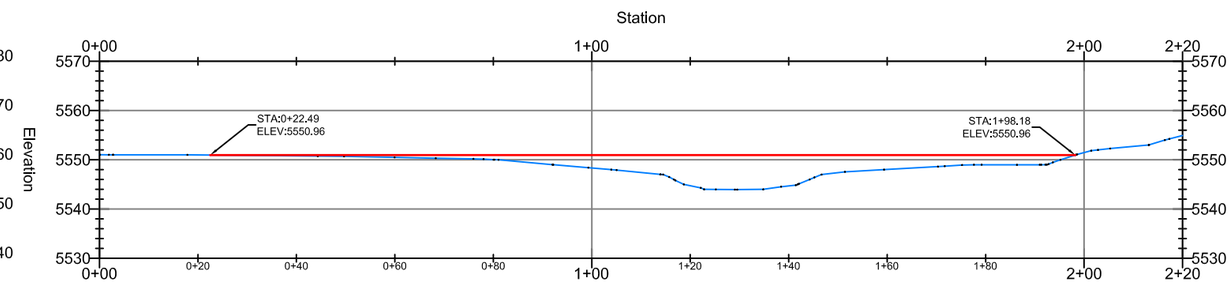
BULLSEYE X SEC 3



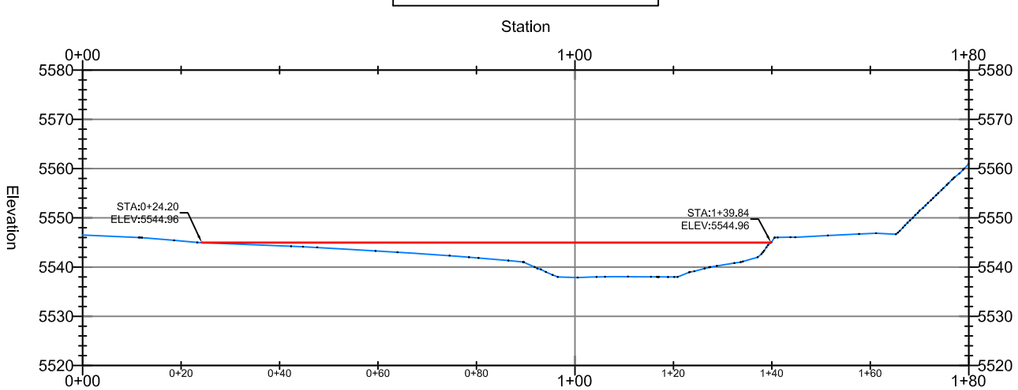
BULLSEYE X SEC 4



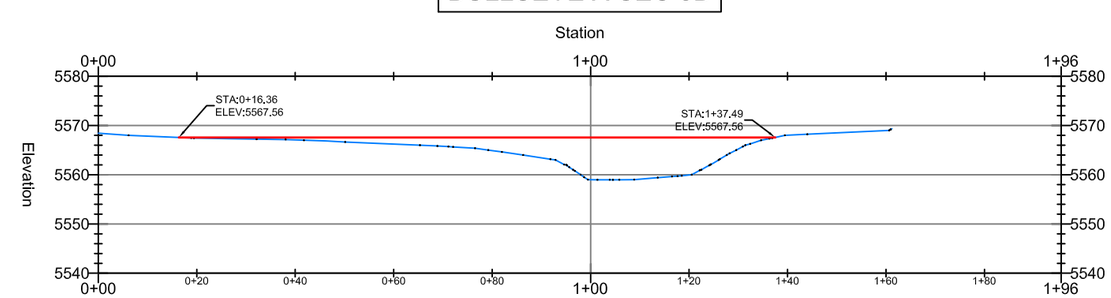
BULLSEYE X SEC 5



BULLSEYE X SEC 6



BULLSEYE X SEC 3B



BASE FLOOD ELEVATION
100-YEAR 24 HOUR (3,100 CFS)

- [ ] DRAFT
- [x] FOR PERMITTING PURPOSES ONLY
- [ ] ISSUED FOR CONSTRUCTION

DATE: 5/2016
FILE: 3401-661-34-34-00
CAD: FLOODPLAIN ANALYSIS.DWG

DRAWN BY: RE
DESIGN BY: RE
REVIEWED BY: DO

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
ENERGY FUELS RESOURCES (USA) INC.

REVISIONS

NO.	DATE	DESCRIPTION
1	6/1/2016	ISSUED FOR PERMIT

BULLSEYE PORTAL AREA
CROSS SECTIONS

DANEROS MINE
SAN JUAN COUNTY, UTAH

WWW.WCGRP.COM

FIGURE 5

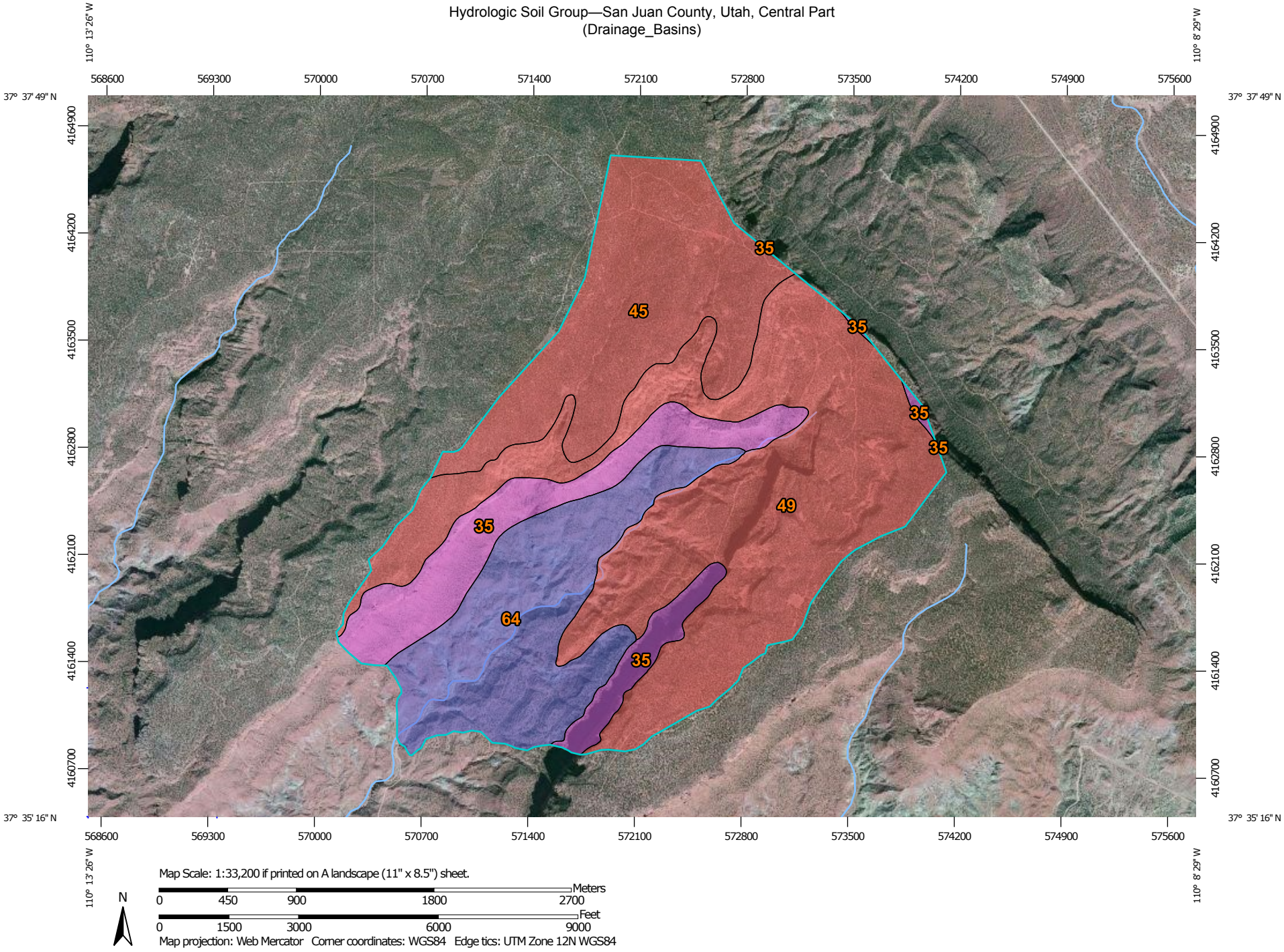
COPYRIGHT © 2016 WEAVER CONSULTANTS GROUP. ALL RIGHTS RESERVED.

g:\projects\energy fuels\daneros\floodplain\2016\floodplain analysis.dwg figure 5 rellis

ATTACHMENT A

WEB SOIL SURVEY OUTPUT

Hydrologic Soil Group—San Juan County, Utah, Central Part
(Drainage_Basins)



Map Scale: 1:33,200 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 450 900 1800 2700

Feet: 0 1500 3000 6000 9000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
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: San Juan County, Utah, Central Part
Survey Area Data: Version 11, Sep 28, 2015

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

Date(s) aerial images were photographed: Jun 16, 2010—Oct 13, 2010

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.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — San Juan County, Utah, Central Part (UT638)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
35	Myton family-Skos-Rock outcrop association	A	294.7	13.5%
45	Rizno-Barx-Yarts complex	D	491.9	22.5%
49	Rizno-Rock outcrop complex	D	963.6	44.1%
64	Strych-Skos-Badland complex	B	435.0	19.9%
Totals for Area of Interest			**2,185.2**	**100.0%**

Description

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 soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

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. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

ATTACHMENT B

TR-55 MANUAL TABLES

Table 2-1 Runoff depth for selected CN's and rainfall amounts [1/]

Rainfall	Runoff depth for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

[1/] Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown.

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1]

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

1 Average runoff condition, and I_a, = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

Chapter 4 Graphical Peak Discharge Method

This chapter presents the Graphical Peak Discharge method for computing peak discharge from rural and urban areas. The Graphical method was developed from hydrograph analyses using TR-20, "Computer Program for Project Formulation—Hydrology" (SCS 1983). The peak discharge equation used is:

$$q_p = q_u A_m Q F_p \qquad \text{[eq. 4-1]}$$

where:

q_p = peak discharge (cfs)
q_u = unit peak discharge (csm/in)
A_m = drainage area (mi^2)
Q = runoff (in)
F_p = pond and swamp adjustment factor

The input requirements for the Graphical method are as follows: (1) T_c (hr), (2) drainage area (mi^2), (3) appropriate rainfall distribution (I, IA, II, or III), (4) 24-hour rainfall (in), and (5) CN. If pond and swamp areas are spread throughout the watershed and are not considered in the T_c computation, an adjustment for pond and swamp areas is also needed.

Peak discharge computation

For a selected rainfall frequency, the 24-hour rainfall (P) is obtained from appendix B or more detailed local precipitation maps. CN and total runoff (Q) for the watershed are computed according to the methods outlined in chapter 2. The CN is used to determine the initial abstraction (I_a) from table 4-1. I_a / P is then computed.

If the computed I_a / P ratio is outside the range in exhibit 4 (4-I, 4-IA, 4-II, and 4-III) for the rainfall distribution of interest, then the limiting value should be used. If the ratio falls between the limiting values, use linear interpolation. Figure 4-1 illustrates the sensitivity of I_a / P to CN and P.

Peak discharge per square mile per inch of runoff (q_u) is obtained from exhibit 4-I, 4-IA, 4-II, or 4-III by using T_c (chapter 3), rainfall distribution type, and I_a / P ratio. The pond and swamp adjustment factor is obtained from table 4-2 (rounded to the nearest table value). Use worksheet 4 in appendix D to aid in computing the peak discharge using the Graphical method.

Figure 4-1 Variation of I_a / P for P and CN

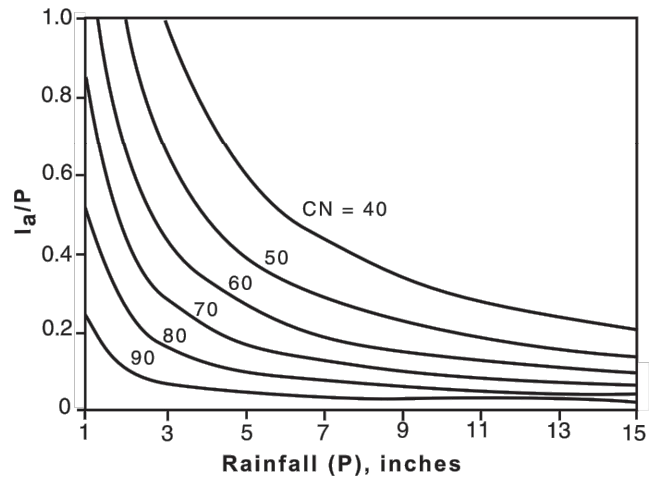
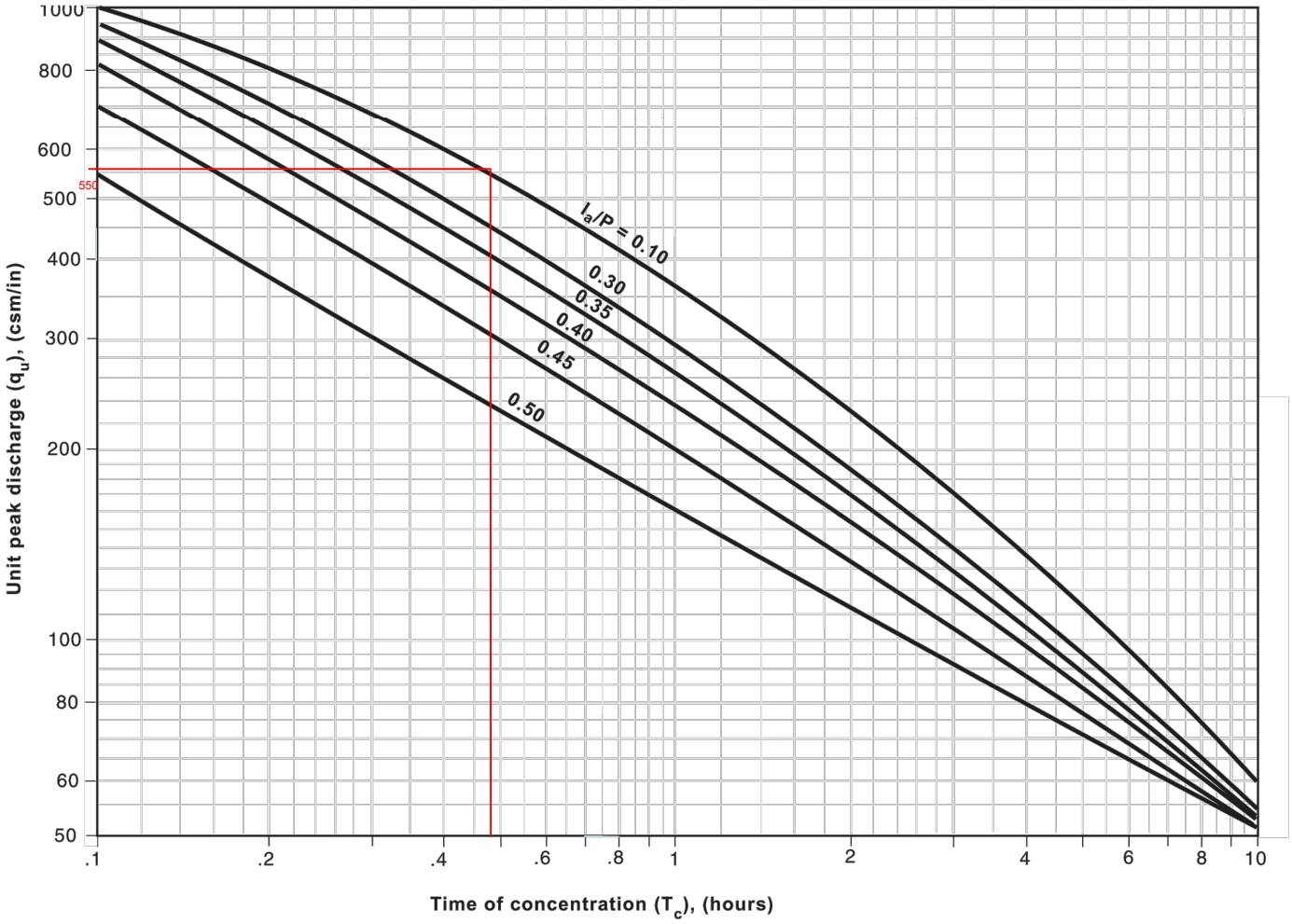


Table 4-1 I_a values for runoff curve numbers

Curve number	I_a (in)	Curve number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899		

Exhibit 4-II Unit peal discharge (q_u) for NRCS (SCS) type II rainfall distribution



Worksheet 4: Graphical Peak Discharge method

Project	Daneros Mine	By	Ryan Ellis	Date	6/10/16
Location	Bullseye Canyon	Checked	Dave O'Sadnik	Date	6/10/16

Check one: [X] Present [ ] Developed

1. Data

Drainage area ..... A_m = 3.41 mi^2 (acres/640)

Runoff curve number .....CN = 88 (From worksheet 2)

Time of concentration ..... T_c = 0.48 hr (From worksheet 3)

Rainfall distribution ..... = II (I, IA, II III)

Pond and swamp areas sprea
throughout watershed ..... = 0 percent of A_m (_____ acres or mi^2 covered)

	Storm #1	Storm #2	Storm #3
2. Frequency ..... yr	100		
3. Rainfall, P (24-hour) ..... in	2.8		
4. Initial abstraction, I_a ..... in (Use CN with table 4-1)	0.237		
5. Compute I_a/P	0.085		
6. Unit peak discharge, q_u ..... csm/in (Use T_c and I_a/P with exhibit 4– _____)	550		
7. Runoff, Q ..... in (From worksheet 2) Figure 2-6	1.65		
8. Pond and swamp adjustment factor, F_p ..... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)	1.0		
9. Peak discharge, q_p ..... ft^3/s	3,100		

(Where $q_p = q_u A_m Q F_p$)

ATTACHMENT C

PRECIPITATION DATA

NOAA Atlas 14, Volume 1, Version 5
Location name: Lake Powell, Utah, US*
Latitude: 37.5961°, Longitude: -110.1956°
Elevation: 5637 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

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	0.131 (0.114–0.153)	0.169 (0.147–0.198)	0.229 (0.199–0.267)	0.283 (0.244–0.332)	0.365 (0.310–0.432)	0.436 (0.366–0.518)	0.518 (0.429–0.624)	0.612 (0.498–0.751)	0.758 (0.597–0.955)	0.889 (0.684–1.15)
10-min	0.198 (0.173–0.232)	0.257 (0.224–0.301)	0.349 (0.303–0.407)	0.431 (0.372–0.506)	0.555 (0.473–0.657)	0.664 (0.558–0.789)	0.788 (0.653–0.949)	0.931 (0.758–1.14)	1.15 (0.909–1.45)	1.35 (1.04–1.75)
15-min	0.246 (0.214–0.288)	0.319 (0.278–0.373)	0.432 (0.375–0.504)	0.534 (0.461–0.627)	0.688 (0.586–0.814)	0.823 (0.691–0.978)	0.977 (0.810–1.18)	1.16 (0.939–1.42)	1.43 (1.13–1.80)	1.68 (1.29–2.17)
30-min	0.332 (0.288–0.388)	0.429 (0.374–0.501)	0.582 (0.505–0.679)	0.719 (0.620–0.844)	0.926 (0.789–1.10)	1.11 (0.931–1.32)	1.32 (1.09–1.59)	1.56 (1.27–1.91)	1.93 (1.52–2.43)	2.26 (1.74–2.93)
60-min	0.410 (0.356–0.480)	0.531 (0.463–0.621)	0.721 (0.625–0.841)	0.890 (0.768–1.05)	1.15 (0.977–1.36)	1.37 (1.15–1.63)	1.63 (1.35–1.96)	1.92 (1.57–2.36)	2.38 (1.88–3.00)	2.80 (2.15–3.62)
2-hr	0.493 (0.433–0.568)	0.625 (0.549–0.720)	0.842 (0.737–0.969)	1.04 (0.898–1.19)	1.34 (1.14–1.54)	1.61 (1.35–1.86)	1.92 (1.58–2.23)	2.30 (1.83–2.69)	2.88 (2.21–3.44)	3.41 (2.53–4.14)
3-hr	0.545 (0.488–0.619)	0.688 (0.611–0.784)	0.901 (0.799–1.02)	1.09 (0.958–1.24)	1.39 (1.20–1.57)	1.65 (1.41–1.88)	1.97 (1.65–2.25)	2.34 (1.92–2.70)	2.92 (2.32–3.47)	3.45 (2.66–4.18)
6-hr	0.679 (0.617–0.757)	0.847 (0.766–0.944)	1.07 (0.968–1.19)	1.27 (1.14–1.42)	1.57 (1.39–1.75)	1.82 (1.59–2.04)	2.12 (1.83–2.39)	2.49 (2.11–2.83)	3.08 (2.54–3.56)	3.60 (2.91–4.23)
12-hr	0.842 (0.765–0.931)	1.05 (0.956–1.17)	1.32 (1.19–1.46)	1.53 (1.38–1.70)	1.85 (1.65–2.05)	2.10 (1.86–2.33)	2.36 (2.08–2.64)	2.69 (2.33–3.03)	3.26 (2.77–3.71)	3.78 (3.17–4.35)
24-hr	0.984 (0.893–1.09)	1.24 (1.12–1.37)	1.57 (1.42–1.74)	1.84 (1.65–2.03)	2.21 (1.97–2.44)	2.49 (2.22–2.77)	2.80 (2.47–3.11)	3.12 (2.73–3.48)	3.56 (3.07–3.99)	3.91 (3.34–4.41)
2-day	1.16 (1.04–1.29)	1.46 (1.31–1.62)	1.84 (1.65–2.05)	2.16 (1.92–2.40)	2.61 (2.30–2.90)	2.96 (2.60–3.30)	3.34 (2.90–3.72)	3.73 (3.21–4.17)	4.28 (3.63–4.83)	4.72 (3.95–5.37)
3-day	1.26 (1.13–1.40)	1.59 (1.43–1.77)	2.01 (1.80–2.24)	2.36 (2.10–2.63)	2.84 (2.51–3.17)	3.22 (2.83–3.60)	3.63 (3.16–4.06)	4.05 (3.49–4.54)	4.64 (3.94–5.24)	5.11 (4.28–5.82)
4-day	1.37 (1.22–1.52)	1.72 (1.54–1.92)	2.18 (1.95–2.43)	2.56 (2.28–2.86)	3.08 (2.72–3.43)	3.49 (3.06–3.90)	3.92 (3.41–4.40)	4.37 (3.77–4.92)	5.00 (4.25–5.66)	5.50 (4.61–6.26)
7-day	1.59 (1.42–1.78)	2.01 (1.79–2.25)	2.55 (2.26–2.87)	2.99 (2.64–3.37)	3.61 (3.16–4.06)	4.09 (3.56–4.62)	4.60 (3.96–5.20)	5.14 (4.38–5.84)	5.88 (4.94–6.72)	6.47 (5.37–7.46)
10-day	1.78 (1.59–2.00)	2.24 (2.00–2.52)	2.85 (2.53–3.21)	3.32 (2.94–3.75)	3.97 (3.50–4.48)	4.48 (3.92–5.06)	5.01 (4.34–5.67)	5.55 (4.78–6.31)	6.30 (5.35–7.22)	6.89 (5.79–7.95)
20-day	2.27 (2.02–2.57)	2.87 (2.55–3.24)	3.64 (3.22–4.12)	4.24 (3.74–4.80)	5.07 (4.45–5.74)	5.72 (4.98–6.48)	6.38 (5.51–7.26)	7.07 (6.05–8.06)	8.01 (6.76–9.19)	8.75 (7.30–10.1)
30-day	2.77 (2.47–3.13)	3.50 (3.12–3.95)	4.41 (3.92–4.99)	5.11 (4.52–5.79)	6.06 (5.33–6.87)	6.79 (5.93–7.70)	7.53 (6.54–8.57)	8.29 (7.14–9.46)	9.29 (7.91–10.7)	10.1 (8.49–11.6)
45-day	3.32 (2.96–3.76)	4.20 (3.74–4.75)	5.28 (4.70–5.99)	6.12 (5.43–6.95)	7.26 (6.38–8.25)	8.13 (7.10–9.25)	9.03 (7.83–10.3)	9.95 (8.55–11.4)	11.2 (9.52–12.9)	12.2 (10.2–14.2)
60-day	3.83 (3.40–4.31)	4.84 (4.30–5.46)	6.08 (5.38–6.87)	7.03 (6.20–7.94)	8.28 (7.26–9.36)	9.22 (8.04–10.5)	10.2 (8.82–11.6)	11.2 (9.59–12.8)	12.5 (10.6–14.4)	13.5 (11.4–15.6)

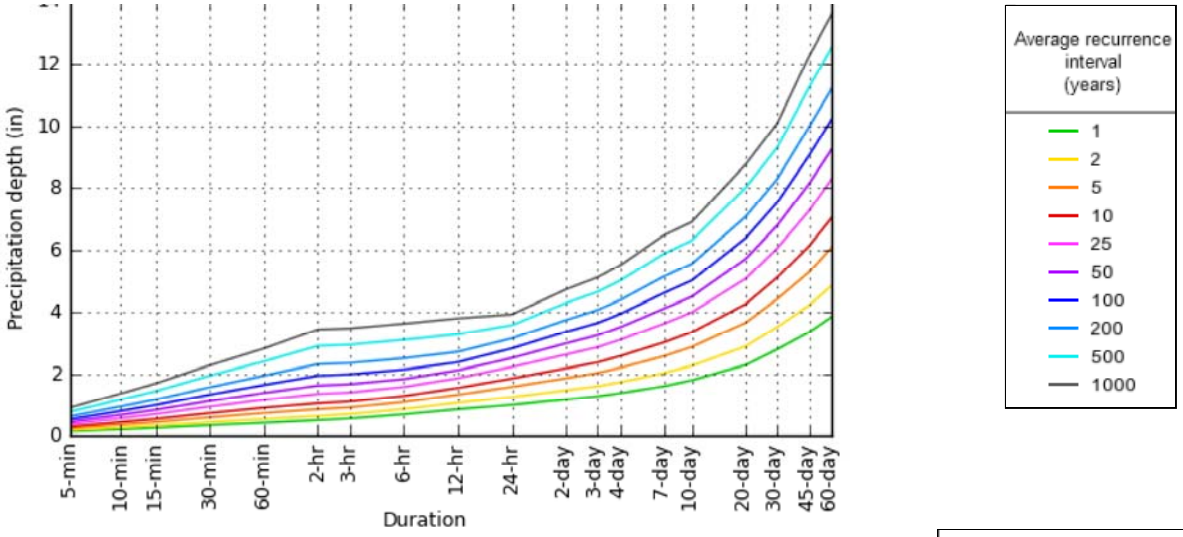
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

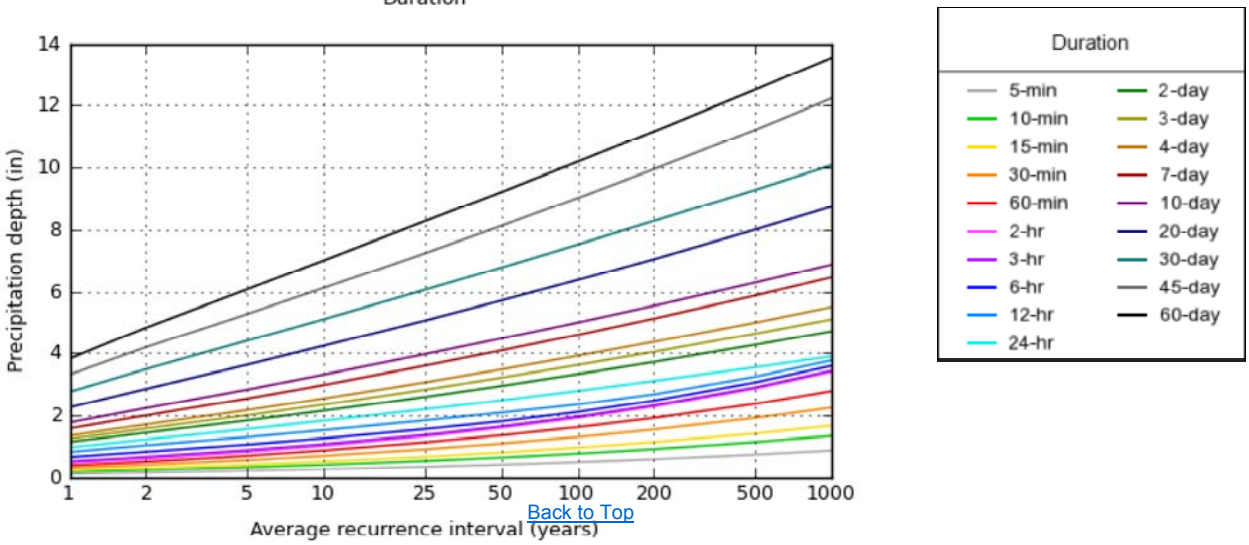
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper 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.

Back to Top

PF graphical



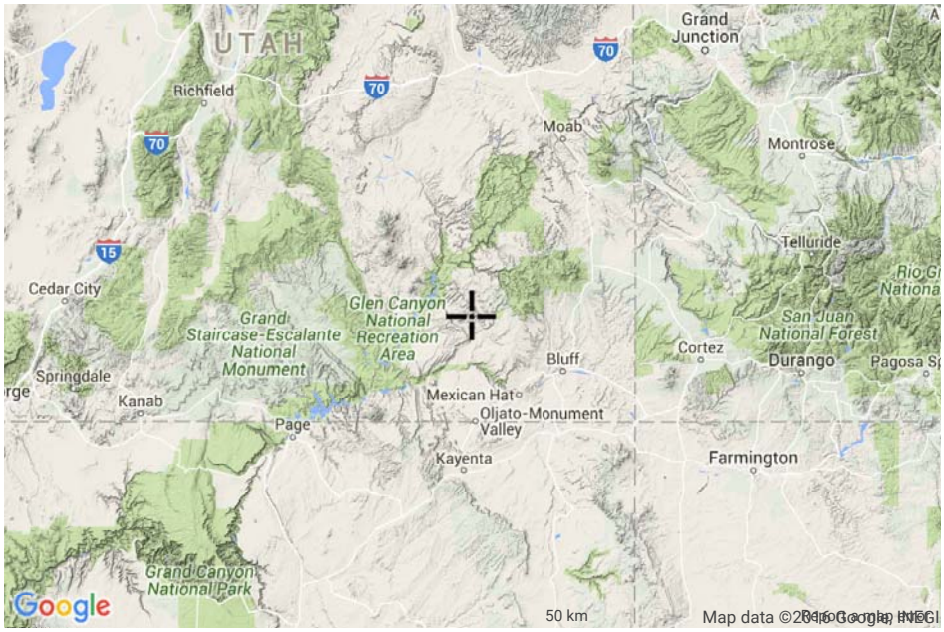


Back to Top

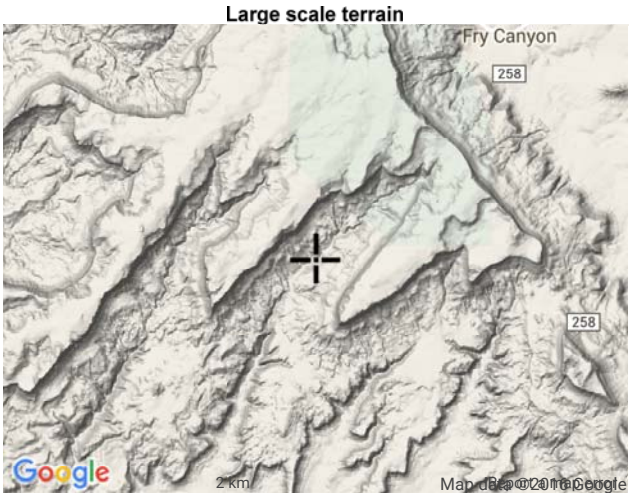
Maps & aerials

NOAA Atlas 14, Volume 1, Version 5 Created (GMT): Mon May 2 22:08:35 2016

Small scale terrain

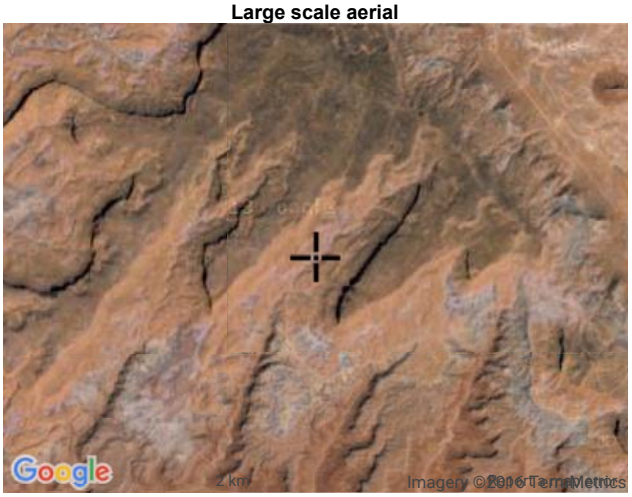


Large scale terrain



Large scale map

Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910