PRELIMINARY HYDROLOGY STUDY

FOR

BIOMARIN

999 3^{RD} Street, San Rafael
Marin County, California

Prepared by:
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CSW|ST2 File No.:
5.692.28

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PRELIMINARY HYDROLOGY STUDY October 1, 2018

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Preliminary Hydrology Study
October 1, 2018

A. Introduction

This Preliminary Hydrology Study compares post-project hydrologic conditions to pre-project hydrologic conditions for BioMarin's project site located at 999 3rd Street in San Rafael, CA. The property is bounded by 3rd Street to the north, 2nd Street to the south, Lindaro Street to the east and Brooks Street to the west. The property has been developed and in its current condition is paved with asphalt and concrete as part of the site remediation completed by Pacific Gas and Electric Company's site closure efforts.

The project proposes to construct two, multi-story office buildings in two phases. Additionally, the northwest corner of the site is reserved for construction of a senior center and housing facility. This Preliminary Hydrology Study examines the ultimate development condition which entails construction of the two office buildings and the senior housing facility.

B. Pre-Project Conditions

The total drainage area examined in this study is 3.37 acres. The site is relatively flat, with slopes on the order of 1% to 5% which fall in elevation from 12.0+/- NAVD88 (North American Vertical Datum of 1988) in the northwest to 8.5 +/- NAVD88 in the southeast. As discussed above, the property has been developed and in its current condition is paved with asphalt and concrete. In the pre-project condition, approximately 3.30 acres is covered by pavement. Landscape areas comprise approximately 0.07 acres of the total drainage area examined and are mostly located in the sidewalks surrounding the project site.

A municipal storm drain system is located in all four streets surrounding the project site. There are at least six locations where runoff from the project site enters the municipal storm drain system. Five locations, labeled "B", "C", "D", "E" and "F" in the Pre- and Post-Project Hydrology Maps accompanying this study, are comprised of municipal drainage inlets which intercept runoff from the curb and gutter surrounding the site. At a sixth location, labeled "A" in the enclosed maps, the existing storm drain system within the project site ties into a municipal storm drain manhole in Lindaro Street. A majority of the project site (2.44 acres out of 3.37 acres) discharges to Point "A". Drainage areas contributing runoff to inlets at Points "B" through "F" range in size from 0.04 acres to 0.48 acres.

C. Post-Project Conditions

At ultimate re-development of the site, three buildings will exist with accompanying parking lots, utility infrastructure, drainage facilities and landscape areas. Within the 3.37 acre drainage area examined herein, 2.96 acres will be covered by building and hardscape and 0.41 acres will be covered by landscape areas. Additionally, the project will treat stormwater runoff through the use of bioretention planters and pervious pavements dispersed throughout the site.

D. Method of Analysis

The Rational Method was used to estimate pre- and post-development runoff quantities. The Rational Method calculates peak runoff (Q) in cfs described by the equation Q=CIA. The terms are defined as follows:

Q – the flow of runoff measured in cubic feet per second (cfs),
C – the runoff coefficient (unitless).
I – the intensity of the storm measured in inches per hour (in/hr), and

A – the amount of area contributing to the flow at a given point of concentration measured in acres.

Storm intensity (I) was derived using the National Oceanic and Atmospheric Administration's (NOAA) Atlas 14 Point Precipitation Frequency Estimates.

Time of Travel for overland sheet flow was determined using the overland flow formula per the County of Marin's Hydrology Manual. Velocities for gutter and pipe flow were determined using the Hydraflow Express computer program distributed by Autodesk which calculates normal depth in open channel flow regimes by the use of Manning's Formula.

A runoff coefficient of 0.7 for vegetated areas was used following the County of Marin's Hydrology Manual. A runoff coefficient of 0.90 was assumed for areas covered by roof and pavement. Weighted runoff coefficients were determined for drainage areas comprised of a combination of impervious and vegetated surfaces.

While bioretention areas and pervious pavements provide treatment and capacity for runoff absorption during low-intensity storm events, they were included in the "impervious area" surfaces of the site when calculating runoff coefficients for this Study. This is because, during higher intensity storm events, runoff will mostly sheet flow over the permeable pavement surfaces and the soils of bioretention areas will most likely be saturated so that runoff in those systems will immediately pond and continue directly to the overflow structures.

E. Results

Overall, by completion of Phase 2 and future construction of the Senior Center and Housing facility, the project increases coverage of the site by pervious surfaces, both with landscape and with permeable pavements. Table 1, below lists the pervious surface areas provided by landscape in the pre- and post-project conditions.

Table 1: Site Coverage by Pervious Surface, Pre- and Post-Project

3.37 Acre Project Site	Pervious Area	Percent Coverage of Project Site
Pre-Project	0.07 acres	2%
Post-Project	0.41 acres	12%

By inspection, because the project site increases coverage by landscape area, overall, the project will decrease the amount of runoff discharged from the site.

As shown in Table 2, with the grading plans at the current schematic level of detail, the drainage areas tributary to points "B", "E" and "F" have the potential to be increased.

Table 2: Areas Contributing Runoff to each Point of Concentration

Points of Concentration	Pre-Project Area (acres)	Post-Project Area (acres) Schematic Design	Percent change in Tributary Areas to each Point of Concentration
A	2.44	1.67	- 31.6%
B	0.18	0.53	+ 194.4%
C	0.06	0.03	- 50.0%
D	0.04	0.02	-50.0%
E	0.48	0.53	+ 10.4%
F	0.17	0.59	+247.1%
Total	3.37	3.37	0.0%

However, as shown in Table 3, below, while the drainage areas are potentially increased to points "B", "E" and "F", only Points "B" and "F" have calculated increases in peak flow. The peak flow to Point "E" was reduced in spite of the small increase in tributary area because the percentage of landscape coverage was increased in Drainage Area "E" from 7% to 19%.

Table 3: Pre- and Post-Project Peak Flow to each Point of Concentration

Points of Concentration	Pre-Project Q100 (cfs)	Post-Project Q100 (cfs) Schematic Design	Percent change in Q100
A	9.05	6.07	-32.9%
B	0.65	1.66	+155.4%
C	0.28	0.13	-53.6%
D	0.19	0.09	-52.6%
E	2.02	1.88	-6.9%
F	0.65	1.97	+203.1%

As part of this Preliminary Study, calculations are provided in Appendix III demonstrating that localized increases in peak flow to each point of concentration around the site can be mitigated to at- or below pre-project peak flows. The results of the calculations are provided below in Table 4. The combination of options selected to demonstrate that peak flows can also be mitigated at Points "B" and "F" include (a) the assumption that grading and storm drain system in Drainage Area B will be further refined to shift some of Drainage Area B to Drainage Area A and (b) capacity for large-storm detention is provided in Drainage Area F.

Table 4: Pre- and Post-Project Peak Flow* to each Point of Concentration

Points of Concentration	Pre-Project Q100 (cfs)	Post-Project Q100 (cfs) Mitigated	Percent change in Q100
A	9.05	7.12	-21.3%
B	0.65	0.65	0%
C	0.28	0.13	-53.6%
D	0.19	0.09	-52.6%
E	2.02	1.88	-6.9%
F	0.65	0.65	+0%

* With a potential mitigation alternative incorporated into the site design as plans progress to a level commensurate with construction.

F. Conclusion and Recommendations

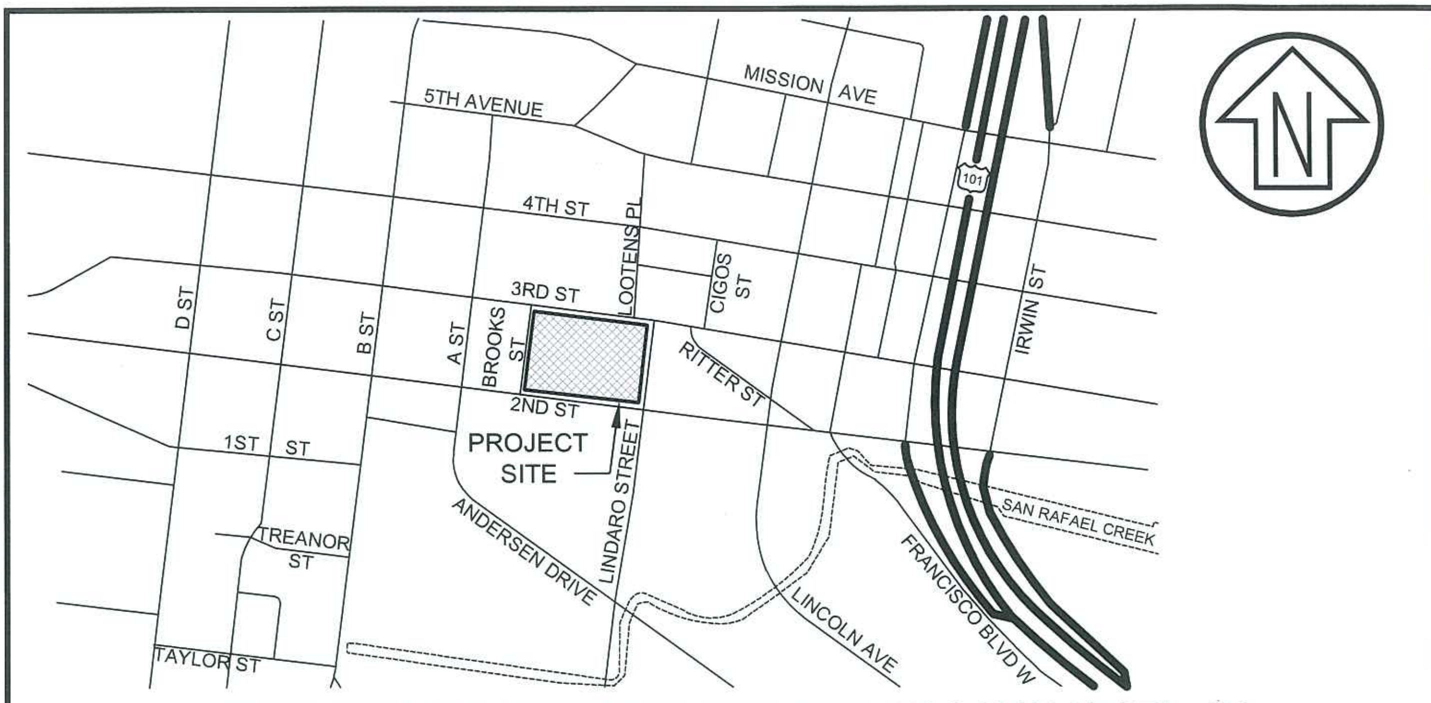
As is evident from the preceding study, the project at 999 3rd Street in San Rafael can be constructed so that peak flows from the site can be mitigated to at-or below pre-project levels for up to a 100-year storm frequency event.

As plans progress to a level commensurate for construction, analysis of the project should be provided in a Final Hydrology and Hydraulic Study to confirm that the proposed combination of site grading, routing of onsite storm water pipe facilities and storm water treatment systems continue to mitigate increases in calculated peak flows to the individual points of concentration around the site, to at or below pre-project conditions.

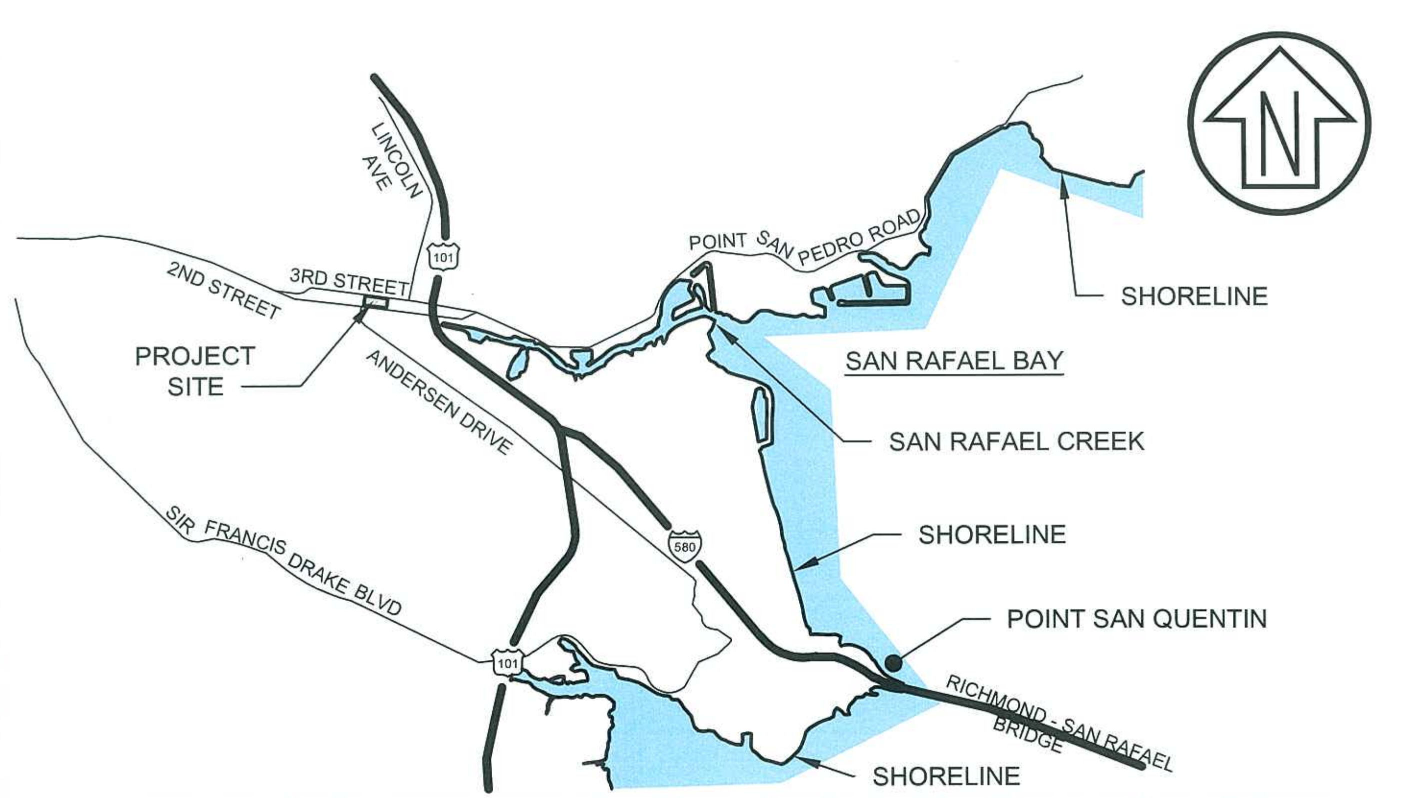
Alternatively, at the individual points of entry to the municipal storm drain system, should post-project peak flows exceed pre-project peak flows, an analysis should be provided to confirm whether the surrounding municipal storm drain system may intercept the increases in peak flow without further adverse effects, or upgrades are needed to mitigate potential adverse impacts.

APPENDIX I

Vicinity Map



VICINITY MAP: PROJECT SITE WITHIN SAN RAFAEL, CA



VICINITY MAP: PROJECT SITE RELATIVE TO POINT SAN QUENTIN

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BIOMARIN
VICINITY MAPS

999 3RD SHEET

SAN RAFAEL | MARIN COUNTY | CALIFORNIA

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APPENDIX II

Pre-Project Calculations

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SHEET NO. 1/

JOB NO. 569228 JOB 999 Third Street BY KNP DATE

CLIENT SUBJECT Pre-Project Hydrology CHK'D DATE

Pre-Project Peak Flow: Point A

Area = 2.44 Ac

C = 0.90

Time of Concentration

Overland Flow

length = 67 LF
elev up = 11.8 (Point A')
elev down = 9.5 (Point B')

$S = \text{slope} = \frac{11.8-9.5}{67} = 0.034\ \text{ft/ft}$

$t_o = \frac{1.8(1.1-C)\sqrt{L}}{[S(100)]^{1/3}} + 5\ \text{min}$

$t_o = \frac{1.8(1.1-0.90)\sqrt{67}}{[(0.034)(100)]^{1/3}} + 5\ \text{min}$

$t_o = \frac{2.947}{1.504} + 5\ \text{min}$

$t_o = 7.0\ \text{min}$

Pipe Flow

Pipe Segment	Length	Slope	velocity*	Time of Travel
B'-C'	87'	1%	3.1 ft/s	$t_{t_{B'C'}} = 87\left(\frac{1\,sec}{3.1\,ft}\right)\left(\frac{1\,min}{60\,sec}\right) = 0.5\,min$
C'-D'	87'	0.4%	2.7 ft/s	$t_{t_{C'-D'}} = 87'\left(\frac{1\,sec}{2.7\,ft}\right)\left(\frac{1\,min}{60\,sec}\right) = 0.5\,min$
D'-E'	104'	0.4%	2.7 ft/s	$t_{t_{D'-E'}} = 104'\left(\frac{1\,sec}{2.7\,ft}\right)\left(\frac{1\,min}{60\,sec}\right) = 0.6\,min$
E'-F'	141'	0.5%	3.5 ft/s	$t_{t_{E'-F'}} = 141'\left(\frac{1\,sec}{3.5\,ft}\right)\left(\frac{1\,min}{60\,sec}\right) = 0.7\,min$
F'-G'	113'	0.5%	2.7 ft/s	$t_{t_{F'-G'}} = 113'\left(\frac{1\,sec}{2.7'}\right)\left(\frac{1\,min}{60\,sec}\right) = 0.7\,min$
G' - Point A	53'	0.5%	3.9 ft/s	$t_{t_{G'-\text{Point A}}} = 53'\left(\frac{1\,sec}{3.9\,ft}\right)\left(\frac{1\,min}{60\,sec}\right) = 0.2\,min$

* velocity calculated using Hydraflow Express assuming pipe is flowing full
assume n = 0.012

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JOB NO. 5692.2B JOB 999 Third Street BY KNP DATE

CLIENT SUBJECT Pre-Project Hydrology CHK'D DATE

Pre-Project Peak Flow : Point A

Time of Concentration : Tc

$T_c = t_o + t_{t B'-C'} + t_{t C'-D'} + t_{t D'-E'} + t_{t E'-F'} + t_{t F'-G'} + t_{t G'-EXMH A}$

T_c = 7.0 min + 0.5 min + 0.5 min + 0.6 min + 0.7 min + 0.7 min + 0.2 min

T_c = 10.2 min

Intensity : I

For 100-year frequency event, from NOAA Atlas 14

$I_{10min,100}$ = 4.15 in/hr

$I_{15min,100}$ = 3.34 in/hr

$I_{10.2,100}$:

$$\frac{10.2-10}{15-10} = \frac{X-4.15}{3.34-4.15}$$

$$\frac{0.2}{5} = \frac{X-4.15}{-0.81}$$

$X - 4.15 = -0.03$

$X = 4.12$ in/hr

$I_{10.2,100} = 4.12$ in/hr

Q_{100} (Rational Method)

$Q_{100} = CIA$

= (0.90)(4.12 in/hr)(2.44 Ac)

Q_{100} = 9.05 cfs

At Point A :

Q_{100} = 9.05 cfs Pre-Project Peak Flow

T_c = 10.2 min

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SHEET NO. 3/

JOB NO. 569228 JOB 999 3rd street BY KNP DATE

CLIENT SUBJECT Pre-Project Hydrology CHK'D DATE

Pre-Project Peak Flow : Point B

Area = 0.18

C = 0.89

Time of Concentration

Overland Flow

Length = 15'
elev up = 10.29
elev down = 8.95

$$t_o = \frac{1.8(1.1-c)\sqrt{L}}{[S(100)]^{1/3}} + 5\text{ min}$$

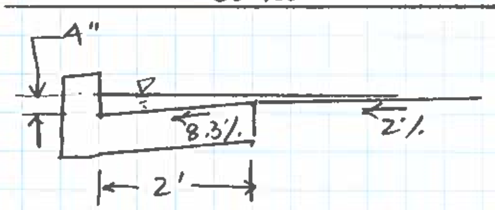
$$S = \text{slope} = \frac{10.29-8.95}{15} = 0.09\ \text{ft/ft}$$

$$t_o = \frac{1.8(1.1-0.89)\sqrt{15'}}{[(0.09)(100)]^{1/3}} + 5\text{ min}$$

$$t_o = \frac{1.464}{2.080} + 5\text{ min}$$

$$t_o = 5.7\text{ min}$$

Shallow Concentrated Flow (gutter)



n = 0.015

Length = 396'
elev up = 8.45
elev down = 7.48

$$S = \text{slope} = \frac{8.45-7.48}{396} = 0.002\ \text{ft/ft}$$

Assume gutter is flowing at 4" depth

Find velocity of flow in gutter using Hydraflow Express

$v = 1.33$ ft/s

$$t_t = 396'\left(\frac{1\text{ sec}}{1.33\text{ ft}}\right)\left(\frac{1\text{ min}}{60\text{ sec}}\right) = 5.0\text{ min}$$

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JOB NO. 569228 JOB 999 3rd street BY KNP DATE

CLIENT SUBJECT Pre-Project Hydrology CHK'D DATE

Pre-Project Peak Flow : Point B

Time of Concentration : Tc

$T_c = t_o + t_t$

$T_c = 5.7\,min + 5.0\,min$

$T_c = 10.7\,min$

Intensity : I

For 100-year frequency event, from NOAA Atlas 14

$I_{10\,min,100} = 4.15\ in/hr$

$I_{15\,min,100} = 3.34\ in/hr$

$I_{10.7,100}$: $\frac{10.7-10}{15-10} = \frac{X-4.15}{3.34-4.15}$ → $X - 4.15 = -0.11$

$\frac{0.7}{5} = \frac{X-4.15}{-0.81}$

$X = 4.04\ in/hr$

$I_{10.7,100} = 4.04\ in/hr$

Q_{100} (Rational Method)

$Q_{100} = CIA$

$= (0.89)(4.04\ in/hr)(0.18\ Ac)$

$Q_{100} = 0.65\ cfs$

At Point B :

$Q_{100} = 0.65\ cfs$ Pre-Project Peak Flow

$T_c = 10.7\,min$

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JOB NO. 569228 JOB 999 3rd Street BY KNP DATE

CLIENT SUBJECT Pre-Project Hydrology CHK'D DATE

Pre-Project Peak Flow : Point C

Area = 0.06 Acres

C = 0.90

Time of Concentration

Overland Flow

length = 20'
upstream elevation = 9.38
elev down = 8.51

$s = \text{slope} = \frac{9.38 - 8.51}{20'} = 0.04 \text{ ft/ft}$

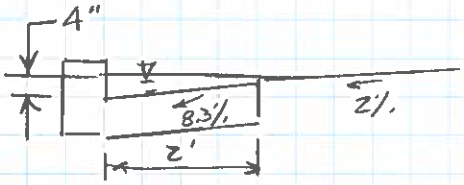
$$t_o = \frac{1.8(1.1 - C)\sqrt{L}}{[S(100)]^{1/3}} + 5 \text{ min}$$

$$t_o = \frac{1.8(1.1 - 0.90)\sqrt{20}}{[(0.04)(100)]^{1/3}} + 5 \text{ min}$$

$$t_o = \frac{1.6100}{1.5874} + 5 \text{ min}$$

$$t_o = 6.0 \text{ min}$$

Shallow Concentrated Flow (gutter)



n = 0.015

length = 100'
upstream elev = 8.03
elev down = 7.50

$s = \text{slope} = \frac{8.03 - 7.50}{100'} = 0.005 \text{ ft/ft}$

Assume gutter is flowing @ 4" depth.

Find velocity of flow in gutter using Hydraflow Express.

$v = 2.10 \text{ ft/s}$

$$t_t = 100'\left(\frac{1 \text{ sec}}{2.10 \text{ ft}}\right)\left(\frac{1 \text{ min}}{60 \text{ sec}}\right) = 0.8 \text{ min}$$

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JOB NO. 569228 JOB 999 3rd Street BY KNP DATE

CLIENT SUBJECT Pre-Project Hydrology CHK'D DATE

Pre-Project Peak Flow : Point C

Time of Concentration : Tc

$T_c = t_o + t_t$

$T_c = 6.0\,min + 0.8\,min$

$\boxed{T_c = 6.8\,min}$

Intensity : I

For 100-year frequency event, from NOAA Atlas 14

$I_{5min,100} = 5.78\ in/hr$

$I_{10min,100} = 4.15\ in/hr$

$I_{6.8,100}$:

$$\frac{6.8-5}{10-5} = \frac{X-5.78}{4.15-5.78}$$

$$\frac{1.8}{5} = \frac{X-5.78}{-1.63}$$

$\rightarrow X - 5.78 = -0.59$

$X = 5.19\ in/hr$

$\boxed{I_{6.8,100} = 5.19\ in/hr}$

Q_{100} (Rational Method)

$Q_{100} = C\,I\,A$

$= (0.90)(5.19\ in/hr)(0.06\ Ac)$

$\boxed{Q_{100} = 0.28\ cfs}$

At Point C :

$Q_{100} = 0.28\ cfs$ Pre-Project Peak Flow

$T_c = 6.8\ min$

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JOB NO. 569228 JOB 999 3rd street BY KNP DATE

CLIENT SUBJECT Pre-Project Hydrology CHK'D DATE

Pre-Project Peak Flow: Point D

Area = 0.04 Acres

C = 0.89

Time of Concentration

Overland Flow

$$t_o = \frac{1.8(1.1-C)\sqrt{L}}{[S(100)]^{1/3}} + 5\text{ min}$$

length = 9'
upstream elev = 9.09
elev down = 8.84

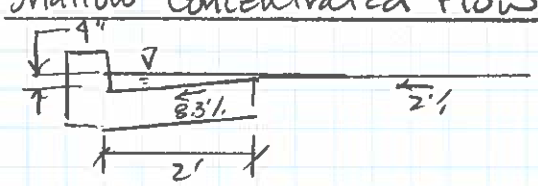
$$S = \text{slope} = \frac{9.09-8.84}{9'} = 0.03\ \text{ft/ft}$$

$$t_o = \frac{1.8(1.1-0.89)\sqrt{9}}{[0.03(100)]^{1/3}} + 5\text{min}$$

$$t_o = \frac{1.134}{1.442} + 5\text{ min}$$

$$t_o = 5.8\text{ min}$$

Shallow Concentrated Flow (gutter)



n=0.015

length = 48'
elev up = 8.39
elev down = 8.16

$$S = \text{slope} = \frac{8.39-8.16}{48'} = 0.005\ \text{ft/ft}$$

Assume gutter is flowing @ 4" depth

Find velocity of flow in gutter using Hydraflow Express

$v = 2.10$ ft/s

$$t_t = 48'\left(\frac{1\text{ sec}}{2.1\text{ ft}}\right)\left(\frac{1\text{min}}{60\text{ sec}}\right) = 0.4\text{ min}$$

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SHEET NO. 8/

JOB NO. 569228 JOB 999 3rd street BY KNP DATE

CLIENT SUBJECT Pre-Project Hydrology CHK'D DATE

Pre-Project Peak Flow : Point D

Time of Concentration: Tc

$T_c = t_o + t_t$

$T_c = 5.8 \text{ min} + 0.4 \text{ min}$

$T_c = 6.2 \text{ min}$

Intensity: I

For 100-year frequency event, from NOAA Atlas 14

$I_{5min,100} = 5.78 \text{ in/hr}$

$I_{10min,100} = 4.15 \text{ in/hr}$

$I_{6.2,100}$:

$$\frac{6.2-5}{10-5} = \frac{X-5.78}{4.15-5.78}$$

$$\frac{1.2}{5} = \frac{X-5.78}{-1.63}$$

$X - 5.78 = -0.39$

$X = 5.39 \text{ in/hr}$

$I_{6.2,100} = 5.39 \text{ in/hr}$

Q_{100} (Rational Method)

$Q_{100} = CIA$

$= (0.89)(5.39 \text{ in/hr})(0.04 \text{ Ac})$

$Q_{100} = 0.19 \text{ cfs}$

At Point D:

$Q_{100} = 0.19 \text{ cfs}$ Pre-Project Peak Flow

$T_c = 6.2 \text{ min}$

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JOB NO. 569228 JOB 999 3rd street BY KWP DATE

CLIENT SUBJECT Pre-Project Hydrology CHK'D DATE

Pre-Project Peak Flow: Point E

Area = 0.48 Ac

C = 0.89

Time of Concentration

Overland Flow

Length = 26'
elev up = 12.08
elev down = 10.41

$$S = \text{slope} = \frac{12.08 - 10.41}{26} = 0.06 \text{ ft/ft}$$

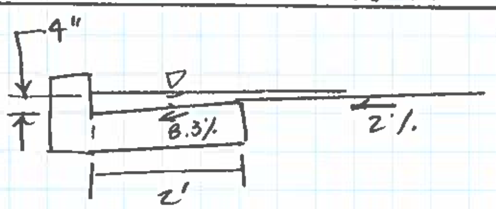
$$t_o = \frac{1.8(1.1 - C)\sqrt{L}}{[S(100)]^{1/3}} + 5 \text{ min}$$

$$t_o = \frac{1.8(1.1 - 0.89)\sqrt{26}}{[(0.06)(100)]^{1/3}} + 5 \text{ min}$$

$$t_o = \frac{1.927}{1.817} + 5 \text{ min}$$

$$t_o = 6.1 \text{ min}$$

Shallow Concentrated Flow (gutter)



n=0.015

Length = 314'
elev up = 10.13
elev down = 7.82

$$S = \text{slope} = \frac{10.13 - 7.82}{314} = 0.007 \text{ ft/ft}$$

Assume gutter is flowing @ 4" depth

Find velocity of flow in gutter using Hydraflow Express

v = 2.49 ft/s

$$t_t = 314'\left(\frac{1 \text{ sec}}{2.49 \text{ ft}}\right)\left(\frac{1 \text{ min}}{60 \text{ sec}}\right) = 2.1 \text{ min}$$

Pre-Project Peak Flow : Point E

Time of Concentration : T_c

$T_c = t_o + t_t$

$T_c = 6.1\text{min} + 2.1\text{min}$

$T_c = 8.2$ min

Intensity : I

For 100-year frequency event, from NOAA Atlas 14

$I_{5min,100} = 5.78$ in/hr

$I_{10min,100} = 4.15$ in/hr

$I_{8.2,100}$:

$$\frac{8.2-5}{10-5} = \frac{X-5.78}{4.15-5.78}$$

$$\frac{3.2}{5} = \frac{X-5.78}{-1.63}$$

$X - 5.78 = -1.04$

$X = 4.74$ in/hr

$I_{8.2,100} = 4.74$ in/hr

Q_{100} (Rational Method)

$Q_{100} = C\,I\,A$

$= (0.89)(4.74\ \text{in/hr})(0.48\text{Ac})$

$Q_{100} = 2.02$ cfs

At Point E :

$Q_{100} = 2.02$ cfs — Pre-Project Peak Flow

$T_c = 8.2$ min

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SHEET NO. 11 /

JOB NO. 569228 JOB 999 3rd street BY KNP DATE

CLIENT SUBJECT Pre-Project Hydrology CHK'D DATE

Pre-Project Peak Flow: Point F

Area = 0.17 Ac

C = 0.88

Time of Concentration:

Overland Flow

length = 13'
elev up = 10.94
elev down = 10.10

$$S = \text{slope} = \frac{10.94 - 10.10}{13} = 0.06 \text{ ft/ft}$$

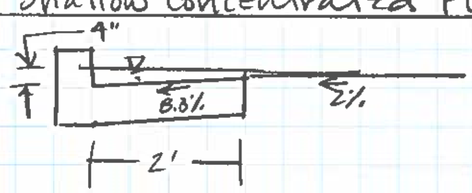
$$t_o = \frac{1.8(1.1 - C)\sqrt{L}}{[S(100)]^{1/3}} + 5 \text{ min}$$

$$t_o = \frac{1.8(1.1 - 0.88)\sqrt{13}}{[(0.06)(100)]^{1/3}} + 5 \text{ min}$$

$$t_o = \frac{1.428}{1.817} + 5 \text{ min}$$

$$t_o = 5.8 \text{ min}$$

Shallow Concentrated Flow (gutter)



n = 0.015

Length = 350'
elev up = 9.69
elev down = 8.60

$$S = \text{slope} = \frac{9.69 - 8.60}{350} = 0.003 \text{ ft/ft}$$

Assume gutter is flowing @ 4" depth

Find velocity of flow in gutter using Hydraflow Express

$v = 1.63$ ft/s

$$t_t = 350' \left(\frac{1 \text{ sec}}{1.63 \text{ ft}}\right)\left(\frac{1 \text{ min}}{60 \text{ sec}}\right) = 3.6 \text{ min}$$

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SHEET NO. 121

JOB NO. 569228 JOB 999 3rd Street BY KNP DATE

CLIENT SUBJECT Pre-Project Hydrology CHK'D DATE

Pre-Project Peak Flow : Point F

Time of Concentration : T_c

$T_c = t_o + t_t$

$T_c = 5.8\ min + 3.6\ min$

$T_c = 9.4\ min$

Intensity : I

For 100-year frequency event, from NOAA Atlas 14

$I_{5min,100} = 5.78\ in/hr$

$I_{10min,100} = 4.15\ in/hr$

$I_{9.4,100}$: $\frac{9.4-5}{10-5} = \frac{X-5.78}{4.15-5.78}$

$\frac{4.4}{5} = \frac{X-5.78}{-1.63}$ → $X - 5.78 = -1.43$

$X = 4.35\ in/hr$

$I_{9.4,100} = 4.35\ in/hr$

Q_{100} (Rational Method)

$Q_{100} = CIA$

$= (0.88)(4.35\ in/hr)(0.17\ Ac)$

$Q_{100} = 0.65\ cfs$

At Point F :	
$Q_{100} = 0.65\ cfs$	Pre-Project Peak Flow
$T_c = 9.4\ min$	

APPENDIX III

Post-Project Calculations

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CLIENT SUBJECT Post-Project Hydrology CHK'D DATE

Post-Project Peak Flow : Point A

Area = 1.67 AC

C = 0.90

Time of Concentration

Overland Flow (assume 2% slope across roof) length = 108' (point A' to B')

$$t_o = \frac{1.8(1.1-C)\sqrt{L}}{[S(100)]^{1/3}} + 5 \text{ min}$$

$$t_o = \frac{1.8(1.1-0.9)\sqrt{108}}{[0.02(100)]^{1/3}} + 5 \text{ min}$$

$$t_o = \frac{3.741}{1.260} + 5 \text{ min}$$

$$t_o = 8.0 \text{ min}$$

Pipe Flow

Pipe Segment	length	Slope	velocity*	Time of Travel
B'-C'	233'	1%	3.09 ft/s	$t_{t_{B'-C'}} = 233'\left(\frac{1 sec}{3.09 ft}\right)\left(\frac{1 min}{60 sec}\right) = 1.3$ min
C'-POINT A	285'	0.5'	3.47 ft/s	$t_{t_{C'POINT A}} = 285'\left(\frac{1 sec}{3.47'}\right)\left(\frac{1 min}{60 sec}\right) = 1.4$ min

* velocity calculated using Hydraflow Express assuming pipe is flowing full.

assume n = 0.012 for PVC pipe

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CLIENT SUBJECT Post-Project Hydrology CHK'D DATE

Post-Project Peak Flow: Point A

Time of Concentration : Tc

$T_c = t_o + tt_{B'-C'} + t_{t\,C'-\text{POINT A}}$

$T_c = 8.0\,\text{min} + 1.3\,\text{min} + 1.4\,\text{min}$

$T_c = 10.7\,\text{min}$

Intensity : I

For 100-year frequency event, from NOAA Atlas 14

$I_{10min,100} = 4.15\ \text{in/hr}$

$I_{15min,100} = 3.34\ \text{in/hr}$

$I_{10.7,100}$: $\frac{10.7 - 10}{15 - 10} = \frac{X - 4.15}{3.34 - 4.15}$

$\frac{0.7}{5} = \frac{X - 4.15}{-0.81}$ → $X - 4.15 = -0.11$

$X = 4.04\ \text{in/hr}$

$I_{10.7,100} = 4.04\ \text{in/hr}$

Q_{100} (Rational Method)

$Q_{100} = CIA$

$= (0.90)(4.04\ \text{in/hr})(1.67\ \text{Ac})$

$Q_{100} = 6.07\ \text{cfs}$

At Point A :

$Q_{100} = 6.07\ \text{cfs}$ Post-Project Peak Flow

$T_c = 10.7\,\text{min}$

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CLIENT SUBJECT Post-Project Hydrology CHK'D DATE

Post-Project Peak Flow : Point B

Area = 0.53 Ac

C = 0.81

Time of Concentration

Overland Flow

length = 20'
elev up = 9.37'
elev down = 8.95'

$S = \text{slope} = \frac{9.37' - 8.95'}{20'} = 0.021$ ft/ft

$$t_o = \frac{1.8(1.1-C)\sqrt{L}}{[S(100)]^{1/3}} + 5\text{min}$$

$$t_o = \frac{1.8(1.1-0.81)\sqrt{20'}}{[(0.021)(100)]^{1/3}} + 5\text{min}$$

$$t_o = \frac{2.334}{1.281} + 5\text{min}$$

$$t_o = 6.8 \text{ min}$$

Shallow Concentrated Flow (gutter)

t_t = 5.0 min (see shallow concentrated flow calculation for pre-project Peak Flow to Point B)

Time of Concentration : Tc

$$T_c = t_o + t_t$$

$$T_c = 6.8\text{min} + 5.0\text{min}$$

$$T_c = 11.8 \text{ min}$$

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CLIENT SUBJECT Post-Project Hydrology CHK'D DATE

Post-Project Peak Flow: Point B

Intensity: I

For 100-year frequency event, from NOAA Atlas 14

$I_{10min,100} = 4.15$ in/hr

$I_{15min,100} = 3.34$ in/hr

$I_{11.8,100}$: $\frac{11.8-10}{15-10} = \frac{X-4.15}{3.34-4.15}$

$\frac{1.8}{5} = \frac{X-4.15}{-0.81}$ → $X - 4.15 = -0.29$

$X = 3.86$ in/hr

$I_{11.8,100} = 3.86$ in/hr

Q_{100} (Rational Method)

$Q_{100} = CIA$

$= (0.81)(3.86 \text{ in/hr})(0.53 \text{ Ac})$

$Q_{100} = 1.66$ cfs

At Point B:

$Q_{100} = 1.66$ cfs — Post-Project Peak Flow

$T_c = 11.8$ min

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CLIENT SUBJECT Post-Project Hydrology CHK'D DATE

Post-Project Peak Flow: Point C

Area = 0.03 Ac

C = 0.83

Time of Concentration

Overland Flow

Length = 10'
elev up = 8.66
elev down = 8.51

$$S = \text{slope} = \frac{8.66 - 8.51}{10'} = 0.015 \text{ ft/ft}$$

$$t_o = \frac{1.8(1.1-c)\sqrt{L}}{[S(100)]^{1/3}} + 5\text{min}$$

$$t_o = \frac{1.8(1.1-0.83)\sqrt{10}}{[(0.015)(100)]^{1/3}} + 5\text{min}$$

$$t_o = \frac{1.537}{1.145} + 5\text{min}$$

$$t_o = 6.3\text{ min}$$

Shallow Concentrated Flow (gutter)

$t_t = 0.8$ min (see shallow concentrated flow calculation for pre-project Peak Flow to Point C)

Time of Concentration: T_c

$$T_c = t_o + t_t$$

$$T_c = 6.3\text{min} + 0.8\text{min}$$

$$\boxed{T_c = 7.1\text{min}}$$

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CLIENT SUBJECT Post-Project Hydrology CHK'D DATE

Post-Project Peak Flow ; Point C

Intensity : I

For 100-year frequency event, from NOAA Atlas 14

$I_{5min,100} = 5.78$ in/hr

$I_{10min,100} = 4.15$ in/hr

$I_{7.1,100}$:

$$\frac{7.1-5}{10-5} = \frac{X-5.78}{4.15-5.78}$$

$$\frac{2.1}{5} = \frac{X-5.78}{-1.63}$$

$X - 5.78 = -0.68$

$X = 5.10$

$I_{7.1,100} = 5.10$ in/hr

Q_{100} (Rational Method)

$Q_{100} = CIA$

$= (0.83)(5.10 \text{ in/hr})(0.03 \text{ Ac})$

$Q_{100} = 0.13$ cfs

At Point C :

$Q_{100} = 0.13$ cfs Post-Project Peak Flow

$T_c = 7.1$ min

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JOB NO. 569228 JOB 999 3rd street BY KNP DATE

CLIENT SUBJECT Post-Project Hydrology CHK'D DATE

Post-Project Peak Flow: Point D

Area = 0.02 Ac

C = 0.82

Time of Concentration

Overland Flow

Length = 10'
elev up = 8.99
elev down = 8.84

slope = $\frac{8.99 - 8.84}{10}$ = 0.015 ft/ft

$t_o = \frac{1.8(1.1 - 0.82)\sqrt{10}}{[(0.015)(100)]^{1/3}} + 5\ min$

$t_o = \frac{1.594}{1.145} + 5\ min$

$t_o = 6.4\ min$

Shallow Concentrated Flow (gutter)

$t_t = 0.4\ min$ (see shallow concentrated flow calculation for pre-project Peak Flow to Point D)

Time of Concentration: Tc

$T_c = t_o + t_t$

$T_c = 6.4\ min + 0.4\ min$

$\boxed{T_c = 6.8\ min}$

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CLIENT SUBJECT Post-Project Hydrology CHK'D DATE

Post-Project Peak Flow: Point D

Intensity: I

For 100-year frequency event, from NOAA Atlas 14

$I_{5min,100} = 5.78$ in/hr

$I_{10min,100} = 4.15$ in/hr

$I_{6.8,100}$: $\frac{6.8-5}{10-5} = \frac{X-5.78}{4.15-5.78}$

$\frac{1.8}{5} = \frac{X-5.78}{-1.63}$

$X - 5.78 = -0.59$

$X = 5.19$ in/hr

$I_{6.8,100} = 5.19$ in/hr

Q_{100} (Rational Method)

$Q_{100} = CIA$

$= (0.82)(5.19\text{ in/hr})(0.02\text{ Ac})$

$Q_{100} = 0.09$ cfs

At Point D:

$Q_{100} = 0.09$ cfs Post-Project Peak Flow

$T_c = 6.8$ min

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SHEET NO. 91

JOB NO. 569228 JOB 999 3rd Street BY KNP DATE

CLIENT SUBJECT Post-Project Hydrology CHK'D DATE

Post-Project Peak Flow : Point E

Area = 0.53 Ac

C = 0.86

Time of Concentration

Overland Flow

length = 168'
elev up = 12.27 (A')
elev down : 8.90 (B')

$$t_o = \frac{1.8(1.1-C)\sqrt{L}}{[S(100)]^{1/3}} + 5\text{ min}$$

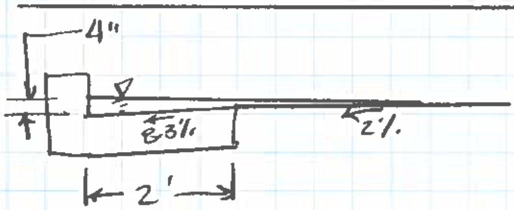
$$S = \text{slope} = \frac{12.27-8.90}{168'} = 0.02 \text{ ft/ft}$$

$$t_o = \frac{1.8(1.1-0.86)\sqrt{168}}{[(0.02)(100)]^{1/3}} + 5\text{ min}$$

$$t_o = \frac{5.599}{1.260} + 5\text{ min}$$

$$t_o = 9.4\text{ min}$$

Shallow Concentrated Flow (gutter)



n=0.015

Length = 134'
elev up = 8.90 (B')
elev down = 7.82 (Point E)

$$S = \text{slope} = \frac{8.90-7.82}{134} = 0.008 \text{ ft/ft}$$

Assume gutter is flowing @ 4" depth

Find velocity of flow in gutter using Hydraflow Express

$v = 2.66$ ft/s

$$t_t = 134'\left(\frac{1\text{ sec}}{2.66\text{ ft}}\right)\left(\frac{1\text{ min}}{60\text{ sec}}\right) = 0.8\text{ min}$$

Post-Project Peak Flow: Point E

Time of Concentration: T_c

$T_c = t_o + t_t$

$T_c = 9.4\text{ min} + 0.8\text{ min}$

$T_c = 10.2\text{ min}$

Intensity: I

For 100-year frequency event, from NOAA Atlas 14:

$I_{10min,100} = 4.15\text{ in/hr}$

$I_{15min,100} = 3.34\text{ in/hr}$

$I_{10.2,100}$:

$$\frac{10.2-10}{15-10} = \frac{X-4.15}{3.34-4.15}$$

$$\frac{0.2}{5} = \frac{X-4.15}{-0.81}$$

$X - 4.15 = -0.03$

$X = 4.12\text{ in/hr}$

$I_{10.2,100} = 4.12\text{ in/hr}$

Q_{100} (Rational Method)

$Q_{100} = CIA$

$= (0.86)(4.12\text{ in/hr})(0.53\text{ Ac})$

$Q_{100} = 1.88\text{ cfs}$

At Point E:

$Q_{100} = 1.88\text{ cfs}$

$T_c = 10.2\text{ min}$

Post-Project Peak Flow

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CLIENT SUBJECT Post-Project Hydrology CHK'D DATE

Post-Project Peak Flow : Point F

Area = 0.59 Ac

C = 0.88

Time of Concentration :

Overland Flow (assume 2% slope across roof & across pvmt to gutter) length = 162' (point A' to B')

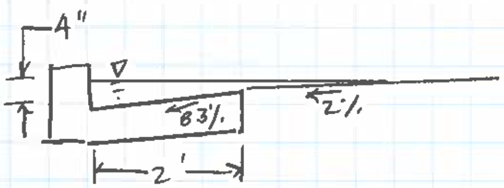
$$t_o = \frac{1.8(1.1-C)\sqrt{L}}{[S(100)]^{1/3}} + 5\text{ min}$$

$$t_o = \frac{1.8(1.1-0.9)\sqrt{162}}{[0.02(100)]^{1/3}} + 5\text{ min}$$

$$t_o = \frac{4.582}{1.260} + 5\text{ min}$$

$$t_o = 8.6\text{ min}$$

Shallow Concentrated Flow (gutter)



n = 0.015 length = 350'
elev up = 9.69 (B')
elev down = 8.60 (Point F)

$$S = \text{slope} = \frac{9.69 - 8.60}{350} = 0.003\ \text{ft/ft}$$

Assume gutter is flowing @ 4" depth

Find velocity of flow in gutter using Hydraflow Express

$v = 1.63$ ft/s

$$t_t = 350'\left(\frac{1\text{ sec}}{1.63\text{ ft}}\right)\left(\frac{1\text{ min}}{60\text{ sec}}\right) = 3.6\text{ min}$$

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CLIENT SUBJECT Post-Project Hydrology CHK'D DATE

Post-Project Peak Flow: Point F

Time of Concentration: Tc

$T_c = t_o + t_t$

$T_c = 8.6\,min + 3.6\,min$

$T_c = 12.2\,min$

Intensity: I

For 100-year frequency event, from NOAA Atlas 14

$I_{10min,100} = 4.15\ in/hr$

$I_{15min,100} = 3.34\ in/hr$

$I_{12.2,100}$:

$$\frac{12.2-10}{15-10} = \frac{X-4.15}{3.34-4.15}$$

$$\frac{2.2}{5} = \frac{X-4.15}{-0.81}$$

$X - 4.15 = -0.36$

$X = 3.79\ in/hr$

$I_{12.2,100} = 3.79\ in/hr$

Q_{100} (Rational Method)

$Q_{100} = CIA$

$= (0.88)(3.79\ in/hr)(0.59\ Ac)$

$Q_{100} = 1.97\ cfs$

At Point F:

$Q_{100} = 1.97\ cfs$ Post-Project Peak Flow

$T_c = 12.2\ min$

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CLIENT SUBJECT Post-Project Hydrology CHK'D DATE

Drainage Area B: Mitigation Option.

The following calculations are included to demonstrate that the peak flow discharged from Drainage Area B can be mitigated to at-or below pre-project conditions if a portion of Drainage Area B can be graded or the runoff otherwise captured in a storm drain system so that some of the runoff from Drainage Area B is discharged to Point A.

Pre-Project Peak Flow from Area B:

$Q_{100_{pre}} = 0.65$ cfs

$C = 0.89$

$I = 4.04$ in/hr

$A = 0.18$ Ac

Unmitigated Post Project Peak Flow from Area B:

$Q_{100_{post}} = 1.66$ cfs

$I = 3.86$ in/hr

$C = 0.81$

$A = 0.53$ Ac

$Q = CIA$

$A = \frac{Q}{CI}$

How much area in Drainage Area B may discharge to curb & gutter in Lindaro?

$Q = 0.65$ cfs $I = 3.86$ in/hr $C = 0.81$

$A = \frac{0.65 \text{ cfs}}{(0.81)(3.86)} = 0.21$ Ac

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Drainage Area B: Mitigation Option cont'd

How much area would be shifted to Drainage Area A?

shifted area = 0.53 Ac − 0.21 Ac = 0.32 acres.

What is the resulting peak flow at Point A?

$Q_{100_A} = (\Sigma CA) I$

$= [(1.67Ac)(0.90) + (0.32Ac)(0.81)] (4.04 \text{ in/hr}) = 7.12 \text{ cfs}$

from Point A Post Project Peak Flow — from Point A

Post Project Peak Flow at Point A: $Q_{100_A} = 7.12$ cfs

Post Project Peak Flow at Point B: $Q_{100_B} = 0.65$ cfs

check!

7.12 cfs (Q_{100_A} post project) < 9.05 cfs (Q_{100_A} pre-project) ∴ ok

0.65 cfs (Q_{100_B} post project) = 0.65 cfs (Q_{100_B} pre-project) ∴ ok

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JOB NO. 569228 JOB 999 3rd street BY KNP DATE

CLIENT SUBJECT Post Project Hydrology CHK'D DATE

Drainage Area F: Mitigation Option

The following calculations are included to demonstrate that the peak flow discharged from Drainage Area F can be mitigated to at-or below- pre project conditions with the use of a detention system.

Pre Project: $Q_{100} = 0.65$ cfs

Post Project: $Q_{100} = 1.97$ cfs

Using Hydraflow Hydrographs computer program by Autodesk, A detention system with 2,275 cu ft of storage capacity can detain post-project peak flows so that peak flows are at- or below pre-project peak flows from Drainage Area F.

Post Project (mitigated)	$Q_{100} = 0.65$ cfs

At 6' wide, the system would be 108.3' long and 3 feet deep. Some of the detention capacity can be accommodated by the proposed detention system.

Additionally, detention could be reduced if part of the tributary drainage area were graded to drain to a different area.

Drainage Area F
Mitigation Option

Hydrograph Report

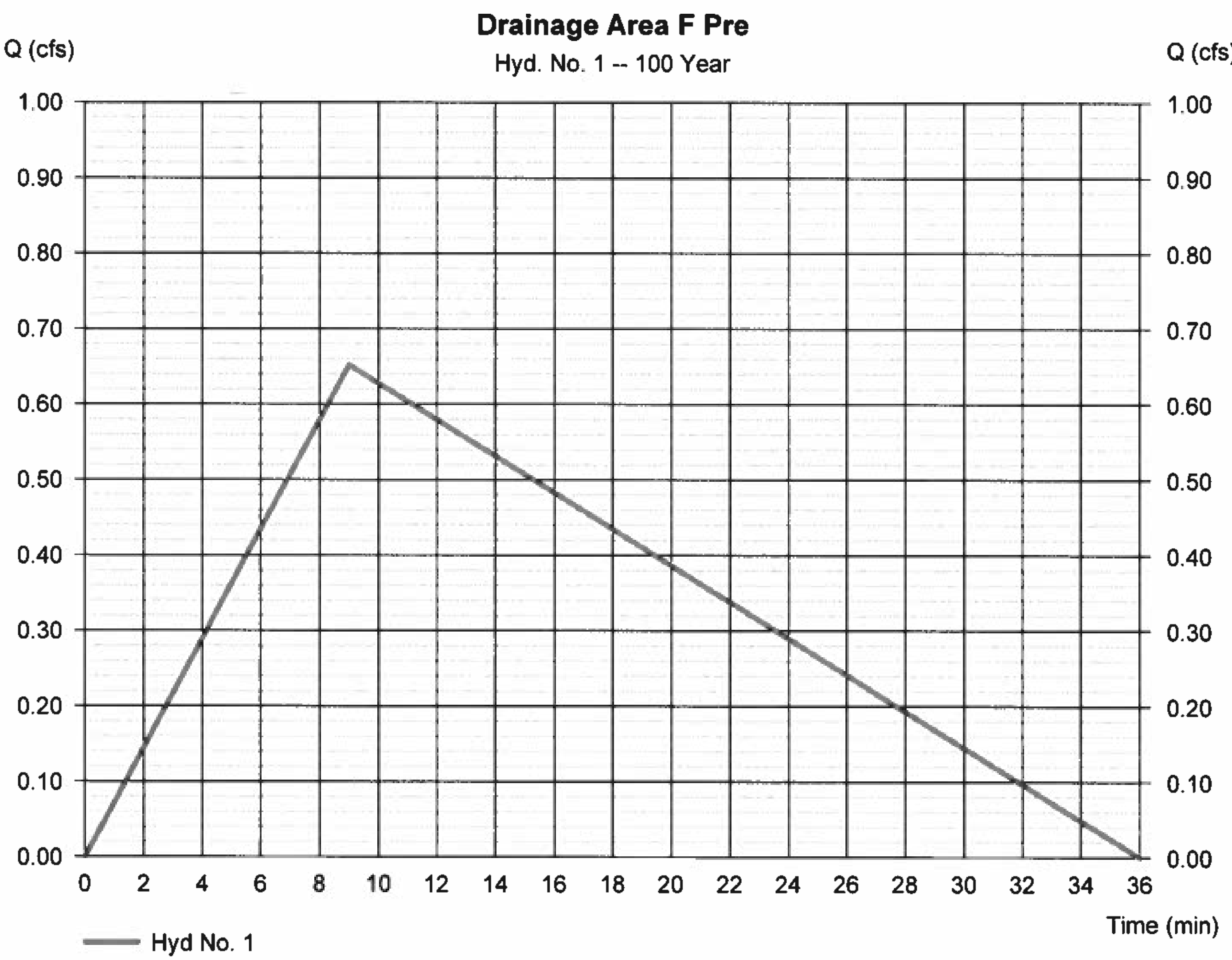
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Monday, 10 / 1 / 2018

Hyd. No. 1

Drainage Area F Pre

Pre-Project Hydrograph

Hydrograph type	= Rational	Peak discharge	= 0.652 cfs
Storm frequency	= 100 yrs	Time to peak	= 9 min
Time interval	= 1 min	Hyd. volume	= 704 cuft
Drainage area	= 0.170 ac	Runoff coeff.	= 0.87
Intensity	= 4.410 in/hr	Tc by User	= 9.00 min
IDF Curve	= SD-LevelAnalysis.IDF	Asc/Rec limb fact	= 1/3



Hydrograph Report

Drainage Area F
Mitigation Option

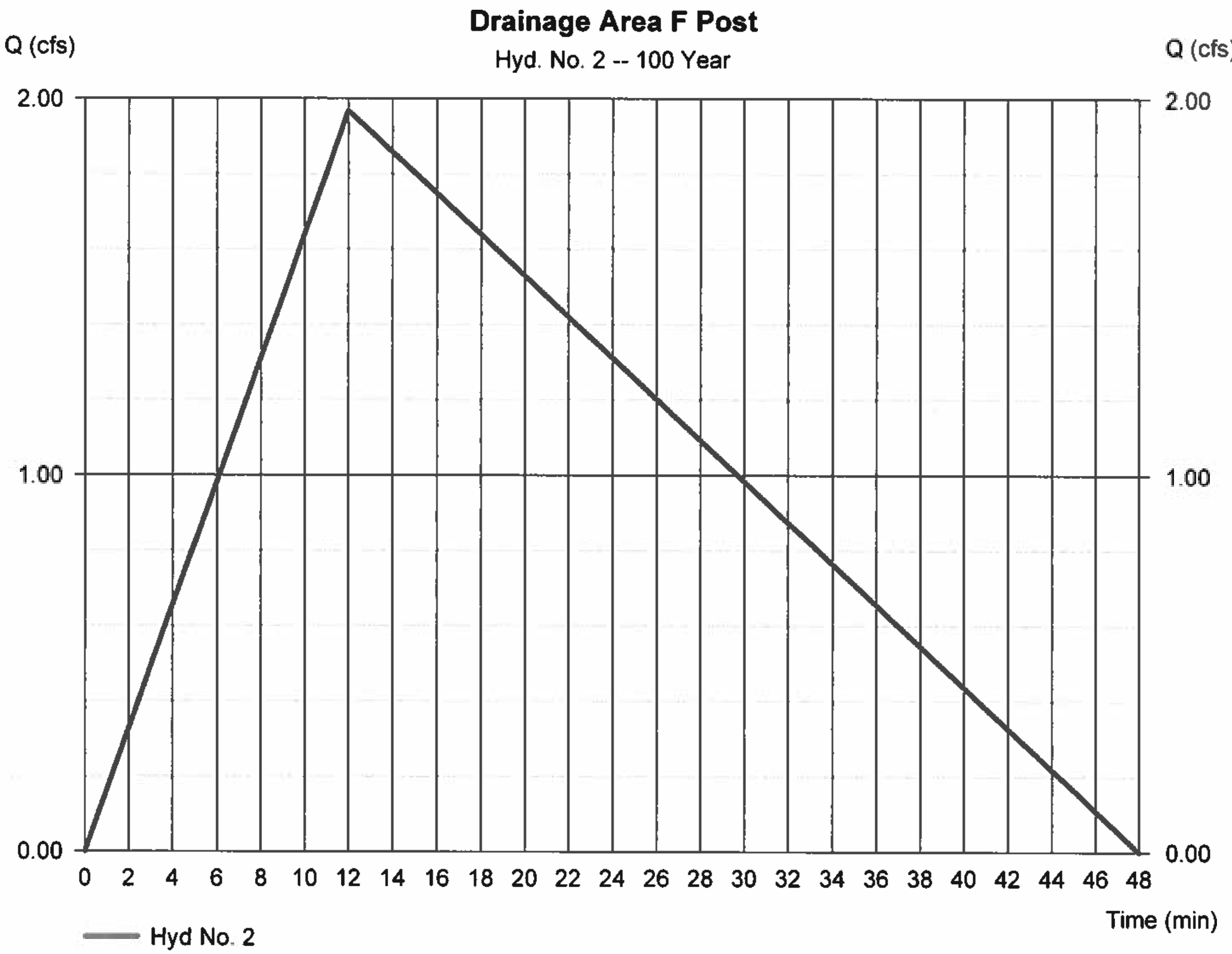
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Monday, 10 / 1 / 2018

Hyd. No. 2

Drainage Area F Post

Post-Project Hydrograph (unmitigated peak flow)

Hydrograph type	= Rational	Peak discharge	= 1.968 cfs
Storm frequency	= 100 yrs	Time to peak	= 12 min
Time interval	= 1 min	Hyd. volume	= 2,834 cuft
Drainage area	= 0.580 ac	Runoff coeff.	= 0.88
Intensity	= 3.855 in/hr	Tc by User	= 12.00 min
IDF Curve	= SD-LevelAnalysis.IDF	Asc/Rec limb fact	= 1/3



Hydrograph Report

Drainage Area F
Mitigation Option

18/

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Monday, 10 / 1 / 2018

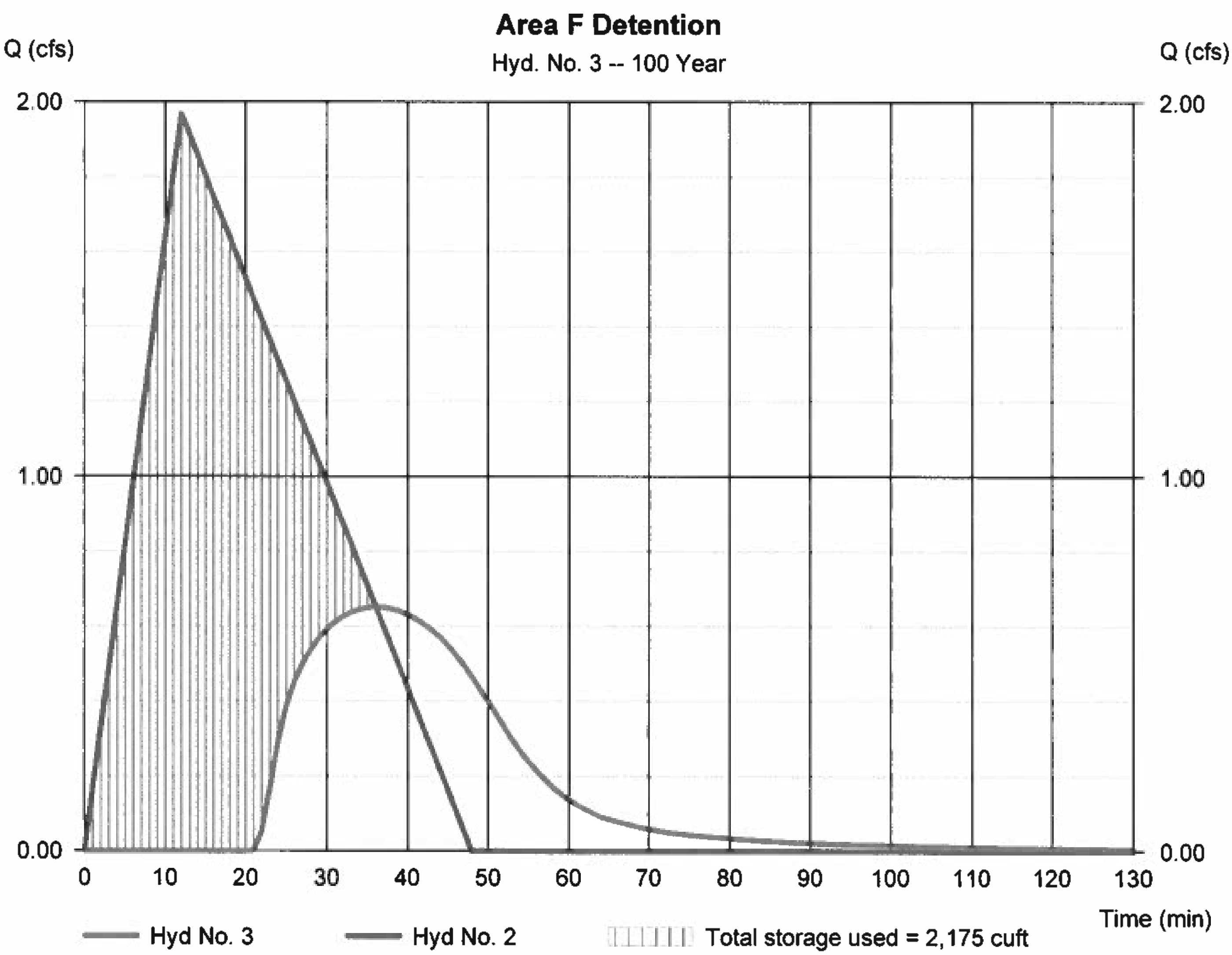
Hyd. No. 3

Post Project Hydrograph (Mitigated Peak Flow)

Area F Detention

Hydrograph type	= Reservoir	Peak discharge	= 0.652 cfs
Storm frequency	= 100 yrs	Time to peak	= 36 min
Time interval	= 1 min	Hyd. volume	= 1,204 cuft
Inflow hyd. No.	= 2 - Drainage Area F Post	Max. Elevation	= 13.35 ft
Reservoir name	= Area F Bioretention	Max. Storage	= 2,175 cuft

Storage Indication method used.



Pond Report

Drainage Area F Mitigation Option

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 — Monday, 10 / 1 / 2018

Pond No. 1 - Area F Bioretention

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 10.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	10.00	650	0	0
0.50	10.50	650	325	325
1.00	11.00	650	325	650
1.50	11.50	650	325	975
2.00	12.00	650	325	1,300
2.50	12.50	650	325	1,625
3.00	13.00	650	325	1,950
3.50	13.50	650	325	2,275

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 4.00	4.00	0.00	0.00
Span (in)	= 4.00	4.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 12.50	12.65	0.00	0.00
Length (ft)	= 10.00	10.00	0.00	0.00
Slope (%)	= 2.00	2.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	10.00	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.05	32	10.05	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.10	65	10.10	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.15	97	10.15	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.20	130	10.20	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.25	162	10.25	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.30	195	10.30	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.35	227	10.35	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.40	260	10.40	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.45	292	10.45	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.50	325	10.50	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.55	357	10.55	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.60	390	10.60	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.65	422	10.65	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.70	455	10.70	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.75	487	10.75	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.80	520	10.80	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.85	552	10.85	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.90	585	10.90	0.00	0.00	---	---	---	---	---	---	---	---	0.000
0.95	617	10.95	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.00	650	11.00	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.05	682	11.05	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.10	715	11.10	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.15	747	11.15	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.20	780	11.20	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.25	812	11.25	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.30	845	11.30	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.35	877	11.35	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.40	910	11.40	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.45	942	11.45	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.50	975	11.50	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.55	1,007	11.55	0.00	0.00	---	---	---	---	---	---	---	---	0.000

Continues on next page...

Drainage Area F
Mitigation Option

Area F Bioretention

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
1.60	1,040	11.60	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.65	1,072	11.65	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.70	1,105	11.70	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.75	1,137	11.75	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.80	1,170	11.80	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.85	1,202	11.85	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.90	1,235	11.90	0.00	0.00	---	---	---	---	---	---	---	---	0.000
1.95	1,267	11.95	0.00	0.00	---	---	---	---	---	---	---	---	0.000
2.00	1,300	12.00	0.00	0.00	---	---	---	---	---	---	---	---	0.000
2.05	1,332	12.05	0.00	0.00	---	---	---	---	---	---	---	---	0.000
2.10	1,365	12.10	0.00	0.00	---	---	---	---	---	---	---	---	0.000
2.15	1,397	12.15	0.00	0.00	---	---	---	---	---	---	---	---	0.000
2.20	1,430	12.20	0.00	0.00	---	---	---	---	---	---	---	---	0.000
2.25	1,462	12.25	0.00	0.00	---	---	---	---	---	---	---	---	0.000
2.30	1,495	12.30	0.00	0.00	---	---	---	---	---	---	---	---	0.000
2.35	1,527	12.35	0.00	0.00	---	---	---	---	---	---	---	---	0.000
2.40	1,560	12.40	0.00	0.00	---	---	---	---	---	---	---	---	0.000
2.45	1,592	12.45	0.00	0.00	---	---	---	---	---	---	---	---	0.000
2.50	1,625	12.50	0.00	0.00	---	---	---	---	---	---	---	---	0.000
2.55	1,657	12.55	0.01 ic	0.00	---	---	---	---	---	---	---	---	0.006
2.60	1,690	12.60	0.02 ic	0.00	---	---	---	---	---	---	---	---	0.024
2.65	1,722	12.65	0.05 ic	0.00	---	---	---	---	---	---	---	---	0.050
2.70	1,755	12.70	0.08 ic	0.01 ic	---	---	---	---	---	---	---	---	0.090
2.75	1,787	12.75	0.12 ic	0.02 ic	---	---	---	---	---	---	---	---	0.143
2.80	1,820	12.80	0.15 ic	0.05 ic	---	---	---	---	---	---	---	---	0.205
2.85	1,852	12.85	0.18 ic	0.08 ic	---	---	---	---	---	---	---	---	0.263
2.90	1,885	12.90	0.20 ic	0.12 ic	---	---	---	---	---	---	---	---	0.323
2.95	1,917	12.95	0.22 ic	0.15 ic	---	---	---	---	---	---	---	---	0.378
3.00	1,950	13.00	0.24 ic	0.18 ic	---	---	---	---	---	---	---	---	0.422
3.05	1,982	13.05	0.26 ic	0.20 ic	---	---	---	---	---	---	---	---	0.463
3.10	2,015	13.10	0.28 ic	0.22 ic	---	---	---	---	---	---	---	---	0.500
3.15	2,047	13.15	0.29 ic	0.24 ic	---	---	---	---	---	---	---	---	0.535
3.20	2,080	13.20	0.31 ic	0.26 ic	---	---	---	---	---	---	---	---	0.567
3.25	2,112	13.25	0.32 ic	0.28 ic	---	---	---	---	---	---	---	---	0.597
3.30	2,145	13.30	0.33 ic	0.29 ic	---	---	---	---	---	---	---	---	0.626
3.35	2,177	13.35	0.35 ic	0.31 ic	---	---	---	---	---	---	---	---	0.654
3.40	2,210	13.40	0.36 ic	0.32 ic	---	---	---	---	---	---	---	---	0.681
3.45	2,242	13.45	0.37 ic	0.33 ic	---	---	---	---	---	---	---	---	0.706
3.50	2,275	13.50	0.38 ic	0.35 ic	---	---	---	---	---	---	---	---	0.731

...End

APPENDIX IV

NOAA Precipitation-Frequency Data

NOAA Atlas 14, Volume 6, Version 2
Location name: San Rafael, California, USA*
Latitude: 37.9716°, Longitude: -122.5268°
Elevation: 10.14 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	**1.93** (1.73-2.20)	**2.39** (2.12-2.71)	**3.04** (2.69-3.46)	**3.59** (3.16-4.13)	**4.40** (3.71-5.27)	**5.06** (4.16-6.23)	**5.78** (4.62-7.32)	**6.58** (5.08-8.59)	**7.70** (5.66-10.6)	**8.65** (6.11-12.4)
10-min	**1.39** (1.24-1.57)	**1.71** (1.52-1.94)	**2.17** (1.93-2.47)	**2.57** (2.26-2.96)	**3.15** (2.66-3.77)	**3.63** (2.99-4.46)	**4.15** (3.31-5.24)	**4.71** (3.64-6.16)	**5.52** (4.06-7.58)	**6.20** (4.37-8.87)
15-min	**1.12** (0.996-1.27)	**1.38** (1.23-1.57)	**1.75** (1.55-2.00)	**2.07** (1.82-2.38)	**2.54** (2.14-3.04)	**2.93** (2.41-3.60)	**3.34** (2.67-4.23)	**3.80** (2.93-4.96)	**4.45** (3.28-6.12)	**5.00** (3.53-7.15)
30-min	**0.832** (0.742-0.944)	**1.03** (0.916-1.17)	**1.31** (1.16-1.49)	**1.55** (1.36-1.78)	**1.89** (1.60-2.27)	**2.18** (1.79-2.68)	**2.49** (1.99-3.15)	**2.83** (2.19-3.70)	**3.32** (2.44-4.56)	**3.72** (2.63-5.33)
60-min	**0.595** (0.530-0.674)	**0.736** (0.654-0.835)	**0.933** (0.827-1.06)	**1.10** (0.970-1.27)	**1.35** (1.14-1.62)	**1.56** (1.28-1.92)	**1.78** (1.42-2.25)	**2.02** (1.56-2.64)	**2.37** (1.74-3.26)	**2.66** (1.88-3.81)
2-hr	**0.448** (0.400-0.508)	**0.557** (0.496-0.632)	**0.708** (0.628-0.806)	**0.839** (0.736-0.965)	**1.03** (0.867-1.23)	**1.18** (0.973-1.45)	**1.35** (1.08-1.71)	**1.53** (1.18-2.00)	**1.79** (1.32-2.46)	**2.01** (1.42-2.87)
3-hr	**0.380** (0.338-0.431)	**0.472** (0.420-0.535)	**0.599** (0.531-0.683)	**0.709** (0.623-0.816)	**0.868** (0.732-1.04)	**0.997** (0.820-1.23)	**1.14** (0.907-1.44)	**1.29** (0.993-1.68)	**1.50** (1.10-2.06)	**1.68** (1.19-2.40)
6-hr	**0.282** (0.251-0.319)	**0.350** (0.311-0.397)	**0.443** (0.393-0.505)	**0.523** (0.459-0.602)	**0.638** (0.538-0.764)	**0.730** (0.601-0.897)	**0.829** (0.662-1.05)	**0.935** (0.722-1.22)	**1.09** (0.798-1.49)	**1.21** (0.853-1.73)
12-hr	**0.201** (0.179-0.228)	**0.251** (0.223-0.285)	**0.318** (0.282-0.362)	**0.375** (0.329-0.432)	**0.456** (0.385-0.546)	**0.521** (0.428-0.640)	**0.589** (0.470-0.745)	**0.662** (0.511-0.865)	**0.764** (0.562-1.05)	**0.847** (0.598-1.21)
24-hr	**0.138** (0.124-0.157)	**0.173** (0.156-0.196)	**0.220** (0.197-0.250)	**0.259** (0.231-0.297)	**0.314** (0.272-0.371)	**0.358** (0.304-0.430)	**0.403** (0.335-0.496)	**0.451** (0.365-0.569)	**0.518** (0.403-0.678)	**0.571** (0.431-0.772)
2-day	**0.093** (0.083-0.105)	**0.116** (0.104-0.132)	**0.147** (0.132-0.168)	**0.173** (0.154-0.198)	**0.209** (0.180-0.246)	**0.237** (0.201-0.285)	**0.265** (0.220-0.326)	**0.295** (0.239-0.372)	**0.336** (0.262-0.440)	**0.368** (0.278-0.498)
3-day	**0.070** (0.063-0.080)	**0.088** (0.080-0.100)	**0.112** (0.101-0.128)	**0.132** (0.117-0.151)	**0.158** (0.137-0.187)	**0.179** (0.151-0.215)	**0.199** (0.166-0.245)	**0.221** (0.179-0.279)	**0.251** (0.195-0.328)	**0.274** (0.207-0.370)
4-day	**0.058** (0.052-0.066)	**0.073** (0.066-0.083)	**0.093** (0.083-0.105)	**0.109** (0.097-0.124)	**0.130** (0.113-0.154)	**0.147** (0.125-0.177)	**0.164** (0.136-0.201)	**0.181** (0.146-0.228)	**0.204** (0.159-0.268)	**0.222** (0.168-0.300)
7-day	**0.040** (0.036-0.046)	**0.051** (0.046-0.058)	**0.064** (0.058-0.073)	**0.075** (0.067-0.086)	**0.090** (0.078-0.106)	**0.101** (0.086-0.121)	**0.112** (0.093-0.138)	**0.124** (0.100-0.156)	**0.139** (0.108-0.182)	**0.150** (0.113-0.203)
10-day	**0.033** (0.030-0.037)	**0.041** (0.037-0.047)	**0.052** (0.047-0.060)	**0.061** (0.055-0.070)	**0.073** (0.063-0.086)	**0.082** (0.069-0.098)	**0.090** (0.075-0.111)	**0.099** (0.080-0.125)	**0.110** (0.086-0.144)	**0.119** (0.090-0.160)
20-day	**0.022** (0.019-0.024)	**0.027** (0.025-0.031)	**0.035** (0.031-0.039)	**0.040** (0.036-0.046)	**0.047** (0.041-0.056)	**0.052** (0.045-0.063)	**0.057** (0.048-0.071)	**0.062** (0.050-0.078)	**0.068** (0.053-0.089)	**0.072** (0.055-0.098)
30-day	**0.017** (0.016-0.020)	**0.022** (0.020-0.025)	**0.028** (0.025-0.032)	**0.032** (0.029-0.037)	**0.038** (0.033-0.045)	**0.042** (0.035-0.050)	**0.045** (0.038-0.056)	**0.049** (0.039-0.061)	**0.053** (0.041-0.069)	**0.056** (0.042-0.075)
45-day	**0.014** (0.013-0.016)	**0.018** (0.017-0.021)	**0.023** (0.021-0.026)	**0.027** (0.024-0.030)	**0.031** (0.027-0.036)	**0.034** (0.029-0.041)	**0.036** (0.030-0.045)	**0.039** (0.031-0.049)	**0.042** (0.032-0.054)	**0.043** (0.033-0.059)
60-day	**0.013** (0.012-0.014)	**0.016** (0.015-0.019)	**0.021** (0.018-0.023)	**0.024** (0.021-0.027)	**0.027** (0.023-0.032)	**0.030** (0.025-0.035)	**0.032** (0.026-0.039)	**0.034** (0.027-0.042)	**0.036** (0.028-0.047)	**0.037** (0.028-0.051)

[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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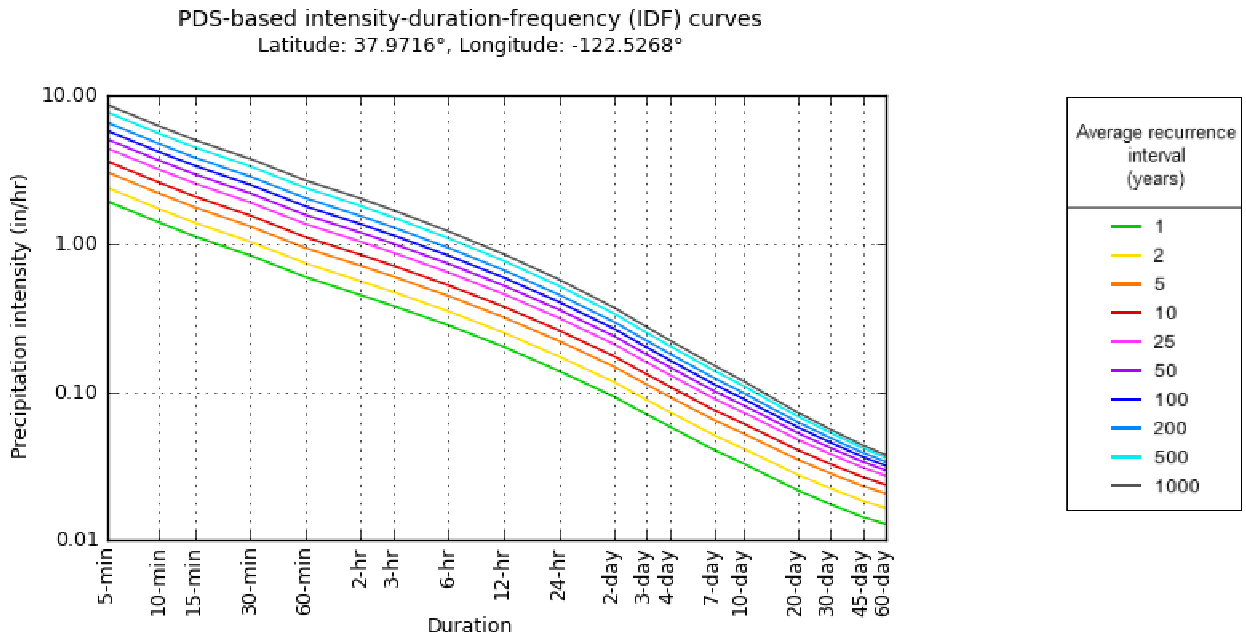
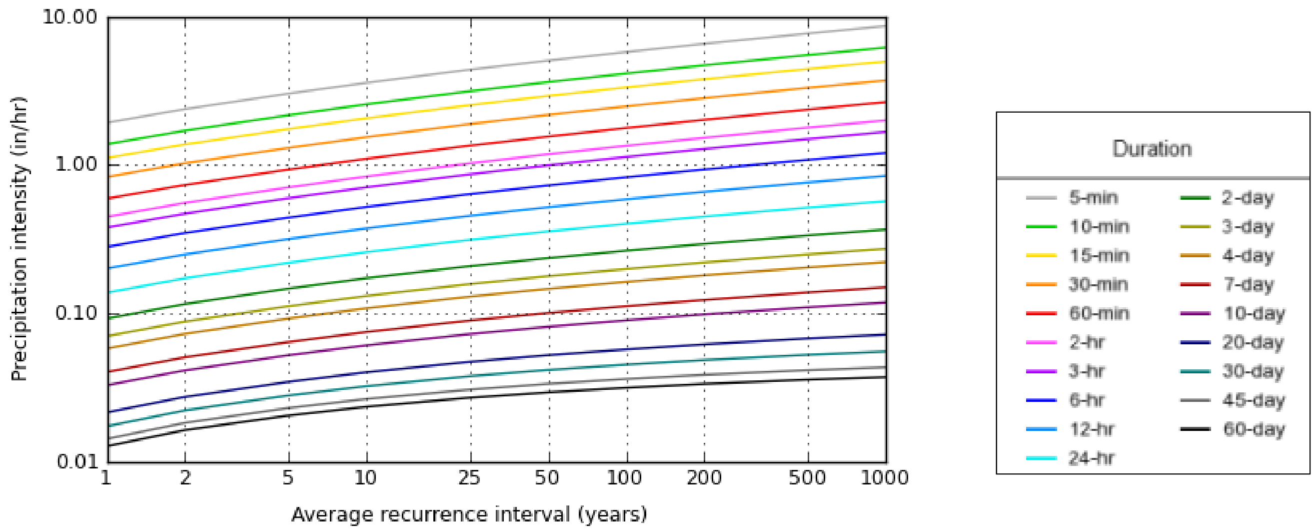
PF graphical





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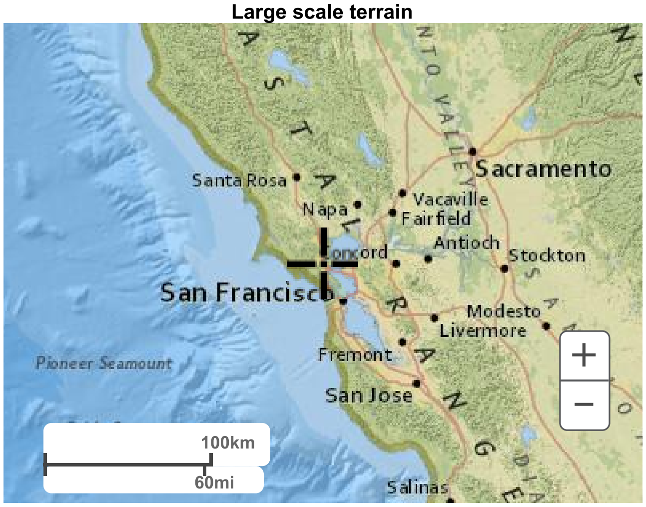
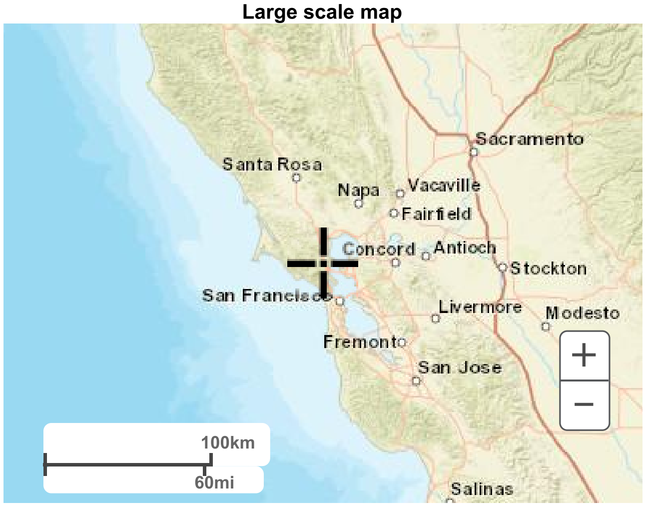
Maps & aerials

Small scale terrain

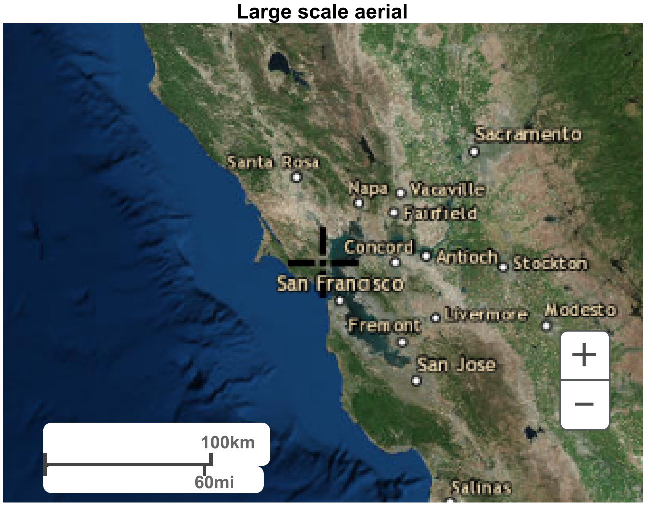
Large scale terrain



Large scale map



Large scale aerial



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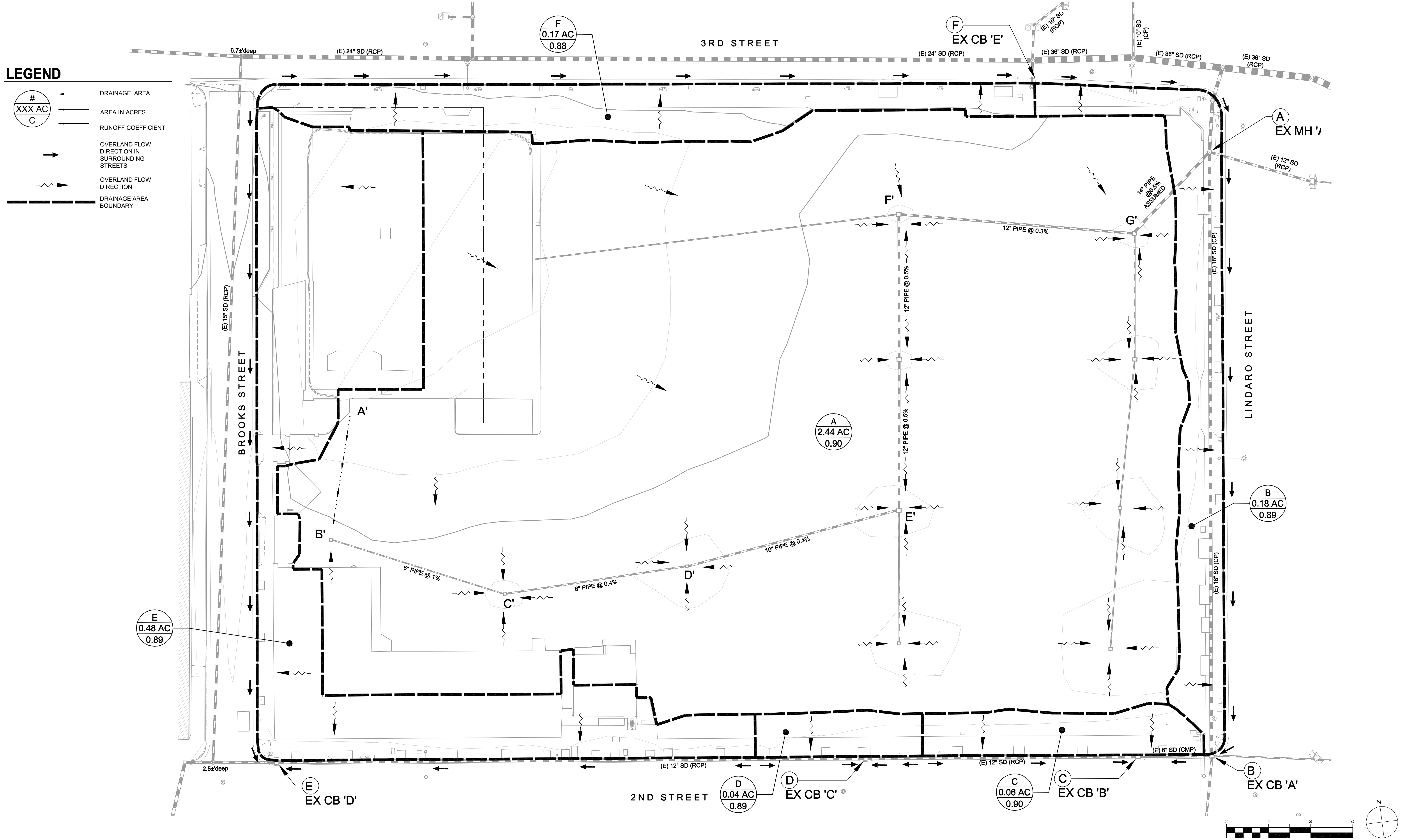
APPENDIX V

Pre-Project Hydrology Map



BIOMARIN JOHNSON FAIN CSW ST2

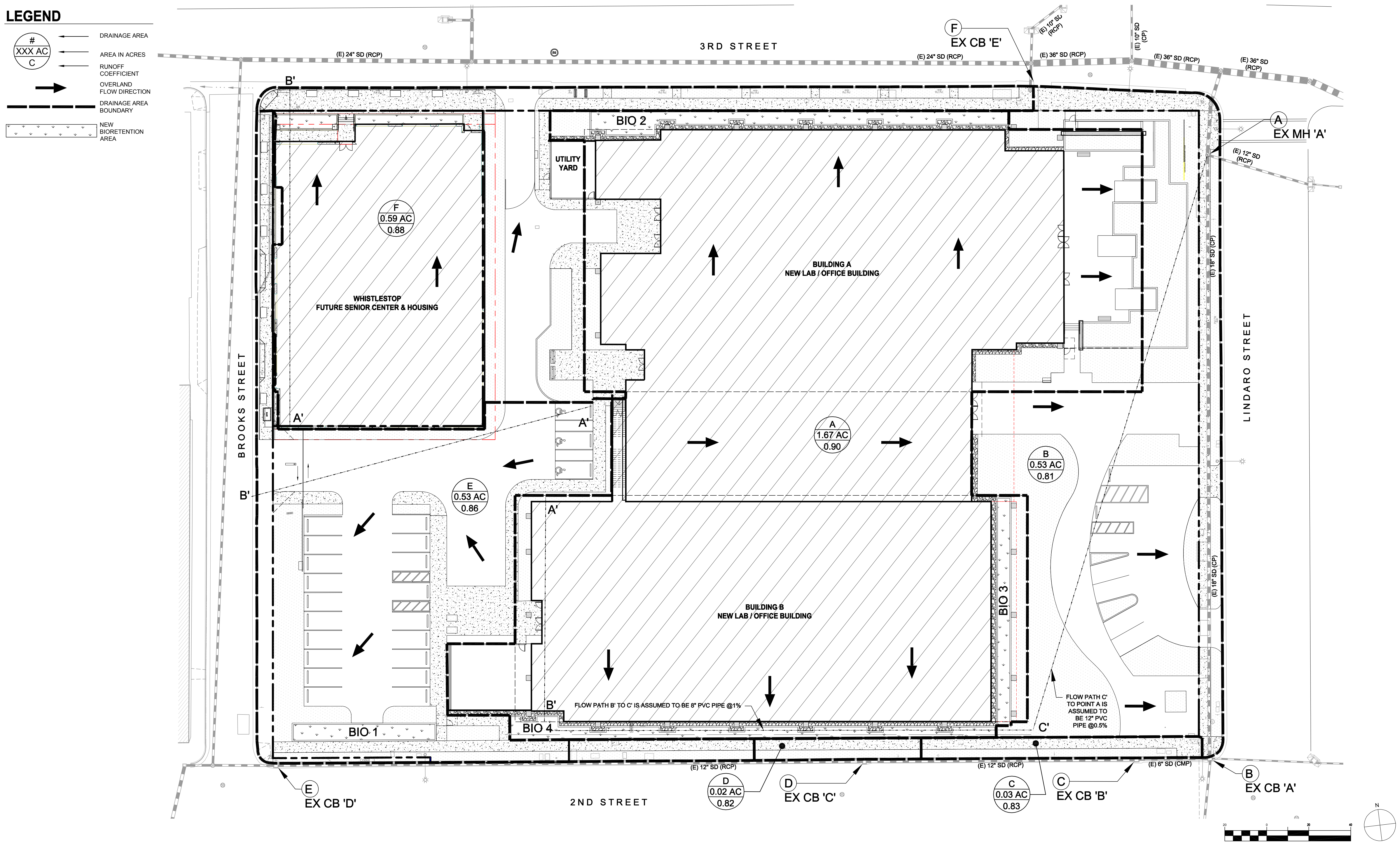
999 THIRD STREET

PRE-PROJECT HYDROLOGY MAP

H1.0

APPENDIX VI

Post-Project Hydrology Map



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POST-PROJECT HYDROLOGY MAP

H2.0