OBERKAMPER & ASSOCIATES
CIVIL ENGINEERS, INC.

May 29, 2018

Ray Wrysinski
Town Engineer
Town of Fairfax
142 Bolinas Road
Fairfax, CA 94930

RE: Marinda Heights Subdivision - Hydrology comments from February 21, 2018 letter

Dear Ray,

This letter is to address the hydrology comments of your letter dated February 21, 2018. We typically do use the 1974 Caltrans Guidelines which were also adopted by the County of Marin DPW for hydrology calculations across Marin County. However, in this instance we have modified our approach due to the site characteristics which requires further explanation.

The objective of our hydrology study is to determine the existing flows and calculate the proposed flows while using storm water detention and a careful flow routing process to ensure that the proposed flows do not exceed the existing flows. This means we have reviewed each flow path to ensure that we don't alter flow from one shed to another with the construction of the improvements.

The project site is primarily a ridgetop site consisting of a graded road and graded house pads which lack vegetation and are relatively well compacted. Although, the pads are level the runoff coefficient would tend to be high due to these factors. There are also steep wooded and vegetated hillsides sloping down off the ridgetop. Our hydrology calculations are focused on maintaining the flow at the source along the ridgetop knowing that the project will not alter the downstream condition if the upstream condition is not changed.

When sizing the detention storage, the existing flow is stored and regulated by an orifice in order to reduce the rate of flow below the existing condition. If a higher runoff coefficient was used for the existing condition, the difference between the existing and proposed C would be less (say 0.7 vs 0.9) and the net effect would be that that less detention storage was required. In utilizing a lower runoff coefficient at the ridgetop, the amount of detention provided is actually greater because the increase in flow due to the improvements appears much larger. We didn't analyze the existing drainage facilities downstream but we did provide an analysis that shows we won't be changing those existing conditions. A rational method example for a typical 1500 sf roof area is as follows:

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Q=CiA with Area = 0.034 ac. and i= 4.3 in/hr		increase mitigated for with detention
with existing C= 0.7	Q= 0.10 cfs	0.10 – 0.13 = 0.03 cfs
with existing C= 0.57	Q= 0.08 cfs	0.08 – 0.13 = 0.05 cfs more conservative
with proposed C= 0.90	Q= 0.13 cfs	

With the existence of global warming and more frequent FEMA FIRM updates, we are using the latest rainfall date gathered from the National Oceanic and Atmospheric Administration (NOAA) website rather than the process from the Caltrans Guidelines. We are providing a comparison of the results between the NOAA IDF information and the Caltrans IDF for Fairfax (attached herewith). What we have found (in this instance and in other instances) is that the NOAA intensities tend to be higher by approximately 1.25 times. A comparison is shown as follows:

Intensity (in/hr) Comparison between Caltrans and NOAA for 100-year event

	5 min.	10 min	15 min	30 min	1 hour
Caltrans 100yr	4.3	3.2	2.7	2.0	1.5
NOAA 100yr	5.62	4.17	3.47	2.5	1.79

Lastly, the Caltrans Guidelines uses the following formula for time of concentration:

$$T_{sheet\ flow} = \frac{1.8(1.1 - C)\sqrt{L}}{\sqrt[3]{S(100)}} + 5Min$$

$$\begin{aligned}
&where:\\
&C = Runoff\ Coefficient\\
&L = Longest\ run\ in\ feet\\
&S = Average\ Slope\ in\ ft/ft = \frac{\Delta H}{L}
\end{aligned}$$

The equation is best used in watersheds where sheet flow occurs. In this instance, we provided calculations at the ridgetop where there is minimal sheet flow and a minimum Tc is used. Basically, runoff is hitting the roof of the proposed house before being collected in downspouts and directed to the bioretention planters and outlet dissipaters. The Caltrans equation provides for a 5 minute minimum time of concentration. Using the NOAA IDF curves, a 5 min. Tc translates to 5.62 in/hr which is extremely high. The Sonoma County Water Agency uses a 7 minute time of concentration for commercial or similar areas with their Rational Method Procedure. A 7 min. Tc works out to 4.848 in/hr using the NOAA IDF curves which is greater than the 5 min Tc of 4.3 in/hr using the Caltrans procedure.

In summary, we believe the calculations provided are appropriate and sufficiently conservative for the conditions. We are using the most current rainfall intensity information available for Fairfax and are applying the intensity at a time of concentration that appears to be appropriate.

Please feel free to contact me at (415)599-2521, if you have any questions or need additional information.

Sincerely,

Philip Buckley, P.E.
Oberkamper & Associates

Enclosed. IDF info from Caltrans and NOAA procedures (9 pages)

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CALTRANS IDF CURVE

IDF CURVE
FAIRFAX

1. 1 Hour 100 yr Intensity From Map "I" = 1.5 per hour
2. Zone ~~X1~~ C2 From Map "V"   1 Hour = 0.7   24 Hour = 0.67
3. Use Chart "K" for Zone ~~X~~ C. For 100 yr Top Row
4. Use Chart "R" at 1 Hour to Find Factors of Storm Frequencies

* use corresponding subzone + time in [illegible] to retreive these val[ues] & use C[hart] "[R]"

Min	(0.723) 5	(0.718) 10	(0.714) 15	(0.707) 30	(0.70) 60	Chart R
100 yr	4.3"	3.2"	2.7"	2.0"	1.5"	
50 yr	3.94" 0.917	2.93" 0.915	2.47" 0.913	1.82" 0.91	1.37" .91	
25 yr	3.59" 0.835	2.67" 0.833	2.24" 0.83	1.65" 0.825	1.23" .82	
10 yr	3.11"	2.30"	1.93"	1.41"	1.05"	
5 yr	2.73" 0.635	2.01" 0.628	1.67" 0.62	1.22" 0.61	0.91" 0.603	
3 yr	2.42" 0.562	1.78" 0.555	1.49" 0.55	1.08" 0.532	0.79" 0.523	
2 yr	2.15" 0.50	1.58" 0.495	1.31" 0.485	0.94" 0.47	0.68" 0.456	
1 yr	1.20" 0.28	0.85" 0.265	0.61" 0.225	0.48" 0.24	0.33" 0.22	

5. once you find intensity value for 100yr - 60 min storm; follow line to find other time intervals.
6. Find Chart R's necessary values. (see note above).
   ↳ Ratio betwen 10 yr + 100 yr are then found on Chart R's x-axis.
7. Find remaining ratios using Chart R + corresponding time intervals.
8. Mutiply Frequency Distribution Ratio by 100-yr intensity values.

APPENDIX "D" C

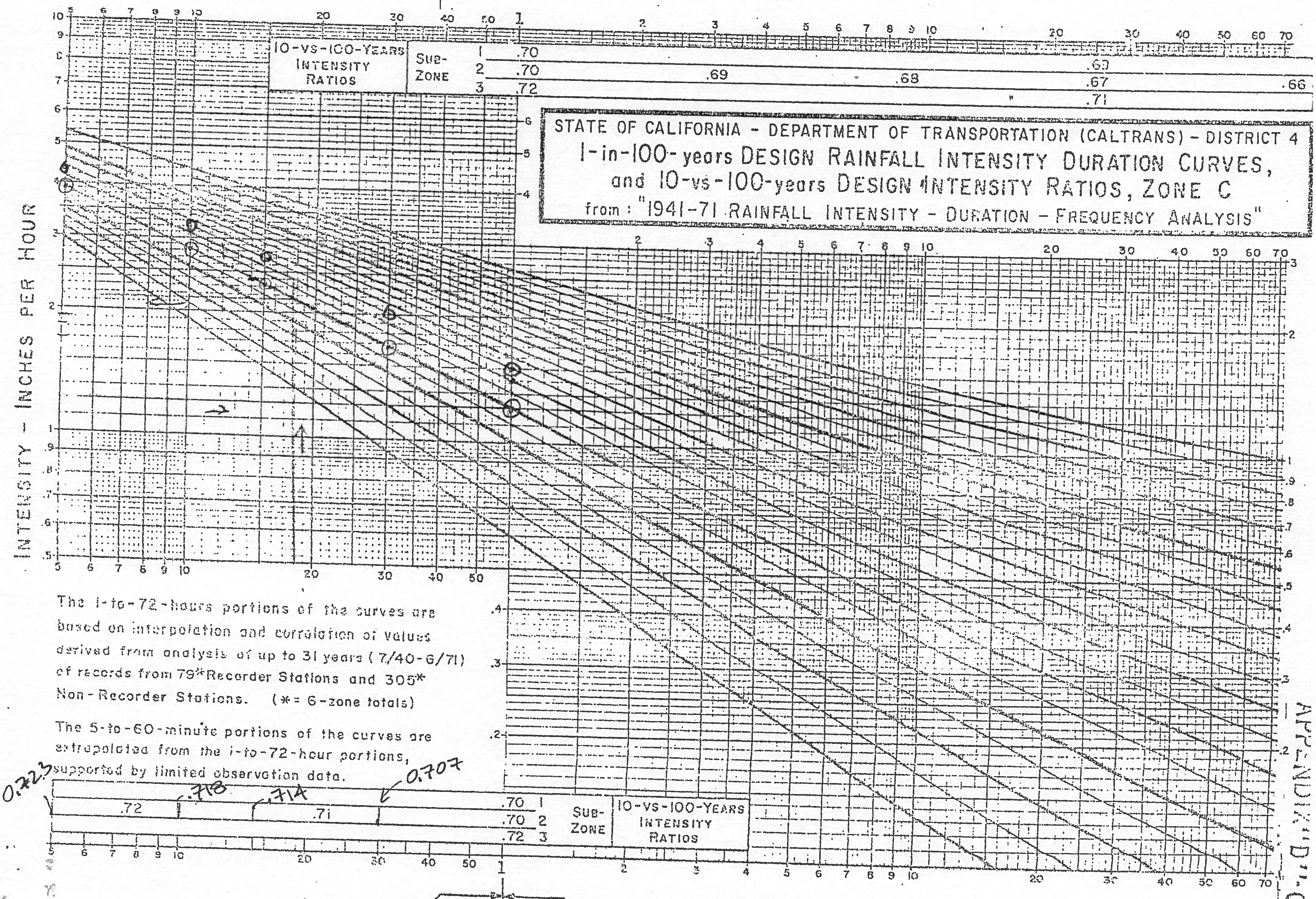


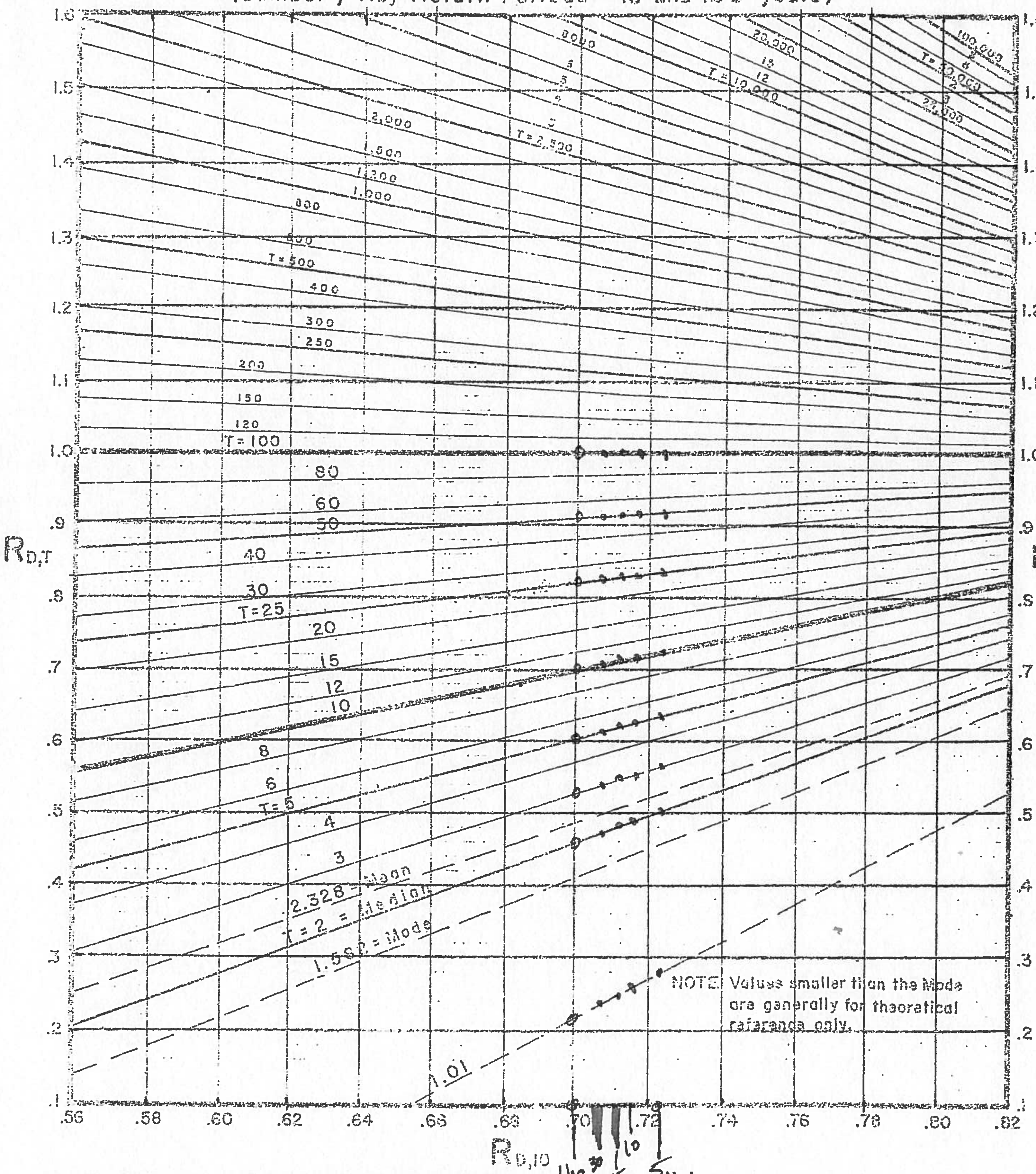
CHART "K" . ZONE C

EK/ERR

STATE OF CALIFORNIA – DEPARTMENT OF TRANSPORTATION (CALTRANS) – DISTRICT 4

FREQUENCY DISTRIBUTION RATIOS CHART "R"

(Gumbel ; Key Return Periods = 10 and 100 years)



EQUATIONS SEE "1941-71 RAINFALL INTENSITY-DURATION-FREQUENCY ANALYSIS"

(29) $R_{D,T} = I_{D,T} / I_{D,100}$, where

(31) $I_{D,T} = I_{D,100}\left\{1 + \left[\left(\frac{1-R_{D,10}}{y_{100}-y_{10}}\right)(y_T - y_{100})\right]\right\}$ and

(4) $y_T = -\ln\left[-\ln(1 - 1/T)\right]$

T = Return Period, Years

R = Ratio

I_D = Intensity (For a given duration D), Inches/Hr.

Other parameters, such as discharge rate (Q) may be substituted for I_D.

FK/FRR 9/74

NOAA Atlas 14, Volume 6, Version 2
Location name: Fairfax, California, USA*
Latitude: 37.9852°, Longitude: -122.5904°
Elevation: 110.45 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	0.162 (0.144-0.184)	0.198 (0.176-0.225)	0.249 (0.221-0.284)	0.293 (0.258-0.338)	0.358 (0.301-0.428)	0.410 (0.337-0.504)	0.467 x12 (0.373-0.591)	0.529 (0.408-0.692)	0.618 (0.454-0.849)	0.692 (0.488-0.99
10-min	0.232 (0.207-0.263)	0.284 (0.253-0.323)	0.357 (0.317-0.407)	0.420 (0.369-0.484)	0.512 (0.432-0.614)	0.588 (0.483-0.723)	0.669 x6 (0.534-0.847)	0.758 (0.585-0.992)	0.886 (0.651-1.22)	0.991 (0.699-1.42
15-min	0.281 (0.250-0.318)	0.344 (0.306-0.390)	0.432 (0.383-0.492)	0.509 (0.446-0.585)	0.620 (0.522-0.743)	0.711 (0.584-0.874)	0.809 x4 (0.646-1.02)	0.916 (0.707-1.20)	1.07 (0.787-1.47)	1.20 (0.846-1.72
30-min	0.433 (0.386-0.491)	0.530 (0.472-0.602)	0.667 (0.591-0.759)	0.784 (0.689-0.903)	0.956 (0.806-1.15)	1.10 (0.902-1.35)	1.25 x2 (0.997-1.58)	1.41 (1.09-1.85)	1.65 (1.21-2.27)	1.85 (1.30-2.65)
60-min	0.622 (0.554-0.705)	0.761 (0.677-0.864)	0.957 (0.849-1.09)	1.13 (0.989-1.30)	1.37 (1.16-1.65)	1.58 (1.30-1.94)	1.79 x1 (1.43-2.27)	2.03 (1.57-2.66)	2.37 (1.74-3.26)	2.66 (1.87-3.80)
2-hr	0.928 (0.827-1.05)	1.14 (1.01-1.29)	1.42 (1.26-1.62)	1.67 (1.46-1.92)	2.02 (1.70-2.42)	2.30 (1.89-2.83)	2.61 (2.08-3.30)	2.93 (2.27-3.84)	3.40 (2.50-4.67)	3.78 (2.67-5.41)
3-hr	1.20 (1.07-1.36)	1.46 (1.30-1.66)	1.83 (1.62-2.08)	2.14 (1.88-2.46)	2.58 (2.18-3.10)	2.94 (2.42-3.61)	3.32 (2.65-4.20)	3.72 (2.88-4.87)	4.30 (3.16-5.91)	4.76 (3.36-6.82)
6-hr	1.78 (1.59-2.02)	2.19 (1.95-2.48)	2.74 (2.43-3.12)	3.20 (2.81-3.68)	3.84 (3.24-4.60)	4.35 (3.58-5.35)	4.89 (3.90-6.19)	5.45 (4.21-7.14)	6.24 (4.59-8.58)	6.87 (4.85-9.84)
12-hr	2.50 (2.23-2.83)	3.12 (2.78-3.54)	3.95 (3.50-4.50)	4.64 (4.07-5.34)	5.59 (4.71-6.70)	6.33 (5.21-7.78)	7.10 (5.67-8.99)	7.90 (6.10-10.3)	9.01 (6.62-12.4)	9.88 (6.97-14.1)
24-hr	3.50 (3.15-3.97)	4.45 (4.01-5.05)	5.71 (5.12-6.50)	6.75 (6.01-7.73)	8.16 (7.05-9.64)	9.27 (7.85-11.2)	10.4 (8.62-12.8)	11.6 (9.35-14.6)	13.2 (10.2-17.3)	14.4 (10.9-19.5)
2-day	4.60 (4.14-5.21)	5.82 (5.23-6.60)	7.44 (6.67-8.46)	8.76 (7.80-10.0)	10.6 (9.13-12.5)	12.0 (10.1-14.4)	13.4 (11.1-16.5)	14.9 (12.0-18.8)	16.9 (13.1-22.2)	18.5 (13.9-25.0)
3-day	5.30 (4.77-6.01)	6.69 (6.02-7.59)	8.52 (7.64-9.69)	10.0 (8.92-11.5)	12.0 (10.4-14.2)	13.6 (11.5-16.4)	15.2 (12.6-18.7)	16.8 (13.6-21.3)	19.1 (14.8-25.0)	20.8 (15.7-28.2)
4-day	5.87 (5.28-6.65)	7.41 (6.66-8.41)	9.42 (8.45-10.7)	11.0 (9.84-12.7)	13.2 (11.4-15.6)	14.9 (12.7-18.0)	16.6 (13.8-20.5)	18.4 (14.8-23.2)	20.7 (16.1-27.2)	22.5 (17.0-30.5)
7-day	7.15 (6.44-8.10)	9.06 (8.15-10.3)	11.5 (10.3-13.1)	13.4 (12.0-15.4)	16.0 (13.8-18.9)	17.9 (15.2-21.6)	19.8 (16.4-24.4)	21.7 (17.6-27.4)	24.2 (18.9-31.8)	26.1 (19.7-35.4)
10-day	8.36 (7.53-9.47)	10.6 (9.57-12.1)	13.5 (12.1-15.4)	15.7 (14.0-18.0)	18.7 (16.1-22.0)	20.8 (17.6-25.0)	22.9 (19.0-28.2)	25.0 (20.2-31.6)	27.7 (21.5-36.3)	29.7 (22.4-40.2)
20-day	11.0 (9.90-12.5)	14.1 (12.7-16.0)	17.9 (16.1-20.4)	20.8 (18.6-23.9)	24.5 (21.2-28.9)	27.1 (23.0-32.7)	29.7 (24.6-36.5)	32.1 (25.9-40.6)	35.2 (27.4-46.2)	37.4 (28.2-50.7)
30-day	13.4 (12.1-15.2)	17.3 (15.5-19.6)	21.9 (19.7-24.9)	25.4 (22.6-29.1)	29.7 (25.7-35.1)	32.8 (27.8-39.5)	35.7 (29.6-44.0)	38.5 (31.1-48.6)	41.9 (32.6-55.0)	44.4 (33.4-60.1)
45-day	16.5 (14.8-18.7)	21.2 (19.1-24.1)	26.8 (24.1-30.5)	31.0 (27.6-35.5)	36.1 (31.2-42.7)	39.7 (33.7-47.8)	43.0 (35.7-53.0)	46.2 (37.3-58.3)	50.0 (38.9-65.6)	52.7 (39.7-71.4)
60-day	19.6 (17.6-22.2)	25.2 (22.6-28.6)	31.7 (28.4-36.1)	36.5 (32.5-41.8)	42.4 (36.6-50.1)	46.4 (39.3-55.9)	50.2 (41.6-61.7)	53.7 (43.4-67.8)	57.9 (45.0-75.9)	60.8 (45.8-82.4)

[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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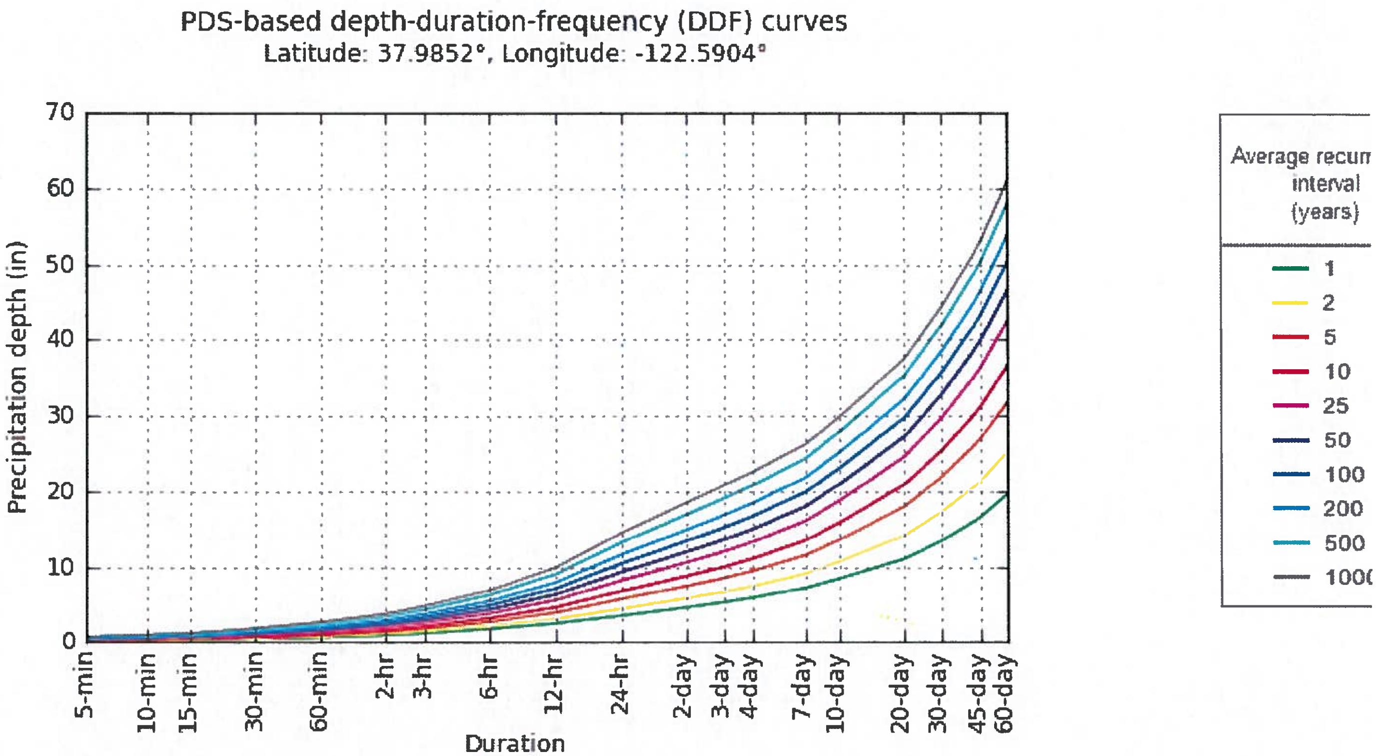
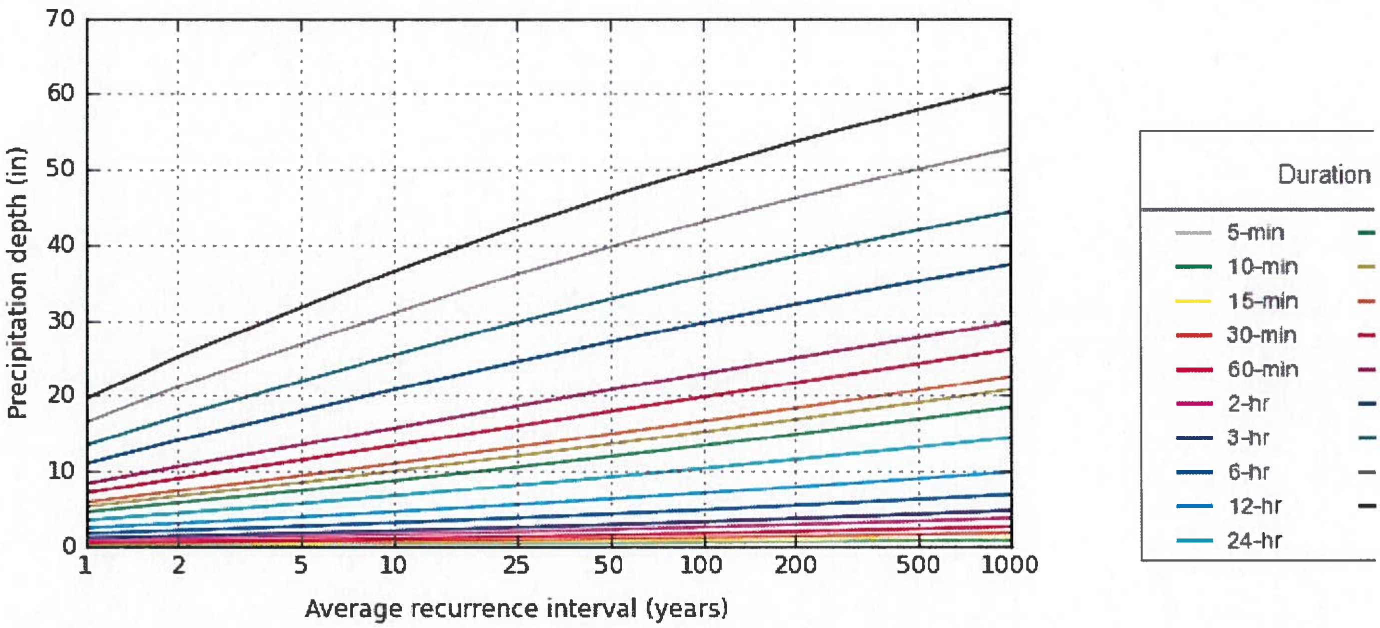
PF graphical





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Created (GMT): Thu May 17 23:05:42 2018

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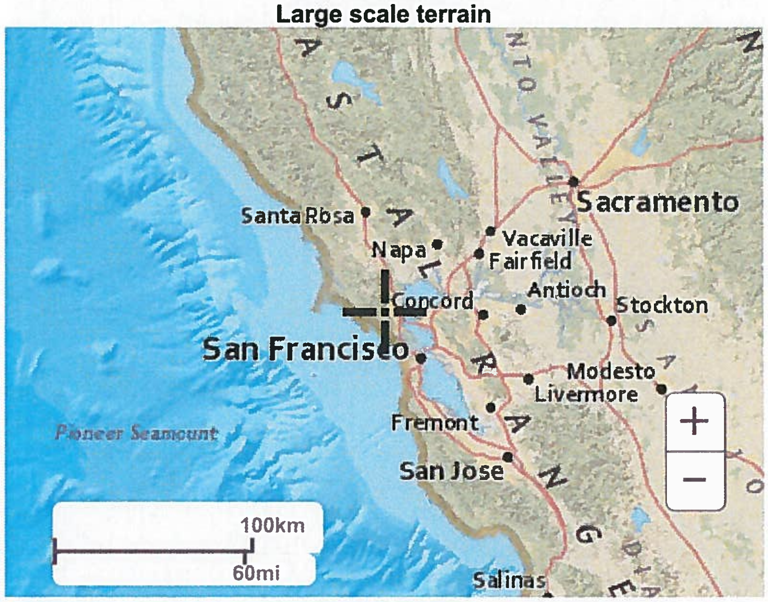
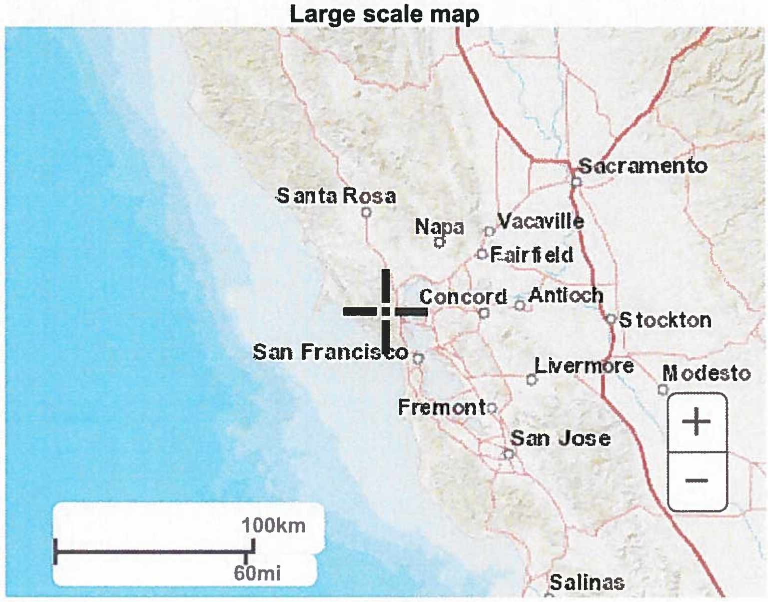
Maps & aerials

Small scale terrain

Large scale terrain



Large scale map



Large scale aerial

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US Department of Commerce
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

Hydraflow Rainfall Report

IDF TABLE USED

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.514 Thursday, 05 / 17 / 2018

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	5.6693	0.8000	0.4892	--------
3	0.0000	0.0000	0.0000	--------
5	7.3163	1.1000	0.4938	--------
10	7.8394	0.6000	0.4719	--------
25	10.7602	1.2000	0.5010	--------
50	12.3905	1.3000	0.5019	--------
100	13.6143	1.0000	0.4935	--------

File name: Fairfax.idf

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	2.40	1.77	1.47	1.28	1.16	1.06	0.98	0.92	0.87	0.83	0.79	0.76
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	3.00	2.23	1.85	1.62	1.46	1.34	1.24	1.17	1.10	1.05	1.00	0.96
10	3.48	2.57	2.14	1.88	1.70	1.56	1.45	1.37	1.29	1.23	1.18	1.13
25	4.31	3.21	2.67	2.33	2.10	1.92	1.78	1.67	1.58	1.50	1.43	1.37
50	4.92	3.67	3.05	2.67	2.40	2.20	2.04	1.91	1.81	1.72	1.64	1.57
100	5.62	4.17	3.47	3.03	2.73	2.50	2.32	2.18	2.06	1.96	1.87	1.79

Tc = time in minutes. Values may exceed 60.

Precip. file name: Sample.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	2.20	0.00	3.30	4.25	5.77	6.80	7.95
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	0.00	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

Hydraflow IDF Curves

IDF file: Fairfax.idf