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**APPROVED**  
**Engineering Department**

*01/03/2022 11:11:25 AM*

*dsdnijkamp*

**EPC Planning & Community  
Development Department**

# Addendum to Preliminary & Final Drainage Report

## **Sanctuary of Peace Residential Community**

**PUD Development,  
Preliminary Plan and  
Final Plat**

**Project Number 61087**

**PCD Proj # SF-21-27**

**September 24, 2021**

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# **Addendum to Preliminary & Final Drainage Report**

for

**Sanctuary of Peace Residential Community**  
PUD Development, Preliminary Plan and Final Plat

**Project No. 61087**

**September 24, 2021**

prepared for

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61087 SOP Final Drainage Report-addendum.odt

## Addendum to Preliminary / Final Drainage Report Sanctuary of Peace Filing No. 1

### PURPOSE

This Addendum to the Preliminary and Final Drainage Report for the Sanctuary of Peace Residential Community PUD Development and Preliminary Plan, and the Final Plat of Sanctuary of Peace Filing No. 1 is to update the Drainage and Bridge Fee calculations for Final Plat recordation. The Addendum also revised existing and developed flows for one sub-basin and one design point. The Existing Drainage Map and Proposed Drainage Map are updated with the revised flow rates. The changes are minor and not consequential to any downstream properties. Developed flow rates are shown to be reduced in this addendum. The Addendum paragraphs below amend the corresponding paragraph in the original report with the revised text in **bold**. Updated calculations and maps are included in the appendix.

### DEVELOPED DRAINAGE BASIN DESCRIPTIONS

**The existing flows at DP EX9, which includes sub-basins OS C, EX-B1 and EX-B2 are 19.1 cfs and 106.5 cfs for the 5-year and 100-year rainfall recurrence intervals, respectively. Developed Condition** Design Point DP9 has storm water flows from Drainage Basin OS C and will flow overland to Benet Lane (private drive) and under Benet Lane via existing culverts. These storm water flows will combine with DP8 and overland flows from Basin B2. This area remains in its existing state of forested land. The rate of flow is  $Q_5 = 19.7$  cfs and  $Q_{100} = 108.3$  cfs and exits the site along its southerly boundary designated as Point of Interest DP9. **This represents minor changes in flow rates of 0.6 cfs in the 5-year and 1.8 cfs in the 100-year events.**

### DRAINAGE, BRIDGE, AND SURCHARGE FEES

The Sanctuary of Peace Residential Community contains 49.58 acres of land. The Board of County Commissioners, County of El Paso, State of Colorado Resolution No. 99-383 allows the drainage basin fee to be based on impervious acreage. Black Squirrel Creek Basin contains 1.55 acres and Smith Creek Basin contains 0.67 acres of developed impervious acreage.

The resolution also allows a fee reduction of 25% for those portions of the development that consist entirely of 2.5 acre and larger lots. The Sanctuary of Peace Residential Community has clustered lots of below the 2.5 acre limit and therefore does not qualify.

FEE CALCULATION (2021 Fees)

Black Squirrel Drainage Basin

Drainage Fee **\$8,968** / Impervious Acre @ 1.55 Acres = **\$13,900.40**

Bridge Fee **\$565** / Impervious Acre @ 1.55 Acres = **\$ 875.75**

Smith Creek Drainage Basin

Drainage Fee **\$8,052** / Impervious Acre @ 0.67 Acres = **\$ 5,394.84**

Bridge Fee **\$1,080** / Impervious Acre @ 0.67 Acres = **\$ 723.60**

Grand Total Fees = **\$20,894.59**

M.V.E., Inc.



David R. Gorman, PE

# Appendices

## **2 Hydrologic Calculations**

Sub-Basin Time of Concentration – Form SF-1  
5-yr Sub-Basin and Combined Flows – Form SF-2  
100-yr Sub-Basin and Combined Flows – Form SF-2  
Sub-Basin Calculations

**Time of Concentration** (Modified from Standard Form SF-1)

Sub-Basin	Sub-Basin Data			Overland			Shallow Channel				Channelized				t <sub>c</sub> Check		
	Area (Acres)	C <sub>5</sub>	C <sub>100</sub> /CN Imp.	L <sub>0</sub> (ft)	S <sub>0</sub> (%)	t <sub>i</sub> (min)	L <sub>0t</sub> (ft)	S <sub>0t</sub> (ft/ft)	V <sub>0sc</sub> (ft/s)	t <sub>t</sub> (min)	L <sub>0c</sub> (ft)	S <sub>0c</sub> (ft/ft)	V <sub>0c</sub> (ft/s)	t <sub>c</sub> (min)	L (min)	t <sub>c,alt</sub> (min)	t <sub>c</sub> (min)
EX-A1	30.11	0.08	0.35	100	9%	8.9	1483	0.072	1.9	13.1	117	0.043	1.6	1.2	1700	N/A	23.3
EX-B1	2.06	0.08	0.35	100	8%	9.3	383	0.044	1.5	4.3	84	0.060	1.9	0.8	567	N/A	14.4
EX-B2	8.75	0.08	0.35	100	7%	9.7	211	0.047	1.5	2.3	0	0.000	0.0	0.0	311	N/A	12.0
EX-C1	5.68	0.08	0.35	100	11%	8.3	622	0.040	1.4	7.4	0	0.000	0.0	0.0	722	N/A	15.7
EX-C2	2.03	0.08	0.35	100	8%	9.3	200	0.085	2.0	1.6	0	0.000	0.0	0.0	300	N/A	10.9
EX-C3	0.66	0.08	0.35	100	10%	8.6	117	0.060	1.7	1.1	0	0.000	0.0	0.0	217	N/A	9.8
OSA	69.40	0.08	0.35	100	3%	12.8	1030	0.063	1.8	9.8	1887	0.041	1.6	19.4	3017	N/A	41.9
OSB	83.92	0.10	0.37	100	3%	12.5	1030	0.063	1.8	9.8	1887	0.041	1.6	19.4	3017	N/A	41.7
<b>OS C</b>	<b>49.12</b>	<b>0.12</b>	<b>0.38</b>	<b>100</b>	<b>5%</b>	<b>10.4</b>	<b>1240</b>	<b>0.077</b>	<b>1.9</b>	<b>10.7</b>	<b>585</b>	<b>0.048</b>	<b>4.9</b>	<b>2.0</b>	<b>1925</b>	<b>N/A</b>	<b>23.0</b>
A1	1.85	0.36	0.55	100	11%	6.1	217	0.055	1.2	3.1	0	0.000	0.0	0.0	317	N/A	9.1
A2	28.30	0.08	0.35	100	9%	8.9	1483	0.072	1.3	18.4	117	0.043	5.7	0.3	1700	N/A	27.7
B1	2.36	0.08	0.35	100	8%	9.3	383	0.044	1.5	4.3	84	0.060	1.9	0.8	567	N/A	14.4
B2	9.23	0.10	0.36	100	7%	9.5	211	0.047	1.5	2.3	0	0.000	0.0	0.0	311	N/A	11.8
C1	4.07	0.27	0.49	100	16%	6.0	457	0.046	1.1	7.1	0	0.000	0.0	0.0	557	N/A	13.1
C2	0.66	0.28	0.49	89	7%	7.5	100	0.060	1.2	1.4	0	0.000	0.0	0.0	189	N/A	8.8
C3	1.36	0.08	0.35	100	7%	9.7	173	0.075	1.4	2.1	0	0.000	0.0	0.0	273	N/A	11.8
C4	0.64	0.08	0.35	81	14%	7.0	140	0.071	1.3	1.7	0	0.000	0.0	0.0	221	N/A	8.8
C5	1.61	0.08	0.35	100	10%	8.6	123	0.065	1.3	1.6	0	0.000	0.0	0.0	223	N/A	10.2

Job No.: **61087**  
 Project: **Sanctuary of Peace**  
 Design Storm: **5-Year Storm**  
 Jurisdiction: **DCM**

Date: **10/12/2021 11:56**  
 Calcs By: **ASM**  
 Checked By:

DCM  
 (20% Probability)

**Sub-Basin and Combined Flows** (Modified from Standard Form SF-2)

DP	Sub-Basin	Area (Acres)	C5	Direct Runoff			Combined Runoff			Streetflow			Pipe Flow			Travel Time				
				t <sub>c</sub> (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	t <sub>c</sub> (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Slope (%)	Mnngs n	Length (ft)	D <sub>pipe</sub> (in)	Length (ft)	V <sub>vac</sub> (ft/s)
	EX-A1	30.11	0.08	23.3	2.41	2.86	6.9													
	EX-B1	2.06	0.08	14.4	0.16	3.59	0.6													
	EX-B2	8.75	0.08	12.0	0.70	3.86	2.7													
	EX-C1	5.68	0.08	15.7	0.45	3.45	1.6													
	EX-C2	2.03	0.08	10.9	0.16	4.00	0.7													
	EX-C3	0.66	0.08	9.8	0.05	4.17	0.2													
	OS A	69.40	0.08	41.9	5.77	1.98	11.4													
	OS B	83.92	0.10	41.7	8.73	1.99	17.4													
	<b>OS C</b>	<b>49.12</b>	<b>0.12</b>	<b>23.0</b>	<b>5.87</b>	<b>2.88</b>	<b>16.9</b>													
	A1	1.85	0.36	9.1	0.66	4.26	2.8													
	A2	28.30	0.08	27.7	2.26	2.60	5.9													
	B1	2.36	0.08	14.4	0.19	3.59	0.7													
	B2	9.23	0.10	11.8	0.89	3.87	3.4													
	C1	4.07	0.27	13.1	1.11	3.72	4.1													
	C2	0.66	0.28	8.8	0.18	4.32	0.8													
	C3	1.36	0.08	11.8	0.11	3.88	0.4													
	C4	0.64	0.08	8.8	0.05	4.33	0.2													
	C5	1.61	0.08	10.2	0.13	4.10	0.5													
EX1		153.32	0.09	41.9	14.13	2.53	35.7													
EX4		2.03	0.08	10.9	0.16	4.00	0.7													
EX5		0.66	0.08	9.8	0.05	4.17	0.2													
EX7		5.68	0.08	15.7	0.45	3.45	1.6													
<b>EX9</b>		<b>59.93</b>	<b>0.11</b>	<b>23.7</b>	<b>6.73</b>	<b>2.83</b>	<b>19.1</b>													
DP1		183.47	0.09	9.1	16.93	4.26	34.8													
DP2		1.85	0.36	9.1	0.66	4.26	2.8													
DP3		0.66	0.28	8.8	0.18	4.32	0.8													
DP4		2.02	0.08	11.8	0.16	3.88	0.4													
DP5		0.64	0.08	8.8	0.05	4.33	0.2													
DP6		4.07	0.27	13.1	1.11	3.72	4.1													
DP7		5.69	0.08	10.2	0.45	4.10	0.6													
DP8		2.36	0.08	14.4	0.19	3.59	0.7													
<b>DP9</b>		<b>60.72</b>	<b>0.11</b>	<b>23.7</b>	<b>6.94</b>	<b>2.83</b>	<b>19.7</b>													

DCM:  $I = C1 * \ln(tc) + C2$   
 C1: 1.5  
 C1: 7.583

Job No.: **61087**  
 Project: **Sanctuary of Peace**  
 Design Storm: **100-Year Storm (1% Probability)**  
 Jurisdiction: **DCM**

Date: **10/12/2021 11:56**  
 Calcs By: **ASM**  
 Checked By:

**Sub-Basin and Combined Flows** (Modified from Standard Form SF-2)

DP	Sub-Basin	Area (Acres)	C100	Direct Runoff			Combined Runoff			Streetflow			Pipe Flow			Travel Time				
				t <sub>c</sub> (min)	CA (Acres)	I100 (in/hr)	Q100 (cfs)	t <sub>c</sub> (min)	CA (Acres)	I100 (in/hr)	Q100 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Slope (%)	Mnngs n	Length (ft)	D <sub>pipe</sub> (in)	Length (ft)	V <sub>vac</sub> (ft/s)
	EX-A1	30.11	0.35	23.3	10.54	4.81	50.6	41.9	54.97	4.23	232.4									
	EX-B1	2.06	0.35	14.4	0.72	6.02	4.3	10.9	0.71	6.71	4.8									
	EX-B2	8.75	0.35	12.0	3.06	6.47	19.8	9.8	0.23	7.00	1.6									
	EX-C1	5.68	0.35	15.7	1.99	5.79	11.5	15.7	1.99	5.79	11.5									
	EX-C2	2.03	0.35	10.9	0.71	6.71	4.8	23.7	22.39	4.76	106.5									
	EX-C3	0.66	0.35	9.8	0.23	7.00	1.6													
	OS A	69.40	0.35	41.9	24.44	3.32	81.1	9.1	65.80	3.50	230.2									
	OS B	83.92	0.37	41.7	30.79	3.34	102.7	9.1	1.02	7.16	7.3									
	<b>OS C</b>	<b>49.12</b>	<b>0.38</b>	<b>23.0</b>	<b>18.61</b>	<b>4.83</b>	<b>89.9</b>	<b>23.7</b>	<b>22.39</b>	<b>4.76</b>	<b>106.5</b>									
	A1	1.85	0.55	9.1	1.02	7.16	7.3													
	A2	28.30	0.35	27.7	9.90	4.37	43.3													
	B1	2.36	0.35	14.4	0.83	6.02	5.0													
	B2	9.23	0.36	11.8	3.34	6.51	21.7													
	C1	4.07	0.49	13.1	1.99	6.25	12.5													
	C2	0.66	0.49	8.8	0.33	7.25	2.4													
	C3	1.36	0.35	11.8	0.48	6.52	3.1													
	C4	0.64	0.35	8.8	0.23	7.27	1.6													
	C5	1.61	0.35	10.2	0.56	6.88	3.9													
EX1		153.32	0.36																	
EX4		2.03	0.35																	
EX5		0.66	0.35																	
EX7		5.68	0.35																	
<b>EX9</b>		<b>59.93</b>	<b>0.37</b>																	
DP1		183.47	0.36																	
DP2		1.85	0.55																	
DP3		0.66	0.49																	
DP4		1.36	0.35																	
DP5		0.64	0.35																	
DP6		4.07	0.49																	
DP7		1.61	0.35																	
DP8		2.36	0.35																	
<b>DP9</b>		<b>60.72</b>	<b>0.38</b>																	

DCM: I = C1 \* In (tc) + C2  
 C1: 2.52  
 C1: 12.735



## Sub-Basin OS C Runoff Calculations

Job No.: 61087  
 Project: Sanctuary of Peace  
 Jurisdiction: DCM  
 Runoff Coefficient: Surface Type

Date: 10/12/2021 11:56  
 Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Soil Type: B  
 Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	2,023,425	46.45	0.02	0.08	0.15	0.25	0.3	0.35	0%
Driveways & Walks	76,619	1.76	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	29,852	0.69	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	9,943	0.23	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>2,139,839</b>	<b>49.12</b>	<b>0.06</b>	<b>0.12</b>	<b>0.19</b>	<b>0.28</b>	<b>0.33</b>	<b>0.38</b>	<b>5.1%</b>

4000

### Basin Travel Time

	Shallow Channel	Ground Cover	Short Pasture/Lawns				
$L_{max,Overland}$	100	ft	$C_v$	7			
$L$ (ft)	$\Delta Z_0$ (ft)	$S_0$ (ft/ft)	$v$ (ft/s)	$t$ (min)	$t_{Alt}$ (min)		
Total	1,925	128	-	-	-		
Initial Time	100	5	0.050	-	10.4	N/A	DCM Eq. 6-8
Shallow Channel	1,240	95	0.077	1.9	10.7	-	DCM Eq. 6-9
Channelized	585	28	0.048	4.9	2.0	-	Trap Ditch
				$t_c$	<b>23.0 min.</b>		

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	2.30	2.88	3.36	3.84	4.32	4.83
<b>Runoff (cfs)</b>	7.0	<b>16.9</b>	30.8	53.3	70.1	<b>89.9</b>
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	7.0	<b>16.9</b>	30.8	53.3	70.1	<b>89.9</b>

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Combined Sub-Basin EX9 Runoff Calculations

Includes Basins OS C EX-B1 EX-B2

Job No.:	<b>61087</b>	Date:	<b>10/12/2021 11:56</b>
Project:	<b>Sanctuary of Peace</b>	Calcs by:	<b>ASM</b>
Jurisdiction	<b>DCM</b>	Checked by:	
Runoff Coefficient	<b>Surface Type</b>	Soil Type	<b>B</b>
		Urbanization	<b>Non-Urban</b>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	2,494,099	57.26	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	29,852	0.69	0.57	0.59	0.63	0.66	0.68	0.7	80%
Driveways & Walks	76,619	1.76	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	9,943	0.23	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>2,610,513</b>	<b>59.93</b>	<b>0.05</b>	<b>0.11</b>	<b>0.18</b>	<b>0.28</b>	<b>0.33</b>	<b>0.37</b>	<b>4.2%</b>

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. $\Delta Z_0$ (ft)	$Q_i$ (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	OS C	-	1,925	128	-	-	-	-	23.0
Channelized-1	Trap Ditch	2	335	25	90	2	2	8.2	0.7
Channelized-2									
Channelized-3									
Total			2,260	153					

2 = Natural, Winding, minimal vegetation/shallow grass

$t_c$  (min) **23.7**

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

$Q_{Minor}$  (cfs) - 5-year Storm

$Q_{Major}$  (cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	2.27	2.83	3.31	3.78	4.25	4.76
<b>Site Runoff (cfs)</b>	7.40	<b>19.08</b>	35.73	62.70	82.86	<b>106.48</b>
<b>OffSite Runoff (cfs)</b>	-	<b>0.00</b>	-	-	-	<b>0.00</b>
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	<b>19.1</b>	-	-	-	<b>106.5</b>

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## Combined Sub-Basin DP9 Runoff Calculations

Includes Basins B1 B2 OS C

Job No.:	<b>61087</b>	Date:	<b>10/12/2021 11:56</b>
Project:	<b>Sanctuary of Peace</b>	Calcs by:	<b>ASM</b>
Jurisdiction	<b>DCM</b>	Checked by:	
Runoff Coefficient	<b>Surface Type</b>	Soil Type	<b>B</b>
		Urbanization	<b>Non-Urban</b>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	2,520,607	57.87	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	29,852	0.69	0.57	0.59	0.63	0.66	0.68	0.7	80%
Driveways & Walks	84,402	1.94	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	9,943	0.23	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>2,644,804</b>	<b>60.72</b>	<b>0.06</b>	<b>0.11</b>	<b>0.18</b>	<b>0.28</b>	<b>0.33</b>	<b>0.38</b>	<b>4.4%</b>

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ <sub>0</sub> (ft)	Q <sub>i</sub> (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	OS C	-	1,925	128	-	-	-	-	23.0
Channelized-1	Trap Ditch	2	335	25	90	2	2	8.2	0.7
Channelized-2									
Channelized-3									
Total			2,260	153					

2 = Natural, Winding, minimal vegetation/shallow grass

**t<sub>c</sub> (min) 23.7**

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q<sub>Minor</sub> (cfs) - 5-year Storm

Q<sub>Major</sub> (cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	2.27	2.83	3.31	3.78	4.25	4.76
<b>Site Runoff (cfs)</b>	7.78	<b>19.67</b>	36.57	63.91	84.36	<b>108.31</b>
<b>OffSite Runoff (cfs)</b>	-	<b>0.00</b>	-	-	-	<b>0.00</b>
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	<b>19.7</b>	-	-	-	<b>108.3</b>

DCM: I = C1 \* ln(tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## **4 Drainage Maps**

Existing Drainage Map	(Map Pocket)
Proposed Drainage Map	(Map Pocket)
Proposed Drainage Map (Detail)	(Map Pocket)

EXISTING DRAINAGE SUMMARY TABLE					
DESIGN POINT	BASIN	AREA (AC)	Tc (MIN.)	RUNOFF	
				Q5 (CFS)	Q100 (CFS)
	OS A	69.40	41.9	11.4	81.1
	OS B	83.92	41.7	17.4	102.7
	EX-A1	30.11	23.3	6.9	50.6
EX1	OS A, OS B, EX-A1	153.32	41.9	35.7	234.4
	EX-C1	5.68	15.7	1.6	11.5
EX7	EX-C1	5.68	15.7	1.6	11.5
	EX-C2	2.03	10.9	0.7	4.8
EX4	EX-C2	2.03	10.9	0.7	4.8
	EX-C3	0.66	9.8	0.2	1.6
EX5	EX-C3	0.66	9.8	0.2	1.6
	EX-B1	2.06	14.4	0.6	4.3
EX8	EX-B1	2.06	14.4	0.6	4.3
	EX-B2	8.75	12.0	2.7	19.8
	OS C	49.12	23.0	16.9	89.9
EX9	EX-B1, EX-B2, OS C	59.93	23.7	19.1	106.5

**LEGEND**

- PROPERTY LINE
- EASEMENT LINE
- LOT LINE

**EXISTING**

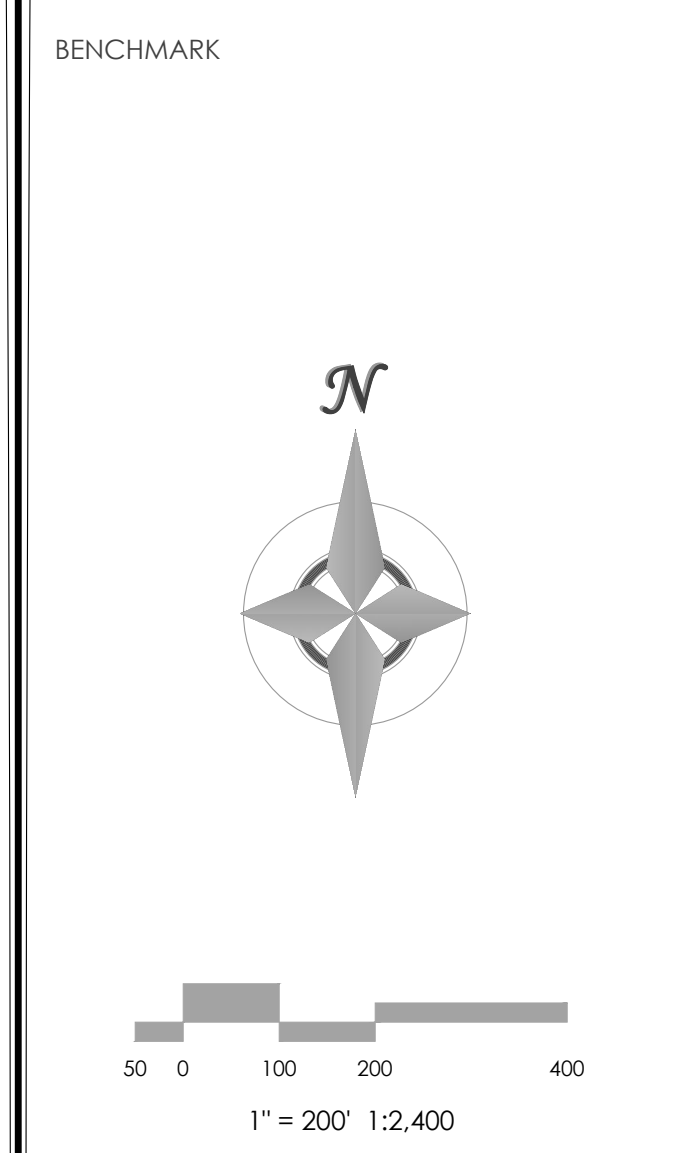
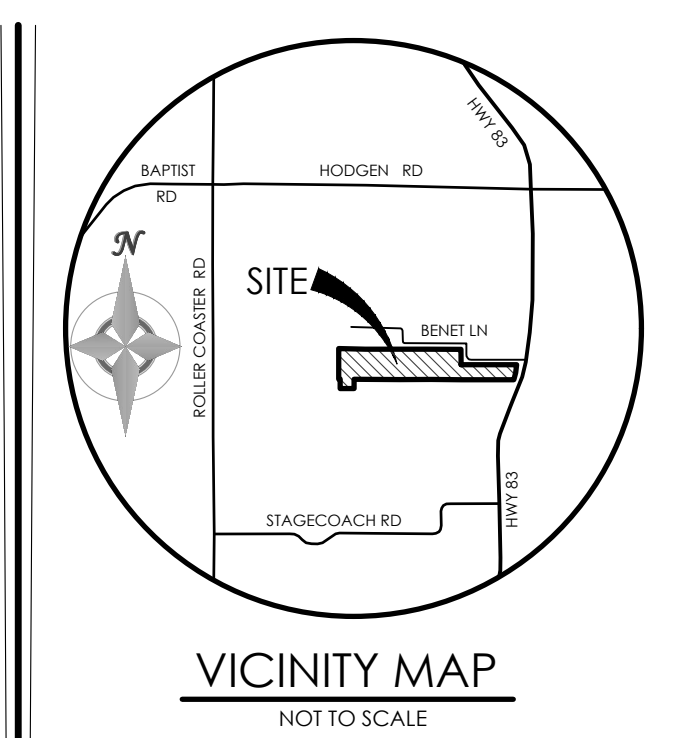
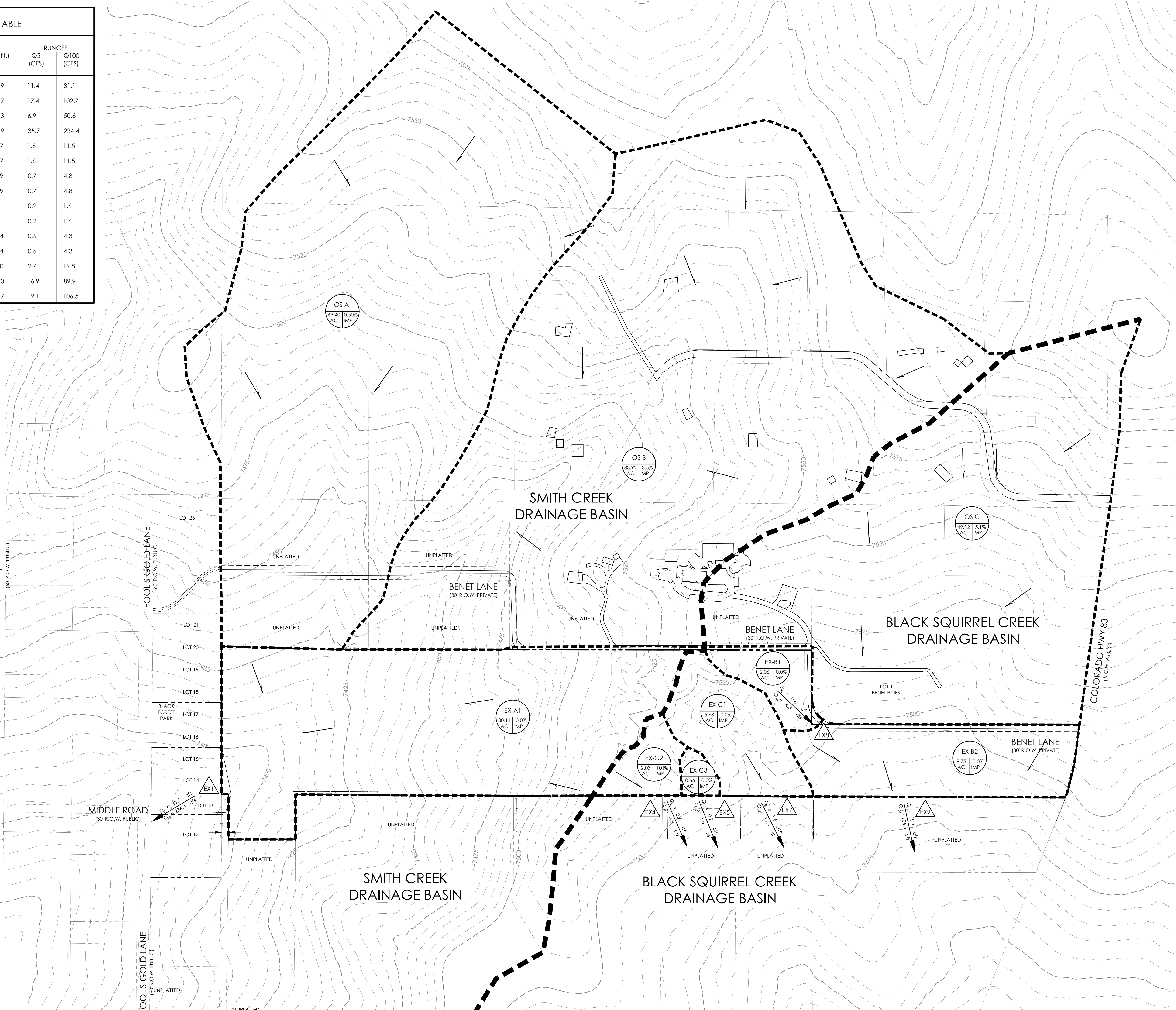
- INDEX CONTOUR
- INTERMEDIATE CONTOUR

**PROPOSED**

- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- BASIN BOUNDARY
- GENERAL FLOW/DIRECTION
- SLOPE DIRECTION AND GRADE
- BASIN LABEL
- POINT OF INTEREST

**FLOODPLAIN STATEMENT:**

NO PORTION OF THE SUBJECT PROPERTY IS LOCATED WITHIN A FEMA DESIGNATED SPECIAL FLOOD HAZARD AREA (SFHA) AS INDICATED ON THE FLOOD INSURANCE RATE MAP (FIRM) FOR EL PASO COUNTY, COLORADO AND INCORPORATED AREAS - MAP NUMBER 08041C0295 G, EFFECTIVE DECEMBER 7, 2018.



**MVE INC.**  
ENGINEERS / SURVEYORS

1903 Leary Street, Suite 200 Colorado Springs, CO 80909 719.635.5726

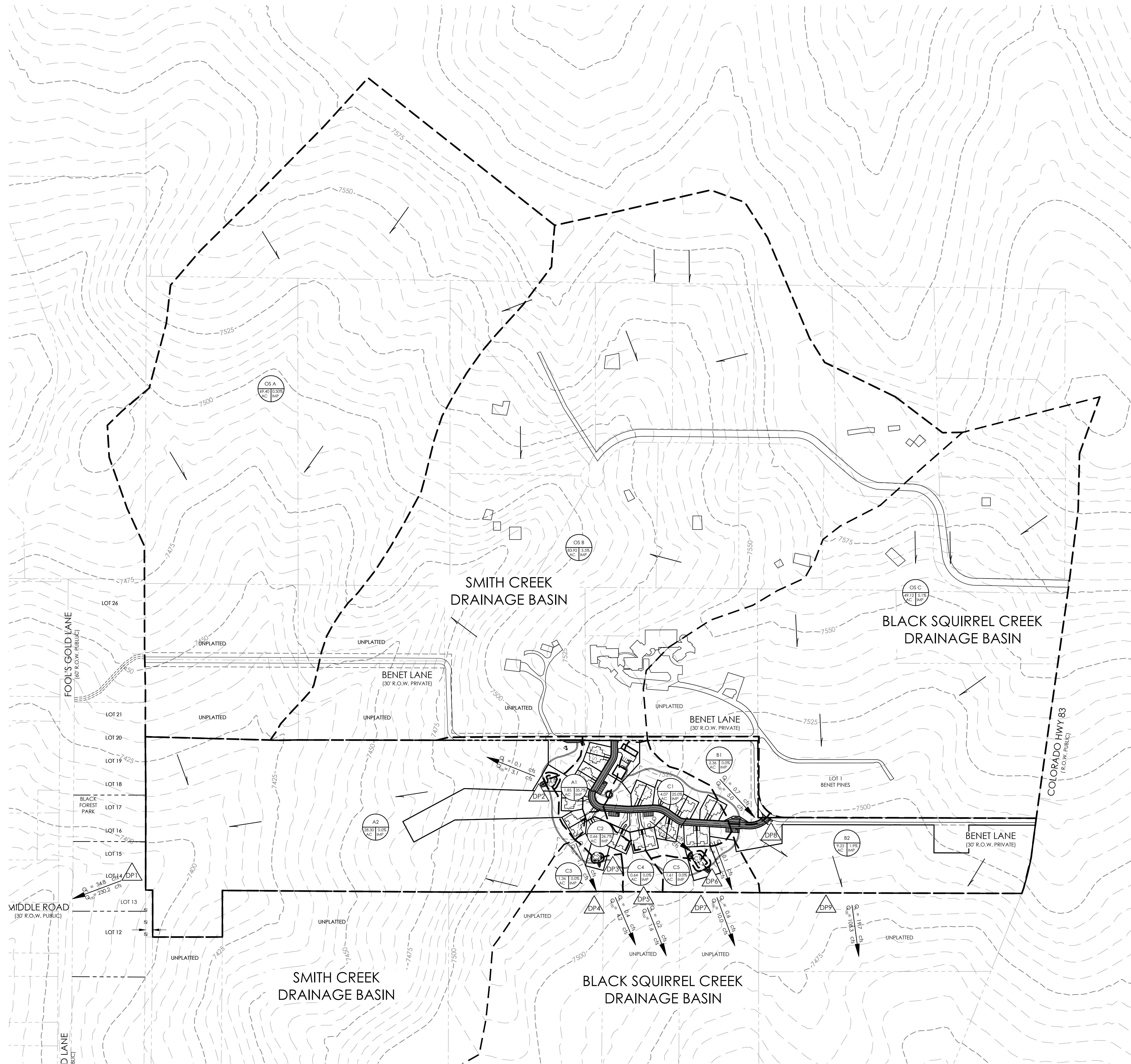
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DRAWN BY \_\_\_\_\_  
CHECKED BY \_\_\_\_\_  
AS-BUILT BY \_\_\_\_\_  
CHECKED BY \_\_\_\_\_

**SANCTUARY OF PEACE**

EXISTING DRAINAGE MAP

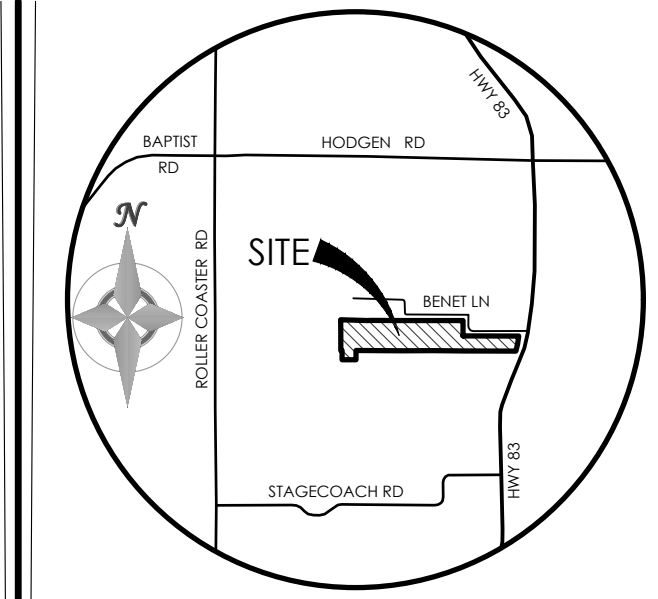
MVE PROJECT **61087**  
MVE DRAWING **EX-DM**

September 24, 2021  
SHEET 1 OF 1



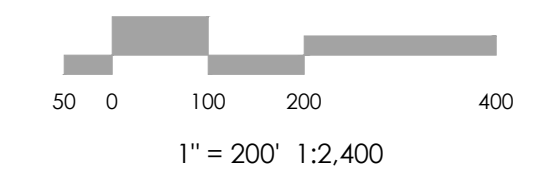
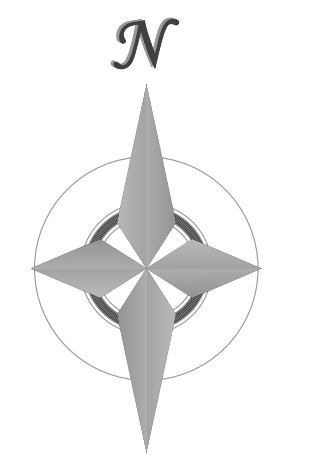
**DEVELOPED DRAINAGE SUMMARY TABLE**

DESIGN POINT	BASIN	AREA (AC)	Tc (MIN)	RUNOFF	
				Q5 (CFS)	Q100 (CFS)
	OS A	69.40	41.9	11.4	81.1
	OS B	83.92	41.7	17.4	102.7
	A1	1.85	9.1	2.8	7.3
	A2	28.30	27.7	5.9	43.3
DP1	OS A, OS B, DP2, A2	183.47	41.9	34.8	230.2
DP2 In	A1	1.85	9.1	2.8	7.3
DP2 Out	A1	1.85	9.1	0.1	3.1
	C2	0.66	8.8	0.8	2.4
DP3 In	C2	0.66	8.8	0.8	2.4
DP3 Out	C2	0.66	8.8	0.0	1.1
	C3	1.36	11.8	0.4	3.1
DP4	C2, C3	2.02	11.8	0.4	4.2
	C4	0.64	8.8	0.2	1.6
DP5	C4	0.64	8.8	0.2	1.6
	C1	4.07	13.1	4.1	12.5
DP6 In	C1	4.07	13.1	4.1	12.5
DP6 Out	C1	4.07	13.1	0.1	6.1
	C5	1.61	10.2	0.5	3.9
DP7	C1, C5	5.69	13.1	0.6	10.0
	B1	2.36	14.4	0.7	5.0
DP8	B1	2.36	14.4	0.7	5.0
	B2	9.23	11.8	3.4	21.7
	OS C	49.12	23.0	16.9	89.9
DP9	B1, B2, OS C	60.72	23.7	19.7	108.3



VICINITY MAP  
NOT TO SCALE

BENCHMARK



- LEGEND**
- PROPERTY LINE
  - EASEMENT LINE
  - LOT LINE
  - EXISTING
    - INDEX CONTOUR
    - INTERMEDIATE CONTOUR
  - PROPOSED
    - INDEX CONTOUR
    - INTERMEDIATE CONTOUR
    - BASIN BOUNDARY
    - GENERAL FLOW/DIRECTION
    - SLOPE DIRECTION AND GRADE
    - BASIN LABEL  
AREA IN ACRES  
PERCENT IMPERVIOUS
    - POINT OF INTEREST
    - FULL SPECTRUM SAND FILTER BASIN (FSSFB)

**FLOODPLAIN STATEMENT:**

NO PORTION OF THE SUBJECT PROPERTY IS LOCATED WITHIN A FEMA DESIGNATED SPECIAL FLOOD HAZARD AREA (SFHA) AS INDICATED ON THE FLOOD INSURANCE RATE MAP (FIRM) FOR EL PASO COUNTY, COLORADO AND INCORPORATED AREAS - MAP NUMBER 08041C0295 G, EFFECTIVE DECEMBER 7, 2018.

**WATER QUALITY BASIN NOTES**

THE FULL SPECTRUM SAND FILTER BASINS A1, B1, AND C1 SHALL BE ESTABLISHED IN THE FIELD BY THE PROJECT ENGINEER AT OR ABOVE THE CALCULATED REQUIRED VOLUME. THE FULL SPECTRUM SAND FILTER BASINS SHALL BE FIELD SURVEYED FOR AS-BUILT CONDITIONS AND APPROVED BY THE PROJECT ENGINEER AS BEING CONSTRUCTED IN SUBSTANTIAL COMPLIANCE WITH APPROVED DETAILS FOR CONSTRUCTION.

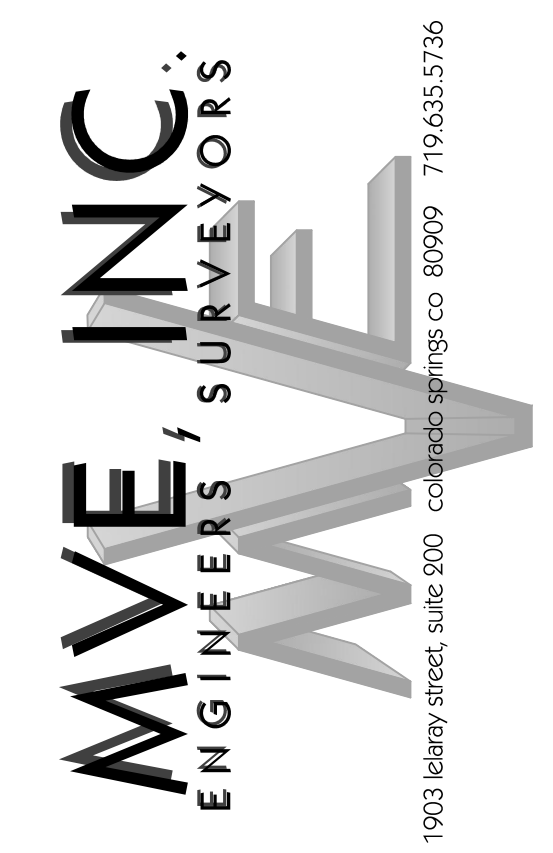
REVISIONS

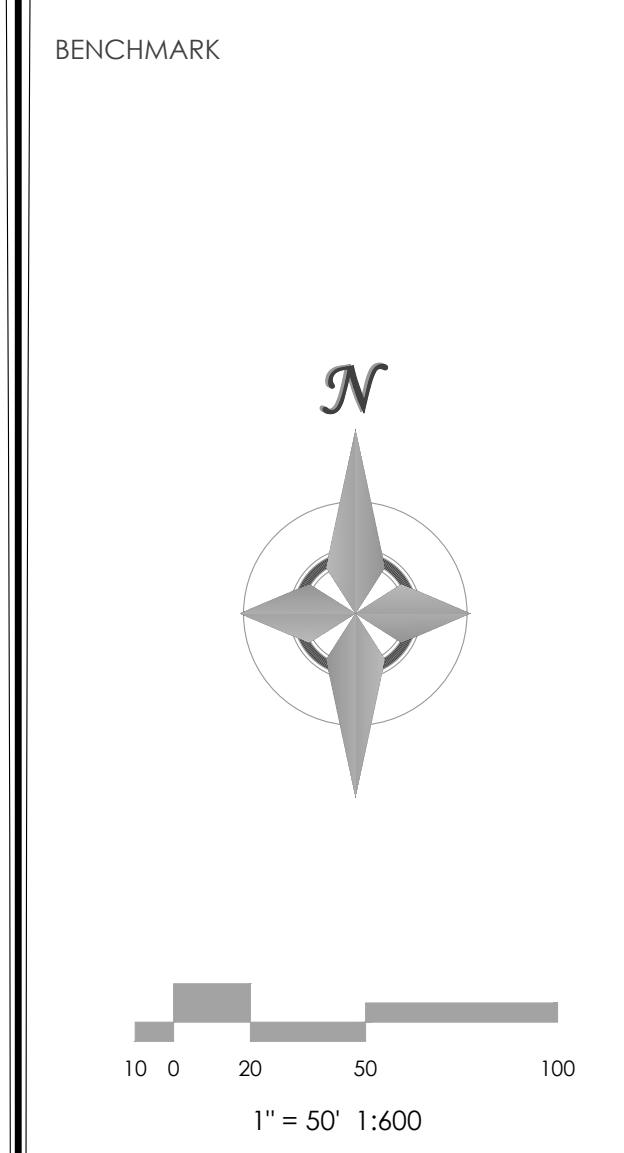
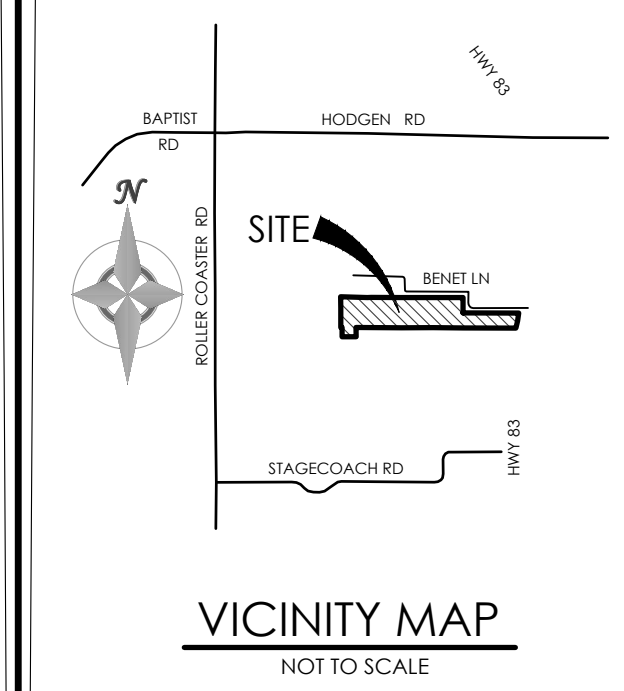
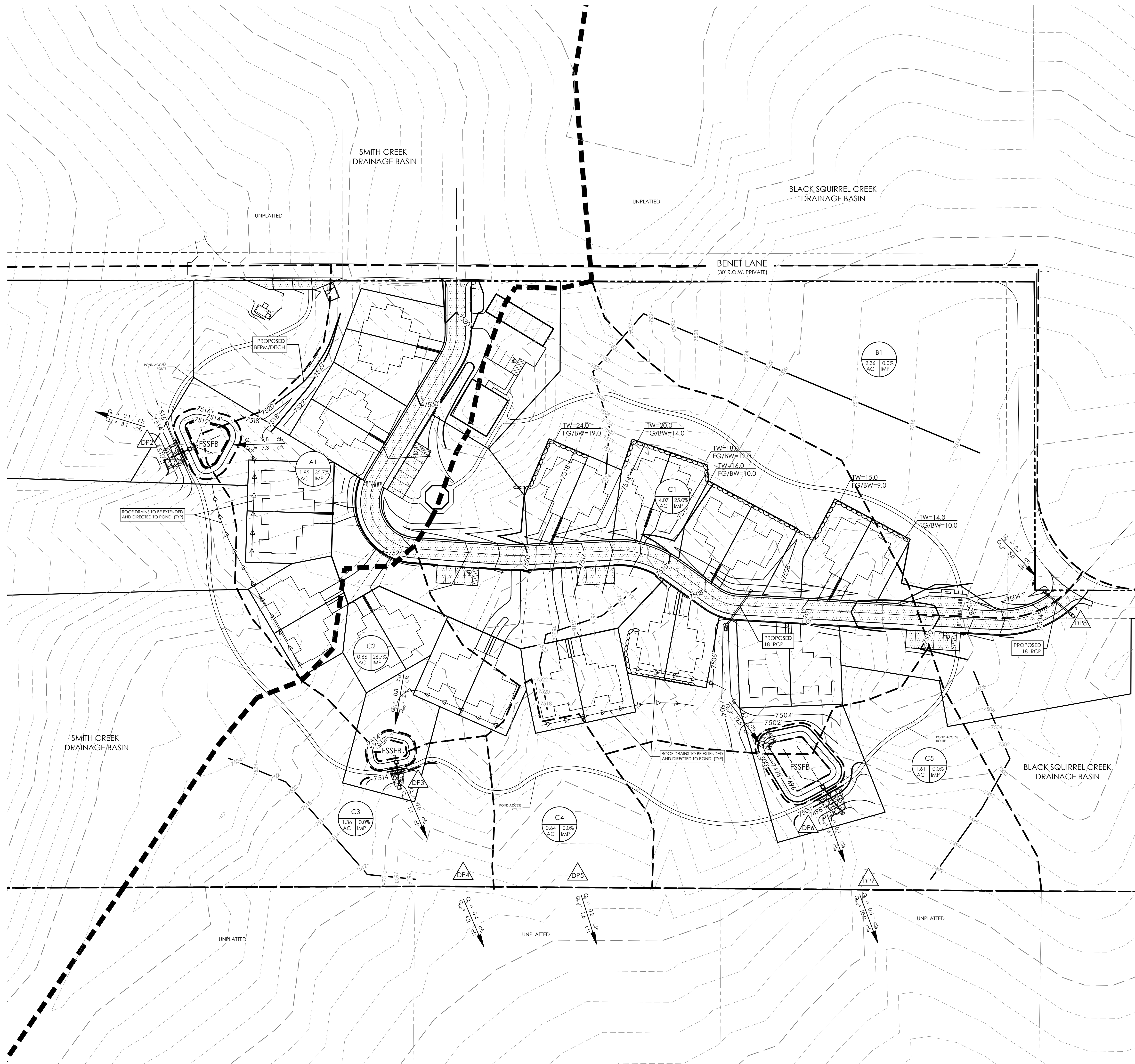
DESIGNED BY \_\_\_\_\_  
 DRAWN BY \_\_\_\_\_  
 CHECKED BY \_\_\_\_\_  
 AS-BUILT BY \_\_\_\_\_  
 CHECKED BY \_\_\_\_\_  
**SANCTUARY OF PEACE**

**PROPOSED DRAINAGE MAP**

MVE PROJECT **61087**  
 MVE DRAWING **PP-DM**

**September 24, 2021**  
**SHEET 1 OF 1**





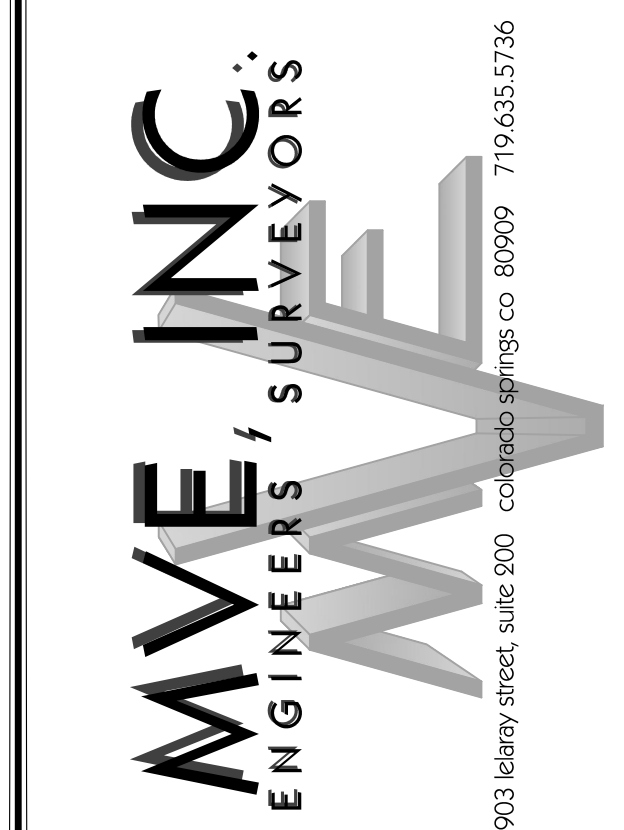
**LEGEND**

—	PROPERTY LINE
- - -	EASEMENT LINE
---	LOT LINE
<b>EXISTING</b>	
- - -	INDEX CONTOUR
- - -	INTERMEDIATE CONTOUR
<b>PROPOSED</b>	
- - -	INDEX CONTOUR
- - -	INTERMEDIATE CONTOUR
---	BASIN BOUNDARY
→	GENERAL FLOW/DIRECTION
1.5%	SLOPE DIRECTION AND GRADE
A1	BASIN LABEL AREA IN ACRES PERCENT IMPERVIOUS
△	POINT OF INTEREST
⊙	FULL SPECTRUM SAND FILTER BASIN (FSSFB)

**FLOODPLAIN STATEMENT:**  
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 THE FULL SPECTRUM SAND FILTER BASINS SHALL BE FIELD SURVEYED FOR AS-BUILT CONDITIONS AND APPROVED BY THE PROJECT ENGINEER AS BEING CONSTRUCTED IN SUBSTANTIAL COMPLIANCE WITH APPROVED DETAILS FOR CONSTRUCTION.

BENCHMARK



REVISIONS

DESIGNED BY \_\_\_\_\_  
 DRAWN BY \_\_\_\_\_  
 CHECKED BY \_\_\_\_\_  
 AS-BUILT BY \_\_\_\_\_  
 CHECKED BY \_\_\_\_\_  
**SANCTUARY OF PEACE**

**PROPOSED DRAINAGE MAP (DETAIL)**

MVE PROJECT **61087**  
 MVE DRAWING **PP-DM2**

**September 24, 2021**  
**SHEET 1 OF 1**



**MVE, INC.**  
ENGINEERS SURVEYORS

1903 kelaray street, suite 200  
colorado springs, co 80909  
719.635.5736

# Preliminary & Final Drainage Report

## **Sanctuary of Peace Residential Community**

**PUD Development,  
Preliminary Plan and  
Final Plat**

**Project Number 61087**

PCD Proj # PUDSP-019-002

**April 28, 2020**

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# **Preliminary & Final Drainage Report**

for

**Sanctuary of Peace Residential Community**  
PUD Development, Preliminary Plan and Final Plat

**Project No. 61087**

**April 28, 2020**

prepared for

**Benet Hill Monastery of Colorado Springs, Inc.**  
3190 Benet Lane  
Colorado Springs, CO 80921  
719.355.1639

prepared by

**MVE, Inc.**  
1903 Lelaray Street, Suite 200  
Colorado Springs, CO 80909  
719.635.5736

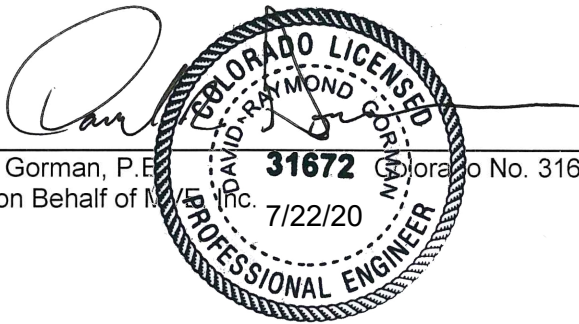
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61087 SOP Final Drainage Report-full.odt

# Statements and Acknowledgments

## Engineer's Statement

This attached Drainage plan and report were prepared by under my direct supervision and are correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.



David R. Gorman, P.E.  
For and on Behalf of M/ Inc.

7/22/20  
Date

## Developer's Statement

Benet Hill Monastery of Colorado Springs, Inc., the owner/developer have read and will comply with all the requirements specified in this drainage report and plan.

A handwritten signature in black ink.

Vincent Crowder  
Benet Hill Monastery of Colorado Springs, Inc.  
3190 Benet Lane  
Colorado Springs, CO 80921

7.22.20  
Date

## El Paso County

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

Jennifer Irvine, P.E. , *County Engineer / ECM Administrator*  
El Paso County

**APPROVED**  
**Engineering Department**

10/08/2020 7:19:51 AM

*dSDNijkamp*

**EPC Planning & Community  
Development Department**

**Final Drainage Report**  
**Sanctuary of Peace Filing No. 1**  
Project No. 61087

**PURPOSE**

This is the Final Drainage Report is for the Sanctuary of Peace Residential Community PUD Development and Preliminary Plan, and the Final Plat of Sanctuary of Peace Filing No. 1. The purpose of this Final Drainage Report is to identify on-site and off-site drainage patterns, storm sewer, culvert and inlet locations, areas tributary to the site and to safely route developed storm water to adequate outfalls.

**SUMMARY OF DATA**

- Black Squirrel Creek Drainage Basin Planning Study – URS Consultants – January, 1989
- Smith Creek Drainage Basin Planning Study – JR Engineering – August, 2002
- Drainage Letter for Benet Hill Monastery/Ministry Center – Bradley B. Bean, PE – August 17, 2007
- City of Colorado Springs “Drainage Criteria Manual, Volume 1”, May, 2014.
- City of Colorado Springs and El Paso County “Drainage Criteria Manual, Volume 2” May, 2014.
- Soil Survey for El Paso County, Colorado, U.S. Department of Agriculture, Soil Conservation Service.
- “Flood Insurance Studies for Colorado Springs and El Paso County, Colorado”, prepared by the Federal Emergency Management Agency (FEMA), December 7, 2018.

Except for the previously mentioned drainage reports, no other drainage reports were reviewed during the course of preparing this drainage report.

**GENERAL LOCATION & DESCRIPTION**

The Sanctuary of Peace Residential Community contains 49.58+/- acres of land. Said Community is situate in South Half of Section 27, Township 11 South, Range 66 West of the 6<sup>th</sup> Principal Meridian within the County of El Paso, and the State of Colorado. The El Paso County Assessor Schedule Number is 7103001034 for the parcel of land and the address is 15760 State Highway 83.

The Sanctuary of Peace Residential Community is bounded on the east by State Highway 83, on the north by Benet Lane, on the west by Black Forest Park subdivision, and on the south by 10 & 20+/- acres parcels of un-platted land.

The Sanctuary of Peace Residential Community is located in two Major Drainage Basins and they are Black Squirrel Creek and Smith Creek of which are both Fee Basins.

## **FLOODPLAIN STATEMENT**

The Sanctuary of Peace Residential Community is not located in a designated floodplain as denoted on the Flood Insurance Rate Map (FIRM), map number 08041C0295G, effective date December 7, 2018. The FIRM is included in the **Appendix** for readers reference.

## **SOILS**

The SCS Soils Map describes the soils as consisting of Kettle gravelly loamy sand (map unit 41), which is Hydrologic group "B". A soils Map and soils information is included for readers reference.

## **PROPOSED DEVELOPMENT**

The proposed PUD Development Plan Preliminary Plan is composed of 27 Lots and 6 Tracts with drives, parking, landscaping, and three (3) Water Quality Sand Filter Basins. The proposed development is composed of 27 lots, clustered on 2.93 acres with 0.77 acres of paved roads, totaling 3.70 acres which is to be developed out of the parcel's total acreage of 49.58 acres. This Final Drainage report assumes a developed state for the entire development.

## **DRAINAGE CRITERIA**

This Final Drainage Report for the Sanctuary of Peace Residential Community has been prepared according to the report guidelines presented in the *El Paso County Drainage Criteria Manual* (DCM). The County has also adopted portions of the City of Colorado Springs Drainage Criteria Volumes 1 and 2, especially concerning the calculation rainfall runoff rates. The hydrologic analysis is based on a collection of data from the DCM, the NRCS Web Soil Survey, topographic mapping and property boundary information provided by Polaris Land Surveying, Inc. and proposed plan layout, grading, and drainage system layout developed by M.V.E., Inc. All proposed drainage facilities are approximate in size and may vary with actual layout and design.

For this final drainage report the Rational Method as described in the *City of Colorado Springs Drainage Criteria Manual* has been used for all Storm Runoff calculations, as the development and all sub-basins are less than 130 acres in area. "Colorado Springs Rainfall Intensity Duration Frequency" curves, Figure 6-5 in the DCM, was used to obtain the design rainfall values; a copy is included in the **Appendix**. The "Overland (Initial) Flow Equation" (Eq. 6-8) in the DCM, and Manning's equation with estimated depths were used in time of concentration calculations. "Runoff Coefficients for Rational Method", Table 6-6 in the

DCM, was utilized as a guide in estimating runoff coefficient and Percent Impervious values; a copy is included in the **Appendix**. Peak runoff discharges were calculated for each drainage sub-basin for both the 5-year storm event and the 100-year storm event with the Rational Method formula, (Eq. 6-5) in the DCM.

## **DRAINAGE CHARACTERISTICS AND EXISTING DRAINAGE FACILITIES**

The Development Plan for this site is proposing a clustered residential community, with drives, parking, landscaping, and three (3) Water Quality Sand Filter Basins. The site site of 49.58 acres, will have 27 Lots clustered on 3.90 acres with drives, parking, and existing trees & vegetation. The remainder of lands will be undisturbed except for placement of the Onsite Wastewater Treatment Systems (OWTS) and the placement of the three (3) Water Quality Basins.

The following descriptions describe how the existing and developed storm water flows are and will be handled. This Final Drainage Report for the PUD Development, Preliminary Plan and Final Plat submittal is hereby provided for the proposed Development. The existing and proposed Drainage Maps have been included in this report showing the improvements on the Sanctuary of Peace Residential Community for the readers reference.

Hydraulic Grade Line calculations are required, but will be provided with the construction drawings.

## **EXISTING DRAINAGE BASIN DESCRIPTIONS**

An Existing Drainage Map is included for readers reference and an analysis has been included in the report. The site is within two Major Drainage Basins split by a ridge traversing the site from north to south near the middle of the site. The Black Squirrel Major Basin composes the eastern portion of the site and contains 19.73 acres. The Smith Creek Basin composes the western portion of the site and contains 29.85 acres.

The off-site drainage Basins OS A, OS B, and OS C storm water flows are calculated as existing flows and will remain as existing as there is no proposed development in these off-site Basins proposed by this plan.

Refer to he included Existing Drainage Map for direction and quantity of these existing storm water flows.

## **DEVELOPED DRAINAGE BASIN DESCRIPTIONS**

A Proposed Drainage Map is included for readers reference and an analysis has been included in the report. The 49.58 acre site has been split into nine (9) on-site Drainage Basins with 7 of these Drainage Basins being located in the Black Squirrel Major Basin and 2 of these Drainage Basins being located in the Smith Creek Major Basin. The off-site Drainage Basins number three (3) with one (1) of these Drainage Basins being located in the Black Squirrel Major Basin and two (2) of these Drainage Basins being located in the Smith Creek Major Basin.

The clustered residential community portion to be developed of 3.90 acres is a very small portion of the total site and includes five (5) on site drainage basins.

The off-site drainage Basins OS A, OS B, and OS C storm water flows are not changed from their existing characteristics and do not affect our site as delineated in the above Existing Drainage Basin Descriptions.

Design Point P1 has existing storm water flows from drainage Basins OS A, OSB, & A2 and will flow overland & under Benet Lane continuing overland and exiting the Subdivision at the west side close to the southwest corner at a rate of  $Q_5 = 34.8$  cfs and  $Q_{100} = 230.2$  cfs as it has historically done.

Design Point PP2 has proposed storm water flows from Drainage Basin A1 and will flow overland across the private drive and overland through 8 lots to the proposed Full Spectrum Sand Filter Basin (FSSFB) - A1 at DP2. Storm Drainage flows will be treated and released at a rate of  $Q_5 = 0.1$  cfs and  $Q_{100} = 3.1$  cfs from the FSSFB - A1. The capacity of said FSSFB - A1 will be not less than 5,991+/- cubic feet (CF) to accept the required Water Quality Capture Volume for the developed Drainage Basin A1. Excess flows above the Water Quality Capture Volume requirement will over flow to a proposed 22' wide emergency spillway from the pond. These flows will pass through a 20' wide & 1' deep concrete weir onto a rip rap emergency spillway. These flows combine on site with Drainage Basin OS A, OS B, & A2 as shown on the included Proposed Drainage Map (Detail) for readers reference. The combined rate of flow is  $Q_5 = 34.8$  cfs and  $Q_{100} = 229.9$  cfs and exit the site at Design Point DP1.

Design Point DP3 has proposed storm water flows from Drainage Basin C2 and will flow overland across the private driveway and overland through 3 lots to the proposed Full Spectrum Sand Filter Basin (FSSFB) - C2 at DP3. Storm Drainage flows will be treated and released at a rate of  $Q_5 = 0.0$  cfs and  $Q_{100} = 1.1$  cfs from the FSSFB - C2. The capacity of said FSSFB - C2 will be not less than 1,783+/- cubic feet (CF) to accept the required Water Quality Capture Volume for the developed Drainage Basin C2. Excess flows above the Water Quality Capture Volume requirement will over flow to a proposed 12' wide emergency spillway from the pond. These flows will pass through a 10' wide & 1' deep concrete weir onto a rip rap emergency spillway. These flows combine on site with Drainage Basin C3 as shown on the included Proposed Drainage Map (Detail) for readers reference. The combined rate of flow is  $Q_5 = 0.4$  cfs and  $Q_{100} = 4.2$  cfs and exit the site at Design Point DP4.

Design Point DP5 has proposed storm water flows from Drainage Basin C4 and will flow overland exiting the subdivision along the southern boundary line at a rate of  $Q_5 = 0.2$  cfs and  $Q_{100} = 1.6$  cfs. This area remains in its existing state of forested land.

Design Point DP6 has proposed storm water flows from Drainage Basin C1 and will flow overland & through 8 lots, under the private drive via an 18" RC Pipe combining with the overland flow through 5 lots to the proposed Full Spectrum Sand Filter Basin (FSSFB) - C1 at PP6. Storm Drainage flows will be treated and released at a rate of  $Q_5 = 0.1$  cfs and  $Q_{100} = 6.1$  cfs from the FSSFB - C1. The capacity of said FSSFB - C1 will be not less than 10,563+/- cubic feet (CF) to accept the required Water Quality Capture Volume for the developed Drainage Basin C1. Excess flows above the Water Quality Capture Volume requirement will over flow to a proposed 26' wide emergency spillway from the pond. These flows will pass through a 24' wide & 1' deep concrete weir onto a rip rap emergency

spillway. These flows combine on site with Drainage Basin C5 as shown on the included Proposed Drainage Map (Detail) for readers reference. The combined rate of flow is Q5 = 0.6 cfs and Q100 = 10.0 cfs and will exit the site at Design Point DP7.

Design Point DP8 has proposed storm water flows from Drainage Basin B1 and will flow overland to Benet Lane (private drive) and cross under said drive via an 18" RC Pipe into Basin B2. This area remains in its existing state of forested land. The rate of flow is Q5 = 0.6 cfs and Q100 = 10.0 cfs and exits at Design Point PP8.

Design Point PP9 has proposed storm water flows from Drainage Basin OS C and will flow overland to Benet Lane (private drive) and under Benet Lane via existing culverts. These storm water flows will combine with DP8 and overland flows from Basin B2. This area remains in its existing state of forested land. The rate of flow is Q5 = 24.9 cfs and Q100 = 137.2 cfs and exits the site along its southerly boundary designated as Point of Interest DP9.

## **WATER QUALITY**

The Urban Drainage and Flood Control District provides criteria for design of a water quality pond as part of the Sand Filter design guidelines. This criteria specifies that this type of water quality pond shall be drained over a 12-hour period. The relief (grade change) of the natural gullies will allow the Water Quality Sand Filter Basin treated storm waters and storm waters to discharge at same grade.

The Full Spectrum Sand Filter Basins ( are to be located on the southern and western side of the clustered housing will be constructed to collect the runoff from the developed portion of the site and treat & reduce the discharges from the site to existing levels. The Full Spectrum Sand Filter Basins will be constructed in accordance with El Paso County drainage criteria as supplemented by the accepted Urban Drainage Criteria, procedures, and methods. They will be owned and maintained by the Sanctuary of Peace Home Owners Association. These Full Spectrum Sand Filter Basins will be sited and located in the field by the Project Engineer to allow the designs to blend with the environment and limit unnecessary disturbance of land, trees, and vegetation. Once the Full Spectrum Sand Filter Basins are constructed, As- Built surveys will be conducted and a Substantial Compliance letter for the construction of them will be prepared by the Project Engineer.

## **EROSION CONTROL**

During future construction, best management practices (BMP's) for erosion control will be employed based on the previously referenced El Paso County Drainage Criteria Manual Volume 1 & 2 and the approved Erosion Control Plan to minimize erosion from the site. The BMP's will remain in place until the site is stabilized with the new hard surfacing or landscape seeding, planting and cover materials. Also, BMP's will be utilized as deemed necessary by the contractor, engineer, owner, or County inspector and are not limited to the measures described on the Erosion Control Plan.

## **WATER QUALITY ENHANCEMENT BEST MANAGEMENT PRACTICES**

This development will utilize the three (3) Full Spectrum Sand Filter Basins to be constructed. The Basins have been adequately sized for this purpose. Other drainage facilities in this project consist of two (2) - 18 " RC Pipes at proposed locations under the new private drive. These facilities will be private and will be maintained by the development's homeowners association. A Grading and Erosion Control Plan for the construction of the site has been prepared in accordance with the provisions of the County's Engineering Criteria Manual in conjunction with the private drive plan & profile design drawings. Placement of construction storm water BMP's will as required by the plan will limit soil erosion and deposition by storm water flowing over the site.

The El Paso County Engineering Criteria Manual (Appendix I, Section I.7.2 ) requires the consideration of a "Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainage-ways, and implementing long term source controls". The Four Step Process is incorporated in this project and the elements are discussed below.

- 1) Runoff Reduction Practices are employed in this project. Impervious surfaces have been reduced as much as practically possible. A significant portion of the site, 45.88 acres, which is 92% will remain as pervious well treed open space.
- 2) There are no drainage paths on the site that are required to be stabilized as they are well vegetated with no visual erosion. The Water Quality Detention Water Quality Basins will intercept flows from developed areas. Additionally, all inflow points will be stabilized by re-vegetation as incoming flows are not erosive.
- 3) The project contains no potentially hazardous uses. All developed areas drain into a proposed a Water Quality Capture Volume (WQCV) BMP.
- 4) The site is residential in nature and contains no storage of potentially harmful substances or use of potentially harmful substances. No Site Specific or Other Source Control BMP's are required.

The following cost opinion is for the construction of the required private storm water appurtenances. There are no public storm water facilities required.

## **DRAINAGE FACILITIES CONSTRUCTION COST ESTIMATE**

### **Opinion of Costs – Private Storm Water Facilities**

•	73 Lf	18" RC Pipe	@ \$ 65 per Lf	= \$ 4,745
•	4 Ea	18" RC Flared End	@ \$ 390 per Ea	= 1,560
•	4 Tn	Type VL Rip-Rap	@ \$ 80 per Tn	= 320
•	1187 Cy	Sand Filter Basin Constr.	@ \$ 20 per Cy	= 23,740
•	3 Ea	Sand Filter Basin Spillway	@ \$2003 per Ea	= 6,009
•	3 Ea	Sand Filter Basin Outlet Str.	@ \$1480 per Ea	= <u>4,440</u>
		<b>Grand Total</b>		<b>= \$40,814</b>



## **DRAINAGE, BRIDGE, AND SURCHARGE FEES**

The Sanctuary of Peace Residential Community contains 49.58 acres of land. The Board of County Commissioners, County of El Paso, State of Colorado Resolution No. 99-383 allows the drainage basin fee to be based on impervious acreage. Black Squirrel Creek Basin contains 1.55 acres and Smith Creek Basin contains 0.67 acres of developed impervious acreage.

The resolution also allows a fee reduction of 25% for those portions of the development that consist entirely of 2.5 acre and larger lots. The Sanctuary of Peace Residential Community has clustered lots of below the 2.5 acre limit and therefore does not qualify.

### **FEE CALCULATION (2020 Fees)**

#### **Black Squirrel Drainage Basin**

Drainage Fee \$8,664 / Impervious Acre @ 1.55 Acres = \$ 13,429.20

Bridge Fee \$545 / Impervious Acre @ 1.55 Acres = \$ 844.75

#### **Smith Creek Drainage Basin**

Drainage Fee \$7,780 / Impervious Acre @ 0.67 Acres = \$ 5,212.60

Bridge Fee \$1,044 / Impervious Acre @ 0.67 Acres = \$ 699.48

Grand Total Fees = \$ 20,186.03

## **CONCLUSION**

The proposed site improvements will direct, control, and treat storm drainage runoff. The downstream drainage facilities will accept the proposed flows as described in this report. The proposed development of said Sanctuary of Peace Residential Community will not negatively impact the adjacent properties and down stream drainage facilities.

# Appendices

## **1 General Maps and Supporting Data**

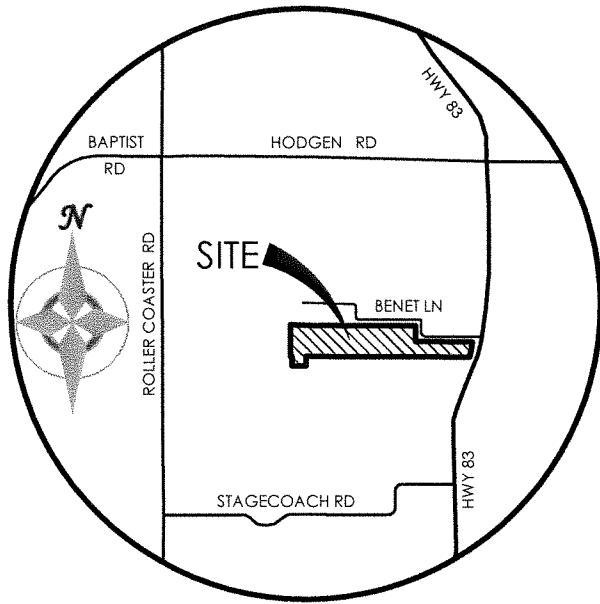
Vicinity Map

Portion of Flood Insurance Rate Map

Soil Type map and Tables

Official Soil Series Descriptions

Hydrologic Soil Group Map and Tables



VICINITY MAP

NOT TO SCALE

# National Flood Hazard Layer FIRMette



39°3'53.61"N



USGS The National Map, Orthoimagery, Data refreshed October, 2017.

39°3'25.68"N

1:6,000

Feet

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

104°45'30.88"W

## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

### SPECIAL FLOOD HAZARD AREAS



Without Base Flood Elevation (BFE)  
Zone A, V, A99  
With BFE or Depth Zone AE, AO, AH, VE, AR  
Regulatory Floodway

0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X  
Future Conditions 1% Annual Chance Flood Hazard Zone X  
Area with Reduced Flood Risk due to Levee. See Notes. Zone X  
Area with Flood Risk due to Levee Zone D



Area of Minimal Flood Hazard Zone X  
Effective LOMFRs  
Area of Undetermined Flood Hazard Zone D

### OTHER AREAS



Channel, Culvert, or Storm Sewer  
Levee, Dike, or Floodwall

### GENERAL STRUCTURES



Cross Sections with 1% Annual Chance Water Surface Elevation  
Coastal Transect  
Base Flood Elevation Line (BFE)  
Limit of Study  
Coastal Transect Baseline  
Profile Baseline  
Hydrographic Feature

### OTHER FEATURES



Digital Data Available  
No Digital Data Available  
Unmapped

### MAP PANELS



Digital Data Available  
No Digital Data Available  
Unmapped

### OTHER FEATURES



Digital Data Available  
No Digital Data Available  
Unmapped



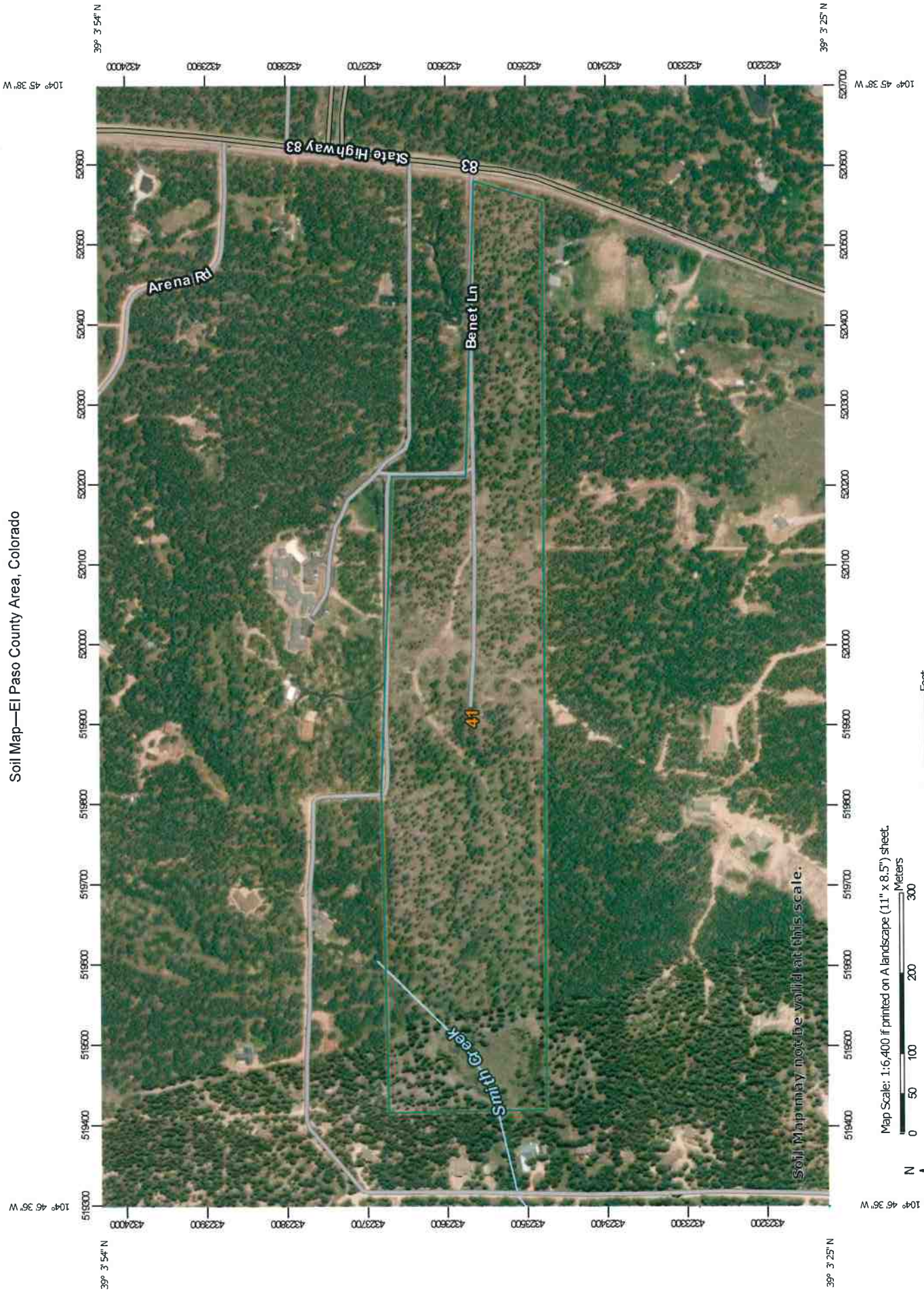
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/9/2019 at 2:51:17 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Soil Map—El Paso County Area, Colorado



Soil Map may not be valid at this scale.

Map Scale: 1:6,400 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

## MAP LEGEND

-  Area of Interest (AOI)
-  Area of Interest (AOI)
- Soils**
-  Soil Map Unit Polygons
-  Soil Map Unit Lines
-  Soil Map Unit Points
- Special Point Features**
-  Blowout
-  Borrow Pit
-  Clay Spot
-  Closed Depression
-  Gravel Pit
-  Gravelly Spot
-  Landfill
-  Lava Flow
-  Marsh or swamp
-  Mine or Quarry
-  Miscellaneous Water
-  Perennial Water
-  Rock Outcrop
-  Saline Spot
-  Sandy Spot
-  Severely Eroded Spot
-  Sinkhole
-  Slide or Slip
-  Sodic Spot
-  Spoil Area
-  Stony Spot
-  Very Stony Spot
-  Wet Spot
-  Other
-  Special Line Features
- Water Features**
-  Streams and Canals
- Transportation**
-  Rails
-  Interstate Highways
-  US Routes
-  Major Roads
-  Local Roads
- Background**
-  Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service  
 Web Soil Survey URL:  
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado  
 Survey Area Data: Version 16, Sep 10, 2018

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

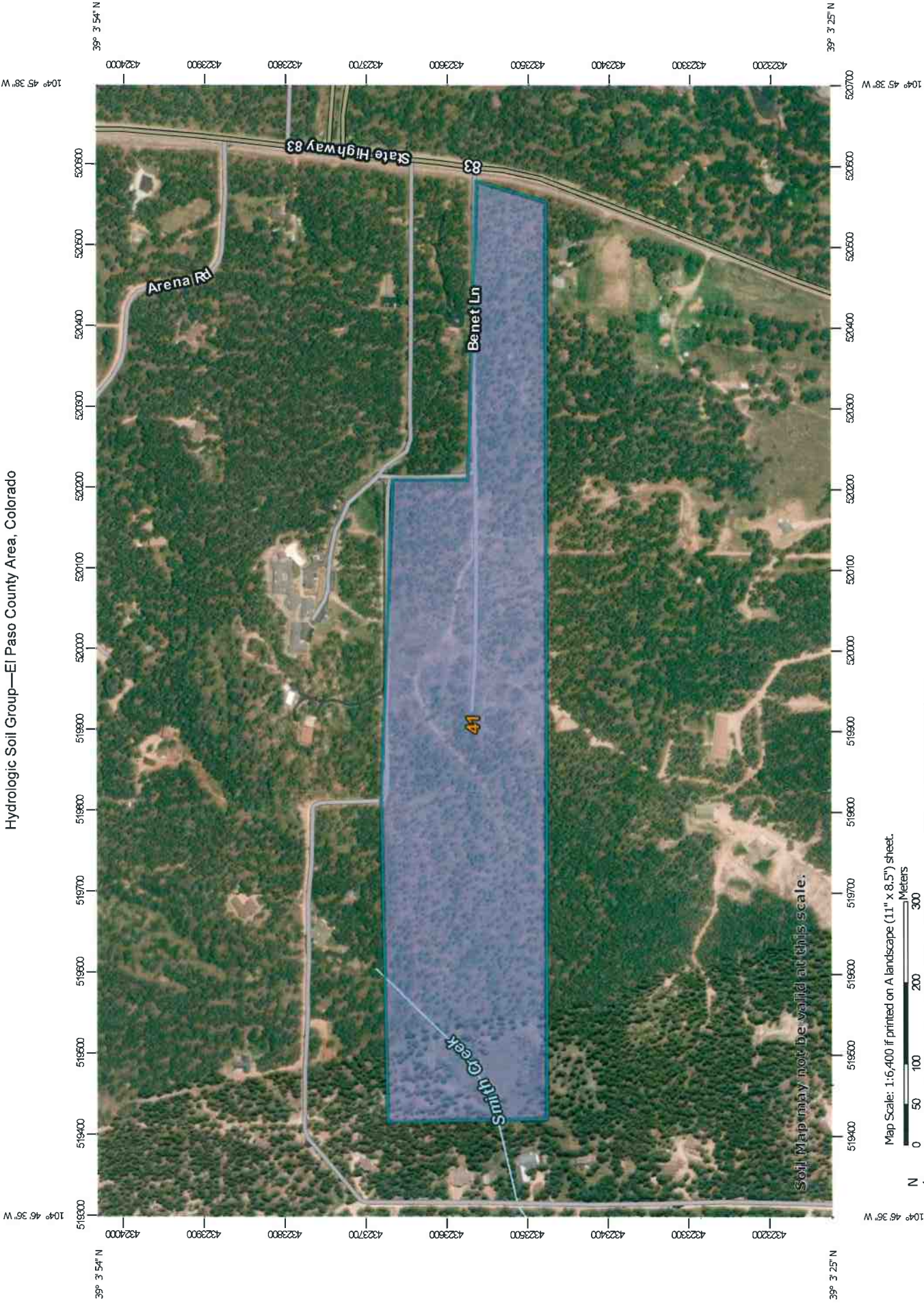
Date(s) aerial images were photographed: Jul 4, 2010—Oct 16, 2017

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
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	47.2	100.0%
<b>Totals for Area of Interest</b>		<b>47.2</b>	<b>100.0%</b>

Hydrologic Soil Group—El Paso County Area, Colorado



Soil Map may not be valid at this scale.

































Map Scale: 1:6,400 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84



## MAP LEGEND

<b>Area of Interest (AOI)</b>	 C
 Area of Interest (AOI)	 C/D
<b>Soils</b>	 D
<b>Soil Rating Polygons</b>	 Not rated or not available
 A	<b>Water Features</b>
 A/D	 Streams and Canals
 B	<b>Transportation</b>
 B/D	 Rails
 C	 Interstate Highways
 C/D	 US Routes
 D	 Major Roads
 Not rated or not available	 Local Roads
<b>Soil Rating Lines</b>	<b>Background</b>
 A	 Aerial Photography
 A/D	
 B	
 B/D	
 C	
 C/D	
 D	
 Not rated or not available	
<b>Soil Rating Points</b>	
 A	
 A/D	
 B	
 B/D	

## 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: El Paso County Area, Colorado  
 Survey Area Data: Version 16, Sep 10, 2018

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

Date(s) aerial images were photographed: Jul 4, 2010—Oct 16, 2017

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.

## Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	47.2	100.0%
<b>Totals for Area of Interest</b>			<b>47.2</b>	<b>100.0%</b>

### Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

### Rating Options

*Aggregation Method:* Dominant Condition

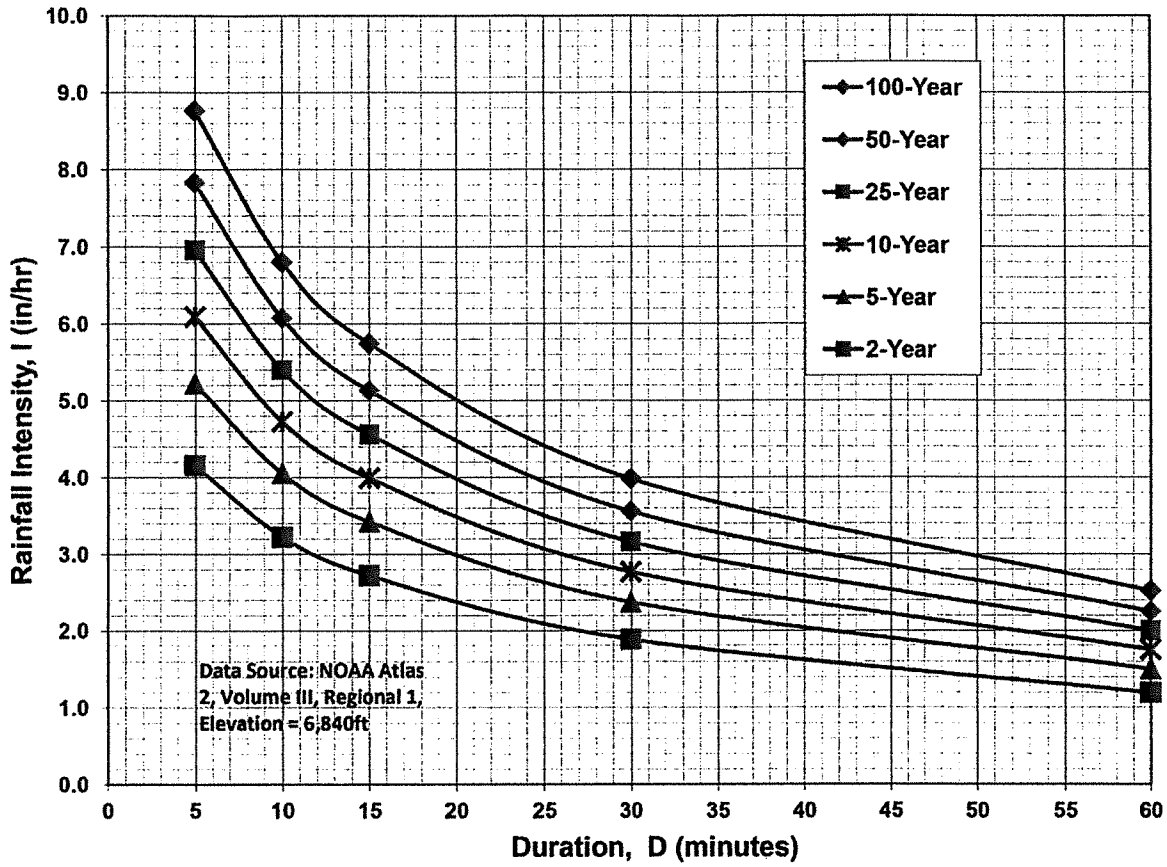
*Component Percent Cutoff: None Specified*

*Tie-break Rule: Higher*

**Table 6-6. Runoff Coefficients for Rational Method**  
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients															
		2-year		5-year		10-year		25-year		50-year		100-year					
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D				
Business																	
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89				
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.62	0.65	0.62	0.68				
Residential																	
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.59	0.62	0.59	0.65				
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.50	0.54	0.50	0.58				
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.47	0.52	0.47	0.57				
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.46	0.51	0.46	0.56				
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.44	0.50	0.44	0.55				
Industrial																	
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74				
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83				
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52				
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54				
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58				
Undeveloped Areas																	
Historic Flow Analysis--																	
Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51				
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50				
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50				
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96				
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59				
Streets																	
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96				
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74				
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96				
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83				
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50				

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



**IDF Equations**

$$I_{100} = -2.52 \ln(D) + 12.735$$

$$I_{50} = -2.25 \ln(D) + 11.375$$

$$I_{25} = -2.00 \ln(D) + 10.111$$

$$I_{10} = -1.75 \ln(D) + 8.847$$

$$I_5 = -1.50 \ln(D) + 7.583$$

$$I_2 = -1.19 \ln(D) + 6.035$$

Note: Values calculated by equations may not precisely duplicate values read from figure.

Job No.: 61087

Project: Sanctuary of Peace

Date: 9/12/2019 15:12

Calcs By: ASM

Checked By:

**Time of Concentration** (Modified from Standard Form SF-1)

Sub-Basin	Sub-Basin Data			Overland			Shallow Channel			Channelized			t <sub>c</sub> Check					
	Area (Acres)	C <sub>5</sub>	C <sub>100</sub> /CN	% Imp.	L <sub>0</sub> (ft)	S <sub>0</sub> (%)	t <sub>i</sub> (min)	L <sub>0t</sub> (ft)	S <sub>0t</sub> (ft/ft)	V <sub>osc</sub> (ft/s)	t <sub>i</sub> (min)	L <sub>0c</sub> (ft)	S <sub>0c</sub> (ft/ft)	V <sub>oc</sub> (ft/s)	t <sub>c</sub> (min)	L (min)	t <sub>c,att</sub> (min)	t <sub>c</sub> (min)
EX-A1	30.11	0.08	0.35	0%	100	9%	8.9	1483	0.072	1.9	13.1	117	0.043	1.6	1.2	1700	N/A	23.3
EX-B1	2.06	0.08	0.35	0%	100	8%	9.3	383	0.044	1.5	4.3	84	0.060	1.9	0.8	567	N/A	14.4
EX-B2	8.75	0.08	0.35	0%	100	7%	9.7	211	0.047	1.5	2.3	0	0.000	0.0	0.0	311	N/A	12.0
EX-C1	5.68	0.08	0.35	0%	100	11%	8.3	622	0.040	1.4	7.4	0	0.000	0.0	0.0	722	N/A	15.7
EX-C2	2.03	0.08	0.35	0%	100	8%	9.3	200	0.085	2.0	1.6	0	0.000	0.0	0.0	300	N/A	10.9
EX-C3	0.66	0.08	0.35	0%	100	10%	8.6	117	0.060	1.7	1.1	0	0.000	0.0	0.0	217	N/A	9.8
OS A	69.40	0.08	0.35	0%	100	3%	12.8	1030	0.063	1.8	9.8	1887	0.041	1.6	19.4	3017	N/A	41.9
OS B	83.92	0.10	0.37	3%	100	3%	12.5	1030	0.063	1.8	9.8	1887	0.041	1.6	19.4	3017	N/A	41.7
OS C	49.12	0.12	0.38	5%	100	5%	10.4	995	0.070	1.9	8.9	597	0.090	2.2	4.6	1692	N/A	23.9
A1	1.85	0.36	0.55	36%	100	11%	6.1	217	0.055	1.2	3.1	0	0.000	0.0	0.0	317	N/A	9.1
A2	28.30	0.08	0.35	0%	100	9%	8.9	1483	0.072	1.3	18.4	117	0.043	5.7	0.3	1700	N/A	27.7
B1	2.36	0.08	0.35	0%	100	8%	9.3	383	0.044	1.5	4.3	84	0.060	1.9	0.8	567	N/A	14.4
B2	9.23	0.10	0.36	2%	100	7%	9.5	211	0.047	1.5	2.3	0	0.000	0.0	0.0	311	N/A	11.8
C1	4.07	0.27	0.49	25%	100	16%	6.0	457	0.046	1.1	7.1	0	0.000	0.0	0.0	557	N/A	13.1
C2	0.66	0.28	0.49	27%	89	7%	7.5	100	0.060	1.2	1.4	0	0.000	0.0	0.0	189	N/A	8.8
C3	1.36	0.08	0.35	0%	100	7%	9.7	173	0.075	1.4	2.1	0	0.000	0.0	0.0	273	N/A	11.8
C4	0.64	0.08	0.35	0%	81	14%	7.0	140	0.071	1.3	1.7	0	0.000	0.0	0.0	221	N/A	8.8
C5	1.61	0.08	0.35	0%	100	10%	8.6	123	0.065	1.3	1.6	0	0.000	0.0	0.0	223	N/A	10.2

Job No.: 61087  
 Project: Sanctuary of Peace  
 Design Storm: 5-Year Storm (20% Probability)  
 Jurisdiction: DCM

Date: 9/16/2019 14:37  
 Calcs By: ASM  
 Checked By:

Sub-Basin and Combined Flows (Modified from Standard Form SF-2)

DP	Sub-Basin	Area (Acres)	C5	Direct Runoff			Combined Runoff			Streetflow			Pipe Flow			Travel Time				
				t <sub>c</sub> (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	t <sub>c</sub> (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Slope (%)	n	Length (ft)	D <sub>Pipe</sub> (in)	Length (ft)	V <sub>osc</sub> (ft/s)
	EX-A1	30.11	0.08	23.3	2.41	2.86	6.9													
	EX-B1	2.06	0.08	14.4	0.16	3.59	0.6													
	EX-B2	8.75	0.08	12.0	0.70	3.86	2.7													
	EX-C1	5.68	0.08	15.7	0.45	3.45	1.6													
	EX-C2	2.03	0.08	10.9	0.16	4.00	0.7													
	EX-C3	0.66	0.08	9.8	0.05	4.17	0.2													
	OSA	69.40	0.08	41.9	5.77	1.98	11.4													
	OSB	83.92	0.10	41.7	8.73	1.99	17.4													
	OSC	49.12	0.12	23.9	5.87	2.82	16.6													
	A1	1.85	0.36	9.1	0.66	4.26	2.8													
	A2	28.30	0.08	27.7	2.26	2.60	5.9													
	B1	2.36	0.08	14.4	0.19	3.59	0.7													
	B2	9.23	0.10	11.8	0.89	3.87	3.4													
	C1	4.07	0.27	13.1	1.11	3.72	4.1													
	C2	0.66	0.28	8.8	0.18	4.32	0.8													
	C3	1.36	0.08	11.8	0.11	3.88	0.4													
	C4	0.64	0.08	8.8	0.05	4.33	0.2													
	C5	1.61	0.08	10.2	0.13	4.10	0.5													
EX1		153.32	0.09					41.9	14.13	2.53	35.7									
EX4		2.03	0.08					10.9	0.16	4.00	0.7									
EX5		0.66	0.08					9.8	0.05	4.17	0.2									
EX7		5.68	0.08					15.7	0.45	3.45	1.6									
EX9		59.93	0.11					23.9	6.73	2.82	19.0									
DP1		183.47	0.09					9.1	16.93	4.26	34.8									
DP2		1.85	0.36					9.1	0.66	4.26	2.8									
DP3		0.66	0.28					8.8	0.18	4.32	0.8									
DP4		2.02	0.08					11.8	0.16	3.88	0.4									
DP5		0.64	0.08					8.8	0.05	4.33	0.2									
DP6		4.07	0.27					13.1	1.11	3.72	4.1									
DP7		5.69	0.08					10.2	0.45	4.10	0.6									
DP8		2.36	0.08					14.4	0.19	3.59	0.7									
DP9		60.72	0.11					14.4	6.94	3.59	24.9									

DCM:  $I = C1 * In(t_c) + C2$   
 C1: 1.5  
 C1: 7.683

Job No.: 61087  
 Project: Sanctuary of Peace  
 Design Storm: 100-Year Storm (1% Probability)  
 Jurisdiction: DCM

Date: 9/16/2019 14:38  
 Calcs By: ASM  
 Checked By:

Sub-Basin and Combined Flows (Modified from Standard Form SF-2)

DP	Sub-Basin	Area (Acres)	C100	Direct Runoff			Combined Runoff			Streetflow			Pipe Flow			Travel Time			
				t <sub>c</sub> (min)	CA (Acres)	I100 (in/hr)	Q100 (cfs)	t <sub>c</sub> (min)	CA (Acres)	I100 (in/hr)	Q100 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Slope (%)	Length (ft)	D <sub>pipe</sub> (in)	Length (ft)	V <sub>obs</sub> (ft/s)
	EX-A1	30.11	0.35	23.3	10.54	4.81	50.6												
	EX-B1	2.06	0.35	14.4	0.72	6.02	4.3												
	EX-B2	8.75	0.35	12.0	3.06	6.47	19.8												
	EX-C1	5.68	0.35	15.7	1.99	5.79	11.5												
	EX-C2	2.03	0.35	10.9	0.71	6.71	4.8												
	EX-C3	0.66	0.35	9.8	0.23	7.00	1.6												
	OSA	69.40	0.35	41.9	24.44	3.32	81.1												
	OSB	83.92	0.37	41.7	30.79	3.34	102.7												
	OSC	49.12	0.38	23.9	18.61	4.73	88.1												
	A1	1.85	0.55	9.1	1.02	7.16	7.3												
	A2	28.30	0.35	27.7	9.90	4.37	43.3												
	B1	2.36	0.35	14.4	0.83	6.02	5.0												
	B2	9.23	0.36	11.8	3.34	6.51	21.7												
	C1	4.07	0.49	13.1	1.99	6.25	12.5												
	C2	0.66	0.49	8.8	0.33	7.25	2.4												
	C3	1.36	0.35	11.8	0.48	6.52	3.1												
	C4	0.64	0.35	8.8	0.23	7.27	1.6												
	C5	1.61	0.35	10.2	0.56	6.88	3.9												
EX1		153.32	0.36					41.9	54.97	4.23	232.4								
EX4		2.03	0.35					10.9	0.71	6.71	4.8								
EX5		0.66	0.35					9.8	0.23	7.00	1.6								
EX7		5.68	0.35					15.7	1.99	5.79	11.5								
EX9		59.93	0.37					23.9	22.39	4.73	106.0								
DP1		183.47	0.36					9.1	65.80	3.50	230.2								
DP2		1.85	0.55					9.1	1.02	7.16	7.3								
DP3		0.66	0.49					8.8	0.33	7.25	2.4								
DP4		1.36	0.35					11.8	0.48	6.52	4.2								
DP5		0.64	0.35					8.8	0.23	7.27	1.6								
DP6		4.07	0.49					13.1	1.99	6.25	12.5								
DP7		1.61	0.35					10.2	0.56	6.88	10.0								
DP8		2.36	0.35					14.4	0.83	6.02	5.0								
DP9		60.72	0.38					14.4	22.78	6.02	137.2								

DCM: I = C1 \* ln(tc) + C2  
 C1: 2.52  
 C2: 12.735



## Sub-Basin Ex-A1 Runoff Calculations

Job No.:	61087	Date:	9/16/2019 10:38
Project:	Sanctuary of Peace	Calcs by:	ASM
Jurisdiction:	DCM	Checked by:	
Runoff Coefficient:	Surface Type	Soil Type:	B
		Urbanization:	Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	1,311,446	30.11	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	1,311,446	30.11	0.02	0.08	0.15	0.25	0.30	0.35	0.0%

4000

### Basin Travel Time

	Shallow Channel Ground Cover		Short Pasture/Lawns			
	$L_{max, Overland}$	100 ft	$S_0$	$v$	$t$	$t_{Alt}$
	L (ft)	$\Delta Z_0$ (ft)	(ft/ft)	(ft/s)	(min)	(min)
Total	1,700	121	-	-	-	-
Initial Time	100	9	0.090	-	8.9	N/A DCM Eq. 6-8
Shallow Channel	1,483	107	0.072	1.9	13.1	- DCM Eq. 6-9
Channelized	117	5	0.043	1.6	1.2	- V-Ditch
				$t_c$	23.3 min.	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.29	2.86	3.34	3.82	4.30	4.81
Runoff (cfs)	1.4	6.9	15.1	28.7	38.8	50.6
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.4	6.9	15.1	28.7	38.8	50.6

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin Ex-B1 Runoff Calculations

Job No.: 61087 Date: 9/16/2019 10:38  
 Project: Sanctuary of Peace Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Jurisdiction: DCM Soil Type: B  
 Runoff Coefficient: Surface Type Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	89,528	2.06	0.02	0.08	0.15	0.25	0.3	0.35	0%
	-	0.00							
<b>Combined</b>	<b>89,528</b>	<b>2.06</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

4000

### Basin Travel Time

	Shallow Channel Ground Cover		Short Pasture/Lawns			
	$L_{max,Overland}$	100 ft			$C_v$	7
	L (ft)	$\Delta Z_0$ (ft)	$S_0$ (ft/ft)	v (ft/s)	t (min)	$t_{Att}$ (min)
Total	567	30	-	-	-	-
Initial Time	100	8	0.080	-	9.3	N/A DCM Eq. 6-8
Shallow Channel	383	17	0.044	1.5	4.3	- DCM Eq. 6-9
Channelized	84	5	0.060	1.9	0.8	- V-Ditch
				$t_c$	<b>14.4 min.</b>	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.86	3.59	4.18	4.78	5.38	6.02
Runoff (cfs)	0.1	0.6	1.3	2.5	3.3	4.3
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	0.6	1.3	2.5	3.3	4.3

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin Ex-B2 Runoff Calculations

Job No.: 61087 Date: 9/16/2019 10:38  
 Project: Sanctuary of Peace Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Jurisdiction: DCM Soil Type: B  
 Runoff Coefficient: Surface Type Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	381,146	8.75	0.02	0.08	0.15	0.25	0.3	0.35	0%
	-	0.00							
<b>Combined</b>	<b>381,146</b>	<b>8.75</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

4000

### Basin Travel Time

	Shallow Channel Ground Cover		Short Pasture/Lawns			
	$L_{max,Overland}$	100 ft	$S_0$	$v$	$t$	$t_{Alt}$
	L (ft)	$\Delta Z_0$ (ft)	(ft/ft)	(ft/s)	(min)	(min)
Total	311	17	-	-	-	-
Initial Time	100	7	0.070	-	9.7	N/A DCM Eq. 6-8
Shallow Channel	211	10	0.047	1.5	2.3	- DCM Eq. 6-9
Channelized			0.000	0.0	0.0	- V-Ditch
				$t_c$	<b>12.0 min.</b>	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.08	3.86	4.50	5.14	5.78	6.47
Runoff (cfs)	0.5	2.7	5.9	11.2	15.2	19.8
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.5	2.7	5.9	11.2	15.2	19.8

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin Ex-C1 Runoff Calculations

Job No.: 61087  
 Project: Sanctuary of Peace  
 Jurisdiction: DCM  
 Runoff Coefficient: Surface Type

Date: 9/16/2019 10:38  
 Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Soil Type: B  
 Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	247,407	5.68	0.02	0.08	0.15	0.25	0.3	0.35	0%
	-	0.00							
<b>Combined</b>	<b>247,407</b>	<b>5.68</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

4000

### Basin Travel Time

	Shallow Channel Ground Cover		Short Pasture/Lawns			
	$L_{max, Overland}$	100 ft			$C_v$	7
	L (ft)	$\Delta Z_0$ (ft)	$S_0$ (ft/ft)	v (ft/s)	t (min)	$t_{Alt}$ (min)
Total	722	36	-	-	-	-
Initial Time	100	11	0.110	-	8.3	N/A DCM Eq. 6-8
Shallow Channel	622	25	0.040	1.4	7.4	- DCM Eq. 6-9
Channelized			0.000	0.0	0.0	- V-Ditch
				$t_c$	<b>15.7 min.</b>	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.76	3.45	4.02	4.60	5.17	5.79
Runoff (cfs)	0.3	1.6	3.4	6.5	8.8	11.5
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.3	1.6	3.4	6.5	8.8	11.5

DCM:  $t = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin Ex-C2 Runoff Calculations

Job No.: 61087  
 Project: Sanctuary of Peace  
 Jurisdiction: DCM  
 Runoff Coefficient: Surface Type

Date: 9/16/2019 10:38  
 Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Soil Type: B  
 Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	88,571	2.03	0.02	0.08	0.15	0.25	0.3	0.35	0%
	-	0.00							
<b>Combined</b>	<b>88,571</b>	<b>2.03</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

### Basin Travel Time

	Shallow Channel Ground Cover		Short Pasture/Lawns			
	$L_{max, Overland}$	100 ft	$S_0$ (ft/ft)	$v$ (ft/s)	$t$ (min)	$t_{Alt}$ (min)
Total	300	25	-	-	-	-
Initial Time	100	8	0.080	-	9.3	N/A DCM Eq. 6-8
Shallow Channel	200	17	0.085	2.0	1.6	- DCM Eq. 6-9
Channelized			0.000	0.0	0.0	- V-Ditch
				$t_c$	<b>10.9 min.</b>	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.19	4.00	4.67	5.33	6.00	6.71
Runoff (cfs)	0.1	0.7	1.4	2.7	3.7	4.8
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	0.7	1.4	2.7	3.7	4.8

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin Ex-C3 Runoff Calculations

Job No.: 61087  
 Project: Sanctuary of Peace  
 Jurisdiction: DCM  
 Runoff Coefficient: Surface Type

Date: 9/16/2019 10:38  
 Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Soil Type: B  
 Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	28,874	0.66	0.02	0.08	0.15	0.25	0.3	0.35	0%
	-	0.00							
<b>Combined</b>	<b>28,874</b>	<b>0.66</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

### Basin Travel Time

	Shallow Channel Ground Cover		Short Pasture/Lawns			
	$L_{max,Overland}$	100 ft	$S_0$	$v$	$t$	$t_{Alt}$
	L (ft)	$\Delta Z_0$ (ft)	(ft/ft)	(ft/s)	(min)	(min)
Total	217	17	-	-	-	-
Initial Time	100	10	0.100	-	8.6	N/A DCM Eq. 6-8
Shallow Channel	117	7	0.060	1.7	1.1	- DCM Eq. 6-9
Channelized			0.000	0.0	0.0	- V-Ditch
				$t_c$	<b>9.8 min.</b>	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.32	4.17	4.86	5.56	6.25	7.00
Runoff (cfs)	0.0	0.2	0.5	0.9	1.2	1.6
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	0.2	0.5	0.9	1.2	1.6

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.036	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin OS A Runoff Calculations

Job No.: 61087  
 Project: Sanctuary of Peace  
 Jurisdiction: DCM  
 Runoff Coefficient: Surface Type

Date: 9/16/2019 10:38  
 Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Soil Type: B  
 Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						%
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
Forest	3,004,559	68.98	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	18,357	0.42	0.57	0.59	0.63	0.66	0.68	0.7	80%
	-	0.00							
	-	0.00							
<b>Combined</b>	<b>3,022,916</b>	<b>69.40</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.5%</b>

4000

### Basin Travel Time

	Shallow Channel Ground Cover		Short Pasture/Lawns				
	$L_{max,Overland}$	100 ft			$C_v$	7	
	L (ft)	$\Delta Z_0$ (ft)	$S_0$ (ft/ft)	v (ft/s)	t (min)	$t_{Alt}$ (min)	
Total	3,017	146	-	-	-	-	
Initial Time	100	3	0.030	-	12.8	N/A	DCM Eq. 6-8
Shallow Channel	1,030	65	0.063	1.8	9.8	-	DCM Eq. 6-9
Channelized	1,887	78	0.041	1.6	19.4	-	V-Ditch
				$t_c$	41.9 min.		

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.59	1.98	2.31	2.64	2.97	3.32
Runoff (cfs)	2.6	11.4	24.5	46.2	62.3	81.1
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	2.6	11.4	24.5	46.2	62.3	81.1

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin OS B Runoff Calculations

Job No.: 61087  
 Project: Sanctuary of Peace  
 Jurisdiction: DCM  
 Runoff Coefficient: Surface Type

Date: 9/16/2019 10:38  
 Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Soil Type: B  
 Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						%
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
Forest	3,507,946	80.53	0.02	0.08	0.15	0.25	0.3	0.35	0%
Driveways & Walks	16,239	0.37	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	77,470	1.78	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	53,907	1.24	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>3,655,562</b>	<b>83.92</b>	<b>0.05</b>	<b>0.10</b>	<b>0.17</b>	<b>0.27</b>	<b>0.32</b>	<b>0.37</b>	<b>3.5%</b>

4000

### Basin Travel Time

	Shallow Channel Ground Cover		Short Pasture/Lawns			
	$L_{max,Overland}$	100 ft	$C_v$	7		
	L (ft)	$\Delta Z_o$ (ft)	$S_o$ (ft/ft)	v (ft/s)	t (min)	$t_{Alt}$ (min)
Total	3,017	146	-	-	-	-
Initial Time	100	3	0.030	-	12.5	N/A DCM Eq. 6-8
Shallow Channel	1,030	65	0.063	1.8	9.8	- DCM Eq. 6-9
Channelized	1,887	78	0.041	1.6	19.4	- V-Ditch
				$t_c$	<b>41.7 min.</b>	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	1.60	1.99	2.32	2.65	2.98	3.34
Runoff (cfs)	6.1	17.4	33.6	60.0	79.7	102.7
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	6.1	17.4	33.6	60.0	79.7	102.7

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes



## Sub-Basin OS C Runoff Calculations

Job No.: 61087 Date: 9/16/2019 10:38  
 Project: Sanctuary of Peace Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Jurisdiction: DCM Soil Type: B  
 Runoff Coefficient: Surface Type Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	2,023,425	46.45	0.02	0.08	0.15	0.25	0.3	0.35	0%
Driveways & Walks	76,619	1.76	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	29,852	0.69	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	9,943	0.23	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>2,139,839</b>	<b>49.12</b>	<b>0.06</b>	<b>0.12</b>	<b>0.19</b>	<b>0.28</b>	<b>0.33</b>	<b>0.38</b>	<b>5.1%</b>

4000

### Basin Travel Time

	Shallow Channel Ground Cover		Short Pasture/Lawns			
	$L_{max, Overland}$	100 ft			$C_v$	7
	L (ft)	$\Delta Z_0$ (ft)	$S_0$ (ft/ft)	v (ft/s)	t (min)	$t_{Att}$ (min)
Total	1,692	129	-	-	-	-
Initial Time	100	5	0.050	-	10.4	N/A DCM Eq. 6-8
Shallow Channel	995	70	0.070	1.9	8.9	- DCM Eq. 6-9
Channelized	597	54	0.090	2.2	4.6	- V-Ditch
				$t_c$	<b>23.9 min.</b>	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.26	2.82	3.29	3.76	4.23	4.73
Runoff (cfs)	6.9	16.6	30.2	52.3	68.8	88.1
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	6.9	16.6	30.2	52.3	68.8	88.1

$$DCM: t = C1 * \ln(t_c) + C2$$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin A1 Runoff Calculations

Job No.: 61087 Date: 9/16/2019 10:38  
 Project: Sanctuary of Peace Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Jurisdiction: DCM Soil Type: B  
 Runoff Coefficient: Surface Type Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	50,438	1.16	0.02	0.08	0.15	0.25	0.3	0.35	0%
Driveways & Walks	16,558	0.38	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	13,532	0.31	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>80,528</b>	<b>1.85</b>	<b>0.31</b>	<b>0.36</b>	<b>0.41</b>	<b>0.48</b>	<b>0.52</b>	<b>0.55</b>	<b>35.7%</b>

### Basin Travel Time

Shallow Channel Ground Cover Forest						
	$L_{max,Overland}$	100 ft			$C_v$	5
	L (ft)	$\Delta Z_o$ (ft)	$S_o$ (ft/ft)	v (ft/s)	t (min)	$t_{Att}$ (min)
Total	317	23	-	-	-	-
Initial Time	100	11	0.110	-	6.1	N/A DCM Eq. 6-8
Shallow Channel	217	12	0.055	1.2	3.1	- DCM Eq. 6-9
Channelized			0.000	0.0	0.0	- V-Ditch
				$t_c$	9.1 min.	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.40	4.26	4.97	5.68	6.39	7.16
Runoff (cfs)	2.0	2.8	3.8	5.1	6.1	7.3
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	2.0	2.8	3.8	5.1	6.1	7.3

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin A2 Runoff Calculations

Job No.: 61087  
 Project: Sanctuary of Peace  
 Jurisdiction: DCM  
 Runoff Coefficient: Surface Type

Date: 9/16/2019 10:38  
 Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Soil Type: B  
 Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	1,232,700	28.30	0.02	0.08	0.15	0.25	0.3	0.35	0%
<b>Combined</b>	<b>1,232,700</b>	<b>28.30</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

### Basin Travel Time

	Shallow Channel Ground Cover		Forest			
	$L_{max,Overland}$	100 ft			$C_v$	5
	L (ft)	$\Delta Z_0$ (ft)	$S_0$ (ft/ft)	v (ft/s)	t (min)	$t_{Alt}$ (min)
Total	1,700	121	-	-	-	-
Initial Time	100	9	0.090	-	8.9	N/A DCM Eq. 6-8
Shallow Channel	1,483	107	0.072	1.3	18.4	- DCM Eq. 6-9
Channelized	117	5	0.043	5.7	0.3	- V-Ditch
				$t_c$	<b>27.7 min.</b>	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.08	2.60	3.04	3.47	3.90	4.37
Runoff (cfs)	1.2	5.9	12.9	24.6	33.1	43.3
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.2	5.9	12.9	24.6	33.1	43.3

DCM:  $i = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin B1 Runoff Calculations

Job No.: 61087 Date: 9/16/2019 10:38  
 Project: Sanctuary of Peace Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Jurisdiction: DCM Soil Type: B  
 Runoff Coefficient: Surface Type Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	102,701	2.36	0.02	0.08	0.15	0.25	0.3	0.35	0%
	-	0.00							
<b>Combined</b>	<b>102,701</b>	<b>2.36</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

4000

### Basin Travel Time

	Shallow Channel Ground Cover		Short Pasture/Lawns			
	$L_{max, Overland}$	100 ft	$C_v$	7		
	L (ft)	$\Delta Z_0$ (ft)	$S_0$ (ft/ft)	v (ft/s)	t (min)	$t_{Alt}$ (min)
Total	567	30	-	-	-	-
Initial Time	100	8	0.080	-	9.3	N/A DCM Eq. 6-8
Shallow Channel	383	17	0.044	1.5	4.3	- DCM Eq. 6-9
Channelized	84	5	0.060	1.9	0.8	- V-Ditch
				$t_c$	<b>14.4 min.</b>	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	2.86	3.59	4.18	4.78	5.38	6.02
<b>Runoff (cfs)</b>	0.1	0.7	1.5	2.8	3.8	5.0
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	0.1	0.7	1.5	2.8	3.8	5.0

DCM:  $i = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin B2 Runoff Calculations

Job No.: 61087  
 Project: Sanctuary of Peace  
 Jurisdiction: DCM  
 Runoff Coefficient: Surface Type

Date: 9/16/2019 10:38  
 Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Soil Type: B  
 Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	394,481	9.06	0.02	0.08	0.15	0.25	0.3	0.35	0%
Driveways & Walks	7,783	0.18	0.89	0.9	0.92	0.94	0.95	0.96	100%
<b>Combined</b>	<b>402,264</b>	<b>9.23</b>	<b>0.04</b>	<b>0.10</b>	<b>0.16</b>	<b>0.26</b>	<b>0.31</b>	<b>0.36</b>	<b>1.9%</b>

4000

### Basin Travel Time

	Shallow Channel Ground Cover		Short Pasture/Lawns			
	$L_{max,Overland}$	100 ft	$C_v$	7		
	L (ft)	$\Delta Z_o$ (ft)	$S_o$ (ft/ft)	v (ft/s)	t (min)	$t_{Att}$ (min)
Total	311	17	-	-	-	-
Initial Time	100	7	0.070	-	9.5	N/A DCM Eq. 6-8
Shallow Channel	211	10	0.047	1.5	2.3	- DCM Eq. 6-9
Channelized			0.000	0.0	0.0	- V-Ditch
				$t_c$	<b>11.8 min.</b>	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.09	3.87	4.52	5.17	5.81	6.51
Runoff (cfs)	1.1	3.4	6.9	12.6	16.8	21.7
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.1	3.4	6.9	12.6	16.8	21.7

$$DCM: I = C1 * \ln(tc) + C2$$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin C1 Runoff Calculations

Job No.: 61087 Date: 9/16/2019 10:38  
 Project: Sanctuary of Peace Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Jurisdiction: DCM Soil Type: B  
 Runoff Coefficient: Surface Type Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	130,377	2.99	0.02	0.08	0.15	0.25	0.3	0.35	0%
Driveways & Walks	20,192	0.46	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	26,845	0.62	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>177,414</b>	<b>4.07</b>	<b>0.22</b>	<b>0.27</b>	<b>0.33</b>	<b>0.41</b>	<b>0.45</b>	<b>0.49</b>	<b>25.0%</b>

177414

### Basin Travel Time

	Shallow Channel Ground Cover Forest		S <sub>0</sub> (ft/ft)	v (ft/s)	t (min)	t <sub>Alt</sub> (min)	C <sub>v</sub>
	L <sub>max,Overland</sub> (ft)	ΔZ <sub>0</sub> (ft)					
Total	557	37	-	-	-	-	5
Initial Time	100	16	0.160	-	6.0	N/A	DCM Eq. 6-8
Shallow Channel	457	21	0.046	1.1	7.1	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				<b>t<sub>c</sub></b>	<b>13.1 min.</b>		

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.97	3.72	4.35	4.97	5.59	6.25
Runoff (cfs)	2.7	4.1	5.8	8.3	10.2	12.5
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	2.7	4.1	5.8	8.3	10.2	12.5

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin C2 Runoff Calculations

Job No.: 61087  
 Project: Sanctuary of Peace  
 Jurisdiction: DCM  
 Runoff Coefficient: Surface Type

Date: 9/16/2019 10:38  
 Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Soil Type: B  
 Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	20,454	0.47	0.02	0.08	0.15	0.25	0.3	0.35	0%
Driveways & Walks	1,280	0.03	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	7,150	0.16	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>28,884</b>	<b>0.66</b>	<b>0.23</b>	<b>0.28</b>	<b>0.33</b>	<b>0.41</b>	<b>0.45</b>	<b>0.49</b>	<b>26.7%</b>

### Basin Travel Time

	Shallow Channel Ground Cover Forest					
	$L_{max,Overland}$	100 ft			$C_v$	5
	L (ft)	$\Delta Z_o$ (ft)	$S_o$ (ft/ft)	v (ft/s)	t (min)	$t_{Att}$ (min)
Total	189	12	-	-	-	-
Initial Time	89	6	0.067	-	7.5	N/A DCM Eq. 6-8
Shallow Channel	100	6	0.060	1.2	1.4	- DCM Eq. 6-9
Channelized			0.000	0.0	0.0	- V-Ditch
				$t_c$	<b>8.8 min.</b>	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.44	4.32	5.04	5.76	6.48	7.25
Runoff (cfs)	0.5	0.8	1.1	1.6	1.9	2.4
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.5	0.8	1.1	1.6	1.9	2.4

DCM:  $t = C1 * \ln(t_c) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin C3 Runoff Calculations

Job No.: 61087  
 Project: Sanctuary of Peace  
 Jurisdiction: DCM  
 Runoff Coefficient: Surface Type

Date: 9/16/2019 10:38  
 Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Soil Type: B  
 Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	59,267	1.36	0.02	0.08	0.15	0.25	0.3	0.35	0%
<b>Combined</b>	<b>59,267</b>	<b>1.36</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

### Basin Travel Time

Shallow Channel Ground Cover Forest

	$L_{max,Overland}$ (ft)	$\Delta Z_0$ (ft)	$S_0$ (ft/ft)	$v$ (ft/s)	$t$ (min)	$t_{Att}$ (min)	
Total	273	20	-	-	-	-	
Initial Time	100	7	0.070	-	9.7	N/A	DCM Eq. 6-8
Shallow Channel	173	13	0.075	1.4	2.1	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				$t_c$	11.8 min.		

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.10	3.88	4.53	5.18	5.82	6.52
Runoff (cfs)	0.1	0.4	0.9	1.8	2.4	3.1
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	0.4	0.9	1.8	2.4	3.1

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes



## Sub-Basin C4 Runoff Calculations

Job No.: 61087  
 Project: Sanctuary of Peace  
 Jurisdiction: DCM  
 Runoff Coefficient: Surface Type

Date: 9/16/2019 10:38  
 Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Soil Type: B  
 Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						%
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	Imperv.
Forest	28,016	0.64	0.02	0.08	0.15	0.25	0.3	0.35	0%
<b>Combined</b>	<b>28,016</b>	<b>0.64</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

28016

### Basin Travel Time

Shallow Channel Ground Cover Forest

	$L_{max,Overland}$	$\Delta Z_0$	$S_0$	$v$	$t$	$t_{ait}$	
	(ft)	(ft)	(ft/ft)	(ft/s)	(min)	(min)	
Total	221	21	-	-	-	-	
Initial Time	81	11	0.136	-	7.0	N/A	DCM Eq. 6-8
Shallow Channel	140	10	0.071	1.3	1.7	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				$t_c$		<b>8.8 min.</b>	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.45	4.33	5.05	5.77	6.49	7.27
Runoff (cfs)	0.0	0.2	0.5	0.9	1.3	1.6
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.0	0.2	0.5	0.9	1.3	1.6

DCM:  $t = C1 * \ln(t_c) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## Sub-Basin C5 Runoff Calculations

Job No.: 61087 Date: 9/16/2019 10:38  
 Project: Sanctuary of Peace Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Jurisdiction: DCM Soil Type: B  
 Runoff Coefficient: Surface Type Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	70,265	1.61	0.02	0.08	0.15	0.25	0.3	0.35	0%
<b>Combined</b>	<b>70,265</b>	<b>1.61</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

### Basin Travel Time

Shallow Channel Ground Cover Forest

	$L_{max,Overland}$	$\Delta Z_0$	$S_0$	$v$	$t$	$t_{Alt}$	
	(ft)	(ft)	(ft/ft)	(ft/s)	(min)	(min)	
Total	223	18	-	-	-	-	
Initial Time	100	10	0.100	-	8.6	N/A	DCM Eq. 6-8
Shallow Channel	123	8	0.065	1.3	1.6	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	V-Ditch
				$t_c$	<b>10.2 min.</b>		

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.27	4.10	4.78	5.46	6.14	6.88
Runoff (cfs)	0.1	0.5	1.2	2.2	3.0	3.9
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	0.5	1.2	2.2	3.0	3.9

DCM:  $t = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

**M.V.E., Inc.**  
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JOB 601087 - SANCTUARY OF PEACE

SHEET NO. 1 OF 1

CALCULATED BY CC Cur DATE 9-16-19

CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_

SCALE \_\_\_\_\_

EX 1

COMBINED BASINS  
OSA, OSB, EX-A1

	$Q_5$	$Q_{100}$
OSA	11.4 cfs	51.1 cfs
OSB	17.4	102.7
EX-A1	6.9	50.6
	<hr/>	<hr/>
$Q_5$	35.7 cfs	204.4

## Combined Sub-Basin EX4 Runoff Calculations

Includes Basins EX-C2

Job No.:	61087	Date:	9/16/2019 10:38
Project:	Sanctuary of Peace	Calcs by:	ASM
Jurisdiction	DCM	Checked by:	
Runoff Coefficient	Surface Type	Soil Type	B
		Urbanization	Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient							% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100		
Forest	88,571	2.03	0.02	0.08	0.15	0.25	0.3	0.35	0%	
<b>Combined</b>	<b>88,571</b>	<b>2.03</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>	

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. $\Delta Z_0$ (ft)	$Q_i$ (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	EX-C2	-	300	25	-	-	-	-	10.9
Channelized-1									
Channelized-2									
Channelized-3									
Total			300	25					
								$t_c$ (min)	10.9

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas: \_\_\_\_\_

$Q_{Minor}$  (cfs) - 5-year Storm: \_\_\_\_\_

$Q_{Major}$  (cfs) - 100-year Storm: \_\_\_\_\_

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	3.19	4.00	4.67	5.33	6.00	6.71
<b>Site Runoff (cfs)</b>	0.13	0.65	1.42	2.71	3.66	4.78
<b>OffSite Runoff (cfs)</b>	-	0.00	-	-	-	0.00
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	0.7	-	-	-	4.8

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## Combined Sub-Basin EX5 Runoff Calculations

Includes Basins EX-C3

Job No.:	<u>61087</u>	Date:	<u>9/16/2019 10:38</u>
Project:	<u>Sanctuary of Peace</u>	Calcs by:	<u>ASM</u>
Jurisdiction	<u>DCM</u>	Checked by:	
Runoff Coefficient	<u>Surface Type</u>	Soil Type	<u>B</u>
		Urbanization	<u>Non-Urban</u>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient							% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100		
Forest	28,874	0.66	0.02	0.08	0.15	0.25	0.3	0.35	0%	
<b>Combined</b>	<b>28,874</b>	<b>0.66</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>	

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. $\Delta Z_0$ (ft)	$Q_i$ (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	EX-C3	-	217	17	-	-	-	-	9.8
Channelized-1									
Channelized-2									
Channelized-3									
Total			217	17					
							$t_c$ (min)		9.8

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

$Q_{Minor}$	(cfs) - 5-year Storm
$Q_{Major}$	(cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.32	4.17	4.86	5.56	6.25	7.00
Site Runoff (cfs)	0.04	0.22	0.48	0.92	1.24	1.62
OffSite Runoff (cfs)	-	0.00	-	-	-	0.00
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	0.2	-	-	-	1.6

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.036	7.583	8.847	10.111	11.375	12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## Combined Sub-Basin EX7 Runoff Calculations

Includes Basins EX-C1

Job No.:	<b>61087</b>	Date:	<b>9/16/2019 10:38</b>
Project:	<b>Sanctuary of Peace</b>	Calcs by:	<b>ASM</b>
Jurisdiction	<b>DCM</b>	Checked by:	
Runoff Coefficient	<b>Surface Type</b>	Soil Type	<b>B</b>
		Urbanization	<b>Non-Urban</b>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	247,407	5.68	0.02	0.08	0.15	0.25	0.3	0.35	0%
<b>Combined</b>	<b>247,407</b>	<b>5.68</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. $\Delta Z_0$ (ft)	$Q_i$ (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	EX-C1	-	722	36	-	-	-	-	15.7
Channelized-1									
Channelized-2									
Channelized-3									
Total			722	36					
								$t_c$ (min)	<b>15.7</b>

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

$Q_{Minor}$  (cfs) - 5-year Storm

$Q_{Major}$  (cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	2.76	3.45	4.02	4.60	5.17	5.79
<b>Site Runoff (cfs)</b>	0.31	<b>1.57</b>	3.43	6.53	8.82	<b>11.51</b>
<b>OffSite Runoff (cfs)</b>	-	<b>0.00</b>	-	-	-	<b>0.00</b>
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	<b>1.6</b>	-	-	-	<b>11.5</b>

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.736

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## Combined Sub-Basin EX8 Runoff Calculations

Includes Basins EX-B1

Job No.:	<u>61087</u>	Date:	<u>9/16/2019 10:38</u>
Project:	<u>Sanctuary of Peace</u>	Calcs by:	<u>ASM</u>
Jurisdiction	<u>DCM</u>	Checked by:	
Runoff Coefficient	<u>Surface Type</u>	Soil Type	<u>B</u>
		Urbanization	<u>Non-Urban</u>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	89,528	2.06	0.02	0.08	0.15	0.25	0.3	0.35	0%
<b>Combined</b>	<b>89,528</b>	<b>2.06</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. $\Delta Z_0$ (ft)	$Q_i$ (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	EX-A1	-	1,700	121	-	-	-	-	23.3
Channelized-1									
Channelized-2									
Channelized-3									
Total			1,700	121					
								$t_c$ (min)	23.3

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

$Q_{Minor}$  (cfs) - 5-year Storm

$Q_{Major}$  (cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	2.29	2.86	3.34	3.82	4.30	4.81
<b>Site Runoff (cfs)</b>	0.09	0.47	1.03	1.96	2.65	3.46
<b>OffSite Runoff (cfs)</b>	-	0.00	-	-	-	0.00
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	0.5	-	-	-	3.5

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## Combined Sub-Basin EX9 Runoff Calculations

Includes Basins OS C EX-B1 EX-B2

Job No.:	<b>61087</b>	Date:	<b>9/16/2019 10:38</b>
Project:	<b>Sanctuary of Peace</b>	Calcs by:	<b>ASM</b>
Jurisdiction	<b>DCM</b>	Checked by:	
Runoff Coefficient	<b>Surface Type</b>	Soil Type	<b>B</b>
		Urbanization	<b>Non-Urban</b>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient							% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100		
Forest	2,494,099	57.26	0.02	0.08	0.15	0.25	0.3	0.35	0%	
Gravel	29,852	0.69	0.57	0.59	0.63	0.66	0.68	0.7	80%	
Driveways & Walks	76,619	1.76	0.89	0.9	0.92	0.94	0.95	0.96	100%	
Roofs	9,943	0.23	0.71	0.73	0.75	0.78	0.8	0.81	90%	
<b>Combined</b>	<b>2,610,513</b>	<b>59.93</b>	<b>0.05</b>	<b>0.11</b>	<b>0.18</b>	<b>0.28</b>	<b>0.33</b>	<b>0.37</b>	<b>4.2%</b>	

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. $\Delta Z_0$ (ft)	$Q_i$ (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	OS C	-	1,692	129	-	-	-	-	23.9
Channelized-1			0	0					
Channelized-2									
Channelized-3									
Total			1,692	129					
								$t_c$ (min)	<b>23.9</b>

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

$Q_{Minor}$  (cfs) - 5-year Storm  
 $Q_{Major}$  (cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	2.26	2.82	3.29	3.76	4.23	4.73
<b>Site Runoff (cfs)</b>	7.37	<b>19.00</b>	35.58	62.44	82.51	<b>106.03</b>
<b>OffSite Runoff (cfs)</b>	-	<b>0.00</b>	-	-	-	<b>0.00</b>
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	<b>19.0</b>	-	-	-	<b>106.0</b>

$$DCM-1 = C1 * \ln(tc) + C2$$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.



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JOB 61087- SANCTUARY OF PEACE  
SHEET NO. 1 OF 1  
CALCULATED BY J.C. Carr DATE 9-16-19  
CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_  
SCALE \_\_\_\_\_

DP 1

Cornered BASINS

DP2, A2, OSA, & OSB

	$Q_5$	$Q_{100}$
DP2-Out	0.1 cfs	3.1 cfs

A2	5.9	43.3
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OSA	11.4	81.1
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OSB	17.4	102.7
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$Q_5 = 34.8$  cfs       $Q_{100} = 230.2$  cfs

## Combined Sub-Basin DP2 Runoff Calculations

Includes Basins A1

Job No.:	<u>61087</u>	Date:	<u>9/16/2019 10:38</u>
Project:	<u>Sanctuary of Peace</u>	Calcs by:	<u>ASM</u>
Jurisdiction	<u>DCM</u>	Checked by:	
Runoff Coefficient	<u>Surface Type</u>	Soil Type	<u>B</u>
		Urbanization	<u>Non-Urban</u>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	50,438	1.16	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	-	0.00	0.57	0.59	0.63	0.66	0.68	0.7	80%
Driveways & Walks	16,558	0.38	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	13,532	0.31	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>80,528</b>	<b>1.85</b>	<b>0.31</b>	<b>0.36</b>	<b>0.41</b>	<b>0.48</b>	<b>0.52</b>	<b>0.55</b>	<b>35.7%</b>

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ <sub>0</sub> (ft)	Q <sub>i</sub> (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	A1	-	317	23	-	-	-	-	9.1
Channelized-1		2	0	0					
Channelized-2									
Channelized-3									
<b>Total</b>			<b>317</b>	<b>23</b>					

2 = Natural, Winding, minimal vegetation/shallow grass

**t<sub>c</sub> (min) 9.1**

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q<sub>Minor</sub> (cfs) - 5-year Storm

Q<sub>Major</sub> (cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	3.40	4.26	4.97	5.68	6.39	7.16
<b>Site Runoff (cfs)</b>	1.98	<b>2.82</b>	3.76	5.05	6.12	<b>7.31</b>
<b>OffSite Runoff (cfs)</b>	-	<b>0.00</b>	-	-	-	<b>0.00</b>
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	<b>2.8</b>	-	-	-	<b>7.3</b>

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## Combined Sub-Basin DP3 Runoff Calculations

Includes Basins C2

Job No.:	<b>61087</b>	Date:	<b>9/16/2019 10:38</b>
Project:	<b>Sanctuary of Peace</b>	Calcs by:	<b>ASM</b>
Jurisdiction	<b>DCM</b>	Checked by:	
Runoff Coefficient	<b>Surface Type</b>	Soil Type	<b>B</b>
		Urbanization	<b>Non-Urban</b>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	20,454	0.47	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	-	0.00	0.57	0.59	0.63	0.66	0.68	0.7	80%
Driveways & Walks	1,280	0.03	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	7,150	0.16	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>28,884</b>	<b>0.66</b>	<b>0.23</b>	<b>0.28</b>	<b>0.33</b>	<b>0.41</b>	<b>0.45</b>	<b>0.49</b>	<b>26.7%</b>

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. $\Delta Z_0$ (ft)	$Q_i$ (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	C2	-	189	12	-	-	-	-	8.8
Channelized-1		2	0	0					
Channelized-2									
Channelized-3									
<b>Total</b>			<b>189</b>	<b>12</b>					

2 = Natural, Winding, minimal vegetation/shallow grass

**t<sub>c</sub> (min) 8.8**

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

$Q_{Minor}$  (cfs) - 5-year Storm  
 $Q_{Major}$  (cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	3.44	4.32	5.04	5.76	6.48	7.25
<b>Site Runoff (cfs)</b>	0.52	0.79	1.11	1.57	1.94	2.36
<b>OffSite Runoff (cfs)</b>	-	0.00	-	-	-	0.00
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	0.8	-	-	-	2.4

DCM:  $I = C1 * \ln(t_c) + C2$

C1	1.19	1.6	1.75	2	2.25	2.52
C2	6.036	7.583	8.847	10.111	11.375	12.736

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## Combined Sub-Basin DP4 Runoff Calculations

Includes Basins C3

Job No.:	<b>61087</b>	Date:	<b>9/16/2019 10:38</b>
Project:	<b>Sanctuary of Peace</b>	Calcs by:	<b>ASM</b>
Jurisdiction	<b>DCM</b>	Checked by:	
Runoff Coefficient	<b>Surface Type</b>	Soil Type	<b>B</b>
		Urbanization	<b>Non-Urban</b>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient							% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100		
Forest	59,267	1.36	0.02	0.08	0.15	0.25	0.3	0.35	0%	
Gravel	-	0.00	0.57	0.59	0.63	0.66	0.68	0.7	80%	
Driveways & Walks	-	0.00	0.89	0.9	0.92	0.94	0.95	0.96	100%	
Roofs	-	0.00	0.71	0.73	0.75	0.78	0.8	0.81	90%	
<b>Combined</b>	<b>59,267</b>	<b>1.36</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>	

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. $\Delta Z_0$ (ft)	$Q_i$ (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	C3	-	273	20	-	-	-	-	11.8
Channelized-1				0					
Channelized-2									
Channelized-3									
Total			273	20					
								$t_c$ (min)	<b>11.8</b>

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas DP3 / Pond C2 Outflow

$Q_{Minor}$  0 (cfs) - 5-year Storm  
 $Q_{Major}$  1.1 (cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	3.10	3.88	4.53	5.18	5.82	6.52
<b>Site Runoff (cfs)</b>	0.08	<b>0.42</b>	0.92	1.76	2.38	<b>3.10</b>
<b>OffSite Runoff (cfs)</b>	-	<b>0.00</b>	-	-	-	<b>1.10</b>
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	<b>0.4</b>	-	-	-	<b>4.2</b>

DCM:  $1 = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.647	10.111	11.375	12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## Combined Sub-Basin DP5 Runoff Calculations

Includes Basins C4

Job No.:	<b>61087</b>	Date:	<b>9/16/2019 10:38</b>
Project:	<b>Sanctuary of Peace</b>	Calcs by:	<b>ASM</b>
Jurisdiction	<b>DCM</b>	Checked by:	
Runoff Coefficient	<b>Surface Type</b>	Soil Type	<b>B</b>
		Urbanization	<b>Non-Urban</b>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	28,016	0.64	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	-	0.00	0.57	0.59	0.63	0.66	0.68	0.7	80%
Driveways & Walks	-	0.00	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	-	0.00	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>28,016</b>	<b>0.64</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. $\Delta Z_0$ (ft)	$Q_i$ (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	C4	-	221	21	-	-	-	-	8.8
Channelized-1		2	0	0					
Channelized-2				0					
Channelized-3									
Total			221	21					

2 = Natural, Winding, minimal vegetation/shallow grass

$t_c$  (min) **8.8**

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

$Q_{Minor}$  (cfs) - 5-year Storm

$Q_{Major}$  (cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	3.45	4.33	5.05	5.77	6.49	7.27
<b>Site Runoff (cfs)</b>	0.04	<b>0.22</b>	0.49	0.93	1.25	<b>1.64</b>
<b>OffSite Runoff (cfs)</b>	-	<b>0.00</b>	-	-	-	<b>0.00</b>
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	<b>0.2</b>	-	-	-	<b>1.6</b>

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## Combined Sub-Basin DP6 Runoff Calculations

Includes Basins C1

Job No.:	<u>61087</u>	Date:	<u>9/16/2019 10:38</u>
Project:	<u>Sanctuary of Peace</u>	Calcs by:	<u>ASM</u>
Jurisdiction	<u>DCM</u>	Checked by:	
Runoff Coefficient	<u>Surface Type</u>	Soil Type	<u>B</u>
		Urbanization	<u>Non-Urban</u>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	130,377	2.99	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	-	0.00	0.57	0.59	0.63	0.66	0.68	0.7	80%
Driveways & Walks	20,192	0.46	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	26,845	0.62	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>177,414</b>	<b>4.07</b>	<b>0.22</b>	<b>0.27</b>	<b>0.33</b>	<b>0.41</b>	<b>0.45</b>	<b>0.49</b>	<b>25.0%</b>

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. $\Delta Z_0$ (ft)	$Q_i$ (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	C1	-	557	37	-	-	-	-	13.1
Channelized-1		2	0	0					
Channelized-2									
Channelized-3									
<b>Total</b>			<b>557</b>	<b>37</b>					

2 = Natural, Winding, minimal vegetation/shallow grass

$t_c$  (min) **13.1**

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

$Q_{Minor}$  (cfs) - 5-year Storm

$Q_{Major}$  (cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	2.97	3.72	4.35	4.97	5.59	6.25
<b>Site Runoff (cfs)</b>	2.71	<b>4.12</b>	5.81	8.27	10.23	<b>12.45</b>
<b>OffSite Runoff (cfs)</b>	-	<b>0.00</b>	-	-	-	<b>0.00</b>
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	<b>4.1</b>	-	-	-	<b>12.5</b>

DCM:  $I = C1 * \ln(Ic) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.036	7.583	8.847	10.111	11.375	12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## Combined Sub-Basin DP7 Runoff Calculations

Includes Basins C5

Job No.: 61087

Date: 9/16/2019 10:38

Project: Sanctuary of Peace

Calcs by: ASM

Jurisdiction DCM  
Runoff Coefficient Surface Type

Checked by: \_\_\_\_\_  
Soil Type B  
Urbanization Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	70,265	1.61	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	-	0.00	0.57	0.59	0.63	0.66	0.68	0.7	80%
Driveways & Walks	-	0.00	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	-	0.00	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>70,265</b>	<b>1.61</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. $\Delta Z_0$ (ft)	$Q_i$ (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	C5	-	223	18	-	-	-	-	10.2
Channelized-1		2	0	0					
Channelized-2									
Channelized-3									
Total			223	18					

2 = Natural, Winding, minimal vegetation/shallow grass

$t_c$  (min) **10.2**

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas DP6 / Pond C1 Outflow

$Q_{Minor}$  0.1 (cfs) - 5-year Storm  
 $Q_{Major}$  6.1 (cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	3.27	4.10	4.78	5.46	6.14	6.88
<b>Site Runoff (cfs)</b>	0.11	<b>0.53</b>	1.16	2.20	2.97	<b>3.88</b>
<b>OffSite Runoff (cfs)</b>	-	<b>0.10</b>	-	-	-	<b>6.10</b>
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	<b>0.6</b>	-	-	-	<b>10.0</b>

DCM:  $I = C1 * \ln(tc) + C2$

C1      1.19      1.5      1.75      2      2.25      2.52  
C2      6.035      7.583      8.847      10.111      11.375      12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## Combined Sub-Basin DP8 Runoff Calculations

Includes Basins B1

Job No.:	<u>61087</u>	Date:	<u>9/16/2019 10:38</u>
Project:	<u>Sanctuary of Peace</u>	Calcs by:	<u>ASM</u>
Jurisdiction	<u>DCM</u>	Checked by:	
Runoff Coefficient	<u>Surface Type</u>	Soil Type	<u>B</u>
		Urbanization	<u>Non-Urban</u>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	102,701	2.36	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	-	0.00	0.57	0.59	0.63	0.66	0.68	0.7	80%
Driveways & Walks	-	0.00	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	-	0.00	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>102,701</b>	<b>2.36</b>	<b>0.02</b>	<b>0.08</b>	<b>0.15</b>	<b>0.25</b>	<b>0.30</b>	<b>0.35</b>	<b>0.0%</b>

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ <sub>0</sub> (ft)	Q <sub>i</sub> (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	B1	-	567	30	-	-	-	-	14.4
Channelized-1				0					
Channelized-2									
Channelized-3									
<b>Total</b>			<b>567</b>	<b>30</b>					
								<b>t<sub>c</sub></b> (min)	<b>14.4</b>

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q<sub>Minor</sub> (cfs) - 5-year Storm  
 Q<sub>Major</sub> (cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	2.86	3.59	4.18	4.78	5.38	6.02
<b>Site Runoff (cfs)</b>	0.14	<b>0.68</b>	1.48	2.82	3.81	<b>4.97</b>
<b>OffSite Runoff (cfs)</b>	-	<b>0.00</b>	-	-	-	<b>0.00</b>
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	<b>0.7</b>	-	-	-	<b>5.0</b>

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.



## Combined Sub-Basin DP9 Runoff Calculations

Includes Basins B1 B2 OS C

Job No.:	<b>61087</b>	Date:	<b>9/16/2019 10:38</b>
Project:	<b>Sanctuary of Peace</b>	Calcs by:	<b>ASM</b>
Jurisdiction	<b>DCM</b>	Checked by:	
Runoff Coefficient	<b>Surface Type</b>	Soil Type	<b>B</b>
		Urbanization	<b>Non-Urban</b>

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	2,520,607	57.87	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	29,852	0.69	0.57	0.59	0.63	0.66	0.68	0.7	80%
Driveways & Walks	84,402	1.94	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	9,943	0.23	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>2,644,804</b>	<b>60.72</b>	<b>0.06</b>	<b>0.11</b>	<b>0.18</b>	<b>0.28</b>	<b>0.33</b>	<b>0.38</b>	<b>4.4%</b>

### Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ <sub>0</sub> (ft)	Q <sub>i</sub> (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	B1	-	567	30	-	-	-	-	14.4
Channelized-1			0	0					
Channelized-2									
Channelized-3									
Total			567	30					
								<b>t<sub>c</sub> (min)</b>	<b>14.4</b>

### Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q <sub>Minor</sub>	(cfs) - 5-year Storm
Q <sub>Major</sub>	(cfs) - 100-year Storm

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
<b>Intensity (in/hr)</b>	2.86	3.59	4.18	4.78	5.38	6.02
<b>Site Runoff (cfs)</b>	9.84	<b>24.91</b>	46.31	80.92	106.80	<b>137.16</b>
<b>OffSite Runoff (cfs)</b>	-	<b>0.00</b>	-	-	-	<b>0.00</b>
<b>Release Rates (cfs/ac)</b>	-	-	-	-	-	-
<b>Allowed Release (cfs)</b>	-	<b>24.9</b>	-	-	-	<b>137.2</b>

DCM:  $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.036	7.583	8.847	10.111	11.375	12.735

### Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

### **3 Hydraulic Calculations**

IRF Worksheet

FS EDB design calculations (UD-BMP)

FS EDB design calculations (UD-Detention)

Spillway Detail

Culvert Calculations

## Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 2

**Designer:** D. Gorman  
**Company:** M.V.E., Inc.  
**Date:** September 13, 2019  
**Project:** Sanctuary of Peace  
**Location:** Sub-basin A1 - Sand Filter

<p>1. Basin Storage Volume</p> <p>A) Effective Imperviousness of Tributary Area, <math>I_a</math> (100% if all paved and roofed areas upstream of sand filter)</p> <p>B) Tributary Area's Imperviousness Ratio (<math>i = I_a/100</math>)</p> <p>C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time <math>WQCV = 0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)</math></p> <p>D) Contributing Watershed Area (including sand filter area)</p> <p>E) Water Quality Capture Volume (WQCV) Design Volume <math>V_{WQCV} = WQCV / 12 * Area</math></p> <p>F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm</p> <p>G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume</p> <p>H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)</p>	<p><math>I_a = </math> <input type="text" value="35.7"/> %</p> <p><math>i = </math> <input type="text" value="0.357"/></p> <p>WQCV = <input type="text" value="0.13"/> watershed inches</p> <p>Area = <input type="text" value="80,528"/> sq ft</p> <p><math>V_{WQCV} = </math> <input type="text" value=""/> cu ft</p> <p><math>d_a = </math> <input type="text" value="0.42"/> in</p> <p><math>V_{WQCV \text{ OTHER}} = </math> <input type="text" value="882"/> cu ft</p> <p><math>V_{WQCV \text{ USER}} = </math> <input type="text" value=""/> cu ft</p>
<p>2. Basin Geometry</p> <p>A) WQCV Depth</p> <p>B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.</p> <p>C) Minimum Filter Area (Flat Surface Area)</p> <p>D) Actual Filter Area</p> <p>E) Volume Provided</p>	<p><math>D_{WQCV} = </math> <input type="text" value="0.7"/> ft</p> <p><math>Z = </math> <input type="text" value="3.00"/> ft / ft <span style="color: red; font-size: small;">DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE</span></p> <p><math>A_{Min} = </math> <input type="text" value="359"/> sq ft</p> <p><math>A_{Actual} = </math> <input type="text" value="1200"/> sq ft</p> <p><math>V_T = </math> <input type="text" value="5990"/> cu ft</p>
<p>3. Filter Material</p>	<p>Choose One _____</p> <p><input checked="" type="radio"/> 18" CDOT Class B or C Filter Material</p> <p><input type="radio"/> Other (Explain): _____</p>
<p>4. Underdrain System</p> <p>A) Are underdrains provided?</p> <p>B) Underdrain system orifice diameter for 12 hour drain time</p> <p style="margin-left: 20px;">i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice</p> <p style="margin-left: 20px;">ii) Volume to Drain in 12 Hours</p> <p style="margin-left: 20px;">iii) Orifice Diameter, 3/8" Minimum</p>	<p>Choose One _____</p> <p><input checked="" type="radio"/> YES</p> <p><input type="radio"/> NO</p> <p><math>y = </math> <input type="text" value="2.0"/> ft</p> <p><math>Vol_{12} = </math> <input type="text" value="882"/> cu ft</p> <p><math>D_o = </math> <input type="text" value="11/16"/> in</p>

Design Procedure Form: Sand Filter (SF)

Sheet 2 of 2

Designer: D. Gorman  
Company: M.V.E., Inc.  
Date: September 13, 2019  
Project: Sanctuary of Peace  
Location: Sub-basin A1 - Sand Filter

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric

A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?

Choose One \_\_\_\_\_  
 YES     NO

6. Inlet / Outlet Works

A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet

emergency spillway with rip-rap protection  
rip-rap at inflow points  
\_\_\_\_\_  
\_\_\_\_\_

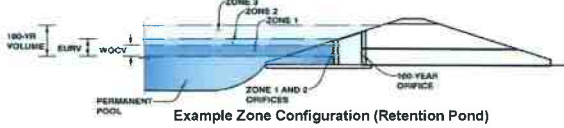
Notes: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: **Sanctuary of Peace**

Basin ID: **Sub-basin A1 - Sand Filter - DP2**



**Required Volume Calculation**

Selected BMP Type =	<b>SF</b>	
Watershed Area =	1.85	acres
Watershed Length =	317	ft
Watershed Slope =	0.073	ft/ft
Watershed Imperviousness =	35.70%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	12.0	hours
Location for 1-hr Rainfall =	User Input	
Water Quality Capture Volume (WQCV) =	0.021	acre-feet
Excess Urban Runoff Volume (EURV) =	0.069	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.054	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.075	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.110	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.172	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	0.213	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	0.268	acre-feet
500-yr Runoff Volume (P1 = 3.4 in.) =	0.408	acre-feet
Approximate 2-yr Detention Volume =	0.050	acre-feet
Approximate 5-yr Detention Volume =	0.071	acre-feet
Approximate 10-yr Detention Volume =	0.099	acre-feet
Approximate 25-yr Detention Volume =	0.113	acre-feet
Approximate 50-yr Detention Volume =	0.118	acre-feet
Approximate 100-yr Detention Volume =	0.137	acre-feet

Optional User Override 1-hr Precipitation		
1.19	inches	
1.50	inches	
1.75	inches	
2.00	inches	
2.25	inches	
2.52	inches	
3.40	inches	

**Stage-Storage Calculation**

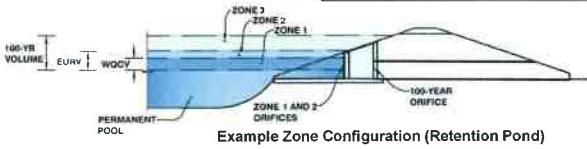
Zone 1 Volume (WQCV) =	0.021	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.048	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.069	acre-feet
Total Detention Basin Volume =	0.137	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft <sup>3</sup>
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H <sub>total</sub> ) =	3.00	ft
Depth of Trickle Channel (H <sub>trc</sub> ) =	N/A	ft
Slope of Trickle Channel (S <sub>trc</sub> ) =	N/A	ft/ft
Slopes of Main Basin Sides (S <sub>main</sub> ) =	3	H:V
Basin Length-to-Width Ratio (R <sub>L/W</sub> ) =	2	
Initial Surcharge Area (A <sub>ISV</sub> ) =	0	ft <sup>2</sup>
Surcharge Volume Length (L <sub>ISV</sub> ) =	0.0	ft
Surcharge Volume Width (W <sub>ISV</sub> ) =	0.0	ft
Depth of Basin Floor (H <sub>FLOOR</sub> ) =	0.00	ft
Length of Basin Floor (L <sub>FLOOR</sub> ) =	49.4	ft
Width of Basin Floor (W <sub>FLOOR</sub> ) =	24.7	ft
Area of Basin Floor (A <sub>FLOOR</sub> ) =	1,222	ft <sup>2</sup>
Volume of Basin Floor (V <sub>FLOOR</sub> ) =	0	ft <sup>3</sup>
Depth of Main Basin (H <sub>MAIN</sub> ) =	3.00	ft
Length of Main Basin (L <sub>MAIN</sub> ) =	67.4	ft
Width of Main Basin (W <sub>MAIN</sub> ) =	42.7	ft
Area of Main Basin (A <sub>MAIN</sub> ) =	2,880	ft <sup>2</sup>
Volume of Main Basin (V <sub>MAIN</sub> ) =	5,978	ft <sup>3</sup>
Calculated Total Basin Volume (V <sub>total</sub> ) =	0.137	acre-feet

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft <sup>2</sup> )	Optional Override Area (ft <sup>2</sup> )	Area (acre)	Volume (ft <sup>3</sup> )	Volume (ac-ft)
Media Surface	0.00		49.4	24.7	1,222		0.028		
	0.25		50.9	26.2	1,331		0.031	306	0.007
	0.50		52.4	27.7	1,448		0.033	653	0.015
	0.66		53.4	28.7	1,531		0.035	907	0.021
Zone 1 (WQCV)	0.75		53.9	29.2	1,571		0.036	1,031	0.024
	1.00		55.4	30.7	1,697		0.039	1,439	0.033
	1.25		56.9	32.2	1,829		0.042	1,880	0.043
	1.50		58.4	33.7	1,965		0.045	2,354	0.054
	1.75		59.9	35.2	2,105		0.048	2,863	0.066
	1.81		60.3	35.6	2,145		0.049	3,011	0.069
Zone 2 (EURV)	2.00		61.4	36.7	2,250		0.052	3,407	0.078
	2.25		62.9	38.2	2,405		0.055	4,012	0.092
	2.50		64.4	39.7	2,559		0.059	4,632	0.106
	2.75		65.9	41.2	2,717		0.062	5,292	0.121
	3.00		67.4	42.7	2,880		0.066	5,991	0.138
	3.25		68.9	44.2	3,048		0.070	6,732	0.155
	3.50		70.4	45.7	3,220		0.074	7,516	0.173
	3.75		71.9	47.2	3,396		0.078	8,342	0.192
	4.00		73.4	48.7	3,577		0.082	9,214	0.212
	4.25		74.9	50.2	3,763		0.086	10,131	0.233
Zone 3 (100-year)	4.50		76.4	51.7	3,953		0.091	11,096	0.255
	4.75		77.9	53.2	4,147		0.095	12,108	0.278
	5.00		79.4	54.7	4,346		0.100	13,170	0.302
	5.25		80.9	56.2	4,550		0.104	14,282	0.328
	5.50		82.4	57.7	4,758		0.109	15,445	0.355
	5.75		83.9	59.2	4,970		0.114	16,661	0.382
	6.00		85.4	60.7	5,187		0.119	17,930	0.412
	6.25		86.9	62.2	5,409		0.124	19,255	0.442
	6.50		88.4	63.7	5,634		0.129	20,635	0.474
	6.75		89.9	65.2	5,865		0.135	22,072	0.507
	7.00		91.4	66.7	6,100		0.140	23,568	0.541
	7.25		92.9	68.2	6,339		0.146	25,123	0.577
	7.50		94.4	69.7	6,583		0.151	26,738	0.614
	7.75		95.9	71.2	6,832		0.157	28,415	0.652
	8.00		97.4	72.7	7,085		0.163	30,154	0.692
	8.25		98.9	74.2	7,342		0.169	31,958	0.734
	8.50		100.4	75.7	7,604		0.175	33,826	0.777
	8.75		101.9	77.2	7,871		0.181	35,760	0.821
	9.00		103.4	78.7	8,142		0.187	37,761	0.867
	9.25		104.9	80.2	8,417		0.193	39,831	0.914
9.50		106.4	81.7	8,697		0.200	41,970	0.964	
9.75		107.9	83.2	8,982		0.206	44,180	1.014	
10.00		109.4	84.7	9,271		0.213	46,462	1.067	
10.25		110.9	86.2	9,564		0.220	48,816	1.121	
10.50		112.4	87.7	9,862		0.226	51,244	1.176	
10.75		113.9	89.2	10,164		0.233	53,747	1.234	
11.00		115.4	90.7	10,471		0.240	56,327	1.293	
11.25		116.9	92.2	10,783		0.248	58,983	1.354	
11.50		118.4	93.7	11,099		0.255	61,719	1.417	
11.75		119.9	95.2	11,419		0.262	64,533	1.481	
12.00		121.4	96.7	11,744		0.270	67,429	1.548	
12.25		122.9	98.2	12,074		0.277	70,406	1.616	
12.50		124.4	99.7	12,408		0.285	73,466	1.687	
12.75		125.9	101.2	12,746		0.293	76,610	1.759	

# Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Sanctuary of Peace  
 Basin ID: Sub-basin A1 - Sand Filter DP2



	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.66	0.021	Filtration Media
Zone 2 (EURV)	1.81	0.048	Orifice Plate
Zone 3 (100-year)	3.00	0.069	Weir&Pipe (Restrict)
		0.137	<b>Total</b>

**User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)**

Underdrain Orifice Invert Depth =	2.00	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	0.72	inches

**Calculated Parameters for Underdrain**

Underdrain Orifice Area =	0.0	ft <sup>2</sup>
Underdrain Orifice Centroid =	0.03	feet

**User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)**

Invert of Lowest Orifice =	0.66	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.86	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

**Calculated Parameters for Plate**

WQ Orifice Area per Row =	N/A	ft <sup>2</sup>
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft <sup>2</sup>

**User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)**

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.65	1.06	1.46					
Orifice Area (sq. inches)	0.76	0.76	0.76					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

**User Input: Vertical Orifice (Circular or Rectangular)**

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

**Calculated Parameters for Vertical Orifice**

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft <sup>2</sup>
Vertical Orifice Centroid =	N/A	N/A	feet

**User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)**

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	2.92	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.92	N/A	feet
Overflow Grate Open Area % =	81%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

**Calculated Parameters for Overflow Weir**

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H <sub>g</sub> =	2.00	N/A	feet
Over Flow Weir Slope Length =	2.92	N/A	feet
Grate Open Area / 100-yr Orifice Area =	32.34	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	6.91	N/A	ft <sup>2</sup>
Overflow Grate Open Area w/ Debris =	3.45	N/A	ft <sup>2</sup>

**User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)**

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	12.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	3.80		inches

**Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate**

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.21	N/A	ft <sup>2</sup>
Outlet Orifice Centroid =	0.19	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.20	N/A	radians

**User Input: Emergency Spillway (Rectangular or Trapezoidal)**

Spillway Invert Stage =	3.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	20.00	feet
Spillway End Slopes =	2.00	H:V
Freeboard above Max Water Surface =	1.00	feet

**Calculated Parameters for Spillway**

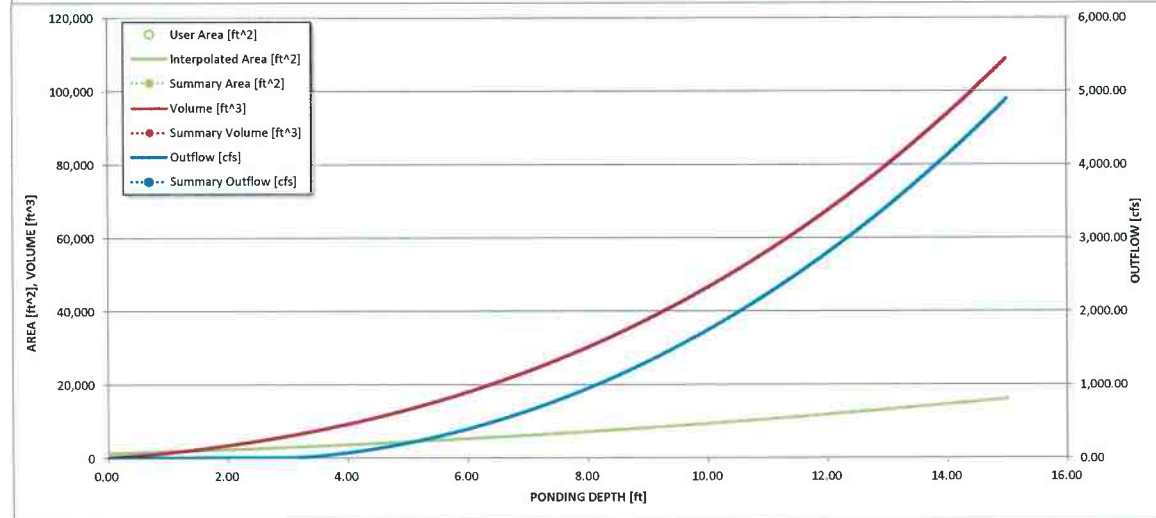
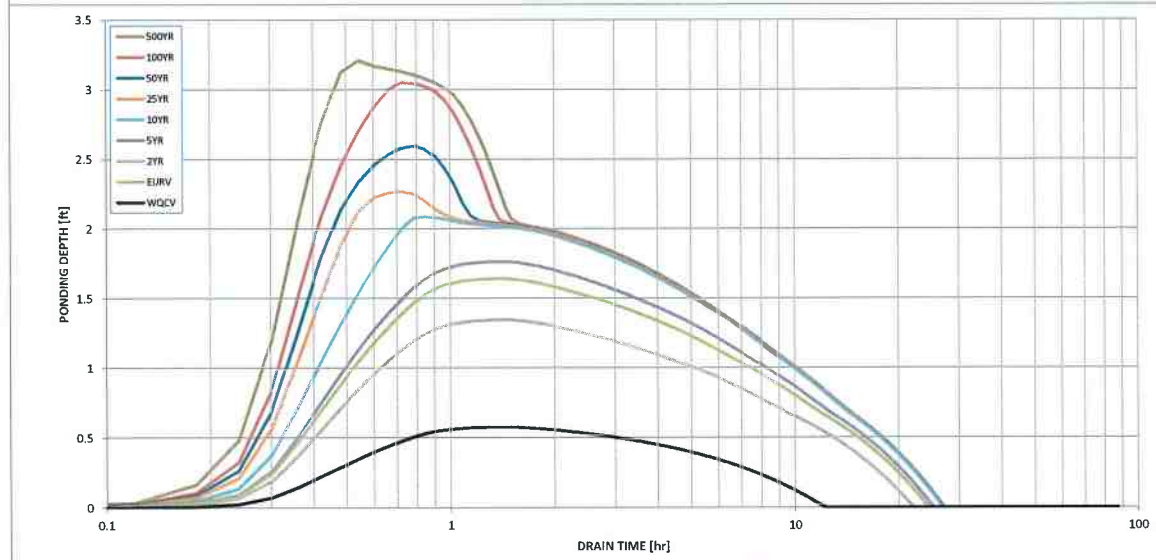
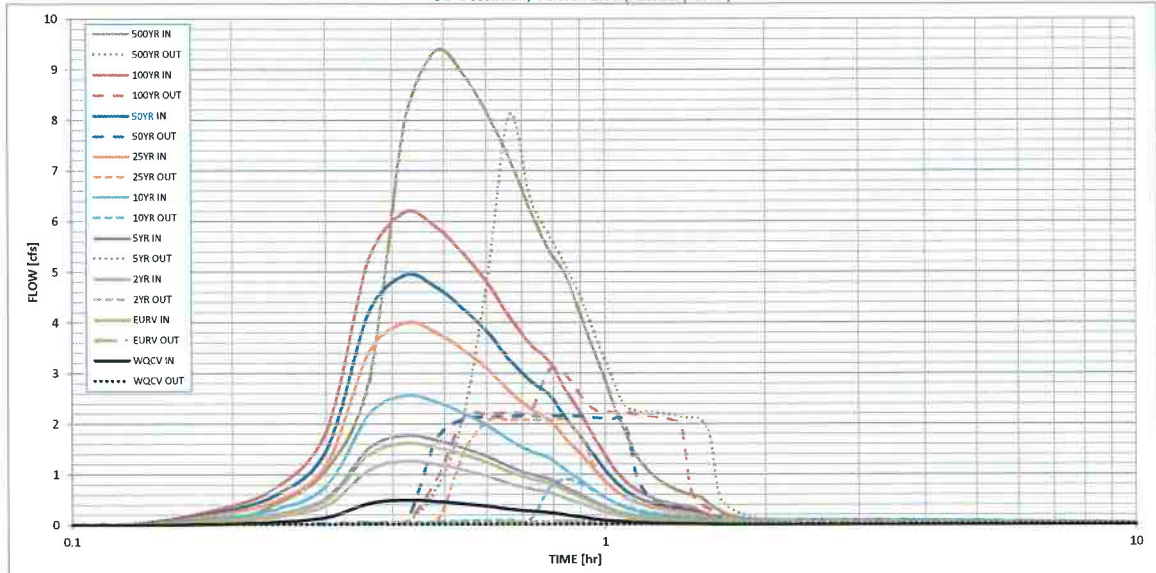
Spillway Design Flow Depth =	0.21	feet
Stage at Top of Freeboard =	4.21	feet
Basin Area at Top of Freeboard =	0.09	acres

**Routed Hydrograph Results**

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in)	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.40
Calculated Runoff Volume (acre-ft)	0.021	0.069	0.054	0.075	0.110	0.172	0.213	0.268	0.408
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft)	0.020	0.068	0.053	0.075	0.109	0.172	0.213	0.267	0.407
Predevelopment Unit Peak Flow, q (cfs/acre)	0.00	0.00	0.02	0.03	0.29	0.90	1.24	1.64	2.61
Predevelopment Peak Q (cfs)	0.0	0.0	0.0	0.1	0.5	1.7	2.3	3.0	4.8
Peak Inflow Q (cfs)	0.5	1.6	1.3	1.8	2.6	4.0	4.9	6.2	9.4
Peak Outflow Q (cfs)	0.0	0.1	0.1	0.1	0.9	2.1	2.2	3.1	8.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.7	1.7	1.3	0.9	1.0	1.7
Structure Controlling Flow =	Filtration Media	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway
Max Velocity through Grate 1 (fps)	N/A	N/A	N/A	N/A	0.1	0.3	0.3	0.3	0.3
Max Velocity through Grate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	12	23	21	24	25	24	23	22	20
Time to Drain 99% of Inflow Volume (hours)	12	24	22	25	26	26	26	25	25
Maximum Ponding Depth (ft)	0.58	1.64	1.35	1.77	2.09	2.27	2.60	3.06	3.21
Area at Maximum Ponding Depth (acres)	0.03	0.05	0.04	0.05	0.05	0.06	0.06	0.07	0.07
Maximum Volume Stored (acre-ft)	0.018	0.061	0.047	0.067	0.083	0.093	0.112	0.141	0.151

# Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



S-A-V-D Chart Axis Override

	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

## Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 2

**Designer:** D. Gorman  
**Company:** M.V.E., Inc.  
**Date:** September 13, 2019  
**Project:** Sanctuary of Peace  
**Location:** Sub-basin C1 - Sand Filter

<p>1. Basin Storage Volume</p> <p>A) Effective Imperviousness of Tributary Area, <math>I_a</math> (100% if all paved and roofed areas upstream of sand filter)</p> <p>B) Tributary Area's Imperviousness Ratio (<math>i = I_a/100</math>)</p> <p>C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time <math>WQCV = 0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)</math></p> <p>D) Contributing Watershed Area (including sand filter area)</p> <p>E) Water Quality Capture Volume (WQCV) Design Volume <math>V_{WQCV} = WQCV / 12 * Area</math></p> <p>F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm</p> <p>G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume</p> <p>H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)</p>	<p><math>I_a = </math> <input type="text" value="25.0"/> %</p> <p><math>i = </math> <input type="text" value="0.250"/></p> <p>WQCV = <input type="text" value="0.11"/> watershed inches</p> <p>Area = <input type="text" value="177,412"/> sq ft</p> <p><math>V_{WQCV} = </math> <input type="text" value=""/></p> <p><math>d_6 = </math> <input type="text" value="0.42"/> in</p> <p><math>V_{WQCV\ OTHER} = </math> <input type="text" value="1,558"/> cu ft</p> <p><math>V_{WQCV\ USER} = </math> <input type="text" value=""/> cu ft</p>
<p>2. Basin Geometry</p> <p>A) WQCV Depth</p> <p>B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.</p> <p>C) Minimum Filter Area (Flat Surface Area)</p> <p>D) Actual Filter Area</p> <p>E) Volume Provided</p>	<p><math>D_{WQCV} = </math> <input type="text" value="0.8"/> ft</p> <p><math>Z = </math> <input type="text" value="3.00"/> ft / ft <span style="color: red; font-weight: bold;">DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE</span></p> <p><math>A_{Min} = </math> <input type="text" value="554"/> sq ft</p> <p><math>A_{Actual} = </math> <input type="text" value="1843"/> sq ft</p> <p><math>V_T = </math> <input type="text" value="1601"/> cu ft</p>
<p>3. Filter Material</p>	<p>Choose One _____</p> <p><input checked="" type="radio"/> 18" CDOT Class B or C Filter Material</p> <p><input type="radio"/> Other (Explain): _____</p> <p>_____</p> <p>_____</p>
<p>4. Underdrain System</p> <p>A) Are underdrains provided?</p> <p>B) Underdrain system orifice diameter for 12 hour drain time</p> <p style="margin-left: 20px;">i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice</p> <p style="margin-left: 20px;">ii) Volume to Drain in 12 Hours</p> <p style="margin-left: 20px;">iii) Orifice Diameter, 3/8" Minimum</p>	<p>Choose One _____</p> <p><input checked="" type="radio"/> YES</p> <p><input type="radio"/> NO</p> <p><math>y = </math> <input type="text" value="2.0"/> ft</p> <p><math>Vol_{12} = </math> <input type="text" value="1,558"/> cu ft</p> <p><math>D_o = </math> <input type="text" value="15/16"/> in</p>



Design Procedure Form: Sand Filter (SF)

Sheet 2 of 2

Designer: D. Gorman  
Company: M.V.E., Inc.  
Date: September 13, 2019  
Project: Sanctuary of Peace  
Location: Sub-basin C1 - Sand Filter

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric

A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?

Choose One \_\_\_\_\_  
 YES     NO

6. Inlet / Outlet Works

A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet

emergency spillway with rip-rap protection  
rip-rap at inflow points

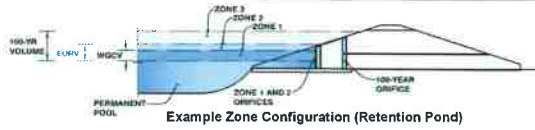
Notes: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Sanctuary of Peace

Basin ID: Sub-basin C1 - Sand Filter - DP6



Example Zone Configuration (Retention Pond)

### Required Volume Calculation

Selected BMP Type =	<b>SF</b>	
Watershed Area =	4.07	acres
Watershed Length =	557	ft
Watershed Slope =	0.066	ft/ft
Watershed Imperviousness =	25.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	12.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.037	acre-feet
Excess Urban Runoff Volume (EURV) =	0.103	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.077	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.112	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.180	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.324	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	0.417	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	0.538	acre-feet
500-yr Runoff Volume (P1 = 3.4 in.) =	0.844	acre-feet
Approximate 2-yr Detention Volume =	0.072	acre-feet
Approximate 5-yr Detention Volume =	0.105	acre-feet
Approximate 10-yr Detention Volume =	0.160	acre-feet
Approximate 25-yr Detention Volume =	0.191	acre-feet
Approximate 50-yr Detention Volume =	0.201	acre-feet
Approximate 100-yr Detention Volume =	0.242	acre-feet

Optional User Override 1-hr Precipitation	
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.40	inches

### Stage-Storage Calculation

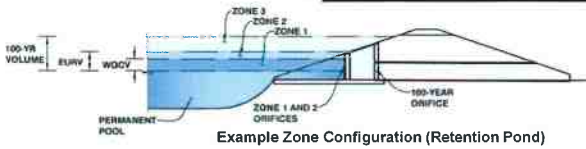
Zone 1 Volume (WQCV) =	0.037	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.066	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.139	acre-feet
Total Detention Basin Volume =	0.242	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft <sup>3</sup>
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H <sub>total</sub> ) =	3.50	ft
Depth of Trickle Channel (H <sub>TC</sub> ) =	N/A	ft
Slope of Trickle Channel (S <sub>TC</sub> ) =	N/A	ft/ft
Slopes of Main Basin Sides (S <sub>main</sub> ) =	3	H:V
Basin Length-to-Width Ratio (R <sub>L/W</sub> ) =	3	
Initial Surcharge Area (A <sub>ISV</sub> ) =	0	ft <sup>2</sup>
Surcharge Volume Length (L <sub>ISV</sub> ) =	0.0	ft
Surcharge Volume Width (W <sub>ISV</sub> ) =	0.0	ft
Depth of Basin Floor (H <sub>fLOOR</sub> ) =	0.00	ft
Length of Basin Floor (L <sub>fLOOR</sub> ) =	74.3	ft
Width of Basin Floor (W <sub>fLOOR</sub> ) =	24.8	ft
Area of Basin Floor (A <sub>fLOOR</sub> ) =	1,843	ft <sup>2</sup>
Volume of Basin Floor (V <sub>fLOOR</sub> ) =	0	ft <sup>3</sup>
Depth of Main Basin (H <sub>MAIN</sub> ) =	3.50	ft
Length of Main Basin (L <sub>MAIN</sub> ) =	95.3	ft
Width of Main Basin (W <sub>MAIN</sub> ) =	45.8	ft
Area of Main Basin (A <sub>MAIN</sub> ) =	4,365	ft <sup>2</sup>
Volume of Main Basin (V <sub>MAIN</sub> ) =	10,552	ft <sup>3</sup>
Calculated Total Basin Volume (V <sub>total</sub> ) =	0.242	acre-feet

Depth Increment =	0.25	ft							
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft <sup>2</sup> )	Optional Override Area (ft <sup>2</sup> )	Area (acre)	Volume (ft <sup>3</sup> )	Volume (ac-ft)
Media Surface	0.00		74.3	24.8	1,843		0.042		
	0.25		75.8	26.2	1,987		0.046	460	0.011
	0.50		77.3	27.7	2,143		0.049	976	0.022
	0.75		78.8	29.2	2,302		0.053	1,531	0.035
Zone 1 (WQCV)	0.77		79.0	29.4	2,322		0.053	1,601	0.037
	1.00		80.3	30.7	2,467		0.057	2,127	0.049
	1.25		81.8	32.2	2,636		0.061	2,765	0.063
	1.50		83.3	33.7	2,809		0.064	3,445	0.079
	1.75		84.8	35.2	2,987		0.069	4,170	0.096
Zone 2 (EURV)	1.85		85.4	35.9	3,066		0.070	4,503	0.103
	2.00		86.3	36.7	3,169		0.073	4,939	0.113
	2.25		87.8	38.3	3,363		0.077	5,788	0.133
	2.50		89.3	39.8	3,555		0.082	6,653	0.153
	2.75		90.8	41.3	3,751		0.086	7,566	0.174
	3.00		92.3	42.8	3,951		0.091	8,528	0.196
	3.25		93.8	44.3	4,156		0.095	9,542	0.219
Zone 3 (100-year)	3.49		95.3	45.7	4,357		0.100	10,563	0.242
	3.50		95.3	45.8	4,365		0.100	10,607	0.243
	3.75		96.8	47.3	4,579		0.105	11,725	0.269
	4.00		98.3	48.8	4,798		0.110	12,897	0.296
	4.25		99.8	50.3	5,021		0.115	14,124	0.324
	4.50		101.3	51.8	5,248		0.120	15,408	0.354
	4.75		102.8	53.3	5,480		0.126	16,749	0.384
	5.00		104.3	54.8	5,717		0.131	18,148	0.417
	5.25		105.8	56.3	5,958		0.137	19,607	0.450
	5.50		107.3	57.8	6,203		0.142	21,127	0.485
	5.75		108.8	59.3	6,453		0.148	22,709	0.521
	6.00		110.3	60.8	6,707		0.154	24,354	0.559
	6.25		111.8	62.3	6,966		0.160	26,063	0.598
	6.50		113.3	63.8	7,230		0.166	27,838	0.639
	6.75		114.8	65.3	7,498		0.172	29,678	0.681
	7.00		116.3	66.8	7,770		0.178	31,587	0.725
	7.25		117.8	68.3	8,047		0.185	33,564	0.771
	7.50		119.3	69.8	8,329		0.191	35,611	0.818
	7.75		120.8	71.3	8,615		0.198	37,729	0.866
	8.00		122.3	72.8	8,905		0.204	39,918	0.916
	8.25		123.8	74.3	9,200		0.211	42,181	0.968
	8.50		125.3	75.8	9,499		0.218	44,519	1.022
	8.75		126.8	77.3	9,803		0.225	46,932	1.077
	9.00		128.3	78.8	10,112		0.232	49,421	1.135
	9.25		129.8	80.3	10,425		0.239	51,988	1.193
	9.50		131.3	81.8	10,742		0.247	54,634	1.254
	9.75		132.8	83.3	11,064		0.254	57,359	1.317
	10.00		134.3	84.8	11,391		0.261	60,166	1.381
	10.25		135.8	86.3	11,722		0.269	63,055	1.448
	10.50		137.3	87.8	12,057		0.277	66,027	1.516
	10.75		138.8	89.3	12,397		0.285	69,084	1.586
	11.00		140.3	90.8	12,741		0.293	72,226	1.658
	11.25		141.8	92.3	13,090		0.301	75,455	1.732
	11.50		143.3	93.8	13,444		0.309	78,772	1.808
	11.75		144.8	95.3	13,802		0.317	82,177	1.887
	12.00		146.3	96.8	14,164		0.325	85,673	1.967
	12.25		147.8	98.3	14,531		0.334	89,260	2.049
	12.50		149.3	99.8	14,903		0.342	92,939	2.134

## Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Sanctuary of Peace  
Basin ID: Sub-basin C1 - Sand Filter DP6



	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.77	0.037	Filtration Media
Zone 2 (EURV)	1.85	0.066	Orifice Plate
Zone 3 (100-year)	3.49	0.139	Weir&Pipe (Restrict)
		0.242	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth = 2.00 ft (distance below the filtration media surface)  
Underdrain Orifice Diameter = 0.96 inches

Calculated Parameters for Underdrain

Underdrain Orifice Area = 0.0 ft<sup>2</sup>  
Underdrain Orifice Centroid = 0.04 feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice = 0.77 ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate = 1.86 ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing = 4.20 inches  
Orifice Plate: Orifice Area per Row = 0.68 sq. inches (diameter = 15/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row = 4.722E-03 ft<sup>2</sup>  
Elliptical Half-Width = N/A feet  
Elliptical Slot Centroid = N/A feet  
Elliptical Slot Area = N/A ft<sup>2</sup>

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.77	1.13	1.50					
Orifice Area (sq. inches)	0.68	0.68	0.68					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft <sup>2</sup>
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, H <sub>o</sub> =	2.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	2.92	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.92	N/A	feet
Overflow Grate Open Area % =	81%	N/A	% grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H <sub>i</sub> =	2.00	N/A	feet
Over Flow Weir Slope Length =	2.92	N/A	feet
Grate Open Area / 100-yr Orifice Area =	18.37	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	6.91	N/A	ft <sup>2</sup>
Overflow Grate Open Area w/ Debris =	3.45	N/A	ft <sup>2</sup>

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	12.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	5.80		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.38	N/A	ft <sup>2</sup>
Outlet Orifice Centroid =	0.28	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.54	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage = 3.50 ft (relative to basin bottom at Stage = 0 ft)  
Spillway Crest Length = 24.00 feet  
Spillway End Slopes = 2.00 H:V  
Freeboard above Max Water Surface = 1.00 feet

Calculated Parameters for Spillway

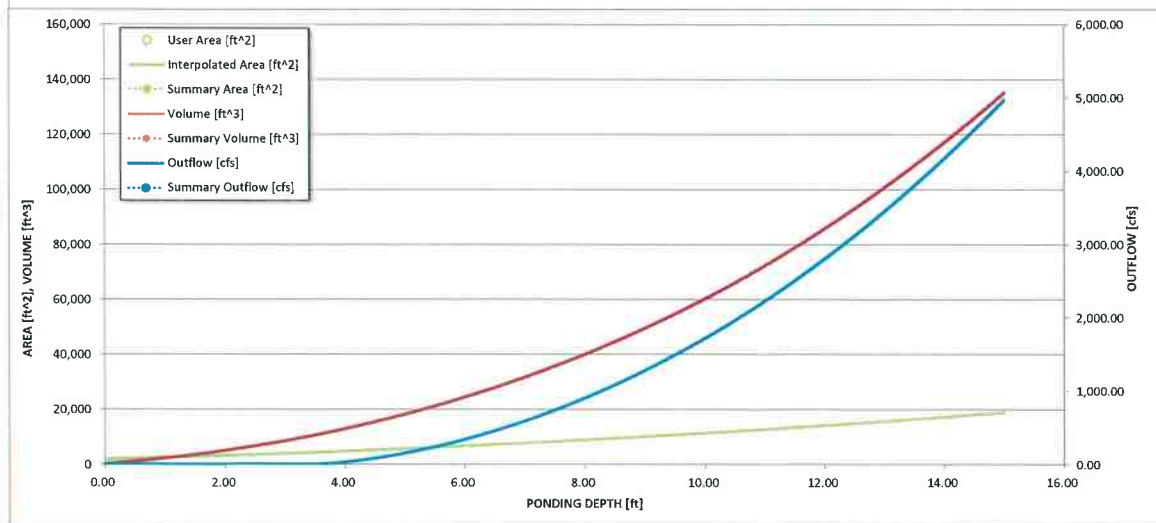
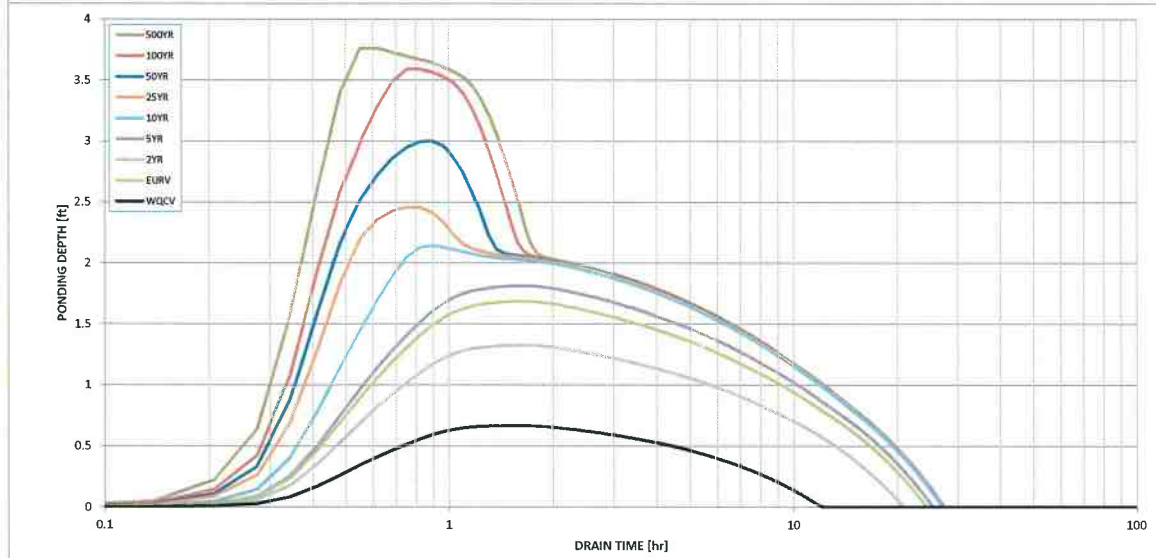
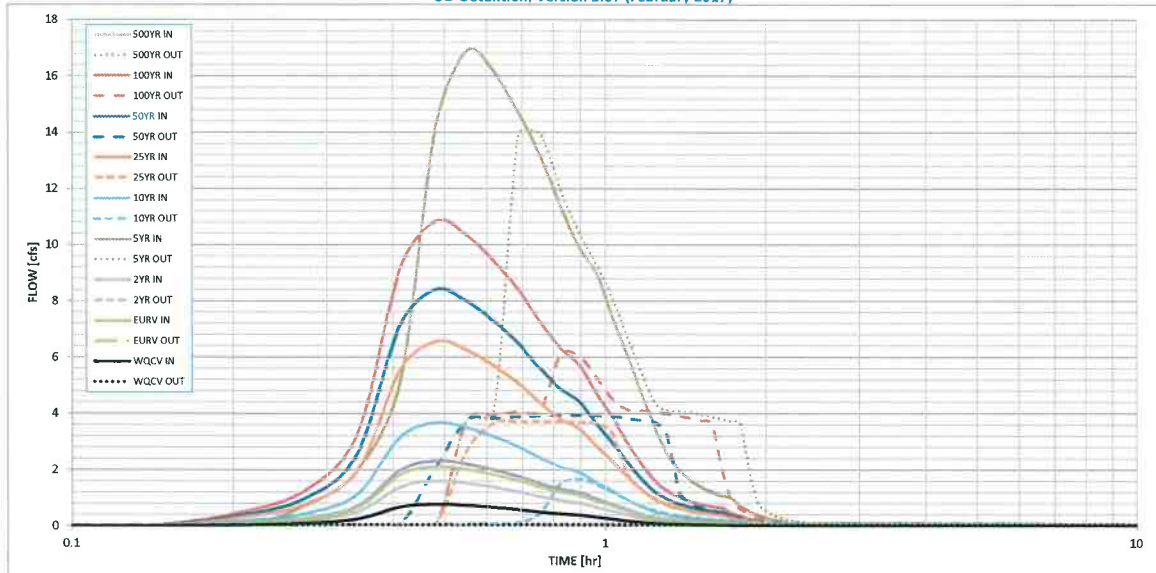
Spillway Design Flow Depth = 0.27 feet  
Stage at Top of Freeboard = 4.77 feet  
Basin Area at Top of Freeboard = 0.13 acres

### Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in)	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.40
Calculated Runoff Volume (acre-ft)	0.037	0.103	0.077	0.112	0.180	0.324	0.417	0.538	0.844
OPTIONAL Override Runoff Volume (acre-ft)									
Inflow Hydrograph Volume (acre-ft)	0.036	0.102	0.077	0.112	0.179	0.323	0.416	0.537	0.843
Predevelopment Unit Peak Flow, q (cfs/acre)	0.00	0.00	0.01	0.02	0.25	0.79	1.09	1.46	2.32
Predevelopment Peak Q (cfs)	0.0	0.0	0.1	0.1	1.0	3.2	4.4	5.9	9.5
Peak Inflow Q (cfs)	0.8	2.1	1.6	2.3	3.7	6.6	8.4	10.8	16.9
Peak Outflow Q (cfs)	0.0	0.1	0.1	0.1	1.7	3.7	3.9	6.1	13.9
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	1.0	1.7	1.2	0.9	1.0	1.5
Structure Controlling Flow =	Filtration Media	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway
Max Velocity through Grate 1 (fps)	N/A	N/A	N/A	N/A	0.2	0.5	0.5	0.6	0.6
Max Velocity through Grate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	12	23	20	24	25	24	23	22	19
Time to Drain 99% of Inflow Volume (hours)	12	24	21	25	27	26	26	26	25
Maximum Ponding Depth (ft)	0.67	1.69	1.33	1.81	2.14	2.46	3.00	3.59	3.76
Area at Maximum Ponding Depth (acres)	0.05	0.07	0.06	0.07	0.08	0.08	0.09	0.10	0.11
Maximum Volume Stored (acre-ft)	0.031	0.092	0.068	0.101	0.124	0.149	0.196	0.252	0.269

# Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



S-A-V-D Chart Axis Override

	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

## Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 2

Designer: D. Gorman  
 Company: M.V.E., Inc.  
 Date: September 13, 2019  
 Project: Sanctuary of Peace  
 Location: Sub-basin C2 - Sand Filter

<p>1. Basin Storage Volume</p> <p>A) Effective Imperviousness of Tributary Area, <math>I_p</math> (100% if all paved and roofed areas upstream of sand filter)</p> <p>B) Tributary Area's Imperviousness Ratio (<math>i = I_p/100</math>)</p> <p>C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time <math>WQCV = 0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)</math></p> <p>D) Contributing Watershed Area (including sand filter area)</p> <p>E) Water Quality Capture Volume (WQCV) Design Volume <math>V_{WQCV} = WQCV / 12 * Area</math></p> <p>F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm</p> <p>G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume</p> <p>H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)</p>	<p><math>I_p = </math> <input type="text" value="26.7"/> %</p> <p><math>i = </math> <input type="text" value="0.267"/></p> <p>WQCV = <input type="text" value="0.11"/> watershed inches</p> <p>Area = <input type="text" value="28,884"/> sq ft</p> <p><math>V_{WQCV} = </math> <input type="text" value=""/> cu ft</p> <p><math>d_6 = </math> <input type="text" value="0.42"/> in</p> <p><math>V_{WQCV\ OTHER} = </math> <input type="text" value="265"/> cu ft</p> <p><math>V_{WQCV\ USER} = </math> <input type="text" value=""/> cu ft</p>
<p>2. Basin Geometry</p> <p>A) WQCV Depth</p> <p>B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.</p> <p>C) Minimum Filter Area (Flat Surface Area)</p> <p>D) Actual Filter Area</p> <p>E) Volume Provided</p>	<p><math>D_{WQCV} = </math> <input type="text" value="0.9"/> ft</p> <p><math>Z = </math> <input type="text" value="3.00"/> ft / ft <span style="color: red; font-weight: bold;">DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE</span></p> <p><math>A_{Min} = </math> <input type="text" value="96"/> sq ft</p> <p><math>A_{Actual} = </math> <input type="text" value="546"/> sq ft</p> <p><math>V_T = </math> <input type="text" value="270"/> cu ft</p>
<p>3. Filter Material</p>	<p>Choose One _____</p> <p><input checked="" type="radio"/> 18" CDOT Class B or C Filter Material</p> <p><input type="radio"/> Other (Explain): _____</p> <p>_____</p> <p>_____</p>
<p>4. Underdrain System</p> <p>A) Are underdrains provided?</p> <p>B) Underdrain system orifice diameter for 12 hour drain time</p> <p style="margin-left: 20px;">i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice</p> <p style="margin-left: 20px;">ii) Volume to Drain in 12 Hours</p> <p style="margin-left: 20px;">iii) Orifice Diameter, 3/8" Minimum</p>	<p>Choose One _____</p> <p><input checked="" type="radio"/> YES</p> <p><input type="radio"/> NO</p> <p><math>y = </math> <input type="text" value="2.0"/> ft</p> <p><math>Vol_{12} = </math> <input type="text" value="265"/> cu ft</p> <p><math>D_o = </math> <input type="text" value="3/8"/> in</p>

Design Procedure Form: Sand Filter (SF)

Sheet 2 of 2

Designer: D. Gorman  
Company: M.V.E., Inc.  
Date: September 13, 2019  
Project: Sanctuary of Peace  
Location: Sub-basin C2 - Sand Filter

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric

A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?

Choose One \_\_\_\_\_  
 YES  NO

6. Inlet / Outlet Works

A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet

emergency spillway with rip-rap protection  
rip-rap at inflow points  
\_\_\_\_\_  
\_\_\_\_\_

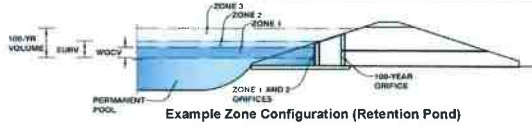
Notes: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Sanctuary of Peace

Basin ID: Sub-basin C2 - Sand Filter - DP3



### Required Volume Calculation

Selected BMP Type =	<b>SF</b>	
Watershed Area =	0.66	acres
Watershed Length =	189	ft
Watershed Slope =	0.063	ft/ft
Watershed Imperviousness =	26.70%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	12.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.006	acre-feet
Excess Urban Runoff Volume (EURV) =	0.018	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.014	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.020	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.031	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.054	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	0.069	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	0.089	acre-feet
500-yr Runoff Volume (P1 = 3.4 in.) =	0.138	acre-feet
Approximate 2-yr Detention Volume =	0.013	acre-feet
Approximate 5-yr Detention Volume =	0.018	acre-feet
Approximate 10-yr Detention Volume =	0.027	acre-feet
Approximate 25-yr Detention Volume =	0.032	acre-feet
Approximate 50-yr Detention Volume =	0.034	acre-feet
Approximate 100-yr Detention Volume =	0.041	acre-feet

Optional User Override 1-hr Precipitation	
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.40	inches

### Stage-Storage Calculation

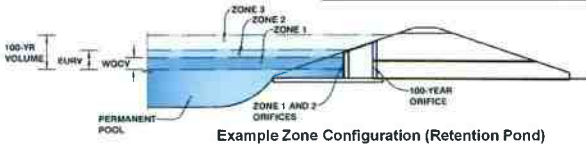
Zone 1 Volume (WQCV) =	0.006	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.012	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.023	acre-feet
Total Detention Basin Volume =	0.041	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft <sup>3</sup>
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H <sub>total</sub> ) =	2.00	ft
Depth of Trickle Channel (H <sub>TC</sub> ) =	N/A	ft
Slope of Trickle Channel (S <sub>TC</sub> ) =	N/A	ft/ft
Slopes of Main Basin Sides (S <sub>main</sub> ) =	3	H:V
Basin Length-to-Width Ratio (R <sub>L/W</sub> ) =	2	
Initial Surcharge Area (A <sub>ISV</sub> ) =	0	ft <sup>2</sup>
Surcharge Volume Length (L <sub>ISV</sub> ) =	0.0	ft
Surcharge Volume Width (W <sub>ISV</sub> ) =	0.0	ft
Depth of Basin Floor (H <sub>FLOOR</sub> ) =	0.00	ft
Length of Basin Floor (L <sub>FLOOR</sub> ) =	33.0	ft
Width of Basin Floor (W <sub>FLOOR</sub> ) =	16.5	ft
Area of Basin Floor (A <sub>FLOOR</sub> ) =	546	ft <sup>2</sup>
Volume of Basin Floor (V <sub>FLOOR</sub> ) =	0	ft <sup>3</sup>
Depth of Main Basin (H <sub>MAIN</sub> ) =	2.00	ft
Length of Main Basin (L <sub>MAIN</sub> ) =	45.0	ft
Width of Main Basin (W <sub>MAIN</sub> ) =	28.5	ft
Area of Main Basin (A <sub>MAIN</sub> ) =	1,285	ft <sup>2</sup>
Volume of Main Basin (V <sub>MAIN</sub> ) =	1,779	ft <sup>3</sup>
Calculated Total Basin Volume (V <sub>total</sub> ) =	0.041	acre-feet

Depth Increment =	0.25	ft							
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft <sup>2</sup> )	Optional Override Area (ft <sup>2</sup> )	Area (acre)	Volume (ft <sup>3</sup> )	Volume (ac-ft)
Media Surface	0.00		33.0	16.5	546		0.013		
	0.25		34.5	18.0	619		0.014	140	0.003
	0.50		36.0	19.5	700		0.016	270	0.006
Zone 1 (WQCV)	0.44		35.7	19.2	684		0.016	270	0.006
	0.50		36.0	19.5	700		0.016	305	0.007
	0.75		37.5	21.0	786		0.018	490	0.011
Zone 2 (EURV)	1.00		39.0	22.5	876		0.020	698	0.016
	1.09		39.6	23.1	913		0.021	787	0.018
	1.25		40.5	24.0	970		0.022	929	0.021
Zone 3 (100-year)	1.50		42.0	25.5	1,069		0.025	1,183	0.027
	1.75		43.5	27.0	1,173		0.027	1,464	0.034
	2.00		45.0	28.5	1,280		0.029	1,770	0.041
Optional User Override 1-hr Precipitation	2.00		45.0	28.5	1,285		0.029	1,783	0.041
	2.25		46.5	30.0	1,397		0.032	2,118	0.049
	2.50		48.0	31.5	1,515		0.035	2,482	0.057
	2.75		49.5	33.0	1,636		0.038	2,876	0.066
	3.00		51.0	34.5	1,762		0.040	3,300	0.076
	3.25		52.5	36.0	1,893		0.043	3,757	0.086
	3.50		54.0	37.5	2,028		0.047	4,247	0.098
	3.75		55.5	39.0	2,168		0.050	4,772	0.110
	4.00		57.0	40.5	2,312		0.053	5,331	0.122
	4.25		58.5	42.0	2,460		0.056	5,928	0.136
	4.50		60.0	43.5	2,613		0.060	6,562	0.151
	4.75		61.5	45.0	2,771		0.064	7,235	0.166
	5.00		63.0	46.5	2,933		0.067	7,948	0.182
	5.25		64.5	48.0	3,100		0.071	8,702	0.200
	5.50		66.0	49.5	3,271		0.075	9,498	0.218
	5.75		67.5	51.0	3,446		0.079	10,338	0.237
	6.00		69.0	52.5	3,627		0.083	11,222	0.258
	6.25		70.5	54.0	3,811		0.087	12,151	0.279
	6.50		72.0	55.5	4,000		0.092	13,128	0.301
	6.75		73.5	57.0	4,194		0.096	14,152	0.325
	7.00		75.0	58.5	4,392		0.101	15,225	0.350
	7.25		76.5	60.0	4,595		0.105	16,348	0.375
	7.50		78.0	61.5	4,802		0.110	17,523	0.402
	7.75		79.5	63.0	5,013		0.115	18,749	0.430
8.00		81.0	64.5	5,229		0.120	20,030	0.460	
8.25		82.5	66.0	5,450		0.125	21,364	0.490	
8.50		84.0	67.5	5,675		0.130	22,755	0.522	
8.75		85.5	69.0	5,905		0.136	24,202	0.556	
9.00		87.0	70.5	6,139		0.141	25,708	0.590	
9.25		88.5	72.0	6,377		0.146	27,272	0.626	
9.50		90.0	73.5	6,620		0.152	28,897	0.663	
9.75		91.5	75.0	6,868		0.158	30,583	0.702	
10.00		93.0	76.5	7,120		0.163	32,331	0.742	
10.25		94.5	78.0	7,377		0.169	34,143	0.784	
10.50		96.0	79.5	7,638		0.175	36,020	0.827	
10.75		97.5	81.0	7,904		0.181	37,962	0.871	
11.00		99.0	82.5	8,174		0.188	39,972	0.918	
11.25		100.5	84.0	8,448		0.194	42,050	0.965	
11.50		102.0	85.5	8,727		0.200	44,197	1.015	
11.75		103.5	87.0	9,011		0.207	46,414	1.066	
12.00		105.0	88.5	9,299		0.213	48,702	1.118	
12.25		106.5	90.0	9,592		0.220	51,064	1.172	
12.50		108.0	91.5	9,889		0.227	53,499	1.228	

## Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Sanctuary of Peace  
Basin ID: Sub-basin C2 - Sand Filter DP3



	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.44	0.006	Filtration Media
Zone 2 (EURV)	1.09	0.012	Orifice Plate
Zone 3 (100-year)	2.00	0.023	Weir&Pipe (Restrict)
		0.041	<b>Total</b>

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	2.00	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	0.38	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	0.0	ft <sup>2</sup>
Underdrain Orifice Centroid =	0.02	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.44	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.09	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	4.20	inches
Orifice Plate: Orifice Area per Row =	0.28	sq. inches (diameter = 9/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.944E-03	ft <sup>2</sup>
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft <sup>2</sup>

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.44	0.66	0.87					
Orifice Area (sq. inches)	0.28	0.28	0.28					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft <sup>2</sup>
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, H <sub>o</sub> =	1.25	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	2.92	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.92	N/A	feet
Overflow Grate Open Area % =	81%	N/A	% grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H <sub>g</sub> =	1.25	N/A	feet
Over Flow Weir Slope Length =	2.92	N/A	feet
Grate Open Area / 100-yr Orifice Area =	80.27	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	6.91	N/A	ft <sup>2</sup>
Overflow Grate Open Area w/ Debris =	3.45	N/A	ft <sup>2</sup>

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	12.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	2.00	N/A	inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.09	N/A	ft <sup>2</sup>
Outlet Orifice Centroid =	0.10	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	0.84	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	2.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	10.00	feet
Spillway End Slopes =	2.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth =	0.16	feet
Stage at Top of Freeboard =	3.16	feet
Basin Area at Top of Freeboard =	0.04	acres

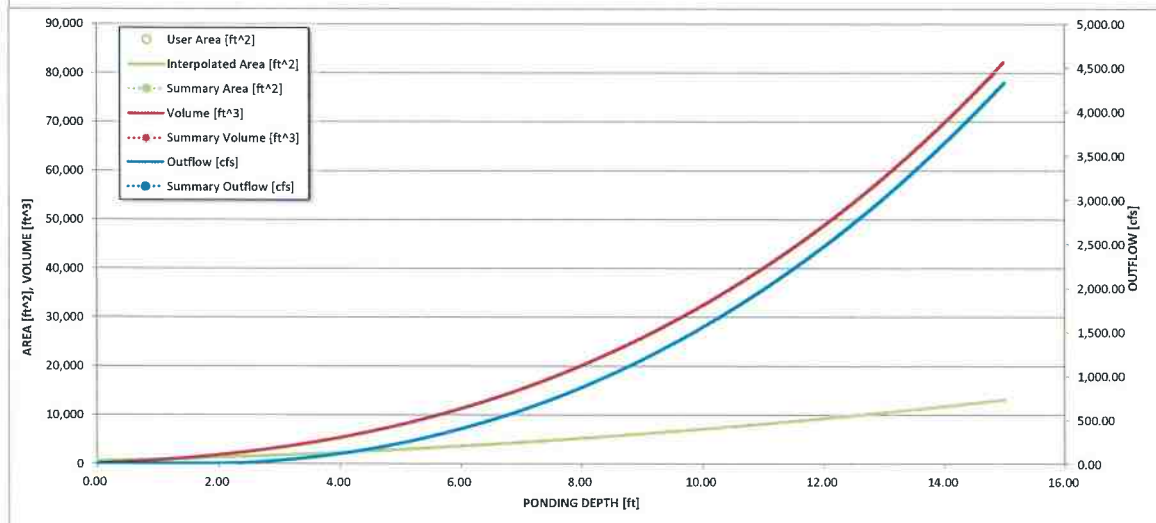
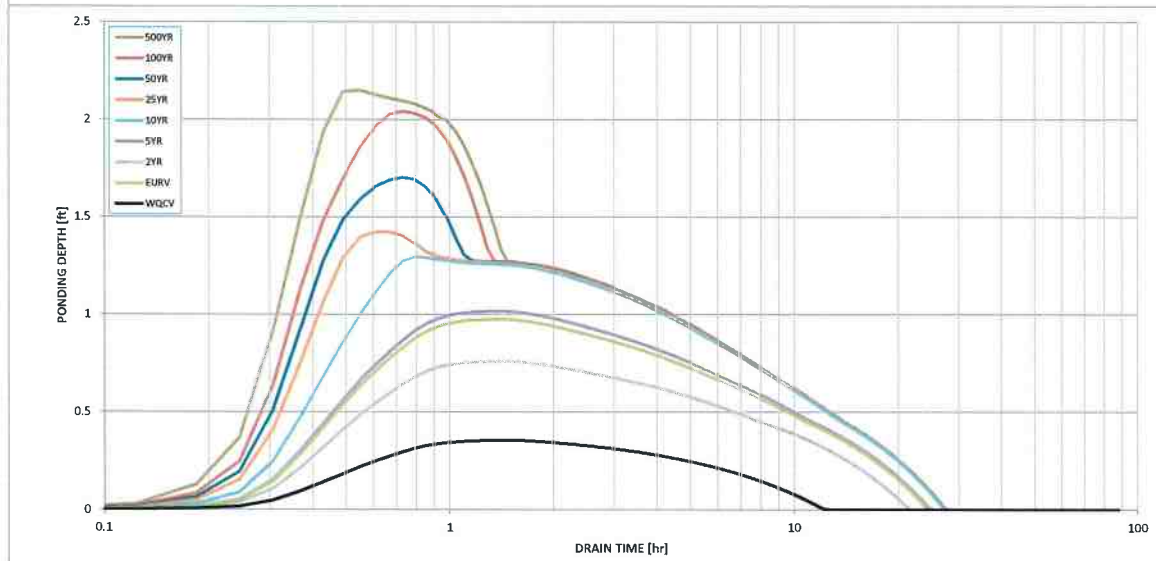
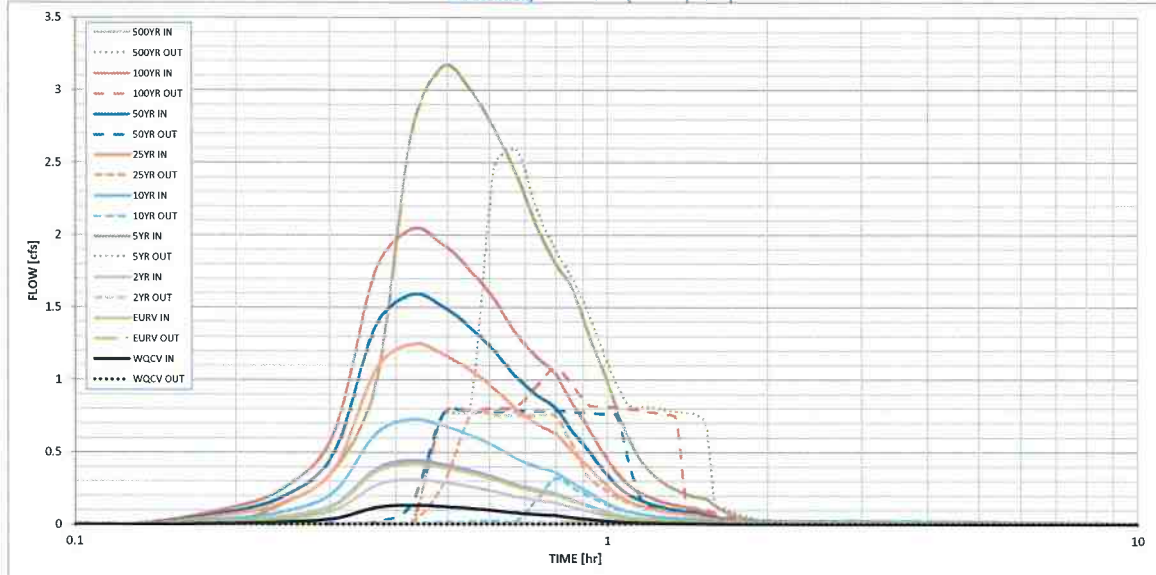
### Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period									
One-Hour Rainfall Depth (in)	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.40
Calculated Runoff Volume (acre-ft)	0.006	0.018	0.014	0.020	0.031	0.054	0.069	0.089	0.138
OPTIONAL Override Runoff Volume (acre-ft)									
Inflow Hydrograph Volume (acre-ft)	0.006	0.018	0.013	0.019	0.031	0.053	0.068	0.088	0.137
Predevelopment Unit Peak Flow, q (cfs/acre)	0.00	0.00	0.02	0.03	0.29	0.90	1.24	1.64	2.62
Predevelopment Peak Q (cfs)	0.0	0.0	0.0	0.0	0.2	0.6	0.8	1.1	1.7
Peak Inflow Q (cfs)	0.1	0.4	0.3	0.4	0.7	1.2	1.6	2.0	3.2
Peak Outflow Q (cfs)	0.0	0.0	0.0	0.0	0.3	0.8	0.8	1.1	2.6
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	1.2	1.7	1.3	1.0	1.0	1.5
Structure Controlling Flow	Filtration Media	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway
Max Velocity through Grate 1 (fps)	N/A	N/A	N/A	N/A	0.0	0.1	0.1	0.1	0.1
Max Velocity through Grate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	12	23	21	24	25	24	23	22	19
Time to Drain 99% of Inflow Volume (hours)	12	24	21	25	27	26	26	26	25
Maximum Ponding Depth (ft)	0.35	0.98	0.76	1.02	1.30	1.42	1.70	2.04	2.15
Area at Maximum Ponding Depth (acres)	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Maximum Volume Stored (acre-ft)	0.005	0.016	0.012	0.016	0.022	0.025	0.033	0.042	0.045



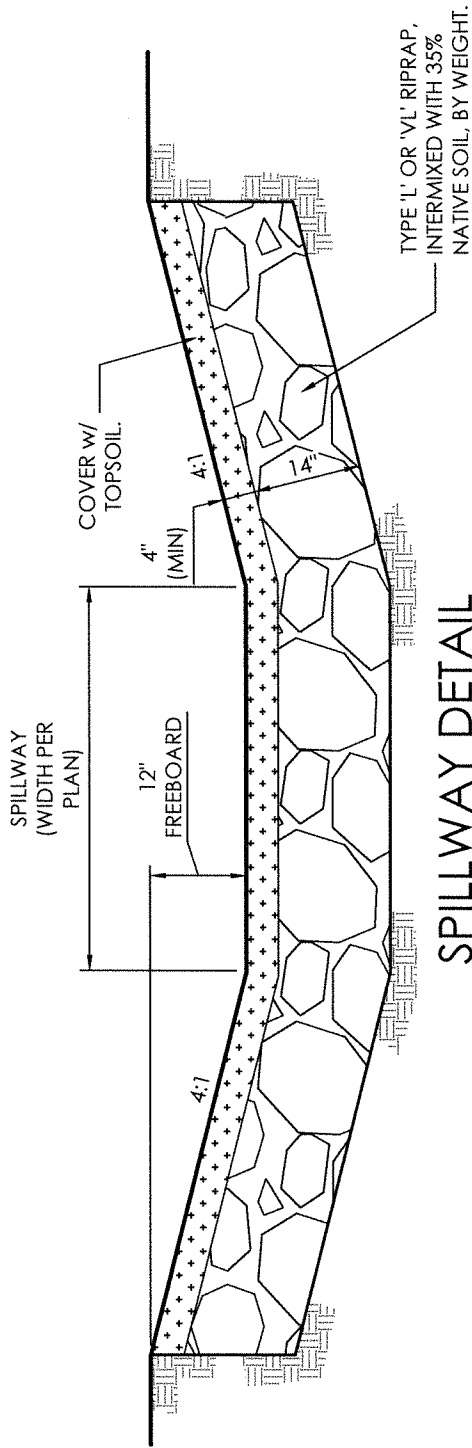
# Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



S-A-V-D Chart Axis Override

	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			



## SPILLWAY DETAIL

SCALE: NTS

RIP-RAP GRADATION TABLE		
% SMALLER BY WEIGHT	TYPE VL INTER. ROCK DIM. (INCHES)	TYPE L INTER. ROCK DIM. (INCHES)
70 - 100	$d_{100} = 12$	$d_{100} = 15$
50 - 70	$d_{70} = 9$	$d_{70} = 12$
35 - 50	$d_{50} = 6$	$d_{50} = 9$
2 - 10	$d_{10} = 2$	$d_{10} = 3$

**MONUMENT VALLEY  
ENGINEERS INC.**

ENGINEERS \* SURVEYORS  
1903 LELARAY STREET  
COLORADO SPRINGS, COLORADO 80909  
PHONE (719) 635-5736



PROJECT:

SANCTUARY OF PEACE

TITLE:

SAND FILTER BASIN

PROJ. NO.  
61087

DATE:  
1/10/2018

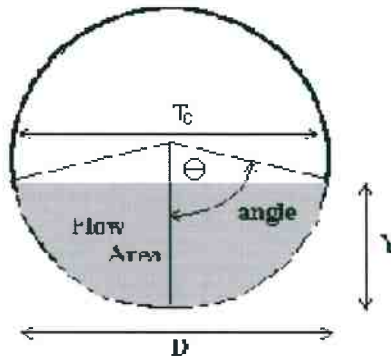
DRAWING NO.  
-SF-DET

SHEET  
2 OF 2

## CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: **61087 - Sanctuary of Peace**

Pipe ID: **Culvert B1**



### Design Information (Input)

Pipe Invert Slope	$S_o =$	0.0050	ft/ft
Pipe Manning's n-value	$n =$	0.0130	
Pipe Diameter	$D =$	18.00	inches
Design discharge	$Q =$	5.00	cfs

### Full-flow Capacity (Calculated)

Full-flow area	$A_f =$	1.77	sq ft
Full-flow wetted perimeter	$P_f =$	4.71	ft
Half Central Angle	$\theta =$	3.14	radians
Full-flow capacity	$Q_f =$	7.45	cfs

### Calculation of Normal Flow Condition

Half Central Angle ( $0 < \theta < 3.14$ )	$\theta =$	1.77	radians
Flow area	$A_n =$	1.11	sq ft
Top width	$T_n =$	1.47	ft
Wetted perimeter	$P_n =$	2.66	ft
Flow depth	$Y_n =$	0.90	ft
Flow velocity	$V_n =$	4.52	fps
Discharge	$Q_n =$	5.00	cfs
Percent Full Flow	$\text{Flow} =$	67.1%	of full flow
Normal Depth Froude Number	$Fr_n =$	0.92	subcritical

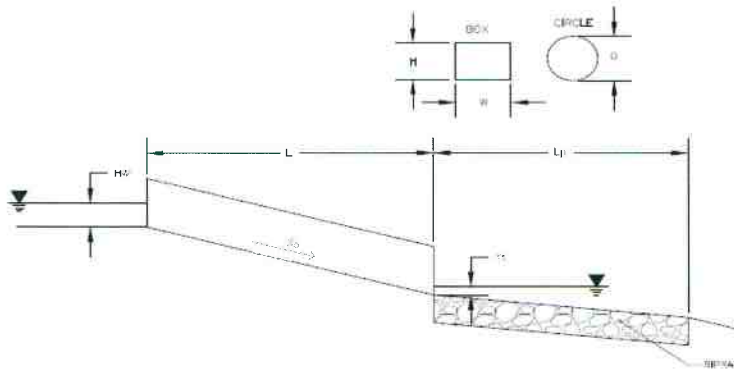
### Calculation of Critical Flow Condition

Half Central Angle ( $0 < \theta_c < 3.14$ )	$\theta_c =$	1.72	radians
Critical flow area	$A_c =$	1.05	sq ft
Critical top width	$T_c =$	1.48	ft
Critical flow depth	$Y_c =$	0.86	ft
Critical flow velocity	$V_c =$	4.77	fps
Critical Depth Froude Number	$Fr_c =$	1.00	

## Determination of Culvert Headwater and Outlet Protection

Project: **61087 - Sanctuary of Peace**

Basin ID: **Culvert B1**



Soil Type:

Choose One:  
 Sandy  
 Non-Sandy

### Design Information (Input):

Design Discharge

Q =  cfs

Circular Culvert:

Barrel Diameter in Inches

D =  inches

Inlet Edge Type (Choose from pull-down list)

1.5 : 1 Beveled Edge

Box Culvert:

Barrel Height (Rise) in Feet

Height (Rise) =  ft

Barrel Width (Span) in Feet

Width (Span) =  ft

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

No =

Inlet Elevation

Elev IN =  ft

Outlet Elevation OR Slope

So =  ft/ft

Culvert Length

L =  ft

Manning's Roughness

n =

Bend Loss Coefficient

$k_b$  =

Exit Loss Coefficient

$k_x$  =

Tailwater Surface Elevation

Elev  $Y_t$  =  ft

Max Allowable Channel Velocity

V =  ft/s

### Required Protection (Output):

Tailwater Surface Height

$Y_t$  =  ft

Flow Area at Max Channel Velocity

$A_c$  =  ft<sup>2</sup>

Culvert Cross Sectional Area Available

A =  ft<sup>2</sup>

Entrance Loss Coefficient

$k_e$  =

Friction Loss Coefficient

$k_f$  =

Sum of All Losses Coefficients

$k_s$  =  ft

Culvert Normal Depth

$Y_n$  =  ft

Culvert Critical Depth

$Y_c$  =  ft

Tailwater Depth for Design

d =  ft

Adjusted Diameter OR Adjusted Rise

$D_a$  =  ft

Expansion Factor

$1/(2*\tan(\theta))$  =

Flow/Diameter<sup>2.5</sup> OR Flow/(Span \* Rise<sup>1.5</sup>)

$Q/D^{2.5}$  =  ft<sup>0.5</sup>/s

Froude Number

Fr =

Tailwater/Adjusted Diameter OR Tailwater/Adjusted Rise

YVD =

Inlet Control Headwater

HW<sub>i</sub> =  ft

Outlet Control Headwater

HW<sub>o</sub> =  ft

Design Headwater Elevation

HW =  ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D =

Minimum Theoretical Riprap Size

$d_{50}$  =  in

Nominal Riprap Size

$d_{50}$  =  in

UDFCD Riprap Type

Type =

Length of Protection

$L_p$  =  ft

Width of Protection

T =  ft

## Sub-Basin C1 (Culvert) Runoff Calculations

Job No.: 61087  
 Project: Sanctuary of Peace  
 Jurisdiction: DCM  
 Runoff Coefficient: Surface Type

Date: 9/16/2019 10:38  
 Calcs by: ASM  
 Checked by: \_\_\_\_\_  
 Soil Type: B  
 Urbanization: Non-Urban

### Basin Land Use Characteristics

Surface	Area		Runoff Coefficient						% Imperv.
	(SF)	(Acres)	C2	C5	C10	C25	C50	C100	
Forest	74,698	1.71	0.02	0.08	0.15	0.25	0.3	0.35	0%
Driveways & Walks	5,171	0.12	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	15,854	0.36	0.71	0.73	0.75	0.78	0.8	0.81	90%
<b>Combined</b>	<b>95,723</b>	<b>2.20</b>	<b>0.18</b>	<b>0.23</b>	<b>0.29</b>	<b>0.38</b>	<b>0.42</b>	<b>0.46</b>	<b>20.3%</b>

95723

### Basin Travel Time

Shallow Channel Ground Cover Forest						
	$L_{max,Overland}$	100 ft			$C_v$	5
	L (ft)	$\Delta Z_0$ (ft)	$S_0$ (ft/ft)	v (ft/s)	t (min)	$t_{Att}$ (min)
Total	367	25	-	-	-	-
Initial Time	100	16	0.160	-	6.3	N/A DCM Eq. 6-8
Shallow Channel	267	9	0.034	0.9	4.8	- DCM Eq. 6-9
Channelized			0.000	0.0	0.0	- V-Ditch
				$t_c$	11.1 min.	

### Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.17	3.97	4.63	5.29	5.95	6.66
Runoff (cfs)	1.3	2.0	3.0	4.4	5.5	6.7
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.3	2.0	3.0	4.4	5.5	6.7

DCM:  $t = C1 * \ln(t_c) + C2$

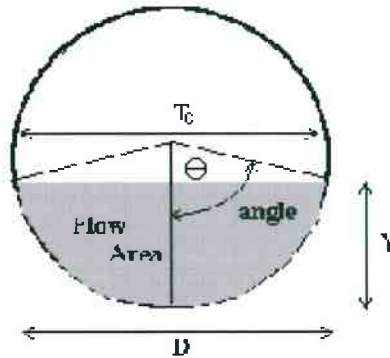
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

### Notes

## CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: 61087 - Sanctuary of Peace

Pipe ID: Culvert C1



### Design Information (Input)

Pipe Invert Slope	$S_o =$	0.0050	ft/ft
Pipe Manning's n-value	$n =$	0.0130	
Pipe Diameter	$D =$	18.00	inches
Design discharge	$Q =$	6.70	cfs

### Full-flow Capacity (Calculated)

Full-flow area	$A_f =$	1.77	sq ft
Full-flow wetted perimeter	$P_f =$	4.71	ft
Half Central Angle	$\theta =$	3.14	radians
Full-flow capacity	$Q_f =$	7.45	cfs

### Calculation of Normal Flow Condition

Half Central Angle ( $0 < \theta < 3.14$ )	$\theta =$	2.07	radians
Flow area	$A_n =$	1.40	sq ft
Top width	$T_n =$	1.31	ft
Wetted perimeter	$P_n =$	3.11	ft
Flow depth	$Y_n =$	1.11	ft
Flow velocity	$V_n =$	4.77	fps
Discharge	$Q_n =$	6.70	cfs
Percent Full Flow	$\text{Flow} =$	89.9%	of full flow
Normal Depth Froude Number	$Fr_n =$	0.81	subcritical

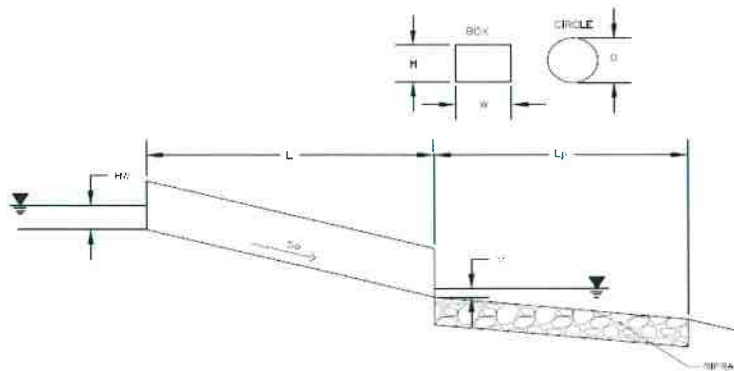
### Calculation of Critical Flow Condition

Half Central Angle ( $0 < \theta_c < 3.14$ )	$\theta_c =$	1.91	radians
Critical flow area	$A_c =$	1.25	sq ft
Critical top width	$T_c =$	1.41	ft
Critical flow depth	$Y_c =$	1.00	ft
Critical flow velocity	$V_c =$	5.34	fps
Critical Depth Froude Number	$Fr_c =$	1.00	

## Determination of Culvert Headwater and Outlet Protection

Project: **61087 - Sanctuary of Peace**

Basin ID: **Culvert C1**



Soil Type: \_\_\_\_\_

Choose One:  
 Sandy  
 Non-Sandy

### Design Information (Input):

Design Discharge

Q =  cfs

Circular Culvert:

Barrel Diameter in Inches

D =  inches

Inlet Edge Type (Choose from pull-down list)

1.5 : 1 Beveled Edge

Box Culvert:

Barrel Height (Rise) in Feet

Height (Rise) =  ft

Barrel Width (Span) in Feet

Width (Span) =  ft

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

No =

Inlet Elevation

Elev IN =  ft

Outlet Elevation OR Slope

So =  ft/ft

Culvert Length

L =  ft

Manning's Roughness

n =

Bend Loss Coefficient

k<sub>b</sub> =

Exit Loss Coefficient

k<sub>x</sub> =

Tailwater Surface Elevation

Elev Y<sub>t</sub> =  ft

Max Allowable Channel Velocity

V =  ft/s

### Required Protection (Output):

Tailwater Surface Height

Y<sub>t</sub> =  ft

Flow Area at Max Channel Velocity

A<sub>v</sub> =  ft<sup>2</sup>

Culvert Cross Sectional Area Available

A =  ft<sup>2</sup>

Entrance Loss Coefficient

k<sub>e</sub> =

Friction Loss Coefficient

k<sub>f</sub> =

Sum of All Losses Coefficients

k<sub>s</sub> =

Culvert Normal Depth

Y<sub>n</sub> =  ft

Culvert Critical Depth

Y<sub>c</sub> =  ft

Tailwater Depth for Design

d =  ft

Adjusted Diameter OR Adjusted Rise

D<sub>a</sub> =  ft

Expansion Factor

1/(2\*tan(θ)) =

Flow/Diameter<sup>2.5</sup> OR Flow/(Span \* Rise<sup>1.5</sup>)

Q/D<sup>2.5</sup> =  ft<sup>0.5</sup>/s

Froude Number

Fr =

Tailwater/Adjusted Diameter OR Tailwater/Adjusted Rise

Y/D =

Inlet Control Headwater

HW<sub>i</sub> =  ft

Outlet Control Headwater

HW<sub>o</sub> =  ft

Design Headwater Elevation

HW =  ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D =

Minimum Theoretical Riprap Size

d<sub>50</sub> =  in

Nominal Riprap Size

d<sub>50</sub> =  in

UDFCD Riprap Type

Type =

Length of Protection

L<sub>p</sub> =  ft

Width of Protection

T =  ft

#### **4 Drainage Maps**

Existing Conditions Drainage Map  
Proposed Conditions Drainage Map

(Map Pocket)  
(Map Pocket)



EXISTING DRAINAGE SUMMARY TABLE					
DESIGN POINT	BASIN	AREA (AC)	Tc (MIN.)	RUNOFF	
				Q5 (CFS)	Q100 (CFS)
	OS A	69.40	41.9	11.4	81.1
	OS B	83.92	41.7	17.4	102.7
	EX-A1	30.11	23.3	6.9	50.6
EX1	OS A, OS B, EX-A1	153.32	41.9	35.7	234.4
	EX-C1	5.68	15.7	1.6	11.5
EX7	EX-C1	5.68	15.7	1.6	11.5
	EX-C2	2.03	10.9	0.7	4.8
EX4	EX-C2	2.03	10.9	0.7	4.8
	EX-C3	0.66	9.8	0.2	1.6
EX5	EX-C3	0.66	9.8	0.2	1.6
	EX-B1	2.06	14.4	0.6	4.3
EX8	EX-B1	2.06	14.4	0.6	4.3
	EX-B2	8.75	12.0	2.7	19.8
	OS C	49.12	23.9	16.6	88.1
EX9	EX-B1, EX-B2, OS C	59.93	23.9	19.0	106.0

**LEGEND**

PROPERTY LINE  
 EASEMENT LINE  
 LOT LINE

**EXISTING**  
 5985 INDEX CONTOUR  
 84 INTERMEDIATE CONTOUR

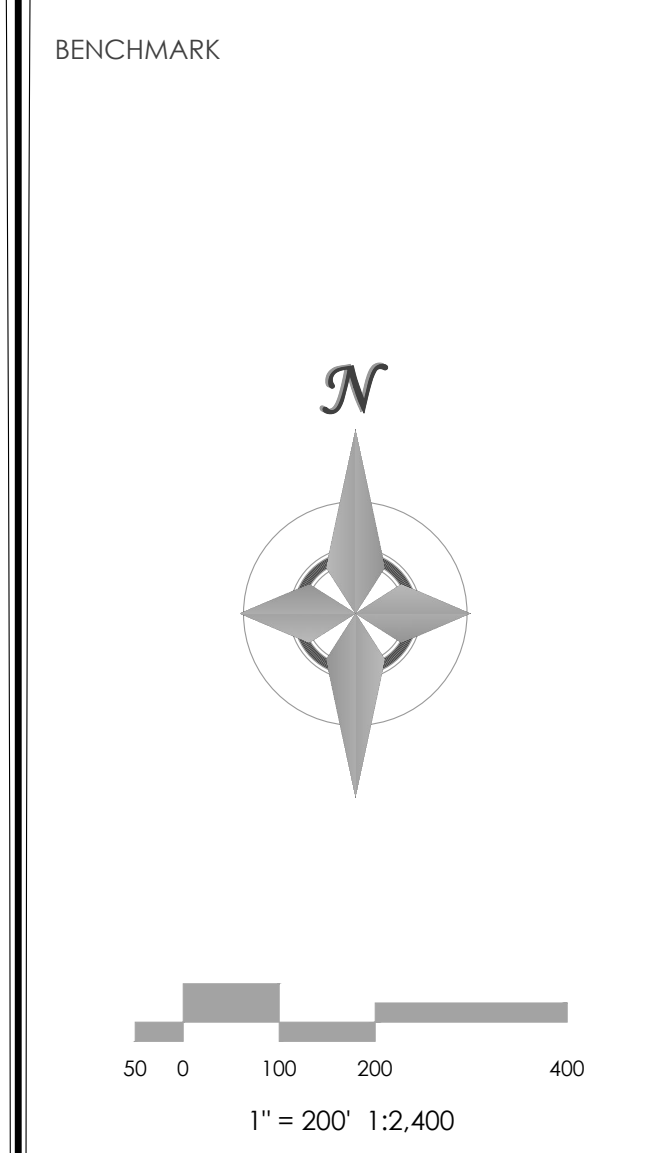
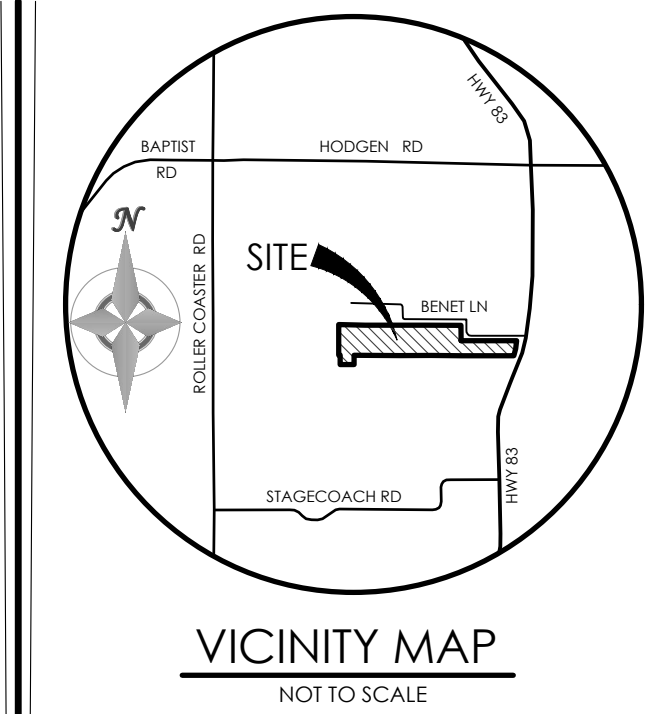
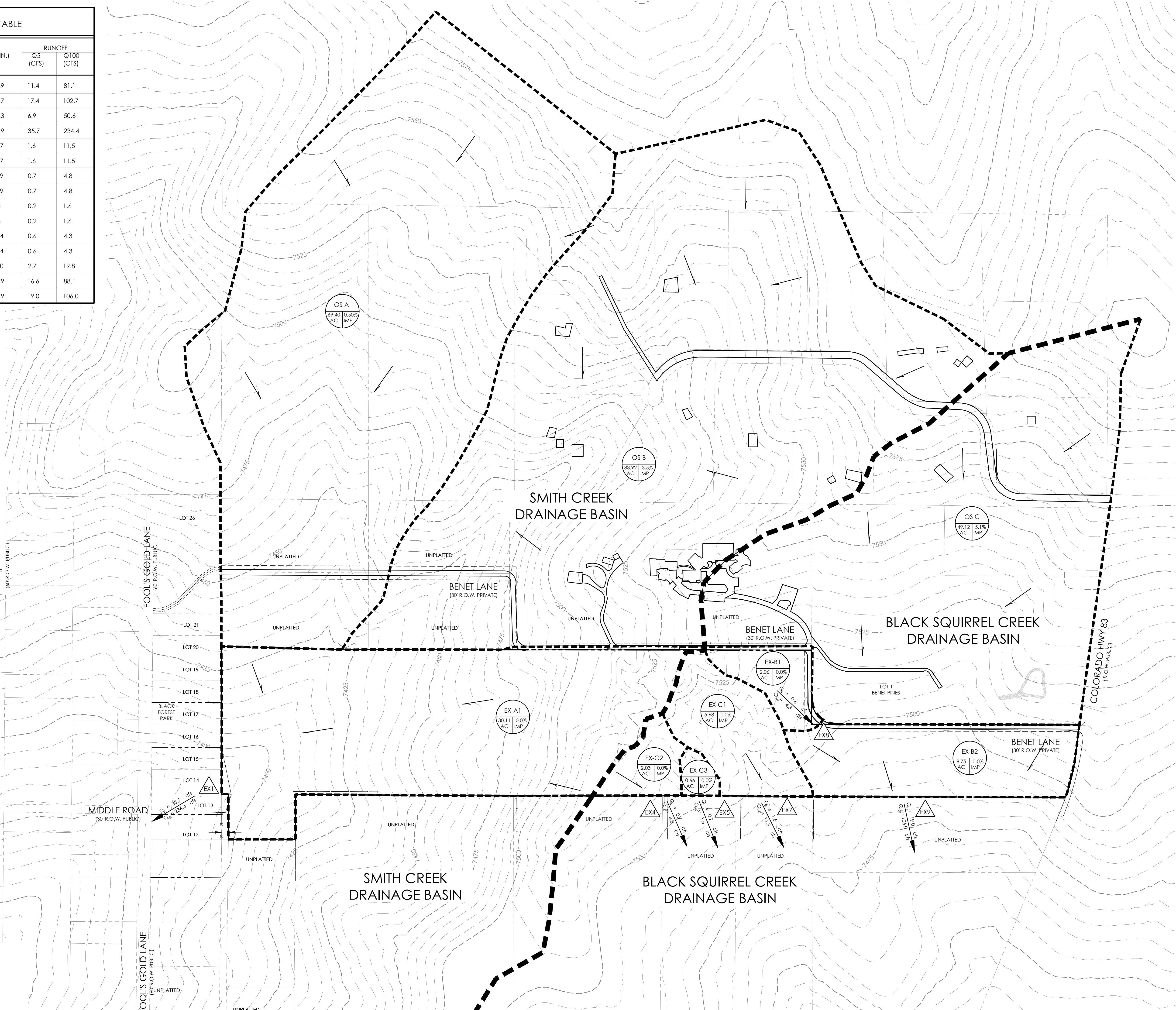
**PROPOSED**  
 5985 INDEX CONTOUR  
 84 INTERMEDIATE CONTOUR

BASIN BOUNDARY  
 2 = 192' cfs  
 4 = 603' cfs  
 1.5% SLOPE DIRECTION AND GRADE

BASIN LABEL  
 AREA IN ACRES  
 PERCENT IMPERVIOUS

POINT OF INTEREST

**FLOODPLAIN STATEMENT:**  
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 ENGINEERS / SURVEYORS

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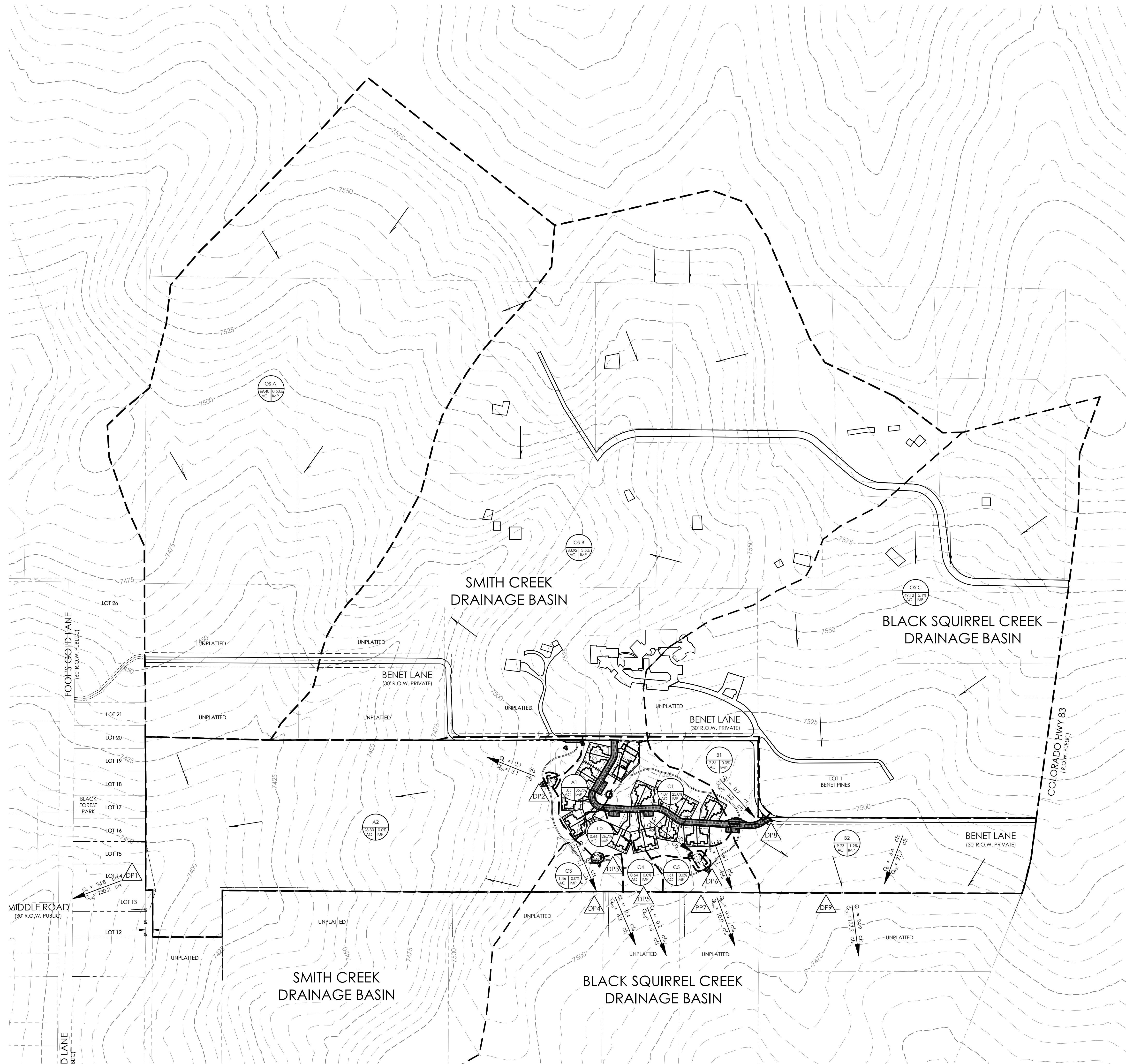
DESIGNED BY \_\_\_\_\_  
 DRAWN BY \_\_\_\_\_  
 CHECKED BY \_\_\_\_\_  
 AS-BUILT BY \_\_\_\_\_  
 CHECKED BY \_\_\_\_\_

**SANCTUARY OF PEACE**

**EXISTING DRAINAGE MAP**

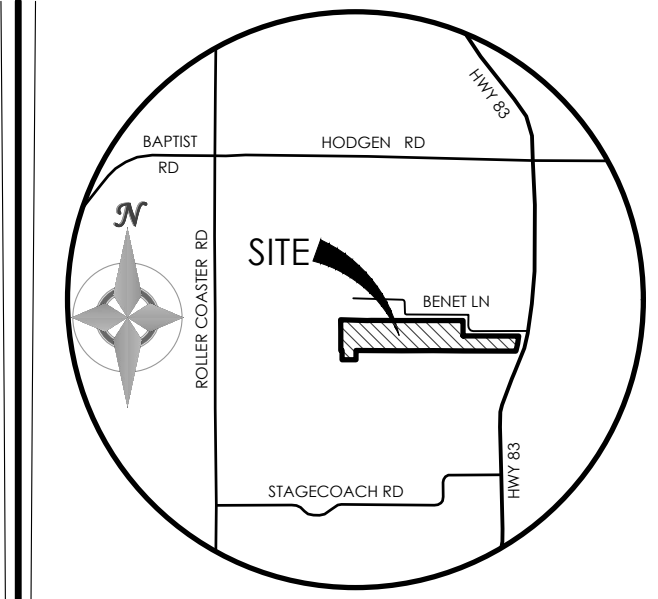
MVE PROJECT **61087**  
 MVE DRAWING **EX-DM**

**April 28, 2020**  
**SHEET 1 OF 1**



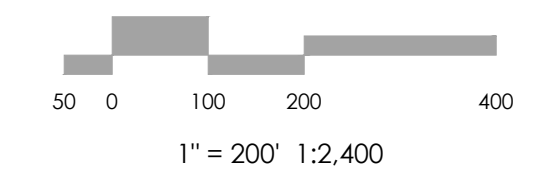
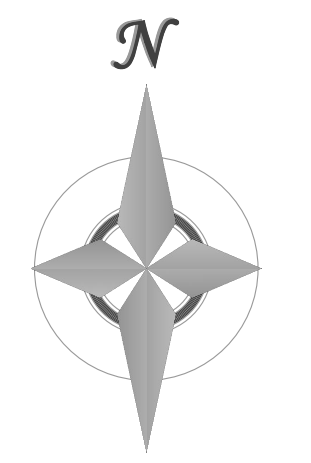
**DEVELOPED DRAINAGE SUMMARY TABLE**

DESIGN POINT	BASIN	AREA (AC)	Tc (MIN)	RUNOFF	
				Q5 (CFS)	Q100 (CFS)
	OS A	69.40	41.9	11.4	81.1
	OS B	83.92	41.7	17.4	102.7
	A1	1.85	9.1	2.8	7.3
	A2	28.30	27.7	5.9	43.3
DP1	OS A, OS B, DP2, A2	183.47	41.9	34.8	230.2
DP2 In	A1	1.85	9.1	2.8	7.3
DP2 Out	A1	1.85	9.1	0.1	3.1
	C1	0.66	8.8	0.8	2.4
DP3 In	C2	0.66	8.8	0.8	2.4
DP3 Out	C2	0.66	8.8	0.0	1.1
	C3	1.36	11.8	0.4	3.1
DP4	C2, C3	2.02	11.8	0.4	4.2
	C4	0.64	8.8	0.2	1.6
DP5	C4	0.64	8.8	0.2	1.6
	C1	4.07	13.1	4.1	12.5
DP6 In	C1	4.07	13.1	4.1	12.5
DP6 Out	C1	4.07	13.1	0.1	6.1
	C5	1.61	10.2	0.5	3.9
DP7	C1, C5	5.69	13.1	0.6	10.0
	B1	2.36	14.4	0.7	5.0
DP8	B1	2.36	14.4	0.7	5.0
	B2	9.23	11.8	3.4	21.7
	OS C	49.12	23.9	16.6	88.1
DP9	B1, B2, OS C	60.72	14.4	24.9	137.2



VICINITY MAP  
NOT TO SCALE

BENCHMARK



- LEGEND**
- PROPERTY LINE
  - EASEMENT LINE
  - LOT LINE
- EXISTING**
- INDEX CONTOUR
  - INTERMEDIATE CONTOUR
- PROPOSED**
- INDEX CONTOUR
  - INTERMEDIATE CONTOUR
  - BASIN BOUNDARY
  - GENERAL FLOW/DIRECTION
  - SLOPE DIRECTION AND GRADE
  - BASIN LABEL
  - AREA IN ACRES
  - PERCENT IMPERVIOUS
  - POINT OF INTEREST
  - FULL SPECTRUM SAND FILTER BASIN (FSSFB)

**FLOODPLAIN STATEMENT:**  
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**WATER QUALITY BASIN NOTES**  
THE FULL SPECTRUM SAND FILTER BASINS A1, B1, AND C1 SHALL BE ESTABLISHED IN THE FIELD BY THE PROJECT ENGINEER AT OR ABOVE THE CALCULATED REQUIRED VOLUME.  
THE FULL SPECTRUM SAND FILTER BASINS SHALL BE FIELD SURVEYED FOR AS-BUILT CONDITIONS AND APPROVED BY THE PROJECT ENGINEER AS BEING CONSTRUCTED IN SUBSTANTIAL COMPLIANCE WITH APPROVED DETAILS FOR CONSTRUCTION.

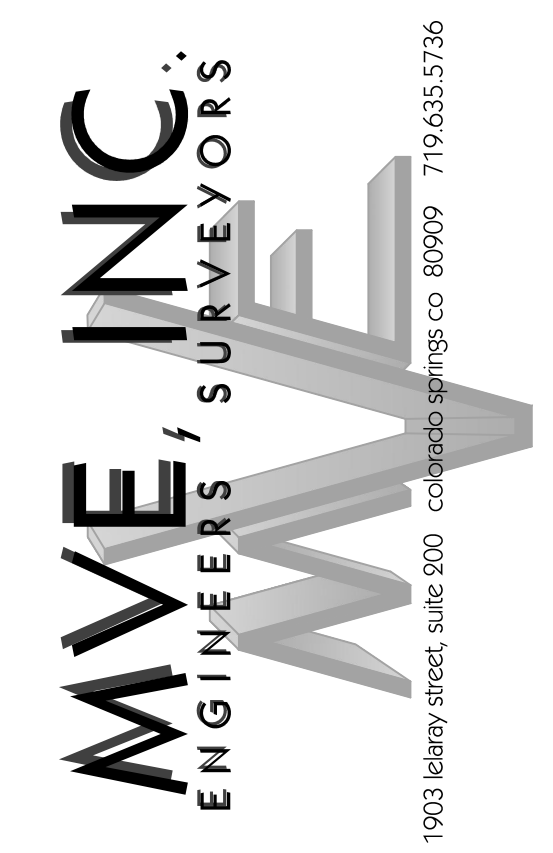
REVISIONS

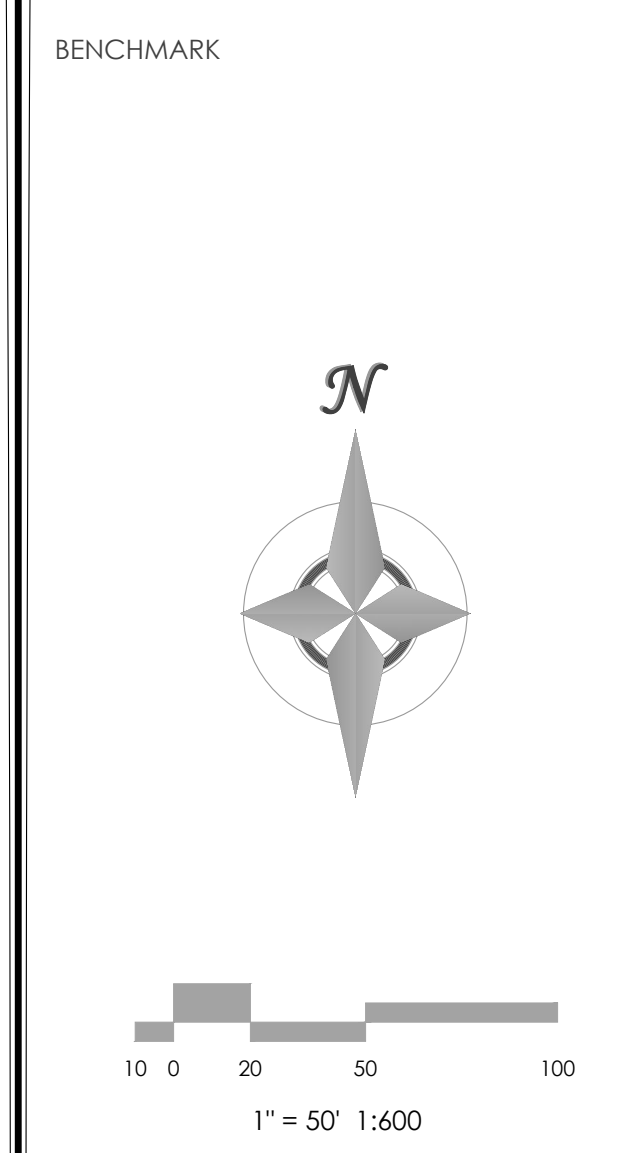
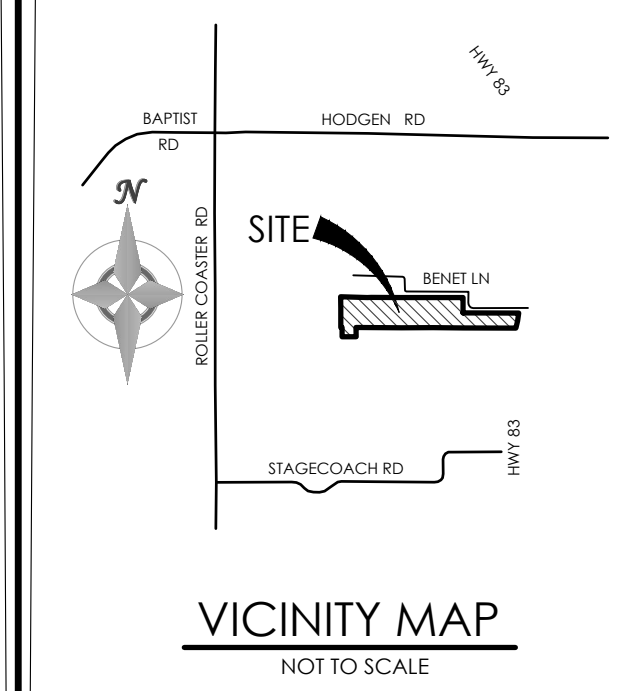
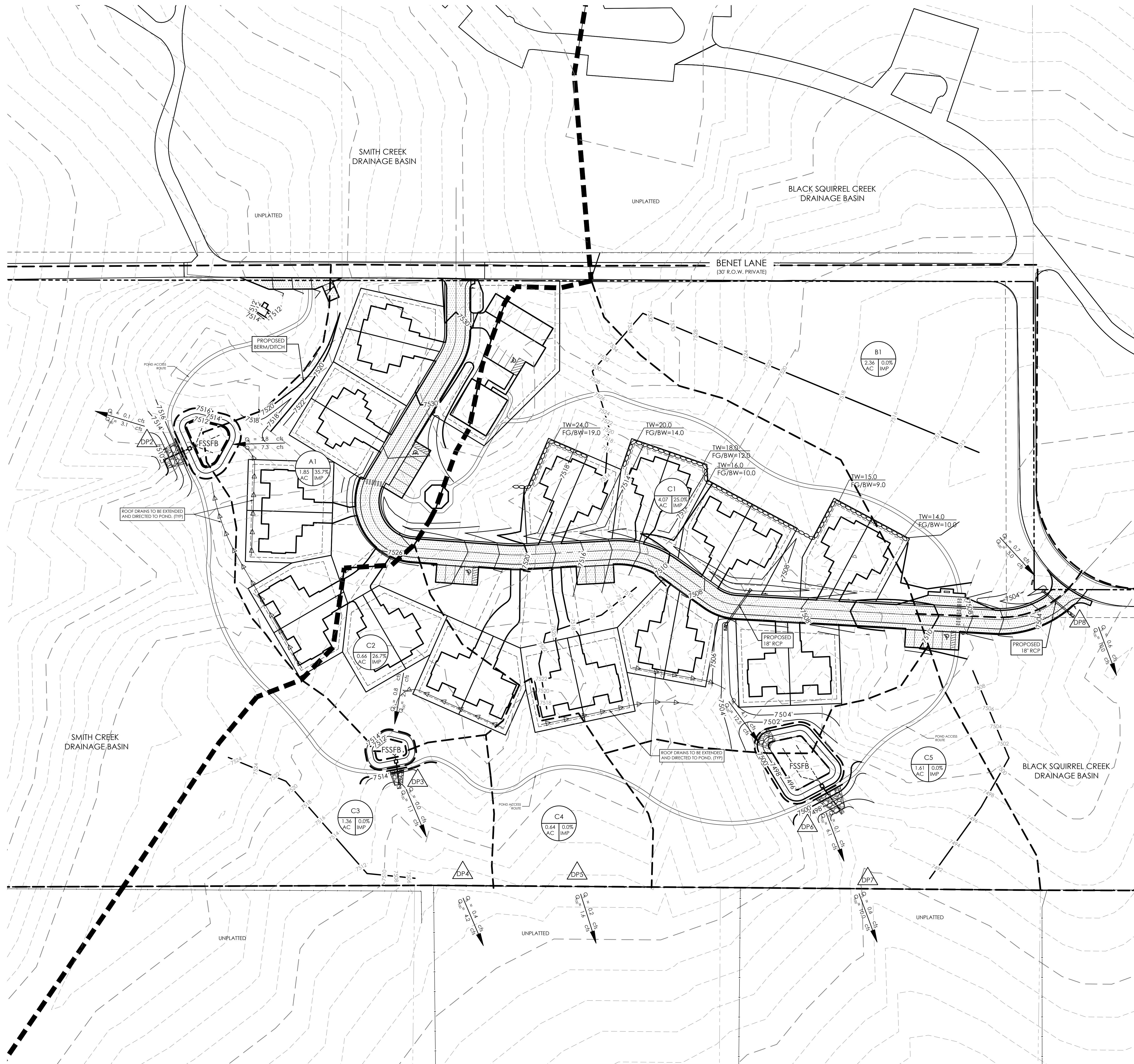
DESIGNED BY \_\_\_\_\_  
DRAWN BY \_\_\_\_\_  
CHECKED BY \_\_\_\_\_  
AS-BUILT BY \_\_\_\_\_  
CHECKED BY \_\_\_\_\_  
**SANCTUARY OF PEACE**

**PROPOSED DRAINAGE MAP**

MVE PROJECT **61087**  
MVE DRAWING **PP-DM**

**April 28, 2020**  
**SHEET 1 OF 1**





**LEGEND**

---	PROPERTY LINE
- - - -	EASEMENT LINE
---	LOT LINE
---	EXISTING INDEX CONTOUR
---	EXISTING INTERMEDIATE CONTOUR
---	PROPOSED INDEX CONTOUR
---	PROPOSED INTERMEDIATE CONTOUR
---	BASIN BOUNDARY
---	GENERAL FLOW/DIRECTION
---	SLOPE DIRECTION AND GRADE
---	BASIN LABEL AREA IN ACRES PERCENT IMPERVIOUS
---	POINT OF INTEREST
---	FULL SPECTRUM SAND FILTER BASIN (FSSFB)

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DESIGNED BY \_\_\_\_\_  
DRAWN BY \_\_\_\_\_  
CHECKED BY \_\_\_\_\_  
AS-BUILTS BY \_\_\_\_\_  
CHECKED BY \_\_\_\_\_

SANCTUARY OF PEACE

**PROPOSED DRAINAGE MAP (DETAIL)**