DRAINAGE REPORT

Uptown Sedona Parking Garage

Prepared for:

City of Sedona
Public Works Department
102 Roadrunner Drive
Sedona, AZ 86336

Prepared by:

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Prescott, Arizona 86501

091885002
August 2022

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Section **Page No.**

List of Appendices

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1.0 BACKGROUND

This Drainage Design Report for the Uptown Sedona Parking Garage (USPG) has been prepared to address the drainage requirements outlined in the City of Sedona – Design Review Engineering and Administrative Manual (DREAM) and Coconino County – Drainage Manual (CCDM). The main purposes of this report are the following:

- Illustrate compliance with the DREAM and CCDM by controlling post-project runoff to a level similar to pre-project conditions.
- Establish drainage parameters and criteria for design.
- Establish the feasibility of the development of the site.

The project site (Site) is located along the north side of Forest Road west of Smith Road. The Site is bounded to the north and east by single family residential, west by Lumen/CenturyLink facility, south by Forest Road. The Site is located within the City of Sedona, Section 7, Township 17 North, Range 06 East. The Site consists of parcels 40116071 and 40116100 with a combined area of approximately 1.2 acres. See **Appendix A** for a Vicinity Map.

As part of this project, the USPG will be constructed, including underground detention, and the reconstruction of Forest Road. The limits of the Forest Road reconstruction will be from Van Deren Road to the limits of the Forest Road Construction project.

A small amount off-site runoff currently drains across the site. This runoff will be collected in a small swale and directed to the east end of the structure where it will be collected in a storm drain system. The storm drain system will outlet into Forest Road, which is the ultimate concentration point.

2.0 METHODOLOGY

The rational method was used to determine the 2-, 10-, 25-, and 100-year peak discharges for pre- and post- project conditions. A minimum 10-minute storm duration was used for all storms per the CCDM. Results of this analysis can be found in **Appendix E**.

Rainfall depth and intensity were taken from the National Oceanic and Atmospheric Administration Atlas 14 (NOAA 14) for the Site. Existing and proposed subbasins were delineated based on the topographic survey and anticipated grading of the Site.

Surface retention loss and percent impervious were used to estimate a c value based on Figure 2-1 found in the ADOT Hydrology Manual Volume 2. Parameters have been averaged for composite subbasins based on the methods described in the CCDM. A summary of the runoff coefficients can be found in **Appendix E**.

Time of concentration and storage coefficients for each subbasins were determined using the methods outlined in CCDM.

3.0 EXISTING CONDITIONS ANALYSIS

The existing site is developed as a single-family residence. The property slopes north to south toward the existing Forest Road. Runoff sheet flow across Forest Road to the south curb line. It makes its way east in the curb line and is collected by a catch basin between Wilson Road and Van

Deren Road. The existing storm drain system ultimately outlets into Oak Creek. Primarily one soil type is prevalent on the Site, summarized in **Table 1** below. Refer to **Appendix B** for the Soils Map.

Table 1. Soil Data

Soil Code	NRCS Soil Survey	Soil Type	Hydrologic Soil Group
406	AZ639	Sedona Soils, Turist soils, 3-15% slopes	D

There are no irrigation facilities near the Site.

The site currently existing as an abandoned single-family residence. The site is covered with native trees and brush. Along with residential landscaping near the existing structure.

3.1 FEMA FLOODPLAIN CLASSIFICATION

The Site falls within the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel Number 04005C7657G, effective date September 03, 2010. The entire site is defined as Zone X. The FEMA FIRMette is included as **Appendix C**.

4.0 PROPOSED CONDITIONS ANALYSIS

The proposed Site is divided into eight (8) subbasins. Calculations comparing the pre-development and post-development are shown in **Appendix E**. Runoff from the subbasin will either continue to drain to its historic concentration point or will be directed to the proposed underground storage facility. The runoff from the garage itself and the center driveway will be directed to the detention facility. Prior to entering the Detention facility this runoff will pass through a sand oil separator to treat the runoff per the first flush requirements. The runoff from the remaining driveway will drain to Forest Road as the floor level of the garage will be above the roadway. The small amount of off-site runoff will be conveyed in a swale north of the structure. The swale drains to an area drain that will collect the runoff and direct it to Forest Road by mean of a 24” pipe and sidewalk scupper. The post development drainage exhibit can be found in **Appendix D**.

4.1 PROPOSED STORMWATER DETENTION

Runoff from the garage structure will be directed to an underground detention basin. The basin will consist of an underground 84” diameter HDPE Pipe. The basin will attenuate the 2-, 10-, 25- and 100-year peak runoff per the DREAM. The basin will utilize a weir structure within the outlet manhole to control the rate at which the detention facility releases runoff. The manhole and weir will be designed so that a foot of free board is provided before the weir overtops. This overtopping of the weir will provide the emergency overflow for the detention facility. Refer to **Table** 2 for the detention facility summaries. The detention facility will outlet into 18” storm pipe that will extend east along Forest Road to the existing catch basin. This catch basin is the pre-development point of concentration. Therefore, the capacity of the existing system will not be exceeded as the detention basin outlet will maintain the overall rate of runoff to the pre-development levels.

Table 2. Retention Basin Summary

Storm Event	Peak Inflow [cfs]	Peak Stage [ft]	Peak Storage [ft^3]
2-year	2.5	5.3	1,725
10-year	4.3	6.0	1,995
100-year	7.5	6.3	2,290

4.2 FIRST FLUSH TREATMENT

The first flush volume for the site will be treated and stored in the detention facility. First flush runoff (0.5 inches) from the impervious areas of each sub-basin will be stored at the lowest stage of detention facility. A summary of the first flush retention is shown below in **Table 3**.

Table 3. First Flush Retention Summary

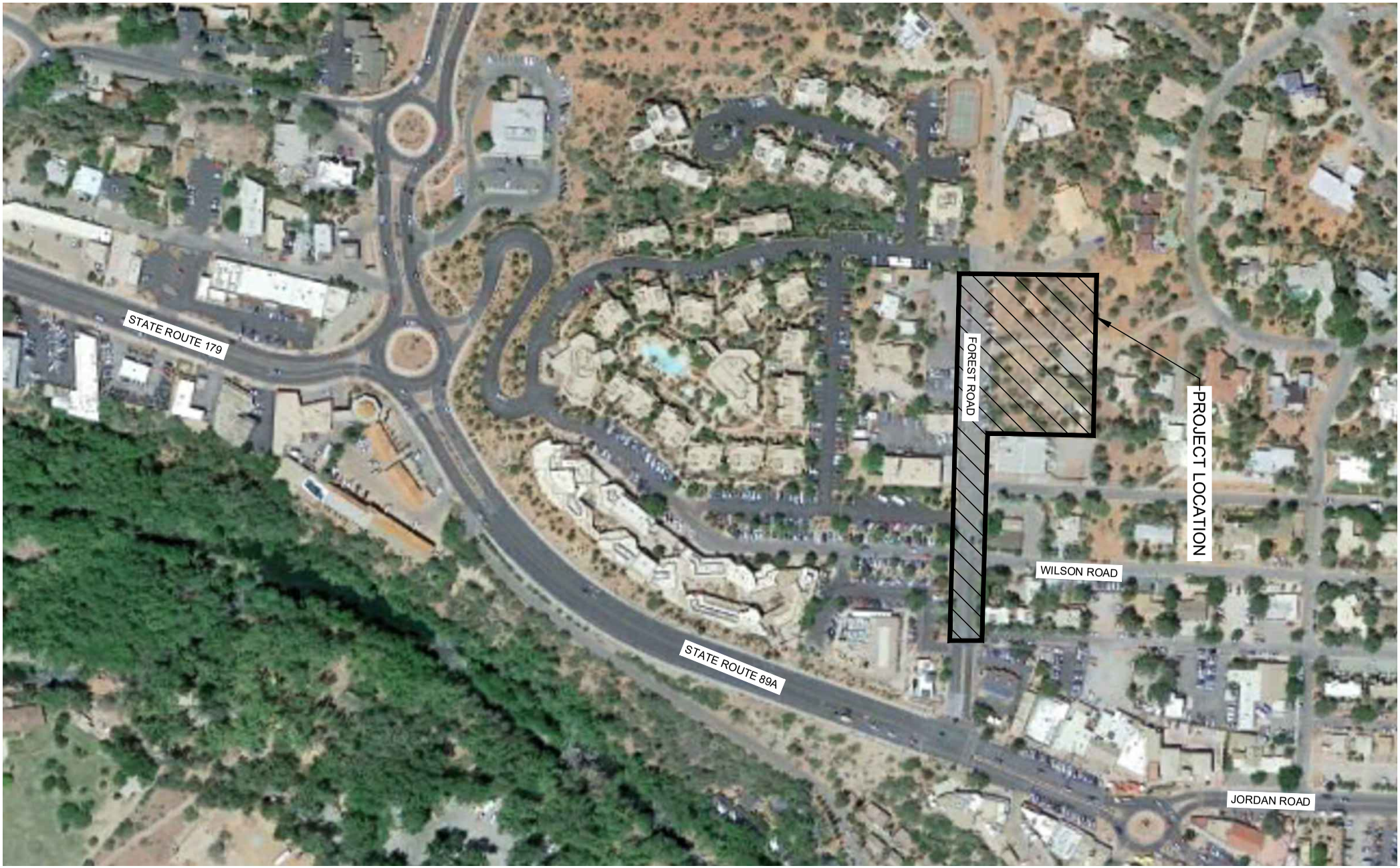
Runoff to Retain/Treat [in]	Impervious Area [ft^2]	Required Volume [ft^3]	Provided Volume [ft^3]
0.5”	39,625	1,664	1,665

5.0 RESULTS

Stormwater runoff from the site will be attenuated by mean of the proposed detention facility. The offsite runoff will be directed around the structure to the historic concentration point and will not impact the detention facility. The majority of the onsite runoff will be routed to the detention facility and released at pre-development levels. No adjacent properties will be adversely impacted by the development of the site.

Appendix A

Vicinity Map



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UPTOWN SEDONA PARKING GARAGE

VICINITY MAP

August 30, 2022

0 100 200 400 600

NORTH

Appendix B

USDA Soils Survey - Soils Map

Map Scale: 1:983 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 10 20 40 60

Feet
0 45 90 180 270

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

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

Special Point Features

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Black Hills-Sedona Area, Arizona, Parts of Coconino and Yavapai Counties
Survey Area Data: Version 9, Jun 3, 2020

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

Date(s) aerial images were photographed: Dec 31, 2009—Oct 12, 2017

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
406	Sedona soils, Turist soils and Urban land, 3 to 15 percent slopes	4.8	100.0%
Totals for Area of Interest		**4.8**	**100.0%**

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Appendix C

FEMA - FIRMette

National Flood Hazard Layer FIRMette

FEMA

111°46'8"W 34°52'22"N

111°45'31"W 34°51'52"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

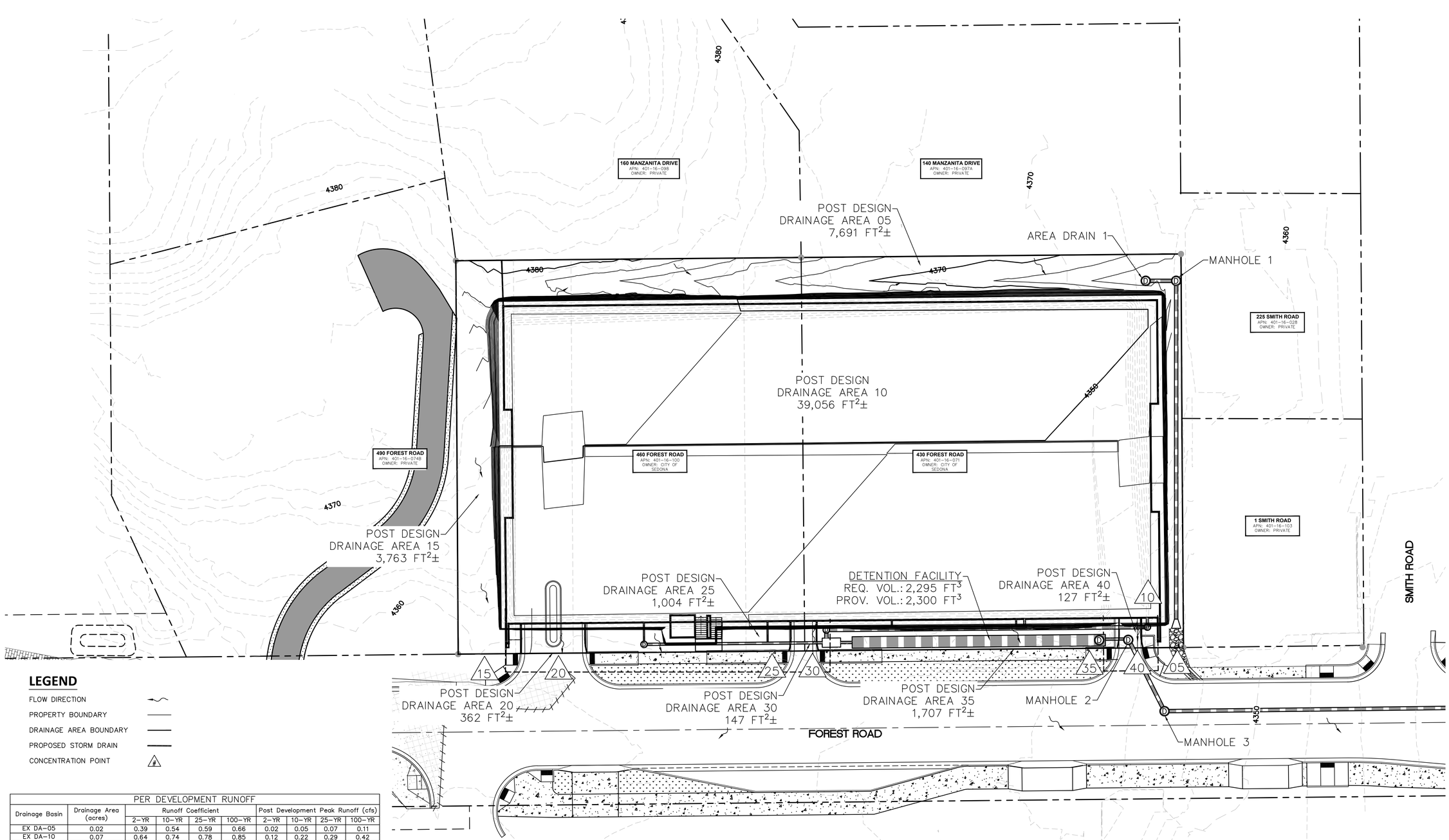
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 11/17/2021 at 10:53 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Appendix D

Drainage Area Map



LEGEND

- FLOW DIRECTION
- PROPERTY BOUNDARY
- DRAINAGE AREA BOUNDARY
- PROPOSED STORM DRAIN
- CONCENTRATION POINT (#)

PER DEVELOPMENT RUNOFF									
Drainage Basin	Drainage Area (acres)	Runoff Coefficient				Post Development Peak Runoff (cfs)			
		2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
EX DA-05	0.02	0.39	0.54	0.59	0.66	0.02	0.05	0.07	0.11
EX DA-10	0.07	0.64	0.74	0.78	0.85	0.12	0.22	0.29	0.42
EX DA-15	0.02	0.39	0.54	0.59	0.66	0.02	0.05	0.07	0.10
EX DA-20	0.46	0.39	0.54	0.59	0.66	0.44	1.01	1.37	2.08
EX DA-25	0.10	0.39	0.54	0.59	0.66	0.09	0.21	0.29	0.56
EX DA-30	0.06	0.39	0.54	0.59	0.66	0.06	0.13	0.18	0.39
EX DA-35	0.51	0.39	0.54	0.59	0.66	0.49	1.12	1.53	2.30

POST DEVELOPMENT RUNOFF									
Drainage Basin	Drainage Area (acres)	Runoff Coefficient				Post Development Peak Runoff (cfs)			
		2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
DA-05	0.18	0.39	0.54	0.59	0.66	0.17	0.39	0.53	0.80
DA-10	0.90	0.93	0.95	0.95	0.95	2.08	3.48	4.35	5.88
DA-15	0.09	0.64	0.74	0.78	0.85	0.14	0.26	0.34	0.51
DA-20	0.01	0.93	0.95	0.95	0.95	0.02	0.03	0.04	0.05
DA-25	0.02	0.39	0.54	0.59	0.66	0.02	0.05	0.07	0.11
DA-30	0.01	0.93	0.95	0.95	0.95	0.01	0.01	0.02	0.02
DA-35	0.04	0.39	0.54	0.59	0.66	0.04	0.09	0.12	0.18
DA-40	0.01	0.93	0.95	0.95	0.95	0.01	0.01	0.01	0.02

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UPTOWN SEDONA PARKING GARAGE

POST DESIGN DRAINAGE EXHIBIT

August 30, 2022

0 10 20 40 60

NORTH

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Appendix E

Hydrology Calculations

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Rational Method Calculations

General Project Information			
Project #	Uptown Sedona Parking Garage		
Designed by	JRW	Date	08/30/2022
Design Storm Event		100	
Minimum T_c [min]		10	

Pre Development

		Coefficient				Intensity (in/hr)				Peak Discharge (cfs)			
Basin	Area (ac)	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
EX. DA-05	0.02	0.39	0.54	0.59	0.66	2.50	4.09	5.11	6.90	0.02	0.05	0.07	0.11
EX. DA-10	0.07	0.64	0.74	0.78	0.85	2.50	4.09	5.11	6.90	0.12	0.22	0.29	0.42
EX. DA-15	0.02	0.39	0.54	0.59	0.66	2.50	4.09	5.11	6.90	0.02	0.05	0.07	0.10
EX. DA-20	0.46	0.39	0.54	0.59	0.66	2.50	4.09	5.11	6.90	0.44	1.01	1.37	2.08
EX. DA-25	0.10	0.39	0.54	0.59	0.85	2.50	4.09	5.11	6.90	0.09	0.21	0.29	0.56
EX. DA-30	0.06	0.39	0.54	0.59	0.95	2.50	4.09	5.11	6.90	0.06	0.13	0.18	0.39
EX. DA-35	0.51	0.39	0.54	0.59	0.66	2.50	4.09	5.11	6.90	0.49	1.12	1.53	2.30
										1.25	2.79	3.80	5.97

Post Development

		Coefficient				Intensity (in/hr)				Peak Discharge (cfs)			
Basin	Area (ac)	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
DA-05	0.177	0.39	0.54	0.59	0.66	2.50	4.09	5.11	6.90	0.17	0.39	0.53	0.80
DA-10	0.897	0.93	0.95	0.95	0.95	2.50	4.09	5.11	6.90	2.08	3.48	4.35	5.88
DA-15	0.086	0.64	0.74	0.78	0.85	2.50	4.09	5.11	6.90	0.14	0.26	0.34	0.51
DA-20	0.008	0.93	0.95	0.95	0.95	2.50	4.09	5.11	6.90	0.02	0.03	0.04	0.05
DA-25	0.023	0.39	0.54	0.59	0.66	2.50	4.09	5.11	6.90	0.02	0.05	0.07	0.11
DA-30	0.003	0.93	0.95	0.95	0.95	2.50	4.09	5.11	6.90	0.01	0.01	0.02	0.02
DA-35	0.039	0.39	0.54	0.59	0.66	2.50	4.09	5.11	6.90	0.04	0.09	0.12	0.18
DA-40	0.003	0.93	0.95	0.95	0.95	2.50	4.09	5.11	6.90	0.01	0.01	0.01	0.02
										2.49	4.33	5.49	7.57

NOAA Atlas 14, Volume 1, Version 5
Location name: Sedona, Arizona, USA*
Latitude: 34.869°, Longitude: -111.7639°
Elevation: 4366.29 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	**0.212** (0.177-0.254)	**0.274** (0.227-0.327)	**0.368** (0.305-0.441)	**0.447** (0.372-0.535)	**0.560** (0.461-0.666)	**0.654** (0.535-0.778)	**0.755** (0.613-0.899)	**0.864** (0.692-1.03)	**1.02** (0.804-1.23)	**1.16** (0.898-1.40)
10-min	**0.323** (0.269-0.387)	**0.417** (0.346-0.498)	**0.560** (0.464-0.670)	**0.681** (0.565-0.814)	**0.852** (0.702-1.01)	**0.995** (0.814-1.19)	**1.15** (0.933-1.37)	**1.32** (1.05-1.57)	**1.56** (1.22-1.87)	**1.76** (1.37-2.13)
15-min	**0.401** (0.334-0.479)	**0.517** (0.429-0.617)	**0.694** (0.575-0.831)	**0.844** (0.701-1.01)	**1.06** (0.870-1.26)	**1.23** (1.01-1.47)	**1.43** (1.16-1.70)	**1.63** (1.31-1.95)	**1.93** (1.52-2.32)	**2.18** (1.70-2.64)
30-min	**0.540** (0.450-0.645)	**0.696** (0.578-0.831)	**0.935** (0.775-1.12)	**1.14** (0.944-1.36)	**1.42** (1.17-1.69)	**1.66** (1.36-1.98)	**1.92** (1.56-2.29)	**2.19** (1.76-2.62)	**2.60** (2.04-3.13)	**2.94** (2.28-3.55)
60-min	**0.668** (0.556-0.799)	**0.862** (0.715-1.03)	**1.16** (0.959-1.39)	**1.41** (1.17-1.68)	**1.76** (1.45-2.09)	**2.06** (1.68-2.45)	**2.38** (1.93-2.83)	**2.72** (2.17-3.24)	**3.22** (2.53-3.87)	**3.64** (2.82-4.40)
2-hr	**0.791** (0.687-0.923)	**1.00** (0.861-1.17)	**1.32** (1.14-1.54)	**1.59** (1.36-1.86)	**1.98** (1.69-2.30)	**2.30** (1.93-2.68)	**2.66** (2.21-3.10)	**3.04** (2.49-3.55)	**3.61** (2.91-4.22)	**4.07** (3.23-4.77)
3-hr	**0.850** (0.747-0.986)	**1.08** (0.949-1.25)	**1.38** (1.21-1.59)	**1.64** (1.43-1.89)	**2.01** (1.74-2.33)	**2.33** (2.00-2.69)	**2.69** (2.27-3.12)	**3.08** (2.57-3.57)	**3.64** (2.98-4.25)	**4.11** (3.30-4.82)
6-hr	**1.04** (0.930-1.15)	**1.29** (1.15-1.43)	**1.60** (1.43-1.77)	**1.87** (1.67-2.08)	**2.27** (2.01-2.52)	**2.58** (2.28-2.87)	**2.93** (2.56-3.27)	**3.30** (2.84-3.69)	**3.84** (3.26-4.34)	**4.28** (3.57-4.86)
12-hr	**1.33** (1.20-1.48)	**1.65** (1.49-1.83)	**2.01** (1.81-2.22)	**2.31** (2.08-2.54)	**2.73** (2.45-3.00)	**3.05** (2.71-3.35)	**3.38** (2.98-3.73)	**3.72** (3.25-4.11)	**4.19** (3.61-4.66)	**4.57** (3.90-5.11)
24-hr	**1.70** (1.54-1.86)	**2.11** (1.92-2.33)	**2.63** (2.39-2.90)	**3.04** (2.76-3.36)	**3.62** (3.27-4.00)	**4.08** (3.67-4.49)	**4.54** (4.06-5.01)	**5.02** (4.48-5.55)	**5.68** (5.01-6.31)	**6.20** (5.42-6.92)
2-day	**1.99** (1.81-2.19)	**2.48** (2.26-2.74)	**3.08** (2.81-3.41)	**3.57** (3.25-3.94)	**4.25** (3.85-4.68)	**4.78** (4.31-5.26)	**5.34** (4.78-5.87)	**5.91** (5.25-6.52)	**6.70** (5.89-7.40)	**7.31** (6.38-8.11)
3-day	**2.14** (1.96-2.36)	**2.67** (2.43-2.95)	**3.33** (3.04-3.68)	**3.87** (3.52-4.26)	**4.62** (4.19-5.08)	**5.23** (4.71-5.74)	**5.85** (5.24-6.43)	**6.50** (5.78-7.16)	**7.41** (6.52-8.19)	**8.12** (7.09-9.01)
4-day	**2.29** (2.10-2.52)	**2.86** (2.61-3.15)	**3.58** (3.27-3.95)	**4.17** (3.80-4.59)	**5.00** (4.53-5.49)	**5.67** (5.11-6.21)	**6.37** (5.70-6.99)	**7.10** (6.31-7.80)	**8.12** (7.15-8.98)	**8.93** (7.79-9.92)
7-day	**2.69** (2.47-2.95)	**3.35** (3.07-3.68)	**4.15** (3.80-4.55)	**4.82** (4.41-5.28)	**5.75** (5.24-6.30)	**6.49** (5.89-7.12)	**7.26** (6.57-7.98)	**8.07** (7.24-8.86)	**9.18** (8.16-10.1)	**10.1** (8.85-11.1)
10-day	**3.07** (2.81-3.37)	**3.81** (3.49-4.19)	**4.70** (4.30-5.16)	**5.40** (4.94-5.93)	**6.35** (5.77-6.96)	**7.09** (6.42-7.78)	**7.84** (7.06-8.61)	**8.59** (7.70-9.45)	**9.61** (8.54-10.6)	**10.4** (9.17-11.5)
20-day	**3.98** (3.66-4.34)	**4.93** (4.54-5.39)	**5.98** (5.51-6.54)	**6.78** (6.23-7.40)	**7.80** (7.15-8.51)	**8.56** (7.82-9.35)	**9.30** (8.47-10.2)	**10.0** (9.09-11.0)	**10.9** (9.85-12.0)	**11.6** (10.4-12.7)
30-day	**4.79** (4.40-5.22)	**5.93** (5.45-6.47)	**7.16** (6.56-7.80)	**8.09** (7.41-8.79)	**9.27** (8.46-10.1)	**10.1** (9.22-11.0)	**11.0** (9.94-11.9)	**11.8** (10.6-12.8)	**12.8** (11.5-14.0)	**13.5** (12.1-14.8)
45-day	**5.66** (5.17-6.25)	**7.02** (6.42-7.75)	**8.49** (7.75-9.34)	**9.61** (8.76-10.6)	**11.1** (10.1-12.1)	**12.1** (11.0-13.3)	**13.2** (11.9-14.5)	**14.2** (12.8-15.6)	**15.5** (13.9-17.1)	**16.4** (14.6-18.1)
60-day	**6.61** (6.03-7.24)	**8.20** (7.48-8.98)	**9.85** (8.98-10.8)	**11.1** (10.1-12.1)	**12.6** (11.4-13.8)	**13.7** (12.4-15.0)	**14.8** (13.3-16.2)	**15.8** (14.2-17.3)	**17.0** (15.2-18.6)	**17.9** (16.0-19.6)

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

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

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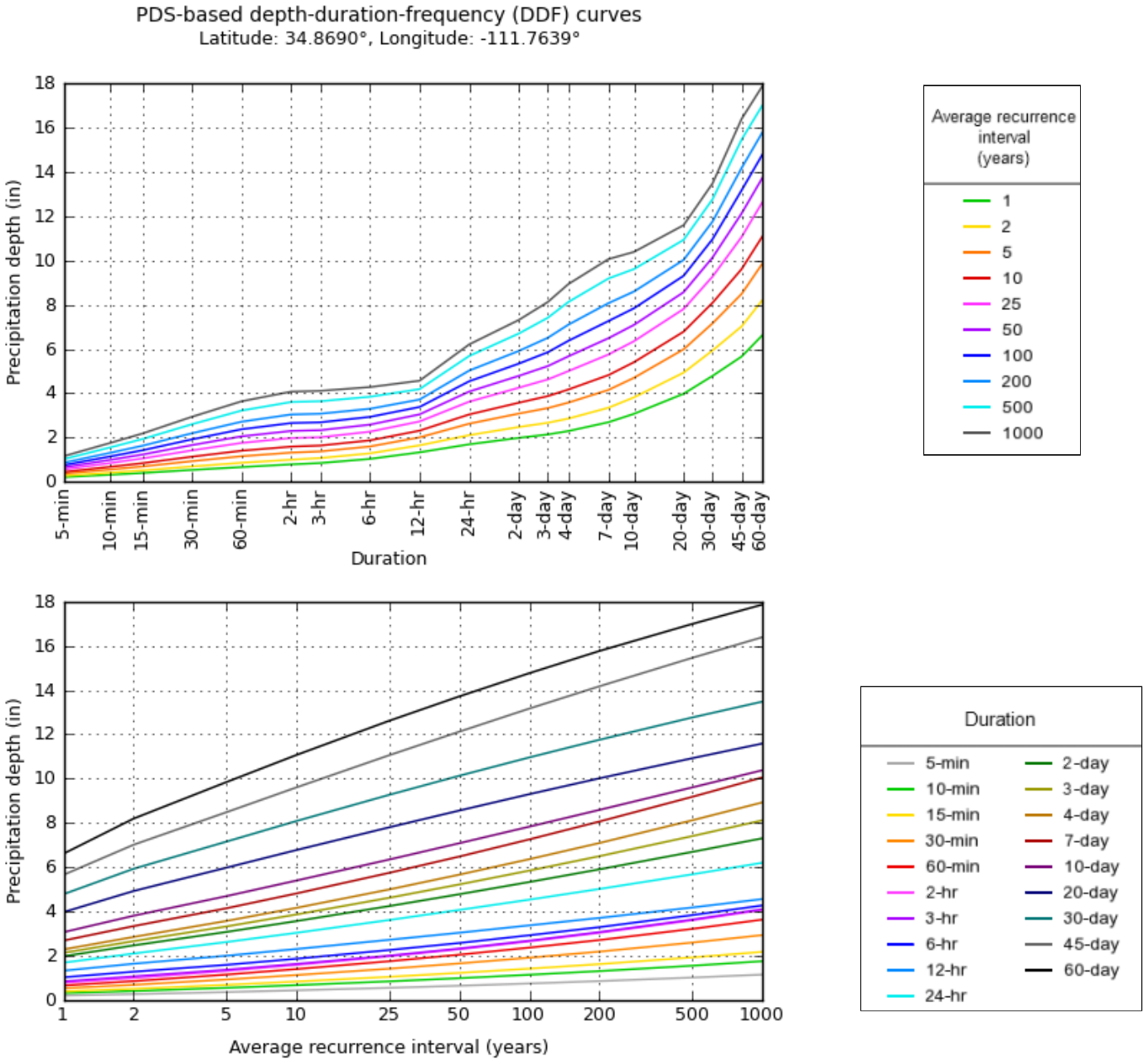
PF graphical



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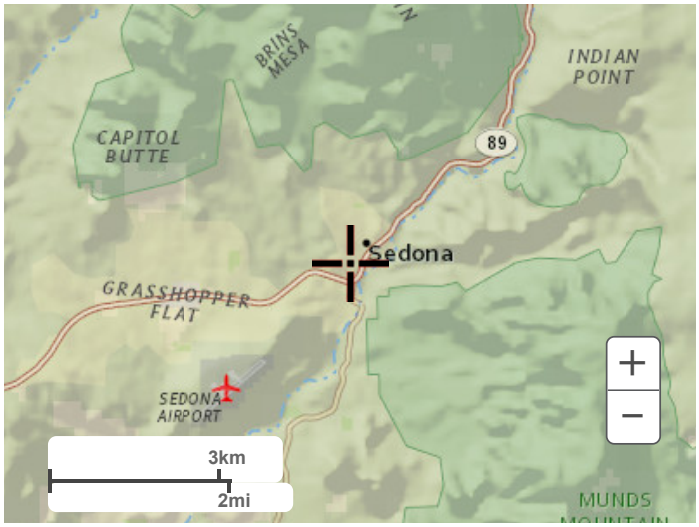
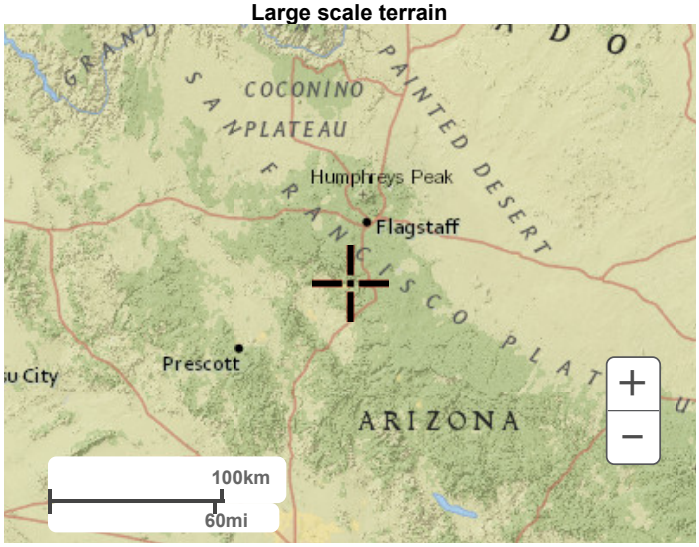
Maps & aerials

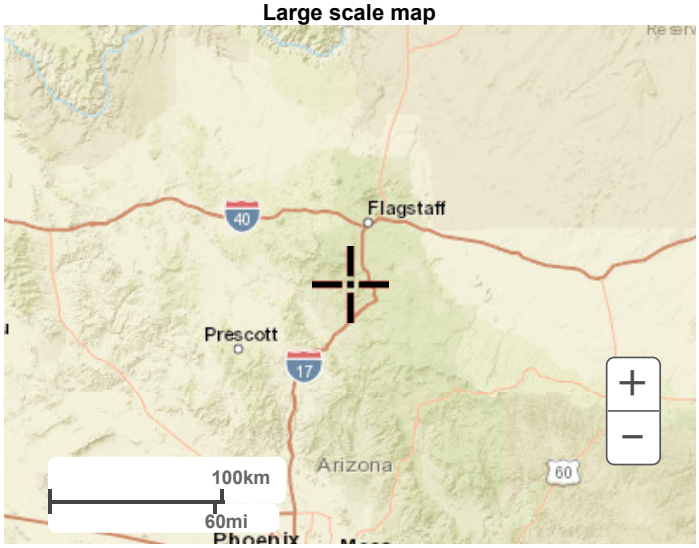
Small scale terrain



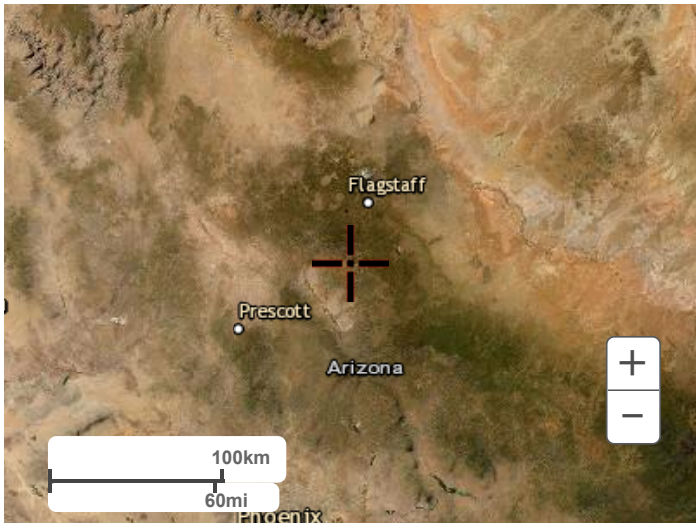
Large scale terrain



Large scale map



Large scale aerial



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NOAA Atlas 14, Volume 1, Version 5
Location name: Sedona, Arizona, USA*
Latitude: 34.869°, Longitude: -111.7639°
Elevation: 4366.29 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/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**2.54** (2.12-3.05)	**3.29** (2.72-3.92)	**4.42** (3.66-5.29)	**5.36** (4.46-6.42)	**6.72** (5.53-7.99)	**7.85** (6.42-9.34)	**9.06** (7.36-10.8)	**10.4** (8.30-12.4)	**12.3** (9.65-14.8)	**13.9** (10.8-16.8)
10-min	**1.94** (1.61-2.32)	**2.50** (2.08-2.99)	**3.36** (2.78-4.02)	**4.09** (3.39-4.88)	**5.11** (4.21-6.08)	**5.97** (4.88-7.11)	**6.90** (5.60-8.21)	**7.89** (6.32-9.41)	**9.35** (7.34-11.2)	**10.6** (8.20-12.8)
15-min	**1.60** (1.34-1.92)	**2.07** (1.72-2.47)	**2.78** (2.30-3.32)	**3.38** (2.80-4.04)	**4.22** (3.48-5.03)	**4.94** (4.04-5.88)	**5.70** (4.62-6.79)	**6.52** (5.22-7.78)	**7.73** (6.07-9.28)	**8.73** (6.78-10.6)
30-min	**1.08** (0.900-1.29)	**1.39** (1.16-1.66)	**1.87** (1.55-2.24)	**2.27** (1.89-2.72)	**2.84** (2.34-3.38)	**3.32** (2.72-3.95)	**3.84** (3.11-4.57)	**4.39** (3.51-5.24)	**5.20** (4.09-6.25)	**5.88** (4.56-7.11)
60-min	**0.668** (0.556-0.799)	**0.862** (0.715-1.03)	**1.16** (0.959-1.39)	**1.41** (1.17-1.68)	**1.76** (1.45-2.09)	**2.06** (1.68-2.45)	**2.38** (1.93-2.83)	**2.72** (2.17-3.24)	**3.22** (2.53-3.87)	**3.64** (2.82-4.40)
2-hr	**0.396** (0.344-0.462)	**0.500** (0.430-0.585)	**0.660** (0.569-0.770)	**0.796** (0.680-0.928)	**0.990** (0.842-1.15)	**1.15** (0.966-1.34)	**1.33** (1.11-1.55)	**1.52** (1.25-1.77)	**1.80** (1.46-2.11)	**2.04** (1.61-2.38)
3-hr	**0.283** (0.249-0.328)	**0.358** (0.316-0.416)	**0.458** (0.401-0.530)	**0.546** (0.476-0.631)	**0.670** (0.579-0.775)	**0.777** (0.667-0.896)	**0.895** (0.757-1.04)	**1.02** (0.854-1.19)	**1.21** (0.994-1.41)	**1.37** (1.10-1.61)
6-hr	**0.173** (0.155-0.192)	**0.215** (0.193-0.239)	**0.267** (0.238-0.296)	**0.313** (0.279-0.347)	**0.378** (0.336-0.421)	**0.431** (0.380-0.479)	**0.490** (0.427-0.546)	**0.551** (0.474-0.617)	**0.641** (0.544-0.724)	**0.714** (0.596-0.812)
12-hr	**0.111** (0.100-0.123)	**0.137** (0.124-0.151)	**0.167** (0.150-0.184)	**0.192** (0.172-0.211)	**0.226** (0.203-0.249)	**0.253** (0.225-0.278)	**0.281** (0.247-0.309)	**0.308** (0.270-0.341)	**0.347** (0.300-0.387)	**0.379** (0.324-0.424)
24-hr	**0.071** (0.064-0.077)	**0.088** (0.080-0.097)	**0.109** (0.100-0.121)	**0.127** (0.115-0.140)	**0.151** (0.136-0.167)	**0.170** (0.153-0.187)	**0.189** (0.169-0.209)	**0.209** (0.187-0.231)	**0.237** (0.209-0.263)	**0.259** (0.226-0.288)
2-day	**0.041** (0.038-0.046)	**0.052** (0.047-0.057)	**0.064** (0.059-0.071)	**0.074** (0.068-0.082)	**0.089** (0.080-0.097)	**0.100** (0.090-0.110)	**0.111** (0.100-0.122)	**0.123** (0.109-0.136)	**0.139** (0.123-0.154)	**0.152** (0.133-0.169)
3-day	**0.030** (0.027-0.033)	**0.037** (0.034-0.041)	**0.046** (0.042-0.051)	**0.054** (0.049-0.059)	**0.064** (0.058-0.071)	**0.073** (0.065-0.080)	**0.081** (0.073-0.089)	**0.090** (0.080-0.099)	**0.103** (0.091-0.114)	**0.113** (0.098-0.125)
4-day	**0.024** (0.022-0.026)	**0.030** (0.027-0.033)	**0.037** (0.034-0.041)	**0.043** (0.040-0.048)	**0.052** (0.047-0.057)	**0.059** (0.053-0.065)	**0.066** (0.059-0.073)	**0.074** (0.066-0.081)	**0.085** (0.074-0.094)	**0.093** (0.081-0.103)
7-day	**0.016** (0.015-0.018)	**0.020** (0.018-0.022)	**0.025** (0.023-0.027)	**0.029** (0.026-0.031)	**0.034** (0.031-0.037)	**0.039** (0.035-0.042)	**0.043** (0.039-0.048)	**0.048** (0.043-0.053)	**0.055** (0.049-0.060)	**0.060** (0.053-0.066)
10-day	**0.013** (0.012-0.014)	**0.016** (0.015-0.017)	**0.020** (0.018-0.022)	**0.023** (0.021-0.025)	**0.026** (0.024-0.029)	**0.030** (0.027-0.032)	**0.033** (0.029-0.036)	**0.036** (0.032-0.039)	**0.040** (0.036-0.044)	**0.043** (0.038-0.048)
20-day	**0.008** (0.008-0.009)	**0.010** (0.009-0.011)	**0.012** (0.011-0.014)	**0.014** (0.013-0.015)	**0.016** (0.015-0.018)	**0.018** (0.016-0.019)	**0.019** (0.018-0.021)	**0.021** (0.019-0.023)	**0.023** (0.021-0.025)	**0.024** (0.022-0.027)
30-day	**0.007** (0.006-0.007)	**0.008** (0.008-0.009)	**0.010** (0.009-0.011)	**0.011** (0.010-0.012)	**0.013** (0.012-0.014)	**0.014** (0.013-0.015)	**0.015** (0.014-0.017)	**0.016** (0.015-0.018)	**0.018** (0.016-0.019)	**0.019** (0.017-0.021)
45-day	**0.005** (0.005-0.006)	**0.006** (0.006-0.007)	**0.008** (0.007-0.009)	**0.009** (0.008-0.010)	**0.010** (0.009-0.011)	**0.011** (0.010-0.012)	**0.012** (0.011-0.013)	**0.013** (0.012-0.014)	**0.014** (0.013-0.016)	**0.015** (0.014-0.017)
60-day	**0.005** (0.004-0.005)	**0.006** (0.005-0.006)	**0.007** (0.006-0.007)	**0.008** (0.007-0.008)	**0.009** (0.008-0.010)	**0.010** (0.009-0.010)	**0.010** (0.009-0.011)	**0.011** (0.010-0.012)	**0.012** (0.011-0.013)	**0.012** (0.011-0.014)

[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.

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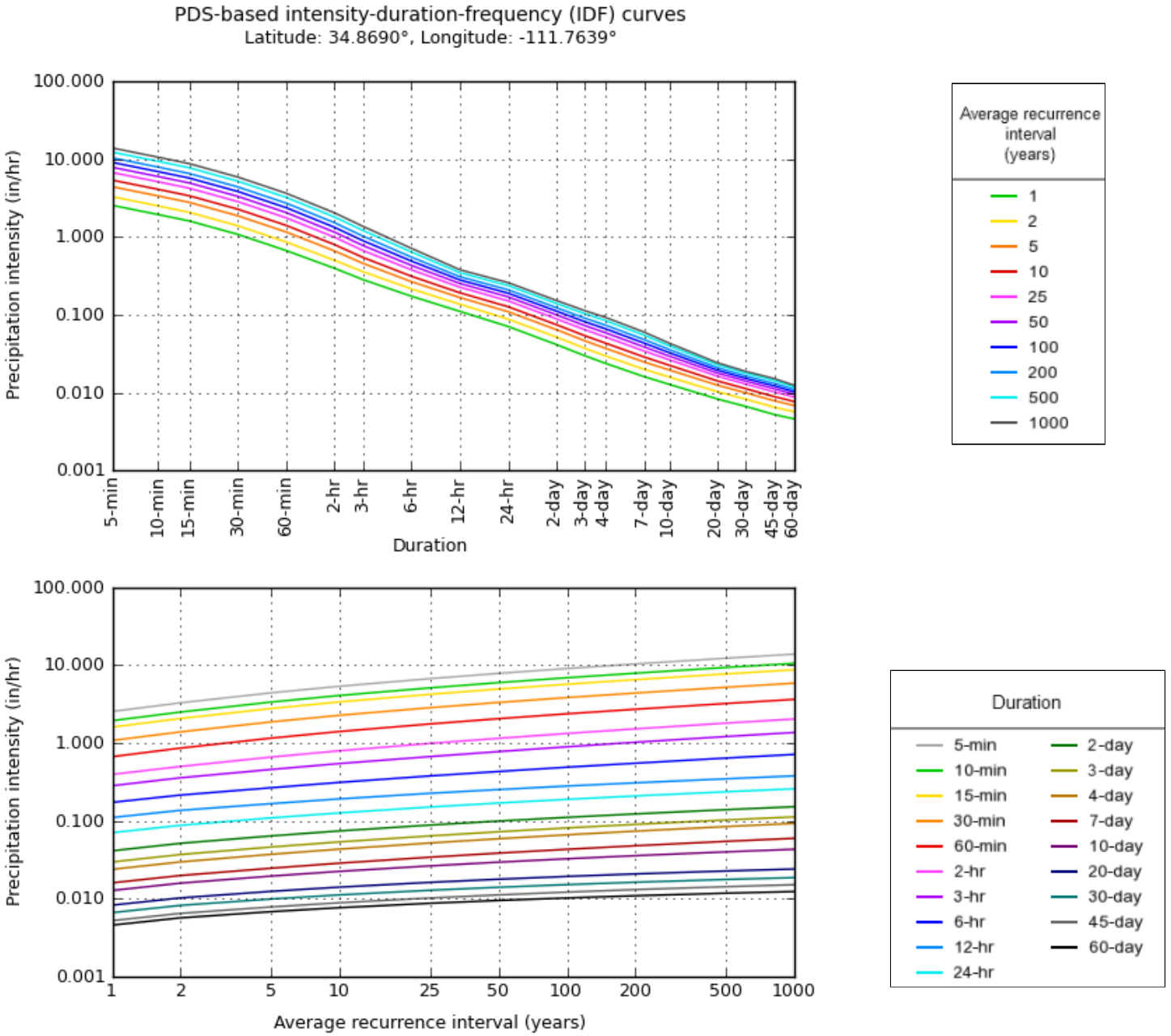
PF graphical



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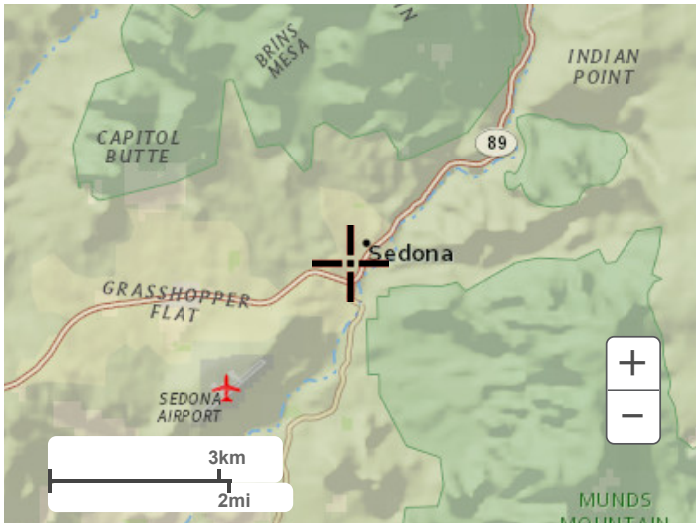
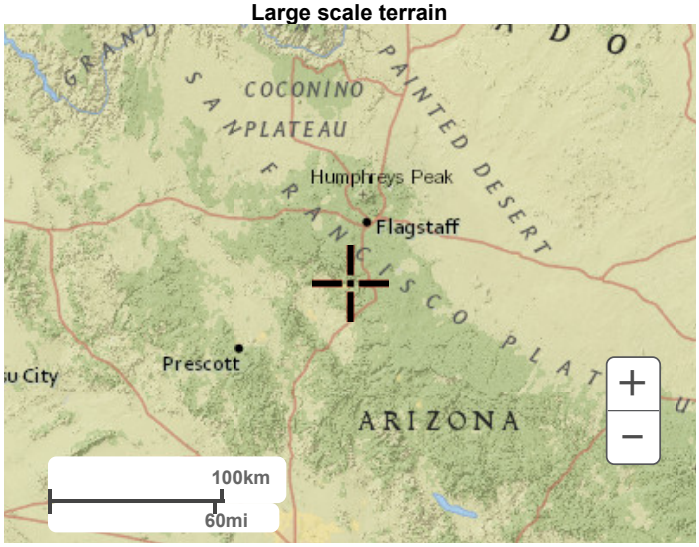
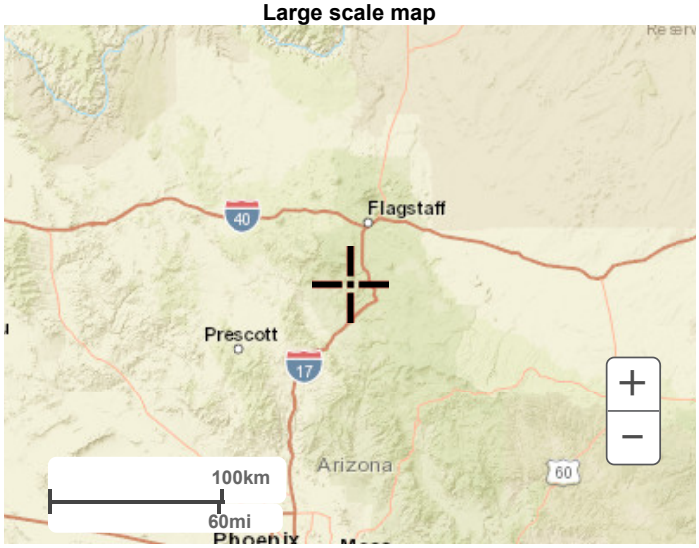
Small scale terrain



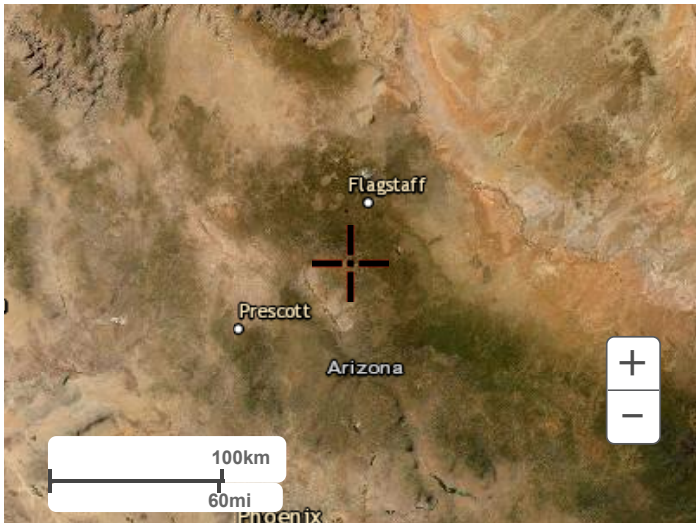
Large scale terrain



Large scale map



Large scale aerial



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1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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Appendix F

Hydraulic Calculations

Off-Site Swale

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035
Channel Slope	0.022 ft/ft
Left Side Slope	2.000 H:V
Right Side Slope	2.000 H:V
Discharge	5.91 cfs

Results

Normal Depth	11.0 in
Flow Area	1.7 ft²
Wetted Perimeter	4.1 ft
Hydraulic Radius	4.9 in
Top Width	3.68 ft
Critical Depth	10.6 in
Critical Slope	0.027 ft/ft
Velocity	3.49 ft/s
Velocity Head	0.19 ft
Specific Energy	1.11 ft
Froude Number	0.906
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	11.0 in
Critical Depth	10.6 in
Channel Slope	0.022 ft/ft
Critical Slope	0.027 ft/ft

Area Drain 1 to Manhole 1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.012 ft/ft
Diameter	18.0 in
Discharge	5.87 cfs

Results	
Normal Depth	9.0 in
Flow Area	0.9 ft²
Wetted Perimeter	2.4 ft
Hydraulic Radius	4.5 in
Top Width	1.50 ft
Critical Depth	11.2 in
Percent Full	50.1 %
Critical Slope	0.006 ft/ft
Velocity	6.63 ft/s
Velocity Head	0.68 ft
Specific Energy	1.43 ft
Froude Number	1.520
Maximum Discharge	12.58 cfs
Discharge Full	11.70 cfs
Slope Full	0.003 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	50.1 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	9.0 in
Critical Depth	11.2 in
Channel Slope	0.012 ft/ft
Critical Slope	0.006 ft/ft

Manhole 1 to Outlet

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.012
Channel Slope	0.018 ft/ft
Diameter	18.0 in
Discharge	5.87 cfs

Results	
Normal Depth	7.7 in
Flow Area	0.7 ft²
Wetted Perimeter	2.1 ft
Hydraulic Radius	4.1 in
Top Width	1.49 ft
Critical Depth	11.2 in
Percent Full	43.0 %
Critical Slope	0.005 ft/ft
Velocity	8.08 ft/s
Velocity Head	1.01 ft
Specific Energy	1.66 ft
Froude Number	2.036
Maximum Discharge	16.42 cfs
Discharge Full	15.27 cfs
Slope Full	0.003 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	43.0 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	7.7 in
Critical Depth	11.2 in
Channel Slope	0.018 ft/ft
Critical Slope	0.005 ft/ft

Sidewalk Scupper

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.010 ft/ft
Bottom Width	4.00 ft
Discharge	5.87 cfs

Results	
Normal Depth	3.7 in
Flow Area	1.2 ft²
Wetted Perimeter	4.6 ft
Hydraulic Radius	3.2 in
Top Width	4.00 ft
Critical Depth	4.9 in
Critical Slope	0.004 ft/ft
Velocity	4.74 ft/s
Velocity Head	0.35 ft
Specific Energy	0.66 ft
Froude Number	1.504
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.7 in
Critical Depth	4.9 in
Channel Slope	0.010 ft/ft
Critical Slope	0.004 ft/ft

Detention Outlet

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.012
Channel Slope	0.061 ft/ft
Diameter	12.0 in
Discharge	8.50 cfs

Results	
Normal Depth	8.8 in
Flow Area	0.6 ft²
Wetted Perimeter	2.1 ft
Hydraulic Radius	3.6 in
Top Width	0.88 ft
Critical Depth	11.9 in
Percent Full	73.4 %
Critical Slope	0.044 ft/ft
Velocity	13.75 ft/s
Velocity Head	2.94 ft
Specific Energy	3.67 ft
Froude Number	2.897
Maximum Discharge	10.28 cfs
Discharge Full	9.56 cfs
Slope Full	0.049 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	73.4 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	8.8 in
Critical Depth	11.9 in
Channel Slope	0.061 ft/ft
Critical Slope	0.044 ft/ft

Manhole 2 to Manhole 3

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.030 ft/ft
Diameter	18.0 in
Discharge	8.50 cfs

Results	
Normal Depth	8.6 in
Flow Area	0.8 ft²
Wetted Perimeter	2.3 ft
Hydraulic Radius	4.4 in
Top Width	1.50 ft
Critical Depth	13.6 in
Percent Full	48.0 %
Critical Slope	0.008 ft/ft
Velocity	10.15 ft/s
Velocity Head	1.60 ft
Specific Energy	2.32 ft
Froude Number	2.393
Maximum Discharge	19.64 cfs
Discharge Full	18.25 cfs
Slope Full	0.007 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	48.0 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	8.6 in
Critical Depth	13.6 in
Channel Slope	0.030 ft/ft
Critical Slope	0.008 ft/ft

Manhole 3 to Exisitng CB

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.061 ft/ft
Diameter	18.0 in
Discharge	8.50 cfs

Results	
Normal Depth	7.1 in
Flow Area	0.6 ft²
Wetted Perimeter	2.0 ft
Hydraulic Radius	3.8 in
Top Width	1.47 ft
Critical Depth	13.5 in
Percent Full	39.4 %
Critical Slope	0.008 ft/ft
Velocity	13.13 ft/s
Velocity Head	2.68 ft
Specific Energy	3.27 ft
Froude Number	3.483
Maximum Discharge	27.86 cfs
Discharge Full	25.90 cfs
Slope Full	0.007 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	39.4 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	7.1 in
Critical Depth	13.5 in
Channel Slope	0.061 ft/ft
Critical Slope	0.008 ft/ft