

**Drainage Analysis**  
**For**  
**Spirit Living Group Senior Housing**  
**55 Thomas Drive, Mill Valley CA**  
**APN 034-012-26**

**JN 24114**  
**May 30, 2025**

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My license expires 6/30/2025



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# **1. Drainage Narrative**

# Spirit Living Group Senior Housing Drainage Narrative

## Project Description

The project is located at 55 Thomas Drive in Mill Valley, California. The overall project site is approximately 6.02 acres. The site is undeveloped with existing brush and trees throughout. The project proposes to construct a new senior living housing building, AC driveway, concrete walkway, and associated hardscaping and landscaping.

Existing slopes in the area of the proposed site vary between 15% to 50%. Runoff currently sheet flows westerly towards either an existing dirt swale, which outfalls into the stormdrain system within Thomas Drive, or a concrete swale which outfalls into the storm drain system within Central Court. Both storm drain systems ultimately route and connect to Central Drive. The soil type belongs to hydrologic soil group D, see Soil Analysis in **Appendix II**. For existing conditions, see attached **Aerial Photo**.

For the proposed development, the design intent is to direct runoff strategically and limit runoff from the property site in order to maintain and mimic the pre-development drainage conditions. This site will have two drainage outfall locations placed to mimic the existing drainage conditions. One outfall will direct runoff to the stormdrain system within Thomas drive and the other outfall will direct runoff to the existing concrete swale. Both routes ultimately discharge into the drainage system within Central Court. Runoff volume will be limited to match the pre-existing discharge by oversizing the proposed bioretention facilities. The excess volume of runoff due to the proposed development will be detained on-site within the increased storage depth of the bioretention facilities. The historic drainage patterns will remain, with the ultimate runoff being directed to the storm drain system within Central Drive.

## Methodology

Pursuant to the BASMAA Post-Construction Manual dated January 2019, runoff from impervious areas is required to direct stormwater runoff to Permanent Post Construction Best Management Practices (BMPs). Treatment will be provided within bioretention prior to discharging from the site. Please refer to the BASMAA report for more information on the sizing and locations of bioretention areas.

Pre – existing and post – construction drainage patterns were observed and compared in relation to the area of development and ultimate outfall locations, see attached **Pre – Construction Hydrology Map** and **Post – Construction Detention Map**. Existing 10-yr

peak flow rates were estimated 8.18 cfs for A1 and 3.29 cfs for A2, see **Pre-Construction Rational Method Study**. Proposed 10-yr peak flow rates were estimated 8.42 cfs for A1 and 3.85 cfs for A2, see **Post – Construction Detention Rational Method Study**. Detention analyses show the attenuated discharge flows from the outlet structures. Storm water will be stored in the void within the underground drain rock chambers of the bioretention facilities. BIO-1 will provide an additional 2.0' of storage depth and BIO-2 will provide an additional 1.5' to the required dimensions, stated within the BASMAA manual, see **Detention Analysis**.

Runoff from the impervious areas will be collected in a proposed storm drain network and ultimately outfall into the existing storm drain networks, see **Post Construction Map** for proposed routing. The Rational Method has been used to calculate the 10- and 100- year peak runoff in accordance with the County of Marin Hydrology Manual shown in the **10- and 100- Year Rational Method Drainage Calculations**.

Proposed inlets were conservatively calculated for capacity using worst case scenarios with largest subbasin/inflow for a given inlet size, see **Inlet Capacity Calculations**. The **Overland Release Map** shows drainage routing in the event of over inundation.

Autodesk *Hydraulic Toolbox 4.4* has been used to calculate normal depth in the proposed storm drain pipes and swales as presented in **Appendix I, Stormdrain/swale Analysis**. Concrete swales, upslope of the retaining walls, were calculated for maximum depth of stormwater flow during its shallowest portions and steepest portions in order to demonstrate that the area of flow will be maintained within its dimensions at all times. Proposed system was analyzed using a 10 year storm event. Manning's n value was 0.0120 for the pipe material, 0.015 for the concrete swales and 0.035 for the bioswales.

## **Conclusion**

In accordance with the County of Marin's Hydrology Manual, all drainage facilities are designed to convey, without surcharge, runoff from the 10-yr storm event. The project will maintain the pre-construction 10-yr storm runoff during post-construction 10-yr storm events by using bioretention facilities for storage and controlling the release of the runoff off the property. Ultimate runoff quantity into the 24" Storm drain underneath Central Drive will remain as per what is existing through the oversizing of the bioretention facilities. The project has been designed to allow for overland release in case of inundation of the storm drain system.

## **2. Aerial Photo**

# Spirit Living Group Senior Housing

55 Thomas Drive, Mill Valley CA

Horse Hill Preserve



Project Site

55 Thomas Dr

Ross Academy Montessori School

MagoNic

101

Google Earth



1000 ft

### **3. Pre-Construction Hydrology Map**

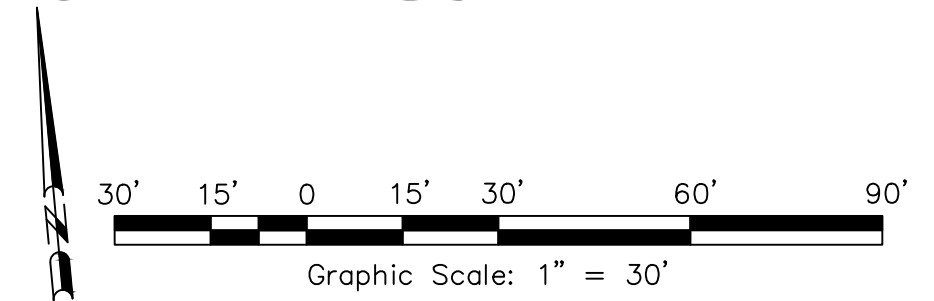
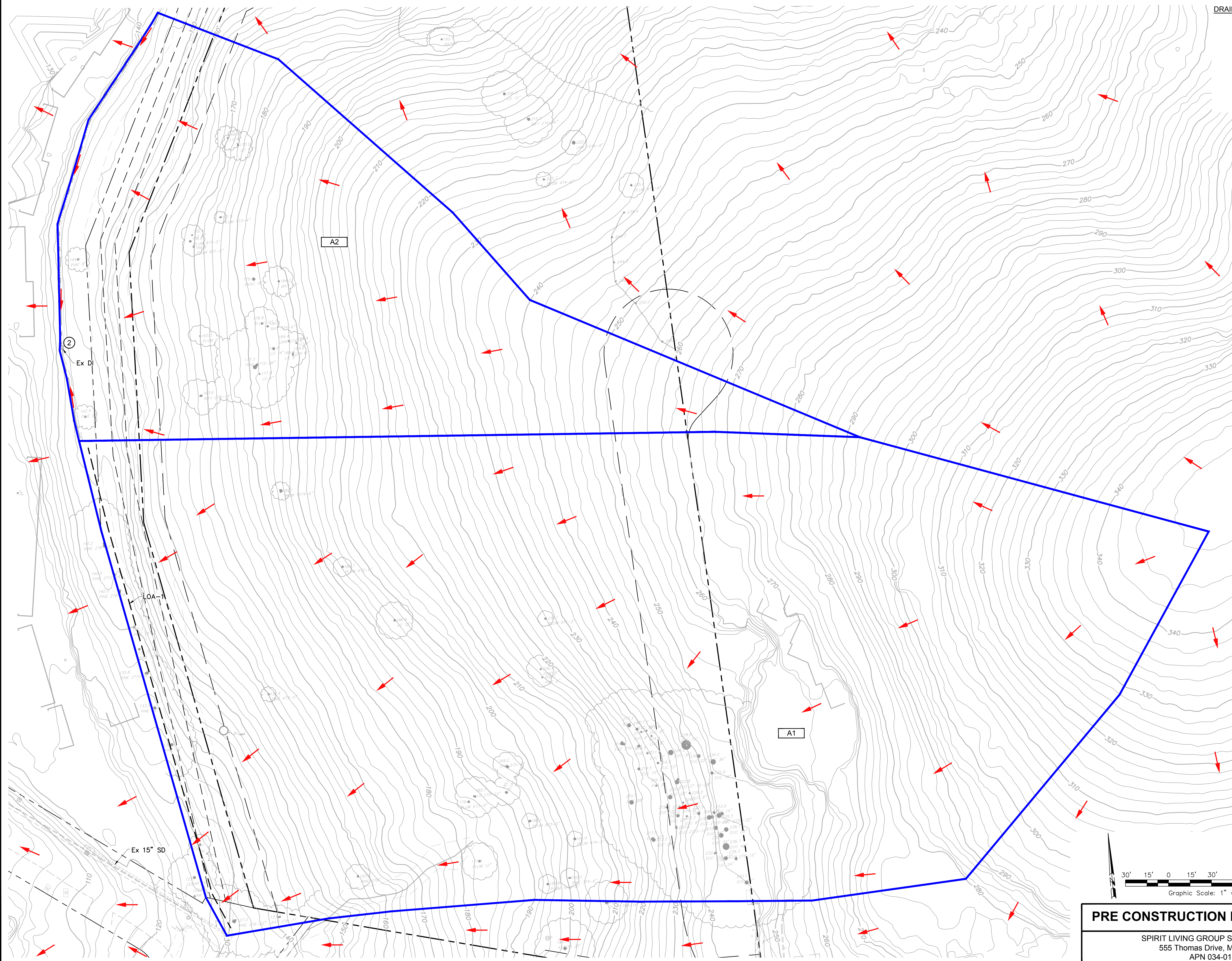
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**DRAINAGE AREA TABLE**

A1=4.90 AC  
(213,370 SF)  
A2=1.89 AC  
(82,250 SF)

**DRAINAGE AREA LEGEND**

- A1 DRAINAGE AREA
- 1 POINT OF CONCENTRATION
- DRAINAGE AREA BOUNDARY
- PROPERTY LINE (PL)
- LINE OF ANALYSIS
- DIRECTION OF FLOW



May 29, 2025

**PRE CONSTRUCTION HYDROLOGY MAP**

SPIRIT LIVING GROUP SENIOR HOUSING  
555 Thomas Drive, Mill Valley, CA  
APN 034-012-26

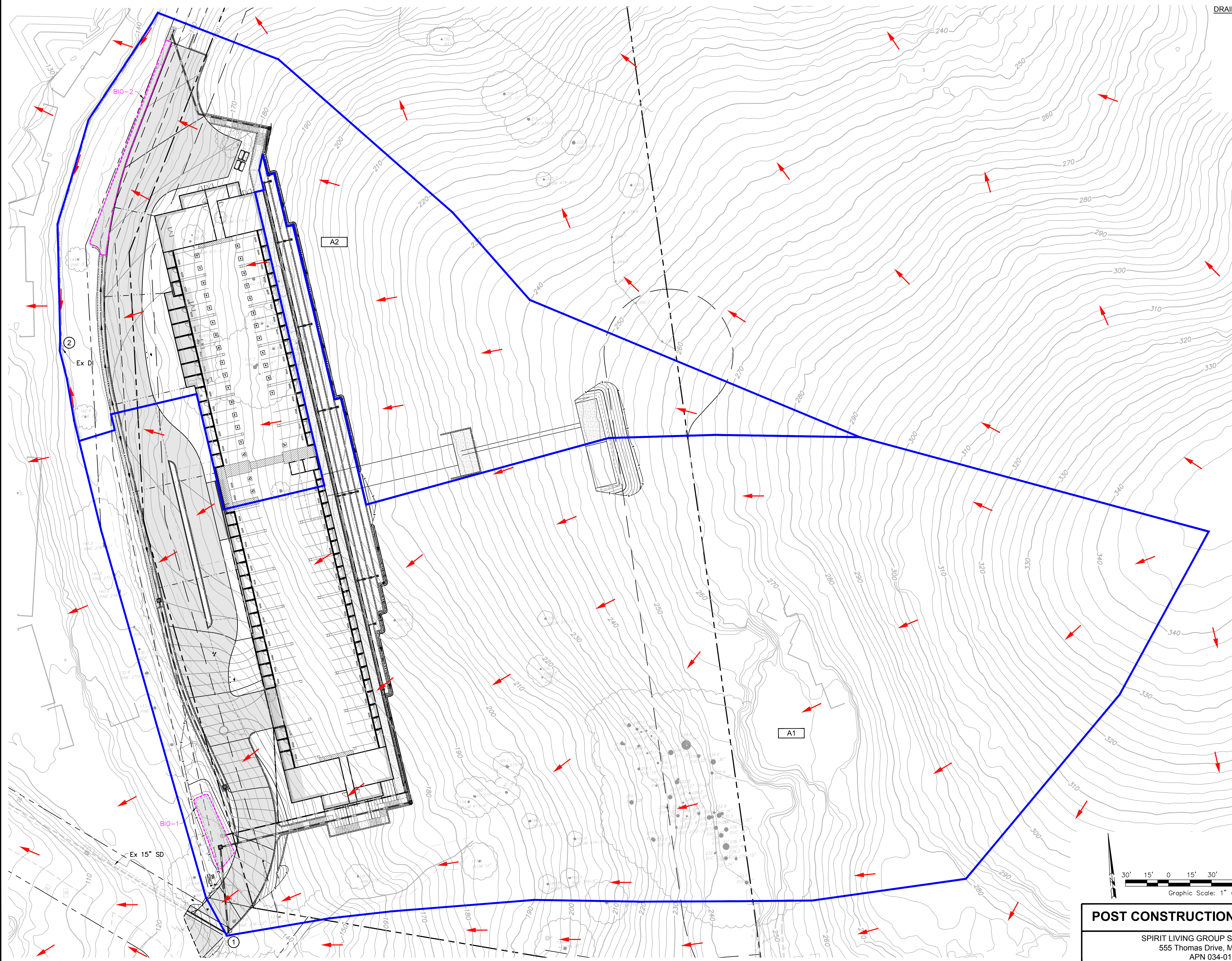
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## **4. Post-Construction Detention Map**

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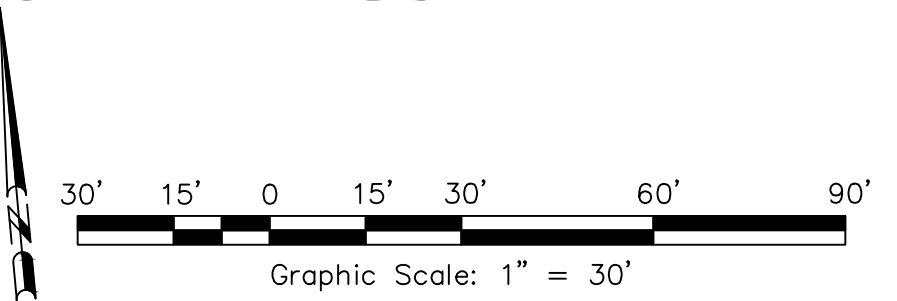


**DRAINAGE AREA TABLE**

A1=4.84 AC  
(210,950 SF)  
A2=1.94 AC  
(84,648 SF)

**DRAINAGE AREA LEGEND**

- A1 DRAINAGE AREA
- 1 POINT OF CONCENTRATION
- DRAINAGE AREA BOUNDARY
- PROPERTY LINE (P)
- LINE OF ANALYSIS
- DIRECTION OF FLOW



June 4, 2025

**POST CONSTRUCTION DETENTION MAP**

SPIRIT LIVING GROUP SENIOR HOUSING  
555 Thomas Drive, Mill Valley, CA  
APN 034-012-26

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## **5. Detention Volume Calculations**

**Rational Method Drainage Study**  
**10-Yr Storm Event Pre Construction**

Project: 24114-Spirit Living Group Senior Housing

Date: 5/29/2025

Point of Concentration	Area	Δ Elev.	Distance	Slope	V(ft/s)	Travel Time (min)	Total Time (min)	I	K	C	A	A <sub>total</sub>	AC	Sum AC	Q (cfs)	Remarks
<b>10 Year Storm Event</b>																
1	A 1	230	820	0.28	N/A	12.00	12.00	2.38	-	0.70	4.90	4.90	3.43	3.43	8.18	Total Flow to Ex 15" SD
2	A 2	150	560	0.27	N/A	11.00	11.00	2.49	-	0.70	1.89	1.89	1.32	1.32	3.29	Total Flow to Ex DI

**POST CONSTRUCTION RUNOFF COEFFICIENT**

Area Number	A <sub>T</sub>	A <sub>V</sub>	A <sub>G</sub>	A <sub>P</sub>	C <sub>T</sub>
A 1	4.90	4.90	0.00	0.00	0.70
A 2	1.89	1.89	0.00	0.00	0.70

**NOTE:**

Vegetated area : C<sub>V</sub> = 0.70  
 Residential area : C<sub>P</sub> = 0.90  
 Mixed area : C = (A<sub>V</sub> / SA)\*C<sub>V</sub>+ (A<sub>P</sub> / SA)\*C<sub>P</sub>+(A<sub>G</sub>/SA)\*C<sub>G</sub>

**Time of Concentration Equation**

$$t_c = \frac{1.8(1.1-C)\sqrt{L}}{\sqrt{S(100)}} + 5Min$$

C = Runoff Coefficient \*

L = Longest run in feet

$$S = \text{Average Slope in ft/ft} = \frac{\Delta H}{L}$$

**Rainfall Intensity vs Duration**

$$I = 8.34 / t^{0.50}$$

**Rational Method Drainage Study**  
**100-Yr Storm Event Pre Construction**

Project: 24114-Spirit Living Group Senior Housing

Date: 5/29/2025

Point of Concentration	Area	Δ Elev.	Distance	Slope	V(ft/s)	Travel Time (min)	Total Time (min)	I	K	C	A	A <sub>total</sub>	AC	Sum AC	Q (cfs)	Remarks
<b>100 Year Storm Event</b>																
1	A 1	230	820	0.28	N/A	12.00	12.00	3.88	-	0.70	4.90	4.90	3.43	3.43	13.29	Total Flow to Ex 15" SD
2	A 2	150	560	0.27	N/A	11.00	11.00	4.05	-	0.70	1.89	1.89	1.32	1.32	5.35	Total Flow to Ex DI

**POST CONSTRUCTION RUNOFF COEFFICIENT**

Area Number	A <sub>T</sub>	A <sub>V</sub>	A <sub>G</sub>	A <sub>P</sub>	C <sub>T</sub>
A 1	4.90	4.90	0.00	0.00	0.70
A 2	1.89	1.89	0.00	0.00	0.70

**NOTE:**

Vegetated area : C<sub>V</sub> = 0.70  
 Residential area : C<sub>P</sub> = 0.90  
 Mixed area : C = (A<sub>V</sub> / SA)\*C<sub>V</sub>+ (A<sub>P</sub> / SA)\*C<sub>P</sub>+(A<sub>G</sub>/SA)\*C<sub>G</sub>

**Time of Concentration Equation**

$$t_c = \frac{1.8(1.1-C)\sqrt{L}}{\sqrt{S(100)}} + 5Min$$

C = Runoff Coefficient \*

L = Longest run in feet

$$S = \text{Average Slope in ft/ft} = \frac{\Delta H}{L}$$

**Rainfall Intensity vs Duration**

$$I = 13.56 / t^{0.50}$$

**Rational Method Drainage Study**  
**10-Yr Storm Event Post - Construction Detention**

Project: 24114-Spirit Living Group Senior Housing

Date: 5/29/2025

Point of Concentration	Area	Δ Elev.	Distance	Slope	V(ft/s)	Travel Time (min)	Total Time (min)	I	K	C	A	A <sub>total</sub>	AC	Sum AC	Q (cfs)	Remarks
<b>10 Year Storm Event</b>																
1	A 1	230	820	0.28	N/A	12.00	12.00	2.38	-	0.73	4.84	4.84	3.53	3.53	8.42	Total Flow to Ex 15" SD
2	A 2	150	560	0.27	N/A	10.00	10.00	2.61	-	0.76	1.94	1.94	1.47	1.47	3.85	Total Flow to Ex DI

**POST CONSTRUCTION RUNOFF COEFFICIENT**

Area Number	A <sub>T</sub>	A <sub>V</sub>	A <sub>G</sub>	A <sub>P</sub>	C <sub>T</sub>
A 1	4.84	4.84	0.00	0.00	0.73
A 2	1.94	1.94	0.00	0.00	0.76

**NOTE:**

Vegetated area : C<sub>V</sub> = 0.70  
 Residential area : C<sub>P</sub> = 0.90  
 Mixed area : C = (A<sub>V</sub> / SA)\*C<sub>V</sub>+ (A<sub>P</sub> / SA)\*C<sub>P</sub>+(A<sub>G</sub>/SA)\*C<sub>G</sub>

**Time of Concentration Equation**

$$t_c = \frac{1.8(1.1-C)\sqrt{L}}{\sqrt{S(100)}} + 5Min$$

C = Runoff Coefficient \*

L = Longest run in feet

$$S = \text{Average Slope in ft/ft} = \frac{\Delta H}{L}$$

**Rainfall Intensity vs Duration**

$$I = 8.34 / t^{0.50}$$

**Rational Method Drainage Study**  
**100-Yr Storm Event Post - Construction Detention**

Project: 24114-Spirit Living Group Senior Housing

Date: 5/30/2025

Point of Concentration	Area	Δ Elev.	Distance	Slope	V(ft/s)	Travel Time (min)	Total Time (min)	I	K	C	A	A <sub>total</sub>	AC	Sum AC	Q (cfs)	Remarks
<b>100 Year Storm Event</b>																
1	A 1	230	820	0.28	N/A	12.00	12.00	3.88	-	0.73	4.84	4.84	3.53	3.53	13.69	Total Flow to Ex 15" SD
2	A 2	150	560	0.27	N/A	10.00	10.00	4.25	-	0.76	1.94	1.94	1.47	1.47	6.26	Total Flow to Ex DI

**POST CONSTRUCTION RUNOFF COEFFICIENT**

Area Number	A <sub>T</sub>	A <sub>V</sub>	A <sub>G</sub>	A <sub>P</sub>	C <sub>T</sub>
A 1	4.84	4.84	0.00	0.00	0.73
A 2	1.94	1.94	0.00	0.00	0.76

**NOTE:**

Vegetated area : C<sub>V</sub> = 0.70  
 Residential area : C<sub>P</sub> = 0.90  
 Mixed area : C = (A<sub>V</sub> / SA)\*C<sub>V</sub>+ (A<sub>P</sub> / SA)\*C<sub>P</sub>+(A<sub>G</sub>/SA)\*C<sub>G</sub>

**Time of Concentration Equation**

$$t_c = \frac{1.8(1.1-C)\sqrt{L}}{\sqrt{S(100)}} + 5Min$$

C = Runoff Coefficient \*

L = Longest run in feet

$$S = \text{Average Slope in ft/ft} = \frac{\Delta H}{L}$$

**Rainfall Intensity vs Duration**

$$I = 13.56 / t^{0.50}$$

# Detention Analysis

## BIO-1

### Project Data

Project Title: 24114-Spirit Living Group Senior Housing  
Designer: KM  
Project Date: 5/30/2025  
Notes:

### Storage Capacity: Known Area & Volume

Elevation (ft)	Depth (ft)	Area (ft <sup>2</sup> )	Volume (ft <sup>3</sup> )	Composite Porosity <sup>1</sup>	Effective Volume (ft <sup>3</sup> ) <sup>2</sup>	Total Volume (ft <sup>3</sup> ) <sup>3</sup>
122.75	-	630	-	-	-	-
124.75	2.0	630	1,260	0.40	504	504
125.75	1.0	630	630	0.40	252	756
127.25	1.5	630	945	1.00	945	1,701
128.00	0.8	630	473	1.00	473	2,174

### Notes:

- <sup>1</sup> Composite Porosity is the porosity of the storage medium.
- <sup>2</sup> Effective volume is the area multiplied by the composite porosity.
- <sup>3</sup> Total volume is the sum of the effective volumes for each storage medium.
- <sup>4</sup> The amended soil section volume is not taken into account for the total volume.

# Outlet Structure

## BIO-1

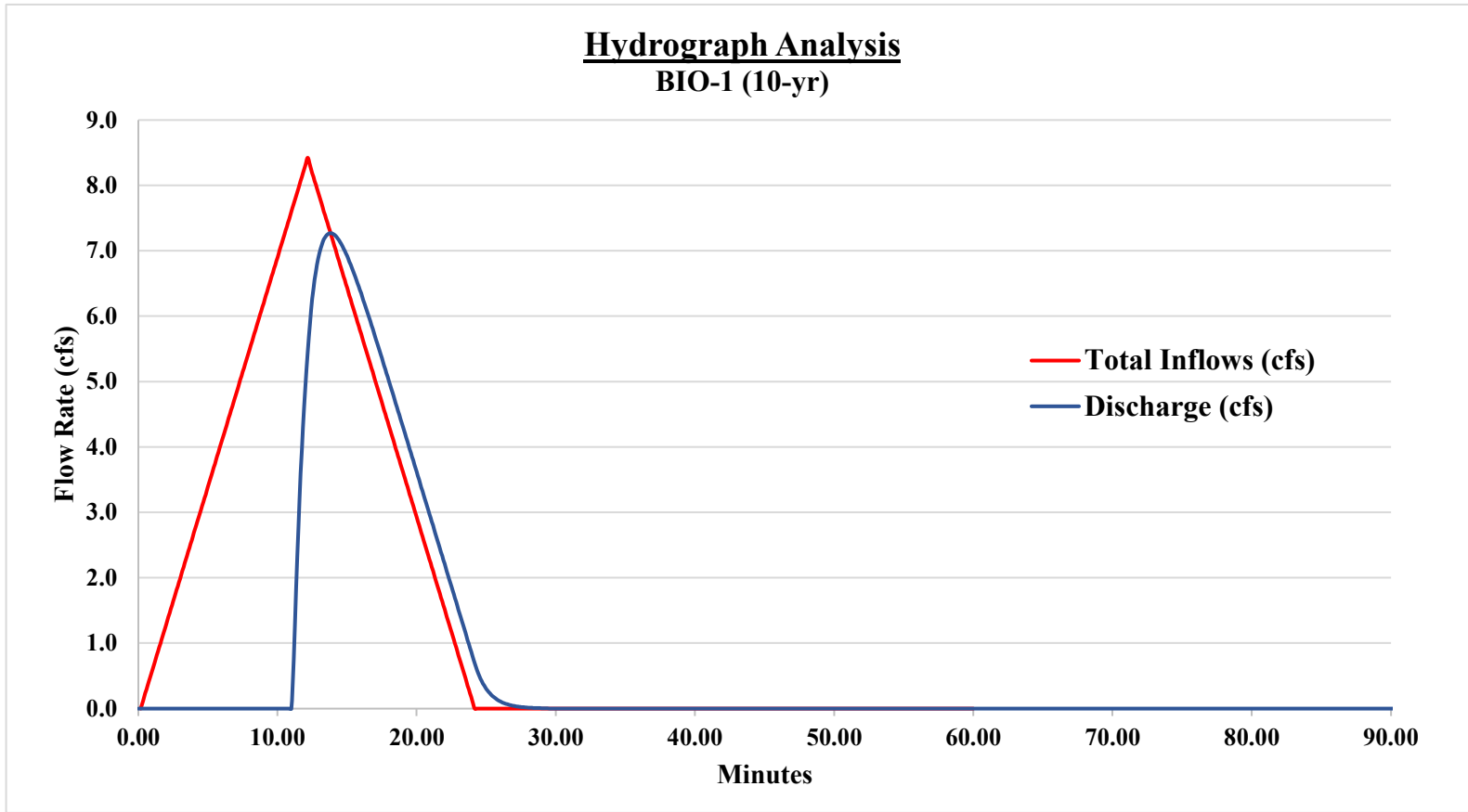
### Outlet Structure Parameters (DI)

		Notes
<b><u>Weir :</u></b> Weir 1 (W20"xH6") all sides		
Weir Length (ft):	1.5	(W=18")
Weir Coefficient:	3.33	
Height above Base Elevation (ft):	4.50	(127.25 SO)
Base Elevation (ft):	122.75	
<b><u>Standpipe:</u></b> Top Grate (24" square)		
Pipe Diameter (ft):	2.25	(equivalent to 24"x24")
Weir Coefficient:	3.33	
Orifice Coefficient:	0.56	
Height above base (ft):	4.75	(127.75 GR)
Base Elevation (ft):	122.75	

### BIO-1 (10-yr)

Peak Inflow (cfs) = **8.42**  
Peak Discharge (cfs) = **7.27**  
Max Allowable Discharge (cfs) = **8.18** (= 10-yr Pre-construction)

#### Hydrograph Analysis BIO-1 (10-yr)



### BIO-1 (100-yr)

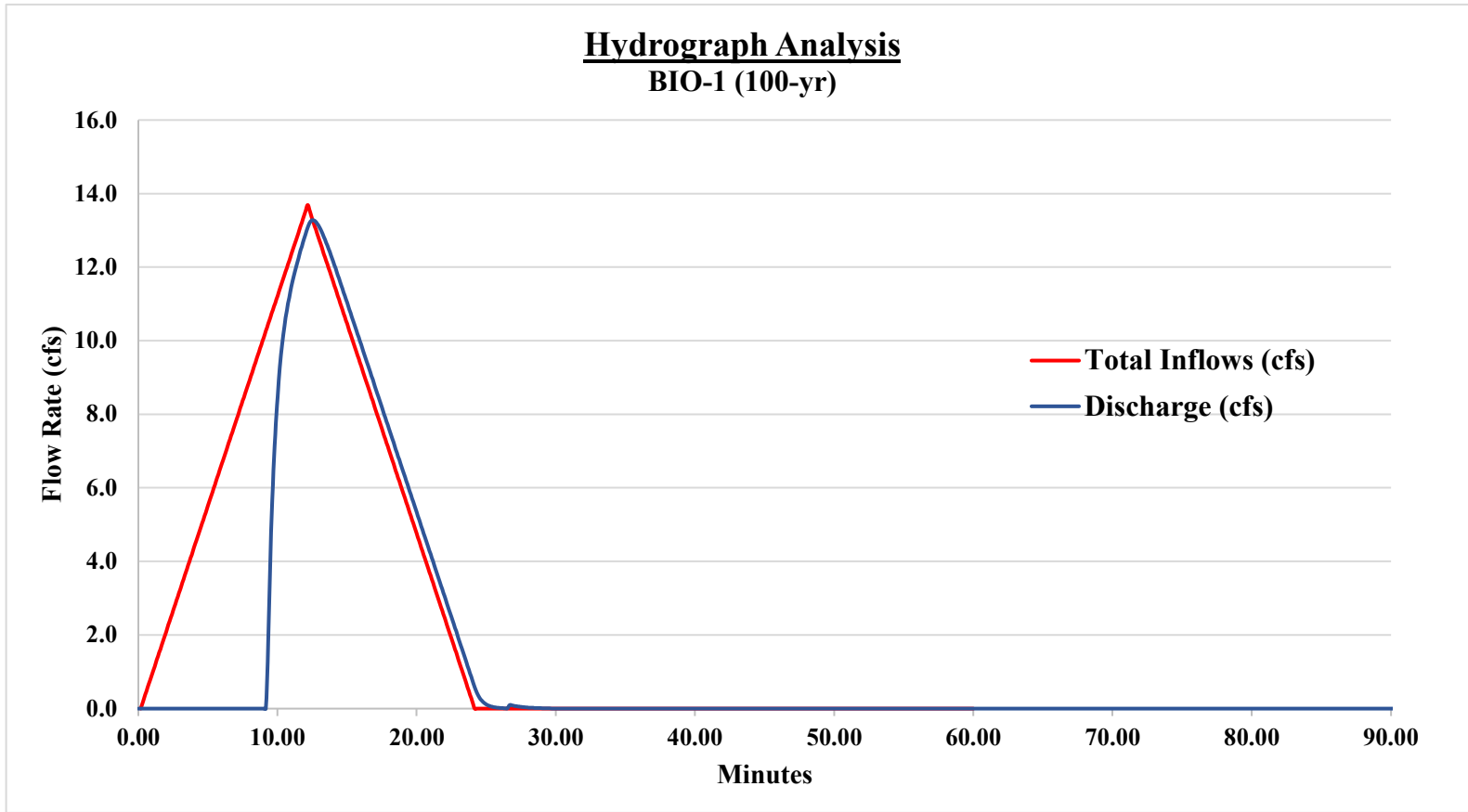
Peak Inflow (cfs) = **13.69**

Peak Discharge (cfs) = **13.28**

Max Allowable Discharge (cfs) = **13.29** (= 100-yr Pre-construction)

#### Hydrograph Analysis

BIO-1 (100-yr)



# Detention Analysis

## BIO-2

### Project Data

Project Title: 24114-Spirit Living Group Senior Housing

Designer: KM

Project Date: 5/30/2025

Notes:

### Storage Capacity: Known Area & Volume

Elevation (ft)	Depth (ft)	Area (ft <sup>2</sup> )	Volume (ft <sup>3</sup> )	Composite Porosity <sup>1</sup>	Effective Volume (ft <sup>3</sup> ) <sup>2</sup>	Total Volume (ft <sup>3</sup> ) <sup>3</sup>
143.0	0.0	500	0	0.00	0	0
144.5	1.5	500	750	0.40	300	300
145.5	1.0	500	500	0.40	200	300
147.0	1.5	500	750	1.00	750	1,050
147.5	0.5	500	250	1.00	250	1,300

### Notes:

<sup>1</sup> Composite Porosity is the porosity of the storage medium.

<sup>2</sup> Effective volume is the area multiplied by the composite porosity.

<sup>3</sup> Total volume is the sum of the effective volumes for each storage medium.

<sup>4</sup> The amended soil section volume is not taken into account for the total volume.

# Outlet Structure

## BIO-2

### Outlet Structure Parameters Overland Release

### Notes

Weir : Riprap outfall

Weir Length (ft):	4.00	
Weir Coefficient:	3.33	
Height above Base Elevation (ft):	4.00	(147.00 SO)
Base Elevation (ft):	143.00	

### BIO-2 (10-yr)

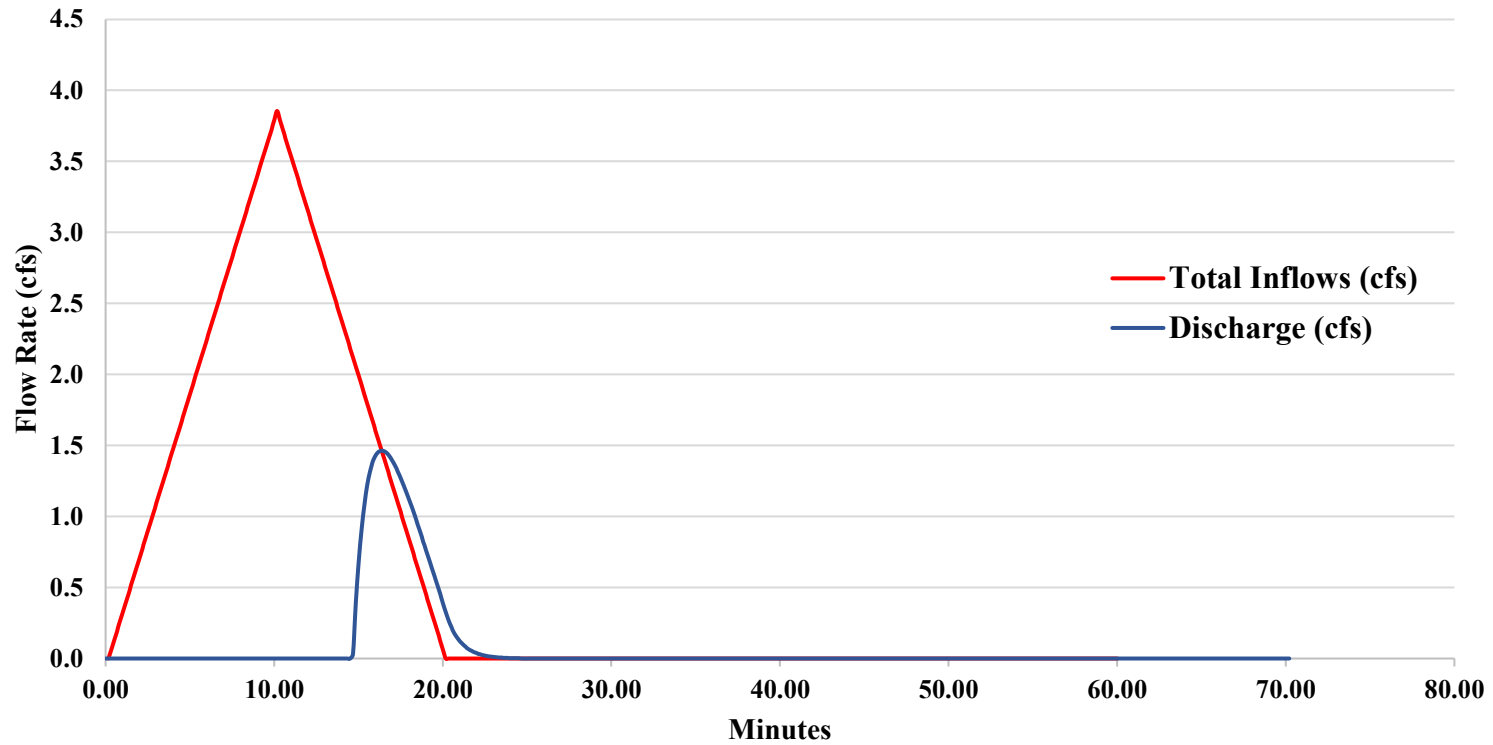
Peak Inflow (cfs) = **3.85**

Peak Discharge (cfs) = **1.46**

Max Allowable Discharge (cfs) = **3.29** (=10-yr Pre-construction)

#### Hydrograph Analysis

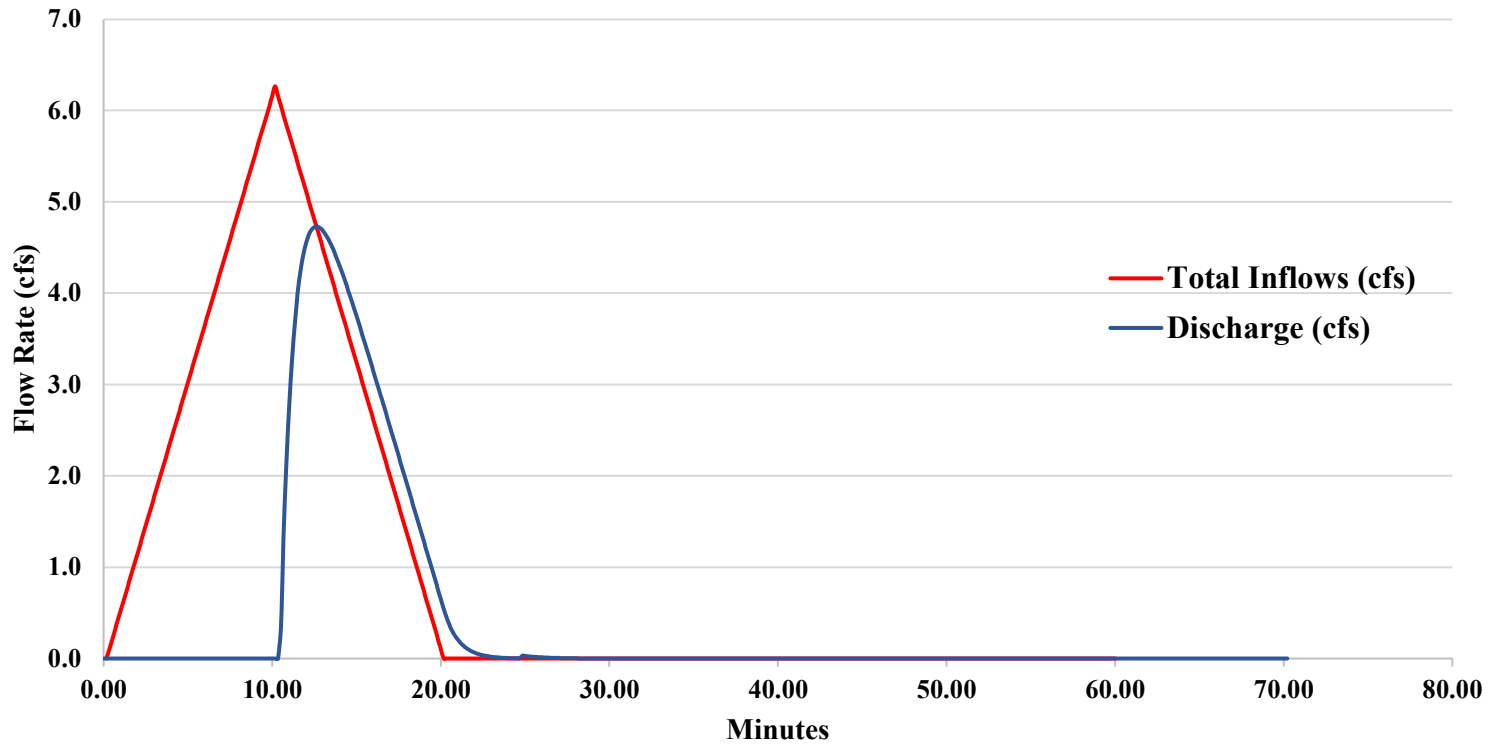
BIO-2 (10-yr)



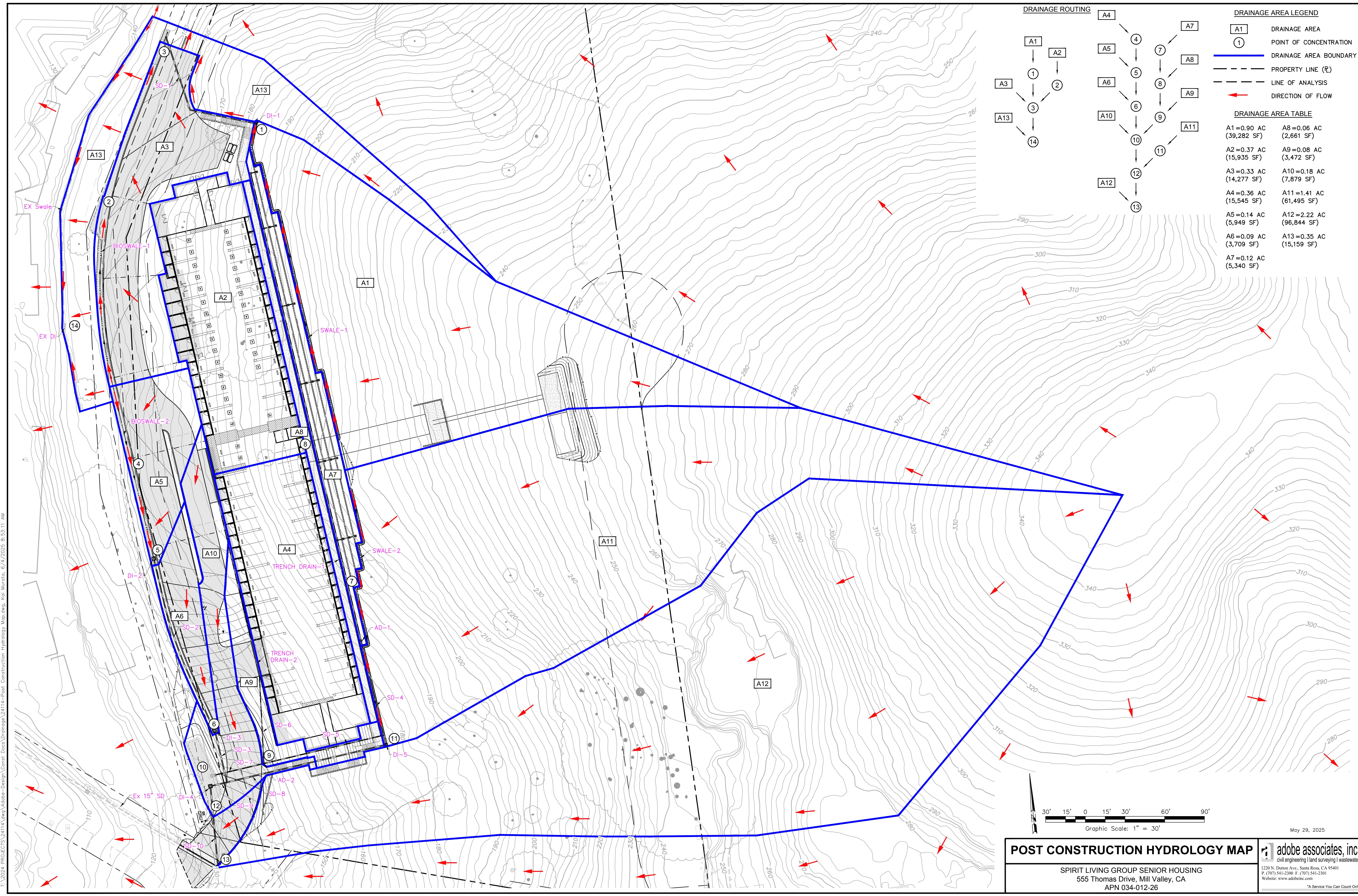
### BIO-2 (100-yr)

Peak Inflow (cfs) = **6.26**  
Peak Discharge (cfs) = **4.73**  
Max Allowable Discharge (cfs) = **5.35** (=100-yr Pre-construction)

#### Hydrograph Analysis BIO-2 (100-yr)



## **6. Post-Construction Hydrology Map**



**DRAINAGE ROUTING**

```

    graph TD
      A13 --> 14
      A13 --> 3
      A3 --> 3
      A2 --> 2
      A1 --> 1
      1 --> 3
      3 --> 4
      3 --> 5
      3 --> 6
      3 --> 7
      3 --> 8
      3 --> 9
      3 --> 10
      3 --> 11
      3 --> 12
      3 --> 13
  
```

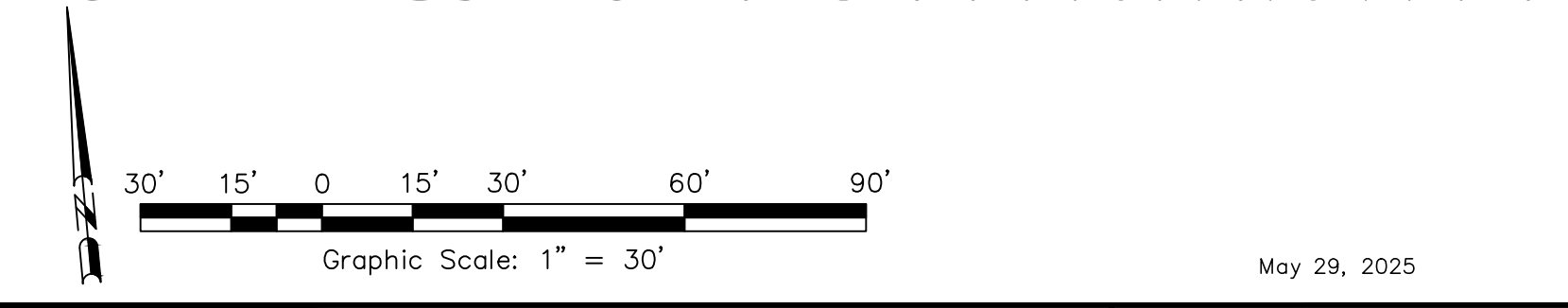
**DRAINAGE AREA LEGEND**

- A1 DRAINAGE AREA
- ① POINT OF CONCENTRATION
- DRAINAGE AREA BOUNDARY
- - - PROPERTY LINE (P)
- - - LINE OF ANALYSIS
- DIRECTION OF FLOW

**DRAINAGE AREA TABLE**

A1=0.90 AC (39,282 SF)	A8=0.06 AC (2,661 SF)
A2=0.37 AC (15,935 SF)	A9=0.08 AC (3,472 SF)
A3=0.33 AC (14,277 SF)	A10=0.18 AC (7,879 SF)
A4=0.36 AC (15,545 SF)	A11=1.41 AC (61,495 SF)
A5=0.14 AC (5,949 SF)	A12=2.22 AC (96,844 SF)
A6=0.09 AC (3,709 SF)	A13=0.35 AC (15,159 SF)
A7=0.12 AC (5,340 SF)	

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May 29, 2025

**POST CONSTRUCTION HYDROLOGY MAP**

SPIRIT LIVING GROUP SENIOR HOUSING  
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## **7. 10 and 100 Year Rational Method Drainage Study**

**Rational Method Drainage Study**  
**10-Yr Storm Event Post Construction**

Project: 24114-Spirit Living Group Senior Housing

Date: 5/29/2025

Point of Concentration	Area	Δ Elev.	Distance	Slope	V(ft/s)	Travel Time (min)	Total Time (min)	I	K	C	A	A <sub>total</sub>	AC	Sum AC	Q (cfs)	Remarks
<b>10 Year Storm Event</b>																
1	A 1	109	470	0.23		10.00	10.00	2.61	-	0.70	0.90	0.90	0.63	0.63	1.65	Total Flow to AD-1, SD-1, Swale-1
2	A 2					5.00	5.00	3.71	-	0.90	0.37	0.37	0.33	0.33	1.22	Total Flow through Downspouts
3	A 3	5	120	0.04		8.00	8.00	2.92	-	0.82	0.33	0.33	0.27	0.27	0.78	Overland Flow to Bioswale-1
3						8.00	8.00	2.92			Combines A2 & A3			1.75	Total Flow to Bioswale-1	
14	A 13	12	250	0.05		10.00	10.00	2.61	-	0.70	0.348	0.348	0.244	0.244	0.64	Overland Flow to Ex Swale, Ex DI
14						10.00	10.00	2.61			Combines A1 - A3, A13			3.85	Total Flow to Ex Swale, Ex DI	
4	A 4					5.00	5.00	3.71	-	0.90	0.36	0.36	0.32	0.32	1.19	Total Flow through Downspouts
5	A 5	6	165	0.04		9.00	9.00	2.76	-	0.83	0.14	0.14	0.11	0.11	0.31	Overland Flow to Bioswale-2
5						9.00	9.00	2.76			Combines A4 - A5			1.20	Total Flow to Bioswale-2, DI-1, SD-2	
6	A 6	19	175	0.11		8.00	8.00	2.92	-	0.84	0.085	0.085	0.072	0.072	0.21	Overland Flow to DI-2, SD-3
6						9.00	9.00	2.76			Combines A4 - A6			1.40	Total Flow to SD-3	
7	A 7					5.00	5.00	3.71	-	0.72	0.123	0.123	0.088	0.088	0.33	Total Flow to AD-2, SD-4
8	A 8					5.00	5.00	3.71	-	0.90	0.061	0.061	0.055	0.055	0.20	Overland Flow to Trench Drain-1, SD-5
8						5.00	5.00	3.71			Combines A7 - A8			0.53	Total Flow to SD-5	
9	A 9					5.00	5.00	3.71	-	0.73	0.080	0.080	0.058	0.058	0.21	Total Flow to Trench Drain-2, AD-3, SD-6
9						5.00	5.00	3.71			Combines A7 - A9			0.74	Total Flow to SD-7	
10	A 10	26	280	0.09		8.00	8.00	2.92	-	0.87	0.180	0.180	0.156	0.156	0.46	Overland Flow To DI-4, SD-10
11	A 11	171	800	0.21		12.00	12.00	2.38	-	0.70	1.412	1.412	0.988	0.988	2.36	Total Flow to Swale-2, DI-5, SD-8
12						12.00	12.00	2.38			Combines A4 - A6, A11			3.56	Total Flow to SD-9	
12						12.00	12.00	2.38			Combines A4 - A11			4.41	Total Flow to SD-10	
13	A 12	215	780	0.28		12.00	12.00	2.38	-	0.70	2.223	2.223	1.556	1.556	3.71	Overland Flow to Ex 15" SD
13						12.00	12.00	2.38			Combines A4 - A12			8.13	Total Flow to Ex 15" SD	

**POST CONSTRUCTION RUNOFF COEFFICIENT**

Area Number	A <sub>T</sub>	A <sub>V</sub>	A <sub>G</sub>	A <sub>P</sub>	C <sub>T</sub>
A 1	0.90	0.90	0.00	0.00	0.70
A 2	0.37	0.00	0.00	0.37	0.90
A 3	0.33	0.14	0.00	0.19	0.82
A 4	0.36	0.00	0.00	0.36	0.90
A 5	0.14	0.05	0.00	0.09	0.83
A 6	0.09	0.03	0.00	0.06	0.84
A 7	0.12	0.11	0.00	0.01	0.72
A 8	0.06	0.00	0.00	0.06	0.90
A 9	0.08	0.07	0.00	0.01	0.73
A 10	0.18	0.03	0.00	0.15	0.87
A 11	1.41	1.41	0.00	0.00	0.70
A 12	2.22	2.22	0.00	0.00	0.70
A 13	0.35	0.35	0.00	0.00	0.70

**NOTE:**

Vegetated area : C<sub>V</sub> = 0.70  
 Residential area : C<sub>P</sub> = 0.90  
 Mixed area : C = (A<sub>V</sub> / SA)\*C<sub>V</sub>+ (A<sub>P</sub> / SA)\*C<sub>P</sub>+(A<sub>G</sub>/SA)\*C<sub>G</sub>

**Time of Concentration Equation**

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

C = Runoff Coefficient \*

L = Longest run in feet

$$S = \text{Average Slope in ft/ft} = \frac{\Delta H}{L}$$

**Rainfall Intensity vs Duration**

$$I = 8.34 / t^{0.50}$$

**Rational Method Drainage Study**  
**100-Yr Storm Event Post Construction**

Project: 24114-Spirit Living Group Senior Housing

Date: 5/29/2025

Point of Concentration	Area	Δ Elev.	Distance	Slope	V(ft/s)	Travel Time (min)	Total Time (min)	I	K	C	A	A <sub>total</sub>	AC	Sum AC	Q (cfs)	Remarks
<b>100 Year Storm Event</b>																
1	A 1	109	470	0.23		10.00	10.00	4.25	-	0.70	0.90	0.90	0.63	0.63	2.68	Total Flow to AD-1, SD-1, Swale-1
2	A 2					5.00	5.00	6.03	-	0.90	0.37	0.37	0.33	0.33	1.99	Total Flow through Downspouts
3	A 3	5	120	0.04		8.00	8.00	4.75	-	0.82	0.33	0.33	0.27	0.27	1.27	Overland Flow to Bioswale-1
3						8.00	8.00	4.75			Combines A2 & A3			2.84	Total Flow to Bioswale-1	
14	A 13	12	250	0.05		10.00	10.00	4.25	-	0.70	0.348	0.348	0.244	0.244	1.04	Overland Flow to Ex Swale, Ex DI
14						10.00	10.00	4.25			Combines A1 - A3, A13			6.26	Total Flow to Ex Swale, Ex DI	
4	A 4					5.00	5.00	6.03	-	0.90	0.36	0.36	0.32	0.32	1.94	Total Flow through Downspouts
5	A 5	6	165	0.04		9.00	9.00	4.48	-	0.83	0.14	0.14	0.11	0.11	0.51	Overland Flow to Bioswale-2
5						9.00	9.00	4.48			Combines A4 - A5			1.95	Total Flow to Bioswale-2, DI-1, SD-2	
6	A 6	19	175	0.11		8.00	8.00	4.75	-	0.84	0.085	0.085	0.072	0.072	0.34	Overland Flow to DI-2, SD-3
6						9.00	9.00	4.48			Combines A4 - A6			2.27	Total Flow to SD-3	
7	A 7					5.00	5.00	6.03	-	0.72	0.123	0.123	0.088	0.088	0.53	Total Flow to AD-2, SD-4
8	A 8					5.00	5.00	6.03	-	0.90	0.061	0.061	0.055	0.055	0.33	Overland Flow to Trench Drain-1, SD-5
8						5.00	5.00	6.03			Combines A7 - A8			0.86	Total Flow to SD-5	
9	A 9					5.00	5.00	6.03	-	0.73	0.080	0.080	0.058	0.058	0.35	Total Flow to Trench Drain-2, AD-3, SD-6
9						5.00	5.00	6.03			Combines A7 - A9			1.21	Total Flow to SD-7	
10	A 10	26	280	0.09		8.00	8.00	4.75	-	0.87	0.180	0.180	0.156	0.156	0.74	Overland Flow To DI-4, SD-10
11	A 11	171	800	0.21		12.00	12.00	3.88	-	0.70	1.412	1.412	0.988	0.988	3.83	Total Flow to Swale-2, DI-5, SD-8
12						12.00	12.00	3.88			Combines A4 - A6, A11			5.80	Total Flow to SD-9	
12						12.00	12.00	3.88			Combines A4 - A11			7.18	Total Flow to SD-10	
13	A 12	215	780	0.28		12.00	12.00	3.88	-	0.70	2.223	2.223	1.556	1.556	6.03	Overland Flow to Ex 15" SD
13						12.00	12.00	3.88			Combines A4 - A12			13.21	Total Flow to Ex 15" SD	

**POST CONSTRUCTION RUNOFF COEFFICIENT**

Area Number	A <sub>T</sub>	A <sub>V</sub>	A <sub>G</sub>	A <sub>P</sub>	C <sub>T</sub>
A 1	0.90	0.90	0.00	0.00	0.70
A 2	0.37	0.00	0.00	0.37	0.90
A 3	0.33	0.14	0.00	0.19	0.82
A 4	0.36	0.00	0.00	0.36	0.90
A 5	0.14	0.05	0.00	0.09	0.83
A 6	0.09	0.03	0.00	0.06	0.84
A 7	0.12	0.11	0.00	0.01	0.72
A 8	0.06	0.00	0.00	0.06	0.90
A 9	0.08	0.07	0.00	0.01	0.73
A 10	0.18	0.03	0.00	0.15	0.87
A 11	1.41	1.41	0.00	0.00	0.70
A 12	2.22	2.22	0.00	0.00	0.70
A 13	0.35	0.35	0.00	0.00	0.70

**NOTE:**

Vegetated area : C<sub>V</sub> = 0.70  
 Residential area : C<sub>P</sub> = 0.90  
 Mixed area : C = (A<sub>V</sub> / SA)\*C<sub>V</sub>+ (A<sub>P</sub> / SA)\*C<sub>P</sub>+(A<sub>G</sub>/SA)\*C<sub>G</sub>

**Time of Concentration Equation**

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

C = Runoff Coefficient \*

L = Longest run in feet

$$S = \text{Average Slope in ft/ft} = \frac{\Delta H}{L}$$

**Rainfall Intensity vs Duration**

$$I = 13.56 / t^{0.50}$$

# Intensity Duration Frequency Curve (IDF Curve)

NOAA Atlas 14 Point Precipitation Frequency Estimates

[https://hdsc.nws.noaa.gov/hdsc/pfds/pfds\\_map\\_cont.html](https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html)

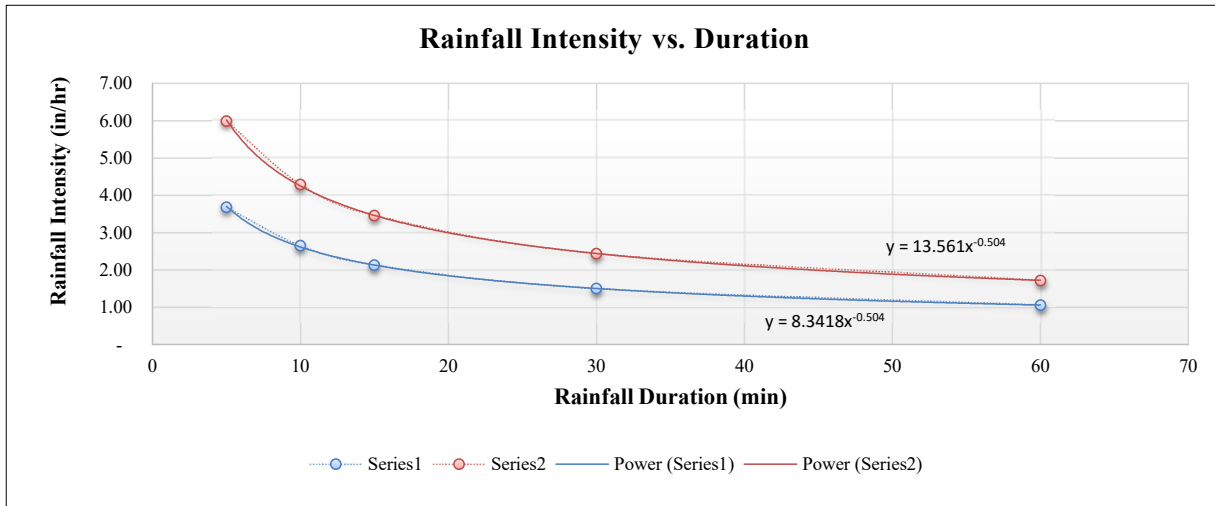
**Project:** Spirit Living Group

**JN:** 24114

**Date:** 5/29/2025

**Designer:** KM

**Location:** Mill Valley, CA



NOAA Atlas 14 Data Rainfall Intensity (in/hr)		
Duration (min)	10-yr	100-yr
5	3.68	5.99
10	2.65	4.29
15	2.13	3.46
30	1.50	2.44
60	1.06	1.72

### Rainfall Intensity vs Duration

$$I = a * t^b$$

I = intensity (in/hour)

t = time of concentration/ rainfall duration (minutes)

10-Year Trendline Values	
a =	8.342
b =	-0.504

100-Year Trendline Values	
a =	13.561
b =	-0.504



**NOAA Atlas 14, Volume 6, Version 2**  
**Location name: Mill Valley, California, USA\***  
**Latitude: 37.9057°, Longitude: -122.5117°**  
**Elevation: 162 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 & aeriels](#)

**PF tabular**

<b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)<sup>1</sup></b>										
<b>Duration</b>	<b>Average recurrence interval (years)</b>									
	<b>1</b>	<b>2</b>	<b>5</b>	<b>10</b>	<b>25</b>	<b>50</b>	<b>100</b>	<b>200</b>	<b>500</b>	<b>1000</b>
<b>5-min</b>	<b>1.94</b> (1.73-2.20)	<b>2.42</b> (2.16-2.75)	<b>3.11</b> (2.75-3.53)	<b>3.68</b> (3.24-4.25)	<b>4.54</b> (3.83-5.44)	<b>5.23</b> (4.31-6.43)	<b>5.99</b> (4.78-7.57)	<b>6.80</b> (5.26-8.90)	<b>7.98</b> (5.87-11.0)	<b>8.96</b> (6.32-12.8)
<b>10-min</b>	<b>1.39</b> (1.24-1.58)	<b>1.74</b> (1.55-1.97)	<b>2.23</b> (1.97-2.53)	<b>2.65</b> (2.32-3.04)	<b>3.25</b> (2.74-3.90)	<b>3.76</b> (3.08-4.61)	<b>4.29</b> (3.43-5.43)	<b>4.87</b> (3.76-6.38)	<b>5.72</b> (4.20-7.87)	<b>6.42</b> (4.53-9.19)
<b>15-min</b>	<b>1.12</b> (1.00-1.27)	<b>1.40</b> (1.25-1.59)	<b>1.79</b> (1.59-2.04)	<b>2.13</b> (1.87-2.45)	<b>2.62</b> (2.21-3.14)	<b>3.03</b> (2.49-3.72)	<b>3.46</b> (2.76-4.38)	<b>3.93</b> (3.03-5.14)	<b>4.61</b> (3.39-6.34)	<b>5.18</b> (3.65-7.41)
<b>30-min</b>	<b>0.790</b> (0.704-0.894)	<b>0.986</b> (0.878-1.12)	<b>1.26</b> (1.12-1.44)	<b>1.50</b> (1.32-1.73)	<b>1.85</b> (1.56-2.21)	<b>2.13</b> (1.75-2.62)	<b>2.44</b> (1.95-3.08)	<b>2.77</b> (2.14-3.62)	<b>3.25</b> (2.39-4.47)	<b>3.65</b> (2.57-5.22)
<b>60-min</b>	<b>0.556</b> (0.496-0.630)	<b>0.695</b> (0.619-0.789)	<b>0.890</b> (0.789-1.01)	<b>1.06</b> (0.929-1.22)	<b>1.30</b> (1.10-1.56)	<b>1.50</b> (1.24-1.85)	<b>1.72</b> (1.37-2.17)	<b>1.95</b> (1.51-2.55)	<b>2.29</b> (1.68-3.15)	<b>2.57</b> (1.81-3.68)
<b>2-hr</b>	<b>0.409</b> (0.364-0.463)	<b>0.508</b> (0.452-0.577)	<b>0.650</b> (0.576-0.740)	<b>0.773</b> (0.679-0.889)	<b>0.954</b> (0.804-1.14)	<b>1.10</b> (0.908-1.36)	<b>1.27</b> (1.01-1.60)	<b>1.45</b> (1.12-1.89)	<b>1.71</b> (1.26-2.35)	<b>1.93</b> (1.36-2.76)
<b>3-hr</b>	<b>0.346</b> (0.308-0.392)	<b>0.429</b> (0.382-0.487)	<b>0.548</b> (0.486-0.624)	<b>0.652</b> (0.573-0.750)	<b>0.805</b> (0.679-0.965)	<b>0.932</b> (0.766-1.15)	<b>1.07</b> (0.855-1.36)	<b>1.22</b> (0.944-1.60)	<b>1.45</b> (1.06-1.99)	<b>1.63</b> (1.15-2.34)
<b>6-hr</b>	<b>0.251</b> (0.223-0.284)	<b>0.312</b> (0.278-0.355)	<b>0.399</b> (0.354-0.455)	<b>0.474</b> (0.416-0.546)	<b>0.584</b> (0.493-0.700)	<b>0.675</b> (0.555-0.830)	<b>0.773</b> (0.617-0.979)	<b>0.880</b> (0.680-1.15)	<b>1.04</b> (0.762-1.42)	<b>1.17</b> (0.823-1.67)
<b>12-hr</b>	<b>0.170</b> (0.151-0.192)	<b>0.216</b> (0.192-0.245)	<b>0.279</b> (0.247-0.317)	<b>0.332</b> (0.291-0.382)	<b>0.408</b> (0.344-0.488)	<b>0.468</b> (0.385-0.576)	<b>0.533</b> (0.425-0.674)	<b>0.601</b> (0.464-0.787)	<b>0.698</b> (0.513-0.960)	<b>0.777</b> (0.548-1.11)
<b>24-hr</b>	<b>0.113</b> (0.102-0.128)	<b>0.146</b> (0.131-0.166)	<b>0.190</b> (0.171-0.216)	<b>0.227</b> (0.202-0.260)	<b>0.279</b> (0.241-0.329)	<b>0.319</b> (0.271-0.384)	<b>0.361</b> (0.299-0.444)	<b>0.405</b> (0.328-0.512)	<b>0.467</b> (0.363-0.612)	<b>0.516</b> (0.389-0.698)
<b>2-day</b>	<b>0.076</b> (0.068-0.086)	<b>0.097</b> (0.087-0.110)	<b>0.126</b> (0.113-0.143)	<b>0.150</b> (0.133-0.172)	<b>0.183</b> (0.158-0.216)	<b>0.210</b> (0.178-0.253)	<b>0.237</b> (0.197-0.292)	<b>0.267</b> (0.215-0.337)	<b>0.307</b> (0.239-0.403)	<b>0.340</b> (0.256-0.460)
<b>3-day</b>	<b>0.058</b> (0.053-0.066)	<b>0.074</b> (0.067-0.084)	<b>0.096</b> (0.086-0.109)	<b>0.113</b> (0.101-0.130)	<b>0.139</b> (0.120-0.164)	<b>0.159</b> (0.134-0.191)	<b>0.179</b> (0.149-0.221)	<b>0.202</b> (0.163-0.255)	<b>0.233</b> (0.181-0.305)	<b>0.258</b> (0.194-0.349)
<b>4-day</b>	<b>0.049</b> (0.044-0.055)	<b>0.062</b> (0.055-0.070)	<b>0.079</b> (0.071-0.090)	<b>0.094</b> (0.084-0.108)	<b>0.115</b> (0.099-0.135)	<b>0.131</b> (0.111-0.158)	<b>0.148</b> (0.123-0.183)	<b>0.167</b> (0.135-0.210)	<b>0.192</b> (0.149-0.252)	<b>0.213</b> (0.160-0.288)

<b>7-day</b>	<b>0.034</b> (0.030-0.038)	<b>0.043</b> (0.038-0.048)	<b>0.055</b> (0.049-0.063)	<b>0.065</b> (0.058-0.075)	<b>0.079</b> (0.068-0.094)	<b>0.091</b> (0.077-0.109)	<b>0.102</b> (0.085-0.126)	<b>0.114</b> (0.092-0.145)	<b>0.132</b> (0.102-0.173)	<b>0.145</b> (0.110-0.197)
<b>10-day</b>	<b>0.027</b> (0.025-0.031)	<b>0.035</b> (0.031-0.040)	<b>0.045</b> (0.040-0.051)	<b>0.053</b> (0.047-0.061)	<b>0.065</b> (0.056-0.076)	<b>0.073</b> (0.062-0.088)	<b>0.083</b> (0.068-0.102)	<b>0.092</b> (0.074-0.117)	<b>0.105</b> (0.082-0.138)	<b>0.116</b> (0.087-0.157)
<b>20-day</b>	<b>0.018</b> (0.016-0.020)	<b>0.023</b> (0.020-0.026)	<b>0.029</b> (0.026-0.033)	<b>0.035</b> (0.031-0.040)	<b>0.042</b> (0.036-0.049)	<b>0.047</b> (0.040-0.057)	<b>0.052</b> (0.043-0.065)	<b>0.058</b> (0.047-0.073)	<b>0.065</b> (0.051-0.086)	<b>0.071</b> (0.053-0.096)
<b>30-day</b>	<b>0.014</b> (0.013-0.016)	<b>0.018</b> (0.017-0.021)	<b>0.024</b> (0.021-0.027)	<b>0.028</b> (0.025-0.032)	<b>0.033</b> (0.029-0.039)	<b>0.037</b> (0.032-0.045)	<b>0.041</b> (0.034-0.051)	<b>0.045</b> (0.036-0.057)	<b>0.050</b> (0.039-0.066)	<b>0.054</b> (0.041-0.074)
<b>45-day</b>	<b>0.012</b> (0.010-0.013)	<b>0.015</b> (0.014-0.017)	<b>0.019</b> (0.017-0.022)	<b>0.023</b> (0.020-0.026)	<b>0.027</b> (0.023-0.032)	<b>0.030</b> (0.025-0.036)	<b>0.033</b> (0.027-0.040)	<b>0.036</b> (0.029-0.045)	<b>0.039</b> (0.030-0.052)	<b>0.042</b> (0.031-0.057)
<b>60-day</b>	<b>0.010</b> (0.009-0.012)	<b>0.014</b> (0.012-0.015)	<b>0.017</b> (0.015-0.020)	<b>0.020</b> (0.018-0.023)	<b>0.024</b> (0.020-0.028)	<b>0.026</b> (0.022-0.031)	<b>0.028</b> (0.023-0.035)	<b>0.031</b> (0.025-0.039)	<b>0.034</b> (0.026-0.044)	<b>0.036</b> (0.027-0.048)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

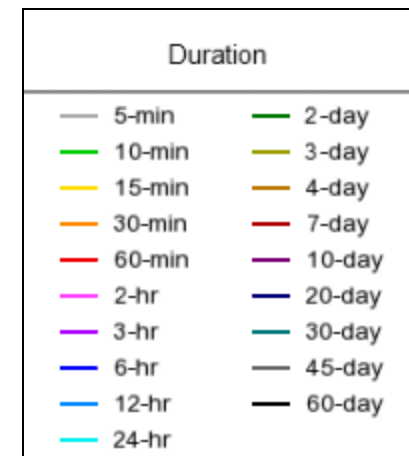
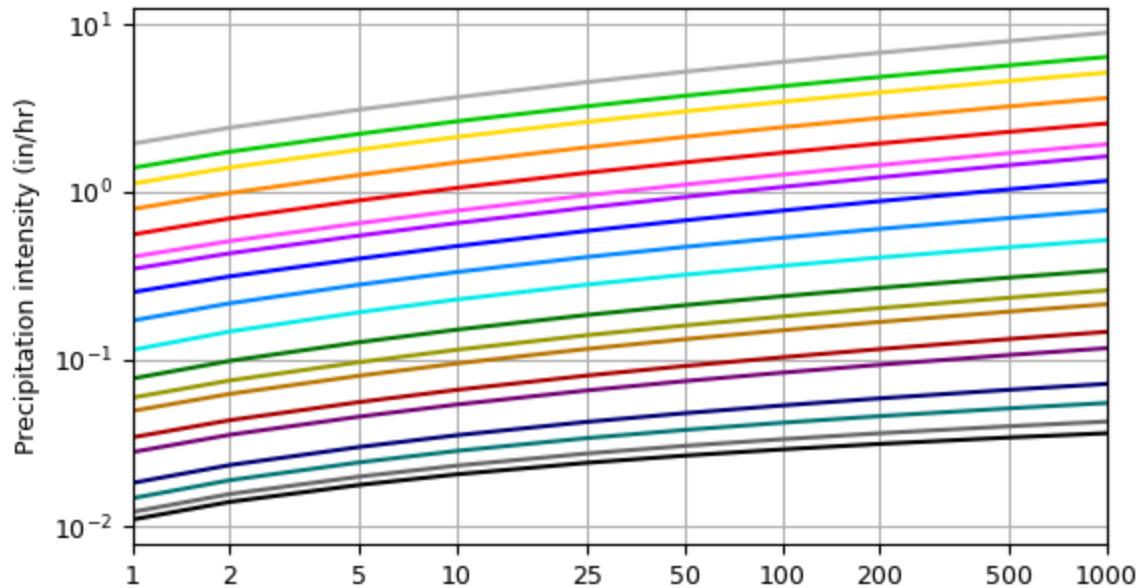
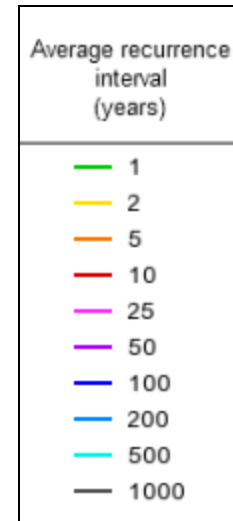
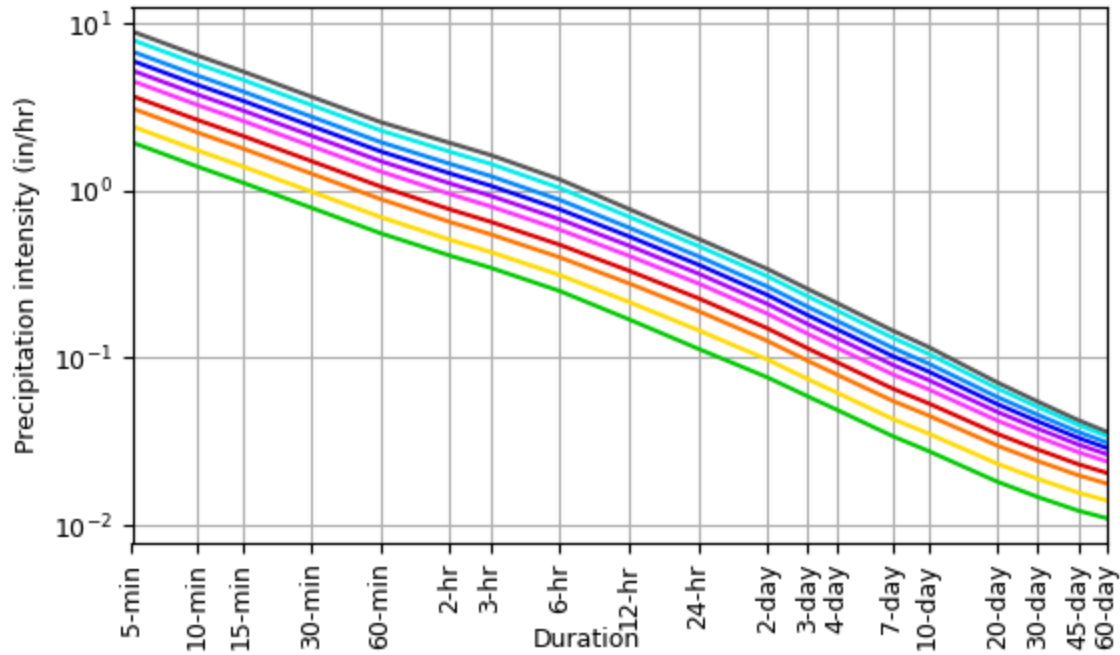
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper 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.

[Back to Top](#)

**PF graphical**

PDS-based intensity-duration-frequency (IDF) curves  
 Latitude: 37.9057°, Longitude: -122.5117°



Average recurrence interval (years)

[Back to Top](#)

## Maps & aerials

Small scale terrain



Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

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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](mailto:HDSC.Questions@noaa.gov)

[Disclaimer](#)

## **8. Inlet Capacity Calculations**

# Inlet Capacity Calculations

**10-Year Storm Event  
Post Construction**

**Project:** Spirit Living Group Senior Housing

**Date:** 5/29/2025

**JN:** 24114

Structure	p or b (ft)	Q (cfs)	H (ft)	GR Elev.	Ponding Elev.	Grate Notes
DI-2	4.00	1.20	0.22	135.35	135.57	Oldcastle Model DI-2424
DI-3	4.00	0.21	0.07	128.73	128.80	Oldcastle Model DI-2424
AD-1	1.57	0.33	0.17	140.09	140.26	6" Area Drain
AD-2	1.57	0.21	0.13	178.34	178.47	6" Area Drain
Trench Drain-1	420.00	0.20	0.00	178.34	178.34	420 LF Trench Drain
Trench Drain-2	27.00	0.21	0.02	178.34	178.36	27 LF Trench Drain

**Grate Equation:**

Flow through top grate:  $H = (Q/3.0*p)^{2/3}$

**Where:** p = 1/2 grate perimeter (ft)

H = water depth (ft) from top grate

Structure	p or b (ft)	Q (cfs)	h (ft)	SO Elev.	Ponding Elev.	Side Opening Notes
DI-1	1.50	1.65	0.48	179.75	180.23	24" x 24" Drop Inlet w/ 18" Side Opening. Top grate @ 180.25 GR; Side Opening @ 179.75 SO.
DI-4	1.50	0.46	0.20	127.50	127.70	24" x 24" Drop Inlet w/ 18" Side Opening. Top grate @ 127.75 GR; Side Opening @ 127.50 SO.
DI-5	1.50	2.36	0.61	169.25	169.86	24" x 24" Drop Inlet w/ 18" Side Opening. Top grate @ 170.00 GR; Side Opening @ 169.25 SO.

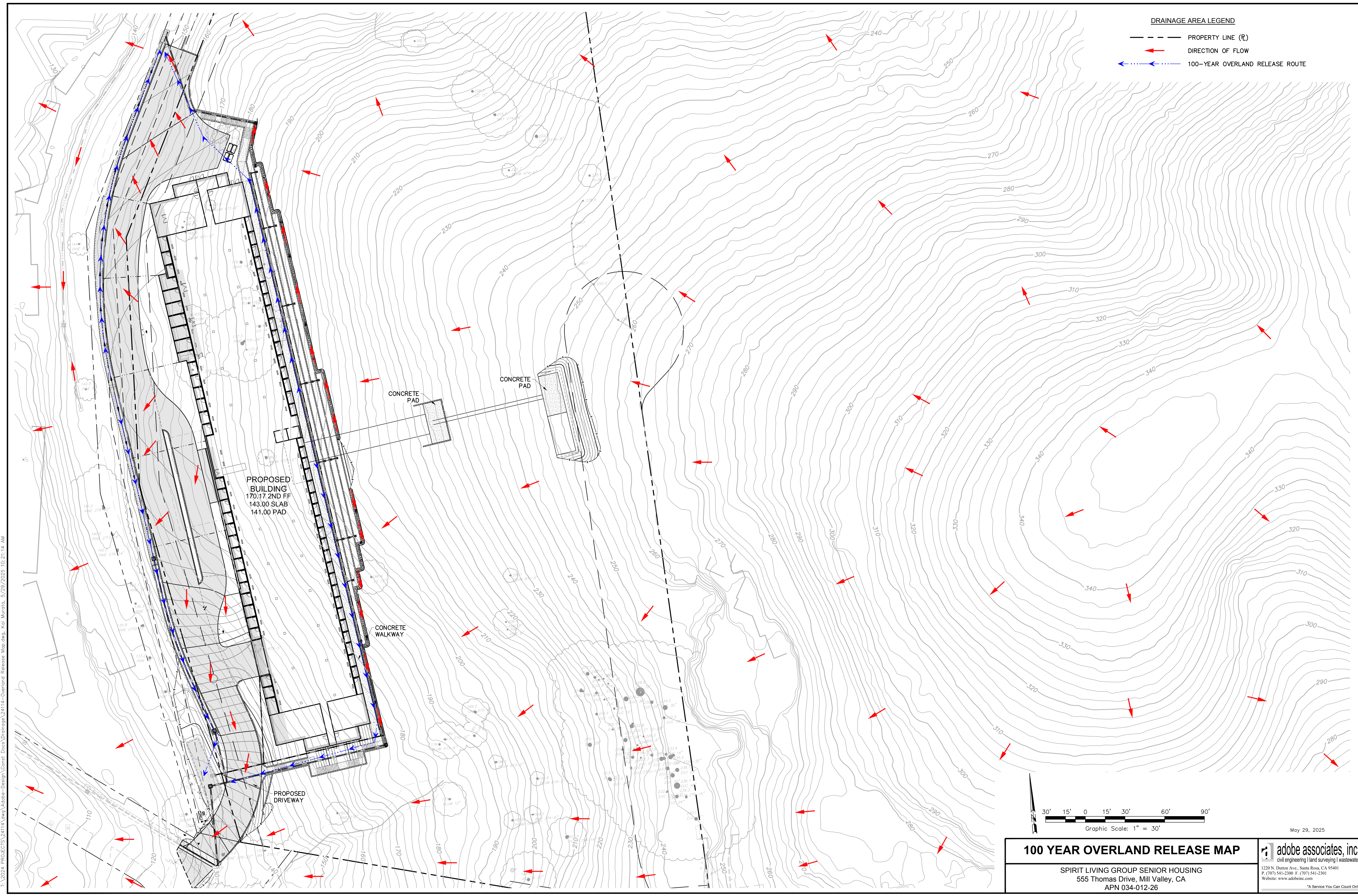
**Side Opening Equation:**

Flow through side opening:  $h = [ Q / (3.33*b) ]^{2/3}$

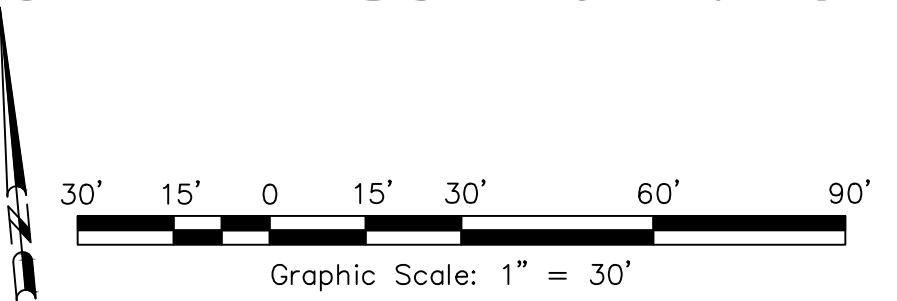
**Where:** b = length of opening (ft)

h = water depth (ft) from opening flow line

## **9. Overland Release Map**



I:\2024 PROJ\ECTS\24114\eng\Adobe-Design\Cons\Docs\Drainage\24114-Overland\_Release\_Map.dwg, Koi Morata, 5/29/2025 10:21:14 AM



May 29, 2025

**100 YEAR OVERLAND RELEASE MAP**

**SPIRIT LIVING GROUP SENIOR HOUSING**  
555 Thomas Drive, Mill Valley, CA  
APN 034-012-26

**adobe associates, inc.**  
civil engineering | land surveying | wastewater  
1220 N. Dutton Ave., Santa Rosa, CA 95401  
P: (707) 541-2300 F: (707) 541-2301  
Website: www.adobeinc.com  
"A Service You Can Count On"

# **Appendix I**

## **Stormdrain/ Swale Analysis**

# Hydraulic Analysis Report

## Project Data

Project Title: 24114-Hydraulic Analysis

Designer:

Project Date: Friday, May 30, 2025

Project Units: U.S. Customary Units

Notes:

## Channel Analysis: SD-1

Notes:

## Input Parameters

Channel Type: Circular

Pipe Diameter: 1.0000 ft

Longitudinal Slope: 0.0500 ft/ft

Manning's n: 0.0120

Flow: 1.6500 cfs

## Result Parameters

Depth: 0.2963 ft

Area of Flow: 0.1948 ft<sup>2</sup>

Wetted Perimeter: 1.1512 ft

Hydraulic Radius: 0.1692 ft

Average Velocity: 8.4711 ft/s

Top Width: 0.9132 ft

Froude Number: 3.2325

Critical Depth: 0.5459 ft

Critical Velocity: 3.7625 ft/s

Critical Slope: 0.0055 ft/ft

Critical Top Width: 1.00 ft

Calculated Max Shear Stress: 0.9244 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.5279 lb/ft<sup>2</sup>

# Tee Dissipater Calculator

**Project:** Spirit Living Group Senior Housing  
**JN:** 24114

**Date:** 5/30/2025

## Equations

+ Flow rate thru perforations (cfs/lf):

$$q = C_d \times A \times \sqrt{2 \times g \times h}$$

+ Perforated pipe capacity (cfs):

$$Q = L \times q$$

where:

**q** = flow rate per pipe linear feet (cfs/lf)

**C<sub>d</sub>** = orifice discharge coefficient, **0.6**

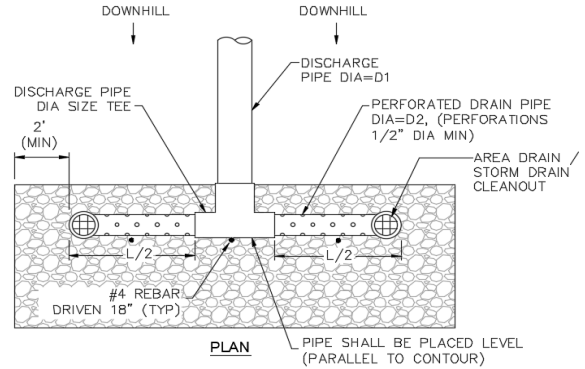
**A** = orifice area per pipe linear feet (ft<sup>2</sup>/lf)

**g** = acceleration of gravity (ft/s<sup>2</sup>), **32.2**

**h** = hydraulic head (ft), h=0.75\*D for two downward-facing holes in 3-hole patterns.

**L** = pipe length (lf)

**Q** = perforated pipe capacity (cfs)



## PERFORATED PIPE ENERGY DISSIPATER

NTS

## Dissipater Capacity

### Calculate Dissipater for **SD-1**

<b>Design Flow (Q<sub>10</sub>) =</b>	<b>1.65</b> cfs
<b>Discharge Pipe Size (D1) =</b>	<b>12</b> -inch
<b>Perf Pipe Size (D2) =</b>	<b>12</b> -inch
<b>Perforated Pipe Length (L) =</b>	<b>14</b> lf
<b>Perforation Hole Diameter (d) =</b>	<b>0.500</b> -inch
<b>Perforation Hole per Pipe Length =</b>	<b>24</b> (hole/lf, 3 rows/lf - calculate for only 2 downward-facing holes/r
<b>Orifice Area (A) =</b>	<b>0.0327</b> (ft <sup>2</sup> /lf)
<b>Flow Rate (q) =</b>	<b>0.136</b> cfs/lf
<b>Perforated Pipe Capacity (Q) =</b>	<b>1.91</b> cfs

Updated: July 16, 2020

\\fs01\Company\2024 PROJECTS\24114\Reports\Drainage\Drainage\[24114-Tee Dissipater Calculator.xlsx]SD-4

## Channel Analysis: SD-2

Notes:

### Input Parameters

Channel Type: Circular

Pipe Diameter: 0.6700 ft

Longitudinal Slope: 0.1200 ft/ft

Manning's n: 0.0120

Flow: 1.2000 cfs

### Result Parameters

Depth: 0.2336 ft

Area of Flow: 0.1094 ft<sup>2</sup>

Wetted Perimeter: 0.8465 ft

Hydraulic Radius: 0.1293 ft

Average Velocity: 10.9663 ft/s

Top Width: 0.6386 ft

Froude Number: 4.6686

Critical Depth: 0.5182 ft

Critical Velocity: 4.1011 ft/s

Critical Slope: 0.0092 ft/ft

Critical Top Width: 0.56 ft

Calculated Max Shear Stress: 1.7495 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.9680 lb/ft<sup>2</sup>

## Channel Analysis: SD-3

Notes:

### Input Parameters

Channel Type: Circular

Pipe Diameter: 1.0000 ft

Longitudinal Slope: 0.0760 ft/ft

Manning's n: 0.0120

Flow: 1.4000 cfs

### Result Parameters

Depth: 0.2450 ft

Area of Flow: 0.1492 ft<sup>2</sup>

Wetted Perimeter: 1.0356 ft

Hydraulic Radius: 0.1441 ft

Average Velocity: 9.3827 ft/s

Top Width: 0.8601 ft

Froude Number: 3.9699

Critical Depth: 0.5005 ft

Critical Velocity: 3.5606 ft/s

Critical Slope: 0.0052 ft/ft

Critical Top Width: 1.00 ft

Calculated Max Shear Stress: 1.1618 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.6833 lb/ft<sup>2</sup>

## Channel Analysis: SD-4

Notes:

### Input Parameters

Channel Type: Circular

Pipe Diameter: 0.5000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0120

Flow: 0.3300 cfs

### Result Parameters

Depth: 0.2626 ft

Area of Flow: 0.1045 ft<sup>2</sup>

Wetted Perimeter: 0.8105 ft

Hydraulic Radius: 0.1289 ft

Average Velocity: 3.1593 ft/s

Top Width: 0.4994 ft

Froude Number: 1.2173

Critical Depth: 0.2910 ft

Critical Velocity: 2.7827 ft/s

Critical Slope: 0.0072 ft/ft

Critical Top Width: 0.49 ft

Calculated Max Shear Stress: 0.1638 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.0804 lb/ft<sup>2</sup>

## Channel Analysis: SD-5

Notes:

### Input Parameters

Channel Type: Circular

Pipe Diameter: 0.5000 ft

Longitudinal Slope: 0.3000 ft/ft

Manning's n: 0.0120

Flow: 0.5300 cfs

### Result Parameters

Depth: 0.1349 ft

Area of Flow: 0.0427 ft<sup>2</sup>

Wetted Perimeter: 0.5462 ft

Hydraulic Radius: 0.0782 ft

Average Velocity: 12.4049 ft/s

Top Width: 0.4438 ft

Froude Number: 7.0460

Critical Depth: 0.3711 ft

Critical Velocity: 3.3917 ft/s

Critical Slope: 0.0094 ft/ft

Critical Top Width: 0.44 ft

Calculated Max Shear Stress: 2.5252 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 1.4644 lb/ft<sup>2</sup>

## Channel Analysis: SD-6

Notes:

### Input Parameters

Channel Type: Circular

Pipe Diameter: 0.5000 ft

Longitudinal Slope: 0.0200 ft/ft

Manning's n: 0.0120

Flow: 0.2100 cfs

### Result Parameters

Depth: 0.1683 ft

Area of Flow: 0.0581 ft<sup>2</sup>

Wetted Perimeter: 0.6190 ft

Hydraulic Radius: 0.0938 ft

Average Velocity: 3.6162 ft/s

Top Width: 0.4726 ft

Froude Number: 1.8179

Critical Depth: 0.2297 ft

Critical Velocity: 2.3849 ft/s

Critical Slope: 0.0064 ft/ft

Critical Top Width: 0.50 ft

Calculated Max Shear Stress: 0.2101 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.1171 lb/ft<sup>2</sup>

## Channel Analysis: SD-7

Notes:

### Input Parameters

Channel Type: Circular

Pipe Diameter: 0.5000 ft

Longitudinal Slope: 0.0400 ft/ft

Manning's n: 0.0120

Flow: 0.7400 cfs

### Result Parameters

Depth: 0.2817 ft

Area of Flow: 0.1140 ft<sup>2</sup>

Wetted Perimeter: 0.8489 ft

Hydraulic Radius: 0.1342 ft

Average Velocity: 6.4933 ft/s

Top Width: 0.4960 ft

Froude Number: 2.3872

Critical Depth: 0.4316 ft

Critical Velocity: 4.1064 ft/s

Critical Slope: 0.0137 ft/ft

Critical Top Width: 0.34 ft

Calculated Max Shear Stress: 0.7030 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.3351 lb/ft<sup>2</sup>

## Channel Analysis: SD-8

Notes:

### Input Parameters

Channel Type: Circular

Pipe Diameter: 1.0000 ft

Longitudinal Slope: 0.3000 ft/ft

Manning's n: 0.0120

Flow: 2.3600 cfs

### Result Parameters

Depth: 0.2256 ft

Area of Flow: 0.1328 ft<sup>2</sup>

Wetted Perimeter: 0.9899 ft

Hydraulic Radius: 0.1341 ft

Average Velocity: 17.7739 ft/s

Top Width: 0.8360 ft

Froude Number: 7.8593

Critical Depth: 0.6572 ft

Critical Velocity: 4.3121 ft/s

Critical Slope: 0.0063 ft/ft

Critical Top Width: 0.95 ft

Calculated Max Shear Stress: 4.2233 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 2.5110 lb/ft<sup>2</sup>

## Channel Analysis: SD-9

Notes:

### Input Parameters

Channel Type: Circular

Pipe Diameter: 1.0000 ft

Longitudinal Slope: 0.3000 ft/ft

Manning's n: 0.0120

Flow: 3.5600 cfs

### Result Parameters

Depth: 0.2776 ft

Area of Flow: 0.1779 ft<sup>2</sup>

Wetted Perimeter: 1.1099 ft

Hydraulic Radius: 0.1603 ft

Average Velocity: 20.0120 ft/s

Top Width: 0.8957 ft

Froude Number: 7.9132

Critical Depth: 0.8057 ft

Critical Velocity: 5.2501 ft/s

Critical Slope: 0.0088 ft/ft

Critical Top Width: 0.79 ft

Calculated Max Shear Stress: 5.1972 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 3.0004 lb/ft<sup>2</sup>

## Channel Analysis: SD-10

Notes:

### Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0120

Flow: 4.4100 cfs

### Result Parameters

Depth: 0.6481 ft

Area of Flow: 0.7313 ft<sup>2</sup>

Wetted Perimeter: 2.1519 ft

Hydraulic Radius: 0.3398 ft

Average Velocity: 6.0307 ft/s

Top Width: 1.4861 ft

Froude Number: 1.5151

Critical Depth: 0.8057 ft

Critical Velocity: 4.5605 ft/s

Critical Slope: 0.0047 ft/ft

Critical Top Width: 1.50 ft

Calculated Max Shear Stress: 0.4044 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.2121 lb/ft<sup>2</sup>

# RipRap Apron Sizing Calculations<sup>1</sup>

**Project:** Spirit Living Group Senior Housing  
**JN:** 24114

**Date:** 5/30/2025

## Equation 10.4

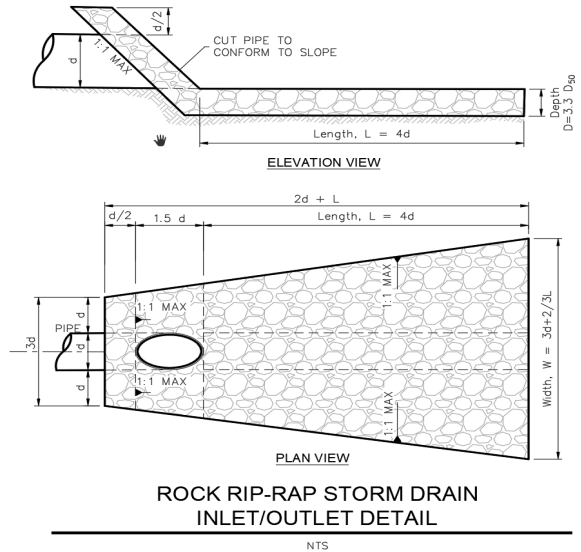
$$D_{50} = 0.2d \left( \frac{Q}{\sqrt{g}d^{2.5}} \right)^{4/3} \left( \frac{d}{Tw} \right)$$

**where:**

- D<sub>50</sub>** = riprap size (ft)
- Q** = design discharge (cfs)
- d** = culvert diameter (circular) (ft)
- Tw** = tailwater depth (ft)
- g** = acceleration of gravity (32.2 ft/s<sup>2</sup>)

## Minimum RipRap Size

<b>Sizing for :</b>	<b>SD-10</b>
Pipe Size (d) =	1.50 ft
Flow Rate (Q <sub>10</sub> ) =	4.41 cfs
Tailwater (Tw) <sup>2</sup> =	0.60 ft
Calculated D <sub>50</sub> =	0.14 ft



## Apron Design<sup>3</sup>

Class	D <sub>50</sub> (ft)	Apron Length (ft)	Apron Depth (ft)
1	0.53	4 d	3.5 D <sub>50</sub>
2	0.79	4 d	3.3 D <sub>50</sub>
3	1.06	5 d	2.4 D <sub>50</sub>
4	1.33	6 d	2.2 D <sub>50</sub>
5	1.56	7 d	2.0 D <sub>50</sub>
6	1.83	8 d	2.0 D <sub>50</sub>

\*Table 10.1 Example Riprap Classes and Apron Dimensions

## Apron Sizing

Specified Class =	1
D <sub>50</sub> =	0.53 ft
Apron Length (L) =	6.00 ft
Apron Depth (D) =	1.84 ft
Apron Width (W) <sup>4</sup> =	8.50 ft

### Notes:

- <sup>1</sup> The equations in this spreadsheet are from the Federal Highway Administration HEC 14 Method in the *Hydraulic Design of Energy Dissipators for Culverts and Channels*. (Page 10-17)
- <sup>2</sup> Tailwater depth (Tw) = 0.4d
- <sup>3</sup> Values Obtained from Table 10.1. Example RipRap Classes and Apron Dimensions
- <sup>4</sup> Width = 3d + (2/3)L

Updated: December 2020

\\fs01\Company\2024 PROJECTS\24114\Reports\Drainage\Drainage\24114-RipRap Apron Sizing Calculator.xlsx\SD-1

## Channel Analysis: Ex 15" SD

Notes:

### Input Parameters

Channel Type: Circular

Pipe Diameter: 1.2500 ft

Longitudinal Slope: 0.1700 ft/ft

Manning's n: 0.0120

Flow: 8.1300 cfs

### Result Parameters

Depth: 0.4539 ft

Area of Flow: 0.4024 ft<sup>2</sup>

Wetted Perimeter: 1.6169 ft

Hydraulic Radius: 0.2489 ft

Average Velocity: 20.2030 ft/s

Top Width: 1.2022 ft

Froude Number: 6.1538

Critical Depth: 1.1206 ft

Critical Velocity: 7.0086 ft/s

Critical Slope: 0.0119 ft/ft

Critical Top Width: 0.76 ft

Calculated Max Shear Stress: 4.8149 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 2.6402 lb/ft<sup>2</sup>

## Channel Analysis: Swale-1

Notes:

### Input Parameters

Channel Type: Triangular  
Side Slope 1 (Z1): 1.0000 ft/ft  
Side Slope 2 (Z2): 1.0000 ft/ft  
Longitudinal Slope: 0.0080 ft/ft  
Manning's n: 0.0150  
Flow: 1.6500 cfs

### Result Parameters

Depth: 0.6905 ft  
Area of Flow: 0.4767 ft<sup>2</sup>  
Wetted Perimeter: 1.9529 ft  
Hydraulic Radius: 0.2441 ft  
Average Velocity: 3.4610 ft/s  
Top Width: 1.3809 ft  
Froude Number: 1.0381  
Critical Depth: 0.7009 ft  
Critical Velocity: 3.3591 ft/s  
Critical Slope: 0.0074 ft/ft  
Critical Top Width: 1.40 ft  
Calculated Max Shear Stress: 0.3447 lb/ft<sup>2</sup>  
Calculated Avg Shear Stress: 0.1219 lb/ft<sup>2</sup>

## Channel Analysis: Swale-1

Notes:

### Input Parameters

Channel Type: Triangular  
Side Slope 1 (Z1): 1.0000 ft/ft  
Side Slope 2 (Z2): 1.0000 ft/ft  
Longitudinal Slope: 0.5000 ft/ft  
Manning's n: 0.0150  
Flow: 1.6500 cfs

### Result Parameters

Depth: 0.3180 ft  
Area of Flow: 0.1011 ft<sup>2</sup>  
Wetted Perimeter: 0.8994 ft  
Hydraulic Radius: 0.1124 ft  
Average Velocity: 16.3177 ft/s  
Top Width: 0.6360 ft  
Froude Number: 7.2117  
Critical Depth: 0.7009 ft  
Critical Velocity: 3.3591 ft/s  
Critical Slope: 0.0074 ft/ft  
Critical Top Width: 1.40 ft  
Calculated Max Shear Stress: 9.9213 lb/ft<sup>2</sup>  
Calculated Avg Shear Stress: 3.5077 lb/ft<sup>2</sup>

## Channel Analysis: Swale-2

Notes:

### Input Parameters

Channel Type: Triangular  
Side Slope 1 (Z1): 1.0000 ft/ft  
Side Slope 2 (Z2): 1.0000 ft/ft  
Longitudinal Slope: 0.0050 ft/ft  
Manning's n: 0.0150  
Flow: 2.3600 cfs

### Result Parameters

Depth: 0.8624 ft  
Area of Flow: 0.7437 ft<sup>2</sup>  
Wetted Perimeter: 2.4392 ft  
Hydraulic Radius: 0.3049 ft  
Average Velocity: 3.1733 ft/s  
Top Width: 1.7248 ft  
Froude Number: 0.8516  
Critical Depth: 0.8087 ft  
Critical Velocity: 3.6084 ft/s  
Critical Slope: 0.0070 ft/ft  
Critical Top Width: 1.62 ft  
Calculated Max Shear Stress: 0.2691 lb/ft<sup>2</sup>  
Calculated Avg Shear Stress: 0.0951 lb/ft<sup>2</sup>

## Channel Analysis: Swale-2

Notes:

### Input Parameters

Channel Type: Triangular  
Side Slope 1 (Z1): 1.0000 ft/ft  
Side Slope 2 (Z2): 1.0000 ft/ft  
Longitudinal Slope: 0.5000 ft/ft  
Manning's n: 0.0150  
Flow: 2.3600 cfs

### Result Parameters

Depth: 0.3637 ft  
Area of Flow: 0.1323 ft<sup>2</sup>  
Wetted Perimeter: 1.0286 ft  
Hydraulic Radius: 0.1286 ft  
Average Velocity: 17.8449 ft/s  
Top Width: 0.7273 ft  
Froude Number: 7.3748  
Critical Depth: 0.8087 ft  
Critical Velocity: 3.6084 ft/s  
Critical Slope: 0.0070 ft/ft  
Critical Top Width: 1.62 ft  
Calculated Max Shear Stress: 11.3463 lb/ft<sup>2</sup>  
Calculated Avg Shear Stress: 4.0115 lb/ft<sup>2</sup>

## Channel Analysis: Bioswale-1

Notes:

### Input Parameters

Channel Type: Trapezoidal  
Side Slope 1 (Z1): 2.0000 ft/ft  
Side Slope 2 (Z2): 2.0000 ft/ft  
Channel Width: 2.0000 ft  
Longitudinal Slope: 0.0100 ft/ft  
Manning's n: 0.0350  
Flow: 1.7500 cfs

### Result Parameters

Depth: 0.3610 ft  
Area of Flow: 0.9827 ft<sup>2</sup>  
Wetted Perimeter: 3.6146 ft  
Hydraulic Radius: 0.2719 ft  
Average Velocity: 1.7807 ft/s  
Top Width: 3.4441 ft  
Froude Number: 0.5875  
Critical Depth: 0.2623 ft  
Critical Velocity: 2.6424 ft/s  
Critical Slope: 0.0313 ft/ft  
Critical Top Width: 3.05 ft  
Calculated Max Shear Stress: 0.2253 lb/ft<sup>2</sup>  
Calculated Avg Shear Stress: 0.1697 lb/ft<sup>2</sup>

## Channel Analysis: Bioswale-2

Notes:

### Input Parameters

Channel Type: Trapezoidal  
Side Slope 1 (Z1): 2.0000 ft/ft  
Side Slope 2 (Z2): 2.0000 ft/ft  
Channel Width: 2.0000 ft  
Longitudinal Slope: 0.0100 ft/ft  
Manning's n: 0.0350  
Flow: 1.2000 cfs

### Result Parameters

Depth: 0.2926 ft  
Area of Flow: 0.7565 ft<sup>2</sup>  
Wetted Perimeter: 3.3087 ft  
Hydraulic Radius: 0.2286 ft  
Average Velocity: 1.5862 ft/s  
Top Width: 3.1705 ft  
Froude Number: 0.5722  
Critical Depth: 0.2079 ft  
Critical Velocity: 2.3890 ft/s  
Critical Slope: 0.0332 ft/ft  
Critical Top Width: 2.83 ft  
Calculated Max Shear Stress: 0.1826 lb/ft<sup>2</sup>  
Calculated Avg Shear Stress: 0.1427 lb/ft<sup>2</sup>

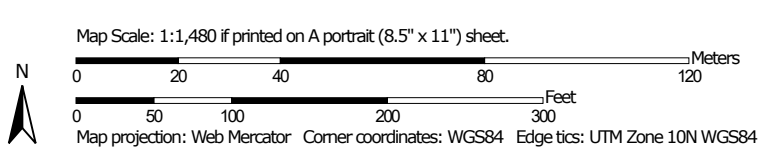
# **Appendix II**

## **Soil Analysis**

Soil Map—Marin County, California




Soil Map may not be valid at this scale.



### 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 18, Sep 8, 2024

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

Date(s) aerial images were photographed: Mar 7, 2021—Mar 31, 2021

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
142	Los Osos-Bonnydoon complex, 30 to 50 percent slopes	6.6	91.2%
143	Los Osos-Urban land-Bonnydoon complex, 15 to 30 percent slopes	0.6	8.8%
<b>Totals for Area of Interest</b>		<b>7.3</b>	<b>100.0%</b>

## Marin County, California

### 142—Los Osos-Bonnydoon complex, 30 to 50 percent slopes

#### Map Unit Setting

*National map unit symbol:* hf2g  
*Elevation:* 200 to 1,200 feet  
*Mean annual precipitation:* 25 to 35 inches  
*Mean annual air temperature:* 59 to 63 degrees F  
*Frost-free period:* 270 to 320 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Los osos and similar soils:* 60 percent  
*Bonnydoon and similar soils:* 20 percent  
*Minor components:* 20 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Los Osos

##### Setting

*Landform:* Hills  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Convex  
*Across-slope shape:* Convex  
*Parent material:* Residuum weathered from sandstone and shale

##### Typical profile

*H1 - 0 to 15 inches:* loam  
*H2 - 15 to 30 inches:* clay  
*H3 - 30 to 34 inches:* bedrock

##### Properties and qualities

*Slope:* 30 to 50 percent  
*Depth to restrictive feature:* 20 to 40 inches to paralithic bedrock  
*Drainage class:* Well drained  
*Runoff class:* Very high  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water supply, 0 to 60 inches:* Low (about 4.5 inches)

##### Interpretive groups

*Land capability classification (irrigated):* 6e  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* D  
*Ecological site:* R015XC032CA - FINE LOAMY CLAYPAN

*Hydric soil rating:* No

## **Description of Bonnydoon**

### **Setting**

*Landform:* Hills

*Landform position (two-dimensional):* Backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Concave

*Across-slope shape:* Convex

*Parent material:* Residuum weathered from shale, or sandstone

### **Typical profile**

*H1 - 0 to 11 inches:* gravelly loam

*H2 - 11 to 15 inches:* bedrock

### **Properties and qualities**

*Slope:* 30 to 50 percent

*Depth to restrictive feature:* 10 to 20 inches to paralithic bedrock

*Drainage class:* Somewhat excessively drained

*Runoff class:* High

*Capacity of the most limiting layer to transmit water*

*(Ksat):* Moderately high to high (0.57 to 1.98 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water supply, 0 to 60 inches:* Very low (about 1.4 inches)

### **Interpretive groups**

*Land capability classification (irrigated):* 6e

*Land capability classification (nonirrigated):* 6e

*Hydrologic Soil Group:* D

*Ecological site:* R015XC037CA - SHALLOW GRAVELLY LOAM

*Hydric soil rating:* No

## **Minor Components**

### **Rock outcrop**

*Percent of map unit:* 5 percent

*Hydric soil rating:* No

### **Yorkville**

*Percent of map unit:* 3 percent

*Hydric soil rating:* No

### **Slumps**

*Percent of map unit:* 3 percent

*Hydric soil rating:* No

### **Slopes more than 50 percent**

*Percent of map unit:* 3 percent

*Hydric soil rating:* No

### **Unnamed, deep**

*Percent of map unit:* 3 percent

*Hydric soil rating:* No

**Tocaloma**

*Percent of map unit:* 3 percent

*Hydric soil rating:* No

**Data Source Information**

Soil Survey Area: Marin County, California

Survey Area Data: Version 18, Sep 8, 2024

## Marin County, California

### 143—Los Osos-Urban land-Bonnydoon complex, 15 to 30 percent slopes

#### Map Unit Setting

*National map unit symbol:* hf2h  
*Elevation:* 200 to 1,200 feet  
*Mean annual precipitation:* 25 to 35 inches  
*Mean annual air temperature:* 57 to 63 degrees F  
*Frost-free period:* 270 to 320 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Los osos and similar soils:* 40 percent  
*Urban land:* 35 percent  
*Bonnydoon and similar soils:* 15 percent  
*Minor components:* 10 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Los Osos

##### Setting

*Landform:* Hills  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Concave  
*Across-slope shape:* Convex  
*Parent material:* Residuum weathered from sandstone and shale

##### Typical profile

*H1 - 0 to 18 inches:* loam  
*H2 - 18 to 38 inches:* clay  
*H3 - 38 to 42 inches:* bedrock

##### Properties and qualities

*Slope:* 15 to 30 percent  
*Depth to restrictive feature:* 20 to 40 inches to paralithic bedrock  
*Drainage class:* Well drained  
*Runoff class:* Very high  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water supply, 0 to 60 inches:* Low (about 5.7 inches)

##### Interpretive groups

*Land capability classification (irrigated):* 4e  
*Land capability classification (nonirrigated):* 4e  
*Hydrologic Soil Group:* D

*Ecological site:* R015XY009CA - Hills 20-40"ppt  
*Hydric soil rating:* No

### **Description of Urban Land**

#### **Setting**

*Landform:* Hills  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear

#### **Interpretive groups**

*Land capability classification (irrigated):* 8  
*Land capability classification (nonirrigated):* 8  
*Ecological site:* R015XY009CA - Hills 20-40"ppt  
*Hydric soil rating:* No

### **Description of Bonnydoon**

#### **Setting**

*Landform:* Hills  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Concave  
*Across-slope shape:* Concave  
*Parent material:* Residuum weathered from shale, or sandstone

#### **Typical profile**

*H1 - 0 to 15 inches:* gravelly loam  
*H2 - 15 to 19 inches:* bedrock

#### **Properties and qualities**

*Slope:* 15 to 30 percent  
*Depth to restrictive feature:* 10 to 20 inches to paralithic bedrock  
*Drainage class:* Somewhat excessively drained  
*Runoff class:* High  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water supply, 0 to 60 inches:* Very low (about 1.9 inches)

#### **Interpretive groups**

*Land capability classification (irrigated):* 6e  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* D  
*Ecological site:* R015XY009CA - Hills 20-40"ppt  
*Hydric soil rating:* No

### **Minor Components**

#### **Saurin**

*Percent of map unit:* 2 percent

*Hydric soil rating: No*

**Henneke**

*Percent of map unit: 2 percent*

*Hydric soil rating: No*

**Unnamed, deep**

*Percent of map unit: 1 percent*

*Hydric soil rating: No*

**Slumps**

*Percent of map unit: 1 percent*

*Hydric soil rating: No*

**Tocaloma**

*Percent of map unit: 1 percent*

*Hydric soil rating: No*

**Slopes less than 15 percent**

*Percent of map unit: 1 percent*

*Hydric soil rating: No*

**Xerorthents**

*Percent of map unit: 1 percent*

*Hydric soil rating: No*

**Rock outcrop**

*Percent of map unit: 1 percent*

*Hydric soil rating: No*

## Data Source Information

Soil Survey Area: Marin County, California

Survey Area Data: Version 18, Sep 8, 2024