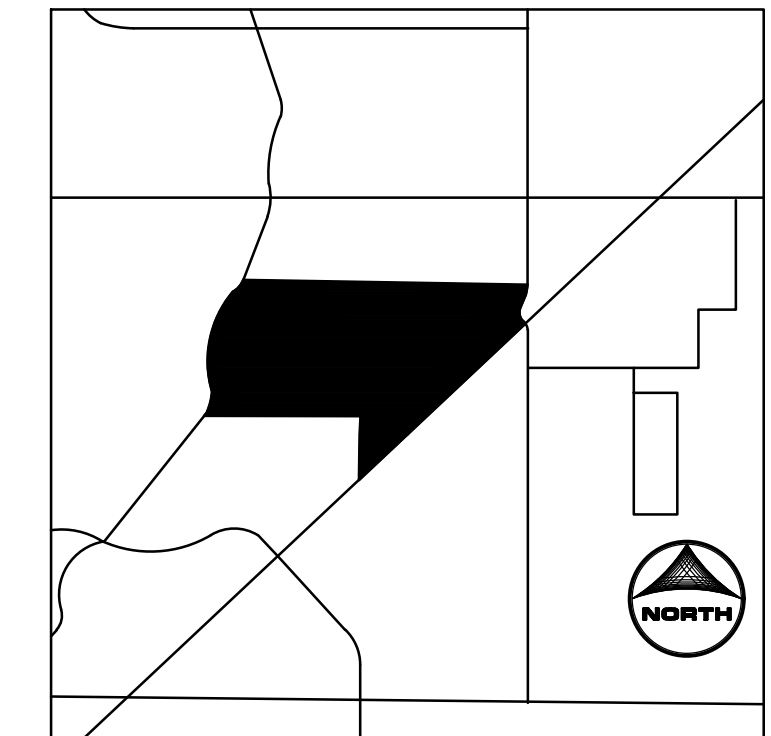
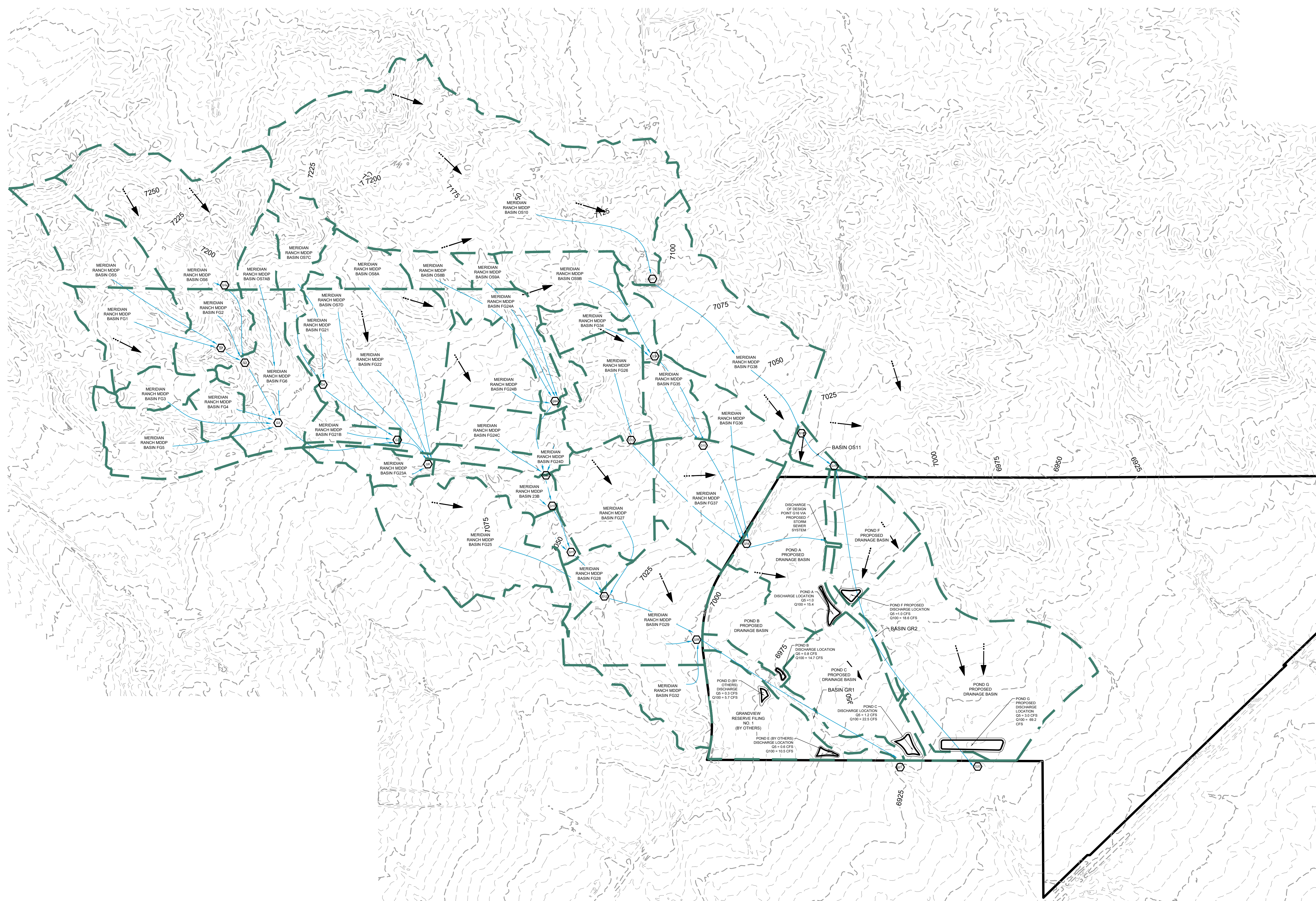


## Appendix J

# Proposed Hydrology Calculations and Reference Materials

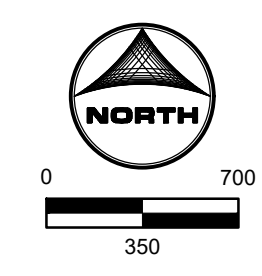
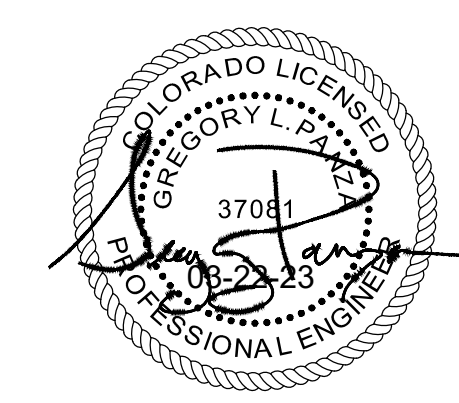


**KEYMAP**

- PROJECT LEGEND:**
- PROPERTY LINE
  - ROAD CENTERLINE
  - RIGHT-OF-WAY LINE
  - PROPOSED DETENTION BASIN
  - PROPOSED MAJOR CONTOUR
  - PROPOSED MINOR CONTOUR
  - EXISTING MAJOR CONTOUR
  - EXISTING MINOR CONTOUR
  - FLOW ARROW
  - PROPOSED BASIN LINE
  - 606 DESIGN POINT

- NOTE:**
1. BASINS WEST OF EASTONVILLE ROAD ARE FROM THE LOCALLY APPROVED AND ACCEPTED BASIN STUDY REFERRED TO AS THE MERIDIAN RANCH MASTER DEVELOPMENT DRAINAGE PLAN
  2. ALL PONDS ARE SIZED AND HAVE DISCHARGE RATES BASED OFF OF MHFD UD-DETENTION SPREADSHEET LOCATED IN APPENDIX K.
  3. VERTICAL DATUM IS NAVD88.

**811** UNCC  
CALL BEFORE  
YOU DIG  
**811**  
OR  
1-800-922-1987  
Utility Notification  
Center of Colorado





**COMPOSITE 'C' FACTORS**

PROJECT:		The Sanctuary PDR-FDR														Date	3/21/2023			
BASIN DESIGNATION	AREA (AC.)																AREA (M <sup>2</sup> )	COMPOSITE 'C' FACTOR	PERCENT IMPERV.	
	UNDEV	LATIGO UNDEV.	GRADED	2.5 AC	1 DU/AC	2 DU/AC	3 DU/AC	4 DU/AC	5 DU/AC	6 DU/AC	8 DU/AC or more	STREETS	SCHOOL, CLUB HSE, REC CTR	OPEN SPACE PARKS/GC	COMM.	TOTAL				
<b>FUTURE</b>																				
OS05	37																37	0.0578	61.0	0.0%
OS06	84																84	0.1313	61.0	0.0%
OS07ab	11																11	0.0170	61.0	0.0%
OS07c	19																19	0.0296	61.0	0.0%
OS07d	2.2																2.2	0.0034	61.0	0.0%
OS08a	16																16	0.0251	61.0	0.0%
OS08b	11																11	0.0165	61.0	0.0%
OS09a	5.9																5.9	0.0093	61.0	0.0%
OS09b	28																28	0.0435	61.0	0.0%
FG01	13				19										2.1		34	0.0538	66.4	16.9%
FG02	12				13												25	0.0391	64.6	10.4%
FG03					13												13	0.0203	68.0	20.0%
FG04					11												11	0.0172	68.0	20.0%
FG05	1.5				33						3.0						37	0.0580	70.1	25.7%
FG06	15				27						0.9		0.5				43	0.0675	66.1	14.4%
FG21a	4.7				1.4												6.1	0.0095	62.6	4.6%
FG21b						3.8							2.5	3.3			9.6	0.0150	73.1	43.1%
FG22	17				16	48					2.1		0.9	3.3			87	0.1354	69.0	23.4%
FG23a	3.1					2.8	5.0				0.6		2.3				14	0.0216	68.6	20.6%
FG23b	14							0.9									15	0.0236	61.8	2.4%
FG23c	4.9							2.1									7.0	0.0109	65.2	12.0%
FG24a	18							2.3	2.4								22	0.0348	64.3	8.8%
FG24b	0.2				4.1	2.7	11.3	14	5.7				0.1				38	0.0589	73.4	34.0%
FG24c								19									19	0.0291	75.0	40.0%
FG24d	5.5							5.7			4.8		0.8				17	0.0262	76.4	42.3%
FG25							9.3	57	0.9				2.6				69	0.1084	74.1	37.3%
FG26								36			0.4		0.5				36	0.0570	78.0	43.1%
FG27	2.5								1.7		35	2.8	1.7				43	0.0679	83.3	56.2%
FG28								1.7			0.1		10				12	0.0184	64.1	8.0%
FG29	62							0.7									63	0.0983	61.2	0.4%
FG32												26					26	0.0402	80.0	52.0%
FG34	16								1.8								18	0.0275	62.7	4.4%
FG35	15								1.6			1.5					18	0.0282	65.5	11.9%
FG36	16											2.4					18	0.0286	65.9	13.1%
FG37	48										3.4						51	0.0797	63.5	6.7%
OS11	4.5																4	0.0070	61.0	2.0%

Additional Time of Concentration Calcs

Name	Sheet Flow						Shallow Concentrated Flow (Unpaved)						Shallow Concentrated Flow (Paved)					
	Length (ft)	US Elev	DS Elev	Slope (ft/ft)	Manning's n	Travel Time (hr)	Length (ft)	US Elev	DS Elev	Slope (ft/ft)	Velocity (fps)	Travel Time (hr)	Length (ft)	US Elev	DS Elev	Slope (ft/ft)	Velocity (fps)	Travel Time (hr)
OS10	300.0	7266.0	7258.0	0.027	0.04	0.16	3061.0	7258.0	7140.0	0.039	3.2	0.27				0.000	0.0	0.00
FG38	300.0	7134.0	7120.0	0.047	0.15	0.37	1572.0	7120.0	7075.0	0.029	2.7	0.16				0.000	0.0	0.00
OS11	500.0	7030.0	7020.0	0.020	0.04	0.27	248.0	7020.0	7014.0	0.024	2.5	0.03				0.000	0.0	0.00

Channel Flow												Time of Conc. (hr)
Length (ft)	US Elev	DS Elev	Slope (ft/ft)	Manning's n	Bottom Width (ft)	Side Slopes (X:1)	Depth (ft)	Hydraulic Radius (ft)	Velocity (fps)	Travel Time (hr)		
2168.0	7140.0	7098.0	0.019	0.035	10	5	5.0	2.9	12.0	0.05	0.48	
2152.4	7075.0	7029.0	0.021	0.035	28	20	1.5	1.0	6.2	0.10	0.62	
3782.3	6994.9	6917.9	0.020	0.035	10	4	2.0	1.4	7.5	0.14	0.14	
7728.5	7051.8	6903.3	0.019	0.035	25	4	2.5	1.9	9.1	0.24	0.24	

Name	Time of Conc. (min)	Lag Time (min)
OS10	28.66	17.19
FG38	37.34	22.41
OS11	0.30	0.18
GR1	8.46	5.08
GR2	14.14	8.49

HEC-HMS Input Data			
Subbasin	Area	Curve	Lag Time
	(sq.mi.)	Number	(min)
FG01	0.0538	66.4	33.8
FG02	0.0391	64.6	16.1
FG03	0.0203	68	11.6
FG04	0.0172	68	7.6
FG05	0.058	70.1	28.4
FG06	0.0675	66.1	18.4
FG21a	0.0095	62.6	21.4
FG21b	0.015	73.1	12.7
FG22	0.1354	69	20.3
FG23a	0.0216	68.6	18
FG23b	0.0236	61.8	15
FG23c	0.0109	65.2	12.1
FG24a	0.0348	64.3	21.9
FG24b	0.0589	73.4	14.5
FG24c	0.0291	75	14.7
FG24d	0.0262	76.4	13.9
FG25	0.1084	74.1	23.8
FG26	0.057	78	25.5
FG27	0.0679	83.3	22.1
FG28	0.0184	64.1	14.8
FG29	0.0983	61.2	19.1
FG32	0.0402	80	23.9
FG34	0.0275	62.7	16.8
FG35	0.0292	65.3	15
FG36	0.0295	65.1	25.8
FG37	0.0754	61.4	21
FG38	0.133064	61	22.41
GR1	0.028	61	5.08
GR2	0.021	61	22.6
OS05	0.0578	61	15.2
OS06	0.1313	61	18.7
OS07ab	0.017	61	13.9
OS07c	0.0296	61	17.4
OS07d	0.0034	61	13.1
OS08a	0.0251	61	16.7
OS08b	0.0165	61	20.3
OS09a	0.0093	61	20.9
OS09b	0.0435	61	25.4
OS10	0.369334	64.72	17.19
OS11	0.0077	61	0.18

HEC-HMS Proposed 5-Year Flows				
Hydrologic Element	Area	Peak Discharge	Time of Peak	Volume
	(sq.mi.)	CFS	(min)	(in)
FG01	0.0538	3.4	01Jul2015, 12:36	0.28
FG01-G1	0.0538	3.4	01Jul2015, 12:36	0.28
FG02	0.0391	2.7	01Jul2015, 12:18	0.24
FG03	0.0203	3	01Jul2015, 12:06	0.33
FG04	0.0172	3.1	01Jul2015, 12:06	0.34
FG05	0.058	6.7	01Jul2015, 12:30	0.4
FG06	0.0675	5.8	01Jul2015, 12:18	0.28
FG21a	0.0095	0.4	01Jul2015, 12:24	0.19
FG21b	0.015	3.9	01Jul2015, 12:06	0.5
FG22	0.1354	16.8	01Jul2015, 12:18	0.36
FG23a	0.0216	2.7	01Jul2015, 12:18	0.35
FG23b	0.0236	0.9	01Jul2015, 12:18	0.18
FG23c	0.0109	1	01Jul2015, 12:12	0.26
FG24a	0.0348	2	01Jul2015, 12:24	0.23
FG24b	0.0589	14.8	01Jul2015, 12:12	0.52
FG24c	0.0291	8.4	01Jul2015, 12:12	0.58
FG24d	0.0262	8.7	01Jul2015, 12:06	0.64
FG25	0.1084	21.8	01Jul2015, 12:18	0.54
FG26	0.057	15.6	01Jul2015, 12:18	0.7
FG27	0.0679	30	01Jul2015, 12:18	0.97
FG28	0.0184	1.2	01Jul2015, 12:12	0.23
FG29	0.0983	2.9	01Jul2015, 12:24	0.16
FG32	0.0402	13.6	01Jul2015, 12:18	0.8
FG32-G06	0.0402	13.2	01Jul2015, 12:24	0.8
FG34	0.0275	1.3	01Jul2015, 12:18	0.2
FG35	0.0292	2.4	01Jul2015, 12:12	0.26
FG36	0.0295	1.7	01Jul2015, 12:30	0.25
FG36-G16	0.0295	1.7	01Jul2015, 12:36	0.25
FG37	0.0754	2.3	01Jul2015, 12:30	0.17
FG38	0.133064	3.5	01Jul2015, 12:30	0.16
GR1	0.028	1.2	01Jul2015, 12:06	0.16
GR1-G19	0.028	1.2	01Jul2015, 12:36	0.16
GR2	0.021	0.6	01Jul2015, 12:30	0.16
GR2-G20	0.0287	0.7	01Jul2015, 14:06	0.15
G06	1.3011	22.4	01Jul2015, 15:30	0.24
G1	0.1116	4.9	01Jul2015, 12:36	0.22
G1a	0.1313	3.8	01Jul2015, 12:24	0.16
G1a-G2	0.1313	3.7	01Jul2015, 12:30	0.16
G1-G2	0.1116	4.8	01Jul2015, 12:36	0.22
G10	0.9	45.9	01Jul2015, 12:30	0.26
G10-G11	0.9	43.8	01Jul2015, 12:36	0.26
G11	0.9109	44.3	01Jul2015, 12:36	0.26
G12	1.1626	20.5	01Jul2015, 15:24	0.23
G12-G06	1.1626	20.5	01Jul2015, 15:36	0.23

G13	0.057	15.6	01Jul2015, 12:18	0.7
G13-POND G	0.057	15.6	01Jul2015, 12:24	0.7
G14	0.071	2	01Jul2015, 12:36	0.17
G14-G15	0.071	1.9	01Jul2015, 12:54	0.17
G15	0.1002	3	01Jul2015, 12:48	0.19
G15-G16	0.1002	3	01Jul2015, 13:06	0.19
G16	0.2051	6.1	01Jul2015, 12:36	0.19
G17	0.369334	25.5	01Jul2015, 12:18	0.24
G17-G18	0.369334	24.7	01Jul2015, 12:30	0.24
G18	0.502397	28.3	01Jul2015, 12:30	0.22
G19	0.0287	0.7	01Jul2015, 12:30	0.16
G2	0.282	10.3	01Jul2015, 12:30	0.19
G2-G3	0.282	10.2	01Jul2015, 12:42	0.19
G20	0.0287	0.7	01Jul2015, 14:06	0.15
G21	0.028	1.2	01Jul2015, 12:36	0.16
G3	0.3195	12.1	01Jul2015, 12:36	0.21
G4	0.0391	1.2	01Jul2015, 12:36	0.16
G4-G7	0.0391	1.2	01Jul2015, 12:36	0.16
G7	0.5161	8.9	01Jul2015, 14:12	0.2
G7-G8	0.5161	8.9	01Jul2015, 14:18	0.2
G8	0.7016	24	01Jul2015, 12:18	0.23
G8-G10	0.7016	23.8	01Jul2015, 12:30	0.23
G9a	0.1195	16.2	01Jul2015, 12:12	0.35
G9a-G9b	0.1195	15.5	01Jul2015, 12:18	0.35
G9b	0.1748	32.3	01Jul2015, 12:12	0.43
G9b-G10	0.1748	30.8	01Jul2015, 12:18	0.42
OS05	0.0578	1.8	01Jul2015, 12:18	0.16
OS05-G1	0.0578	1.7	01Jul2015, 12:24	0.16
OS06	0.1313	3.8	01Jul2015, 12:24	0.16
OS07ab	0.017	0.5	01Jul2015, 12:18	0.16
OS07ab-POND F	0.017	0.5	01Jul2015, 12:42	0.16
OS07c	0.0296	0.9	01Jul2015, 12:24	0.16
OS07c-G4	0.0296	0.9	01Jul2015, 12:36	0.16
OS07d	0.0034	0.1	01Jul2015, 12:18	0.16
OS07d-G8	0.0034	0.1	01Jul2015, 12:30	0.16
OS08a	0.0251	0.7	01Jul2015, 12:24	0.16
OS08b	0.0165	0.4	01Jul2015, 12:24	0.16
OS08b-G9a	0.0165	0.4	01Jul2015, 13:00	0.15
OS08-G8	0.0251	0.7	01Jul2015, 12:30	0.16
OS09a	0.0093	0.3	01Jul2015, 12:30	0.16
OS09a-G9a	0.0093	0.2	01Jul2015, 13:00	0.15
OS09b	0.0435	1.1	01Jul2015, 12:36	0.16
OS09b-G14	0.0435	1.1	01Jul2015, 12:42	0.16
OS10	0.369334	25.5	01Jul2015, 12:18	0.24
OS11	0.0077	0.5	01Jul2015, 12:00	0.16
POND F	0.462	8	01Jul2015, 14:12	0.2
POND F IN	0.462	22.8	01Jul2015, 12:36	0.24



POND F-G7	0.462	8	01Jul2015, 14:24	0.19
POND G	1.1626	20.5	01Jul2015, 15:24	0.23
POND G IN-EAST	0.1249	44.3	01Jul2015, 12:18	0.85
POND G IN-WEST	1.0377	63.3	01Jul2015, 12:30	0.29
REX RD WQCV	0.1748	30.9	01Jul2015, 12:18	0.42

HEC-HMS Proposed 100-Year Flows				
Hydrologic Element	Area	Peak Discharge	Time of Peak	Volume
	(sq.mi.)	CFS	(min)	(in)
FG01	0.0538	31.2	01Jul2015, 12:30	1.7
FG01-G1	0.0538	31.1	01Jul2015, 12:30	1.7
FG02	0.0391	32	01Jul2015, 12:12	1.58
FG03	0.0203	23.6	01Jul2015, 12:06	1.84
FG04	0.0172	22.2	01Jul2015, 12:00	1.84
FG05	0.058	45	01Jul2015, 12:24	1.98
FG06	0.0675	56.2	01Jul2015, 12:12	1.69
FG21a	0.0095	5.9	01Jul2015, 12:18	1.43
FG21b	0.015	20.7	01Jul2015, 12:06	2.24
FG22	0.1354	121.3	01Jul2015, 12:12	1.91
FG23a	0.0216	20.6	01Jul2015, 12:12	1.88
FG23b	0.0236	16.9	01Jul2015, 12:12	1.38
FG23c	0.0109	10.8	01Jul2015, 12:06	1.63
FG24a	0.0348	23.6	01Jul2015, 12:18	1.55
FG24b	0.0589	75.9	01Jul2015, 12:06	2.26
FG24c	0.0291	39.5	01Jul2015, 12:06	2.4
FG24d	0.0262	39	01Jul2015, 12:06	2.52
FG25	0.1084	111.4	01Jul2015, 12:18	2.31
FG26	0.057	65	01Jul2015, 12:18	2.65
FG27	0.0679	98.2	01Jul2015, 12:12	3.14
FG28	0.0184	15	01Jul2015, 12:12	1.55
FG29	0.0983	59.5	01Jul2015, 12:12	1.34
FG32	0.0402	50.9	01Jul2015, 12:18	2.83
FG32-G06	0.0402	50.3	01Jul2015, 12:18	2.82
FG34	0.0275	19.9	01Jul2015, 12:12	1.45
FG35	0.0292	25.3	01Jul2015, 12:12	1.63
FG36	0.0295	18.8	01Jul2015, 12:18	1.61
FG36-G16	0.0295	18.7	01Jul2015, 12:24	1.6
FG37	0.0754	43.8	01Jul2015, 12:18	1.35
FG38	0.133064	72.9	01Jul2015, 12:18	1.32
GR1	0.028	30	01Jul2015, 12:00	1.34
GR1-G19	0.028	26.8	01Jul2015, 12:12	1.3
GR2	0.021	11.5	01Jul2015, 12:18	1.32
GR2-G20	0.0287	13	01Jul2015, 12:54	1.38
G06	1.3011	491	01Jul2015, 12:48	1.66
G1	0.1116	61	01Jul2015, 12:18	1.51
G1a	0.1313	79.8	01Jul2015, 12:12	1.33
G1a-G2	0.1313	78.6	01Jul2015, 12:18	1.32
G1-G2	0.1116	60.6	01Jul2015, 12:18	1.5
G10	0.9	390.3	01Jul2015, 12:24	1.63
G10-G11	0.9	389.1	01Jul2015, 12:30	1.62
G11	0.9109	392.7	01Jul2015, 12:30	1.62
G12	1.1626	449.6	01Jul2015, 12:48	1.66
G12-G06	1.1626	448.7	01Jul2015, 12:54	1.65

G13	0.057	65	01Jul2015, 12:18	2.65
G13-POND G	0.057	63.5	01Jul2015, 12:24	2.64
G14	0.071	37.3	01Jul2015, 12:18	1.36
G14-G15	0.071	37.1	01Jul2015, 12:24	1.35
G15	0.1002	54.9	01Jul2015, 12:18	1.43
G15-G16	0.1002	53.8	01Jul2015, 12:24	1.41
G16	0.2051	112.1	01Jul2015, 12:24	1.41
G17	0.369334	296.1	01Jul2015, 12:12	1.59
G17-G18	0.369334	292.3	01Jul2015, 12:18	1.57
G18	0.502397	365.2	01Jul2015, 12:18	1.51
G19	0.0287	14	01Jul2015, 12:00	1.33
G2	0.282	166.7	01Jul2015, 12:18	1.43
G2-G3	0.282	163.4	01Jul2015, 12:18	1.42
G20	0.0287	13	01Jul2015, 12:54	1.38
G21	0.028	26.8	01Jul2015, 12:12	1.3
G3	0.3195	184.9	01Jul2015, 12:18	1.47
G4	0.0391	24.7	01Jul2015, 12:18	1.35
G4-G7	0.0391	23.8	01Jul2015, 12:18	1.34
G7	0.5161	194.5	01Jul2015, 12:42	1.47
G7-G8	0.5161	194	01Jul2015, 12:42	1.46
G8	0.7016	279	01Jul2015, 12:30	1.55
G8-G10	0.7016	277.7	01Jul2015, 12:36	1.54
G9a	0.1195	97.2	01Jul2015, 12:12	1.85
G9a-G9b	0.1195	95.7	01Jul2015, 12:12	1.84
G9b	0.1748	170.1	01Jul2015, 12:12	2.04
G9b-G10	0.1748	157.9	01Jul2015, 12:18	2.02
OS05	0.0578	39.1	01Jul2015, 12:12	1.33
OS05-G1	0.0578	38.6	01Jul2015, 12:12	1.33
OS06	0.1313	79.8	01Jul2015, 12:12	1.33
OS07ab	0.017	11.9	01Jul2015, 12:06	1.33
OS07ab-POND F	0.017	11.8	01Jul2015, 12:18	1.31
OS07c	0.0296	18.9	01Jul2015, 12:12	1.33
OS07c-G4	0.0296	18.8	01Jul2015, 12:18	1.32
OS07d	0.0034	2.5	01Jul2015, 12:06	1.33
OS07d-G8	0.0034	2.4	01Jul2015, 12:12	1.32
OS08a	0.0251	16.3	01Jul2015, 12:12	1.33
OS08b	0.0165	9.5	01Jul2015, 12:18	1.33
OS08b-G9a	0.0165	9.4	01Jul2015, 12:30	1.29
OS08-G8	0.0251	15.6	01Jul2015, 12:18	1.32
OS09a	0.0093	5.3	01Jul2015, 12:18	1.33
OS09a-G9a	0.0093	5.2	01Jul2015, 12:30	1.3
OS09b	0.0435	21.8	01Jul2015, 12:24	1.32
OS09b-G14	0.0435	21.7	01Jul2015, 12:24	1.31
OS10	0.369334	296.1	01Jul2015, 12:12	1.59
OS11	0.0077	9.4	01Jul2015, 12:00	1.34
POND F	0.462	177.6	01Jul2015, 12:42	1.46
POND F IN	0.462	293	01Jul2015, 12:18	1.56

POND F-G7	0.462	177.3	01Jul2015, 12:42	1.45
POND G	1.1626	449.6	01Jul2015, 12:48	1.66
POND G IN-EAST	0.1249	160.3	01Jul2015, 12:18	2.91
POND G IN-WEST	1.0377	503.2	01Jul2015, 12:24	1.69
REX RD WQCV	0.1748	158.1	01Jul2015, 12:18	2.02

## Appendix K

# Preliminary Onsite Pond Sizing Spreadsheets



## MILE HIGH FLOOD DISTRICT

# DETENTION BASIN DESIGN WORKBOOK

*MHFD-Detention, Version 4.06 (July 2022)*  
*Mile High Flood District*  
*Denver, Colorado*  
*www.mhfd.org*

**Purpose:**

This workbook aids in the estimation of stormwater detention basin sizing and outlet routing based on the modified puls routing method for urban watersheds. Several different BMP types and various outlet configurations can be sized.

**Function:**

1. Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.
2. Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.

---

**Content:**

**This workbook consists of the following sheets:**

**Basin** Tabulates stage-area-volume relationship estimates based on watershed parameters

**Outlet Structure** Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).

**Reference** Provides reference equations and figures.

**User Tips and Tools** Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.

**BMP Zone Images** Provides images of typical BMP zone configurations corresponding with Zone pulldown selections.

**Acknowledgements:** *Spreadsheet Development Team:*  
**Ken MacKenzie, P.E., Holly Piza, P.E.**  
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**Derek N. Rapp, P.E.**  
Peak Stormwater Engineering, LLC

**Dr. James C.Y. Guo, Ph.D., P.E.**  
Professor, Department of Civil Engineering, University of Colorado at Denver

**Comments?**  
**Revisions?**

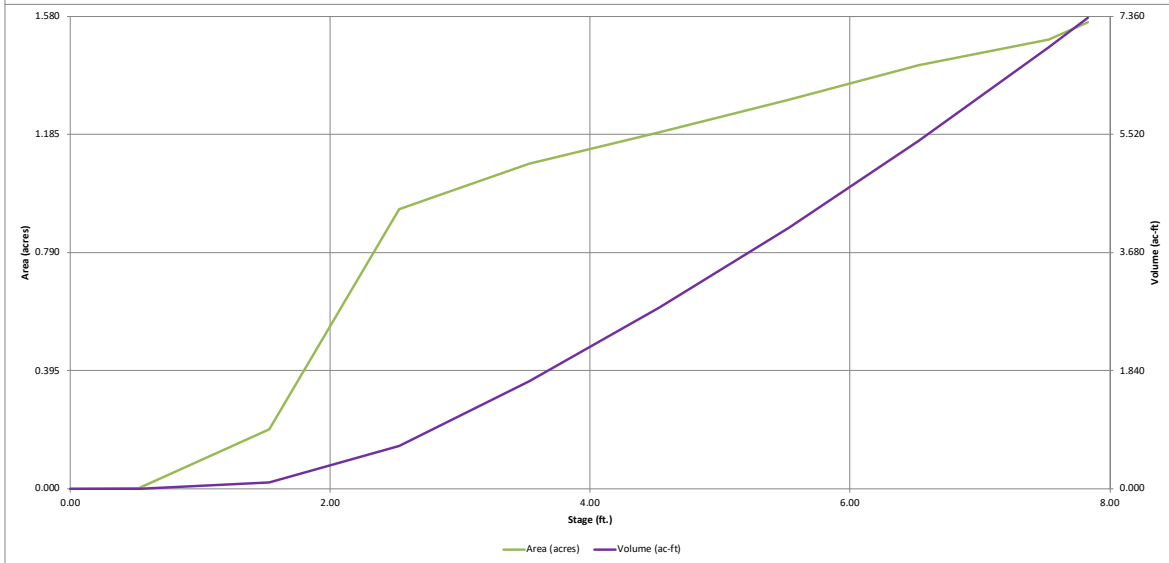
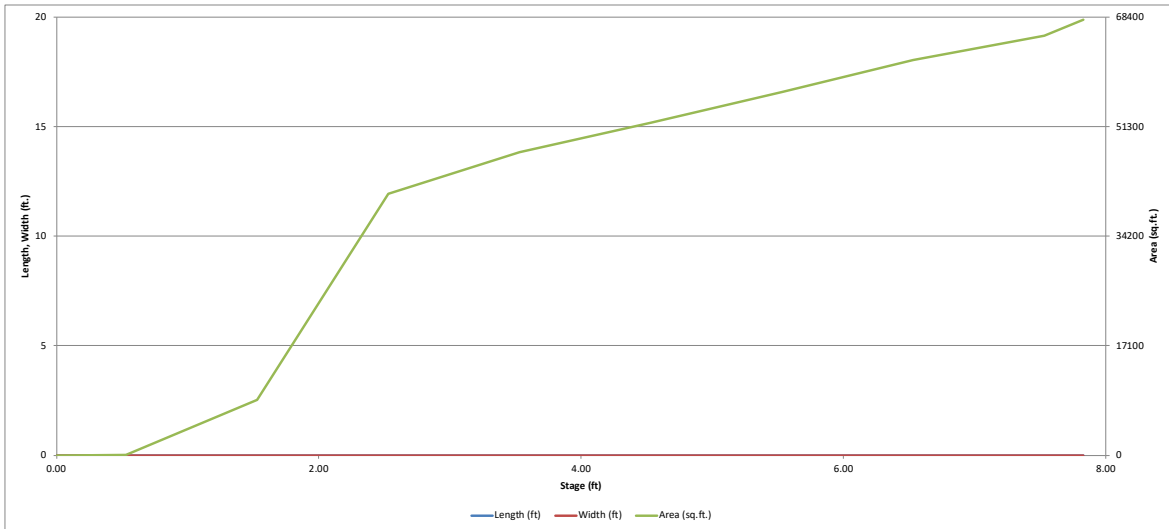
Direct all comments regarding this spreadsheet workbook to:  
Check for revised versions of this or any other workbook at:

[MHFD E-Mail](#)  
[Downloads](#)



# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.06 (July 2022)*



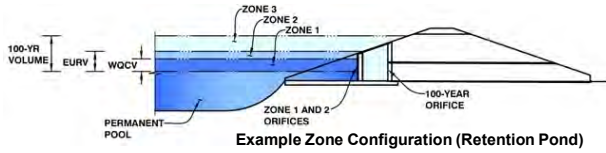


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD- Detention, Version 4.06 (July 2022)

**Project: Grandview - Filing 2**

**Basin ID: Basin A**



**Example Zone Configuration (Retention Pond)**

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.63	0.757	Orifice Plate
Zone 2 (EURV)	4.58	2.117	Rectangular Orifice
Zone 3 (100-year)	5.71	1.419	Weir&Pipe (Restrict)
<b>Total (all zones)</b>		<b>4.293</b>	

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

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

**Calculated Parameters for Underdrain**  
 Underdrain Orifice Area =  ft<sup>2</sup>  
 Underdrain Orifice Centroid =  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)**

Centroid of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
 Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
 Orifice Plate: Orifice Vertical Spacing =  inches  
 Orifice Plate: Orifice Area per Row =  sq. inches (diameter = 1-3/4 inches)

**Calculated Parameters for Plate**  
 WQ Orifice Area per Row =  ft<sup>2</sup>  
 Elliptical Half-Width =  feet  
 Elliptical Slot Centroid =  feet  
 Elliptical Slot Area =  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)	0.00	0.88	1.75					
Orifice Area (sq. inches)	2.42	2.42	2.42					

	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)**

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	2.63	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	4.58	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	2.00	N/A	inches
Vertical Orifice Width =	6.89		inches

**Calculated Parameters for Vertical Orif**

	Zone 2 Rectangular	Not Selected
Vertical Orifice Area =	0.10	N/A
Vertical Orifice Centroid =	0.08	N/A

**User Input: Overflow Weir (Dropbox with Flat or Sloped Gate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)**

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.58	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Gate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Gate Type =	Type C Gate	N/A	
Debris Clogging % =	50%	N/A	%

**Calculated Parameters for Overflow Weir**

	Zone 3 Weir	Not Selected
Height of Gate Upper Edge, H <sub>t</sub> =	4.58	N/A
Overflow Weir Slope Length =	4.00	N/A
Gate Open Area / 100-yr Orifice Area =	8.02	N/A
Overflow Gate Open Area w/o Debris =	11.14	N/A
Overflow Gate Open Area w/ Debris =	5.57	N/A

**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 =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	13.20		inches

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

	Zone 3 Restrictor	Not Selected
Outlet Orifice Area =	1.39	N/A
Outlet Orifice Centroid =	0.61	N/A
Half-Central Angle of Restrictor Plate on Pipe =	2.06	N/A

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

Spillway Invert Stage =	5.70	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	25.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

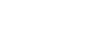
**Calculated Parameters for Spillway**

Spillway Design Flow Depth =	0.97	feet
Stage at Top of Freeboard =	7.67	feet
Basin Area at Top of Freeboard =	1.53	acres
Basin Volume at Top of Freeboard =	7.10	acre-ft

**Routed Hydrograph Results**

*The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AI)*

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Design Storm Return Period =								
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.757	2.874	2.126	2.790	3.322	4.022	4.709	5.545
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.126	2.790	3.322	4.022	4.709	5.545
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.4	0.6	5.0	10.1	16.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.14	0.28	0.47
Peak Inflow Q (cfs) =	N/A	N/A	28.8	37.7	44.5	57.1	68.1	81.4
Peak Outflow Q (cfs) =	0.3	1.1	0.9	1.0	2.8	8.0	14.3	15.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.6	5.0	1.6	1.4	0.9
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1
Max Velocity through Gate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.6	1.2	1.3
Max Velocity through Gate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	67	61	67	70	69	68	66
Time to Drain 99% of Inflow Volume (hours) =	40	72	65	72	76	75	75	75
Maximum Ponding Depth (ft) =	2.63	4.58	3.81	4.36	4.74	4.99	5.22	5.64
Area at Maximum Ponding Depth (acres) =	0.95	1.20	1.11	1.17	1.21	1.24	1.27	1.31
Maximum Volume Stored (acre-ft) =	0.762	2.877	1.976	2.616	3.070	3.377	3.653	4.208



ice

ft<sup>2</sup>

feet

eir

feet

feet

ft<sup>2</sup>

ft<sup>2</sup>

ite

ft<sup>2</sup>

feet

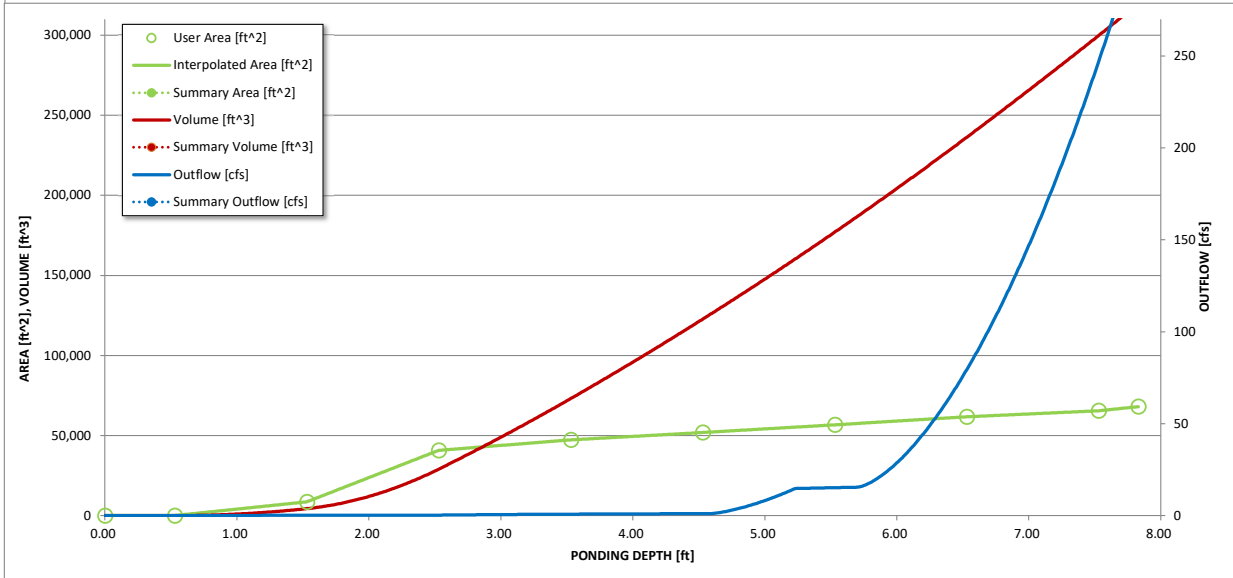
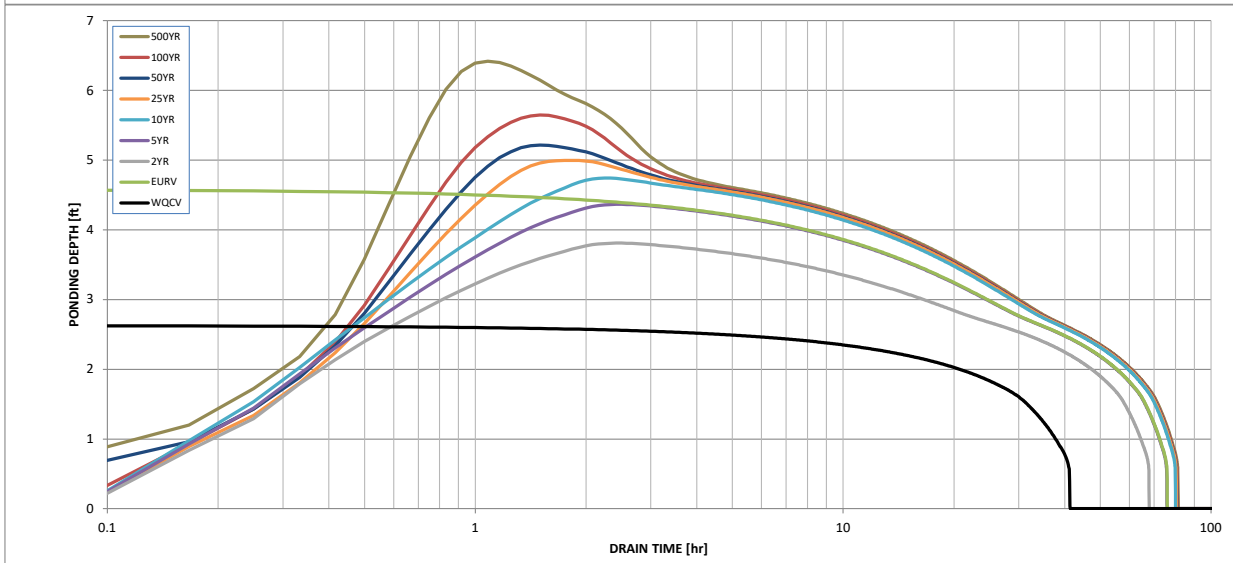
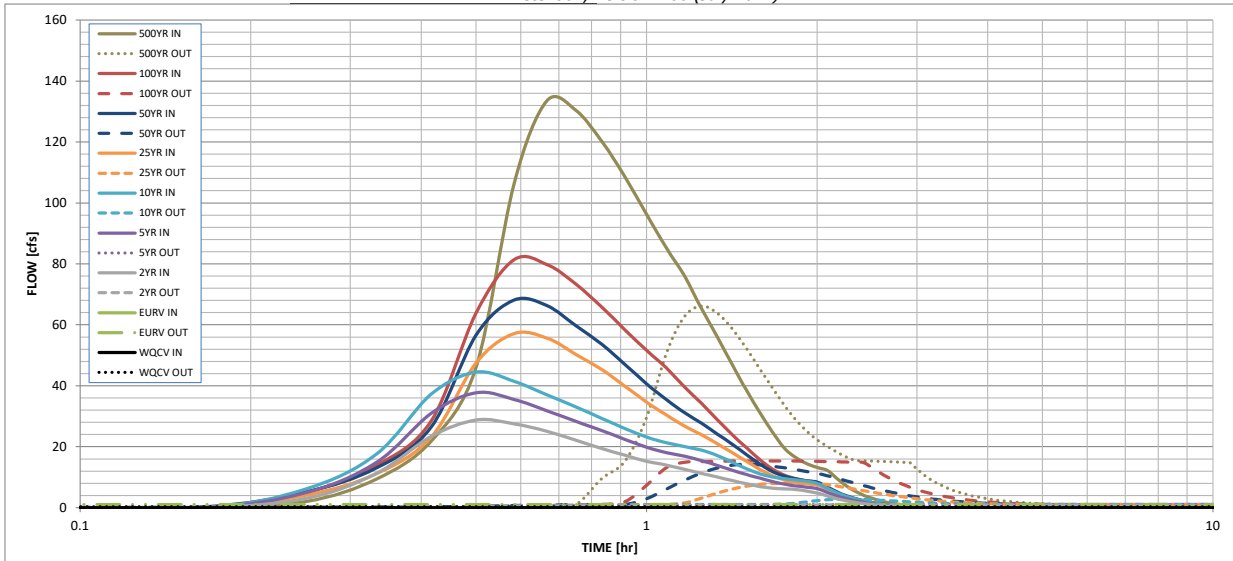
radians

5).

500 Year
3.68
9.033
9.033
44.1
1.22
133.4
66.1
1.5
Spillway
1.3
N/A
61
72
6.42
1.40
5.254

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.03	2.03
	0:15:00	0.00	0.00	3.01	4.89	6.06	4.08	5.15	4.99	9.39
	0:20:00	0.00	0.00	11.19	14.81	17.48	11.07	12.96	13.82	21.85
	0:25:00	0.00	0.00	23.40	30.92	37.22	23.15	26.47	28.47	45.97
	0:30:00	0.00	0.00	28.77	37.72	44.48	47.43	56.58	63.83	106.22
	0:35:00	0.00	0.00	27.53	35.53	41.46	57.08	68.10	81.36	133.45
	0:40:00	0.00	0.00	25.09	31.83	37.05	55.68	66.30	79.83	130.37
	0:45:00	0.00	0.00	22.11	28.32	33.07	50.29	59.71	73.41	120.23
	0:50:00	0.00	0.00	19.45	25.34	29.32	45.33	53.61	65.87	108.49
	0:55:00	0.00	0.00	17.16	22.39	25.96	39.83	46.94	58.31	96.22
	1:00:00	0.00	0.00	15.26	19.81	23.15	34.68	40.66	51.61	85.23
	1:05:00	0.00	0.00	13.99	18.10	21.35	30.40	35.45	45.91	76.01
	1:10:00	0.00	0.00	12.58	16.88	20.07	26.81	31.18	39.61	65.35
	1:15:00	0.00	0.00	11.24	15.46	18.87	23.92	27.71	34.22	56.01
	1:20:00	0.00	0.00	10.05	13.85	17.13	20.94	24.19	28.88	46.87
	1:25:00	0.00	0.00	8.90	12.27	14.89	18.10	20.82	23.98	38.59
	1:30:00	0.00	0.00	7.83	10.86	12.81	15.24	17.47	19.69	31.36
	1:35:00	0.00	0.00	6.96	9.71	11.15	12.64	14.40	15.87	24.92
	1:40:00	0.00	0.00	6.42	8.55	10.11	10.51	11.88	12.70	19.60
	1:45:00	0.00	0.00	6.16	7.72	9.51	9.17	10.33	10.73	16.46
	1:50:00	0.00	0.00	6.01	7.15	9.10	8.36	9.41	9.56	14.51
	1:55:00	0.00	0.00	5.42	6.73	8.66	7.85	8.83	8.79	13.19
	2:00:00	0.00	0.00	4.82	6.27	8.00	7.49	8.42	8.25	12.25
	2:05:00	0.00	0.00	3.87	5.05	6.44	6.05	6.80	6.57	9.68
	2:10:00	0.00	0.00	2.98	3.88	4.95	4.63	5.20	4.93	7.22
	2:15:00	0.00	0.00	2.30	2.99	3.80	3.54	3.97	3.72	5.41
	2:20:00	0.00	0.00	1.76	2.28	2.88	2.69	3.02	2.83	4.10
	2:25:00	0.00	0.00	1.33	1.73	2.17	2.03	2.28	2.14	3.10
	2:30:00	0.00	0.00	1.01	1.28	1.61	1.51	1.69	1.60	2.31
	2:35:00	0.00	0.00	0.74	0.93	1.20	1.11	1.24	1.19	1.71
	2:40:00	0.00	0.00	0.54	0.68	0.89	0.83	0.93	0.89	1.28
	2:45:00	0.00	0.00	0.38	0.48	0.63	0.60	0.68	0.64	0.92
	2:50:00	0.00	0.00	0.24	0.33	0.42	0.41	0.46	0.44	0.62
	2:55:00	0.00	0.00	0.14	0.20	0.26	0.26	0.28	0.27	0.38
	3:00:00	0.00	0.00	0.07	0.11	0.13	0.14	0.15	0.14	0.20
	3:05:00	0.00	0.00	0.03	0.04	0.05	0.05	0.06	0.05	0.07
	3:10:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	



## MILE HIGH FLOOD DISTRICT

# DETENTION BASIN DESIGN WORKBOOK

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**Comments?**  
**Revisions?**

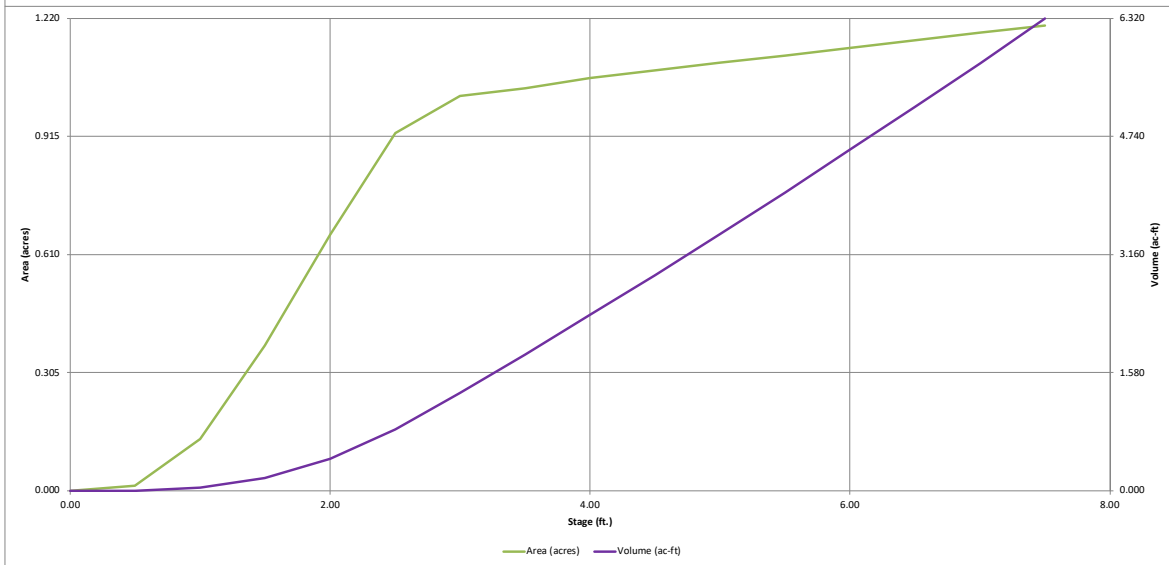
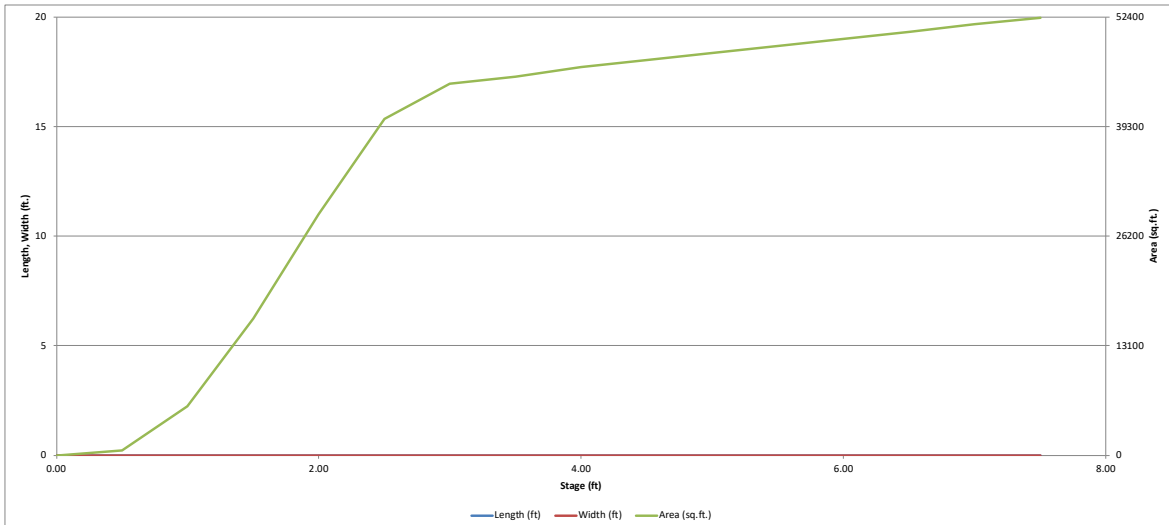
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# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.06 (July 2022)*

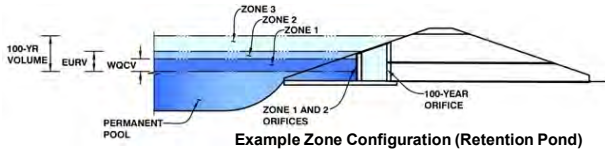


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD- Detention, Version 4.06 (July 2022)

**Project: Grandview - Filing 2**

**Basin ID: Basin B**



**Example Zone Configuration (Retention Pond)**

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.22	0.583	Orifice Plate
Zone 2 (EURV)	3.85	1.601	Rectangular Orifice
Zone 3 (100-year)	4.88	1.107	Weir&Pipe (Restrict)
<b>Total (all zones)</b>		<b>3.292</b>	

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

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

**Calculated Parameters for Underdrain**  
 Underdrain Orifice Area =  ft<sup>2</sup>  
 Underdrain Orifice Centroid =  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)**

Centroid of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
 Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
 Orifice Plate: Orifice Vertical Spacing =  inches  
 Orifice Plate: Orifice Area per Row =  sq. inches

**Calculated Parameters for Plate**  
 WQ Orifice Area per Row =  ft<sup>2</sup>  
 Elliptical Half-Width =  feet  
 Elliptical Slot Centroid =  feet  
 Elliptical Slot Area =  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)	0.00	0.73	1.50					
Orifice Area (sq. inches)	2.11	2.11	2.11					

	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)**

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	2.22	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.85	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	2.00	N/A	inches
Vertical Orifice Width =	5.46		inches

**Calculated Parameters for Vertical Orif**

	Zone 2 Rectangular	Not Selected
Vertical Orifice Area =	0.08	N/A
Vertical Orifice Centroid =	0.08	N/A

**User Input: Overflow Weir (Dropbox with Flat or Sloped Gate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)**

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.83	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Gate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Gate Type =	Type C Gate	N/A	
Debris Clogging % =	50%	N/A	%

**Calculated Parameters for Overflow W**

	Zone 3 Weir	Not Selected
Height of Gate Upper Edge, H <sub>t</sub> =	3.83	N/A
Overflow Weir Slope Length =	4.00	N/A
Gate Open Area / 100-yr Orifice Area =	7.60	N/A
Overflow Gate Open Area w/o Debris =	11.14	N/A
Overflow Gate Open Area w/ Debris =	5.57	N/A

**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 =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	13.90		inches

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

	Zone 3 Restrictor	Not Selected
Outlet Orifice Area =	1.46	N/A
Outlet Orifice Centroid =	0.64	N/A
Half-Central Angle of Restrictor Plate on Pipe =	2.15	N/A

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

Spillway Invert Stage =	4.80	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	38.00	feet
Spillway End Slopes =	10.00	H:V
Freeboard above Max Water Surface =	1.00	feet

**Calculated Parameters for Spillway**

Spillway Design Flow Depth =	0.67	feet
Stage at Top of Freeboard =	6.47	feet
Basin Area at Top of Freeboard =	1.16	acres
Basin Volume at Top of Freeboard =	5.10	acre-ft

**Routed Hydrograph Results**

*The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AI)*

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Design Storm Return Period =								
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.583	2.184	1.618	2.128	2.537	3.086	3.627	4.289
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.618	2.128	2.537	3.086	3.627	4.289
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.4	0.5	4.9	9.8	16.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.17	0.34	0.56
Peak Inflow Q (cfs) =	N/A	N/A	24.9	32.7	38.5	49.7	59.6	72.1
Peak Outflow Q (cfs) =	0.3	0.9	0.7	0.8	2.5	6.6	12.0	14.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.0	4.7	1.3	1.2	0.9
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1
Max Velocity through Gate 1 (fps) =	N/A	0.01	N/A	N/A	0.1	0.5	1.0	1.2
Max Velocity through Gate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	67	61	67	70	69	67	66
Time to Drain 99% of Inflow Volume (hours) =	40	72	65	72	75	75	75	74
Maximum Ponding Depth (ft) =	2.22	3.85	3.20	3.67	3.99	4.19	4.40	4.76
Area at Maximum Ponding Depth (acres) =	0.78	1.06	1.03	1.05	1.07	1.07	1.08	1.10
Maximum Volume Stored (acre-ft) =	0.584	2.190	1.513	2.000	2.339	2.553	2.768	3.171





ice

ft<sup>2</sup>

feet

eir

feet

feet

ft<sup>2</sup>

ft<sup>2</sup>

ite

ft<sup>2</sup>

feet

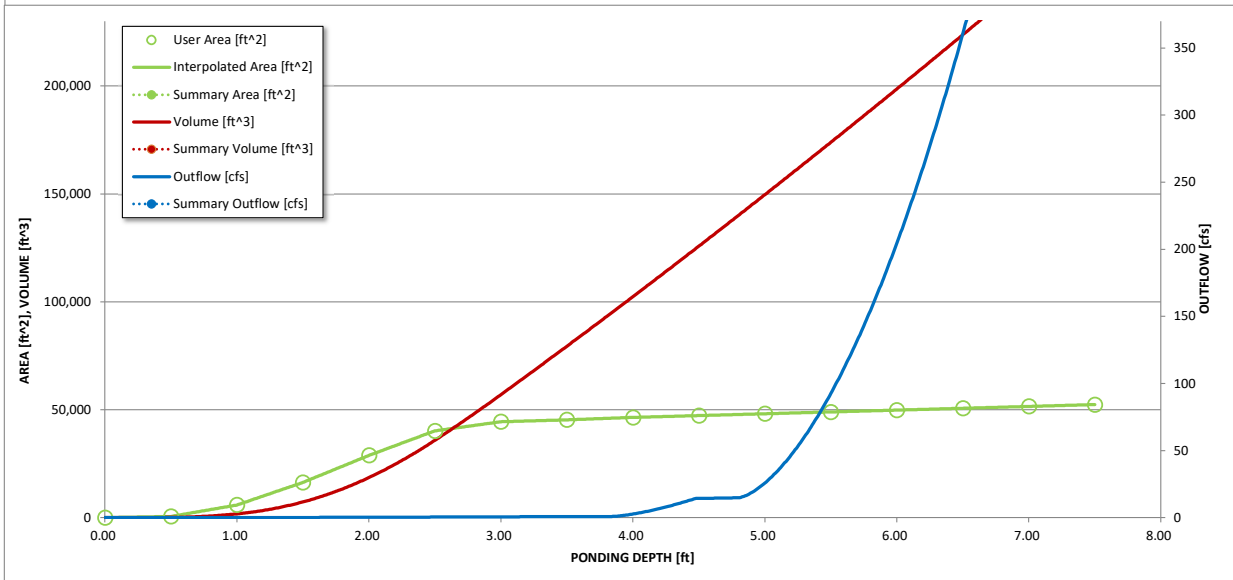
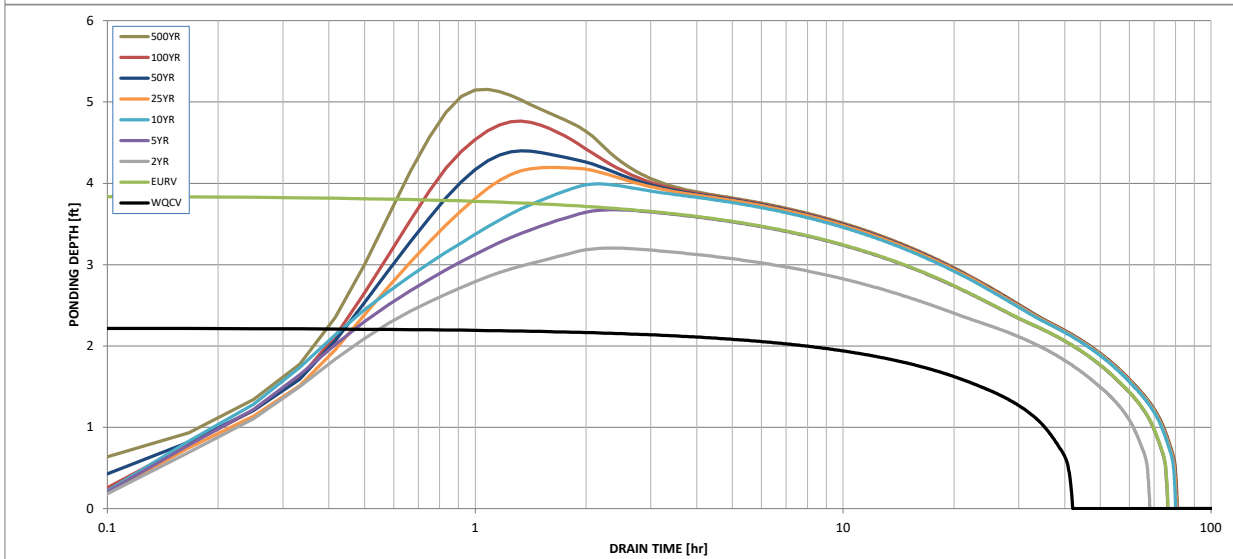
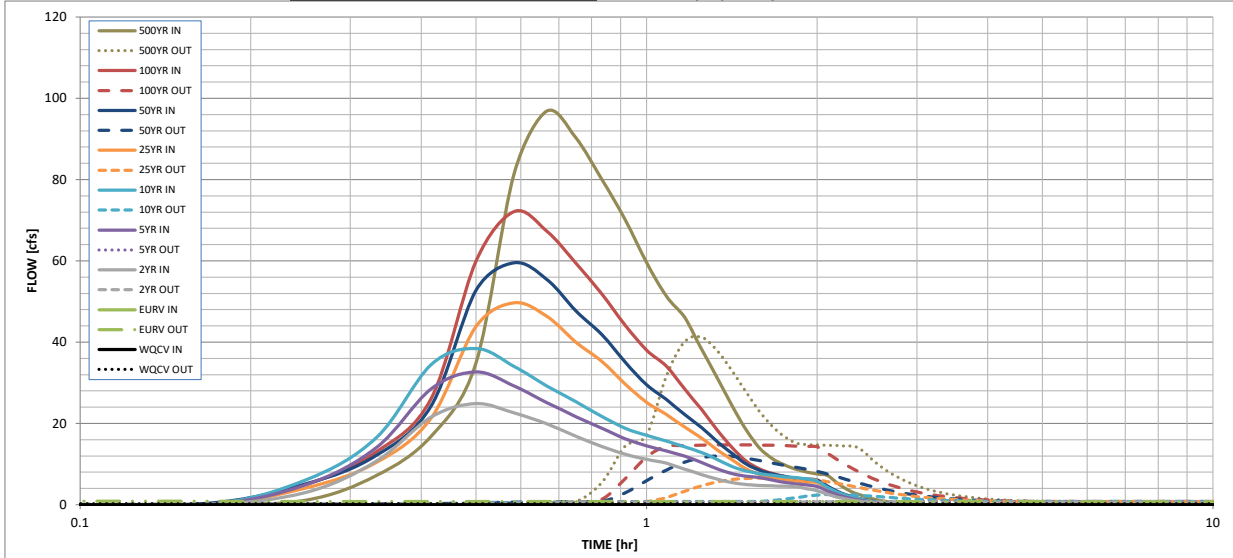
radians

5).

500 Year
3.14
5.737
5.737
29.2
1.01
96.8
41.2
1.4
Spillway
1.3
N/A
62
73
5.15
1.11
3.601

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.03	1.09
	0:15:00	0.00	0.00	3.00	4.87	6.04	4.06	5.08	4.96	7.13
	0:20:00	0.00	0.00	10.67	13.98	16.45	10.38	12.09	12.97	16.87
	0:25:00	0.00	0.00	21.56	28.51	34.45	21.33	24.33	26.17	34.87
	0:30:00	0.00	0.00	24.85	32.66	38.46	43.83	52.74	59.96	81.45
	0:35:00	0.00	0.00	22.59	29.18	34.04	49.69	59.55	72.15	96.83
	0:40:00	0.00	0.00	19.88	25.15	29.24	46.35	55.47	67.35	90.29
	0:45:00	0.00	0.00	16.87	21.67	25.35	40.00	47.70	59.47	80.09
	0:50:00	0.00	0.00	14.33	18.83	21.71	35.26	41.88	51.87	70.16
	0:55:00	0.00	0.00	12.41	16.24	18.84	29.72	35.08	44.19	59.60
	1:00:00	0.00	0.00	11.16	14.51	17.05	25.19	29.53	38.05	51.31
	1:05:00	0.00	0.00	10.19	13.20	15.63	22.18	25.89	34.10	46.13
	1:10:00	0.00	0.00	8.78	11.95	14.24	19.14	22.24	28.50	38.29
	1:15:00	0.00	0.00	7.43	10.39	12.85	16.40	18.96	23.43	31.20
	1:20:00	0.00	0.00	6.26	8.81	11.11	13.49	15.51	18.34	24.25
	1:25:00	0.00	0.00	5.42	7.64	9.33	11.01	12.56	14.01	18.36
	1:30:00	0.00	0.00	4.97	7.03	8.29	8.81	9.97	10.71	13.91
	1:35:00	0.00	0.00	4.74	6.71	7.66	7.50	8.47	8.79	11.34
	1:40:00	0.00	0.00	4.61	6.05	7.21	6.71	7.55	7.67	9.81
	1:45:00	0.00	0.00	4.53	5.52	6.88	6.19	6.96	6.91	8.76
	1:50:00	0.00	0.00	4.47	5.14	6.65	5.83	6.56	6.40	8.06
	1:55:00	0.00	0.00	3.92	4.85	6.34	5.59	6.29	6.03	7.55
	2:00:00	0.00	0.00	3.44	4.50	5.77	5.42	6.09	5.77	7.20
	2:05:00	0.00	0.00	2.60	3.40	4.35	4.11	4.62	4.34	5.41
	2:10:00	0.00	0.00	1.92	2.48	3.16	2.98	3.35	3.15	3.92
	2:15:00	0.00	0.00	1.40	1.81	2.30	2.17	2.44	2.31	2.87
	2:20:00	0.00	0.00	1.02	1.31	1.67	1.58	1.77	1.69	2.10
	2:25:00	0.00	0.00	0.72	0.92	1.19	1.12	1.26	1.20	1.49
	2:30:00	0.00	0.00	0.50	0.63	0.83	0.79	0.88	0.85	1.05
	2:35:00	0.00	0.00	0.34	0.44	0.58	0.56	0.62	0.60	0.74
	2:40:00	0.00	0.00	0.21	0.29	0.37	0.37	0.41	0.39	0.48
	2:45:00	0.00	0.00	0.11	0.17	0.21	0.22	0.24	0.23	0.28
	2:50:00	0.00	0.00	0.05	0.08	0.10	0.10	0.11	0.11	0.13
	2:55:00	0.00	0.00	0.02	0.02	0.03	0.03	0.03	0.03	0.04
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	



## MILE HIGH FLOOD DISTRICT

# DETENTION BASIN DESIGN WORKBOOK

*MHFD-Detention, Version 4.06 (July 2022)*  
*Mile High Flood District*  
*Denver, Colorado*  
*www.mhfd.org*

**Purpose:**

This workbook aids in the estimation of stormwater detention basin sizing and outlet routing based on the modified puls routing method for urban watersheds. Several different BMP types and various outlet configurations can be sized.

**Function:**

1. Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.
2. Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.

---

**Content:**

**This workbook consists of the following sheets:**

**Basin** Tabulates stage-area-volume relationship estimates based on watershed parameters

**Outlet Structure** Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).

**Reference** Provides reference equations and figures.

**User Tips and Tools** Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.

**BMP Zone Images** Provides images of typical BMP zone configurations corresponding with Zone pulldown selections.

**Acknowledgements:** *Spreadsheet Development Team:*  
**Ken MacKenzie, P.E., Holly Piza, P.E.**  
Mile High Flood District

**Derek N. Rapp, P.E.**  
Peak Stormwater Engineering, LLC

**Dr. James C.Y. Guo, Ph.D., P.E.**  
Professor, Department of Civil Engineering, University of Colorado at Denver

**Comments?**  
**Revisions?**

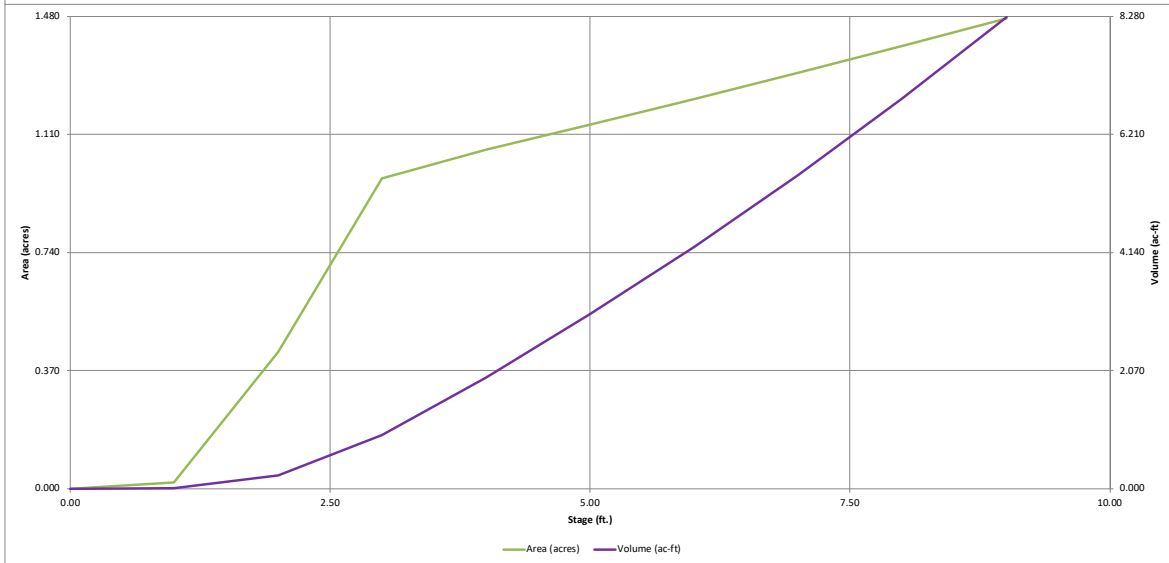
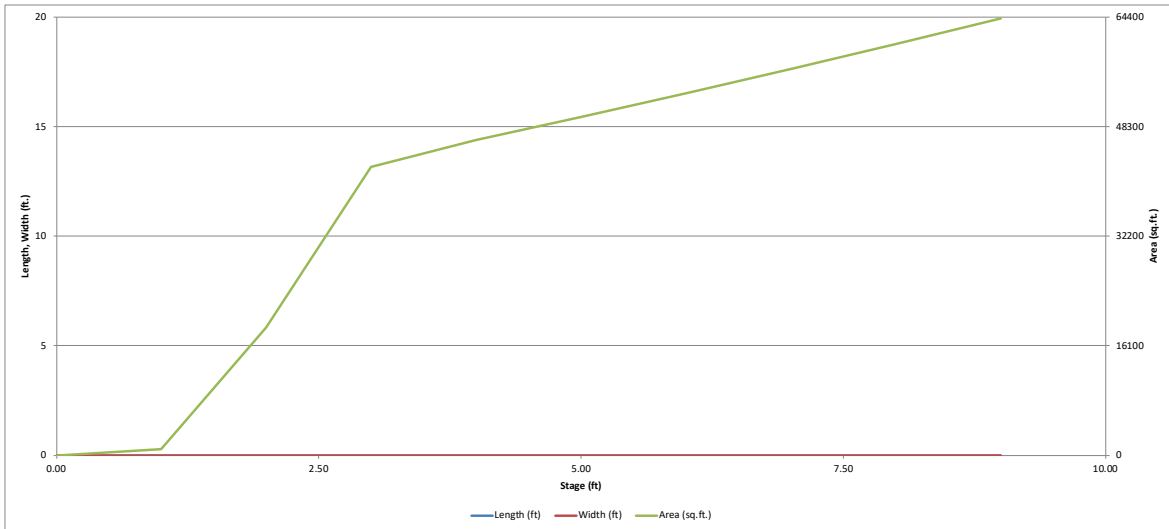
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# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.06 (July 2022)*

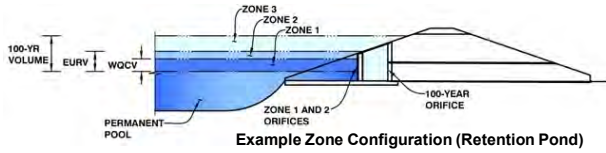


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD- Detention, Version 4.06 (July 2022)

**Project: Grandview**

**Basin ID: Basin C**



**Example Zone Configuration (Retention Pond)**

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.94	0.871	Orifice Plate
Zone 2 (EURV)	5.17	2.379	Rectangular Orifice
Zone 3 (100-year)	6.55	1.661	Weir&Pipe (Restrict)
<b>Total (all zones)</b>		<b>4.910</b>	

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

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

**Calculated Parameters for Underdrain**  
 Underdrain Orifice Area =  ft<sup>2</sup>  
 Underdrain Orifice Centroid =  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)**

Centroid of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
 Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
 Orifice Plate: Orifice Vertical Spacing =  inches  
 Orifice Plate: Orifice Area per Row =  sq. inches (diameter = 1-13/16 inches)

**Calculated Parameters for Plate**  
 WQ Orifice Area per Row =  ft<sup>2</sup>  
 Elliptical Half-Width =  feet  
 Elliptical Slot Centroid =  feet  
 Elliptical Slot Area =  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)	0.00	0.98	1.96					
Orifice Area (sq. inches)	2.65	2.65	2.65					

	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)**

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	<input type="text" value="2.94"/>	<input type="text" value="N/A"/>	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	<input type="text" value="5.19"/>	<input type="text" value="N/A"/>	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	<input type="text" value="2.00"/>	<input type="text" value="N/A"/>	inches
Vertical Orifice Width =	<input type="text" value="7.19"/>	<input type="text" value="N/A"/>	inches

**Calculated Parameters for Vertical Orif**

	Zone 2 Rectangular	Not Selected
Vertical Orifice Area =	<input type="text" value="0.10"/>	<input type="text" value="N/A"/>
Vertical Orifice Centroid =	<input type="text" value="0.08"/>	<input type="text" value="N/A"/>

**User Input: Overflow Weir (Dropbox with Flat or Sloped Gate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)**

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	<input type="text" value="5.19"/>	<input type="text" value="N/A"/>	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	<input type="text" value="4.00"/>	<input type="text" value="N/A"/>	feet
Overflow Weir Gate Slope =	<input type="text" value="0.00"/>	<input type="text" value="N/A"/>	H:V
Horiz. Length of Weir Sides =	<input type="text" value="4.00"/>	<input type="text" value="N/A"/>	feet
Overflow Gate Type =	<input type="text" value="Type C Gate"/>	<input type="text" value="N/A"/>	
Debris Clogging % =	<input type="text" value="50%"/>	<input type="text" value="N/A"/>	%

**Calculated Parameters for Overflow W**

	Zone 3 Weir	Not Selected
Height of Gate Upper Edge, H <sub>t</sub> =	<input type="text" value="5.19"/>	<input type="text" value="N/A"/>
Overflow Weir Slope Length =	<input type="text" value="4.00"/>	<input type="text" value="N/A"/>
Gate Open Area / 100-yr Orifice Area =	<input type="text" value="5.85"/>	<input type="text" value="N/A"/>
Overflow Gate Open Area w/o Debris =	<input type="text" value="11.14"/>	<input type="text" value="N/A"/>
Overflow Gate Open Area w/ Debris =	<input type="text" value="5.57"/>	<input type="text" value="N/A"/>

**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 =	<input type="text" value="0.25"/>	<input type="text" value="N/A"/>	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	<input type="text" value="24.00"/>	<input type="text" value="N/A"/>	inches
Restrictor Plate Height Above Pipe Invert =	<input type="text" value="14.00"/>	<input type="text" value="N/A"/>	inches

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

	Zone 3 Restrictor	Not Selected
Outlet Orifice Area =	<input type="text" value="1.90"/>	<input type="text" value="N/A"/>
Outlet Orifice Centroid =	<input type="text" value="0.66"/>	<input type="text" value="N/A"/>
Half-Central Angle of Restrictor Plate on Pipe =	<input type="text" value="1.74"/>	<input type="text" value="N/A"/>

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

Spillway Invert Stage =	<input type="text" value="6.50"/>	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	<input type="text" value="37.00"/>	feet
Spillway End Slopes =	<input type="text" value="4.00"/>	H:V
Freeboard above Max Water Surface =	<input type="text" value="1.00"/>	feet

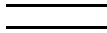
**Calculated Parameters for Spillway**

Spillway Design Flow Depth =	<input type="text" value="0.94"/>	feet
Stage at Top of Freeboard =	<input type="text" value="8.44"/>	feet
Basin Area at Top of Freeboard =	<input type="text" value="1.43"/>	acres
Basin Volume at Top of Freeboard =	<input type="text" value="7.46"/>	acre-ft

**Routed Hydrograph Results**

*The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AI)*

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Design Storm Return Period =								
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.871	3.250	2.420	3.184	3.797	4.625	5.440	6.440
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.420	3.184	3.797	4.625	5.440	6.440
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.3	0.6	0.8	7.7	15.3	25.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.18	0.35	0.58
Peak Inflow Q (cfs) =	N/A	N/A	38.0	50.0	59.0	76.3	91.6	111.0
Peak Outflow Q (cfs) =	0.4	1.2	1.0	1.2	3.6	9.8	18.2	22.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.0	4.3	1.3	1.2	0.9
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1
Max Velocity through Gate 1 (fps) =	N/A	N/A	N/A	N/A	0.2	0.8	1.5	1.9
Max Velocity through Gate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	67	61	68	70	69	68	66
Time to Drain 99% of Inflow Volume (hours) =	40	72	65	72	76	75	75	74
Maximum Ponding Depth (ft) =	2.94	5.17	4.29	4.95	5.39	5.67	5.94	6.42
Area at Maximum Ponding Depth (acres) =	0.94	1.15	1.09	1.14	1.17	1.19	1.22	1.26
Maximum Volume Stored (acre-ft) =	0.879	3.251	2.266	2.988	3.507	3.826	4.164	4.757



ice

ft<sup>2</sup>

feet

eir

feet

feet

ft<sup>2</sup>

ft<sup>2</sup>

ite

ft<sup>2</sup>

feet

radians

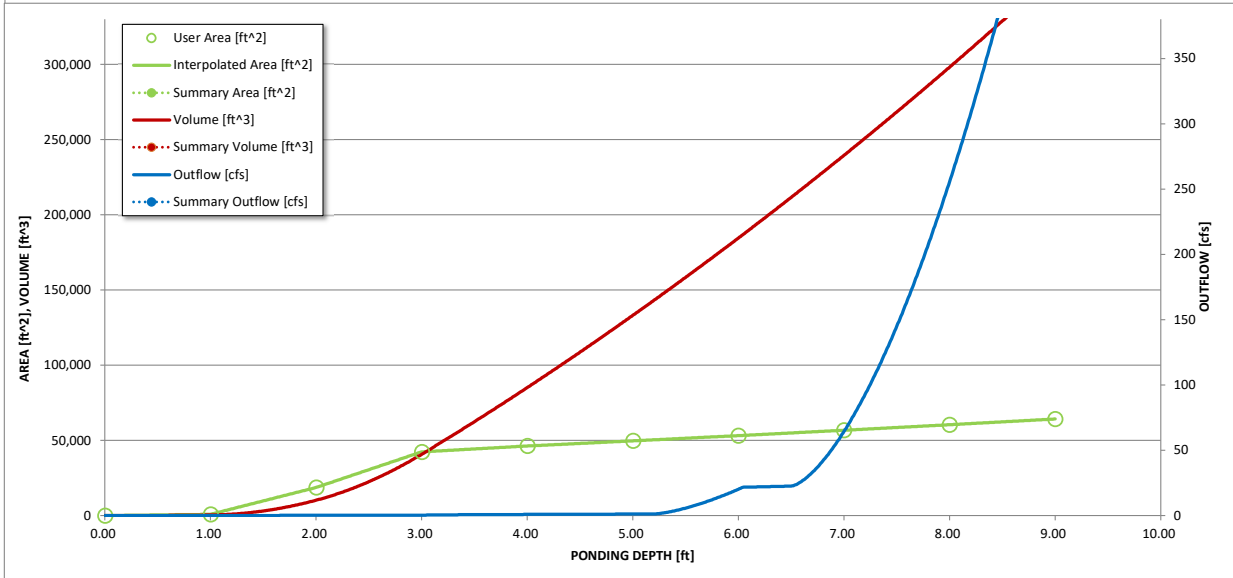
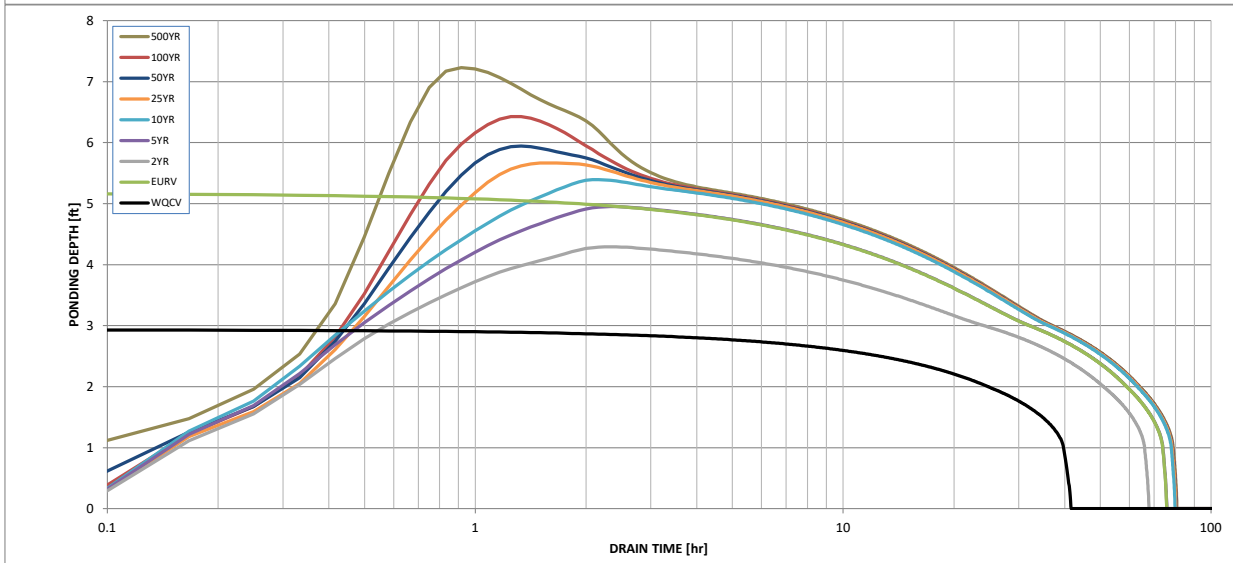
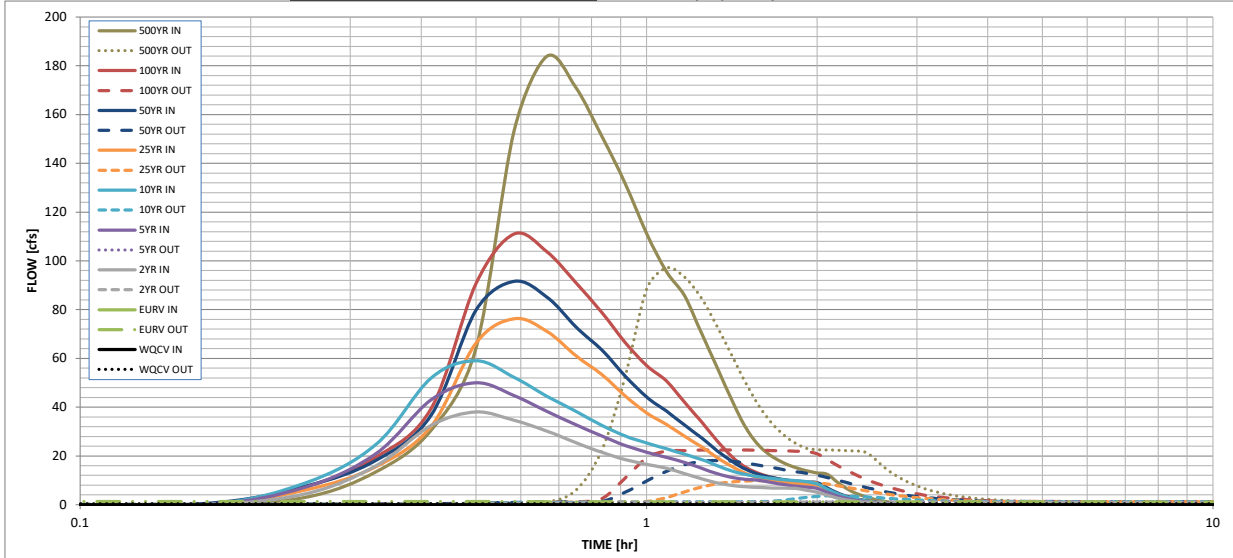
5).

500 Year
3.68
10.618
10.618
65.3
1.50
183.8
97.0
1.5
Spillway
2.0
N/A
60
72
7.23
1.32
5.788



# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.05	2.99
	0:15:00	0.00	0.00	4.43	7.20	8.94	6.01	7.53	7.34	13.50
	0:20:00	0.00	0.00	15.99	21.02	24.75	15.65	18.24	19.54	30.61
	0:25:00	0.00	0.00	32.57	43.04	52.02	32.20	36.74	39.50	64.21
	0:30:00	0.00	0.00	38.00	50.01	58.99	66.24	79.77	90.70	153.22
	0:35:00	0.00	0.00	34.58	44.76	52.23	76.30	91.64	111.00	183.84
	0:40:00	0.00	0.00	30.23	38.29	44.51	71.10	85.23	103.75	171.13
	0:45:00	0.00	0.00	25.49	32.74	38.28	61.09	72.97	91.10	151.18
	0:50:00	0.00	0.00	21.46	28.21	32.54	53.36	63.47	78.86	131.81
	0:55:00	0.00	0.00	18.52	24.27	28.14	44.66	52.75	66.58	111.30
	1:00:00	0.00	0.00	16.57	21.56	25.32	37.65	44.16	57.05	95.71
	1:05:00	0.00	0.00	14.99	19.41	22.99	32.90	38.40	50.80	85.71
	1:10:00	0.00	0.00	12.75	17.36	20.70	28.08	32.62	42.04	70.29
	1:15:00	0.00	0.00	10.64	14.97	18.55	23.74	27.42	34.00	56.12
	1:20:00	0.00	0.00	8.96	12.67	16.04	19.26	22.10	26.11	42.48
	1:25:00	0.00	0.00	7.89	11.18	13.73	15.56	17.67	19.51	31.18
	1:30:00	0.00	0.00	7.34	10.41	12.28	12.71	14.36	15.17	23.95
	1:35:00	0.00	0.00	7.04	9.96	11.36	10.94	12.33	12.67	19.72
	1:40:00	0.00	0.00	6.87	9.01	10.69	9.85	11.08	11.12	17.03
	1:45:00	0.00	0.00	6.75	8.20	10.22	9.11	10.24	10.08	15.19
	1:50:00	0.00	0.00	6.66	7.62	9.88	8.61	9.69	9.37	13.93
	1:55:00	0.00	0.00	5.85	7.19	9.41	8.27	9.30	8.86	13.03
	2:00:00	0.00	0.00	5.12	6.67	8.57	8.03	9.03	8.53	12.46
	2:05:00	0.00	0.00	3.87	5.05	6.45	6.12	6.88	6.48	9.45
	2:10:00	0.00	0.00	2.81	3.64	4.62	4.38	4.92	4.64	6.75
	2:15:00	0.00	0.00	2.02	2.62	3.32	3.16	3.54	3.36	4.88
	2:20:00	0.00	0.00	1.44	1.86	2.38	2.26	2.53	2.42	3.50
	2:25:00	0.00	0.00	1.01	1.28	1.66	1.58	1.76	1.69	2.44
	2:30:00	0.00	0.00	0.68	0.87	1.14	1.09	1.22	1.17	1.68
	2:35:00	0.00	0.00	0.44	0.59	0.77	0.75	0.84	0.80	1.14
	2:40:00	0.00	0.00	0.26	0.37	0.47	0.47	0.52	0.50	0.71
	2:45:00	0.00	0.00	0.13	0.20	0.24	0.26	0.28	0.27	0.37
	2:50:00	0.00	0.00	0.05	0.08	0.10	0.11	0.12	0.11	0.15
	2:55:00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

**APPENDIX F**  
**EASTONVILLE PDR**



▶ [HRGREEN.COM](http://HRGREEN.COM)

## Eastonville Road – Londonderry Dr. to Rex Rd. Preliminary Drainage Report

September 2023

HR Green Project No: 201662.08

**Prepared For:**

D.R. Horton

Contact: Riley Hillen, P.E.

9555 S. Kingston Ct.

Englewood, CO 80112

**Prepared By:**

HR Green Development, LLC

Contact: Colleen Monahan, P.E., LEED AP

[cmonahan@hrgreen.com](mailto:cmonahan@hrgreen.com)

(719) 394-2433



### Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to 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.

---

Colleen Monahan, P.E., LEED AP Date

State of Colorado No. 56067

For and on behalf of HR Green Development, LLC

### Owner/Developer's Statement:

I, the developer, have read and will comply with all of the requirements specified in this drainage report and plan.

By: \_\_\_\_\_

Authorized Signature

\_\_\_\_\_ Date

Address: D.R. Horton  
9555 S. Kingston Court  
Englewood, CO

### El Paso County Statement

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.

---

Joshua Palmer, P.E. Date

County Engineer/ECM Administrator

Conditions:



# Table of Contents

- Table of Contents .....2
- I. General Purpose, Location and Description.....3
  - a. Purpose .....3
  - b. Location .....3
  - c. Description of Property .....3
  - d. Floodplain Statement.....4
- II. Drainage Design Criteria .....4
  - a. Drainage Criteria .....4
- III. Drainage Basins and Subbasins .....4
  - a. Major Basin Description.....4
  - b. Existing Subbasin Description .....5
  - c. Proposed Subbasin Description .....6
- IV. Drainage Facility Design.....9
  - a. General Concept .....9
  - b. Water Quality & Detention .....9
  - c. Inspection and Maintenance.....10
- V. Wetlands Mitigation ..... 10
- VI. Four Step Method to Minimize Adverse Impacts of Urbanization ..... 10
- VII. Drainage and Bridge Fees..... 10
- VIII. Opinion of Probable Cost..... 11
- IX. Hydraulic Grade Line Analysis ..... 11
- X. Summary ..... 11
- XI. Drawings ..... 11
- XII. References ..... 11

## Appendices

- A. Vicinity Map, FEMA Map, NRCS Soil Survey
- B. Hydrologic Analysis
- C. Hydraulic Analysis
- D. Water Quality and Detention Calculations
- E. Reference Material
- F. Drainage Maps

## I. General Purpose, Location and Description

### a. Purpose

The purpose of this Preliminary Drainage Report (PDR) for Eastonville Road is to describe the onsite and offsite drainage patterns, size drainage infrastructure to safely capture and convey developed runoff to water quality and detention facilities, and to safely route detained stormwater to adequate outfalls. This drainage report will detail the improvements of Eastonville Road from Londonderry Drive to Rex Road.

### b. Location

Eastonville Road from Londonderry Drive to Rex Road, referred to as 'the site' herein, is an existing road in El Paso County, Colorado. The site lies within a tract of land within Sections 21 and 28, Township 12 South, Range 64 West of the 6<sup>th</sup> Principal Meridian, in El Paso County, State of Colorado.

The site is bound by undeveloped land to the east and west that has historically been used as ranching lands. Falcon Regional Park, which contains ballparks and parking, and Falcon High School also border the site to the west. All lands to the east and west of the site are unplatted. A vicinity map is presented in Appendix A.

### c. Description of Property

The site is approximately 1.3 miles (15.8 acres) of existing temporary pavement roadway north of Londonderry Drive and south of Rex Road. The temporary pavement width for the length of the project is 26' wide. 4' wide sand shoulders and weedy swales are located on both sides of the roadway. Offsite stormwater is bypassed under the road through a series of existing culverts. See Appendix A for existing condition photo.

The existing roadway has slopes ranging from 0.3% up to about 4%. The general topography of the surrounding area is typical of high desert, short prairie grass with gently rolling hillside with slopes ranging from 2% to 4%. The project site drains generally from the west to the east and is tributary to Black Squirrel Creek.

Per a NRCS soil survey, the site is made up of Type A Columbine gravelly sandy loam, Type A Blakeland loamy sand and Type B Stapleton sandy loam. The NRCS soil survey is presented in Appendix A.

Gieck Ranch Tributary #1 (Channel A) is the only drainageway that traverses the site in the west to east direction through an existing culvert under Eastonville Road. The channel is a mapped wetland and a wetland permit will be required for a part of this Eastonville Road improvement project. Channel A is not within a FEMA floodplain.

Gieck Ranch Tributary #2 is located north of the project site and will not be impacted by this project. There are no known irrigation facilities in the area.

Existing utilities include an underground gas line that runs along the east and western sides of Eastonville, an existing raw water line that follows the west side of Eastonville north of Falcon Regional Park, and an existing aboveground electrical line along the western side of Eastonville Road. An existing drainage map with these facilities is presented in Appendix F.

#### d. Floodplain Statement

Based on FEMA Firm map 08041C0552G December 7, 2018, the site is not located in any FEMA designated floodplain. See FEMA Firm Map in Appendix A. There is a Zone A floodplain north of the site and a Zone AE south of the site, both of which will not be altered with the associated Eastonville Road improvements.

## II. Drainage Design Criteria

### a. Drainage Criteria

Hydrologic data and calculations were performed using Drainage Criteria Manual Volume 1 of El Paso County (EPCDCM), with County adopted Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs Drainage Criteria Manual (CCSDCM), May 2014 revised January 2021.

Onsite drainage improvements are designed for the 5-year storm (minor event) and 100-year storm (major event) using rainfall values from CCSDCM Table 6-2 below. Runoff was calculated per CCSDCM Section 6.3.0 - Rational Method. Private, full spectrum pond design was completed using the latest version of Mile High Flood District's (MHFD) UD-Detention per CCSDCM Section 13.3.2.1 – Private, full spectrum Detention. Detention pond allowable release rate will be limited to less than historic rates.

Return Period (yr)	5	100
1-hr Rainfall Depth (in)	1.50	2.52

Inlet sizing was performed per the methods described in EPCDCM Section III Chapter 7 – Street Drainage and Storm Water Inlets. Storm sewer sizing was performed per the methods described in EPCDCM Section III Chapter 8 – Storm Drains and Appurtenances.

## III. Drainage Basins and Subbasins

### a. Major Basin Description

The site is located within the Gieck Ranch Drainage Basin. The site's drainage characteristics were previously studied in the following reports:

1. "Gieck Ranch Drainage Basin Planning Study" prepared by Drexel, Barrel & Co, February 2010.
2. "Master Development Drainage Plan Meridian Ranch" prepared by Tech Contractors, July 2021.
3. "Final Drainage Report for The Sanctuary Filing 1 at Meridian Ranch" by Tech Contractors, August 2022.

Gieck Ranch Drainage Basin is a 22.05 square mile watershed located in El Paso County, Colorado. Gieck Ranch Drainage Basin is tributary to Black Squirrel Creek which drains to the Arkansas River. The majority of the basin is undeveloped and is rolling range land typical of Colorado's semi-arid climates. It should be noted that the Gieck Ranch DBPS has not been approved at the time of this report.



The Meridian Ranch MDDP and The Final Drainage Report for The Sanctuary Filing 1 at Meridian Ranch indicate that the Eastonville Road culvert crossing at the Gieck Ranch Tributary #1, within the project boundary, does not provide enough capacity for the historic flow rates. This culvert will be upgraded as part of this project.

Within the Gieck Ranch Drainage Basin, ranching has historically dominated the area, with rolling topography between 2%-4% slopes. However, more recently urbanization is occurring, most notably for this project are Meridian Ranch and Latigo Trails Developments. Both are single family residential neighborhoods located upstream to the west and northwest of the Eastonville project site.

## **b. Existing Subbasin Description**

Eastonville Road from Londonderry Drive to Rex Road (the site) accepts flows from areas to the west and northwest of the site, including portions of Meridian Ranch and Latigo Development. The flows and design points used in the following descriptions are taken from the approved Meridian Ranch MDDP and The Final Drainage Report for The Sanctuary Filing 1 at Meridian Ranch which provide the detailed analysis of the pond releases and flows as they outfall from those developments upstream of this Eastonville Road site. For the purpose of this report, full buildout of the Meridian Ranch development was assumed; hence the developed peak flow rates from the “future buildout conditions” for the entirety of Meridian Ranch were used to evaluate the existing conditions below.

Basin EX1 (The Sanctuary Filing 1 FG-38) is 85.16 acres of undeveloped area and temporary pavement area to the crown of Eastonville Road roadway. Stormwater from this basin combines with flows from Latigo Trails South Pond (The Sanctuary Filing 1 G-17) is conveyed overland to DP1 for a total area of 321.5 acres (The Sanctuary Filing 1 G18). Flows at DP1 ( $Q_5 = 28.3$  cfs  $Q_{100} = 365.2$  cfs) are conveyed across Eastonville Road in an existing 24" CMP culvert and discharges to Gieck Ranch Tributary #2 (Channel B). This basin is located upstream of the Eastonville project and is presented here to show where flows go that are upstream of the project site. The Eastonville project will have no impact on this basin.

Basin EX2 (The Sanctuary Filing 1 FG36) is 18.88 acres undeveloped area, parking lot, and temporary pavement to the crown of Eastonville Road roadway. Stormwater from this basin is conveyed overland to DP2 (The Sanctuary Filing 1 FG36). Flows at DP2 ( $Q_5 = 1.7$  cfs  $Q_{100} = 18.8$  cfs) are conveyed southerly across Rex Road in an existing 24" RCP culvert and discharges to Basin EX3.

Basin EX3 is 51.06 acres of undeveloped area and the Falcon Regional Park ball fields and temporary pavement to the crown of Eastonville Road roadway. Stormwater from this basin combines with flows from The Sanctuary Filing 1 Design Point G15 via an existing roadside swale where it then combines with DP2 flows. Flows travel to DP3 for a total area of 131.3 acres (The Sanctuary Filing 1 Design Point G16) where they are conveyed across Eastonville Road in an existing 24" CMP culvert ( $Q_5 = 6.1$  cfs  $Q_{100} = 112.1$  cfs).

Basin EX4 is 62.87 acres of undeveloped area and temporary pavement to the crown of Eastonville Road roadway. Stormwater from this basin combines with flows from The Sanctuary Filing 1 Design Point G12 (Meridian Ranch Pond G) to Gieck Ranch Tributary #1 and an existing roadside swale to DP 4 for a total area of 832.7 acres (The Sanctuary Filing 1 Design Point G06) ( $Q_5 = 22.4$  cfs  $Q_{100} = 491$  cfs). Flows at DP4 are conveyed across Eastonville Road in an existing 18" CMP culvert and discharges to Gieck Ranch Tributary #1 (Channel A).

Basin EX5 is 22.35 acres of undeveloped area and temporary pavement to the crown of Eastonville Road roadway. Stormwater from this basin ( $Q_5 = 7.0$  cfs  $Q_{100} = 43.3$  cfs) is conveyed in an existing roadside swale to DP5. Flows at DP5 are conveyed across Eastonville Road in an existing 18" CMP culvert.

Basin EX6 is 3.05 acres of undeveloped area and temporary pavement. to the crown of Eastonville Road roadway Stormwater from this basin ( $Q_5 = 1.2$  cfs  $Q_{100} = 6.9$  cfs) is conveyed in an existing roadside swale to DP6. Flows at DP6 are conveyed across Eastonville Road in an existing 18" CMP culvert.

Basin EX7 is 1.47 acres of undeveloped area and temporary pavement to the crown of Eastonville Road roadway. Stormwater from this basin ( $Q_5 = 0.9$  cfs  $Q_{100} = 4.2$  cfs) is conveyed in an existing roadside swale to DP7. Flows at DP7 are conveyed across Eastonville Road in an 18" CMP culvert.

Basin EX8 is 13.13 acres of undeveloped area and temporary pavement to the crown of Eastonville Road roadway. Stormwater from this basin ( $Q_5 = 3.8$  cfs  $Q_{100} = 22.6$  cfs) is conveyed in an existing roadside swale to DP8. Flows at DP8 are conveyed across Eastonville Road in an existing an existing 24" CMP culvert.

Basin EX9 is 1.59 acres of undeveloped area and temporary pavement to the crown of Eastonville Road roadway. Stormwater from this basin ( $Q_5 = 0.9$  cfs  $Q_{100} = 3.7$  cfs) is conveyed in an existing roadside swale to DP9. Flows at DP9 are conveyed across Eastonville Road in an existing an existing 36" CMP culvert.

### **c. Proposed Subbasin Description**

#### **Description of Proposed Project**

The proposed project includes improvements to Eastonville Road from Londonderry Drive to Rex Road. As described above, the current condition of the existing roadway in this area consists of 26' wide temporary pavement roadway with 4' wide sand shoulders and weedy swales located on both sides of the roadway. Offsite stormwater is bypassed under the road through a series of existing culverts.

The proposed improvements from Rex Road south to the southern property line of the proposed Grandview Reserve Filing 1 include removal of the 26' wide temporary pavement and replacing the road with a Modified Urban Minor Arterial Roadway Cross-Section consisting of 48' pavement and Type A EPC curb (53' back of curb to back of curb). This includes Basins EA1-EA12.

The proposed improvements from southern property line of the proposed Grandview Reserve south to Londonderry Drive include resurfacing the existing temporary pavement by providing full-depth pavement to replace the temporary pavement along this length of roadway. This is anticipated to be an interim condition until the completion of the full roadway section by others. The proposed interim roadway will be consistent with the Modified Rural Major Collector Roadway Cross-Section, with two 12' wide lanes and 4' shoulders, with existing roadside swales on both sides. The total width of the roadway is 32' including both shoulders, which adds 6' of pavement to the existing 26' temporary pavement roadway. Per ECM Appendix I.7.1.B.2.2, this area of the project is excluded from the requirements of Section 1.7 since the site does not add more than 8.25' of paved width at any location of the existing roadway. This includes Basins EA13-EA15.

#### **Eastonville Road Basins**

Basin EA1 is 0.22 acres of proposed roadway (Modified Urban Minor Arterial Roadway Cross-Section). Stormwater ( $Q_5 = 0.7$  cfs  $Q_{100} = 1.3$  cfs) is conveyed in curb and gutter to DP2. Flows at DP2 are captured in a 5' Type R sump inlet (Public) and piped to Pond A Sand Filter. Basin EA1 will be detained Pond A Sand Filter.

Basin EA2 is 0.25 acres of proposed roadway (Modified Urban Minor Arterial Roadway Cross-Section). Stormwater ( $Q_5 = 0.8$  cfs  $Q_{100} = 1.5$  cfs) is conveyed in curb and gutter to DP3. Flows at DP3 are captured in a 5' Type R sump inlet (Public) and piped to Pond A. Basin EA2 will be detained Pond A Sand Filter.

Basin EA3 is 0.20 acres of proposed roadway (Modified Urban Minor Arterial Roadway Cross-Section). Stormwater ( $Q_5 = 0.7$  cfs  $Q_{100} = 1.4$  cfs) is conveyed in curb and gutter to DP5. Flows at DP5 are captured in a 10' Type R sump inlet (Public) and piped to DP9.1. Basin EA3 will not be detained per the Meridian Ranch MDDP as this basin has been over-detained within Meridian Ranch.

Basin EA4 is 0.17 acres of proposed roadway (Modified Urban Minor Arterial Roadway Cross-Section). Stormwater ( $Q_5 = 0.5$  cfs  $Q_{100} = 1.1$  cfs) is conveyed in curb and gutter to DP6. Flows at DP6 are captured in a 5' Type R sump inlet (Public) and piped to DP9.1. Basin EA4 will not be detained per the Meridian Ranch MDDP as this basin has been over-detained within Meridian Ranch.

Basin EA5 is 0.16 acres of undeveloped area and includes Pond A Sand Filter. Stormwater ( $Q_5 = 0.1$  cfs  $Q_{100} = 0.4$  cfs) is flows directly into Pond A Sand Filter.

Basin EA6 is 0.70 acres of undeveloped area that will be future roadway (Rex Road) once the Grandview Filing 1 development is constructed. Stormwater ( $Q_5 = 3.1$  cfs  $Q_{100} = 5.5$  cfs) is conveyed in a swale to DP10: Temporary Sediment Basin #1 (TSB #1). TSB #1 has been sized for the paved area of the roundabout and the future paved area of Rex Road within Basin EA6. The swale will be removed with the construction of Rex Road curb and gutter. Basin EA6 will be detained in TSB #1.

Basin EA7 is 0.65 acres of undeveloped area that will be future roadway (Rex Road) once the Grandview Filing 1 development is constructed. Stormwater ( $Q_5 = 2.5$  cfs  $Q_{100} = 4.7$  cfs) is conveyed in a swale to DP10: Temporary Sediment Basin #1 (TSB #1). TSB #1 has been sized for the paved area of the roundabout and the future paved area of Rex Road within Basin EA7. The swale will be removed with the construction of Rex Road curb and gutter. Basin EA7 will be detained in TSB #1.

Basin EA8 is 2.08 acres of proposed roadway (Modified Urban Minor Arterial Roadway Cross-Section). Stormwater ( $Q_5 = 5.0$  cfs  $Q_{100} = 9.0$  cfs) is conveyed in curb and gutter to DP14. Flows at DP14 are captured in a 10' Type R sump inlet (Public) and piped to Pond B. Basin EA8 will be detained Pond B Full Spectrum Detention Basin.

Basin EA9 is 2.99 acres of proposed roadway (Modified Urban Minor Arterial Roadway Cross-Section). Stormwater ( $Q_5 = 4.6$  cfs  $Q_{100} = 9.5$  cfs) is conveyed in curb and gutter to DP15. Flows at DP15 are captured in a 10' Type R sump inlet (Public) and piped to Pond B. Basin EA9 will be detained Pond B Full Spectrum Detention Basin.

Basin EA10 is 1.34 acres of proposed roadway (Modified Urban Minor Arterial Roadway Cross-Section). Stormwater ( $Q_5 = 4.0$  cfs  $Q_{100} = 7.4$  cfs) is conveyed in curb and gutter to DP17. Flows at DP17 are captured in a 10' Type R sump inlet (Public) and piped to Pond B. Basin EA10 will be detained Pond B Full Spectrum Detention Basin.

Basin EA11 is 1.99 acres of proposed roadway (Modified Urban Minor Arterial Roadway Cross-Section). Stormwater ( $Q_5 = 4.1$  cfs  $Q_{100} = 8.5$  cfs) is conveyed in curb and gutter to DP18. Flows at DP18 are captured in a 10' Type R sump inlet (Public) and piped to Pond B. Basin EA11 will be detained Pond B Full Spectrum Detention Basin.

Basin EA12 is 0.92 acres of undeveloped area and includes Pond B. Stormwater ( $Q_5 = 0.5$  cfs  $Q_{100} = 2.9$  cfs) flows directly into Pond B Full Spectrum Detention Basin.

Basin EA13 is 1.31 acres of undeveloped area and proposed pavement to the crown of Eastonville Road roadway (Modified Rural Major Collector Roadway Cross-Section). Stormwater ( $Q_5 = 1.0$  cfs  $Q_{100} = 4.0$  cfs) is conveyed in existing roadside swale to an existing 18" CMP storm pipe at DP22 (EX DP 7). Per ECM Appendix I.7.1.B.2.2, this area of the project is excluded from the requirements of Section 1.7.

Basin EA14 is 13.13 acres of undeveloped area and proposed pavement to the crown of Eastonville Road roadway (Modified Rural Major Collector Roadway Cross-Section). Stormwater ( $Q_5 = 4.0$  cfs  $Q_{100} = 23.0$  cfs) is conveyed in existing roadside swale to an existing 24" CMP storm pipe at DP23 (EX DP8). Per ECM Appendix I.7.1.B.2.2, this area of the project is excluded from the requirements of Section 1.7.

Basin EA15 is 1.59 acres of undeveloped area and proposed pavement to the crown of Eastonville Road roadway (Modified Rural Major Collector Roadway Cross-Section). Stormwater ( $Q_5 = 1.0$  cfs  $Q_{100} = 3.9$  cfs) is conveyed in existing roadside swale to an existing 36" CMP storm pipe at DP24 (EX DP 9). Per ECM Appendix I.7.1.B.2.2, this area of the project is excluded from the requirements of Section 1.7.

### **Offsite Basins**

Basin OS1 (EX1) is 85.16 acres of undeveloped area. Stormwater from this basin combines with flows from Latigo Trails South Pond (The Sanctuary Filing 1 G-17) is conveyed overland to DP1 (The Sanctuary Filing 1 G18). Flows at DP1 ( $Q_5 = 28.3$  cfs  $Q_{100} = 365.2$  cfs) are conveyed across Eastonville Road in an existing 24" CMP culvert and discharges to Gieck Ranch Tributary #2 (Channel B). This basin is located upstream of the Eastonville project and is presented here to show where flows go that are upstream of the project site. The Eastonville project will have no impact on this basin.

Basin OS2 is 15.03 acres of undeveloped land and parking area north of Rex Road and contains a portion of Rex Road ( $Q_5 = 4.2$  cfs  $Q_{100} = 21.6$  cfs). Stormwater is conveyed to DP7 and is captured in a proposed 24" RCP culvert and piped south across Rex Road. No development associated with Eastonville Road will occur in Basin OS2.

Basin OS3 is 1.00 acre of undeveloped land ( $Q_5 = 0.2$  cfs  $Q_{100} = 1.2$  cfs) along the western edge of Eastonville Road. Stormwater is conveyed to DP8 and is captured in a proposed 15" RCP culvert and piped south across Rex Road. No development associated with Eastonville Road will occur in Basin OS3.

Basin OS4 is 9.60 acres of undeveloped land ( $Q_5 = 3.8$  cfs  $Q_{100} = 17.3$  cfs) along the western edge of Eastonville Road. Stormwater is conveyed to DP11 in a roadside swale where it combines with Meridian Ranch DP G15 flows ( $Q_5 = 8$  cfs  $Q_{100} = 54.0$  cfs) before being captured in a proposed 30" RCP culvert and piped to Channel B. The combined flows as it reaches DP11 is  $Q_5 = 10.5$  cfs  $Q_{100} = 144.5$  cfs.

Basin OS5 is 40.26 acres of undeveloped land and Falcon Regional Park ( $Q_5 = 13.3$  cfs  $Q_{100} = 64.0$  cfs) along the western edge of Eastonville Road. Stormwater is conveyed to DP12 in a roadside swale and is captured in a proposed 48" RCP culvert and piped to Channel B.

Basin OS6 is 60.97 acres of undeveloped land ( $Q_5 = 8.9$  cfs  $Q_{100} = 60.6$  cfs) along the western edge of Eastonville Road. Basin OS6 flows are adapted directly from the approved The Sanctuary Filing 1 FDR. Stormwater is conveyed to DP16 in a roadside swale where it combines with Meridian Ranch DP G12 flows before being conveyed across Eastonville Road in dual 10' x 3.5' RCBC to Channel A. The combined flows at DP16 (EX4) are  $Q_5 = 22.4$  cfs  $Q_{100} = 491$  cfs.

Basin OS7 is 23.46 acres of undeveloped land ( $Q_5 = 5.7$  cfs  $Q_{100} = 38.6$  cfs) along the western edge of Eastonville Road. Stormwater is conveyed to DP21 in a roadside swale and is captured in a proposed 30" RCP culvert and piped to Channel A.

Basin OS8 is future outflow of 11.42 acres of a future stormwater detention pond outflow developed land that will be detained to meet existing conditions ( $Q_5 = 3.4$  cfs  $Q_{100} = 22.7$  cfs) in the southeast corner of Eastonville Road and Rex Road. From there, stormwater is piped to Channel B.

## IV. Drainage Facility Design

### a. General Concept

The proposed improvements from Rex Road south to the southern property line of the proposed Grandview Reserve Filing 1 include removal of the 26' wide temporary pavement and replacing the road with a Modified Urban Minor Arterial Roadway Cross-Section consisting of 48' pavement and Type A EPC curb (53' back of curb to back of curb). Inlets will be placed at low points and roundabout entrances. Stormwater from this roadway will be piped to either a full spectrum detention pond, sand filter or temporary sediment basin. All ponds and water quality features will discharge at less than historic rates.

The proposed improvements from southern property line of the proposed Grandview Reserve south to Londonderry Drive include resurfacing the existing temporary pavement by providing full-depth pavement to replace the temporary pavement along this length of roadway. This is anticipated to be an interim condition until the completion of the full roadway section by others. The proposed interim roadway will be consistent with the Modified Rural Major Collector Roadway Cross-Section, with two 12' wide lanes and 4' shoulders, with existing roadside swales on both sides. The total width of the roadway is 32' including both shoulders, which adds 6' of pavement to the existing 26' temporary pavement roadway. Per ECM Appendix I.7.1.B.2.2, this area of the project is excluded from the requirements of Section 1.7 since the site does not add more than 8.25' of paved width at any location of the existing roadway. This includes Basins EA13-EA15.

### b. Water Quality & Detention

#### **Pond A (Sand Filter)**

Water quality for Basins EA1, EA2 & EA5 is provided in Pond A; a water quality sand filter. A total of 0.63 acres at 54.0% composite imperviousness will be treated. The WQCV is 523 ft<sup>3</sup> and is released in 12 hours. A 12" PVC underdrain with 5/8" orifices will run beneath the filter material to facilitate the discharge to Channel B. The sand filter design calculations are presented in Appendix D.

#### **Pond B (Full Spectrum Detention Basin)**

Water quality and detention for Basins EA8 – EA12 is provided in Pond B; a private, full spectrum detention pond within Filing 1 of Grandview Reserve. A total of 9.32 acres at 70% composite imperviousness will be detained. The WQCV is 0.215 ac-ft, the EURV is 0.832 ac-ft, and the 100-year volume is 1.230 ac-ft. The WQCV, EURV and 100-year storms are released in 40, 72 and 76 hours, respectively. A forebay is located at the outfall into the pond and a 2.0' trickle channel conveys flow towards the outlet structure. A 10' access and maintenance road is provided to the bottom of the pond to facilitate maintenance of the pond facilities. A 6' emergency overflow spillway is provided that conveys the developed, peak 100-yr flow rate with 2.0' of freeboard towards Channel A.

#### **Temporary Sediment Basin #1 (TSB #1)**

Basin EA6 and EA7 will be detained in a temporary sediment basin (TSB #1) at the end of the Rex Road improvements, in the interim condition. When Rex Road develops further to the east, a permanent, full

spectrum extended detention basin will be required. TSB #1 detains 1.35 acres at 90% composite imperviousness. A Type L riprap emergency spillway is provided with a crest length of 5.0' and a 1.0' of freeboard. The WQCV, EURV and 100-year volume are released in 40, 67 and 71 hours respectively. TSB #1 releases at less than historic rates for the design storms.

### **c. Inspection and Maintenance**

After completion of construction and upon the Board of County Commissioners acceptance, it is anticipated that all drainage facilities within the public Right-of-Way are to be owned and maintained by El Paso County.

All private detention ponds are to be owned and maintained by the Grandview Reserve Metropolitan District NO. 2 (DISTRICT), once established, unless an agreement is reached stating otherwise. Maintenance access for all full spectrum detention facilities will be provided from public Right-of-Way. Maintenance access for the drainageways will be provided through the proposed tracts.

## **V. Wetlands Mitigation**

There is an existing wetland in Gieck Ranch Tributary #1 (Channel A). The wetland is contained entirely within the channel and is classified as jurisdictional. A Nationwide Wetland Permit will be applied for due to the disturbed area at the Dawlish Roundabout. Wetlands maintenance will be the responsibility of the DISTRICT.

## **VI. Four Step Method to Minimize Adverse Impacts of Urbanization**

Step 1 – Reducing Runoff Volumes: Low impact development (LID) practices are utilized to reduce runoff at the source. In general, stormwater discharges are routed across pervious areas prior to capture in storm sewer. This practice promotes infiltration and reduces peak runoff rates. The Impervious Reduction Factor (IRF) method was used and is presented in Appendix D.

Step 2 – Treat and slowly release the WQCV: This step utilizes full spectrum water quality and detention to capture the WQCV and slowly release runoff from the site. Onsite full spectrum detention pond provides water quality treatment for the site. The WQCV is released over a period of 40 hours while the EURV is release over a period of 72 hours.

Step 3 – Stabilize stream channels: This step establishes practices to stabilize drainageways and provide scour protection at stormwater outfalls. Erosion protection is provided at all concentrated stormwater discharge points in the form of riprap pads.

Step 4 – Consider the need for source controls: No industrial or commercial uses are proposed within this development and therefore no source controls are proposed.

## **VII. Drainage and Bridge Fees**

Gieck Ranch drainage basin has not been established as a fee basin within El Paso County. Therefore, no drainage basin fees are due at time of platting.

## VIII. Opinion of Probable Cost

An engineer's opinion of probable cost will be provided with subsequent submittals of the Final Drainage Report.

## IX. Hydraulic Grade Line Analysis

Hydraulic grade line analysis and final pipe sizes will be presented in a subsequent submittal of the Final Drainage Report.

## X. Summary

Eastonville Road lies within the Gieck Ranch Drainage Basin. Water quality and detention for the site is provided in full spectrum water quality and detention ponds, sand filters and temporary sediment basins. There is one major drainageway that traverses the site: Gieck Ranch Tributary 1. The water quality and detention features ponds will be maintained by the Grandview Reserve Metropolitan District No. 2 (DISTRICT). All drainage facilities were sized per the El Paso County Drainage Criteria Manuals.

Based on following EPC methodology for hydrology in the existing and proposed conditions, the development of this project will not adversely affect downstream properties.

## XI. Drawings

Please refer to the appendices for vicinity and drainage basin maps.

## XII. References

1. City of Colorado Springs – Drainage Criteria Manual, May 2014, Revised January 2021.
2. Drainage Criteria Manual of El Paso, Colorado, October 2018.
3. Urban Storm Drainage Criteria Manual, Urban Drainage Flood Control District, January 2018.
4. "Gieck Ranch Drainage Basin Planning Study" prepared by Drexel, Barrel & Co, February 2010.
5. "Master Development Drainage Plan Meridian Ranch" prepared by Tech Contractors, July 2021.
6. "The Sanctuary Filing 1 at Meridian Ranch" prepared by Tech Contractors, August 2022.



## **APPENDIX A – VICINITY MAP, PHOTOS, SOIL MAP, FEMA MAP**