GLCA Hydrologic and Hydraulic Memo

Date:	04/17/2025
Project name:	Glen Canyon Low Water Ramps - Hite
Task Order no:	140P2024F0155
Contract no:	140P2023D0006
Attention:	Mike Will, PE, Denver Service Center
Company:	National Park Service
Prepared by:	Douglas P. Stewart, PE
Reviewed by:	Thom Rutledge, PE, CFM
Copies to:	Aaron Swafford, PE

OBJECTIVE

This memo has been prepared to summarize the hydrologic analysis, parameters, and assumptions that were used to determine the peak flow rates to prospective culvert crossings and ditch sizing along the roadway within the Hite boat ramp area. Major basins were delineated to potential cross-culvert locations placed at natural low points along the roadway alignment. Other minor basins were delineated to calculate the amount of flow in roadside ditches tributary to the prospective culvert crossings.

HYDROLOGIC ANALYSIS

The offsite hydrology was completed using the SCS unit hydrograph method applied within the HEC-HMS model version 4.10. Hydrologic analysis for the ditch sizing was completed using the Rational Method.

Subbasin Delineation and Topography

Major basins were delineated to estimate the concentrated flow at a potential culvert location. Other minor basins were delineated to estimate the flow that would drain directly towards the proposed roadway alignment and will need to be conveyed via ditches to one of the potential culvert locations. Major basins and ditch subbasin boundaries are shown on the Hydrology Map in **Figure 1** included as **Attachment 1** with this memo.

The topography data used for the subbasin delineation included local LiDAR data flown for the project and the 10-meter USGS DEM data. Using these contours, the basins were manually delineated to adjust for the proposed roadway alignment.

Rainfall Data (Frequency, Depth, Distribution)

The hydrologic calculations are completed for the 5-year, 10-year, 50-year, and 100-year storm events. The rainfall data is referenced from National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 1, Version 5 Point Precipitation Frequency Estimate for Lake Powell, Utah, located at latitude 37.8806 and longitude -110.3709. The full NOAA report can be found in **Attachment 2**.

The rainfall values corresponding to each storm event are provided in Table 1 below:

Table 1: Rainfall Data

Return Period (Yr)	Rainfall Intensity* (inch/hr)	Rainfall Depth** (inch)
5	2.12	1.21
10	2.66	1.43
50	4.33	1.99
100	5.24	2.26

*Rainfall Intensity corresponding to 5-minute time of concentration (tc) is listed and the rainfall intensity corresponding to calculated tc was interpolated based on available rainfall intensity values
**Rainfall depth values are corresponding to 24-hour storm duration

Soils

The soil data was downloaded from the United States Department of Agriculture online content. The referenced dataset was developed using the Web Soil Survey for the project area with soil descriptions from the NRCS website. The full report can be found in **Attachment 2**. This dataset is also uploaded to Data Basin and is available with additional information at:
http://app.databasin.org/app/pages/datasetPage.jsp?id=de1a45d142f34bbca8010903eef966d9/.

Based on the data, the project watershed lies mostly in an unrated soil group, which we can assume as the Hydrologic **Soil Group Type D**. A small portion of the watershed lies within Soil Group A. For calculations, Soil Group Type D was designated in that region.

Land Use Data

The land use data was downloaded from the United States Geological Survey (USGS) National Land Cover Database (NLCD) 2021 Land Cover Conterminous United States. The land use categories that cover the project watershed are listed in **Table 2**. The table includes the curve number for each land use category for soil group Type D. The curve numbers are referenced from the *Urban Hydrology for Small Watersheds TR-55* by United States Department of Agriculture (USDA). The corresponding name for each land use category used in TR-55 is also provided in **Table 2**.

Table 2: Land Use Categories

NLCD Color Index	NLCD Land Cover Class	TR 55 Land Use Category	CN (Soil Type D)
11	Open Water	-	98
21	Developed, Open Space	Streets and Roads (Gravel)	91
22	Developed, Low Intensity	Streets and Roads (Paved)	93
31	Barren Land	Desert Shrub (Poor Condition)	88
52	Shrub/Scrub	Desert Shrub (Fair Condition)	86
71	Herbaceous	Herbaceous (Fair Condition)	89

Curve Numbers

Rainfall losses due to soil infiltration, depression storage, and other factors were calculated using the NRCS curve number method, which is a function of soil type, land cover, and antecedent moisture condition.

GIS zonal statistical tool was used to calculate a weighted curve number for each subbasin using the subbasin delineations, soil map unit delineations, the land use layer and curve number matrix. Table 3 below shows the calculated weighted curve numbers for subbasins using the SCS curve number method. The initial abstraction was assumed to be zero.

Table 3: Weighted SCS Curve Numbers

BASIN	% Cover Gravel Road	Weighted Curve No. Gravel Road	% Cover Paved Road	Weighted Curve No. Paved Road	% Cover Desert Shrub	Weighted Curve No. Desert Shrub	TOTAL WEIGHTED CURVE NO.
BH01	0.2%	0.18	0.6%	0.56	99.2%	85.31	86.05
BH02	1.2%	1.09	1.9%	1.77	96.9%	83.33	86.19
BH03	1.6%	1.46	1.3%	1.21	97.1%	83.51	86.18
BH04	25.9%	23.57	0%	0.0	74.1%	63.73	87.30
BH05	1.9%	1.73	0%	0.0	98.1%	84.37	86.10

Lag Times

Based on United States Department of Agriculture, National Engineering Handbook - Part 630 Hydrology, Lag time (T_l) is defined using the following equation:

$T_l = 0.6Tc$

where, Tc =time of concentration in minutes

T_c is time of concentration in minutes and is calculated using the definition provided in TR55 which divides Tc into two components. Initial sheet flow is calculated using Manning's kinematic solution (Overtop and Meadows 1976) and the shallow concentrated flow is calculated using velocity method that uses empirical relationship between the velocity and the slope.

Initial flow:

$$t_c = \frac{\alpha}{P_2^{0.5}} \left(\frac{nL}{\sqrt{S}} \right)^{0.8}$$

where,

α	=	unit conversion constant equal to 0.42
n	=	roughness coefficient (corresponding to fallow land is 0.05)
L	=	flow length (feet)
P_2	=	2-year, 24-hour rainfall depth (0.937 in)
S	=	slope of the surface (ft/ft)

Shallow concentrated flow:

$$T_t = \frac{L}{60V}$$

where,

L	=	flow length (feet)
V	=	velocity, ft/s = $\alpha KS^{0.5}$
α	=	unit conversion constant equal to 33
K	=	dimensionless function of land cover (Nearly bare and untilled overland flow & alluvial fans in western mountain regions = 0.305)
S	=	slope of the surface (ft/ft)

HYDROLOGY ANALYSIS AND PRELIMINARY RESULTS

After developing the input parameters described above, the HEC-HMS model was compiled, and the simulation was successfully run for the 5-year, 10-year, 50-year and 100-year storm events. For offsite subbasins, corresponding peak flows and preliminary culvert locations are shown on the Hydrology Map in Figure 1 included with this memo. An in-depth hydrologic analysis of the calculations described above is included in Attachment 2.

HYDROLOGIC AND HYDRAULIC ANALYSIS FOR DITCHES

The flows for ditch subbasins were estimated using Rational Method which states that,

$Q = CiA$

where,

Q	=	flow (cfs)
C	=	runoff coefficient
i	=	rainfall intensity (inch/hr)
A	=	area (acres)

The runoff coefficient C is calculated from Mile High Flood District Criteria Manual (Volume 1, Chapter 6, Table 6-5). Due to the dry, semi-arid environment of this project location, the imperviousness for the 'Landscape Area' has been increased from the standard 5% to 25%. The ditches were sized for the 10-year flow using Manning's equation. The ditch location, flow directions, design flows and calculated normal depths are provided in a summary table included as Attachment 3 with this memo.

SUMMARY

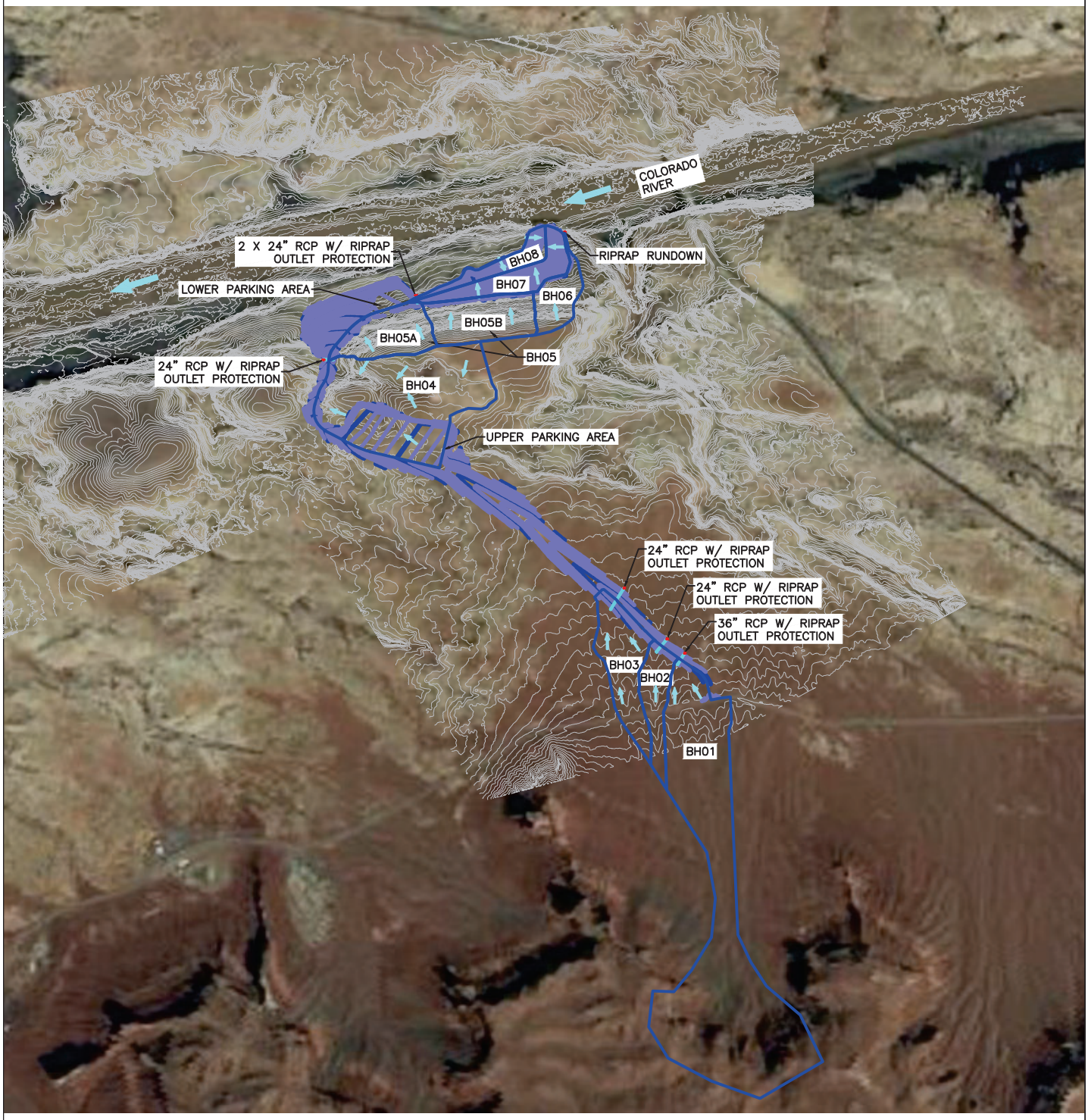
The intent of this memo is to facilitate a review by NPS of the hydrologic and hydraulic analysis, methodology and assumptions. Potential cross-culvert locations and preliminary sizes of the roadside ditches along the proposed project alignment have been provided. Following a review of this memo, Jacobs will update the hydrologic and hydraulic analysis as the project design progresses.

Attachments:

- Attachment 1 – Proposed Drainage Basin Map
- Attachment 2 – Hydrology Calculations
- Attachment 3 - Ditch and Curb Calculations

Attachment 1

ATTACHMENT 1: PROPOSED DRAINAGE BASIN MAP
GLEN CANYON LOW WATER RAMPS - HITE



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0 500' 1000'

LEGEND
BASIN BOUNDARY
FLOW ARROW

BASIN	AREA (AC)	METHODOLOGY	5-YR FLOW (CFS)	10-YR FLOW (CFS)	50-YR FLOW (CFS)	100-YR FLOW (CFS)
BH01	40.36	SCS	22.46	29.79	50.24	60.69
BH02	4.05	SCS	2.57	3.39	5.66	6.82
BH03	7.24	SCS	4.37	5.77	9.66	11.64
BH04	21.41	SCS	14.67	18.70	29.60	35.07
BH05	12.26	SCS	8.20	10.84	18.14	21.86
BH05A	5.70	RATIONAL	2.43	3.97	10.22	13.98
BH05B	6.56	RATIONAL	2.37	3.95	10.46	14.40
BH06	3.30	RATIONAL	1.47	2.44	6.49	8.92
BH07	4.54	RATIONAL	7.17	9.25	15.64	19.18
BH08	2.62	RATIONAL	3.50	4.52	7.64	9.38

Figure 2. Hite Location and Study Area (inset) along the Colorado River

Attachment 2

NOAA Atlas 14, Volume 1, Version 5
Location name: Lake Powell, Utah, USA*
Latitude: 37.8806°, Longitude: -110.3709°
Elevation: 4021 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

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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	0.100 (0.086-0.118)	0.128 (0.112-0.152)	0.177 (0.154-0.210)	0.222 (0.192-0.265)	0.295 (0.251-0.354)	0.361 (0.301-0.435)	0.437 (0.358-0.534)	0.526 (0.422-0.654)	0.666 (0.514-0.848)	0.789 (0.594-1.03)
10-min	0.151 (0.131-0.179)	0.195 (0.170-0.231)	0.269 (0.234-0.319)	0.338 (0.292-0.404)	0.449 (0.381-0.539)	0.549 (0.457-0.662)	0.665 (0.545-0.813)	0.801 (0.642-0.995)	1.01 (0.782-1.29)	1.20 (0.904-1.57)
15-min	0.188 (0.162-0.222)	0.242 (0.210-0.286)	0.334 (0.290-0.396)	0.420 (0.363-0.500)	0.557 (0.473-0.668)	0.680 (0.567-0.821)	0.825 (0.675-1.01)	0.993 (0.796-1.23)	1.26 (0.970-1.60)	1.49 (1.12-1.94)
30-min	0.252 (0.218-0.298)	0.325 (0.283-0.386)	0.450 (0.390-0.533)	0.565 (0.488-0.674)	0.749 (0.636-0.900)	0.916 (0.764-1.10)	1.11 (0.909-1.36)	1.34 (1.07-1.66)	1.69 (1.31-2.16)	2.00 (1.51-2.62)
60-min	0.312 (0.270-0.369)	0.402 (0.350-0.477)	0.556 (0.483-0.659)	0.699 (0.604-0.834)	0.928 (0.788-1.11)	1.13 (0.945-1.37)	1.37 (1.12-1.68)	1.66 (1.33-2.06)	2.09 (1.62-2.67)	2.48 (1.87-3.24)
2-hr	0.371 (0.325-0.429)	0.469 (0.410-0.541)	0.643 (0.560-0.739)	0.799 (0.690-0.916)	1.06 (0.894-1.21)	1.29 (1.07-1.49)	1.56 (1.26-1.82)	1.89 (1.48-2.23)	2.42 (1.82-2.91)	2.90 (2.10-3.55)
3-hr	0.408 (0.365-0.466)	0.516 (0.458-0.592)	0.687 (0.609-0.782)	0.840 (0.736-0.957)	1.08 (0.937-1.23)	1.31 (1.11-1.50)	1.58 (1.31-1.84)	1.90 (1.54-2.26)	2.45 (1.89-2.94)	2.93 (2.19-3.58)
6-hr	0.494 (0.448-0.554)	0.619 (0.559-0.691)	0.800 (0.722-0.891)	0.957 (0.856-1.07)	1.19 (1.05-1.33)	1.39 (1.22-1.56)	1.64 (1.40-1.86)	1.95 (1.64-2.28)	2.47 (2.02-2.97)	2.94 (2.35-3.62)
12-hr	0.589 (0.536-0.649)	0.735 (0.672-0.814)	0.930 (0.845-1.03)	1.09 (0.989-1.20)	1.32 (1.18-1.45)	1.50 (1.34-1.66)	1.70 (1.49-1.89)	1.96 (1.69-2.30)	2.50 (2.04-3.00)	2.97 (2.37-3.65)
24-hr	0.737 (0.649-0.837)	0.937 (0.821-1.06)	1.21 (1.06-1.37)	1.43 (1.25-1.62)	1.74 (1.51-1.97)	1.99 (1.71-2.26)	2.26 (1.92-2.57)	2.54 (2.14-2.90)	2.92 (2.42-3.37)	3.24 (2.65-3.75)
2-day	0.819 (0.725-0.923)	1.04 (0.913-1.17)	1.33 (1.17-1.49)	1.57 (1.38-1.76)	1.92 (1.67-2.16)	2.21 (1.90-2.49)	2.52 (2.15-2.84)	2.84 (2.39-3.24)	3.31 (2.73-3.82)	3.69 (2.99-4.32)
3-day	0.872 (0.775-0.979)	1.10 (0.979-1.23)	1.41 (1.25-1.58)	1.67 (1.47-1.86)	2.03 (1.78-2.27)	2.33 (2.02-2.61)	2.64 (2.27-2.97)	2.98 (2.53-3.38)	3.46 (2.87-3.96)	3.84 (3.13-4.46)
4-day	0.924 (0.826-1.03)	1.16 (1.04-1.30)	1.49 (1.33-1.66)	1.76 (1.57-1.96)	2.14 (1.89-2.38)	2.44 (2.14-2.73)	2.77 (2.40-3.10)	3.11 (2.66-3.52)	3.60 (3.01-4.11)	3.99 (3.27-4.61)
7-day	1.06 (0.925-1.19)	1.33 (1.17-1.50)	1.71 (1.49-1.93)	2.01 (1.75-2.28)	2.44 (2.10-2.76)	2.78 (2.38-3.16)	3.15 (2.67-3.59)	3.54 (2.95-4.07)	4.07 (3.34-4.74)	4.51 (3.63-5.29)
10-day	1.15 (1.01-1.31)	1.46 (1.28-1.66)	1.87 (1.63-2.13)	2.20 (1.91-2.52)	2.67 (2.30-3.04)	3.03 (2.61-3.48)	3.42 (2.91-3.92)	3.81 (3.20-4.41)	4.37 (3.61-5.14)	4.80 (3.92-5.71)
20-day	1.40 (1.24-1.59)	1.78 (1.58-2.01)	2.31 (2.04-2.62)	2.72 (2.39-3.08)	3.29 (2.88-3.74)	3.74 (3.24-4.25)	4.21 (3.60-4.81)	4.69 (3.96-5.36)	5.35 (4.46-6.20)	5.87 (4.82-6.89)
30-day	1.66 (1.46-1.87)	2.09 (1.84-2.36)	2.68 (2.36-3.03)	3.12 (2.74-3.53)	3.72 (3.25-4.22)	4.19 (3.63-4.74)	4.67 (4.01-5.31)	5.15 (4.38-5.90)	5.79 (4.85-6.68)	6.29 (5.21-7.30)
45-day	1.92 (1.70-2.16)	2.42 (2.15-2.72)	3.08 (2.73-3.45)	3.59 (3.17-4.01)	4.28 (3.75-4.78)	4.80 (4.18-5.36)	5.32 (4.61-5.98)	5.85 (5.03-6.61)	6.56 (5.58-7.48)	7.08 (5.94-8.14)
60-day	2.14 (1.89-2.42)	2.70 (2.39-3.05)	3.43 (3.03-3.86)	3.98 (3.51-4.48)	4.74 (4.16-5.32)	5.30 (4.61-5.98)	5.88 (5.09-6.65)	6.46 (5.54-7.33)	7.22 (6.11-8.28)	7.79 (6.52-8.96)

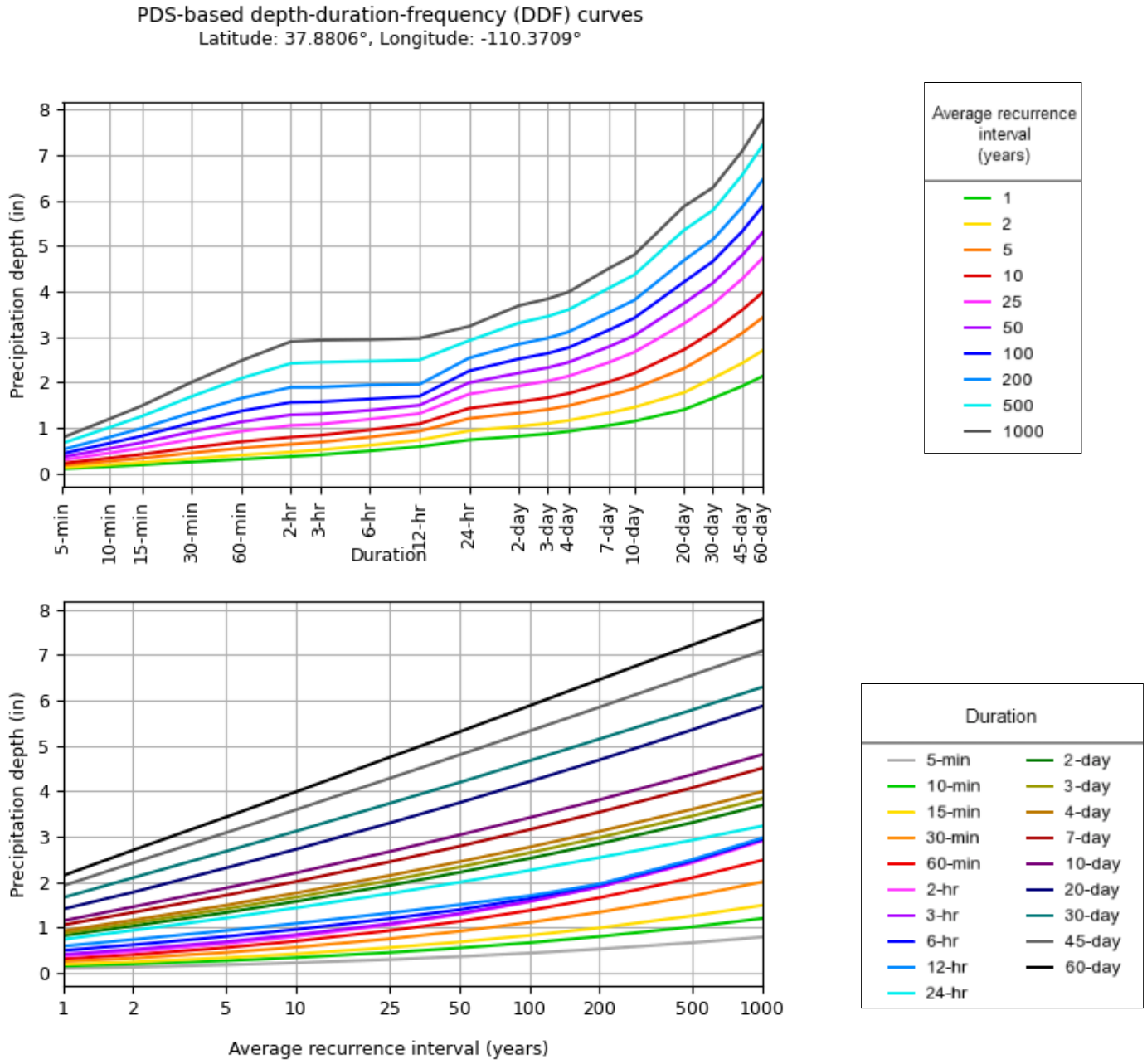
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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



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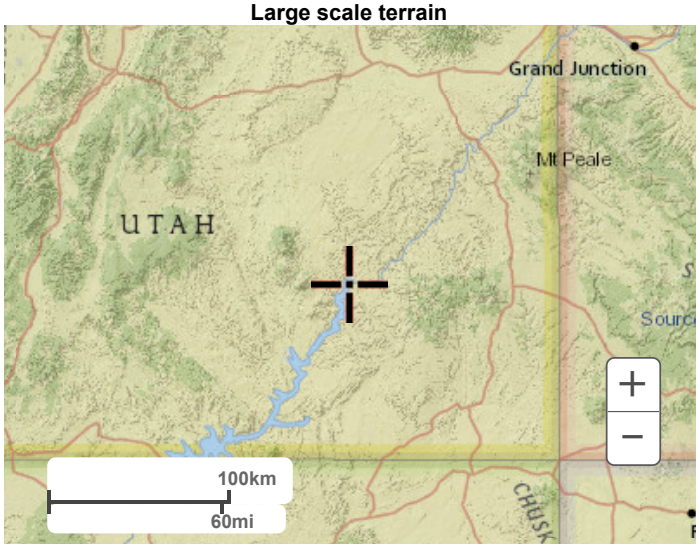
Back to Top

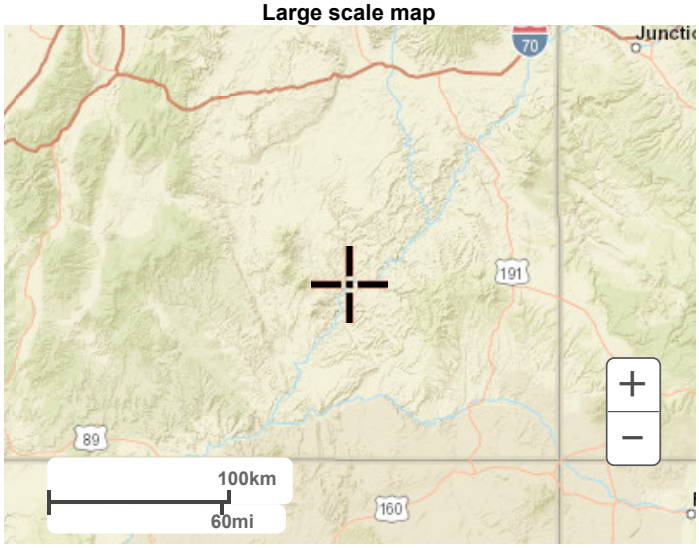
Maps & aerials

Small scale terrain

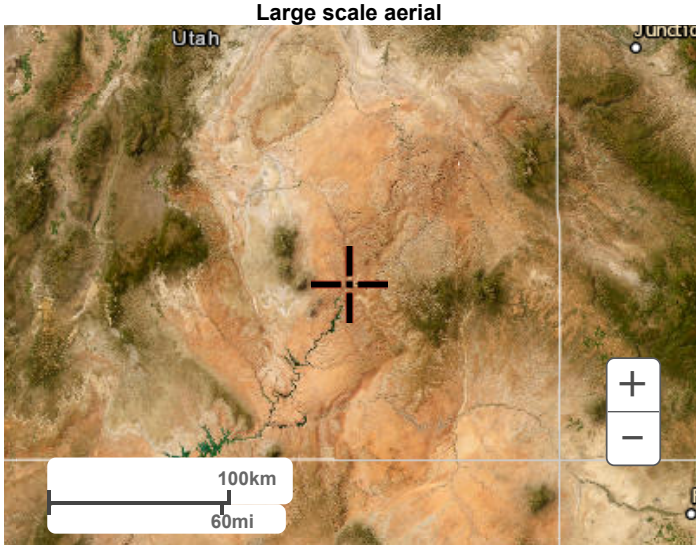
Large scale terrain



Large scale map



Large scale aerial



Back to Top

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Disclaimer

NOAA Atlas 14, Volume 1, Version 5
Location name: Lake Powell, Utah, USA*
Latitude: 37.8806°, Longitude: -110.3709°
Elevation: 4021 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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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/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**1.20** (1.03-1.42)	**1.54** (1.34-1.82)	**2.12** (1.85-2.52)	**2.66** (2.30-3.18)	**3.54** (3.01-4.25)	**4.33** (3.61-5.22)	**5.24** (4.30-6.41)	**6.31** (5.06-7.85)	**7.99** (6.17-10.2)	**9.47** (7.13-12.4)
10-min	**0.906** (0.786-1.07)	**1.17** (1.02-1.39)	**1.61** (1.40-1.91)	**2.03** (1.75-2.42)	**2.69** (2.29-3.23)	**3.29** (2.74-3.97)	**3.99** (3.27-4.88)	**4.81** (3.85-5.97)	**6.08** (4.69-7.75)	**7.21** (5.42-9.41)
15-min	**0.752** (0.648-0.888)	**0.968** (0.840-1.14)	**1.34** (1.16-1.58)	**1.68** (1.45-2.00)	**2.23** (1.89-2.67)	**2.72** (2.27-3.28)	**3.30** (2.70-4.03)	**3.97** (3.18-4.94)	**5.03** (3.88-6.40)	**5.96** (4.48-7.78)
30-min	**0.504** (0.436-0.596)	**0.650** (0.566-0.772)	**0.900** (0.780-1.07)	**1.13** (0.976-1.35)	**1.50** (1.27-1.80)	**1.83** (1.53-2.21)	**2.22** (1.82-2.71)	**2.67** (2.14-3.32)	**3.38** (2.61-4.31)	**4.01** (3.02-5.24)
60-min	**0.312** (0.270-0.369)	**0.402** (0.350-0.477)	**0.556** (0.483-0.659)	**0.699** (0.604-0.834)	**0.928** (0.788-1.11)	**1.13** (0.945-1.37)	**1.37** (1.12-1.68)	**1.66** (1.33-2.06)	**2.09** (1.62-2.67)	**2.48** (1.87-3.24)
2-hr	**0.185** (0.162-0.214)	**0.234** (0.205-0.270)	**0.321** (0.280-0.369)	**0.399** (0.345-0.458)	**0.527** (0.447-0.606)	**0.644** (0.534-0.744)	**0.782** (0.631-0.912)	**0.947** (0.740-1.12)	**1.21** (0.907-1.46)	**1.45** (1.05-1.77)
3-hr	**0.135** (0.121-0.155)	**0.171** (0.152-0.197)	**0.228** (0.202-0.260)	**0.279** (0.245-0.318)	**0.360** (0.312-0.410)	**0.435** (0.369-0.497)	**0.524** (0.435-0.613)	**0.631** (0.512-0.750)	**0.814** (0.630-0.979)	**0.976** (0.729-1.19)
6-hr	**0.082** (0.074-0.092)	**0.103** (0.093-0.115)	**0.133** (0.120-0.148)	**0.159** (0.142-0.178)	**0.199** (0.175-0.222)	**0.232** (0.202-0.260)	**0.273** (0.234-0.310)	**0.324** (0.273-0.380)	**0.412** (0.336-0.495)	**0.491** (0.391-0.604)
12-hr	**0.048** (0.044-0.053)	**0.061** (0.055-0.067)	**0.077** (0.070-0.085)	**0.090** (0.082-0.099)	**0.109** (0.098-0.120)	**0.124** (0.110-0.137)	**0.140** (0.123-0.156)	**0.162** (0.140-0.190)	**0.207** (0.169-0.249)	**0.246** (0.196-0.303)
24-hr	**0.030** (0.027-0.034)	**0.039** (0.034-0.044)	**0.050** (0.044-0.057)	**0.059** (0.052-0.067)	**0.072** (0.063-0.082)	**0.083** (0.071-0.094)	**0.093** (0.080-0.107)	**0.105** (0.089-0.120)	**0.121** (0.100-0.140)	**0.134** (0.110-0.156)
2-day	**0.017** (0.015-0.019)	**0.021** (0.019-0.024)	**0.027** (0.024-0.031)	**0.032** (0.028-0.036)	**0.040** (0.034-0.044)	**0.046** (0.039-0.051)	**0.052** (0.044-0.059)	**0.059** (0.049-0.067)	**0.068** (0.056-0.079)	**0.076** (0.062-0.090)
3-day	**0.012** (0.010-0.013)	**0.015** (0.013-0.017)	**0.019** (0.017-0.021)	**0.023** (0.020-0.025)	**0.028** (0.024-0.031)	**0.032** (0.028-0.036)	**0.036** (0.031-0.041)	**0.041** (0.035-0.046)	**0.047** (0.039-0.055)	**0.053** (0.043-0.062)
4-day	**0.009** (0.008-0.010)	**0.012** (0.010-0.013)	**0.015** (0.013-0.017)	**0.018** (0.016-0.020)	**0.022** (0.019-0.024)	**0.025** (0.022-0.028)	**0.028** (0.024-0.032)	**0.032** (0.027-0.036)	**0.037** (0.031-0.042)	**0.041** (0.034-0.047)
7-day	**0.006** (0.005-0.007)	**0.007** (0.006-0.008)	**0.010** (0.008-0.011)	**0.011** (0.010-0.013)	**0.014** (0.012-0.016)	**0.016** (0.014-0.018)	**0.018** (0.015-0.021)	**0.021** (0.017-0.024)	**0.024** (0.019-0.028)	**0.026** (0.021-0.031)
10-day	**0.004** (0.004-0.005)	**0.006** (0.005-0.006)	**0.007** (0.006-0.008)	**0.009** (0.007-0.010)	**0.011** (0.009-0.012)	**0.012** (0.010-0.014)	**0.014** (0.012-0.016)	**0.015** (0.013-0.018)	**0.018** (0.015-0.021)	**0.020** (0.016-0.023)
20-day	**0.002** (0.002-0.003)	**0.003** (0.003-0.004)	**0.004** (0.004-0.005)	**0.005** (0.004-0.006)	**0.006** (0.005-0.007)	**0.007** (0.006-0.008)	**0.008** (0.007-0.010)	**0.009** (0.008-0.011)	**0.011** (0.009-0.012)	**0.012** (0.010-0.014)
30-day	**0.002** (0.002-0.002)	**0.002** (0.002-0.003)	**0.003** (0.003-0.004)	**0.004** (0.003-0.004)	**0.005** (0.004-0.005)	**0.005** (0.005-0.006)	**0.006** (0.005-0.007)	**0.007** (0.006-0.008)	**0.008** (0.006-0.009)	**0.008** (0.007-0.010)
45-day	**0.001** (0.001-0.001)	**0.002** (0.001-0.002)	**0.002** (0.002-0.003)	**0.003** (0.002-0.003)	**0.003** (0.003-0.004)	**0.004** (0.003-0.004)	**0.004** (0.004-0.005)	**0.005** (0.004-0.006)	**0.006** (0.005-0.006)	**0.006** (0.005-0.007)
60-day	**0.001** (0.001-0.001)	**0.001** (0.001-0.002)	**0.002** (0.002-0.002)	**0.002** (0.002-0.003)	**0.003** (0.002-0.003)	**0.003** (0.003-0.004)	**0.004** (0.003-0.004)	**0.004** (0.003-0.005)	**0.005** (0.004-0.005)	**0.005** (0.004-0.006)

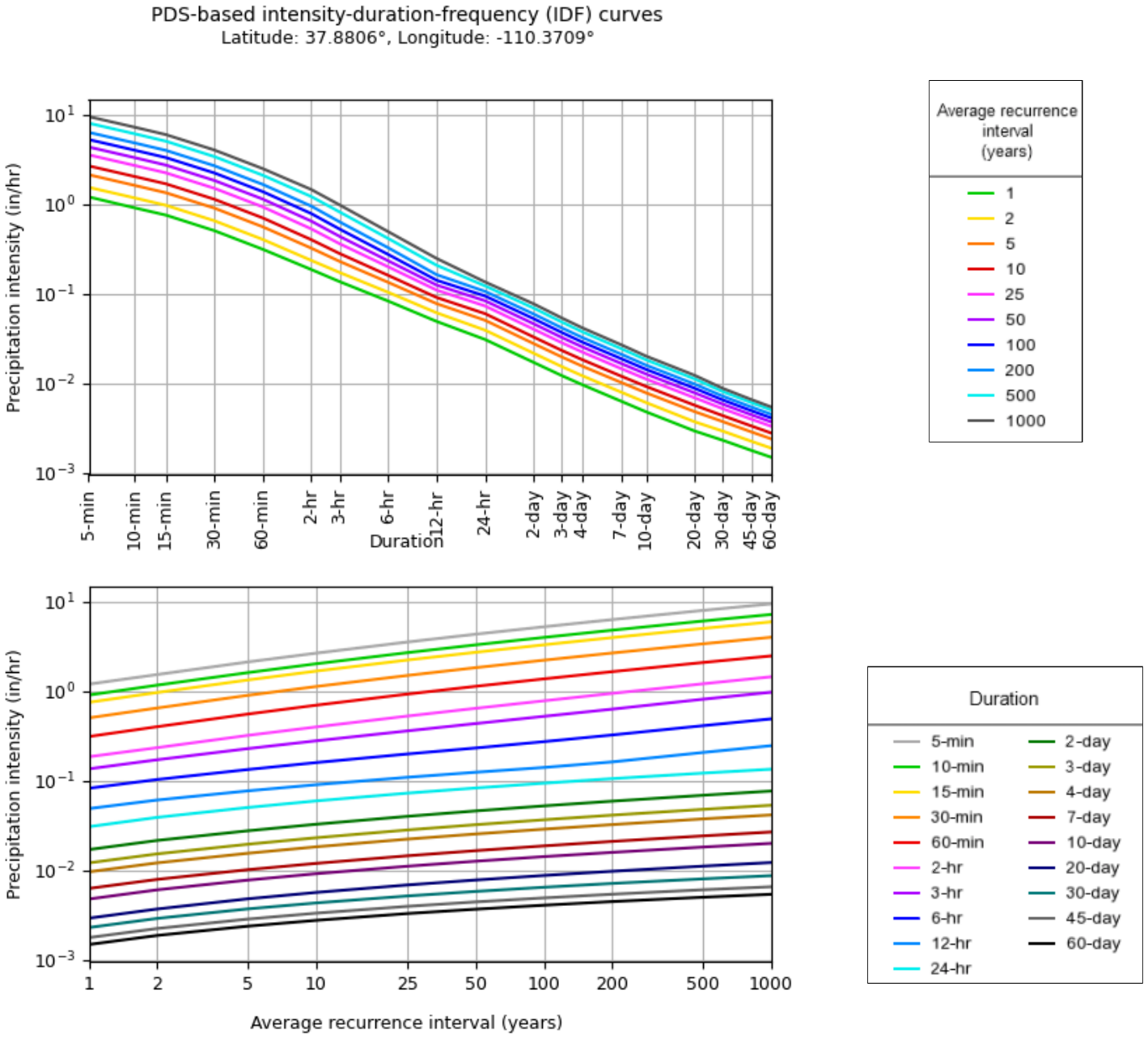
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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



NOAA Atlas 14, Volume 1, Version 5

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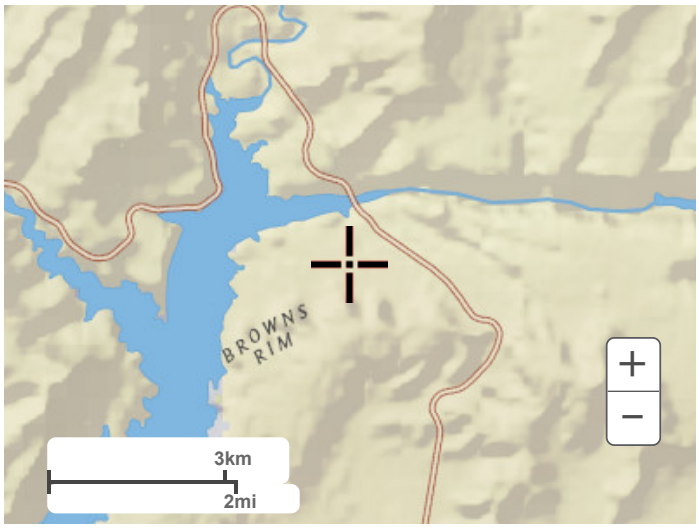
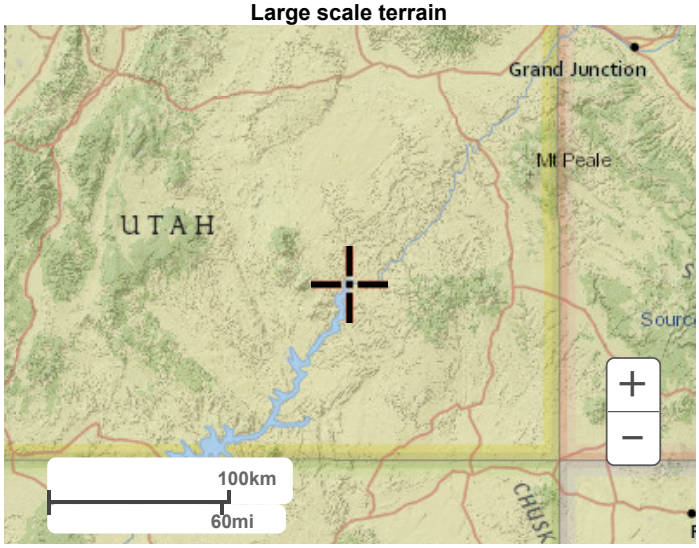
Back to Top

Maps & aerials

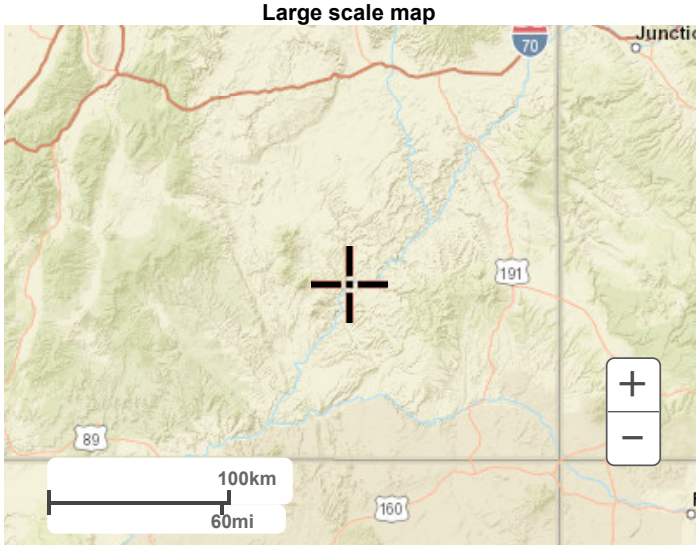
Small scale terrain



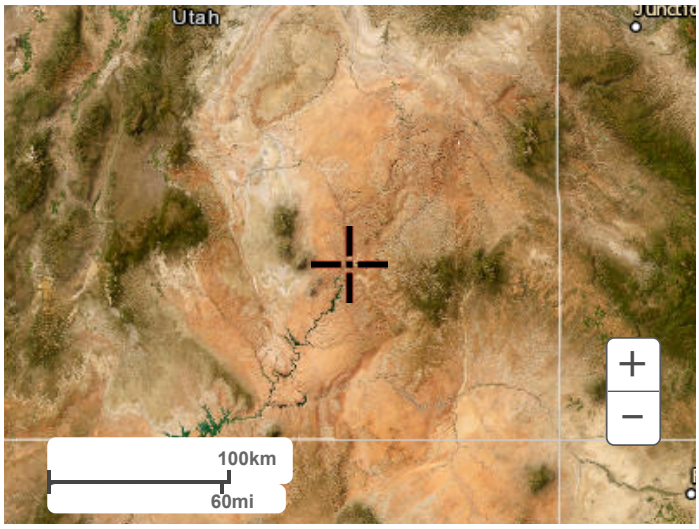
Large scale terrain



Large scale map



Large scale aerial



Back to Top

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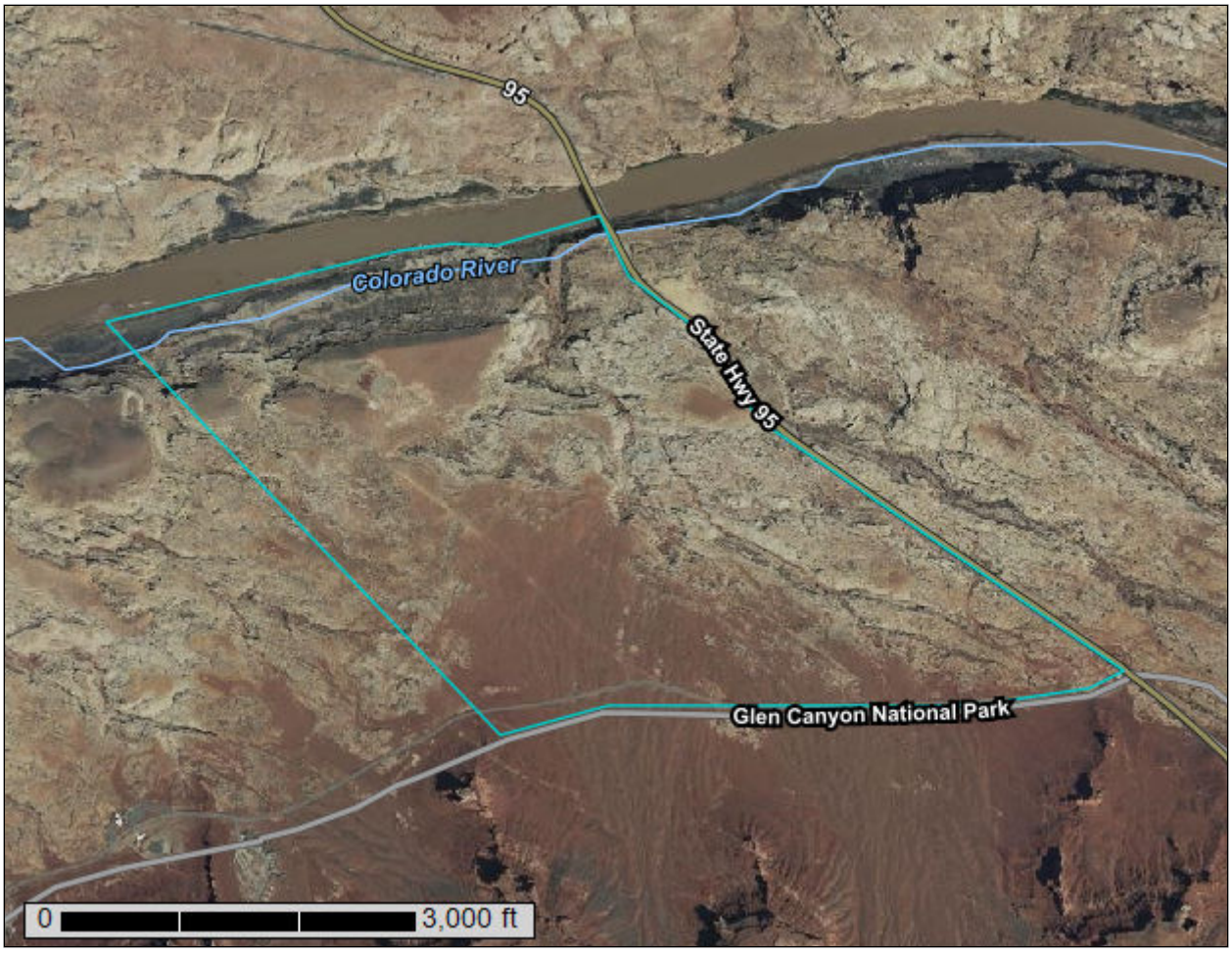
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Glen Canyon National Recreation Area



June 14, 2024

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

Preface.....2
How Soil Surveys Are Made.....5
Soil Map.....8
Soil Map.....9
Legend.....10
Map Unit Legend.....11
Map Unit Descriptions.....11
Glen Canyon National Recreation Area.....13
16—Myton very gravelly sandy loam, 5 to 18 percent slopes, very bouldery.....13
32—Rock outcrop-Needle complex, 2 to 30 percent slopes.....14
33—Rock outcrop-Torriorthents complex, 20 to 65 percent slopes, extremely bouldery.....15
39—Somorent family-Rock outcrop complex, 5 to 12 percent slopes.....16
45—Water.....17
Soil Information for All Uses.....18
Soil Properties and Qualities.....18
Soil Qualities and Features.....18
Hydrologic Soil Group.....18
References.....23

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

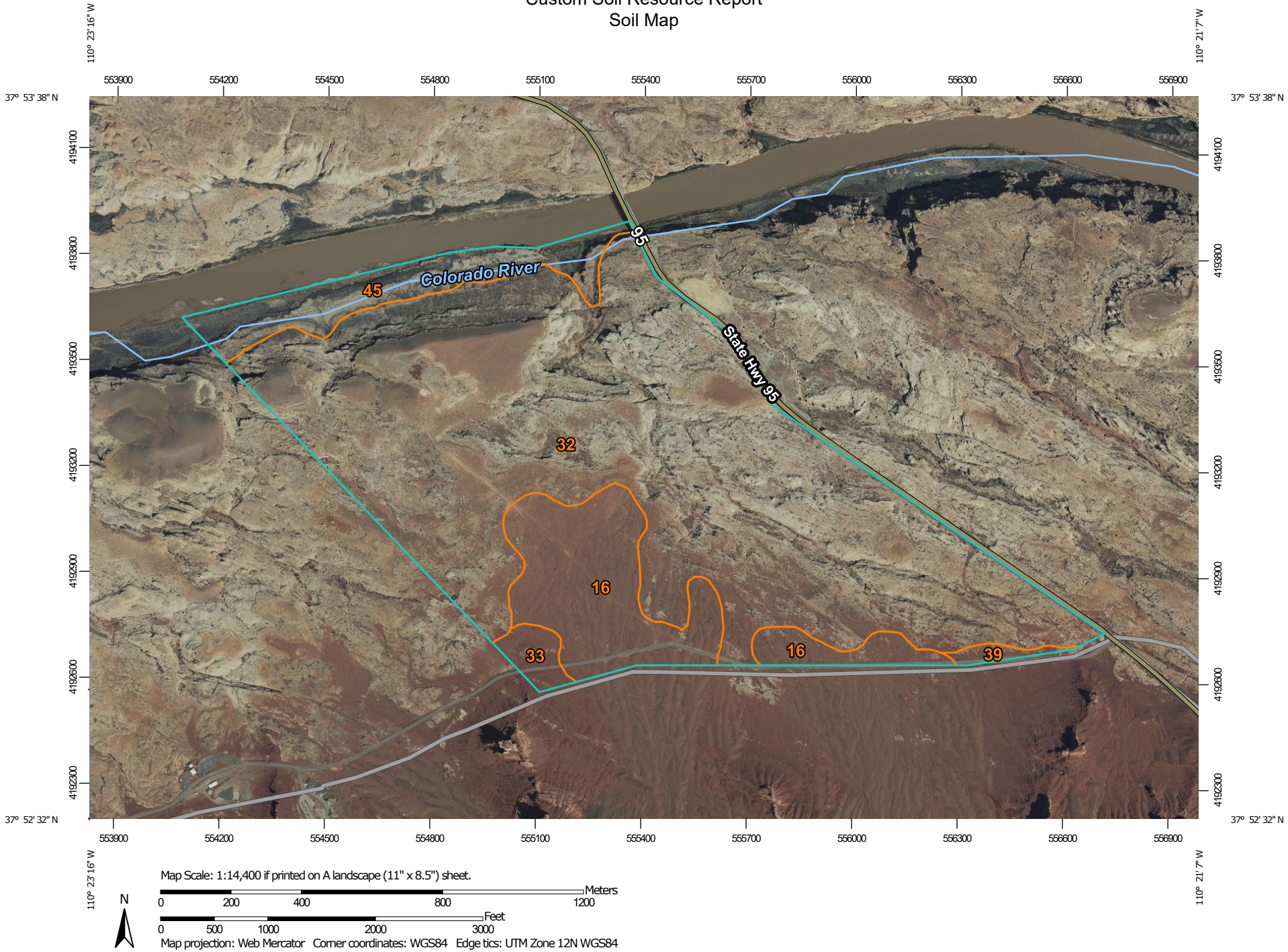
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

Soil Survey Area: Glen Canyon National Recreation Area
Survey Area Data: Version 13, Sep 9, 2023

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

Date(s) aerial images were photographed: Apr 15, 2022—Jun 6, 2022

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
16	Myton very gravelly sandy loam, 5 to 18 percent slopes, very bouldery	60.9	13.9%
32	Rock outcrop-Needle complex, 2 to 30 percent slopes	335.0	76.5%
33	Rock outcrop-Torriorthents complex, 20 to 65 percent slopes, extremely bouldery	6.3	1.4%
39	Somorent family-Rock outcrop complex, 5 to 12 percent slopes	2.8	0.6%
45	Water	32.6	7.5%
Totals for Area of Interest		**437.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it

was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Glen Canyon National Recreation Area

16—Myton very gravelly sandy loam, 5 to 18 percent slopes, very bouldery

Map Unit Setting

National map unit symbol: 2dvlg
Elevation: 3,150 to 4,000 feet
Mean annual precipitation: 6 to 10 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 150 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Myton and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Myton

Setting

Landform: Plateaus
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Colluvium and/or slope alluvium derived from sandstone and shale

Typical profile

C1 - 0 to 2 inches: very gravelly sandy loam
C2 - 2 to 7 inches: gravelly sandy loam
C3 - 7 to 30 inches: extremely gravelly loamy sand
C4 - 30 to 47 inches: very gravelly loamy coarse sand
C5 - 47 to 60 inches: very gravelly loam
C6 - 60 to 64 inches: very stony sandy loam

Properties and qualities

Slope: 5 to 18 percent
Surface area covered with cobbles, stones or boulders: 4.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: A
Ecological site: R035XY136UT - Desert Stony Loam (Shadscale-Bud Sagebrush)

Minor Components

Unnamed soils
Percent of map unit: 5 percent
Hydric soil rating: No

32—Rock outcrop-Needle complex, 2 to 30 percent slopes

Map Unit Setting
National map unit symbol: 2dvl9
Elevation: 3,670 to 5,310 feet
Mean annual precipitation: 6 to 10 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 150 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition
Rock outcrop: 60 percent
Needle and similar soils: 35 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Needle

Setting
Landform: Plateaus
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Eolian sands derived from sandstone

Typical profile
A - 0 to 1 inches: sand
C - 1 to 11 inches: sand
R - 11 to 21 inches: bedrock

Properties and qualities
Slope: 2 to 30 percent
Depth to restrictive feature: 4 to 12 inches to lithic bedrock
Drainage class: Excessively drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 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: 2 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Very low (about 0.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: D
Ecological site: R035XB255AZ - Sandstone Rockland 6-10" p.z.
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 5 percent
Hydric soil rating: No

33—Rock outcrop-Torriorthents complex, 20 to 65 percent slopes, extremely bouldery

Map Unit Setting

National map unit symbol: 2dvlc
Elevation: 3,120 to 4,200 feet
Mean annual precipitation: 6 to 10 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 150 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Rock outcrop: 60 percent
Torriorthents and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Torriorthents

Setting

Landform: Plateaus
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Sandy and gravelly talus derived from sandstone and shale

Typical profile

A - 0 to 2 inches: channery loam
C1 - 2 to 10 inches: very flaggy coarse sandy loam
C2 - 10 to 17 inches: extremely parachannery coarse sandy loam
Cr - 17 to 27 inches: bedrock

Properties and qualities

Slope: 20 to 65 percent
Surface area covered with cobbles, stones or boulders: 15.0 percent
Depth to restrictive feature: 4 to 20 inches to paralithic bedrock
Drainage class: Somewhat excessively drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 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: 5 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Very low (about 1.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: D
Ecological site: R035XY018UT - Talus Slope (Blackbrush-Shadscale)
Hydric soil rating: No

39—Somorent family-Rock outcrop complex, 5 to 12 percent slopes

Map Unit Setting

National map unit symbol: 2dvlh
Elevation: 3,120 to 4,000 feet
Mean annual precipitation: 6 to 10 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 150 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Somorent family and similar soils: 85 percent
Rock outcrop: 10 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Somorent Family

Setting

Landform: Plateaus
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Eolian sands and/or residuum weathered from sandstone and shale

Typical profile

A - 0 to 2 inches: channery sandy loam
Cy - 2 to 7 inches: parachannery sandy loam
Cr - 7 to 17 inches: bedrock

Properties and qualities

Slope: 5 to 12 percent
Depth to restrictive feature: 7 to 15 inches to paralithic bedrock
Drainage class: Somewhat excessively drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 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: 5 percent
Gypsum, maximum content: 5 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Very low (about 0.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: D
Ecological site: R035XY130UT - Desert Shallow Sandy Loam (Shadscale)
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 5 percent
Hydric soil rating: No

45—Water

Map Unit Setting

National map unit symbol: 2krx5
Elevation: 3,130 to 3,700 feet
Mean annual precipitation: 6 to 10 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 150 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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.

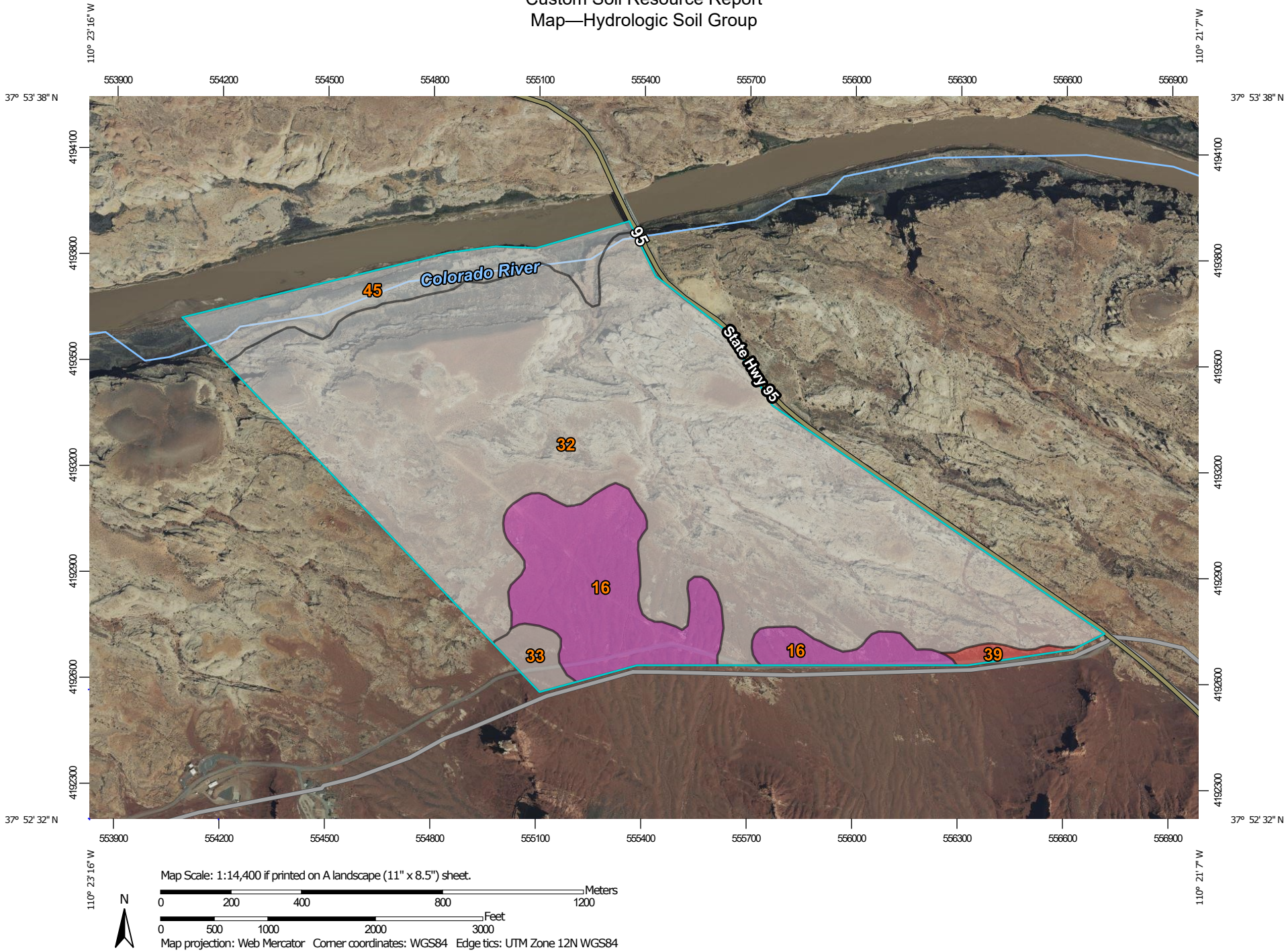
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

Custom Soil Resource Report
Map—Hydrologic Soil Group



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:
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: Glen Canyon National Recreation Area
Survey Area Data: Version 13, Sep 9, 2023

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

Date(s) aerial images were photographed: Apr 15, 2022—Jun 6, 2022

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.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
16	Myton very gravelly sandy loam, 5 to 18 percent slopes, very bouldery	A	60.9	13.9%
32	Rock outcrop-Needle complex, 2 to 30 percent slopes		335.0	76.5%
33	Rock outcrop-Torriorthents complex, 20 to 65 percent slopes, extremely bouldery		6.3	1.4%
39	Somorent family-Rock outcrop complex, 5 to 12 percent slopes	D	2.8	0.6%
45	Water		32.6	7.5%
Totals for Area of Interest			**437.6**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Project: Antelope_Hite
Simulation Run: 5YR Hite
Simulation Start: 31 December 1999, 24:00
Simulation End: 2 January 2000, 24:00

HMS Version: 4.10
Executed: 11 April 2025, 19:50

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Bh01	0.06
Bh02	0.01
Bh03	0.01
Bh04	0.03
Bh05	0.02

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number
Bh01	25.5	86.05
Bh02	27	86.19
Bh03	26.8	86.18
Bh04	39.3	87.3
Bh05	26	86.1

Transform: Scs

Element Name	Lag	Unitgraph Type
Bh01	11.13	Standard
Bh02	8.73	Standard
Bh03	9.84	Standard
Bh04	12.13	Standard
Bh05	7.06	Standard

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)

Bh01	0.06	22.46	01Jan2000, 12:05	0.54
Bh02	0.01	2.57	01Jan2000, 12:02	0.56
Bh03	0.01	4.37	01Jan2000, 12:03	0.56
Bh04	0.03	14.67	01Jan2000, 12:05	0.69
Bh05	0.02	8.2	01Jan2000, 12:01	0.55

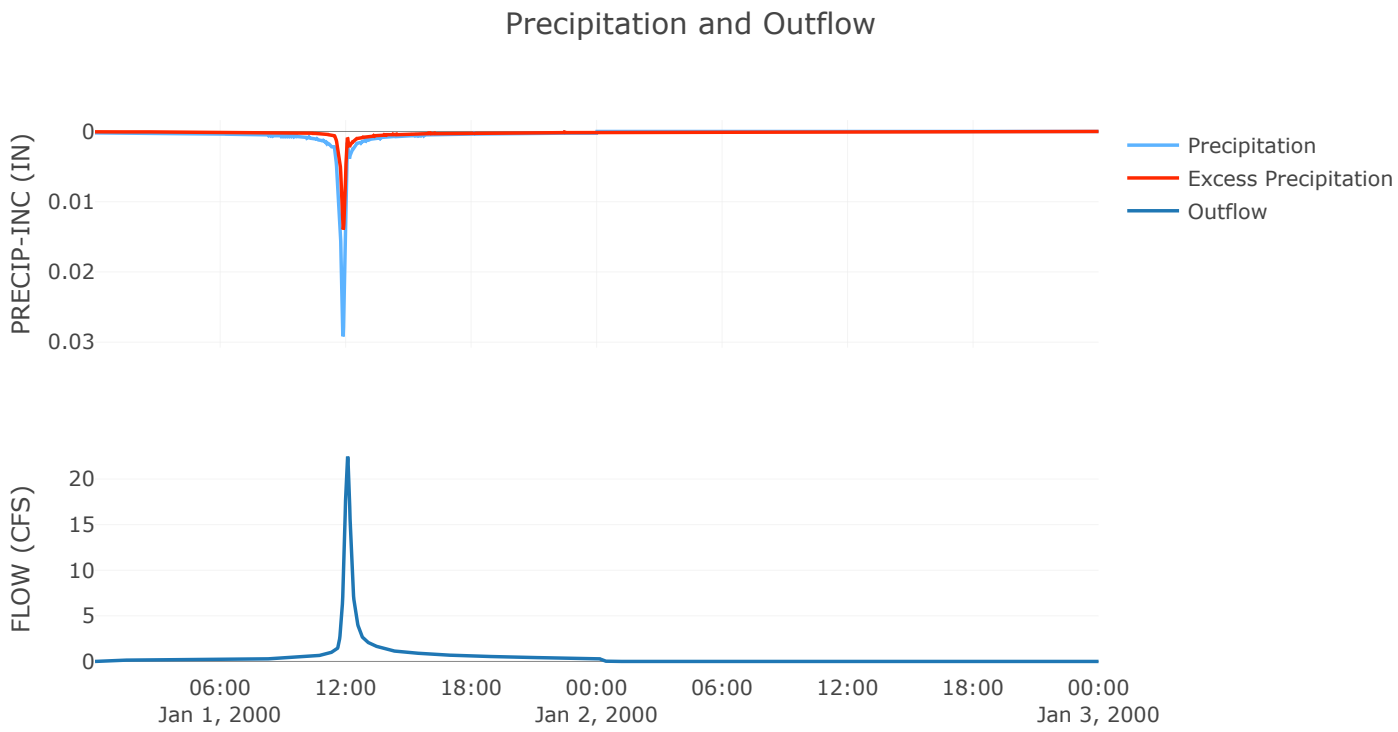
Subbasin: BH01

Area (MI2) : 0.06

Loss Rate: Scs	
Percent Impervious Area	25.5
Curve Number	86.05

Transform: Scs	
Lag	11.13
Unitgraph Type	Standard

Results: BH01	
Peak Discharge (CFS)	22.46
Time of Peak Discharge	01Jan2000, 12:05
Volume (IN)	0.54
Precipitation Volume (AC - FT)	4.07
Loss Volume (AC - FT)	2.25
Excess Volume (AC - FT)	1.82
Direct Runoff Volume (AC - FT)	1.82
Baseflow Volume (AC - FT)	0



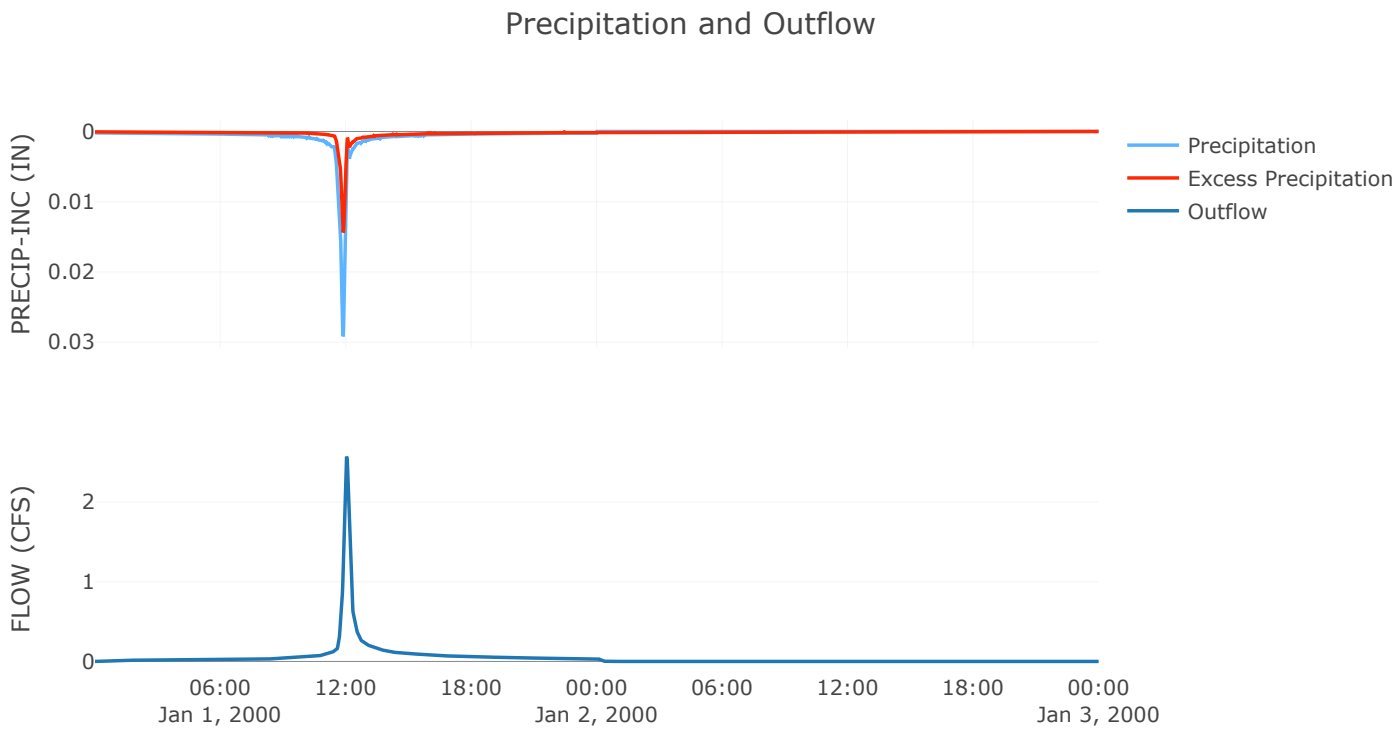
Subbasin: BH02

Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	27
Curve Number	86.19

Transform: Scs	
Lag	8.73
Unitgraph Type	Standard

Results: BH02	
Peak Discharge (CFS)	2.57
Time of Peak Discharge	01Jan2000, 12:02
Volume (IN)	0.56
Precipitation Volume (AC - FT)	0.41
Loss Volume (AC - FT)	0.22
Excess Volume (AC - FT)	0.19
Direct Runoff Volume (AC - FT)	0.19
Baseflow Volume (AC - FT)	0



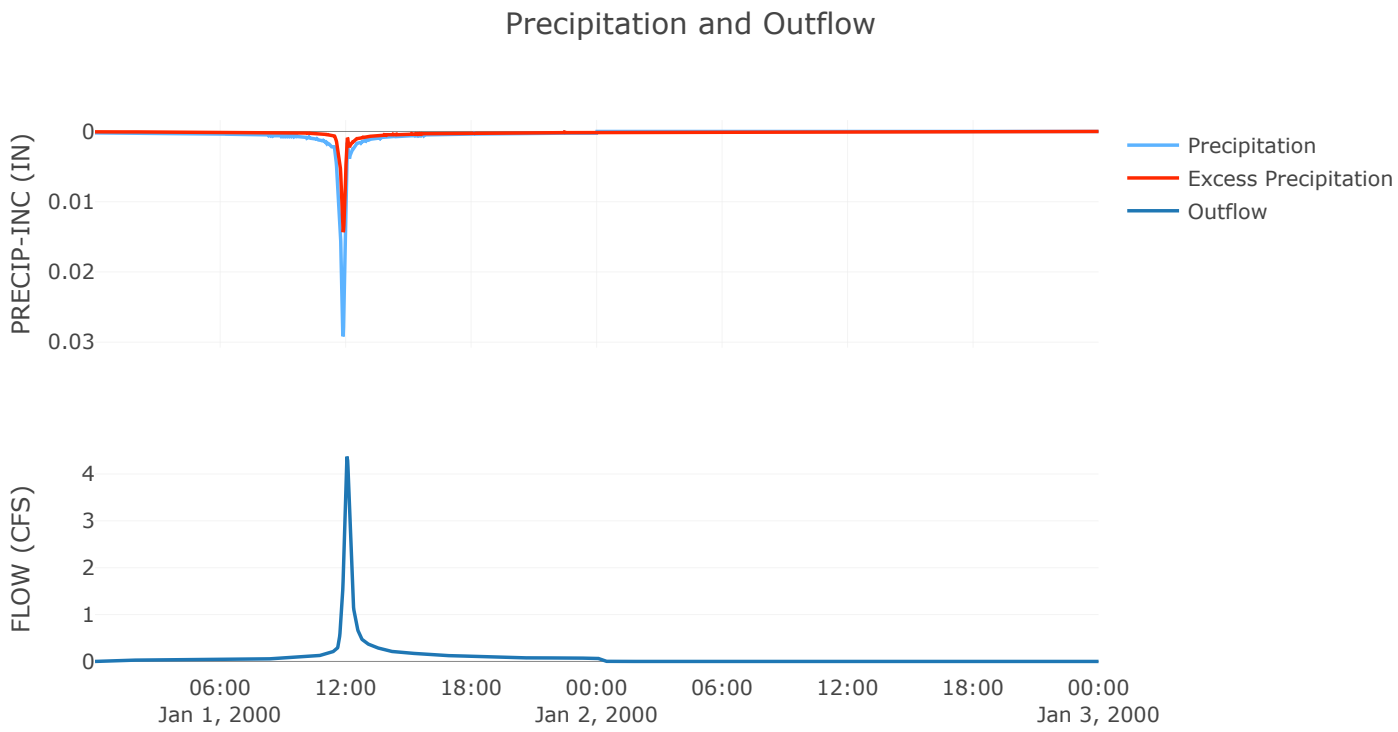
Subbasin: BH03

Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	26.8
Curve Number	86.18

Transform: Scs	
Lag	9.84
Unitgraph Type	Standard

Results: BH03	
Peak Discharge (CFS)	4.37
Time of Peak Discharge	01Jan2000, 12:03
Volume (IN)	0.56
Precipitation Volume (AC - FT)	0.73
Loss Volume (AC - FT)	0.39
Excess Volume (AC - FT)	0.34
Direct Runoff Volume (AC - FT)	0.34
Baseflow Volume (AC - FT)	0



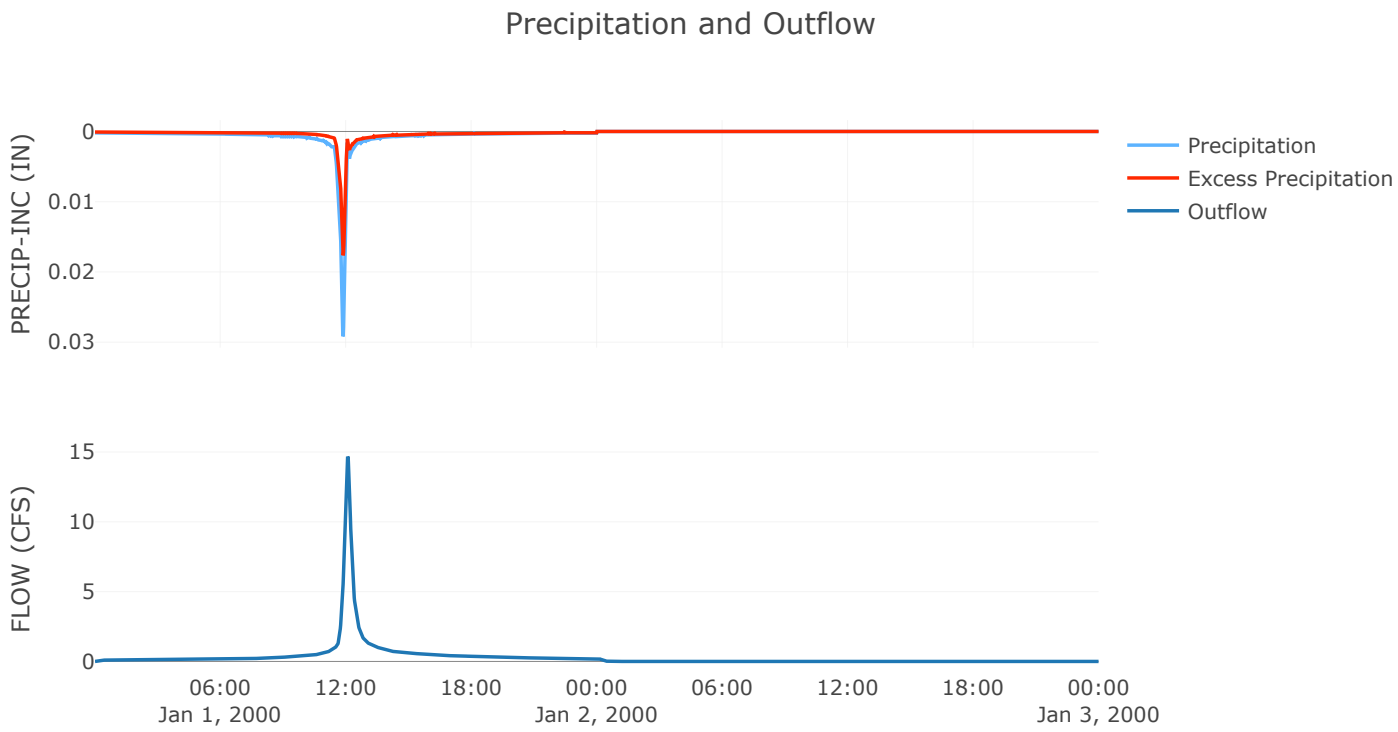
Subbasin: BH04

Area (MI2) : 0.03

Loss Rate: Scs	
Percent Impervious Area	39.3
Curve Number	87.3

Transform: Scs	
Lag	12.13
Unitgraph Type	Standard

Results: BH04	
Peak Discharge (CFS)	14.67
Time of Peak Discharge	01Jan2000, 12:05
Volume (IN)	0.69
Precipitation Volume (AC - FT)	2.16
Loss Volume (AC - FT)	0.93
Excess Volume (AC - FT)	1.23
Direct Runoff Volume (AC - FT)	1.23
Baseflow Volume (AC - FT)	0



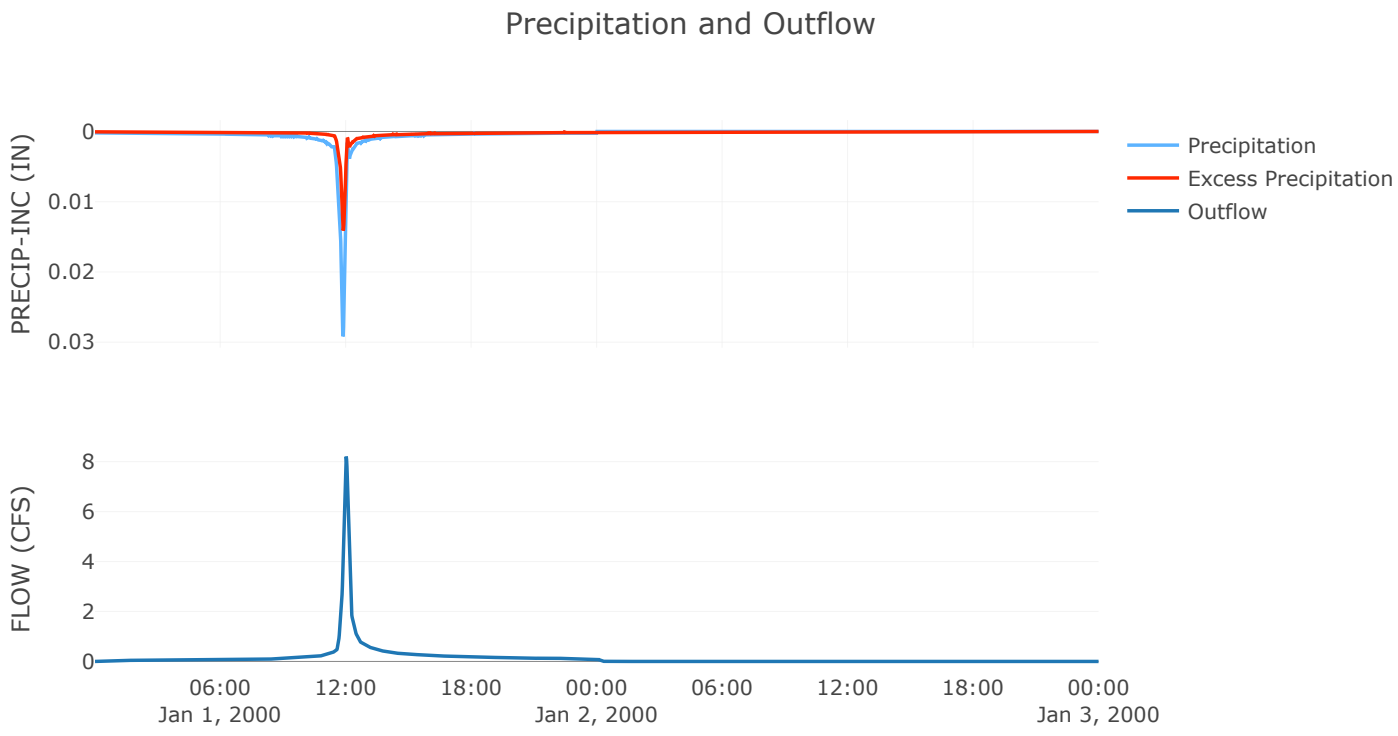
Subbasin: BH05

Area (MI2) : 0.02

Loss Rate: Scs	
Percent Impervious Area	26
Curve Number	86.1

Transform: Scs	
Lag	7.06
Unitgraph Type	Standard

Results: BH05	
Peak Discharge (CFS)	8.2
Time of Peak Discharge	01Jan2000, 12:01
Volume (IN)	0.55
Precipitation Volume (AC - FT)	1.24
Loss Volume (AC - FT)	0.68
Excess Volume (AC - FT)	0.56
Direct Runoff Volume (AC - FT)	0.56
Baseflow Volume (AC - FT)	0



Project: Antelope_Hite
Simulation Run: 10YR Hite
Simulation Start: 31 December 1999, 24:00
Simulation End: 2 January 2000, 24:00

HMS Version: 4.10
Executed: 11 April 2025, 19:25

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Bh01	0.06
Bh02	0.01
Bh03	0.01
Bh04	0.03
Bh05	0.02

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number
Bh01	25.5	86.05
Bh02	27	86.19
Bh03	26.8	86.18
Bh04	39.3	87.3
Bh05	26	86.1

Transform: Scs

Element Name	Lag	Unitgraph Type
Bh01	11.13	Standard
Bh02	8.73	Standard
Bh03	9.84	Standard
Bh04	12.13	Standard
Bh05	7.06	Standard

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)

Bh01	0.06	29.79	01Jan2000, 12:05	0.7
Bh02	0.01	3.39	01Jan2000, 12:02	0.72
Bh03	0.01	5.77	01Jan2000, 12:03	0.72
Bh04	0.03	18.7	01Jan2000, 12:05	0.87
Bh05	0.02	10.84	01Jan2000, 12:01	0.71

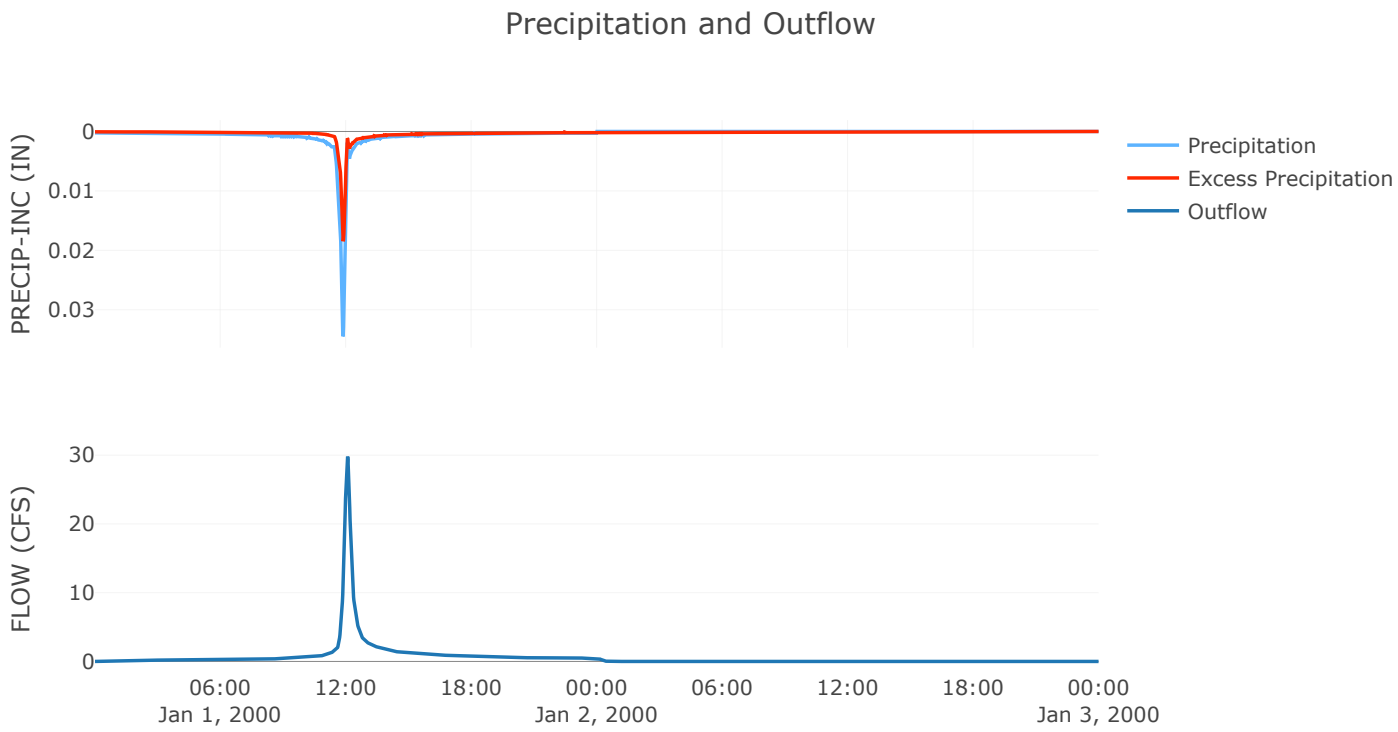
Subbasin: BH01

Area (MI2) : 0.06

Loss Rate: Scs	
Percent Impervious Area	25.5
Curve Number	86.05

Transform: Scs	
Lag	11.13
Unitgraph Type	Standard

Results: BH01	
Peak Discharge (CFS)	29.79
Time of Peak Discharge	01Jan2000, 12:05
Volume (IN)	0.7
Precipitation Volume (AC - FT)	4.81
Loss Volume (AC - FT)	2.46
Excess Volume (AC - FT)	2.35
Direct Runoff Volume (AC - FT)	2.35
Baseflow Volume (AC - FT)	0



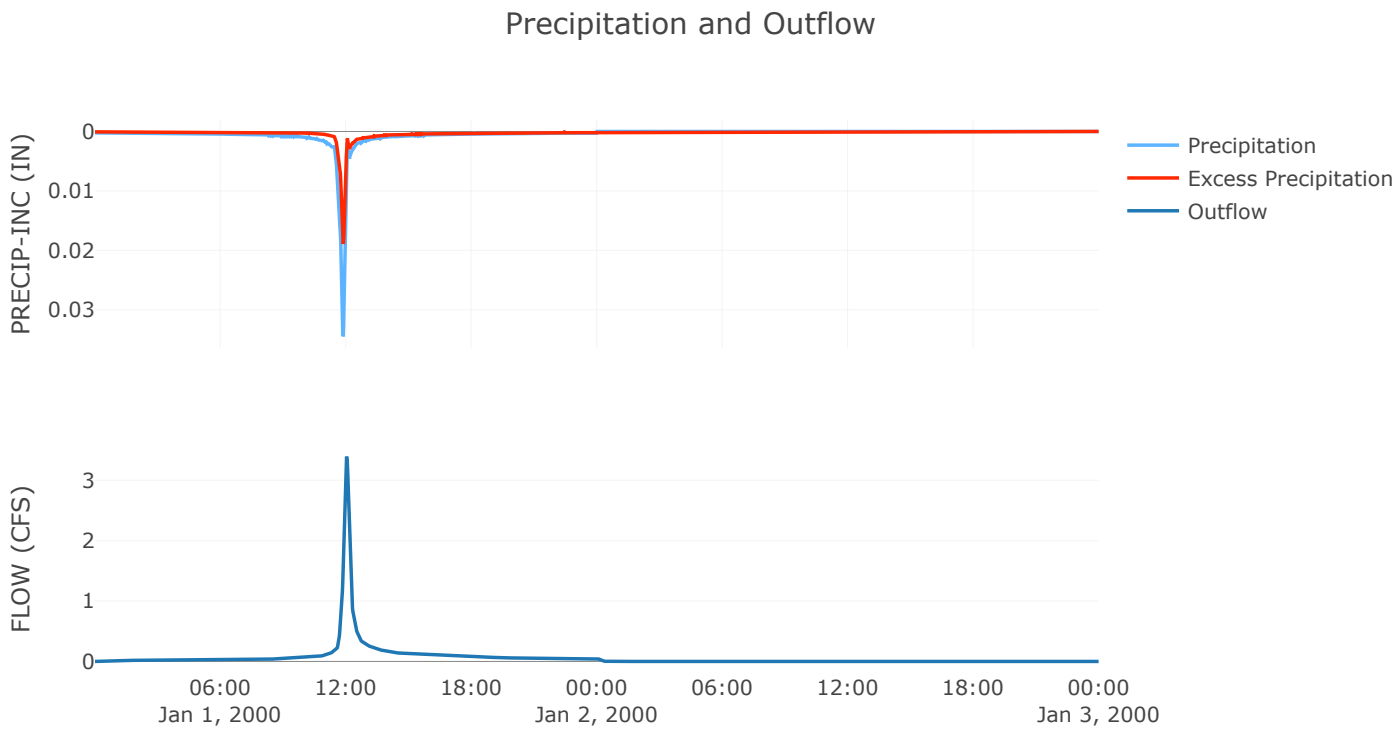
Subbasin: BH02

Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	27
Curve Number	86.19

Transform: Scs	
Lag	8.73
Unitgraph Type	Standard

Results: BH02	
Peak Discharge (CFS)	3.39
Time of Peak Discharge	01Jan2000, 12:02
Volume (IN)	0.72
Precipitation Volume (AC - FT)	0.48
Loss Volume (AC - FT)	0.24
Excess Volume (AC - FT)	0.24
Direct Runoff Volume (AC - FT)	0.24
Baseflow Volume (AC - FT)	0



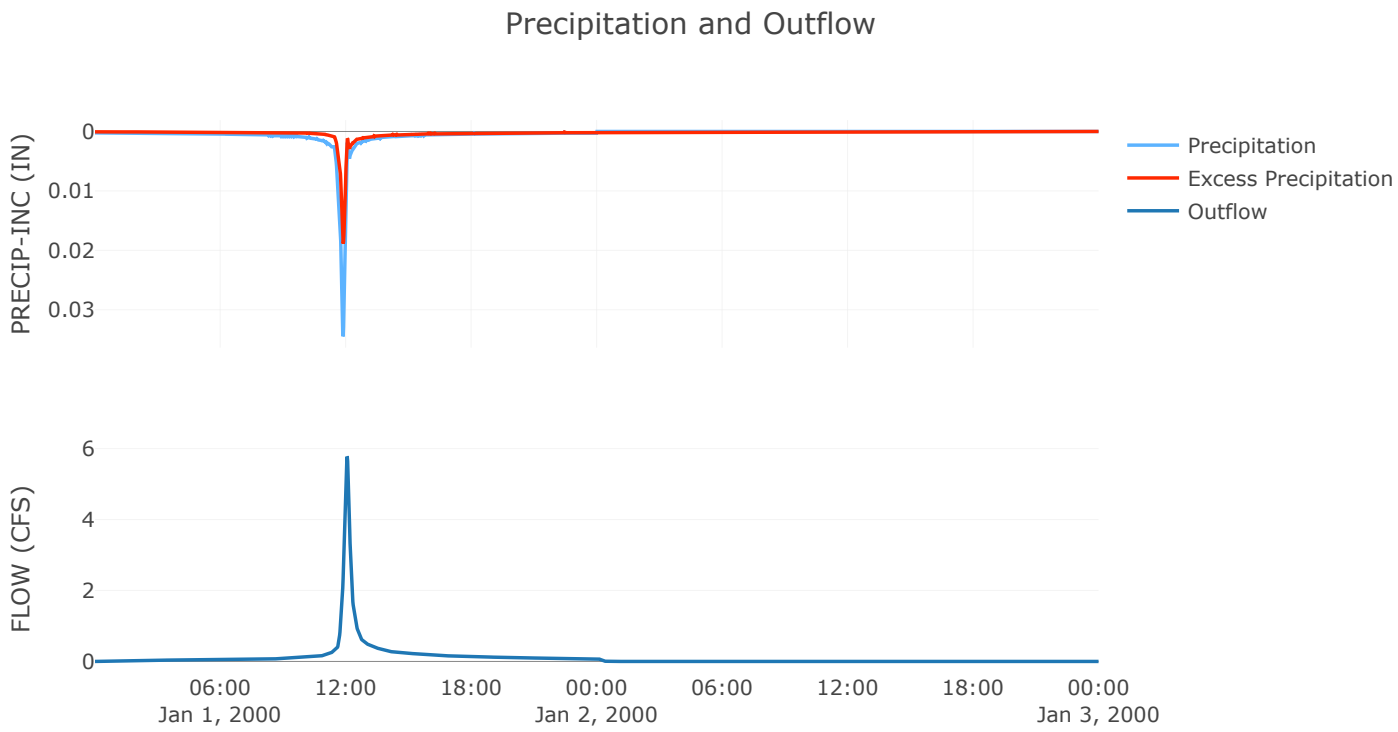
Subbasin: BH03

Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	26.8
Curve Number	86.18

Transform: Scs	
Lag	9.84
Unitgraph Type	Standard

Results: BH03	
Peak Discharge (CFS)	5.77
Time of Peak Discharge	01Jan2000, 12:03
Volume (IN)	0.72
Precipitation Volume (AC - FT)	0.86
Loss Volume (AC - FT)	0.43
Excess Volume (AC - FT)	0.43
Direct Runoff Volume (AC - FT)	0.43
Baseflow Volume (AC - FT)	0



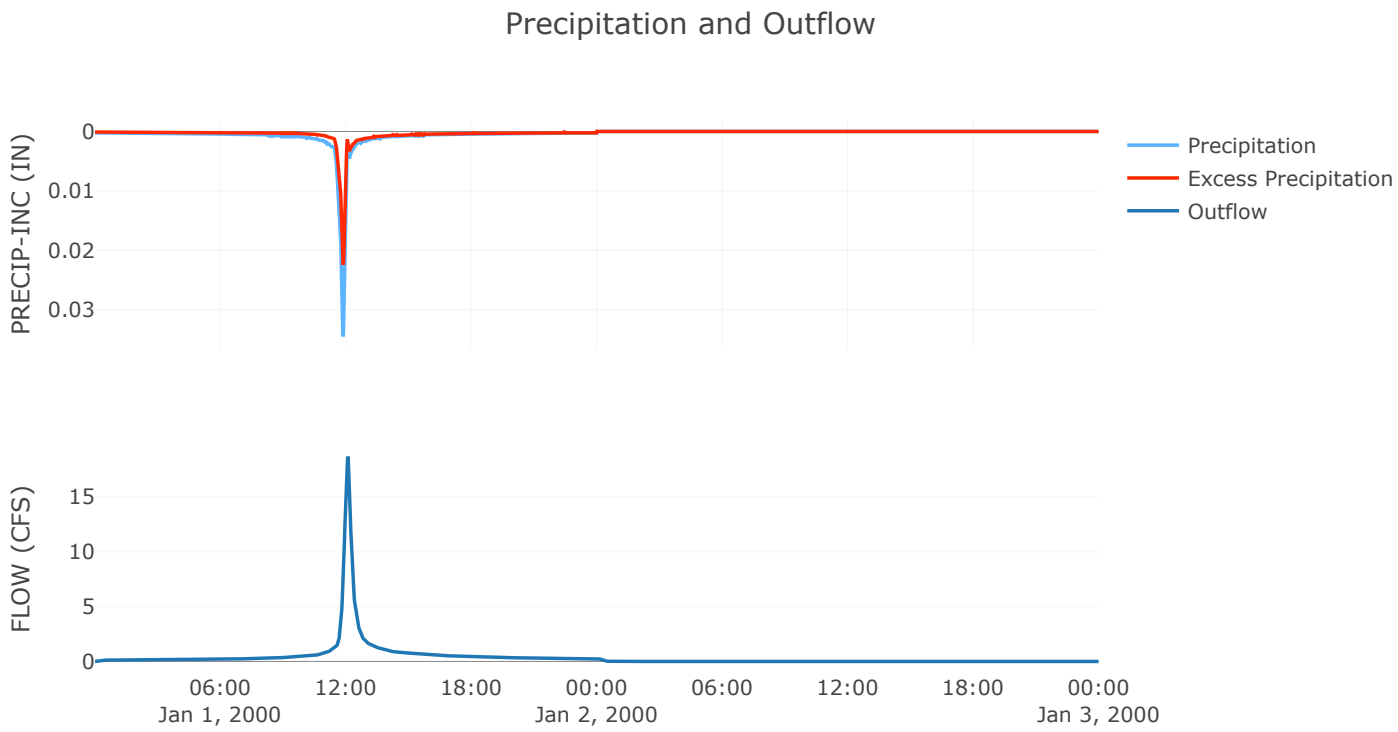
Subbasin: BH04

Area (MI2) : 0.03

Loss Rate: Scs	
Percent Impervious Area	39.3
Curve Number	87.3

Transform: Scs	
Lag	12.13
Unitgraph Type	Standard

Results: BH04	
Peak Discharge (CFS)	18.7
Time of Peak Discharge	01Jan2000, 12:05
Volume (IN)	0.87
Precipitation Volume (AC - FT)	2.55
Loss Volume (AC - FT)	1.01
Excess Volume (AC - FT)	1.54
Direct Runoff Volume (AC - FT)	1.54
Baseflow Volume (AC - FT)	0



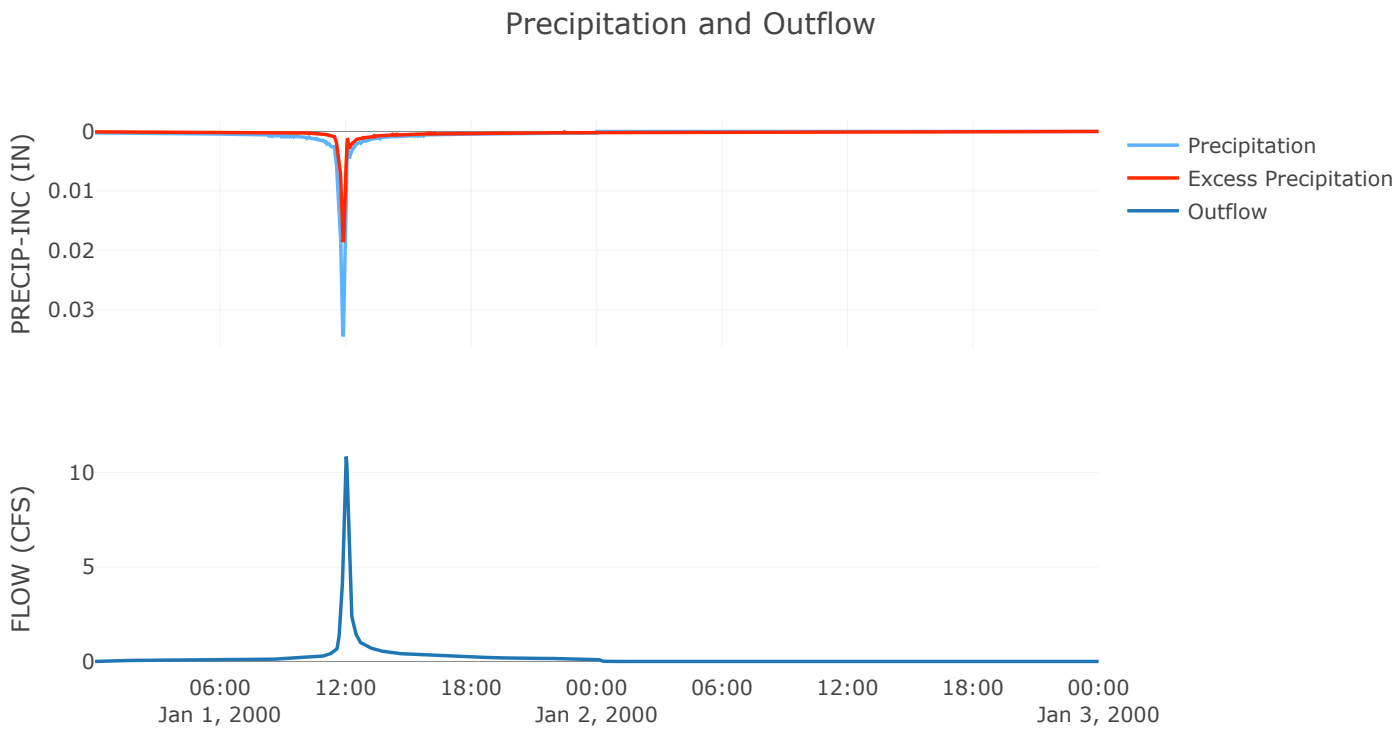
Subbasin: BH05

Area (MI2) : 0.02

Loss Rate: Scs	
Percent Impervious Area	26
Curve Number	86.1

Transform: Scs	
Lag	7.06
Unitgraph Type	Standard

Results: BH05	
Peak Discharge (CFS)	10.84
Time of Peak Discharge	01Jan2000, 12:01
Volume (IN)	0.71
Precipitation Volume (AC - FT)	1.46
Loss Volume (AC - FT)	0.74
Excess Volume (AC - FT)	0.72
Direct Runoff Volume (AC - FT)	0.72
Baseflow Volume (AC - FT)	0



Project: Antelope_Hite
Simulation Run: 50YR Hite
Simulation Start: 31 December 1999, 24:00
Simulation End: 2 January 2000, 24:00

HMS Version: 4.10
Executed: 11 April 2025, 19:53

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Bh01	0.06
Bh02	0.01
Bh03	0.01
Bh04	0.03
Bh05	0.02

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number
Bh01	25.5	86.05
Bh02	27	86.19
Bh03	26.8	86.18
Bh04	39.3	87.3
Bh05	26	86.1

Transform: Scs

Element Name	Lag	Unitgraph Type
Bh01	11.13	Standard
Bh02	8.73	Standard
Bh03	9.84	Standard
Bh04	12.13	Standard
Bh05	7.06	Standard

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)

Bh01	0.06	50.24	01Jan2000, 12:04	1.14
Bh02	0.01	5.66	01Jan2000, 12:02	1.16
Bh03	0.01	9.66	01Jan2000, 12:03	1.16
Bh04	0.03	29.6	01Jan2000, 12:05	1.34
Bh05	0.02	18.14	01Jan2000, 12:01	1.14

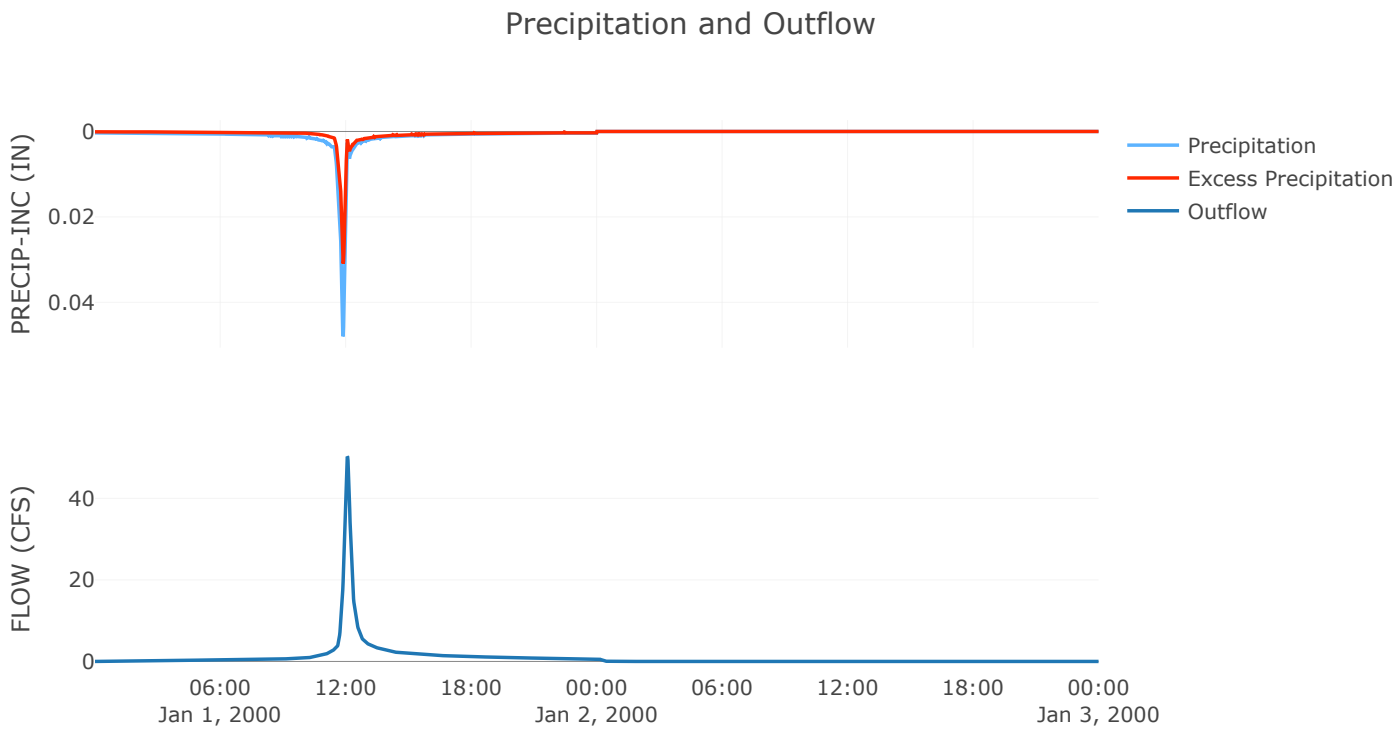
Subbasin: BH01

Area (MI2) : 0.06

Loss Rate: Scs	
Percent Impervious Area	25.5
Curve Number	86.05

Transform: Scs	
Lag	11.13
Unitgraph Type	Standard

Results: BH01	
Peak Discharge (CFS)	50.24
Time of Peak Discharge	01Jan2000, 12:04
Volume (IN)	1.14
Precipitation Volume (AC - FT)	6.69
Loss Volume (AC - FT)	2.87
Excess Volume (AC - FT)	3.82
Direct Runoff Volume (AC - FT)	3.82
Baseflow Volume (AC - FT)	0



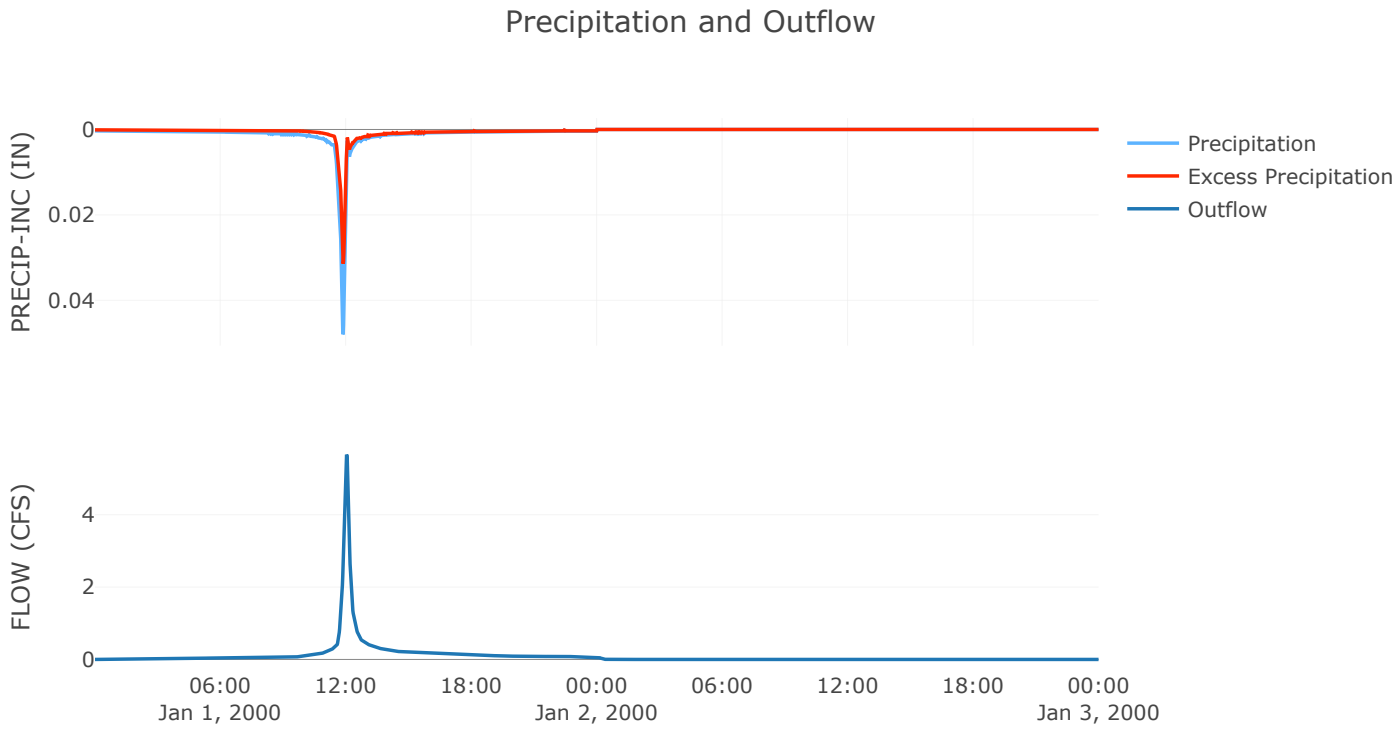
Subbasin: BH02

Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	27
Curve Number	86.19

Transform: Scs	
Lag	8.73
Unitgraph Type	Standard

Results: BH02	
Peak Discharge (CFS)	5.66
Time of Peak Discharge	01Jan2000, 12:02
Volume (IN)	1.16
Precipitation Volume (AC - FT)	0.67
Loss Volume (AC - FT)	0.28
Excess Volume (AC - FT)	0.39
Direct Runoff Volume (AC - FT)	0.39
Baseflow Volume (AC - FT)	0



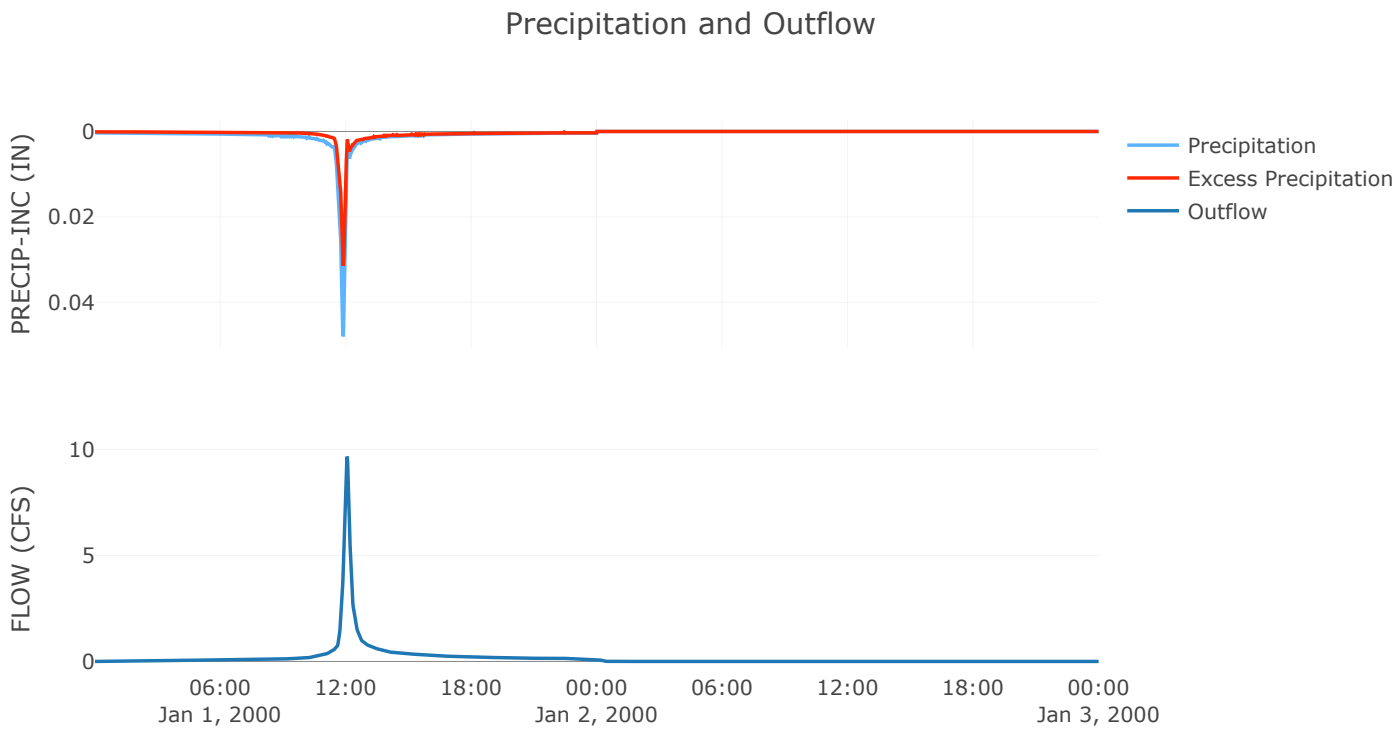
Subbasin: BH03

Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	26.8
Curve Number	86.18

Transform: Scs	
Lag	9.84
Unitgraph Type	Standard

Results: BH03	
Peak Discharge (CFS)	9.66
Time of Peak Discharge	01Jan2000, 12:03
Volume (IN)	1.16
Precipitation Volume (AC - FT)	1.2
Loss Volume (AC - FT)	0.5
Excess Volume (AC - FT)	0.7
Direct Runoff Volume (AC - FT)	0.7
Baseflow Volume (AC - FT)	0



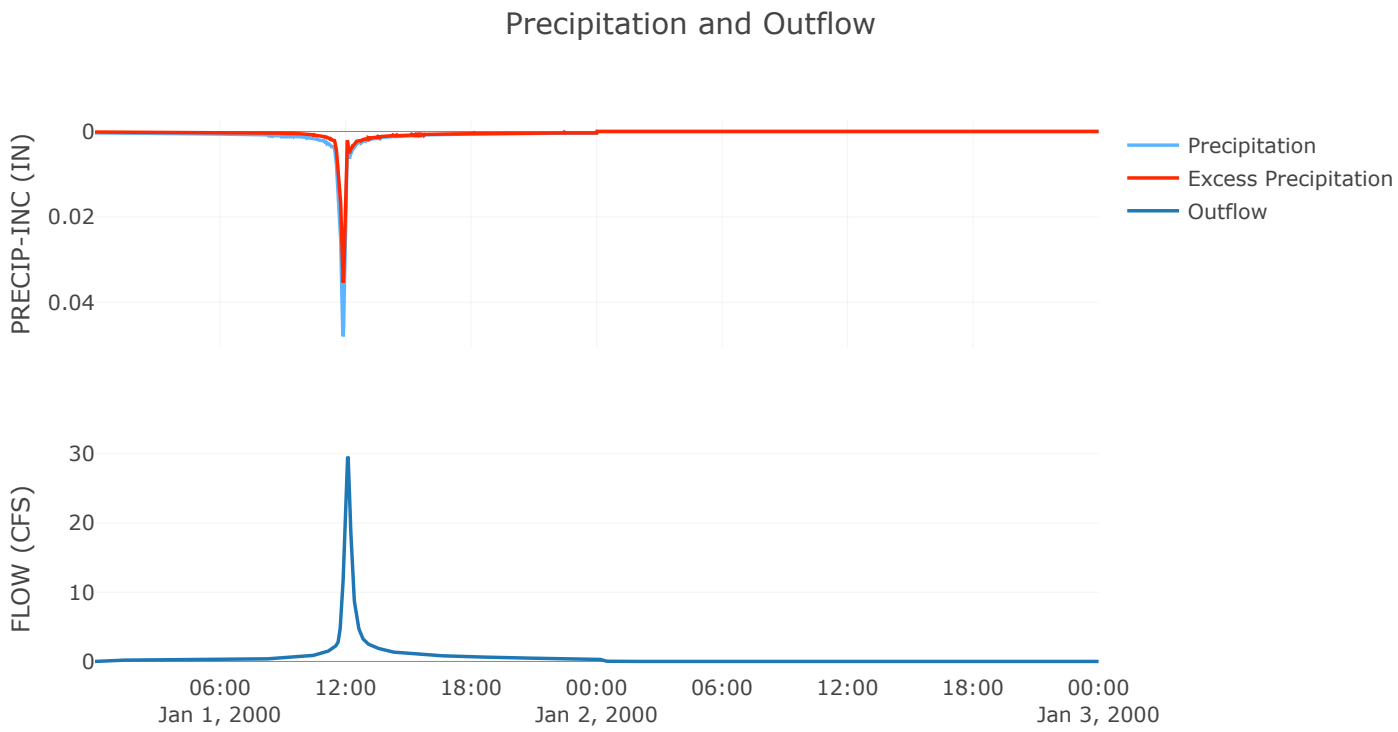
Subbasin: BH04

Area (MI2) : 0.03

Loss Rate: Scs	
Percent Impervious Area	39.3
Curve Number	87.3

Transform: Scs	
Lag	12.13
Unitgraph Type	Standard

Results: BH04	
Peak Discharge (CFS)	29.6
Time of Peak Discharge	01Jan2000, 12:05
Volume (IN)	1.34
Precipitation Volume (AC - FT)	3.55
Loss Volume (AC - FT)	1.16
Excess Volume (AC - FT)	2.39
Direct Runoff Volume (AC - FT)	2.39
Baseflow Volume (AC - FT)	0



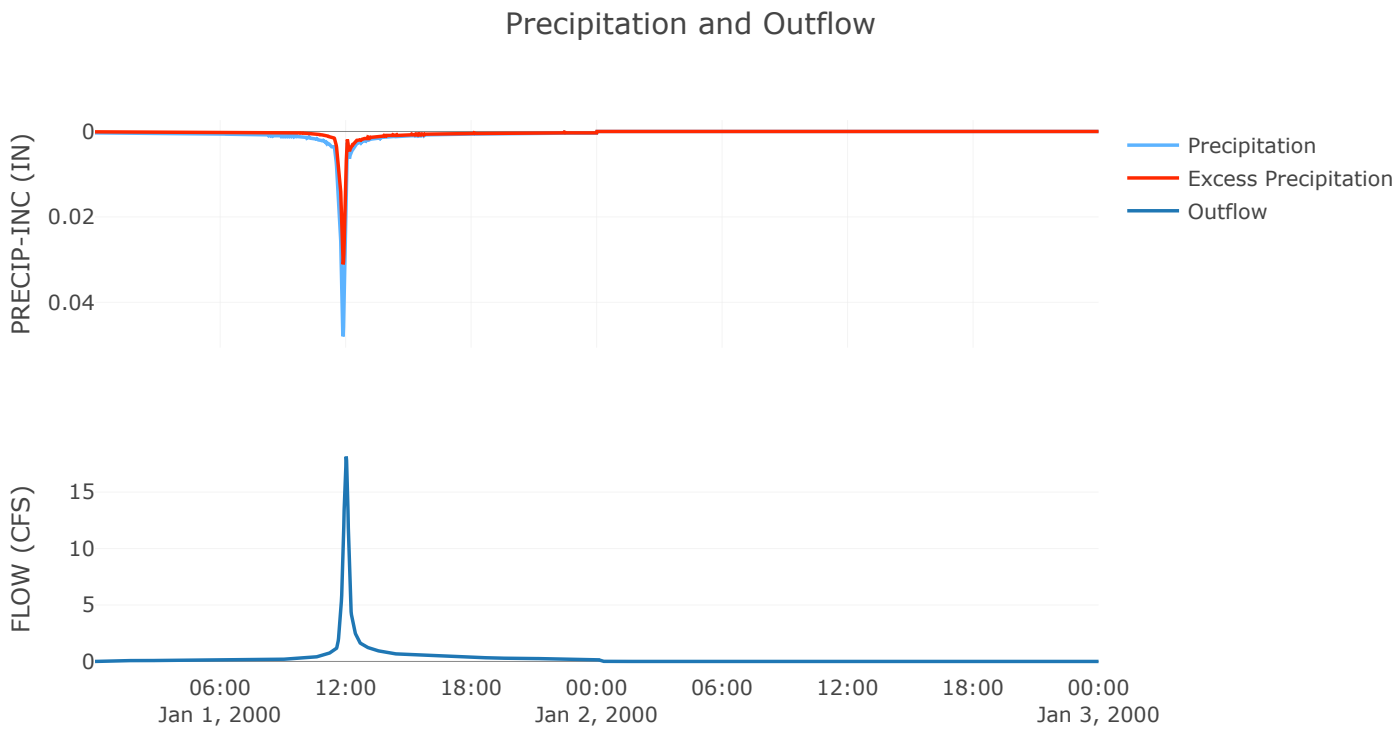
Subbasin: BH05

Area (MI2) : 0.02

Loss Rate: Scs	
Percent Impervious Area	26
Curve Number	86.1

Transform: Scs	
Lag	7.06
Unitgraph Type	Standard

Results: BH05	
Peak Discharge (CFS)	18.14
Time of Peak Discharge	01Jan2000, 12:01
Volume (IN)	1.14
Precipitation Volume (AC - FT)	2.03
Loss Volume (AC - FT)	0.86
Excess Volume (AC - FT)	1.17
Direct Runoff Volume (AC - FT)	1.17
Baseflow Volume (AC - FT)	0



Project: Antelope_Hite
Simulation Run: 100YR Hite
Simulation Start: 31 December 1999, 24:00
Simulation End: 2 January 2000, 24:00

HMS Version: 4.10
Executed: 11 April 2025, 19:49

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Bh01	0.06
Bh02	0.01
Bh03	0.01
Bh04	0.03
Bh05	0.02

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number
Bh01	25.5	86.05
Bh02	27	86.19
Bh03	26.8	86.18
Bh04	39.3	87.3
Bh05	26	86.1

Transform: Scs

Element Name	Lag	Unitgraph Type
Bh01	11.13	Standard
Bh02	8.73	Standard
Bh03	9.84	Standard
Bh04	12.13	Standard
Bh05	7.06	Standard

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)

Bh01	0.06	60.69	01Jan2000, 12:04	1.36
Bh02	0.01	6.82	01Jan2000, 12:02	1.39
Bh03	0.01	11.64	01Jan2000, 12:03	1.38
Bh04	0.03	35.07	01Jan2000, 12:05	1.58
Bh05	0.02	21.86	01Jan2000, 12:00	1.37

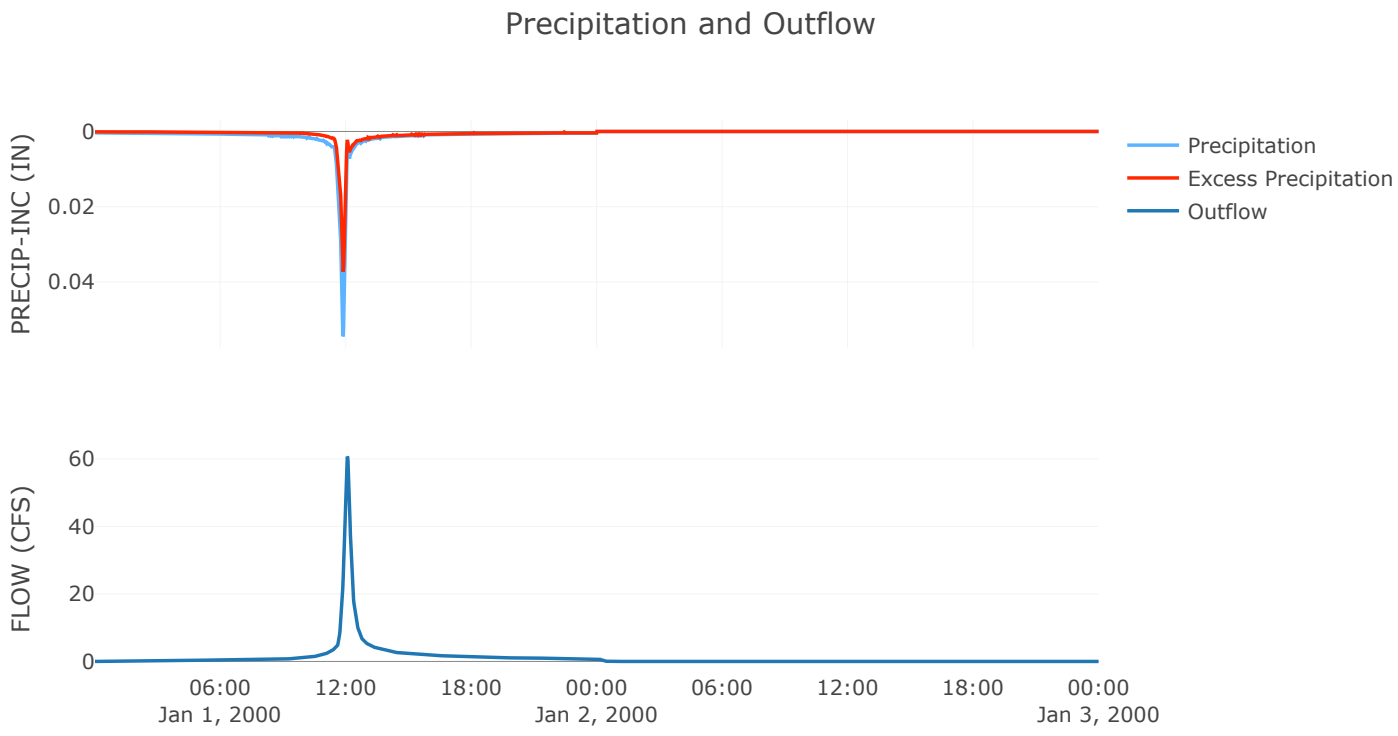
Subbasin: BH01

Area (MI2) : 0.06

Loss Rate: Scs	
Percent Impervious Area	25.5
Curve Number	86.05

Transform: Scs	
Lag	11.13
Unitgraph Type	Standard

Results: BH01	
Peak Discharge (CFS)	60.69
Time of Peak Discharge	01Jan2000, 12:04
Volume (IN)	1.36
Precipitation Volume (AC - FT)	7.6
Loss Volume (AC - FT)	3.02
Excess Volume (AC - FT)	4.58
Direct Runoff Volume (AC - FT)	4.58
Baseflow Volume (AC - FT)	0



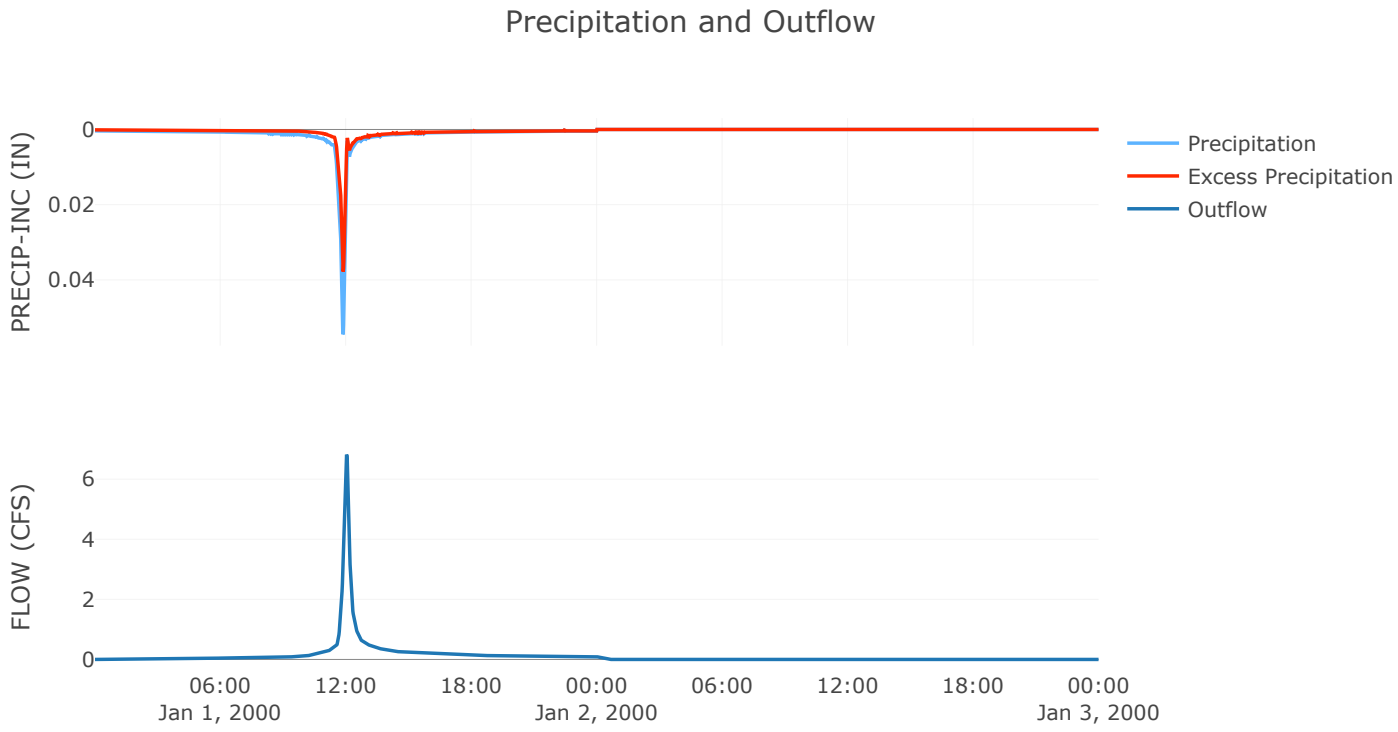
Subbasin: BH02

Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	27
Curve Number	86.19

Transform: Scs	
Lag	8.73
Unitgraph Type	Standard

Results: BH02	
Peak Discharge (CFS)	6.82
Time of Peak Discharge	01Jan2000, 12:02
Volume (IN)	1.39
Precipitation Volume (AC - FT)	0.76
Loss Volume (AC - FT)	0.29
Excess Volume (AC - FT)	0.47
Direct Runoff Volume (AC - FT)	0.47
Baseflow Volume (AC - FT)	0



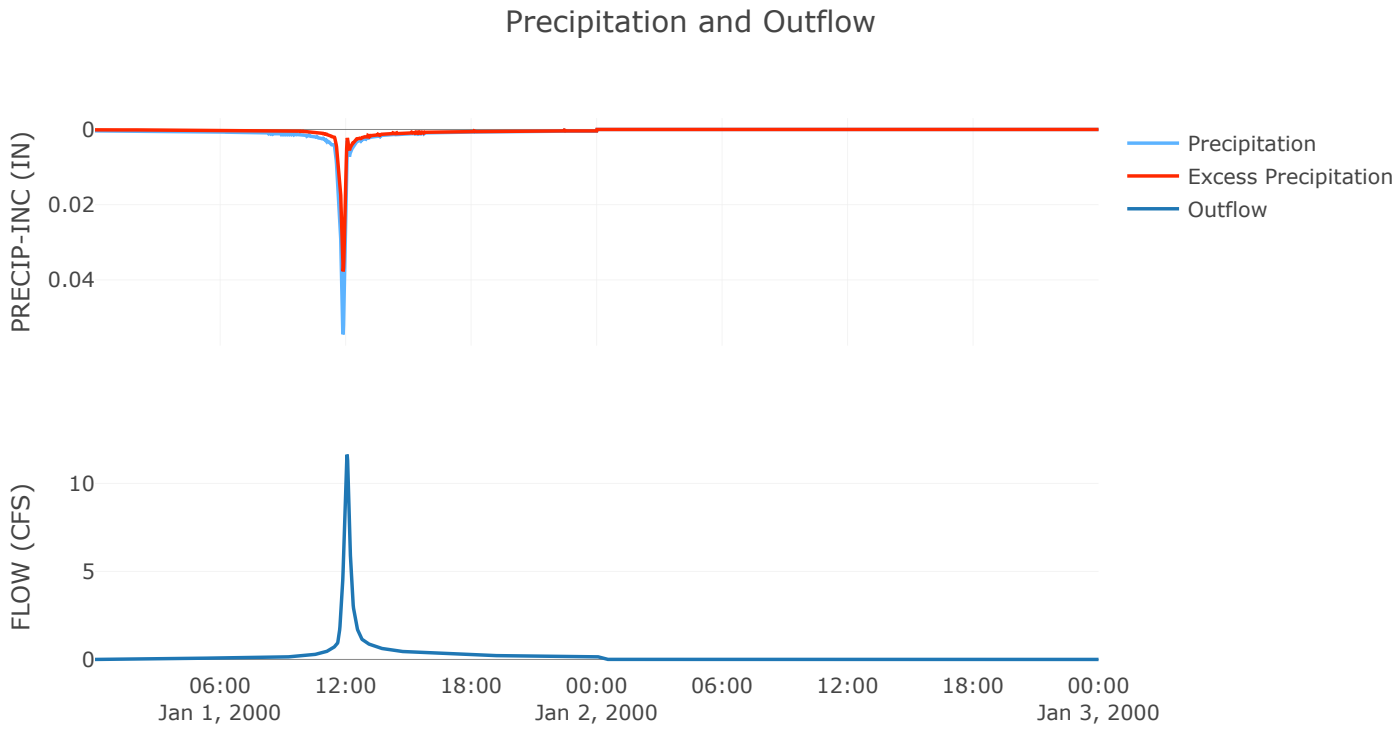
Subbasin: BH03

Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	26.8
Curve Number	86.18

Transform: Scs	
Lag	9.84
Unitgraph Type	Standard

Results: BH03	
Peak Discharge (CFS)	11.64
Time of Peak Discharge	01Jan2000, 12:03
Volume (IN)	1.38
Precipitation Volume (AC - FT)	1.36
Loss Volume (AC - FT)	0.53
Excess Volume (AC - FT)	0.83
Direct Runoff Volume (AC - FT)	0.83
Baseflow Volume (AC - FT)	0



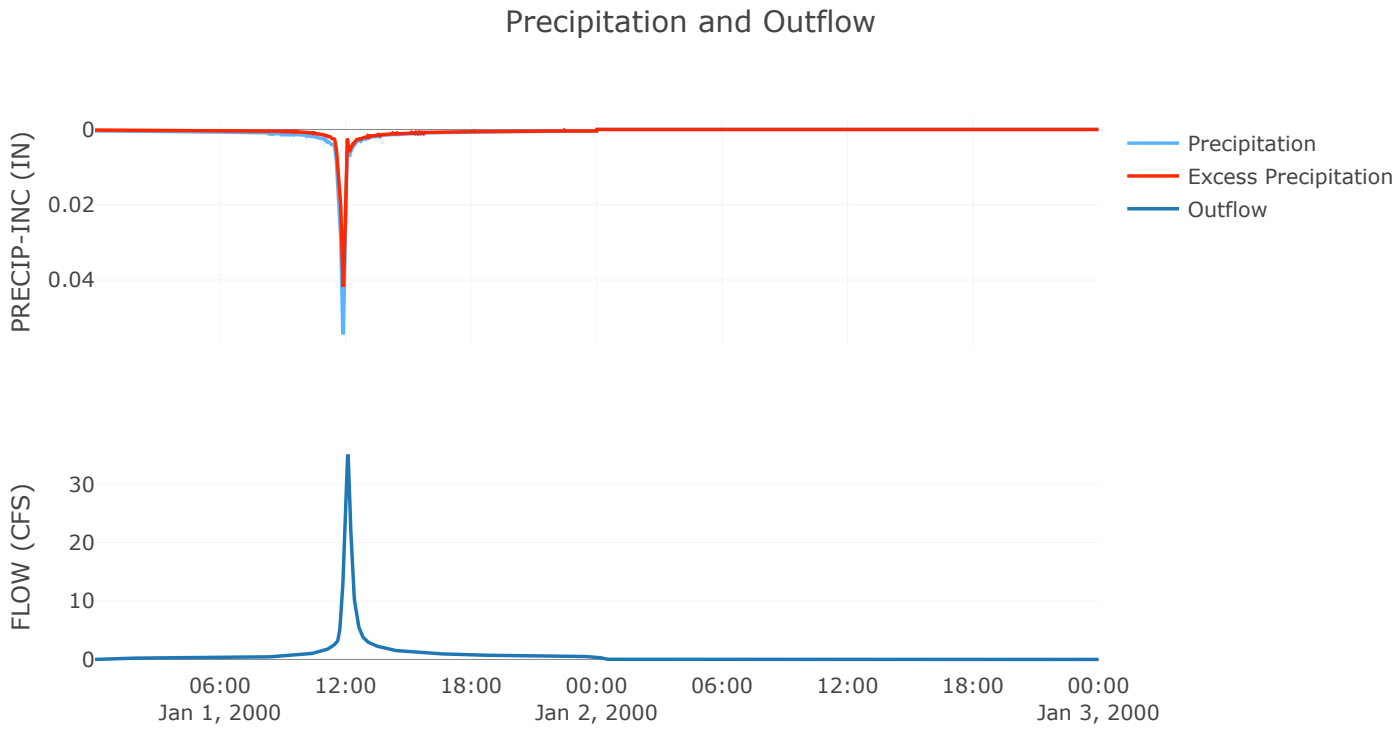
Subbasin: BH04

Area (MI2) : 0.03

Loss Rate: Scs	
Percent Impervious Area	39.3
Curve Number	87.3

Transform: Scs	
Lag	12.13
Unitgraph Type	Standard

Results: BH04	
Peak Discharge (CFS)	35.07
Time of Peak Discharge	01Jan2000, 12:05
Volume (IN)	1.58
Precipitation Volume (AC - FT)	4.03
Loss Volume (AC - FT)	1.22
Excess Volume (AC - FT)	2.81
Direct Runoff Volume (AC - FT)	2.81
Baseflow Volume (AC - FT)	0



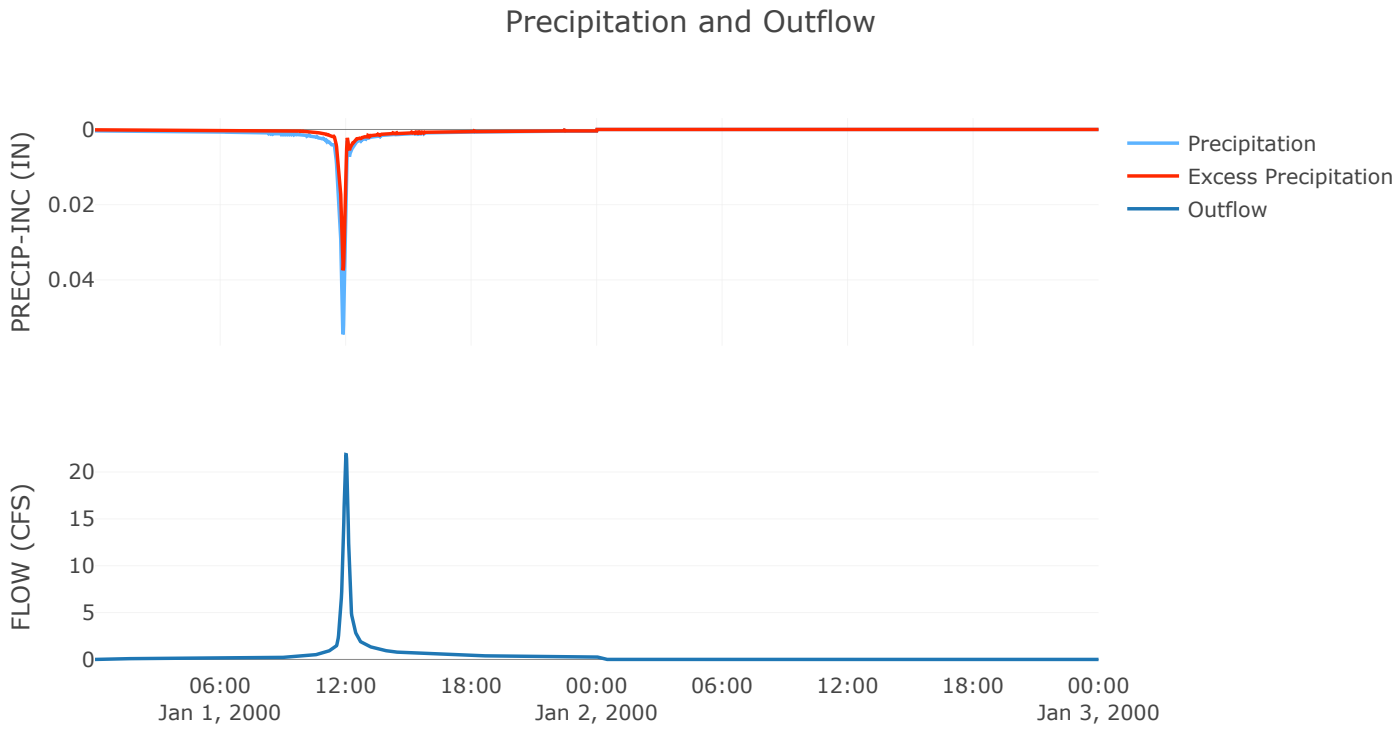
Subbasin: BH05

Area (MI2) : 0.02

Loss Rate: Scs	
Percent Impervious Area	26
Curve Number	86.1

Transform: Scs	
Lag	7.06
Unitgraph Type	Standard

Results: BH05	
Peak Discharge (CFS)	21.86
Time of Peak Discharge	01Jan2000, 12:00
Volume (IN)	1.37
Precipitation Volume (AC - FT)	2.31
Loss Volume (AC - FT)	0.91
Excess Volume (AC - FT)	1.4
Direct Runoff Volume (AC - FT)	1.4
Baseflow Volume (AC - FT)	0



Composite C Calculations

Project Name	**GLCA Low Water Ramps - Hite**							Project No.	**D3167674**
Revised Date	**4/14/2025**							Calculated by	**TAB**
		Pond Area	100%	Impervious	**Roof Area**	100%	Impervious		
		Landscape Area	25%	Impervious	**Gravel Area**	80%	Impervious		
		Paved Area	95%	Impervious	**Rock**	95%	Impervious		

Basin Designation	A_{Pond} (ft^2)	$A_{Landscape}$ (ft^2)	A_{Paved} (ft^2)	A_{Roof} (ft^2)	A_{Gravel} (ft^2)	A_{Rock} (ft^2)	A_{total} (acres)	Impervious %	$C_{C/D}$ 02 yr	$C_{C/D}$ 05 yr	$C_{C/D}$ 10 yr	$C_{C/D}$ 25 yr	$C_{C/D}$ 50 yr	$C_{C/D}$ 100 yr
BH01	0	1743818	9924	0	4245	0	40.36	25.5%	-	-	-	-	-	-
BH02	0	170823	3266	0	2146	0	4.05	27.0%	-	-	-	-	-	-
BH03	0	306059	4208	0	5112	0	7.24	26.8%	-	-	-	-	-	-
BH04	0	690734	0	0	241960	0	21.41	39.3%	-	-	-	-	-	-
BH05	0	523858	0	0	9977	0	12.26	26.0%	-	-	-	-	-	-
BH05A	0	238172	0	0	9977	0	5.70	27.2%	0.19	0.26	0.33	0.47	0.53	0.60
BH05B	0	285690	0	0	0	0	6.56	25.0%	0.18	0.24	0.32	0.46	0.52	0.59
BH06	0	143906	0	0	0	0	3.30	25.0%	0.18	0.24	0.32	0.46	0.52	0.59
BH07	0	0	17777	0	6139	173899	4.54	94.5%	0.78	0.81	0.83	0.85	0.86	0.87
BH08	0	0	27260	0	6431	80442	2.62	94.2%	0.78	0.80	0.82	0.85	0.86	0.87

Time of Concentration

Project Name **GLCA Low Water Ramps - Hite**
Revised Date **4/14/2025**
$t_i = (0.42/P_2^{1/2})*(nL/S^{1/2})^{0.8}$
$t_t = L/(60V)$

$$t_c = \frac{\alpha}{P_2^{0.5}} \left(\frac{nL}{\sqrt{S}}\right)^{0.8} \qquad T_t = \frac{L}{60V}$$

Computed $t_c = t_i + t_t$

Project No. **D3167674**
Calculated by **TAB**

2-yr, 24-hour rainfall depth = 0.937

SUB-BASIN DATA		INITIAL SHEET FLOW (t_i)					SHALLOW CONCENTRATED FLOW (t_t)						$t_i + t_t$	FINAL t_c USED
Basin Designation	**Area**	**Sheet Flow Length, Li**	**U/S Elevation (Optional)**	**D/S Elevation (Optional)**	**Sheet Flow Slope, Si**	**Sheet Flow Time, t_i**	**Concentrated Flow Length, Lt**	**U/S Elevation (Optional)**	**D/S Elevation (Optional)**	**Concentrated Flow Slope, St**	**Concentrated Flow Velocity, Vt**	**Concentrated Flow Time, t_t**	**Computed t_c**	**t_c**
	(acres)	**(ft)**	**(ft)**	**(ft)**	**(ft/ft)**	**(min)**	**(ft)**	**(ft)**	**(ft)**	**(ft/ft)**	**(ft/sec)**	**(min)**	**(min)**	**(min)**
BH01	40.36	300	4600.0	4413.0	0.623	4.57	3038	4413.0	4014.0	0.131	3.62	13.97	18.54	**18.5**
BH02	4.05	197	4070.0	4057.0	0.066	8.02	909	4057.0	4008.0	0.054	2.32	6.53	14.55	**14.5**
BH03	7.24	183	4060.0	4050.0	0.055	8.16	1124	4050.0	3992.0	0.052	2.27	8.25	16.40	**16.4**
BH04	21.41	300	3934.0	3925.0	0.030	15.40	1036	3925.0	3792.0	0.128	3.58	4.82	20.21	**20.2**
BH05	12.26	300	3918.9	3751.0	0.560	4.78	875	3751.0	3713.0	0.043	2.08	7.00	11.77	**11.8**
BH05A	5.70	300	3912.7	3787.0	0.419	5.36	814	3787.0	3698.0	0.109	3.31	4.10	9.46	**9.5**
BH05B	6.56	300	3918.9	3751.0	0.560	4.78	875	3751.0	3713.0	0.043	2.08	7.00	11.77	**11.8**
BH06	3.30	300	3918.6	3751.0	0.559	4.78	647	3751.0	3652.0	0.153	3.91	2.76	7.54	**7.5**
BH07	4.54	18	3714.0	3697.0	0.939	0.41	1315	3697.0	3530.0	0.127	3.56	6.15	6.56	**6.6**
BH08	2.62	81	3709.0	3701.9	0.088	3.52	1300	3701.9	3530.0	0.132	3.64	5.96	9.48	**9.5**

Runoff Calculations (Rational Method)

Project Name **GLCA Low Water Ramps - Hite** Project No. **D3167674**
Revised Date **4/14/2025** Calculated by **TAB**

Basin	Area (ac.)	'c'	cA	t_c (min)	intensity (in/hr)	Q (cfs)	Storm Event
BH05A	5.70	0.26	1.46	9.5	1.66	2.43	05 YR
		0.33	1.89		2.10	3.97	10 YR
		0.53	3.00		3.40	10.22	50 YR
		0.60	3.39		4.12	13.98	100 YR
BH05B	6.56	0.24	1.57	11.8	1.51	2.37	05 YR
		0.32	2.07		1.91	3.95	10 YR
		0.52	3.39		3.09	10.46	50 YR
		0.59	3.84		3.75	14.40	100 YR
BH06	3.30	0.24	0.79	7.5	1.86	1.47	05 YR
		0.32	1.04		2.34	2.44	10 YR
		0.52	1.71		3.80	6.49	50 YR
		0.59	1.94		4.61	8.92	100 YR
BH07	4.54	0.81	3.66	6.6	1.96	7.17	05 YR
		0.83	3.75		2.46	9.25	10 YR
		0.86	3.91		4.01	15.64	50 YR
		0.87	3.95		4.85	19.18	100 YR
BH08	2.62	0.80	2.10	9.5	1.66	3.50	05 YR
		0.82	2.16		2.10	4.52	10 YR
		0.86	2.25		3.40	7.64	50 YR
		0.87	2.28		4.12	9.38	100 YR

Attachment 3

DITCH/GUTTER DESIGN SUMMARY TABLES

DITCH DESIGN					
BASIN ID	OFFSET	BEGIN STATION	END STATION	10-YR FLOW (CFS)	NORMAL DEPTH (FT)
BH05A	RIGHT	57+69	66+50	3.97	0.35
BH05B	RIGHT	75+25	66+50	3.95	0.63
BH06	RIGHT	75+25	78+94	2.44	0.51

GUTTER DESIGN					
BASIN ID	OFFSET	BEGIN STATION	END STATION	10-YR FLOW (CFS)	SPREAD (FT)
BH07	RIGHT	66+55	79+66	9.25	16.60
BH08	LEFT	66+55	79+66	4.52	12.69

Worksheet for BH05A-Trapezoidal

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.02960	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	3.97	ft³/s

Results

Normal Depth	0.35	ft
Flow Area	1.19	ft²
Wetted Perimeter	4.89	ft
Hydraulic Radius	0.24	ft
Top Width	4.81	ft
Critical Depth	0.38	ft
Critical Slope	0.02087	ft/ft
Velocity	3.33	ft/s
Velocity Head	0.17	ft
Specific Energy	0.52	ft
Froude Number	1.18	
Flow Type	Supercritical	

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
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.35	ft
Critical Depth	0.38	ft
Channel Slope	0.02960	ft/ft

Worksheet for BH05A-Trapezoidal

GVF Output Data

Critical Slope	0.02087	ft/ft

Worksheet for BH05B-Triangular

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.02299	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Discharge	3.95	ft^3/s

Results

Normal Depth	0.63	ft
Flow Area	1.18	ft^2
Wetted Perimeter	3.97	ft
Hydraulic Radius	0.30	ft
Top Width	3.76	ft
Critical Depth	0.64	ft
Critical Slope	0.02056	ft/ft
Velocity	3.35	ft/s
Velocity Head	0.17	ft
Specific Energy	0.80	ft
Froude Number	1.05	
Flow Type	Supercritical	

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
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.63	ft
Critical Depth	0.64	ft
Channel Slope	0.02299	ft/ft
Critical Slope	0.02056	ft/ft

Worksheet for BH06-Triangular

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.02670	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Discharge	2.44	ft³/s

Results

Normal Depth	0.51	ft
Flow Area	0.78	ft²
Wetted Perimeter	3.22	ft
Hydraulic Radius	0.24	ft
Top Width	3.05	ft
Critical Depth	0.53	ft
Critical Slope	0.02193	ft/ft
Velocity	3.14	ft/s
Velocity Head	0.15	ft
Specific Energy	0.66	ft
Froude Number	1.10	
Flow Type	Supercritical	

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
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.51	ft
Critical Depth	0.53	ft
Channel Slope	0.02670	ft/ft
Critical Slope	0.02193	ft/ft

Worksheet for BH07-Gutter

Project Description

Solve For	Spread

Input Data

Channel Slope	0.01000	ft/ft
Discharge	9.25	ft^3/s
Gutter Width	1.00	ft
Gutter Cross Slope	0.02	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.016	

Results

Spread	16.60	ft
Flow Area	2.76	ft^2
Depth	0.33	ft
Gutter Depression	0.00	ft
Velocity	3.36	ft/s

Worksheet for BH08-Gutter

Project Description

Solve For	Spread

Input Data

Channel Slope	0.01000	ft/ft
Discharge	4.52	ft^3/s
Gutter Width	1.00	ft
Gutter Cross Slope	0.02	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.016	

Results

Spread	12.69	ft
Flow Area	1.61	ft^2
Depth	0.25	ft
Gutter Depression	0.00	ft
Velocity	2.81	ft/s