PRELIMINARY HYDROLOGY STUDY
FOR
88 Vivian Street, San Rafael Project

Project Address:

88 Vivian Street,
San Rafael, California

Prepared For:

Ashton 3, LLC
5 Hoya Street
Rancho Mission Viejo, California 92694
Contact: Matt Ashton
949.584.2042

Prepared By:

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March 2021
Revised: September 2021

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1.0 PURPOSE OF STUDY:

The preliminary hydrology study will determine the amount of stormwater runoff generated from the project site under pre-development and post-development conditions. The values and statements within this report confirm the Post-Development site is designed and planned in accordance with the Marin County drainage requirements. This study will anticipate whether detention or other peak flow mitigation methods will be required by comparing the Post-Development and Pre-Development condition peak flow rates for the 100-year storm events.

2.0 SITE DESCRIPTION:

The proposed site is located at 88 Vivian Street, in the City of San Rafael, County of Marin. The site is made up of a rectangle shape bordered by Vivian Street to the northerly-west side, Belvedere Street to the northerly-east side, and commercial buildings to the southerly-east and southerly-west side. The Development site is approximately 2.41 acres in gross area and currently consists of an existing closed bowling alley building. The site is classified to be Hydrologic Soil Type "D" based on water table and soil type per soils report prepared by Geocon Consultants, Inc.

Refer to Vicinity Map located in Appendix A for location reference.

3.0 PRE-DEVELOPMENT CONDITIONS:

In the current onsite condition, stormwater generally sheet flows over land from the south-easterly portion of the site to the north-westerly portion of the site. There is no sign of drainage features to the site identified on the perimeter of the property line of the site due to Pre-Development site grading and/or Pre-Development perimeter controls.

According to the Federal Emergency Management Agency (FEMA), FIRM rate map Number 06041C0459F, effective date March 16, 2016, the site is located within flood Zone AE with based flood elevation of 10 feet. Zone AE is areas that present a 1% annual chance of flooding.

Refer to the FIRM rate map located in Appendix E for reference.

The topographic survey was utilized to identify Pre-Development onsite high points and overall site conveyance of storm water runoff. All the Pre-Development onsite stormwater runoff ultimately reaches the outlet on Vivian Street and into an exist catch basin downstream. The site was analyzed as a single area to approximately quantify the runoff based on the longest hydraulic path from the most remote high point to drain low point, which will be used to compare to the proposed condition.

Reference to Preliminary Pre-Development Conditions Hydrology Map located in Appendix B.

4.0 POST-DEVELOPMENT CONDITIONS:

The proposed project consists of 68 residential dwelling units on an approximate 2.41-acre site. The proposed development includes drive aisles, parking, landscaping, walkways, and common open space areas.

The site will be graded to collect runoff at two (2) catch basins routed to bio-retention/ treatment vault via storm drainpipe for water quality treatment, which eventually mitigates to the connected storm drain system to the 24” stormwater pipe along Belvedere Street. The building roof runoff are dispersed to nearby landscaped area and release to the street to the downstream catch basins. There are a portion of the runoff from the building adjacent to the public street which route roof runoff to the bio-treatment vault via storm drain connection prior to discharging offsite. The bio-treatment vault will be designed with the internal bypass for the higher storm event.

In an event where the proposed onsite storm drain system exceeds full capacity, stormwater will overflow through street sheet flow to Vivian Street and follow historical drainage pattern.

Reference to Preliminary Post-Development Conditions Hydrology Map located in Appendix B.

5.0 METHODOLOGY:

For preliminary purposes, the project drainage analysis considers a single initial sub-area for the on-site drainage area to obtain the runoffs generated from the project site. The pre-development and post-development conditions peak flows for the 100-year storm event were analyzed using Rational Method.

$$Q = C(I - F_m)A$$

Q – the flow of runoff measured in cubic feet per second (cfs)
C – the runoff coefficient (0.75 – Residential; 0.9 – Commercial)
I – the intensity of the storm measured in inches per hour (in/hr)
F_m – minor loss obtained with soil group and pervious area
A – area contributing to the flow at a given point of concentration measured in acres

The peak flow rates corresponding with the post-development condition were compared to that of the Pre-Development condition. Storm intensity was derived using the Nation Oceanic and Atmospheric Administration's (NOAA) point precipitation frequency data.

Per the separately prepared Preliminary Stormwater Control Plan, the bio-retention/ treatment will also provide sufficient treatment flow for the BMP Design.

Refer to the Pre- and Post-Development Hydrology Calculation located in Appendix C.
Refer to NOAA's point precipitation frequency estimates located in Appendix E.

6.0 DESIGN ASSUMPTIONS:

1. The property is located in the City of San Rafael, Marin County rainfall region.

2. Assumed Runoff Coefficient C value of Family Residential (C=0.75) for post-development conditions and Commercial (C=0.90) for pre-development conditions. Refer to Marin County Hydrology Manual.

3. The site is classified to be Hydrologic Soil Type "D" based on water table and clay soil type per soils report prepared by Geocon Consultants, Inc. (See separate Stormwater Control Plan for reference).

4. Peak flow rates and time of concentrations were calculated using Rational Method and overland flow described in Marin County Hydrology Manual.

7.0 RESULTS:

Hydrology Summary

The results from this preliminary hydrology study utilizing the Rational Method demonstrate that the post-development storm water runoffs from the project site are lower than the pre-development conditions due to the increase in pervious area and time of concentration in the post-development design. Refer to the hydrologic calculation summary below:

Project Site	Land use	Pervious Area	Percent Coverage of Project Site
Pre-Development	Commercial	0.10 acre	4.1%
Post-Development	Residential	0.30 acre	12.6%

Pre-Project Q100 (cfs)	Post-Project Q100 (cfs)	Percent change in Q100
7.13	6.32	-11.4%

The Q the summation of the flow generated by project site.
Refer to Pre and Post Development Condition Hydrology Map located in Appendix B.
Refer to Pre and Post Development Condition Calculation located in Appendix C.

Bio-Retention/ treatment Sizing
Refer to the separately prepared project Preliminary Stormwater Control Plan for additional information regarding the water quality design.

Catch Basin Sizing
Additional catch basin sizing analysis will be provided during Final Engineering as locations are to be confirmed with final site plan.

Pipe Sizing
A preliminary pipe sizing for onsite runoff conveyance inlets were accomplished using Hydraulic Toolbox ver. 5.0 based on the 100-year storm event peak flow rates and provided in Appendix D of this report. Additional analysis will be provided during Final Engineering as alignments are to be confirmed with final site plan.

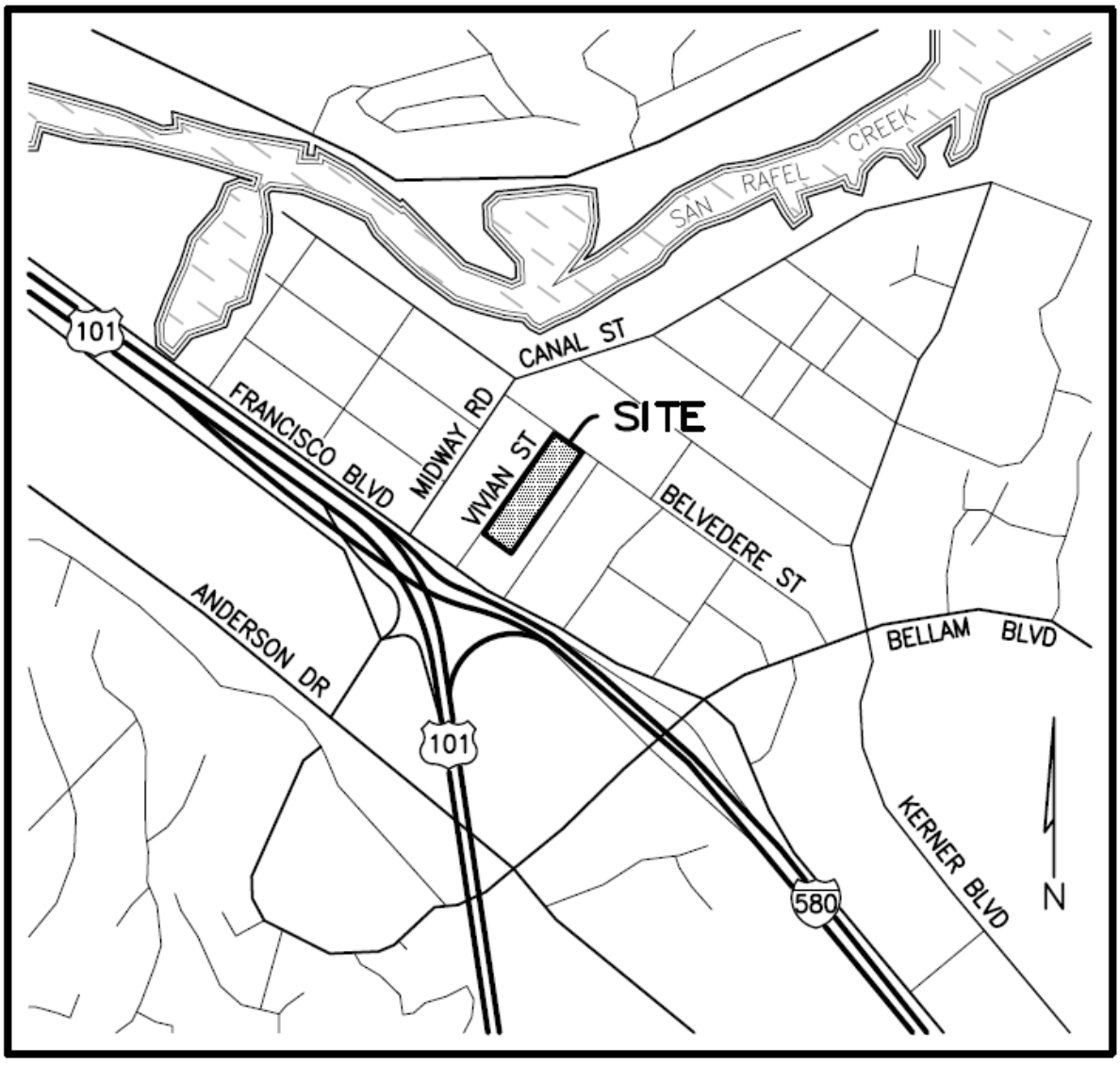
8.0 CONCLUSION:

The results from this preliminary hydrology study utilizing Rational Method demonstrate that the Post-Development condition stormwater peak flow for 100-year storm event from the subject site will decrease compared to the Pre-Development condition peak flow as indicated in the hydrology summary results in Section 7 of this report. This is mainly due to the increased change in pervious area based on the type of development is being proposed and this condition represents lower overall peak flow rates.

A preliminary pipe sizing for onsite runoff conveyance inlets were done using Hydraulic Toolbox ver. 5.0 based on the 100-year storm event peak flow rates and provided in Appendix D of this report.

As plans progress to an adequate level for construction, a Final Hydrology and Hydraulic Study should be provided to confirm that the proposed combination of site grading, routing of onsite storm water pipe facilities and storm water treatment systems are sized adequately to continue to mitigate the generated runoffs from the proposed site. Any additional effect to surrounding drainage system should be calculated at individual points of concentration around the site, to confirm its proposed runoff condition below pre-project conditions or properly mitigated.

APPENDIX A: Vicinity Map



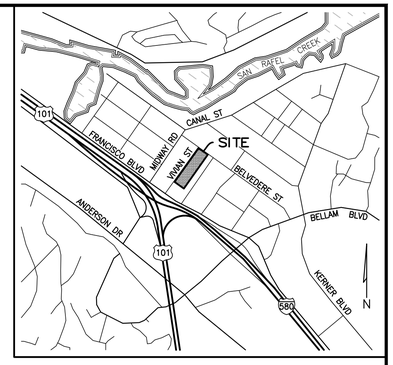
N. T. S.

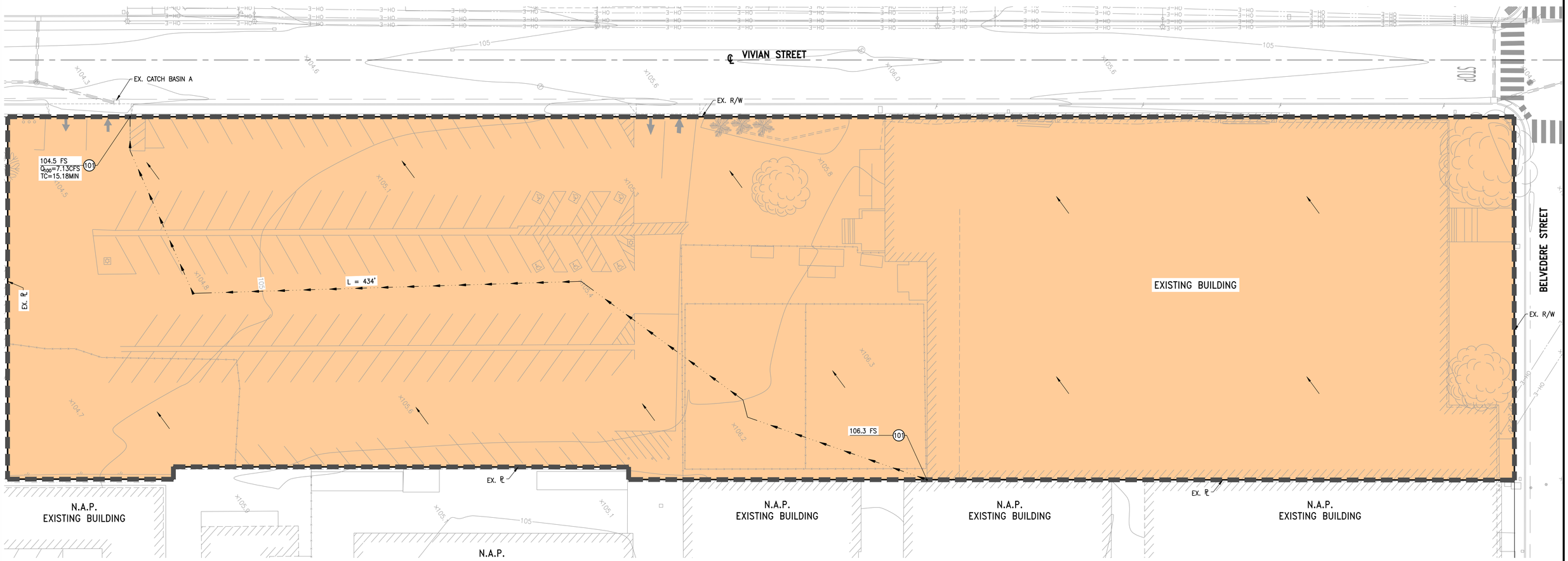
APPENDIX B: Hydrology Maps

Preliminary Pre-Development Conditions Hydrology Map

Preliminary Post-Development Conditions Hydrology Map

PRELIMINARY PRE-DEVELOPMENT HYDROLOGY MAP
88 VIVIAN STREET





LEGEND:

- DRAINAGE MANAGEMENT AREA (DMA) BOUNDARY
- FLOW DIRECTION
- FLOW PATH
- L=999' — FLOW PATH LENGTH
- X — INITIAL SUBAREA NODE
- 00.00 — SPOT ELEVATION
- Q_{100}=X.XX CFS — PEAK RUNOFF IN CUBIC FEET PER SECOND (CFS)
- Tc=X.X MIN — TIME OF CONCENTRATION IN MINUTES (MIN) PROVIDED FOR 100-YR STORM EVENT

NOTE: ALL Q IS SUMMATION OF FLOWS FROM UPSTREAM DMAS

DMA	COLOR	LANDUSE	AREA (SF)	AREA (ACRE)
XA		COMMERCIAL	104,896.84	2.41

PRE-DEVELOPMENT	PERVIOUS	IMPERVIOUS
2.41 ACRES	4161.07 SF (0.10 AC)	100,735.77 SF (2.31 AC)

SCALE: 1" = 20'

0 10 20 40

MARK	REVISIONS	APPR.	DATE

DESIGNED BY _____ DRAWN BY _____ CHECKED BY _____

CITY OF SAN RAFAEL

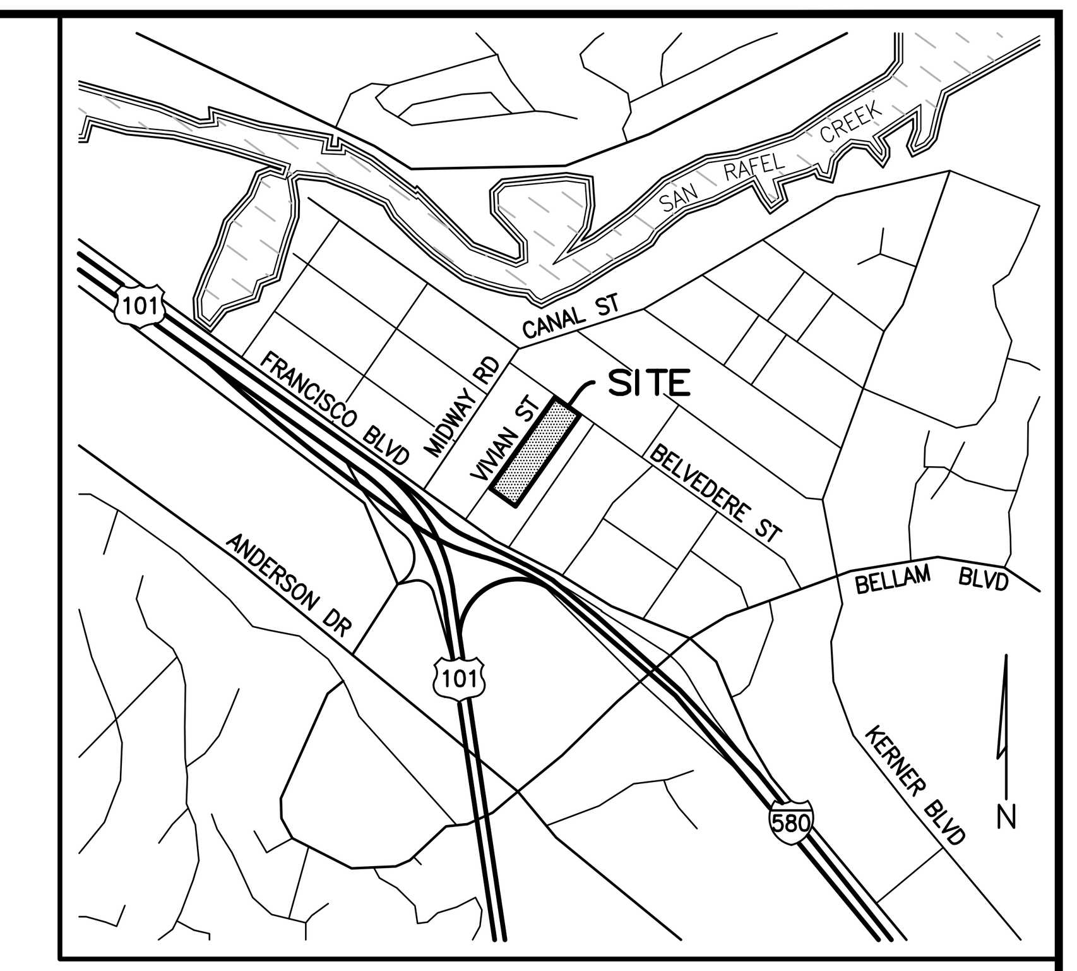
88 VIVIAN STREET

SHEET 1 OF 1

PROJ: BMK028

DWG: P:\MAR\PLOT\dwg\Sheet\BMK028-VIVIAN-PRE2.dwg BY: Ken Sep 01, 2021 - 2:00:22pm

PRELIMINARY POST-DEVELOPMENT HYDROLOGY MAP
88 VIVIAN STREET



LEGEND:

- DRAINAGE MANAGEMENT AREA (DMA) BOUNDARY
- FLOW DIRECTION
- FLOW DIRECTION
- L=999' FLOW PATH LENGTH
- (X) INITIAL SUBAREA NODE
- 00.00 SPOT ELEVATION
- Q_{100}=X.XX CFS PEAK RUNOFF IN CUBIC FEET PER SECOND (CFS)
- Tc=X.X MIN TIME OF CONCENTRATION IN MINUTES (MIN) PROVIDED FOR 100-YR STORM EVENT

NOTE: ALL Q IS SUMMATION OF FLOWS FROM UPSTREAM DMAS

DMA	COLOR	LANDUSE	AREA (SF)	AREA (ACRE)
A		RESIDENTIAL	0.00	0.00
B		RESIDENTIAL	0.00	0.00

POST-DEVELOPMENT	PERVIOUS	IMPERVIOUS
2.41 ACRES	13,240.62 SF (0.30 AC)	91,656.22 SF (2.11 AC)

SCALE: 1" = 20'

0 10 20 40

MARK	REVISIONS	APPR.	DATE

DESIGNED BY____ DRAWN BY____ CHECKED BY____

CITY OF SAN RAFAEL

88 VIVIAN STREET

SHEET 1 OF 1

APPENDIX C: Hydrology Calculations
Pre-Development & Post-Development Conditions
Hydrology Calculations

RATIONAL METHOD STUDY FORM

Marin County **HYDROLOGY**		**STUDY NAME: 88 Vivian Street** **100 YEAR STORM RATIONAL METHOD STUDY**						**CALCULATED BY: KL**			**DATE: 03/02/2021** **PAGE 1 OF 1**
CONC. PT. (MAP AREA)	AREA (ACRES) SUBAREA	LAND USE	DEV. (Ap)	Tc MIN.	I in/hr	Fm in/hr	Q TOTAL	FLOW PATH, FT	SLOPE FT/FT	V FT/SEC	HYDRAULICS AND NOTES
Proposed Area											
A	1.30	RESIDENTIAL	0.125	11.18	3.52	0.025	**3.41**	231	0.0069		Initial Subarea - NODE 100 to 101
B	1.11	RESIDENTIAL	0.125	10.71	3.52	0.025	**2.91**	210	0.0076		Initial Subarea - NODE 100 to 201
Existing Area											
XA	2.41	COMMERCIAL	0.0041	15.18	3.29	0.001	**7.13**	434	0.004		Initial Subarea - NODE 100 to 101

NOTES: RATIONAL METHOD; C = 0.90 for Commercial; C = 0.75 for Residential ; Q = C*(I - Fm)*A; Fm=Ap*Fp; Fp=0.20 (Soil D, USDA Soils Map)
Time of Travel for overland sheet flow was determined using the overland flow formula per the County of Marin's Hydrology Manual.

Q_{100} DURATION	INCH	INTENSITY
15-MIN	0.825	3.30
30-MIN	1.22	2.44

NOTE: INTENSITY IS OBTAINED FROM NOAA PRECIPITATION DATA

APPENDIX D: Hydraulic Calculations
Catch Basin Sizing
Pipe Sizing

Hydraulic Analysis Report

Project Data

Project Title: ASHT-001

Designer: KL

Project Date: Wednesday, March 3, 2021

Project Units: U.S. Customary Units

Notes:

Channel Analysis: 18" Storm Drain Pipe

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.5000 ft/ft

Manning's n: 0.0130

Flow: 6.3200 cfs

Result Parameters

Depth: 0.2958 ft

Area of Flow: 0.2465 ft^2

Wetted Perimeter: 1.3803 ft

Hydraulic Radius: 0.1786 ft

Average Velocity: 25.6353 ft/s

Top Width: 1.1936 ft

Froude Number: 9.9403

Critical Depth: 0.9719 ft

Critical Velocity: 5.2165 ft/s

Critical Slope: 0.0064 ft/ft

Critical Top Width: 1.43 ft

Calculated Max Shear Stress: 9.2279 lb/ft^2

Calculated Avg Shear Stress: 5.5725 lb/ft^2

APPENDIX E: References
USDA Soil Map
FEMA Flood Map
NOAA Precipitation

Soil Map—Marin County, California
(ASHT-001 Soil Map)

Map Scale: 1:1,490 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N 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: Marin County, California
Survey Area Data: Version 14, May 29, 2020

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

Date(s) aerial images were photographed: Apr 22, 2019—Apr 25, 2019

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
202	Urban land-Xerorthents complex, 0 to 9 percent slopes	4.4	100.0%
Totals for Area of Interest		**4.4**	**100.0%**

Marin County, California

202—Urban land-Xerorthents complex, 0 to 9 percent slopes

Map Unit Setting

National map unit symbol: hf4d
Elevation: 0 to 500 feet
Mean annual precipitation: 20 to 30 inches
Mean annual air temperature: 55 to 63 degrees F
Frost-free period: 270 to 350 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 70 percent
Xerorthents and similar soils: 20 percent
Minor components: 9 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform: Valley floors
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear

Interpretive groups

Land capability classification (irrigated): 8
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Description of Xerorthents

Setting

Landform: Tidal flats, valley floors
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Earth spread deposits derived from igneous, metamorphic and sedimentary rock

Properties and qualities

Slope: 0 to 9 percent
Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Interpretive groups

Land capability classification (irrigated): 8s

Land capability classification (nonirrigated): 8s
Hydric soil rating: No

Minor Components

Hydraquents
Percent of map unit: 2 percent
Landform: Tidal flats
Landform position (two-dimensional): Backslope
Hydric soil rating: Yes

Reyes
Percent of map unit: 1 percent
Landform: Salt marshes
Landform position (two-dimensional): Backslope
Hydric soil rating: Yes

Blucher
Percent of map unit: 1 percent
Hydric soil rating: No

Slopes more than 9 percent
Percent of map unit: 1 percent
Hydric soil rating: No

Cole
Percent of map unit: 1 percent
Hydric soil rating: No

Unnamed, briefly flooded soils
Percent of map unit: 1 percent
Hydric soil rating: No

Ballard
Percent of map unit: 1 percent
Hydric soil rating: No

Novato
Percent of map unit: 1 percent
Landform: Salt marshes
Landform position (two-dimensional): Backslope
Hydric soil rating: Yes

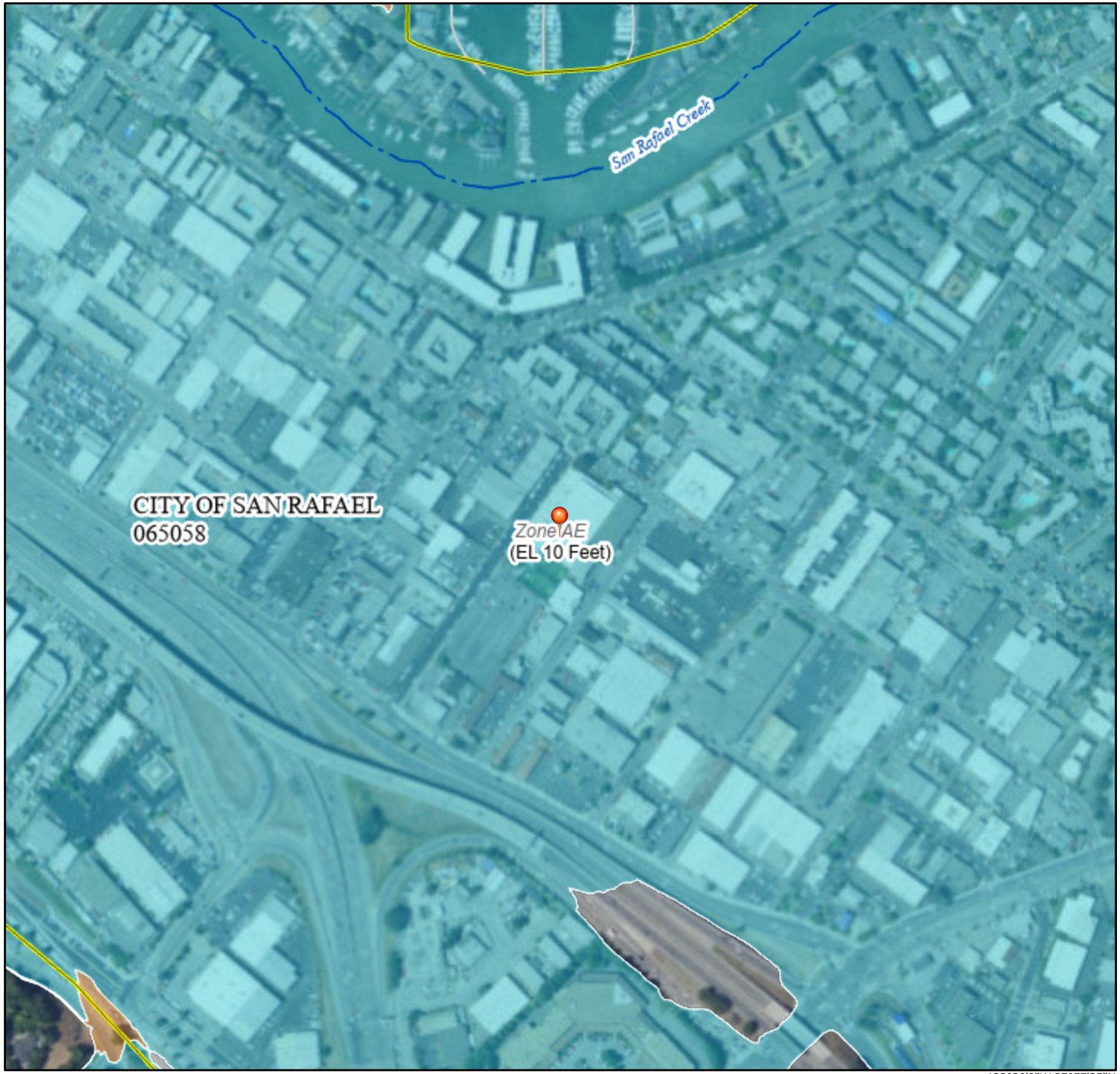
Data Source Information

Soil Survey Area: Marin County, California
Survey Area Data: Version 14, May 29, 2020

National Flood Hazard Layer FIRMette

FEMA

122°30'46"W 37°58'4"N



122°30'9"W 37°57'35"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 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 2/16/2021 at 12:19 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.

NOAA Atlas 14, Volume 6, Version 2
Location name: San Rafael, California, USA*
Latitude: 37.9638°, Longitude: -122.5075°
Elevation: 5.67 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	**0.159** (0.142-0.180)	**0.197** (0.175-0.224)	**0.250** (0.222-0.285)	**0.296** (0.260-0.341)	**0.363** (0.306-0.435)	**0.417** (0.343-0.513)	**0.476** (0.380-0.602)	**0.539** (0.417-0.705)	**0.631** (0.464-0.867)	**0.706** (0.499-1.01)
10-min	**0.228** (0.203-0.258)	**0.283** (0.251-0.321)	**0.359** (0.318-0.409)	**0.425** (0.373-0.489)	**0.520** (0.439-0.623)	**0.598** (0.492-0.735)	**0.682** (0.545-0.863)	**0.773** (0.597-1.01)	**0.904** (0.665-1.24)	**1.01** (0.715-1.45)
15-min	**0.276** (0.246-0.313)	**0.342** (0.304-0.388)	**0.434** (0.385-0.494)	**0.514** (0.451-0.591)	**0.629** (0.530-0.753)	**0.724** (0.595-0.889)	**0.825** (0.659-1.04)	**0.935** (0.722-1.22)	**1.09** (0.804-1.50)	**1.22** (0.864-1.75)
30-min	**0.407** (0.363-0.461)	**0.504** (0.449-0.572)	**0.640** (0.568-0.729)	**0.758** (0.665-0.872)	**0.928** (0.783-1.11)	**1.07** (0.878-1.31)	**1.22** (0.972-1.54)	**1.38** (1.07-1.81)	**1.61** (1.19-2.22)	**1.81** (1.27-2.58)
60-min	**0.582** (0.518-0.659)	**0.721** (0.641-0.818)	**0.915** (0.812-1.04)	**1.08** (0.951-1.25)	**1.33** (1.12-1.59)	**1.53** (1.25-1.88)	**1.74** (1.39-2.20)	**1.97** (1.52-2.58)	**2.31** (1.70-3.17)	**2.58** (1.82-3.69)
2-hr	**0.872** (0.777-0.988)	**1.08** (0.962-1.23)	**1.38** (1.22-1.57)	**1.63** (1.43-1.87)	**2.00** (1.68-2.39)	**2.30** (1.89-2.82)	**2.62** (2.09-3.31)	**2.97** (2.29-3.88)	**3.47** (2.55-4.76)	**3.88** (2.74-5.55)
3-hr	**1.11** (0.988-1.26)	**1.38** (1.22-1.56)	**1.75** (1.55-1.99)	**2.07** (1.81-2.38)	**2.53** (2.13-3.03)	**2.90** (2.39-3.57)	**3.31** (2.64-4.18)	**3.75** (2.89-4.90)	**4.37** (3.22-6.01)	**4.89** (3.45-7.00)
6-hr	**1.63** (1.45-1.85)	**2.03** (1.80-2.30)	**2.57** (2.28-2.92)	**3.03** (2.66-3.49)	**3.70** (3.12-4.43)	**4.23** (3.48-5.20)	**4.80** (3.84-6.08)	**5.42** (4.19-7.09)	**6.30** (4.63-8.65)	**7.01** (4.95-10.0)
12-hr	**2.31** (2.06-2.62)	**2.90** (2.58-3.29)	**3.69** (3.27-4.20)	**4.35** (3.82-5.01)	**5.29** (4.46-6.34)	**6.05** (4.97-7.43)	**6.83** (5.46-8.64)	**7.67** (5.93-10.0)	**8.85** (6.51-12.2)	**9.79** (6.92-14.0)
24-hr	**3.15** (2.84-3.57)	**3.98** (3.58-4.51)	**5.09** (4.57-5.79)	**6.02** (5.36-6.89)	**7.31** (6.32-8.62)	**8.32** (7.06-10.0)	**9.37** (7.78-11.5)	**10.5** (8.48-13.2)	**12.0** (9.36-15.7)	**13.2** (9.98-17.9)
2-day	**4.20** (3.78-4.76)	**5.32** (4.78-6.03)	**6.80** (6.10-7.74)	**8.02** (7.15-9.19)	**9.70** (8.39-11.5)	**11.0** (9.34-13.2)	**12.4** (10.3-15.2)	**13.7** (11.1-17.3)	**15.7** (12.2-20.5)	**17.2** (13.0-23.2)
3-day	**4.80** (4.32-5.44)	**6.08** (5.47-6.90)	**7.77** (6.97-8.84)	**9.15** (8.15-10.5)	**11.0** (9.55-13.0)	**12.5** (10.6-15.0)	**14.0** (11.6-17.2)	**15.5** (12.6-19.6)	**17.6** (13.7-23.1)	**19.3** (14.5-26.0)
4-day	**5.29** (4.76-6.00)	**6.71** (6.04-7.61)	**8.57** (7.69-9.75)	**10.1** (8.99-11.6)	**12.1** (10.5-14.3)	**13.7** (11.6-16.5)	**15.3** (12.7-18.9)	**17.0** (13.8-21.4)	**19.2** (15.0-25.2)	**21.0** (15.8-28.3)
7-day	**6.44** (5.80-7.30)	**8.17** (7.34-9.27)	**10.4** (9.35-11.9)	**12.2** (10.9-14.0)	**14.7** (12.7-17.4)	**16.6** (14.1-19.9)	**18.5** (15.3-22.7)	**20.4** (16.5-25.7)	**23.0** (17.9-30.1)	**24.9** (18.8-33.7)
10-day	**7.49** (6.74-8.49)	**9.52** (8.56-10.8)	**12.1** (10.9-13.8)	**14.2** (12.7-16.3)	**17.0** (14.7-20.1)	**19.1** (16.2-23.0)	**21.2** (17.6-26.1)	**23.3** (18.9-29.4)	**26.2** (20.4-34.3)	**28.3** (21.4-38.2)
20-day	**9.81** (8.83-11.1)	**12.6** (11.3-14.3)	**16.0** (14.4-18.2)	**18.7** (16.6-21.4)	**22.1** (19.1-26.1)	**24.7** (20.9-29.7)	**27.1** (22.5-33.3)	**29.5** (23.9-37.2)	**32.6** (25.4-42.6)	**34.8** (26.3-47.0)
30-day	**11.9** (10.7-13.5)	**15.3** (13.7-17.3)	**19.4** (17.4-22.1)	**22.6** (20.1-25.9)	**26.6** (23.0-31.4)	**29.4** (25.0-35.4)	**32.1** (26.7-39.5)	**34.7** (28.1-43.8)	**38.0** (29.6-49.7)	**40.3** (30.4-54.4)
45-day	**14.7** (13.2-16.6)	**18.9** (17.0-21.4)	**23.9** (21.4-27.1)	**27.6** (24.6-31.6)	**32.2** (27.9-38.0)	**35.5** (30.1-42.7)	**38.5** (31.9-47.3)	**41.3** (33.5-52.1)	**44.8** (34.9-58.7)	**47.2** (35.7-63.8)
60-day	**17.5** (15.8-19.9)	**22.5** (20.2-25.5)	**28.3** (25.4-32.2)	**32.6** (29.0-37.3)	**37.8** (32.7-44.6)	**41.4** (35.1-49.7)	**44.7** (37.1-54.9)	**47.8** (38.6-60.2)	**51.5** (40.1-67.4)	**54.0** (40.8-72.9)

[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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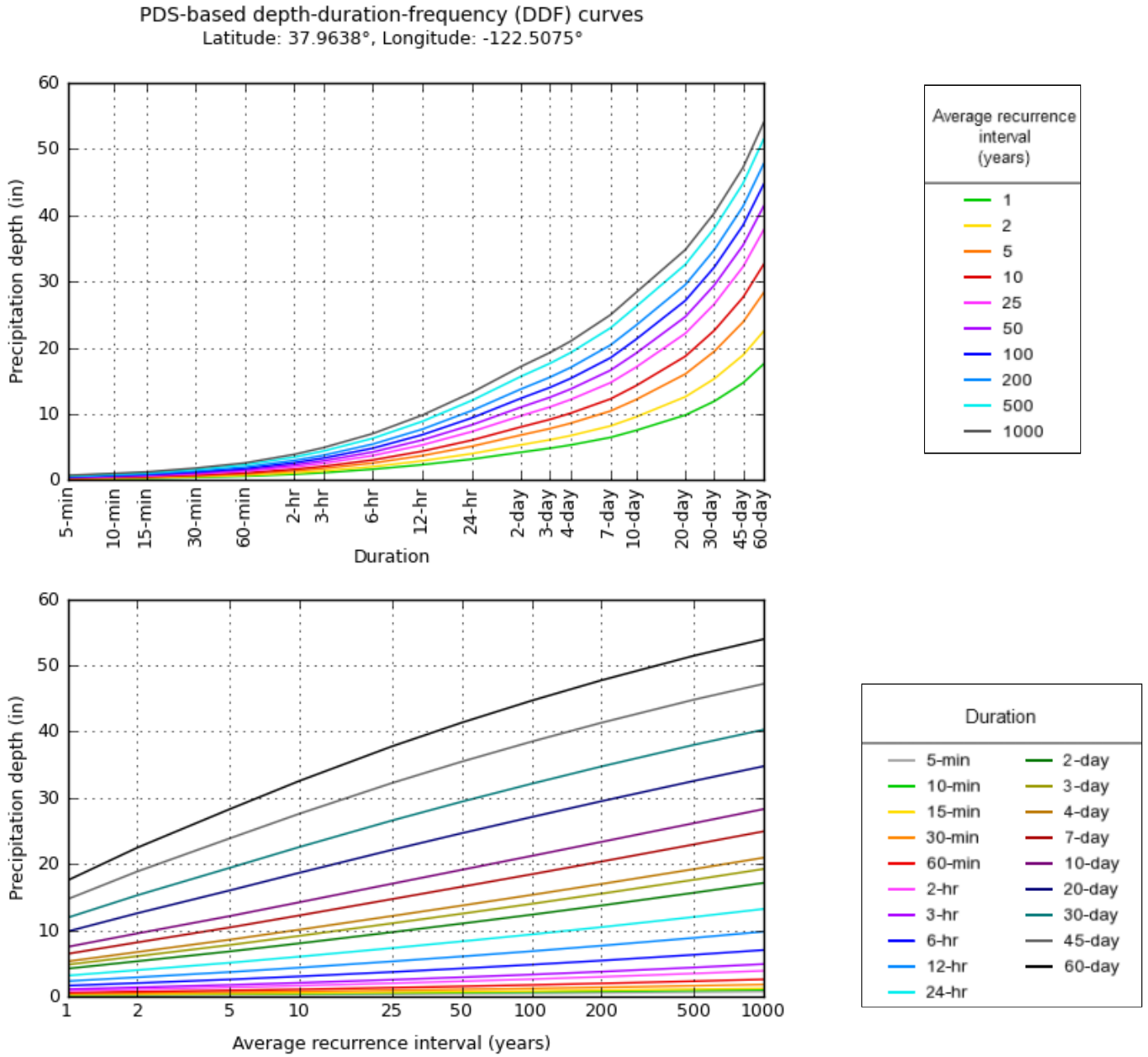
PF graphical



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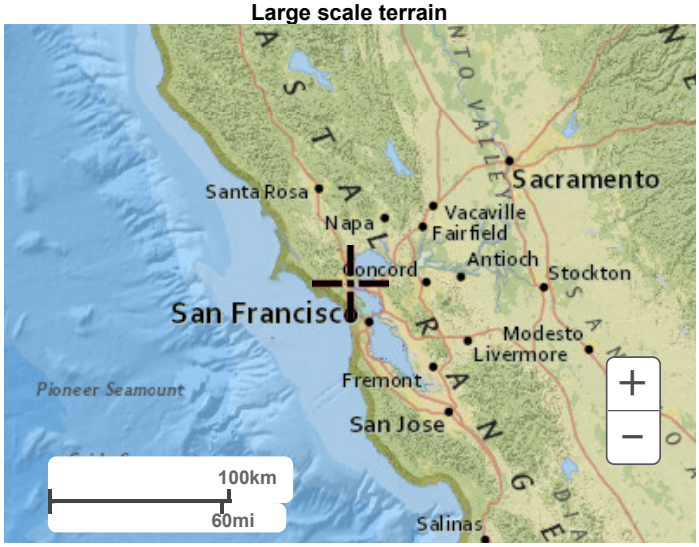
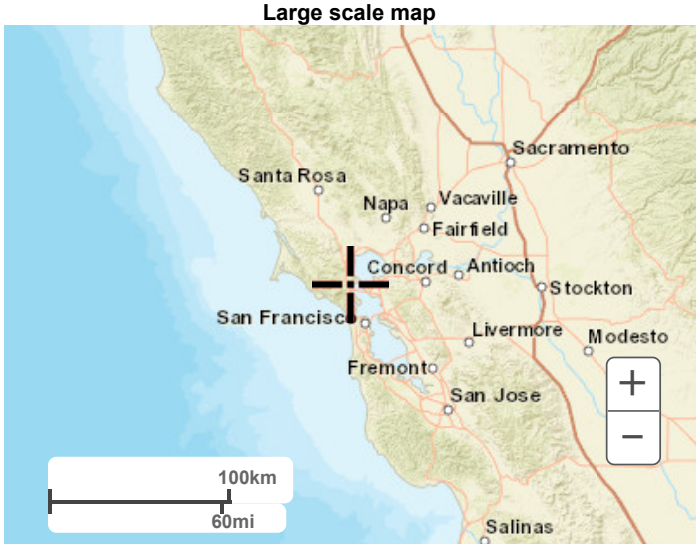
Maps & aerials

Small scale terrain

Large scale terrain



Large scale map



Large scale aerial

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