Drainage Report

For

AWC White Bear Property

Sedona, Arizona

Owner/Developer
WHITE BEAR PROFESSIONAL PLAZA L.L.C.
P.O. BOX 3670
Sedona, Az 86340-3670

Project No. 21-1135

Date: May 2022

1130 N. Alma School Road, Suite 120
Mesa, AZ 85201
623.691.8002
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Appendix

1.0 Introduction

The proposed White Bear Property Property (the Site) is a 1.06-acre property located on the northwest corner of Roadrunner Drive and White Bear Road within the City of Sedona. The Site is planned on an area currently vacant. The Site has frontage road along White Bear Road and Roadrunner Drive, Residential area to the north and Canyon Trails Cowboy Church to west. The Project is located within a portion of the Southeast Quarter of Section 10, Township 17N, Range 5E in Yavapai County, Arizona. See Figure 1 in Appendix A for a Vicinity Map.

The purposed of this drainage report is to determine offsite flows that could potentially impact the new development. It will also outline on-site stormwater management.

2.0 FEMA Flood Zone

A review of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) center indicates that the Project is located within panel 04025C1430G with effective Date of 09/03/2010. The area currently has a Zone X designation.

Flood Zone X is defined as:

Areas of 0.2% annual chance flood, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile. See Figure 2 in Appendix A for FIRM map.

3.0 Offsite Drainage

The Site does not have any major drainage areas directly impacting the Site as shown on the Offsite Drainage Map, Figure 3, Appendix A. Runoff from north and northwest watersheds are conveyed south of the Project by an existing drainage swale along Roadrunner Drive and by an existing Wash running north to south along the west boundary of the Site. There is a small contributing drainage area (Watershed "C") immediately to the north discharging runoff to the northwest boundary of the Site. The subsequent paragraphs provide a brief description of watershed "C":

Watershed "C" is approximately 0.62 Acres in size and begins approximately 250' north of the project. The flow is expected to enter the Site and sheet flow across to White Bear Road and out to the existing Wash. The 100-year, 2-hr peak flow for Watershed "C" is 3 cfs, with a time of concentration of 3.5 minutes and intensity of 9.08 inches per hour with the following parameters:

Area = 0.62 acres
Flow Path Length = 244 feet
Upstream Elevation = 4406.5 feet
Downstream Elevation = 4394 feet
Slope = 270 feet/mile
Kb = 0.15519

Due to the small offsite flow rate, no diversion channel is proposed for the Site. The offsite flows are expected to spread-out and sheet flow across the Site to continue its existing pattern south of the Project. Offsite flows will not be retained onsite.

A new sidewalk along the west alignment of Roadrunner Drive will be placed over the existing drainage swale currently carrying offsite flows. A new drainage swale will be graded adjacent to the sidewalk having an equivalent or greater flow area. The existing grate inlet will be relocated to the new drainage swale and the existing storm pipe extended to convey and maintain existing offsite flow patterns. See Figure 5 in Appendix A for cross-section of existing and proposed drainage swale.

The designs included in this report will not change existing flow patterns. No adverse consequences are expected to the Site due to offsite flows or to downstream properties. See Appendix B for Offsite Watershed Calculations.

4.0 Onsite Drainage Characteristics and Hydrology

The Site is currently undeveloped desert land sloping south at an average gradient of 3.5%. The project is to retain the difference between Pre vs. Post development runoff flow. On-site retention basin is to retain the 100-year, 2-hour excess runoff volume by providing permanent retention pool equal or greater than the required excess volume. The existing runoff coefficient "C" is approximate 0.44. A single 2.7-feet deep retention basin (including 1-ft freeboard) will be graded along the Southwest Exit of the Project. The basin will capture onsite runoff from drainage area “A”, see figure 4, Appendix A. Drainage area “A” will be able to generate the desire excess runoff flow amount to ensure post-development flows are retained in the basin. The ultimate outfall for the Project is located south of the new retention basin and has an elevation of 4387.18.

Proposed On-site grading and drainage patterns are shown on the On-site Drainage Exhibit located in Appendix A. This plan shows the basins and drainage patterns specific to this phase of the project.

5.0 Rainfall Data

Rainfall Data for this project has been taken from NOAA ATLAS 14 ("Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 5). The data taken represents the approximate project location as estimated using Google Earth. Precipitation data from the Average recurrence interval have been used to compute the site-specific runoff. See Appendix B for NOAA ATLAS 14 data.

6.0 Methodology and Criteria

The following subsections give a brief outline of the design methodology and criteria used as outlined in the Sedona Design Review, Engineering and Administrative Manual

(DREAM) and Drainage Design Manual for Yavapai County and Maricopa County Drainage Design Manual.

6.1 Weighted "C" value

The weighted post-development runoff coefficients have been calculated to determine the runoff excess volume produced from the 100-year, 2-hour storm. The coefficients are a weighted average of gravel improvement, desert landscaping 2, Gravel Roadways & Shoulders (Parking Areas) and Pavement & Rooftops from Table 7-6 of the "Rational Method General Runoff Coefficients for Yavapai County" of the Drainage Design Manual for Yavapai County Hydrology. The final weighted post development and existing (Pre-Development) runoff coefficients are 0.68 and 0.44, respectively.

See Appendix C for weighted "C" value and Pre vs. Post Excess Volume calculations.

6.2 Required Retention Volume

The require retention for the Site is calculated using a "C" value of 0.24 (0.68 - 0.44), the entire onsite drainage area and the 100-year, 2-hour storm event of 2.64 inches as determined by NOAA ATLAS 14 data. Onsite basins will include 1 foot of freeboard as required for basins with a maximum overall depth of 2.7 feet. Maximum ponding depth will not exceed 3 feet.

Required Runoff volumes were calculated as:

$$V_{required} = (C * P * A)/12$$

where:
$V_{required}$ = Volume Required (cf) (Pre vs Post)
C = 0.24 (Pre vs Post)
P = 2.64-inches (100-year, 2-hour design storm)
A = Area (sq.ft)

Volume Provided was calculated as:

$$V_{provided} = (Depth)*(A_{top} + A_{bot})/2$$

where:
$V_{provided}$ = Volume Provided (cf)
A_{top} = Area of basin top (sq.ft)
A_{bot} = Area of basin bottom (sq.ft)
Depth= Basin overall depth (ft)

The new basin has a retention ponding depth of approximately 1.7 feet and a 1-foot freeboard, see appendix D for basin calculations.

6.3 Basin De-watering

Sedona Design Review, Engineering and Administrative Manual require all retention basins to drain their volume from the 100-year, 2-hour storm event within a 12-hour period. Percolation rates for the project area were found in the National Resources Conservation Service (NRCS) and were multiplied by a 50% safety factor. Final percolation test and rates can be obtained once retention basin is installed.

See Appendix B for NRCS information. See Appendix D for retention basin and dewatering calculations.

6.4 Rip Rap Apron

To avoid erosions to side-slopes due to flows into the retention basin, rip-rap have been sized using the Isbash equation for bank protection on straight channels with mild curvature (Maricopa Drainage Design Manual, equation 6.34). On-site flow rate for drainage area "A" was calculated and modeled as square channel flowing down the bank of the basin. The minimum D50 required for a 3 cfs flow is 3-Inches. The proposed D50 riprap size for the project is 6-inches. See Appendix D for flow and rip-rap calculations.

6.0 Maintenance

All stormwater management facilities within the project will be maintained by White Bear Professional Plaza LLC. Main access to the site will be the new motorized sliding gate on White Bear Road. See Appendix A, figure 4 for layout. This site will not be open to the public. All the Key maintenance tasks are outlined in section 15.4.3.9 of the Drainage Design Manual for Yavapai County and shall be followed as necessary.

7.0 Conclusions

- White Bear is located within flood zone X.
- Based on improvement outlined in this Report, there are no adverse consequences from offsite drainage flows.
- The existing drainage swale along Roadrunner Drive will be relocated with a similar or greater flow area swale.
- The onsite retention basin will retain the excess of Pre vs. Post runoff flow, 100-year, 2-hour storm event (2.64" rainfall) of 2,260 c.f. by installing a 1.7-feet basin plus freeboard. No adverse consequences to downstream developments are expected due to onsite flows.

- Basins will drain within 12 hours per Sedona Design Review, Engineering and Administrative Manual by natural percolation.

- Rip-rap will be placed on discharge points to retention basin to avoid future erosions. The minimum D50 size is 6-inches.

8.0 References

Sedona Design Review, Engineering and Administrative Manual, February 18, 2020.

Drainage Design Manual for Yavapai County, July 1, 2015.

Flood Control District of Maricopa County, 1995
Drainage Design Manual for Maricopa County, AZ. Volumes 1 & 2

Appendix A: Figures and Exhibits

Figure 1 provides a vicinity map of the property. The surrounding area is primarily comprised of office use and low to medium density residential uses.

Figure 1: Vicinity Map

Figure 2: FIRM Map

FEMA

111°49'11"W 34°52'2"N

111°48'34"W 34°51'32"N

Feet 1:6,000

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

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 / 17.5 Cross Sections with 1% Annual Chance / 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

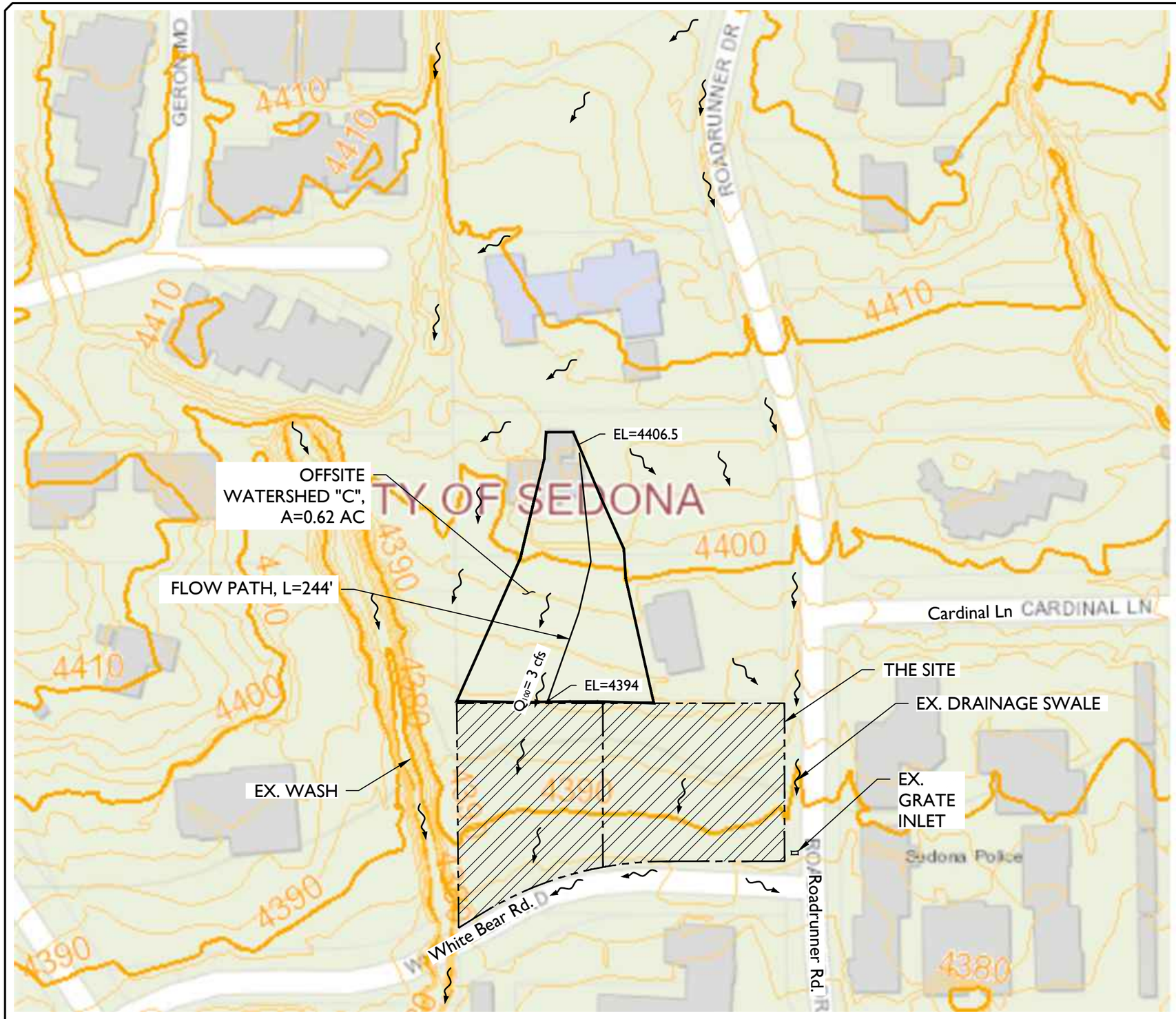
N

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 10/22/2021 at 12:55 PM 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.



NORTH

0.0' 100' 200'

SCALE: 1"=100'

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AWC WHITE BEAR
SEDONA, ARIZONA

FIGURE 3: OFFSITE DRAINAGE MAP

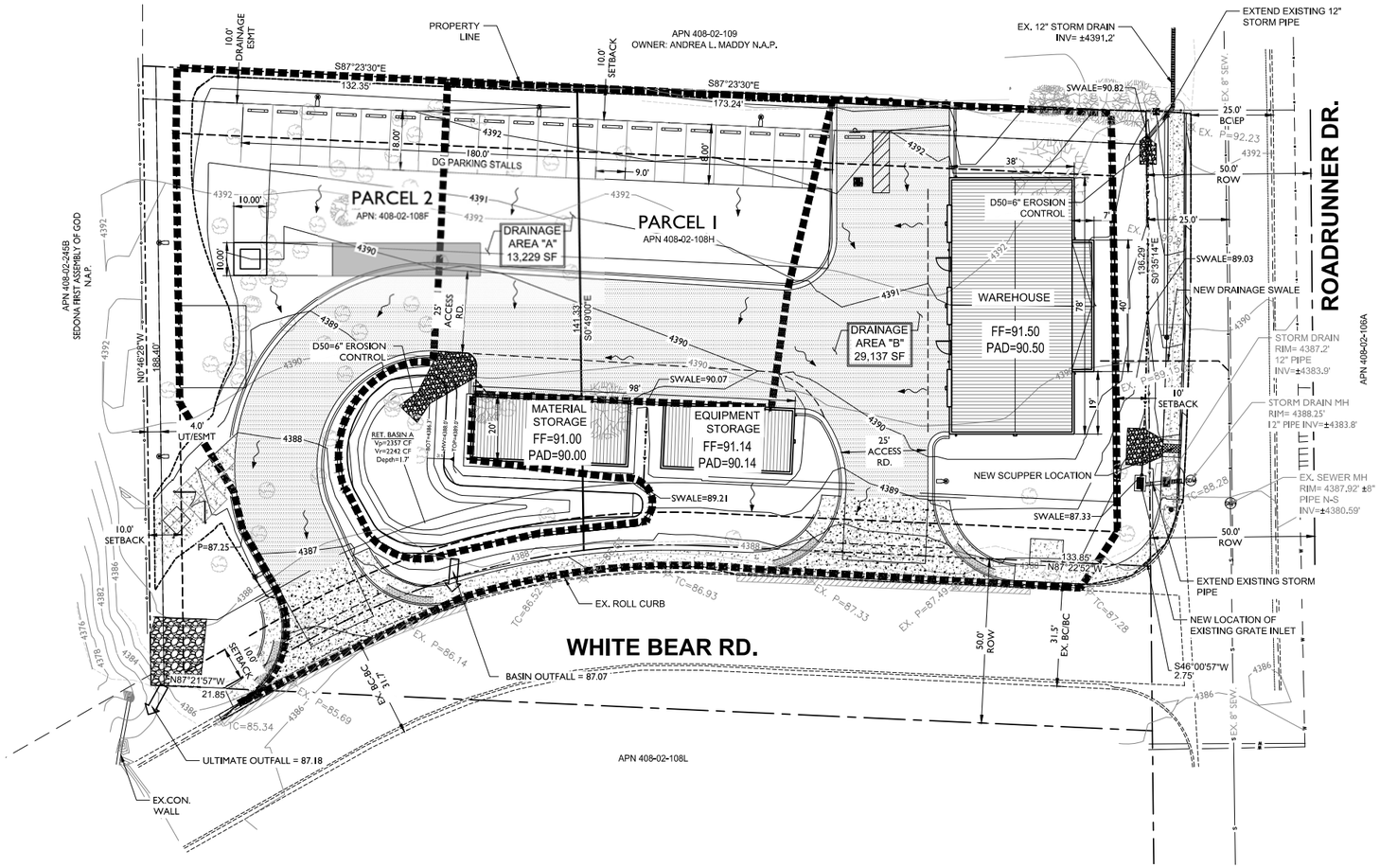
JOB NO
16-264

SHEET
1
OF 1

21-1135 - WHITE BEAR DRAINAGE IMPROVEMENTS

LEGEND

ROW	RIGHT OF WAY		DRAINAGE AREA
ESMT	EASEMENT		SECTION LINE
Y.C.R.	YAVAPAI COUNTY RECORDER		RIGHT OF WAY LINE
V.G.	VALLEY GUTTER		BLUE-STAKED WATER LINE
P	PROPERTY LINE	GAS GAS	BLUE-STAKED GAS LINE
EP	EDGE PAVEMENT		BLUE-STAKED GAS LINE
NO	NUMBER	4686	MAJOR COUNT.
A.P.N.	ASSESSORS PARCEL NUMBER	SDMH	STORM DRAIN MH
§	SECTION LINE	SMH	SANITARY SEWER MH
	LOT LINE		TREE
	WATER METER IRRIGATION CONTROL VALVE		CATUS
C.&G.	CURB AND GUTTER		SIGN
	EX. STORM DRAIN		GRADING WARP LINE
	PROPERTIES LINE		DRAINAGE DIRECTION
TC	TOP OF CURB		
	DRAINAGE SWALE		



N

20 0 20 40
SCALE FEET

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w w w . e p s g r o u p i n c . c o m

AWC WHITE BEAR PROPERTY
IMPROVEMENT PLANS
SEDONA, ARIZONA

Project:

FIGURE 4: ON-SITE DRAINAGE EXHIBIT

Revisions:

Call at least two full working days before you begin excavation. ARIZONA811 Arizona Blue Stake, Inc. Dial 8-1-1 or 1-800-STAKE-IT (782-5348) In Maricopa County: (602)263-1100

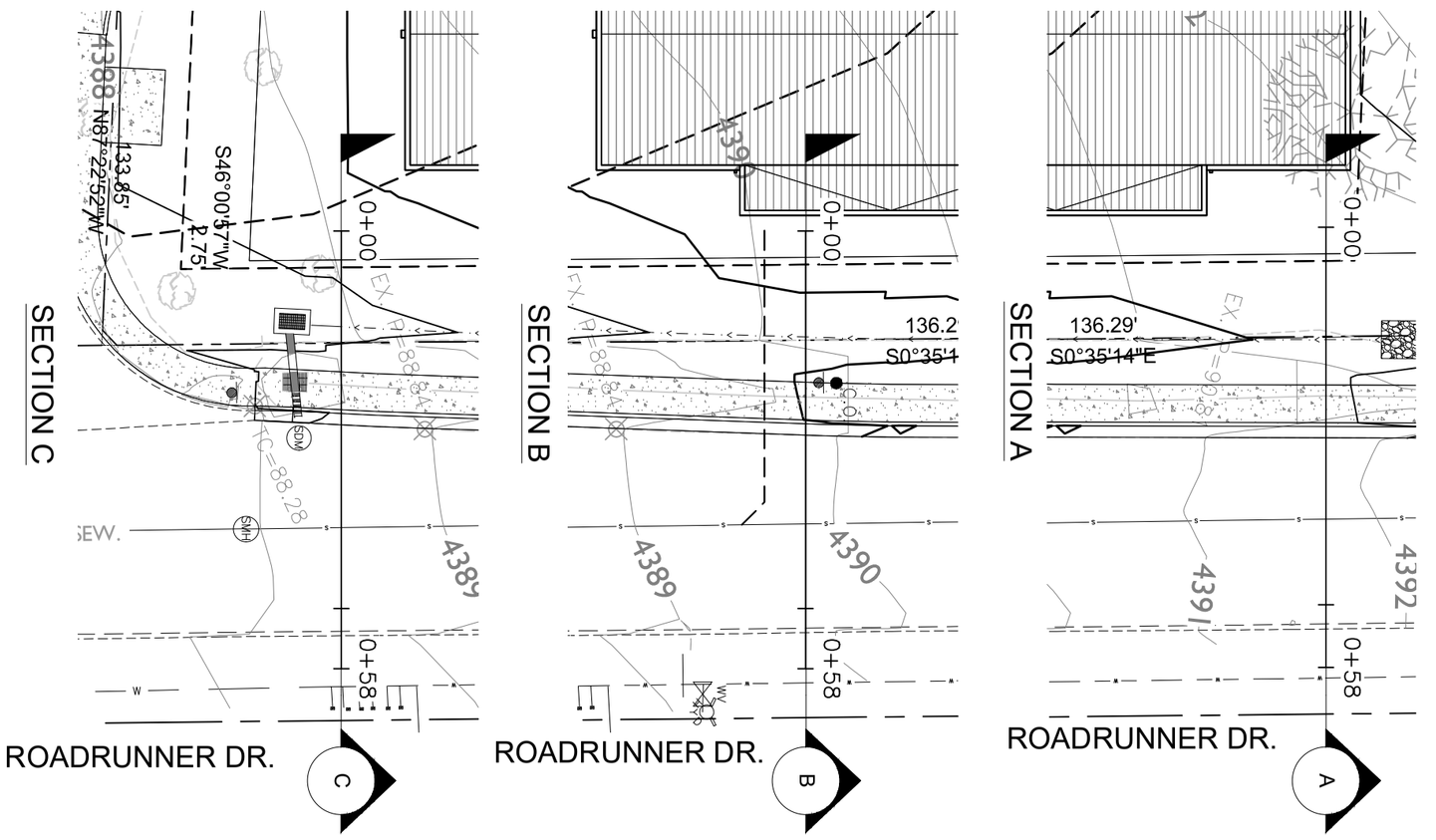
Designer: KD
Drawn by: SCD

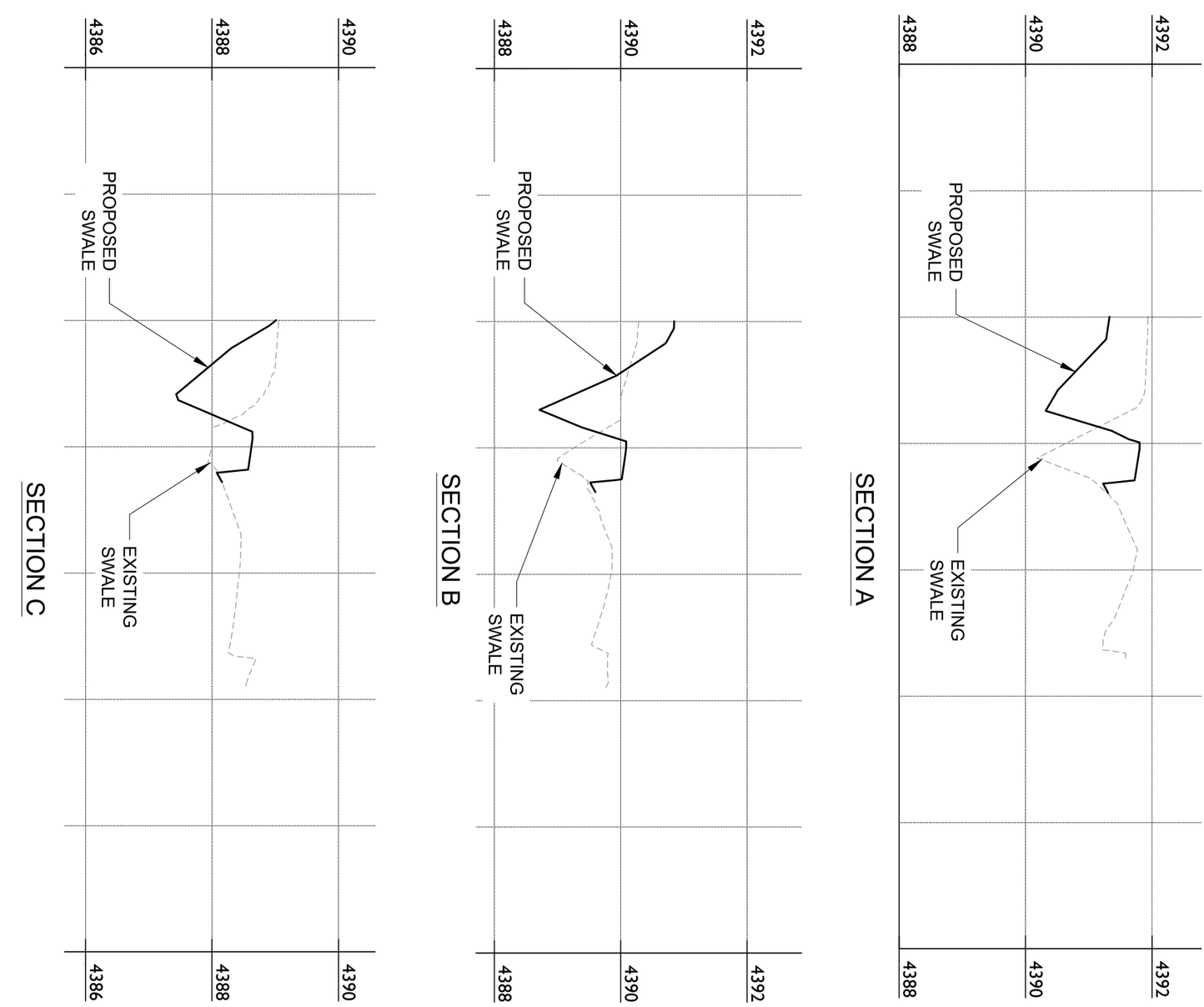
Job No. 21-1135

Sheet No. 1 of 1

PS

kdebuire May 10, 2022 9:10am V:\Projects\2021\21-1135 White Bear\Civil\Construction Documents\Design\Drainage\21-1135 –FIGURE 4 – Drainage Exhibit.dwg





SHEET 1 OF 1	JOB NO 21-1135	AWC WHITE BEAR PROPERTY SEDONA, ARIZONA **FIGURE 5: EXISTING SWALE SECTIONS**	EPS GROUP 1130 N. Alma School Rd Suite 120 Mesa, AZ 85201 T:480.503.2250 | F:480.503.2258 www.epsgroupinc.com

Appendix B: Offsite Watershed Calculations

Project: 21-1135 White Bear (Offsite Drainage)

Design Methodology and Procedures: Maricopa County Drainage Design Manual Volume 2

Inputs:

Area (should not exceed 160 acres):	0.62	acres
Flow path length:	244	feet
	0.046	miles
Upstream elevation:	4406.5	feet
Downstream elevation:	4394	feet
Flow path slope:	270	feet/mile
Land use category:	VLDR (40,000 sq. ft or grater lot size)	

	2-yr	25-yr	100-yr
Runoff coefficient (From Table 3-2):	0.35	0.39	0.44

Watershed roughness type (from Table 3-1):	C
Kb parameter m:	-0.025
Kb parameter b:	0.15
Kb=m log(a) + b:	0.15519

Table 1: Intensity-Duration-Frequency Data (IDF) (2)

Duration (min)	Frequency 2-yr	10-yr	100-yr
	Intensity (in/hr)		
5	3.26	5.36	9.10
10	2.48	4.08	6.90
15	2.06	3.37	5.72
30	1.38	2.28	3.86
60	0.86	1.41	2.38

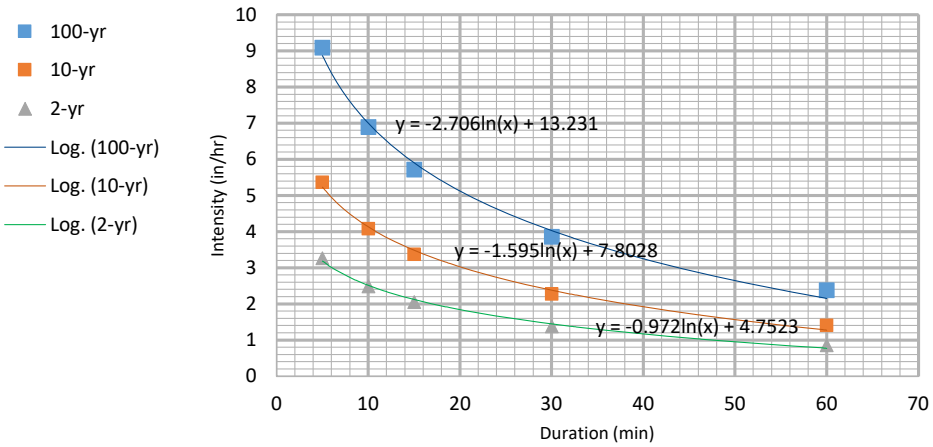


Table 2: Calculation and Output	2-yr	10-yr	100-yr
Time of concentration (3) (hours):	0.11	0.09	0.07
Time of concentration (min):	6.400	5.171	4.206
Intensity (1) (in/hr):	3.096	5.426	9.349
Design Peak flow (cfs):	**0.7**	**1.3**	**2.6**

Notes:

1. Intensity calculated Iteratively as follows: A) Choose a duration and intensity from Table 1 and input in table 2 to calculate Tc. B) Use new Tc to get intensity from Graph and re-calculate Tc. C) Repeat process until new Tc is relative close to previous Tc .
2. Precipitation depth (P) obtained from NOAA Atlas 14. Intensity for each Duration (D) and Frequency calculated as P/D, where: P is precipitation in inches & D is duration in hours.
3. $Tc = 11.4\ L^{0.5}\ K_b^{0.52}\ S^{-0.31}\ I^{-0.38}$, Formula 3.2
4. Q= CiA, Formula 3.1.

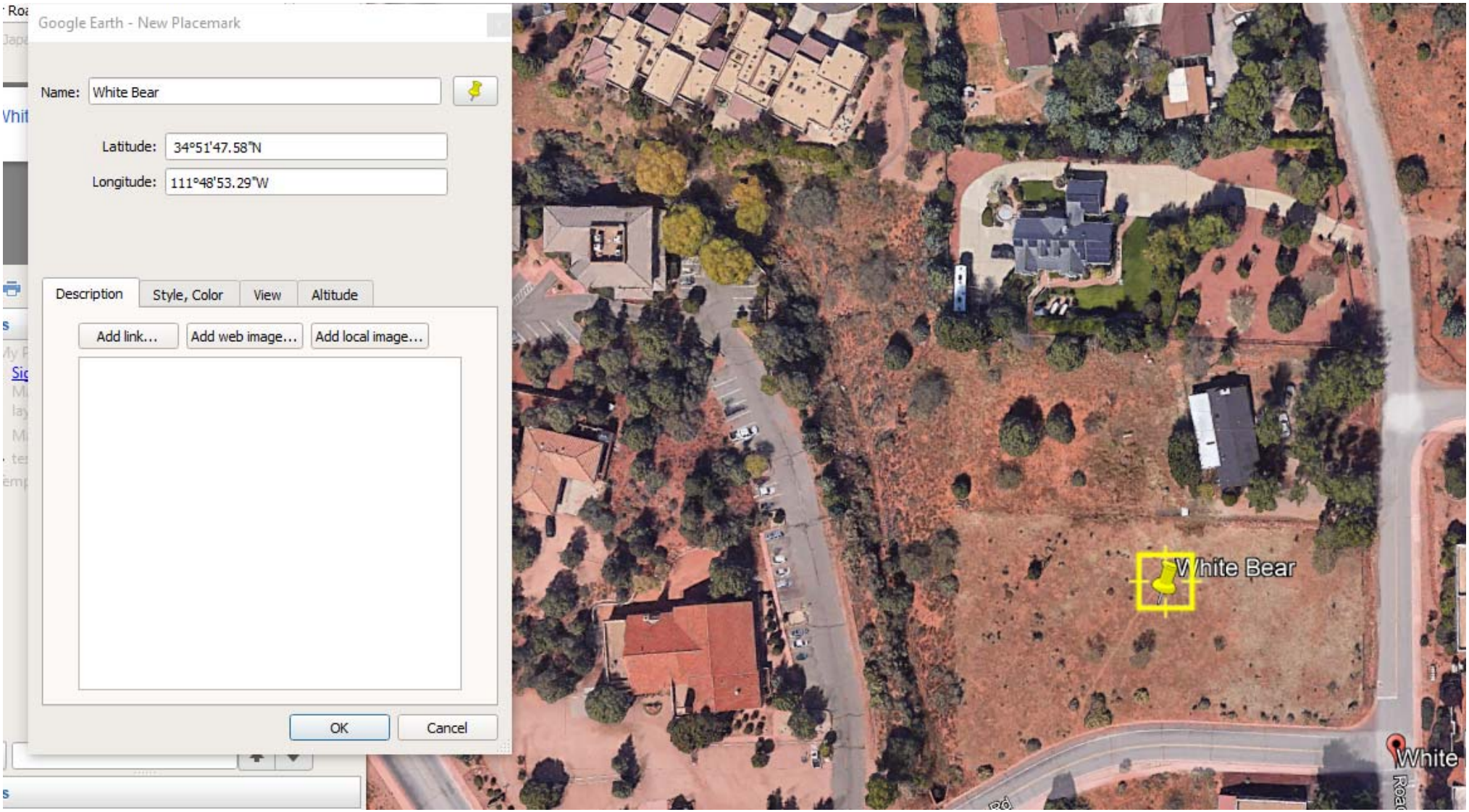
Point precipitation frequency estimates (inches)
NOAA Atlas 14 Volume 1 Version 5
Data type: Precipitation depth
Time series type: Partial duration
Project area: Southwest
Location n: Arizona USA
Station Name: -
Latitude: 34.8632°
Longitude: -111.8148°
Elevation (USGS): 4399.06 ft

PRECIPITATION FREQUENCY ESTIMATES

by duratior	1	2	5	10	25	50	100	200	500	1000
5-min:	0.211	0.272	0.367	0.447	0.561	0.655	0.758	0.868	1.03	1.17
10-min:	0.321	0.414	0.559	0.68	0.853	0.997	1.15	1.32	1.57	1.77
15-min:	0.398	0.514	0.693	0.843	1.06	1.24	1.43	1.64	1.94	2.2
30-min:	0.537	0.692	0.933	1.14	1.42	1.67	1.93	2.21	2.62	2.96
60-min:	0.664	0.856	1.15	1.41	1.76	2.06	2.38	2.73	3.24	3.66
2-hr:	0.784	0.991	1.31	1.58	1.97	2.29	2.64	3.03	3.59	4.07
3-hr:	0.844	1.07	1.37	1.63	2.01	2.33	2.68	3.06	3.63	4.1
6-hr:	1.02	1.27	1.58	1.85	2.25	2.56	2.91	3.28	3.82	4.27
12-hr:	1.31	1.62	1.98	2.28	2.69	3.01	3.34	3.68	4.15	4.55
24-hr:	1.64	2.05	2.55	2.96	3.52	3.96	4.41	4.87	5.51	6.01
2-day:	1.91	2.38	2.97	3.44	4.09	4.6	5.13	5.67	6.42	7
3-day:	2.06	2.56	3.2	3.72	4.43	5	5.59	6.21	7.05	7.72
4-day:	2.2	2.74	3.43	4	4.78	5.41	6.06	6.74	7.69	8.43
7-day:	2.58	3.21	3.99	4.62	5.5	6.19	6.92	7.66	8.69	9.49
10-day:	2.93	3.65	4.5	5.18	6.09	6.79	7.49	8.21	9.17	9.9
20-day:	3.79	4.71	5.73	6.5	7.48	8.2	8.9	9.57	10.4	11
30-day:	4.56	5.66	6.86	7.76	8.91	9.74	10.5	11.3	12.3	13
45-day:	5.4	6.71	8.15	9.24	10.7	11.7	12.7	13.7	14.9	15.8
60-day:	6.28	7.8	9.41	10.6	12.1	13.2	14.2	15.2	16.4	17.2

	Intensity in/hr		
Duration in Min	2 year	10 year	100 year
5	3.264	5.364	9.096
10	2.484	4.08	6.9
15	2.056	3.372	5.72
30	1.384	2.28	3.86
60	0.856	1.41	2.38

Date/time (GMT): Tue Apr 12 21:29:16 2022
pyRunTime: 0.0279200077057


Google Earth - New Placemark
Name: White Bear
Latitude: 34°51'47.58"N
Longitude: 111°48'53.29"W
Description
Style, Color
View
Altitude
Add link...
Add web image...
Add local image...
OK
Cancel
White Bear
White

Degrees Minutes Seconds to Decimal Degrees

Please enter the **degrees, minutes, seconds (DMS)** coordinates values to conver

Degrees for Latitude	Minutes	Seconds
34 °	51 '	47.58 "

Degrees for Longitude	Minutes	Seconds
111 °	48 '	53.29 "

Convert to Decimal Degrees

Decimal Degrees Lat	Decimal Degrees Long
34.86321667 °	111.81480278 °

NOAA Atlas 14, Volume 1, Version 5
Location name: Sedona, Arizona, USA*
Latitude: 34.8631°, Longitude: -111.8145°
Elevation: 4398.77 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	**0.211** (0.177-0.250)	**0.272** (0.228-0.322)	**0.367** (0.308-0.435)	**0.447** (0.374-0.529)	**0.561** (0.466-0.660)	**0.655** (0.540-0.771)	**0.758** (0.618-0.893)	**0.868** (0.699-1.02)	**1.03** (0.813-1.22)	**1.17** (0.906-1.39)
10-min	**0.321** (0.270-0.381)	**0.414** (0.348-0.491)	**0.559** (0.469-0.662)	**0.680** (0.570-0.804)	**0.853** (0.709-1.00)	**0.997** (0.822-1.17)	**1.15** (0.941-1.36)	**1.32** (1.06-1.56)	**1.57** (1.24-1.86)	**1.77** (1.38-2.12)
15-min	**0.398** (0.335-0.472)	**0.514** (0.431-0.608)	**0.693** (0.581-0.821)	**0.843** (0.707-0.997)	**1.06** (0.879-1.25)	**1.24** (1.02-1.46)	**1.43** (1.17-1.68)	**1.64** (1.32-1.93)	**1.94** (1.53-2.31)	**2.20** (1.71-2.63)
30-min	**0.537** (0.451-0.636)	**0.692** (0.581-0.819)	**0.933** (0.783-1.11)	**1.14** (0.952-1.34)	**1.42** (1.18-1.68)	**1.67** (1.37-1.96)	**1.93** (1.57-2.27)	**2.21** (1.78-2.60)	**2.62** (2.07-3.11)	**2.96** (2.30-3.54)
60-min	**0.664** (0.558-0.787)	**0.856** (0.719-1.01)	**1.15** (0.969-1.37)	**1.41** (1.18-1.66)	**1.76** (1.47-2.07)	**2.06** (1.70-2.42)	**2.38** (1.94-2.81)	**2.73** (2.20-3.22)	**3.24** (2.56-3.85)	**3.66** (2.85-4.38)
2-hr	**0.784** (0.682-0.908)	**0.991** (0.858-1.15)	**1.31** (1.13-1.52)	**1.58** (1.36-1.83)	**1.97** (1.68-2.27)	**2.29** (1.93-2.64)	**2.64** (2.20-3.06)	**3.03** (2.49-3.51)	**3.59** (2.90-4.18)	**4.07** (3.21-4.73)
3-hr	**0.844** (0.743-0.973)	**1.07** (0.943-1.23)	**1.37** (1.21-1.58)	**1.63** (1.43-1.87)	**2.01** (1.74-2.30)	**2.33** (2.00-2.66)	**2.68** (2.27-3.08)	**3.06** (2.56-3.53)	**3.63** (2.98-4.20)	**4.10** (3.30-4.78)
6-hr	**1.02** (0.916-1.14)	**1.27** (1.14-1.42)	**1.58** (1.41-1.77)	**1.85** (1.65-2.07)	**2.25** (1.99-2.51)	**2.56** (2.25-2.86)	**2.91** (2.53-3.26)	**3.28** (2.81-3.68)	**3.82** (3.22-4.33)	**4.27** (3.53-4.86)
12-hr	**1.31** (1.18-1.46)	**1.62** (1.46-1.81)	**1.98** (1.78-2.20)	**2.28** (2.05-2.53)	**2.69** (2.40-2.98)	**3.01** (2.67-3.33)	**3.34** (2.93-3.70)	**3.68** (3.20-4.09)	**4.15** (3.57-4.65)	**4.55** (3.86-5.12)
24-hr	**1.64** (1.49-1.81)	**2.05** (1.86-2.27)	**2.55** (2.31-2.82)	**2.96** (2.68-3.27)	**3.52** (3.17-3.89)	**3.96** (3.55-4.37)	**4.41** (3.93-4.87)	**4.87** (4.33-5.39)	**5.51** (4.84-6.12)	**6.01** (5.23-6.69)
2-day	**1.91** (1.74-2.11)	**2.38** (2.17-2.63)	**2.97** (2.70-3.28)	**3.44** (3.13-3.79)	**4.09** (3.71-4.50)	**4.60** (4.15-5.06)	**5.13** (4.60-5.64)	**5.67** (5.06-6.25)	**6.42** (5.67-7.09)	**7.00** (6.13-7.75)
3-day	**2.06** (1.88-2.26)	**2.56** (2.34-2.82)	**3.20** (2.92-3.53)	**3.72** (3.38-4.09)	**4.43** (4.02-4.87)	**5.00** (4.52-5.49)	**5.59** (5.02-6.15)	**6.21** (5.54-6.83)	**7.05** (6.23-7.79)	**7.72** (6.76-8.55)
4-day	**2.20** (2.01-2.42)	**2.74** (2.51-3.02)	**3.43** (3.14-3.78)	**4.00** (3.64-4.39)	**4.78** (4.34-5.24)	**5.41** (4.88-5.92)	**6.06** (5.45-6.65)	**6.74** (6.02-7.41)	**7.69** (6.79-8.48)	**8.43** (7.38-9.35)
7-day	**2.58** (2.36-2.82)	**3.21** (2.94-3.52)	**3.99** (3.65-4.36)	**4.62** (4.22-5.05)	**5.50** (5.00-6.01)	**6.19** (5.61-6.77)	**6.92** (6.24-7.57)	**7.66** (6.87-8.39)	**8.69** (7.71-9.55)	**9.49** (8.35-10.5)
10-day	**2.93** (2.68-3.21)	**3.65** (3.34-4.00)	**4.50** (4.12-4.93)	**5.18** (4.73-5.67)	**6.09** (5.54-6.65)	**6.79** (6.15-7.42)	**7.49** (6.76-8.21)	**8.21** (7.37-9.00)	**9.17** (8.17-10.1)	**9.90** (8.77-10.9)
20-day	**3.79** (3.48-4.15)	**4.71** (4.33-5.15)	**5.73** (5.26-6.26)	**6.50** (5.95-7.09)	**7.48** (6.83-8.15)	**8.20** (7.47-8.94)	**8.90** (8.08-9.71)	**9.57** (8.66-10.4)	**10.4** (9.38-11.4)	**11.0** (9.89-12.1)
30-day	**4.56** (4.17-4.99)	**5.66** (5.18-6.20)	**6.86** (6.27-7.50)	**7.76** (7.09-8.47)	**8.91** (8.11-9.72)	**9.74** (8.85-10.6)	**10.5** (9.54-11.5)	**11.3** (10.2-12.4)	**12.3** (11.0-13.5)	**13.0** (11.6-14.2)
45-day	**5.40** (4.92-5.96)	**6.71** (6.12-7.41)	**8.15** (7.43-8.98)	**9.24** (8.41-10.2)	**10.7** (9.68-11.7)	**11.7** (10.6-12.8)	**12.7** (11.5-14.0)	**13.7** (12.3-15.0)	**14.9** (13.3-16.4)	**15.8** (14.1-17.4)
60-day	**6.28** (5.71-6.90)	**7.80** (7.10-8.57)	**9.41** (8.57-10.3)	**10.6** (9.64-11.6)	**12.1** (11.0-13.3)	**13.2** (11.9-14.5)	**14.2** (12.8-15.6)	**15.2** (13.7-16.7)	**16.4** (14.7-18.0)	**17.2** (15.4-19.0)

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

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

Please refer to NOAA Atlas 14 document for more information.

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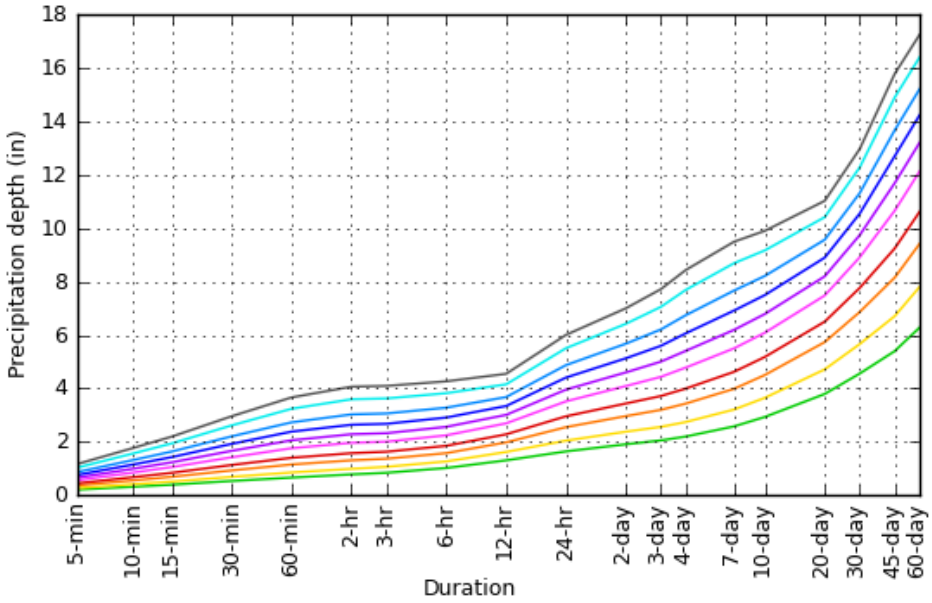
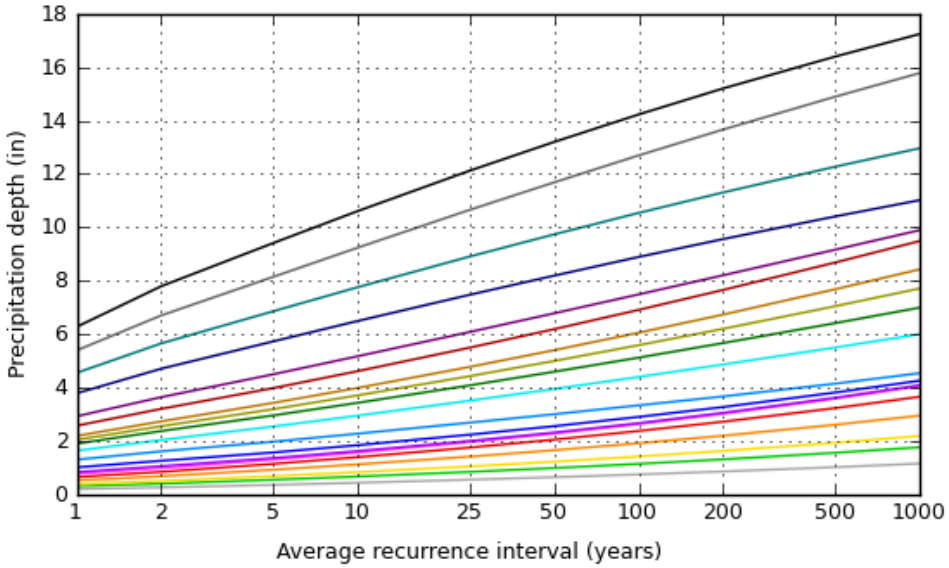
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 34.8631°, Longitude: -111.8145°





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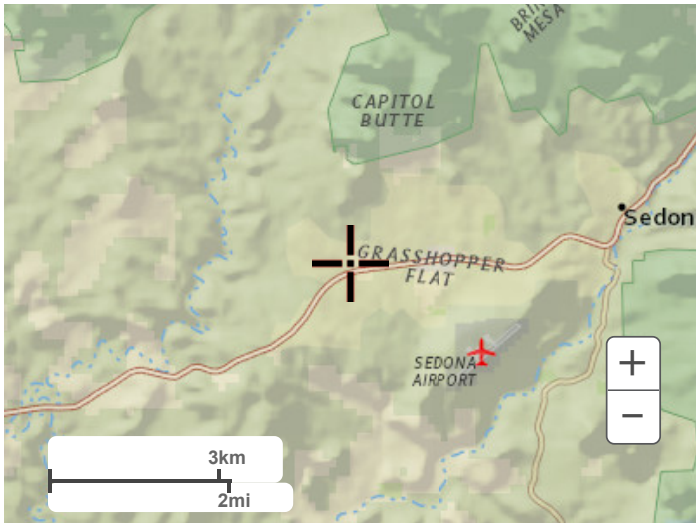
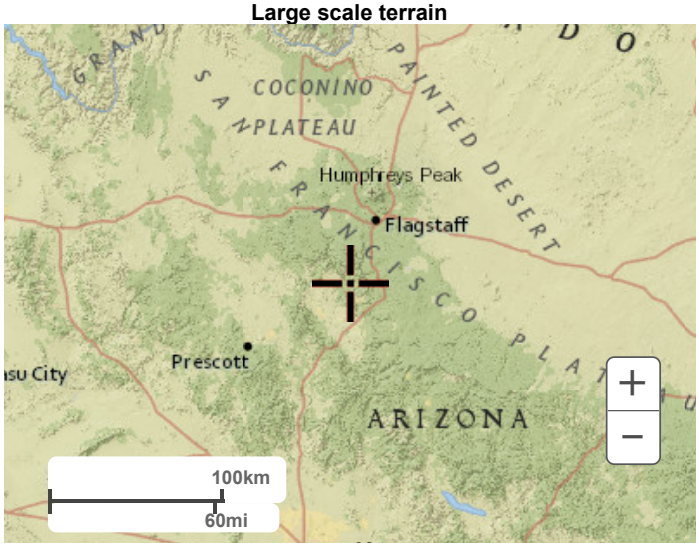
Maps & aerials

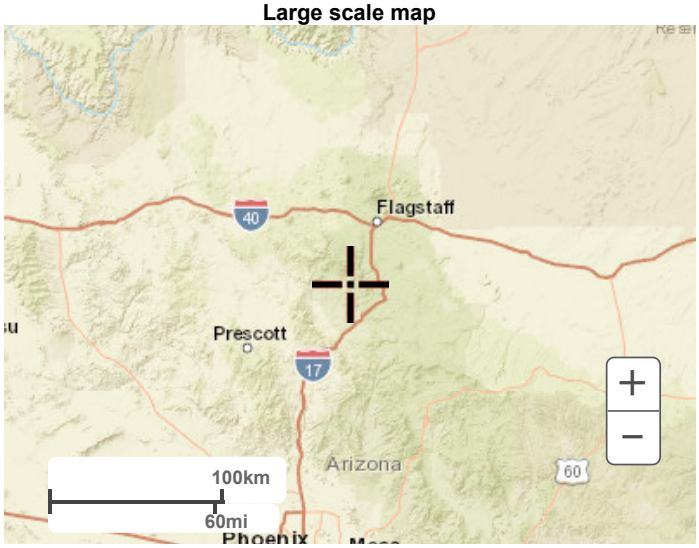
Small scale terrain



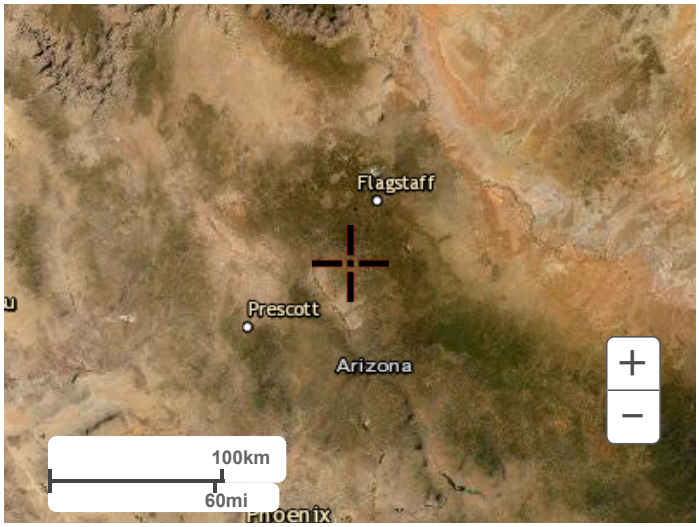
Large scale terrain



Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix C: Weighted C Value & Required Volume Calculations

Pre Vs Post Volume Calculation

Project:	White Bear		
Storm Event:	100-yr 2-hr		
Prepared by:	KD	**Date:**	5/9/2022

V = C * A * P / 12 [1]
Where:
V = Runoff Volume
C = Runoff Coefficient
A = Drainage Area
P = 2.64 in

Post-Development Weighted Runoff Coefficient

Basin ID	*Sub Basin Area Description*	*Contributing Area (ft^2)*	*C =*
Onsite Drainage Areas A & B	Desert Landscaping 2	21,519	0.44
	Gravel Roadways & Shoulders	3,240	0.82
	Pavement & Rooftops	17,607	0.95
	Total	42,366	0.68

Required Volume Calculation: Pre Vs. Post Excess

Description	*C =*	*On-Site Contributing Area (ft^2)*	*Volume Required, V_R (ft^3)*
Pre-Development	0.44	42,366	4,101
Post-Development	0.68	42,366	6,338
Excess	0.24	42,366	**2,237**

(1) Equation 7.7 taken from Yavapai County Drainage Manual.

Appendix D: Retention Calculations & Rip Rap Sizing

Retention Calculations

Project: White Bear

Storm Event: 100-yr 2-hr

Prepared by: KD **Date:** 5/9/2022

V = C * A * P / 12
Where:
V = Runoff Volume
C = Runoff Coefficient
A = Drainage Area
P = 2.64 in

Surface Retention Basin Volume Calculations

Basin ID	Elevation	Area (ft^2)	Incremental Volume (ft^3)	Volume Provided, V_p (ft^3)	Volume Required, Vr (ft^3)
A	4386.3	821	0		
	4388.0	1,951	2,357	2,357	2,237
	4389.0 (Freeboard)	2,719	4,692		

Drainage Area A Post Development Runoff

Basin ID	Sub-Basin ID	Sub Basin Area Description	Contributing Area (ft^2)	C =	Volume (ft^3)	Volume Provided, V_p (ft^3) (1)
Drainage Area A	A1.1	Gravel Roadway (Parking Area)	6,431	0.83	1,174	
	A1.2	Pavement & Rooftops	3,728	0.95	779	
	A1.3	Desert Landscaping 2	3,070	0.44	297	
		Total	13,229	0.77	2,251	2,357

Basin Dewatering

Basin ID	Derated Surface Percolation Rate (ft/hr) (2)	Percolation time (Surface only) (hr) (3)	Volume not drained in 12 hours (cuft)	Assumed Drwell Percolation Rate (cfs)	Drywells Required (4)	Drywells Provided	Drains in Less Than 12 Hours?
A	0.282	6.03	0.00	0.10	0	0	Yes

Notes:
(1) Runoff volume beyond the capacty of the basin will be retained within the freeboard volume.
(2) Surface Percolation Rate taken from National Resource Conservation Service Web Soil Survey =47.7697 µm/s (0.564 ft/hr) with 50% Safety Factor.
(3) Percolation time equals ponding depth divided by percolation rate.
(4) Number of drywells= Volume not drained in 12 hours/Drywell Percolation Rate

Project: 21-1135 White Bear (Onsite Flow, Drainage Area "A" for Rip Rap sizing)
Design Methodology and Procedures: Maricopa County Drainage Design Manual Volume 2

Inputs:

Area (should not exceed 160 acres):	0.33	acres
Flow path length:	190	feet
	0.036	miles
Upstream elevation:	4393.45	feet
Downstream elevation:	4386.30	feet
Flow path slope:	199	feet/mile
Land use category:	VLDR (40,000 sq. ft or grater lot size)	

	2-yr	25-yr	100-yr
Runoff coefficient (From Table 3-2):	0.35	0.39	0.78

Watershed roughness type (from Table 3-1):	C
Kb parameter m:	-0.00625
Kb parameter b:	0.04
Kb=m log(a) + b:	0.04299

Table 1: Intensity-Duration-Frequency Data (IDF) (2)

Duration (min)	Frequency 2-yr	10-yr	100-yr
	Intensity (in/hr)		
5	3.26	5.36	9.10
10	2.48	4.08	6.90
15	2.06	3.37	5.72
30	1.38	2.28	3.86
60	0.86	1.41	2.38

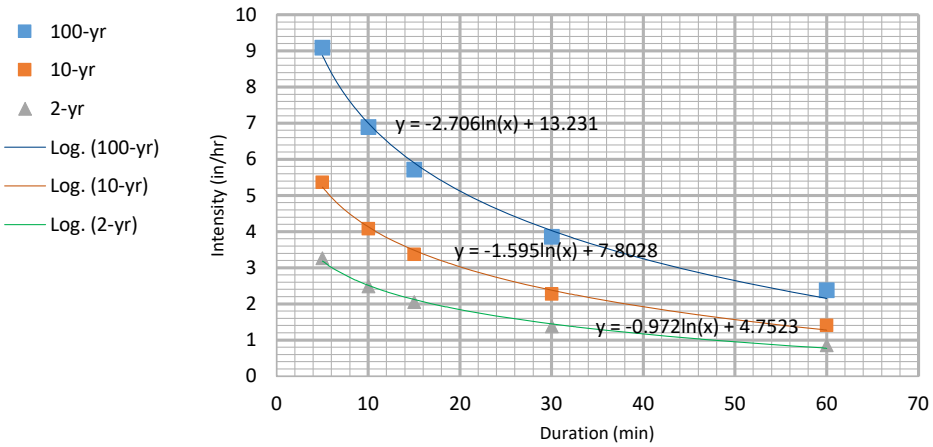


Table 2: Calculation and Output	2-yr	10-yr	100-yr
Time of concentration (3) (hours):	0.05	0.04	0.03
Time of concentration (min):	3.188	2.576	1.940
Intensity (1) (in/hr):	3.096	5.426	11.438
Design Peak flow (cfs):	**0.4**	**0.7**	**3.0**

Notes:

1. Intensity calculated Iteratively as follows: A) Choose a duration and intensity from Table 1 and input in table 2 to calculate Tc. B) Use new Tc to get intensity from Graph and re-calculate Tc. C) Repeat process until new Tc is relative close to previous Tc .
2. Precipitation depth (P) obtained from NOAA Atlas 14. Intensity for each Duration (D) and Frequency calculated as P/D, where: P is precipitation in inches & D is duration in hours.
3. $Tc = 11.4\ L^{0.5}\ K_b^{0.52}\ S^{-0.31}\ I^{-0.38}$, Formula 3.2
4. Q= CiA, Formula 3.1.

Manning Formula Uniform Trapezoidal Channel Flow at Given Slope and Depth

White Bear- Rip-rap size using Isbash and Maricopa county

Printable Subtitle

Inputs

Bottom width	12	ft
Side slope 1 (horiz./vert.)	1	
Side slope 2 (horiz./vert.)	1	
Manning roughness, n ? ◉Strickler ○B/B (See notes)	0.0346	
Channel slope	33	% rise/run
Flow depth	.065	ft
Bend Angle ? (for riprap sizing)	1	
Rock specific gravity (2.65)	2.65	
Design rock size ○Isbash ○Maynord ○Searcy * 1.25 (See notes)	.5	ft

Results

Flow area	0.7843	ft^2
Wetted perimeter	12.1838	ft
Hydraulic radius	0.0644	ft
Velocity, v	3.9623	ft/sec
Flow, Q (See notes)	3.1073	cfs
Velocity head, h_v	0.2440	ft
Top width, T	12.1300	ft
Froude number, F	2.82	
Average shear stress (tractive force), tau	1.3261	psf
n for design rock size per Strickler	0.0346	
n for design rock size per Blodgett	-0.0692	
n for design rock size per Bathurst	0.0116	
Blodgett vs. Bathurst	----	
Required bottom angular rock size, D50 (Isbash & MC) ?	2.1799	in
Required side slope 1 angular rock size, D50 (Isbash & MC) ?	3.0828	in
Required side slope 2 angular rock size, D50 (Isbash & MC) ?	3.0828	in
Required angular rock size, D50 (Maynord, Ruff, and Abt 1989)	4.6008	in
Required angular rock size, D50 (Searcy 1967)	1.2633	in

Notes:

Automated rock size and roughness design iteration

Choose a roughness radio button (BB recommended) and a design rock size radio button (Isbash recommended). Fine-tune depth and rock size safety factor to get your desired flow with an even rock size. Every time you change any input value, the following iteration cycle happens: 1. Roughness is calculated from design rock size. 2. The requested roughness calculation is copied to input roughness. 3. Channel flow and required rock size are calculated. 4. Design rock size is adjusted. 5. Repeat until error in the design rock size is very small.

Basic calculator (no iteration)

Enter your desired roughness value. Ignore the design rock size input area.

Proposed Rip-rap size

required Rip-rap size

Loose Angular Riprap Sizing (d_{50})

In Simons and Senturk (1992) and ASCE (2006), the Isbash equation for low turbulent flow has a term which accounts for bank slope effects. However, in USACE (1994), the Isbash equation does not account for bank slope effects, but has coefficients to account for both low and high turbulent flows. By combining these equations, the Flood Control District of Maricopa County (FCDMC) has developed a modified Isbash equation which accounts for both the bank slope effects and the flow regime (whether low or high turbulent flows).

In USACE (1994), the Isbash equation is based on an average channel velocity. However, the channel velocity for a cross section is not uniform. The maximum velocity is higher than the average velocity. The maximum velocity usually occurs in the middle of a cross section. In alluvial channels, the main channel may laterally migrate within the floodplain. Therefore, using maximum velocity is more reasonable. To account for the maximum velocity for a particular cross section that may occur anywhere, the FCDMC uses the maximum velocity, V. The maximum velocity can be approximated by $1.33V_a$ (Subramanya, 1997). The FCDMC-recommended modified Isbash equation has the form:

$$d_{50} = \frac{V^2}{2gC^2\cos\varphi}\left(\frac{\gamma_w}{\gamma_s - \gamma_w}\right) \qquad (6.33)$$

where:

V = maximum velocity $V = 1.33V_a$ (Subramanya, 1997), (ft/s),

V_a = average velocity (ft/s),

C = coefficient (use 1.2 for low turbulence areas or 0.86 for high turbulence areas),

g = gravitational acceleration (ft/s^2),

γ_s = specific weigh of stone (lb/ft^3),

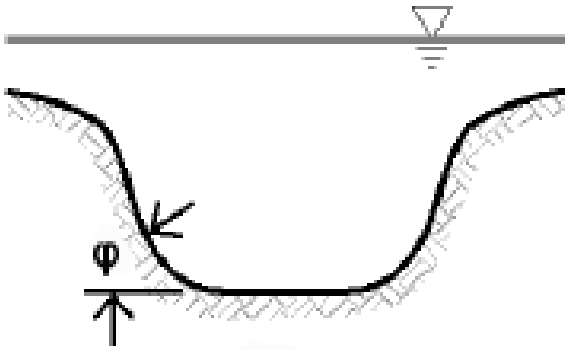
γ_w = specific weight of water (lb/ft^3),

φ = bank angle (degrees), see Figure 6.12 and

d_{50} = median rock size, also defined as the diameter where 50% is finer by weight (ft).

This general equation can be simplified under various conditions: (1) channel banks on straight reaches, (2) channel banks on curve reaches, (3) channel bed on straight reaches, (4) channel bed on curve reaches, (5) downstream of grade control/drop structures, downstream of stilling basins, spur dike/guide bank/abutments, sloped drop structures and rock chutes. Simplified equations are presented on the following pages.

FIGURE 6.12
DEFINITION FOR BANK ANGLE



Channel Banks on Straight Reach

The FCDMC-recommended Isbash equation can be simplified with C = 1.2 for bank protection on a straight reach or a mildly curved reach (a reach with a bend angle, β, $\leq$ 30°). The loose riprap d_{50} for bank protection in a straight channel reach or a mildly curved reach with a bend angle (β) $\leq$ 30° can be calculated with the following equation. The equation has the form:

$$d_{50} = \frac{0.0191\,V_a^2}{\cos\varphi}\left(\frac{\gamma_w}{\gamma_s - \gamma_w}\right) \qquad (6.34)$$

where:

d_{50} = the median diameter (ft),

V_a = average velocity (ft/s),

γ_s = specific weigh of stone (lb/ft^3),

γ_w = specific weight of water (lb/ft^3),

φ = bank angle (degrees), see Figure 6.12 and

β = channel bend angle (degrees).