Assessment of Debris Flow Potential

Alice Claim

Park City, Utah

REGISTERED PROFESSIONAL ENGINEER
A.F. SHARRY, III
186193
STATE OF UTAH

Date: July, 2017

Project No. 17014

Prepared By: **Canyon Engineering**
Park City, Utah

August 7, 2017

Mr. Matt Cassel, PE, City Engineer
Park City Municipal Corp.
PO Box 1480
Park City, UT 84060

Subject: **Woodside Gulch at Alice Claim**
Debris Flow Potential

Dear Matt:

Pursuant to your request, following is our professional opinion as to debris flow potential in Woodside Gulch, and its potential effect on the Alice Claim development. Also included herein is a 100-year floodplain analysis.

EXECUTIVE SUMMARY

Based on watershed recon, research, mapping, and computations, it is our professional opinion that the potential for hazardous debris flow at the Alice Claim development is quite limited. Is a debris flow event up valley possible? Yes, but in all likelihood, it would cover very little ground, with the potential for property damage at the Alice Claim development being exceedingly low.

WATERSHED

For the purposes of hydrologic analysis, our point of interest is the gulch thalweg at the north end of the Alice Claim project (King Road) at lat,long 40.6376,-111.4969. Tributary drainage area at this point is mapped at 290 acres (0.453 square miles). See Watershed Map in the Appendix. Ground elevation ranges from approximately 7,300 to 9,250 feet, with thalweg slope for the entire watershed length averaging almost 17%. For the most part, natural mountainsides slope at less than 45%, with a few steeper areas approaching 60%.

The watershed is for the most part covered with mature vegetation, including oak and sagebrush, and aspen and fir forest. Ground cover on ski runs is largely grass, while the abandoned Silver King Mine buildings and associated tailings cover approximately 16 acres.

There are no perennial streams or water bodies within the watershed. Further, during our recon, we found no wetlands, even along the thalweg.

The thalweg itselt has been stabilized with angular rock riprap along virtually the entire length from the Silver King Mine to King Road, creating a defined channel along which melting snow collects on its way to the King Road storm drain.

CLIMATE

The ecosystem here can be classified as Montane, with average annual precipitation totaling 25-30 inches. Most precipitation falls as snow in winter, while summers are dry and mostly sunny. Typically, summer precipitation is produced by isolated thundershowers that contribute about 6 to 8 inches of precipitation to the annual total. These storms become more frequent during the monsoon season occurring mid-July through mid-September when Park City, being on the northern end of this weather pattern, sees increased atmospheric moisture emanating from Mexico and the eastern Pacific Ocean.

Overall, during summer, soil moisture is continuously removed via near surface evaporation, vegetative root uptake, and transpiration. Virtually without exception, truly saturated soil conditions are extremely rare, regardless of the season.

Runoff from the winter snowpack is typically gradual, beginning in early March and running though early May. In summer, isolated thunderstorms can produce short duration heavy rain concentrated over relatively small areas. By and large, rainfall duration for such storms is less than 30 minutes.

Surface flow in the valley floor is intermittently visible for only very short periods during the melt, and even more rarely when a summertime thunderstorm generates heavy rain simultaneously over a large portion of the watershed.

100-YEAR FLOOD

As the 100-year flood is a theoretical storm event based on statistical data, it would never occur in nature and, as such, would not coincide with an actual debris flow event. However, computation of the 100-year peak runoff and resulting flows does provide a useful tool in assessing flow capacity and potential erosion along the valley floor.

Peak flow for the 100-year storm was computed using the NRCS TR-55 method for small, ungaged watersheds.

A Type II, 24-hour rainfall distribution was used to predict runoff timing resultant from extended thunderstorm activity centered over the watershed. Based on NOAA Atlas 14, the 100-year, 24-hour rainfall for this location is 3.34 inches.

Watershed characteristics were estimated based on site recon, aerial photographs, surficial geology mapping, and USGS quad maps. The watershed is comprised almost entirely of forest and shrub cover on moderately to steeply sloping terrain. The hydraulically most remote point is located at the southwest end of the watershed.

As shown on the tabulated computations entitled Watershed Characteristics and on the separate Watershed Map, analysis and engineering judgement yield the following:

watershed area: 290-acre (0.453 SM)
runoff curve number: 53
time of concentration: 100 minutes (1.67 HR)

Given the above input, the Type II distribution produces a 100-year peak flow of 12 CFS at 13.6 hours after the start of rainfall.

100-YEAR FLOOD (CONT.)

The existing stabilized channel is sized to convey flows well in excess of the computed 100-year flood. The FLOODPLAIN TOP WIDTH COMPUTATION included in the Appendix results in a 3.6-foot water surface top width for the 100-year flood. This width is based on minimum channel dimensions measured in the field. Therefore, top width would be less than 3.6 feet along most of the channel.

Among other factors, given tributary area less than one square mile, the subject watershed is too small for inclusion in the FEMA floodplain mapping program.

STORM DRAIN DESIGN

PCMC storm drain design standards require that drain pipes convey the 10-year event, while detention basins be designed for the 100-year event, discharging at the computed predevelopment rate.

Our computed peak flows at Alice Claim are as follows:

10-year storm:	0.9 CFS
100-year storm:	12.1 CFS

Conservatively, to convey the 100-year peak flow, the STORM DRAIN CAPACITY computation included in the Appendix demonstrates that an 18-inch diameter RCP laid at 7% slope would be more than adequate, flowing just under half full during the 100-year peak.

We understand that final stormwater management design will show the proposed storm drain inlet more than 50 feet upstream of building site no. 1. A detailed inlet design would be completed calling for an appropriate transition from open channel to pipe flow, along with a sediment forebay.

Street and lot improvements at Alice Claim will serve to stabilize the very bottom of the watershed. That said, PCMC should give consideration to improving the Woodside water tank access road, the surface of which is at present persistently eroding, sending sediment down into the King Road storm drain.

POTENTIAL IMPACTS DOWNSTREAM DUE TO ALICE CLAIM DEVELOPMENT

From a stormwater management standpoint, concern has been expressed with regard to the impact the development might have on downstream properties.

PCMC Stormwater Design Standards require new development to limit discharges to predevelopment levels. If the Alice Claim developer complies with these standards, and constructs the development in accordance therewith, then the project would not impact downstream properties.

DEBRIS FLOW POTENTIAL

A debris flow can be described as a slug of saturated soil, rock, vegetative matter, trash, and water moving downslope.

In order for debris flow to occur, several variables must align more or less simultaneously. Key among these factors are watershed slope, soil depth, and percent of soil saturation. Other factors include soil type and, as would be expected with regard to soil saturation, climate.

The matrix entitled Debris Flow Potential in the Appendix summarizes the principal variables that play into a debris flow event. This matrix demonstrates that, although some key factors are always present, this particular location is not at elevated risk.

Working against debris flow potential here are watershed size, climate, vegetative cover, and extensive shallow bedrock.

In particular, climate and precipitation patterns ensure appreciable water holding capacity in soils during the summer and fall, even after above average winter precipitation. Further, this holding capacity extends into the stable, relatively shallow bedrock below through countless fractures that are in many cases standing at dip angles approaching the vertical. As for precipitation, local patterns are very consistent, and simply do not generate the extended wet periods (weeks to months) through spring, summer and fall necessary to completely saturate extensive soil deposits.

Where mine tailings piles are present, the mixture of fines and pervasive angular rock contained therein serves to increase the angle of internal friction beyond that of pure soil, making slope failure less likely. Given the size and location of tailings piles at Silver King Mine, even if a slope failure did occur, any debris flow running northeast would likely attenuate to zero well upgradient of the Woodside water tank.

On all slope aspects within the watershed, extensive mature vegetative cover / forests serve to hold soil in place, both below ground level (root systems) and at ground level (natural forest litter).

One notable cover exception is the unstable sideslope below the resort access road located in the vicinity of lat,long 40.6340,-111.5036. Under a combination of conditions, this ground is steep enough to slide, and close enough to Alice Claim whereby some material could be reasonably expected to migrate thereto. One such scenario could develop if a rapid warming event is accompanied by rainfall on top of an appreciable late season snowpack.

Finally, the upper portion of the watershed, covering 120 acres (41% of total area), drains to a relatively large flat area in the vicinity of the Bonanza ski lift base. Any debris flow originating above this location would be greatly attenuated, if not completely halted, before reaching the Silver King Mine tailings pile area just below.

We appreciate the opportunity to offer this professional opinion for your consideration.

Should you wish to discuss in more detail, or require further information, please don't hesitate to contact me.

Respectfully,

Canyon Engineering
Gus Sharry, PE, President

cc: file
Gregg Brown, DHM Design; Jerry Fiat, Alice Claim;
Brad Cahoon, DJP; Scott Bolton, Stantec Consulting;

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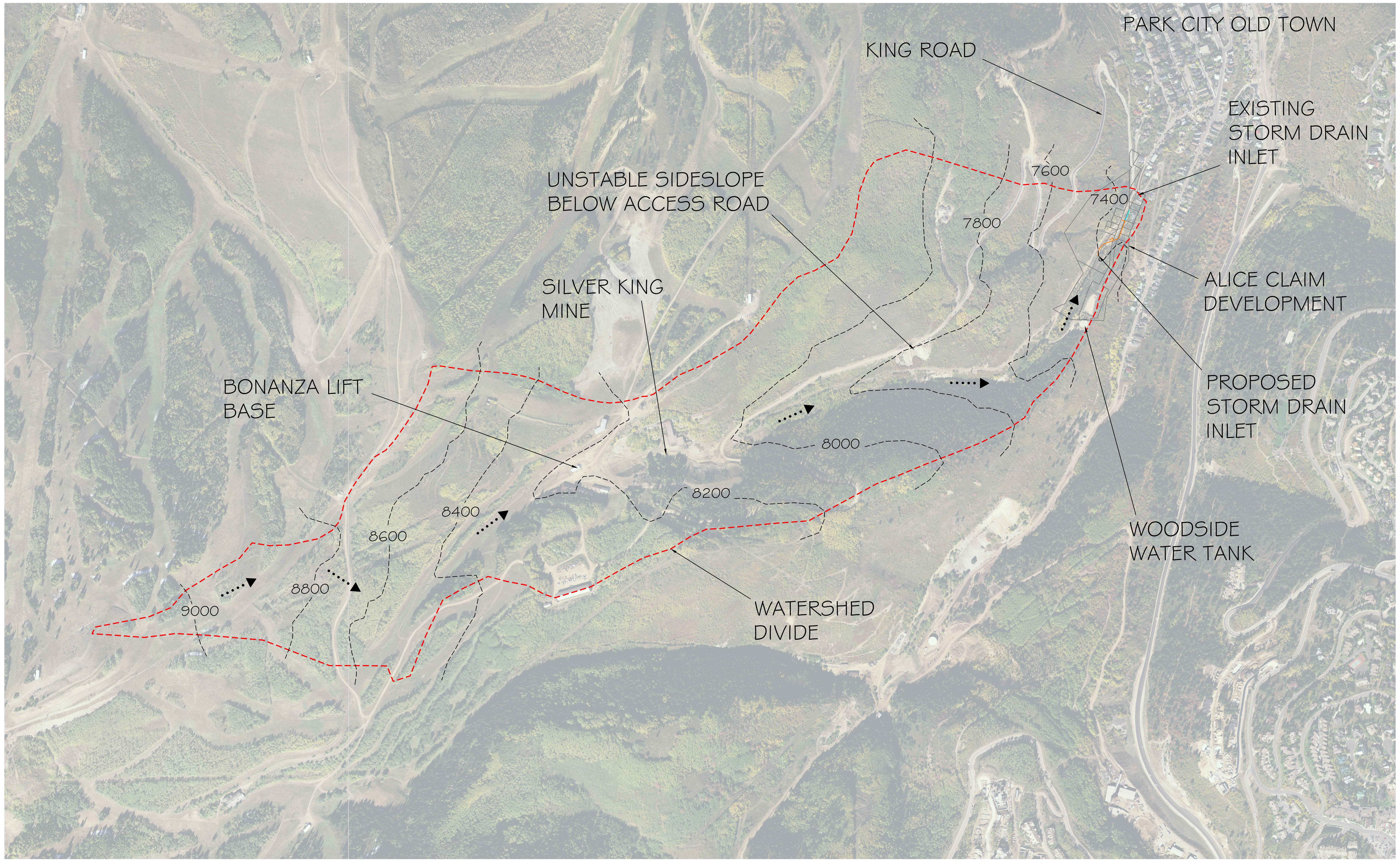
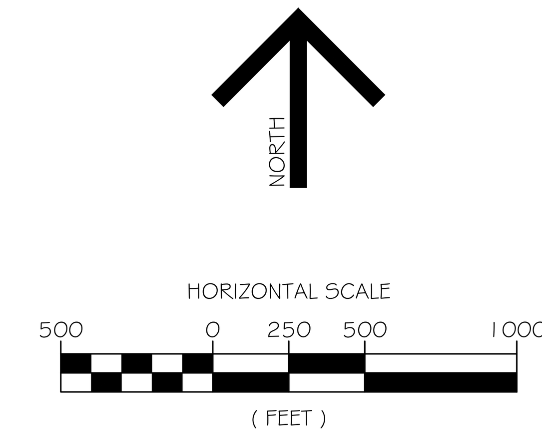
APPENDIX





LEGEND

EXISTING SURFACE RUNOFF DIRECTION

EXISTING SURFACE ELEVATION CONTOUR — — 7600 — — —

NOTES

1. WATERSHED AREA = 290 ACRES (0.453 SQUARE MILES)
2. THALWEG LENGTH = 2.0 MILES
3. CONTOUR INTERVAL = 200 FEET

ABBREVIATIONS

ACP	ASPHALT CONCRETE PAVEMENT
BLDG	BUILDING
CB	CATCH BASIN
CFS	CUBIC FEET PER SECOND
CIP	CAST-IN-PLACE
CL	CENTERLINE
CMH	COMMUNICATIONS MANHOLE
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CO	CLEANOUT
COMM	COMMUNICATIONS
DIA	DIAMETER
DMH	DRAIN MANHOLE
EG	EXISTING GRADE
EL	ELEVATION
EMH	ELECTRIC MANHOLE
ESHGW	ESTIMATED SEASONAL HIGH GROUNDWATER
EX	EXISTING
FDN	FOUNDATION
FE	FLARED END
FG	FINISH GRADE
FRP	FIBERGLASS REINFORCED PLASTIC
GPM	GALLONS PER MINUTE
GW	GROUNDWATER
HDCI	HEAVY DUTY CAST IRON
HDPE	HIGH DENSITY POLYETHYLENE
HP	HIGH POINT
ID	INSIDE DIAMETER
INT	INTERSECTION
INV	INVERT
LD	LONGEST DIMENSION
LF	LINEAR FEET
LOD	LIMIT OF DISTURBANCE
LP	LOW POINT
MDD	MAXIMUM DRY DENSITY
MEG	MATCH EXISTING GRADE
MUTCD	MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES
OD	OUTSIDE DIAMETER
PC	POINT OF CURVATURE
PCC	PORTLAND CEMENT CONCRETE
PE	PLAIN END
PJDI	PUSH-ON JOINT DUCTILE IRON
PRC	PRECAST REINFORCED CONCRETE
PVC	POLYVINYL CHLORIDE; POINT OF VERTICAL CURVATURE
PVI	POINT OF VERTICAL INTERSECTION
PVT	POINT OF VERTICAL TANGENCY
RCP	REINFORCED CONCRETE PIPE
S	SLOPE
SBED	STREAM BED
SD	STORM DRAIN
SMH	SEWER MANHOLE
SS	SANITARY SEWER; STAINLESS STEEL
TBC	TOP BACK OF CURB
TC	TOP OF CONCRETE
TO	TOP OF
TP	TOP OF PAVEMENT
TW	TOP OF WALL
TYP	TYPICAL
UD	UNDERDRAIN
UP	UTILITY POLE
WMH	WATER MANHOLE
WS	WATER SURFACE

ABBREVIATIONS - AGENCY

COE	US ARMY CORPS OF ENGINEERS
FEMA	FEDERAL EMERGENCY MANAGEMENT AGENCY
PCMC	PARK CITY MUNICIPAL CORPORATION
RMP	ROCKY MOUNTAIN POWER
SBWRD	SNYDERVILLE BASIN WATER RECLAMATION DISTRICT
SCEH	SUMMIT COUNTY ENVIRONMENTAL HEALTH
UDOT	UTAH DEPARTMENT OF TRANSPORTATION
WCEH	WASATCH COUNTY ENVIRONMENTAL HEALTH

REFERENCES

1. AERIAL PHOTO BASE FROM STATE OF UTAH AUTOMATED GEOGRAPHIC REFERENCE CENTER.
2. PROPOSED IMPROVEMENTS AT ALICE CLAIM PROVIDED BY STANTEC CONSULTING, INC., SALT LAKE CITY, UTAH.

DRAWING ISSUED FOR

■ PLANNING ☐ CONSTRUCTION

☐ PERMIT ☐ CONSTRUCTION RECORD

SEE DESIGN NOTES FOR INTENT. EXISTING CONDITIONS AND PROPOSED CONCEPTS SHOWN ON THIS DRAWING MAY NOT BE RENDERED IN DETAIL SUFFICIENT FOR PERMITTING PURPOSES. THIS DRAWING IS NOT INTENDED FOR CONSTRUCTION.

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186193
7.24.17
STATE OF UTAH

NO.	DATE	BY	CHK	REVISION DESCRIPTION

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DEBRIS FLOW ASSESSMENT

WATERSHED MAP

WOODSIDE GULCH AT ALICE CLAIM
PARK CITY, UTAH

PREPARED FOR:
KING DEVELOPMENT GROUP, LLC
PARK CITY, UTAH

PLS GRID LOCATION:
S21 T2S R4E
SLB&M

DES. BY: AFS
CHK. BY: AFS
DATE: JULY 2017
JOB 17014

WATERSHED CHARACTERISTICS - TR55 METHOD

			Alice Claim
Subarea No:	1		Park City, Utah
Condition:	existing	Project No.	17014

RUNOFF CURVE NUMBER

Tributary area (AC) : 290.00
Soil hydrologic group: C

Surface Characteristic	Condition	Curve No. CN	Area, A (AC)	CN x A (AC)
oak, aspen & fir forest	fair	50	207.00	10350
ski run; meadow		61	66.00	4026
0.125-acre residential		86	1.00	86
1.0-acre residential		71	0.00	0
abandoned mines & tailings		65	16.00	1040
		TOTALS	290.00	15502

COMPOSITE CN 53

TIME OF CONCENTRATION

Point of interest: north end Alice Claim

Sheet flow variables
2-year, 24-hour rainfall (IN.): 1.69
Roughness coefficient [1]: 0.130

Reach	Channel Type	Flow Length (FT)	Channel Slope (FT/FT)	Flow Velocity (FPS)	Travel Time (MIN)	Comment
1	sheet	300	0.290	na	9.9	mountain ridge
2	shallow concen.	520	0.260	1.2	7.2	ski trail rivulet
3	shallow concen.	1400	0.186	1.0	23.3	ski trail rivulet
4	open channel	900	0.306	3.7	4.1	mountain thread
5	open channel	6750	0.141	2.5	45.0	mountain thread
6	open channel	1900	0.153	3.0	10.6	mountain thread
TOTAL		11770			100.1	

TIME OF CONCENTRATION 100.1 MIN
1.67 HOUR

NOTES:

[1] sheet flow roughness coefficient: pavement / bare soil = 0.011; grass…short = 0.15, dense = 0.24; natural range = 0.13; woods…light underbrush = 0.40, dense underbrush = 0.80

NOAA Atlas 14, Volume 1, Version 5
Location name: Park City, Utah, USA*
Latitude: 40.6337°, Longitude: -111.501°
Elevation: 7618.6 ft**
* source: ESRI Maps
** source: USGS

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	0.130 (0.115-0.152)	0.165 (0.146-0.192)	0.226 (0.198-0.263)	0.282 (0.245-0.329)	0.373 (0.314-0.437)	0.458 (0.374-0.541)	0.557 (0.440-0.667)	0.675 (0.511-0.822)	0.865 (0.620-1.08)	1.04 (0.710-1.33)
10-min	0.198 (0.175-0.231)	0.252 (0.222-0.292)	0.344 (0.302-0.400)	0.429 (0.372-0.500)	0.568 (0.477-0.666)	0.697 (0.570-0.824)	0.849 (0.669-1.02)	1.03 (0.777-1.25)	1.32 (0.943-1.65)	1.58 (1.08-2.03)
15-min	0.246 (0.217-0.286)	0.312 (0.275-0.362)	0.427 (0.374-0.496)	0.532 (0.461-0.620)	0.704 (0.592-0.825)	0.864 (0.706-1.02)	1.05 (0.830-1.26)	1.27 (0.964-1.55)	1.63 (1.17-2.04)	1.96 (1.34-2.52)
30-min	0.332 (0.292-0.386)	0.421 (0.370-0.488)	0.575 (0.504-0.668)	0.717 (0.621-0.835)	0.947 (0.797-1.11)	1.16 (0.951-1.38)	1.42 (1.12-1.70)	1.71 (1.30-2.09)	2.20 (1.58-2.75)	2.64 (1.81-3.39)
60-min	0.410 (0.361-0.477)	0.521 (0.458-0.604)	0.712 (0.624-0.827)	0.888 (0.769-1.03)	1.17 (0.986-1.38)	1.44 (1.18-1.70)	1.75 (1.38-2.10)	2.12 (1.61-2.59)	2.72 (1.95-3.40)	3.27 (2.23-4.19)
2-hr	0.525 (0.471-0.596)	0.651 (0.584-0.740)	0.852 (0.758-0.969)	1.04 (0.914-1.19)	1.35 (1.15-1.55)	1.63 (1.36-1.89)	1.97 (1.59-2.32)	2.38 (1.84-2.86)	3.03 (2.21-3.75)	3.63 (2.53-4.61)
3-hr	0.613 (0.556-0.687)	0.757 (0.688-0.847)	0.958 (0.862-1.07)	1.15 (1.02-1.28)	1.45 (1.26-1.63)	1.71 (1.46-1.95)	2.03 (1.68-2.35)	2.41 (1.93-2.88)	3.05 (2.33-3.79)	3.65 (2.66-4.65)
6-hr	0.831 (0.766-0.911)	1.02 (0.939-1.12)	1.24 (1.14-1.37)	1.45 (1.32-1.59)	1.75 (1.57-1.93)	2.00 (1.76-2.23)	2.28 (1.97-2.58)	2.61 (2.20-2.99)	3.19 (2.61-3.83)	3.72 (2.95-4.70)
12-hr	1.08 (0.994-1.18)	1.32 (1.22-1.45)	1.60 (1.47-1.75)	1.84 (1.68-2.02)	2.20 (1.98-2.42)	2.49 (2.21-2.77)	2.81 (2.45-3.17)	3.16 (2.69-3.62)	3.67 (3.04-4.31)	4.11 (3.32-4.93)
24-hr	1.38 (1.27-1.49)	1.69 (1.56-1.84)	2.04 (1.88-2.21)	2.32 (2.13-2.52)	2.71 (2.48-2.94)	3.02 (2.75-3.28)	3.34 (3.02-3.62)	3.66 (3.30-3.98)	4.10 (3.66-4.47)	4.44 (3.94-4.98)
2-day	1.65 (1.53-1.79)	2.04 (1.88-2.21)	2.45 (2.26-2.66)	2.79 (2.57-3.03)	3.26 (2.99-3.54)	3.63 (3.31-3.95)	4.00 (3.64-4.36)	4.39 (3.96-4.79)	4.90 (4.38-5.38)	5.30 (4.70-5.84)
3-day	1.86 (1.71-2.02)	2.29 (2.11-2.49)	2.76 (2.54-3.00)	3.15 (2.89-3.43)	3.69 (3.38-4.02)	4.12 (3.75-4.49)	4.55 (4.13-4.98)	5.00 (4.50-5.48)	5.61 (5.00-6.18)	6.08 (5.37-6.73)
4-day	2.06 (1.90-2.24)	2.53 (2.33-2.76)	3.06 (2.82-3.34)	3.51 (3.21-3.82)	4.12 (3.76-4.50)	4.60 (4.18-5.03)	5.11 (4.61-5.60)	5.62 (5.05-6.18)	6.32 (5.61-6.98)	6.86 (6.04-7.62)
7-day	2.52 (2.31-2.76)	3.10 (2.84-3.40)	3.74 (3.42-4.10)	4.27 (3.90-4.68)	5.00 (4.55-5.49)	5.57 (5.04-6.13)	6.16 (5.55-6.79)	6.76 (6.04-7.47)	7.57 (6.71-8.42)	8.20 (7.20-9.16)
10-day	2.89 (2.66-3.16)	3.56 (3.27-3.89)	4.28 (3.92-4.66)	4.85 (4.43-5.29)	5.61 (5.11-6.12)	6.18 (5.62-6.76)	6.77 (6.12-7.41)	7.34 (6.61-8.06)	8.09 (7.23-8.93)	8.67 (7.69-9.61)
20-day	3.85 (3.53-4.18)	4.74 (4.35-5.15)	5.63 (5.18-6.12)	6.33 (5.81-6.88)	7.23 (6.63-7.86)	7.88 (7.21-8.58)	8.53 (7.77-9.29)	9.15 (8.31-10.00)	9.93 (8.97-10.9)	10.5 (9.44-11.5)
30-day	4.70 (4.34-5.07)	5.76 (5.33-6.23)	6.82 (6.30-7.36)	7.65 (7.04-8.26)	8.71 (8.00-9.41)	9.49 (8.68-10.3)	10.2 (9.35-11.1)	11.0 (9.99-11.9)	11.9 (10.8-13.0)	12.6 (11.3-13.7)
45-day	5.84 (5.41-6.32)	7.16 (6.62-7.76)	8.46 (7.81-9.16)	9.47 (8.73-10.3)	10.8 (9.91-11.7)	11.7 (10.7-12.7)	12.7 (11.6-13.8)	13.6 (12.3-14.8)	14.7 (13.3-16.1)	15.5 (14.0-17.0)
60-day	6.97 (6.45-7.52)	8.56 (7.93-9.25)	10.1 (9.34-10.9)	11.3 (10.4-12.2)	12.7 (11.7-13.8)	13.8 (12.7-14.9)	14.8 (13.6-16.1)	15.8 (14.4-17.1)	17.0 (15.5-18.5)	17.9 (16.2-19.5)

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

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

Please refer to NOAA Atlas 14 document for more information.

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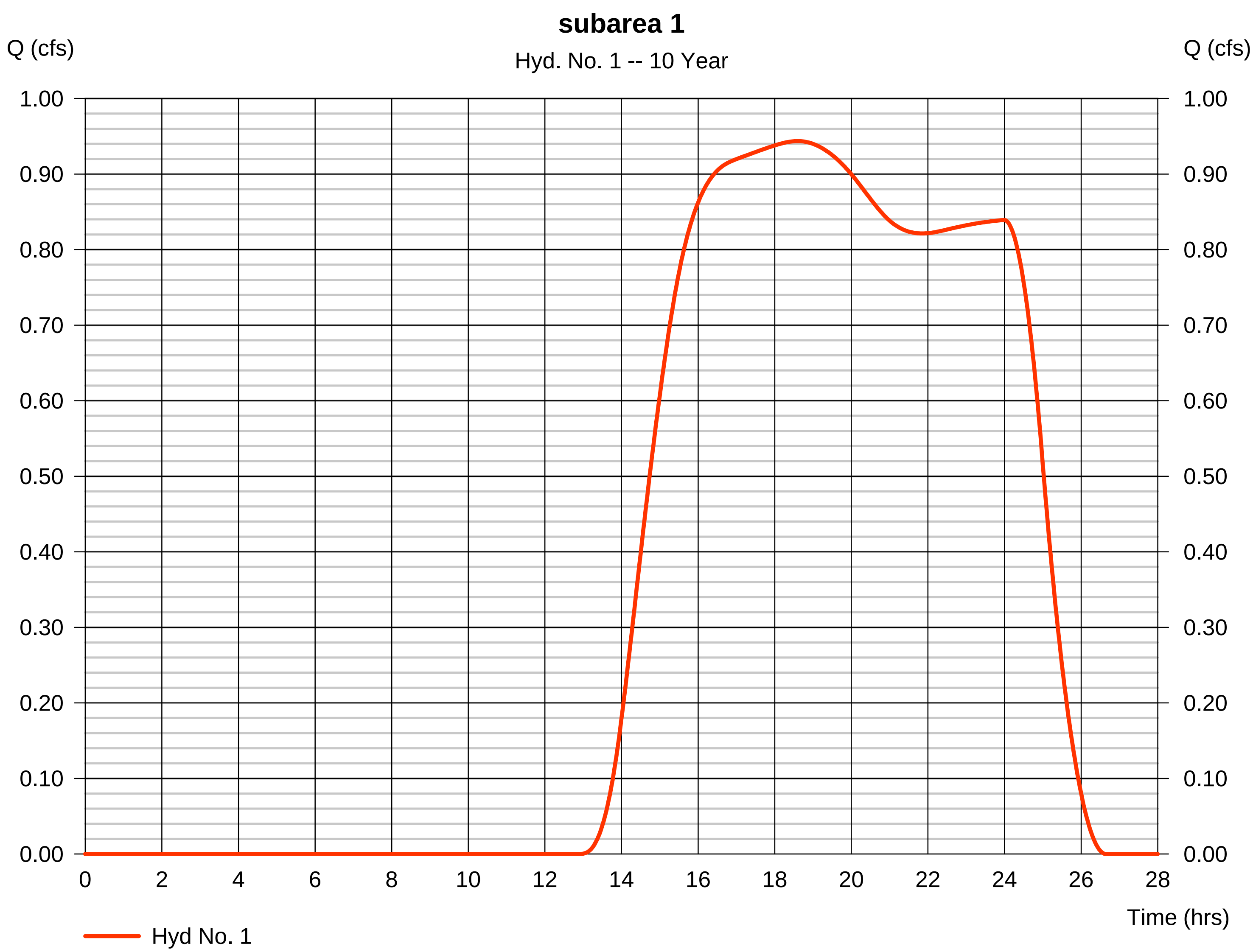
Hydrograph Report

Hyd. No. 1

subarea 1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.944 cfs
Storm frequency	= 10 yrs	Time to peak	= 18.60 hrs
Time interval	= 2 min	Hyd. volume	= 33,385 cuft
Drainage area	= 290.000 ac	Curve number	= 53
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 100.10 min
Total precip.	= 2.32 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

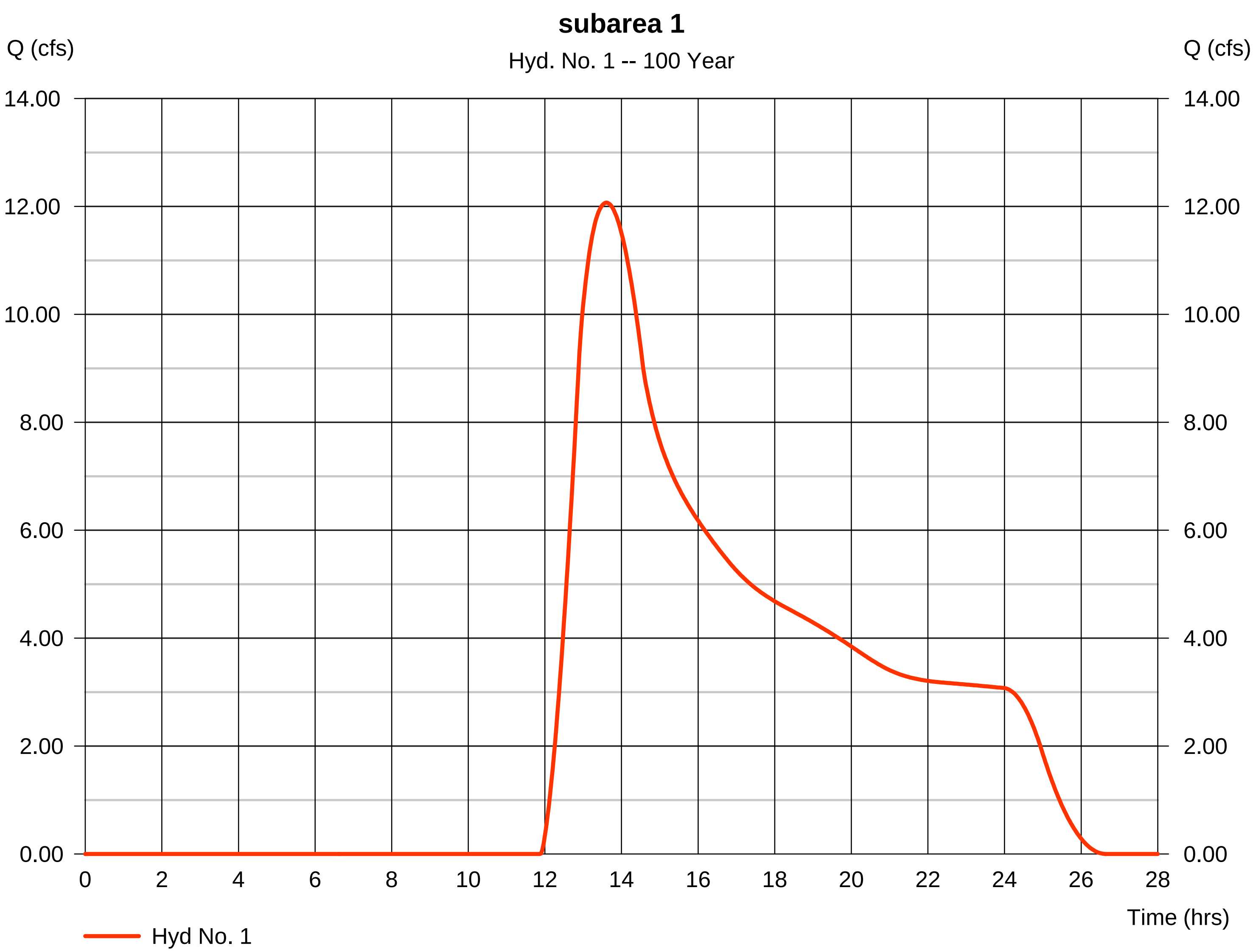


Hydrograph Report

Hyd. No. 1

subarea 1

Hydrograph type	= SCS Runoff	Peak discharge	= 12.07 cfs
Storm frequency	= 100 yrs	Time to peak	= 13.60 hrs
Time interval	= 2 min	Hyd. volume	= 247,194 cuft
Drainage area	= 290.000 ac	Curve number	= 53
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 100.10 min
Total precip.	= 3.34 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



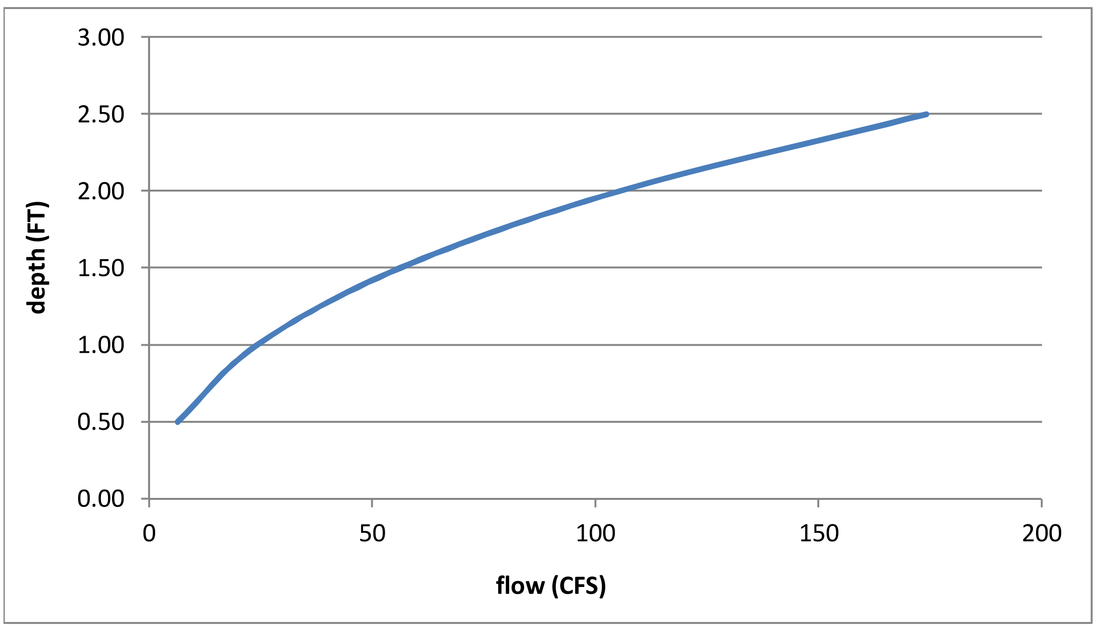
FLOODPLAIN TOP WIDTH COMPUTATION

Alice Claim
Park City, Utah
17014

Open Channel Flow
Lower Alice Claim
Trapezoidal Channel

Parameter	Unit	Value	Remarks
channel slope	FT / FT	0.1200	
left side slope	H/V	1.5	existing channel minimum
right side slope	H/V	1.5	existing channel minimum
depth	FT	0.71	
bottom width	FT	1.5	existing channel minimum
roughness coefficient			
left side slope		0.045	angular riprap
right side slope		0.045	angular riprap
bottom		0.045	angular riprap
composite		0.045	
wetted perimeter	FT	4.1	
hydraulic radius	FT	0.45	
flow area	SF	1.8	
top width	FT	3.6	maximum top width at flow indicated
velocity	FPS	6.7	
flow	CFS	12.2	computed 100-year flood flow = 12.1 CFS

Rating Curve



NOTES:
[1] Flow computed using Manning Eq for open channel flow, after Robert Manning, 1890.

ABBREVIATIONS:
CFS=cubic feet per second; SF=square feet; VF=vertical feet; EA=each; FT=feet; FPS=feet per second; GAL=gallons; GPM=gallons per minute

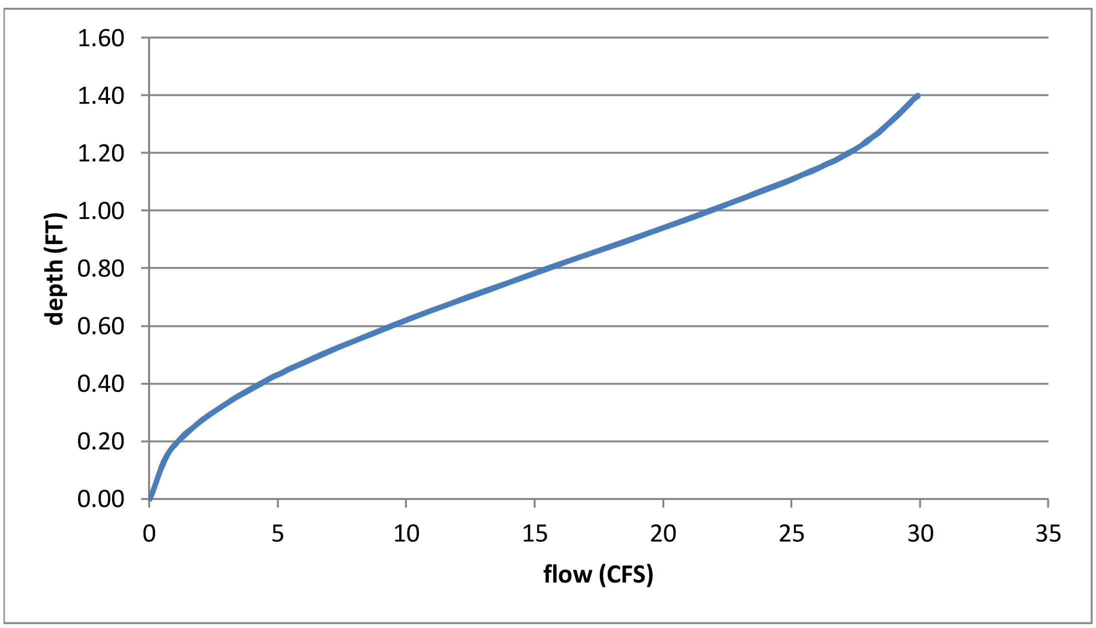
STORM DRAIN CAPACITY

Alice Claim
Park City, Utah
17014

Circular Pipe
Lower Alice Claim

Parameter	Unit	Value	Remarks
channel slope	FT / FT	0.0700	
diameter	FT	1.50	
roughness coefficient		0.013	18-inch dia RCP
depth	FT	0.70	
wetted perimeter	FT	2.26	
hydraulic radius	FT	0.36	
flow area	SF	0.81	
top width	FT	1.50	
percent full	%	46	
specific energy	FT	4.32	
max flow	CFS	29.90	computed 100-year flood flow = 12.1 CFS
velocity	FPS	15.3	
flow	CFS	12.3	computed 100-year flood flow = 12.1 CFS

Rating Curve



NOTES:
[1] Flow computed using Manning Eq for open channel flow, after Robert Manning, 1890.

ABBREVIATIONS:
CFS=cubic feet per second; SF=square feet; VF=vertical feet; EA=each; FT=feet; FPS=feet per second; GAL=gallons; GPM=gallons per minute

Debris Flow Potential

Woodside Gulch at Alice Claim

PARAMETER	WEIGHT	RATING SCALE OF 10	SUBTOTAL	REMARKS
typical saturated soil duration	17	1	17.0	
climate / precipitation pattern	14	2	28.0	
watershed size	12	2	24.0	290 acres
saturated soil depth	10	2	20.0	
existing in-line debris control structures	10	7	70.0	low volume sediment traps
thalweg slope	8	9	72.0	17%
vegetative cover	6	3	18.0	
side slope	4	9	36.0	
thalweg sinuosity	4	8	32.0	relatively straight
frequency / magnitude of seismic activity	4	6	24.0	
presence / location of mining waste	4	7	28.0	
vegetation maturity	3	3	9.0	
rock outcrop frequency	2	3	6.0	
presence of spings	2	2	4.0	
WEIGHT TOTAL	100		388.0	

WEIGHTED RATING 3.88 — indicator of potential

NOTES:

[1] Ratings based on watershed recon and research. A rating of 10 indicates high potential. A rating of 1 indicates low potential.