APPENDIX D – WATER QUALITY & DETENTION

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

				Designer:	**NQJ**
				Company:	**HR GREEN**
***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches	**Date:**	**September 2, 2022**
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches	**Project:**	**EASTONVILLE ROAD**
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches	**Location:**	**POND A**
Optional User Defined Storm	CUHP				
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event				
Max Intensity for Optional User Defined Storm	0				

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**EA1**	**EA2**	**EA5**											
Receiving Pervious Area Soil Type	Sandy Loam	Sandy Loam	Sandy Loam											
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	0.220	0.250	0.160											
Directly Connected Impervious Area (DCIA, acres)	0.160	0.180	0.000											
Unconnected Impervious Area (UIA, acres)	0.000	0.000	0.000											
Receiving Pervious Area (RPA, acres)	0.000	0.000	0.160											
Separate Pervious Area (SPA, acres)	0.060	0.070	0.000											
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C	C	V											

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	0.220	0.250	0.160											
Directly Connected Impervious Area (DCIA, %)	72.7%	72.0%	0.0%											
Unconnected Impervious Area (UIA, %)	0.0%	0.0%	0.0%											
Receiving Pervious Area (RPA, %)	0.0%	0.0%	100.0%											
Separate Pervious Area (SPA, %)	27.3%	28.0%	0.0%											
A_R (RPA / UIA)	0.000	0.000	0.000											
I_a Check	1.000	1.000	1.000											
f / I for WQCV Event:	1.7	1.7	1.7											
f / I for 5-Year Event:	0.5	0.5	0.5											
f / I for 100-Year Event:	0.3	0.3	0.3											
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	1.00	1.00	0.00											
IRF for 5-Year Event:	1.00	1.00	1.00											
IRF for 100-Year Event:	1.00	1.00	1.00											
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	72.7%	72.0%	0.0%											
Effective Imperviousness for WQCV Event:	72.7%	72.0%	0.0%											
Effective Imperviousness for 5-Year Event:	72.7%	72.0%	0.0%											
Effective Imperviousness for 100-Year Event:	72.7%	72.0%	0.0%											
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	0.0%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	0.1%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	**54.0%**
Total Site Effective Imperviousness for WQCV Event:	**54.0%**
Total Site Effective Imperviousness for 5-Year Event:	**54.0%**
Total Site Effective Imperviousness for 100-Year Event:	**54.0%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.07, March 2018)

Designer: NQJ
Company: HR GREEN
Date: August 31, 2022
Project: EASTONVILLE ROAD
Location: EL PASO COUNTY, COLORADO

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of sand filter)	I_a = 24.1 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.241
C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time $WQCV = 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)$	WQCV = 0.11 watershed inches
D) Contributing Watershed Area (including sand filter area)	Area = 61,420 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume $V_{WQCV} = WQCV / 12 * Area$	V_{WQCV} = cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = 523 cu ft
2. Basin Geometry	
A) WQCV Depth	D_{WQCV} = 1.5 ft
B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.	Z = 4.00 ft / ft
C) Minimum Filter Area (Flat Surface Area)	A_{Min} = 185 sq ft
D) Actual Filter Area	A_{Actual} = 703 sq ft
E) Volume Provided	V_T = cu ft
3. Filter Material	Choose One: (•) 18" CDOT Class B or C Filter Material; ( ) Other (Explain):
4. Underdrain System	
A) Are underdrains provided?	Choose One: (•) YES; ( ) NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = 1.0 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 523 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 5/8 in

Design Procedure Form: Sand Filter (SF)

Designer: NQJ
Company: HR GREEN
Date: August 31, 2022
Project: EASTONVILLE ROAD
Location: EL PASO COUNTY, COLORADO

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

Notes:

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

				Designer:	**NQJ**
				Company:	**HR GREEN**
***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches	**Date:**	**August 31, 2022**
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches	**Project:**	**EASTONVILLE ROAD**
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches	**Location:**	**POND B**
Optional User Defined Storm	CUHP				
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event				
Max Intensity for Optional User Defined Storm	0				

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**EA8**	**EA9**	**EA10**	**EA11**	**EA12**									
Receiving Pervious Area Soil Type	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam									
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	2.080	2.990	1.340	1.990	0.920									
Directly Connected Impervious Area (DCIA, acres)	2.060	1.880	1.260	1.300	0.020									
Unconnected Impervious Area (UIA, acres)	0.000	0.000	0.000	0.000	0.000									
Receiving Pervious Area (RPA, acres)	0.000	0.000	0.000	0.000	0.000									
Separate Pervious Area (SPA, acres)	0.020	1.110	0.080	0.690	0.900									
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C	C	C	C	V									

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	2.080	2.990	1.340	1.990	0.920									
Directly Connected Impervious Area (DCIA, %)	99.0%	62.9%	94.0%	65.3%	2.2%									
Unconnected Impervious Area (UIA, %)	0.0%	0.0%	0.0%	0.0%	0.0%									
Receiving Pervious Area (RPA, %)	0.0%	0.0%	0.0%	0.0%	0.0%									
Separate Pervious Area (SPA, %)	1.0%	37.1%	6.0%	34.7%	97.8%									
A_R (RPA / UIA)	0.000	0.000	0.000	0.000	0.000									
I_a Check	1.000	1.000	1.000	1.000	1.000									
f / I for WQCV Event:	1.7	1.7	1.7	1.7	1.7									
f / I for 5-Year Event:	0.5	0.5	0.5	0.5	0.5									
f / I for 100-Year Event:	0.3	0.3	0.3	0.3	0.3									
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	1.00	1.00	1.00	1.00	0.00									
IRF for 5-Year Event:	1.00	1.00	1.00	1.00	1.00									
IRF for 100-Year Event:	1.00	1.00	1.00	1.00	1.00									
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	99.0%	62.9%	94.0%	65.3%	2.2%									
Effective Imperviousness for WQCV Event:	99.0%	62.9%	94.0%	65.3%	2.2%									
Effective Imperviousness for 5-Year Event:	99.0%	62.9%	94.0%	65.3%	2.2%									
Effective Imperviousness for 100-Year Event:	99.0%	62.9%	94.0%	65.3%	2.2%									
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	0.0%	0.0%	0.0%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	0.0%	0.0%	0.0%	11.6%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	**70.0%**
Total Site Effective Imperviousness for WQCV Event:	**70.0%**
Total Site Effective Imperviousness for 5-Year Event:	**70.0%**
Total Site Effective Imperviousness for 100-Year Event:	**70.0%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

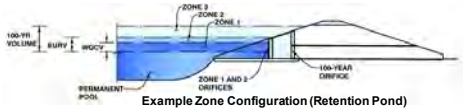
*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: Eastonville Road

Basin ID: POND B: BASIN EA8 - EA12



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	9.32	acres
Watershed Length =	1,750	ft
Watershed Length to Centroid =	500	ft
Watershed Slope =	0.009	ft/ft
Watershed Imperviousness =	70.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.214 acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.827 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.605 acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.790 acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.938 acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.124 acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.306 acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.525 acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.68 in.) =	2.435 acre-feet	3.68	inches
Approximate 2-yr Detention Volume =	0.539 acre-feet		
Approximate 5-yr Detention Volume =	0.704 acre-feet		
Approximate 10-yr Detention Volume =	0.846 acre-feet		
Approximate 25-yr Detention Volume =	1.013 acre-feet		
Approximate 50-yr Detention Volume =	1.112 acre-feet		
Approximate 100-yr Detention Volume =	1.212 acre-feet		

Define Zones and Basin Geometry

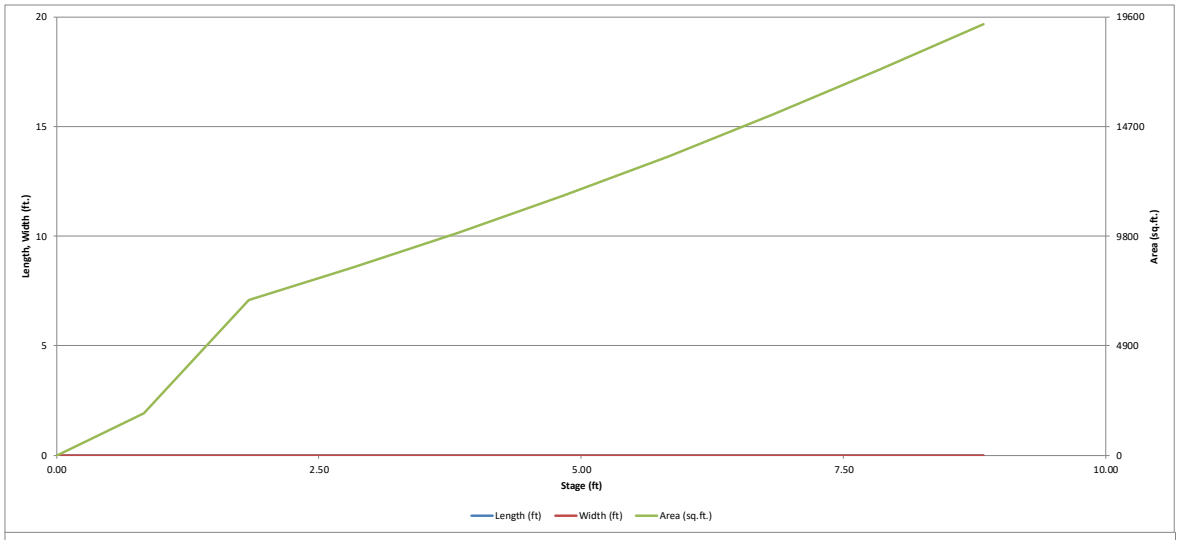
Zone 1 Volume (WQCV) =	0.214	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.613	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.385	acre-feet
Total Detention Basin Volume =	1.212	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

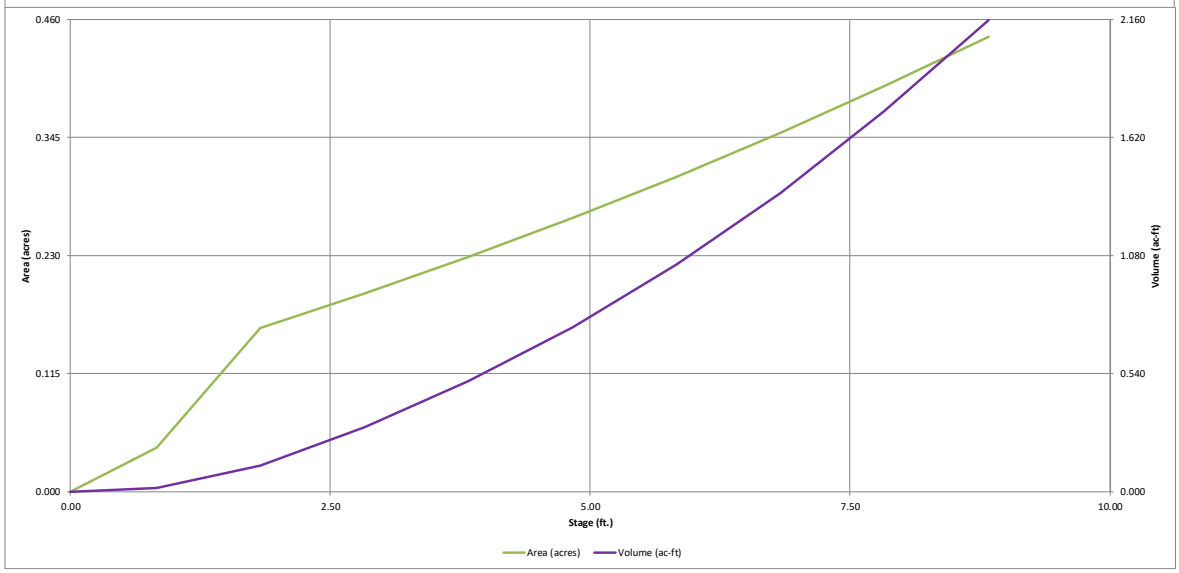
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
6983.17 **Top of Micropool**	--	0.00	--	--	--	0	0.000		
6984	--	0.83	--	--	--	1,862	0.043	773	0.018
6985	--	1.83	--	--	--	6,937	0.159	5,172	0.119
6986	--	2.83	--	--	--	8,399	0.193	12,840	0.295
6987	--	3.83	--	--	--	9,955	0.229	22,017	0.505
6988	--	4.83	--	--	--	11,608	0.266	32,799	0.753
6989	--	5.83	--	--	--	13,342	0.306	45,274	1.039
6990	--	6.83	--	--	--	15,238	0.350	59,564	1.367
6991	--	7.83	--	--	--	17,212	0.395	75,789	1.740
6992	--	8.83	--	--	--	19,304	0.443	94,047	2.159

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)



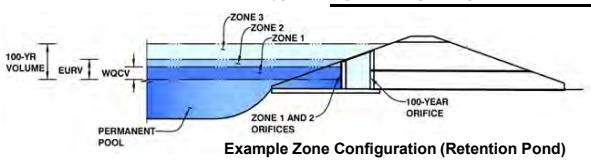


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: **Eastonville Road**

Basin ID: **POND B: BASIN EA8 - EA12**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.40	0.214	Orifice Plate
Zone 2 (EURV)	5.11	0.613	Circular Orifice
Zone 3 (100-year)	6.38	0.385	Weir&Pipe (Restrict)
Total (all zones)		1.212	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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 =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	6.319E-03	ft^2
Depth at top of Zone using Orifice Plate =	2.40	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	9.60	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.91	sq. inches (diameter = 1-1/16 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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	0.80	1.60					
Orifice Area (sq. inches)	0.91	0.91	0.91					

	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 Circular	Not Selected			Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	2.40	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.01	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	5.11	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.06	N/A	feet
Vertical Orifice Diameter =	1.45	N/A	inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.11	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.11	N/A	feet
Overflow Weir Front Edge Length =	2.00	N/A	feet	Overflow Weir Slope Length =	2.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	12.01	N/A	
Horiz. Length of Weir Sides =	2.00	N/A	feet	Overflow Grate Open Area w/o Debris =	2.78	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	1.39	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.17	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.23	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.17	N/A	feet
Restrictor Plate Height Above Pipe Invert =	3.40		inches	Half-Central Angle of Restrictor Plate on Pipe =	0.90	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.40	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.81	feet
Spillway Crest Length =	6.00	feet	Stage at Top of Freeboard =	8.21	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.41	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.89	acre-ft

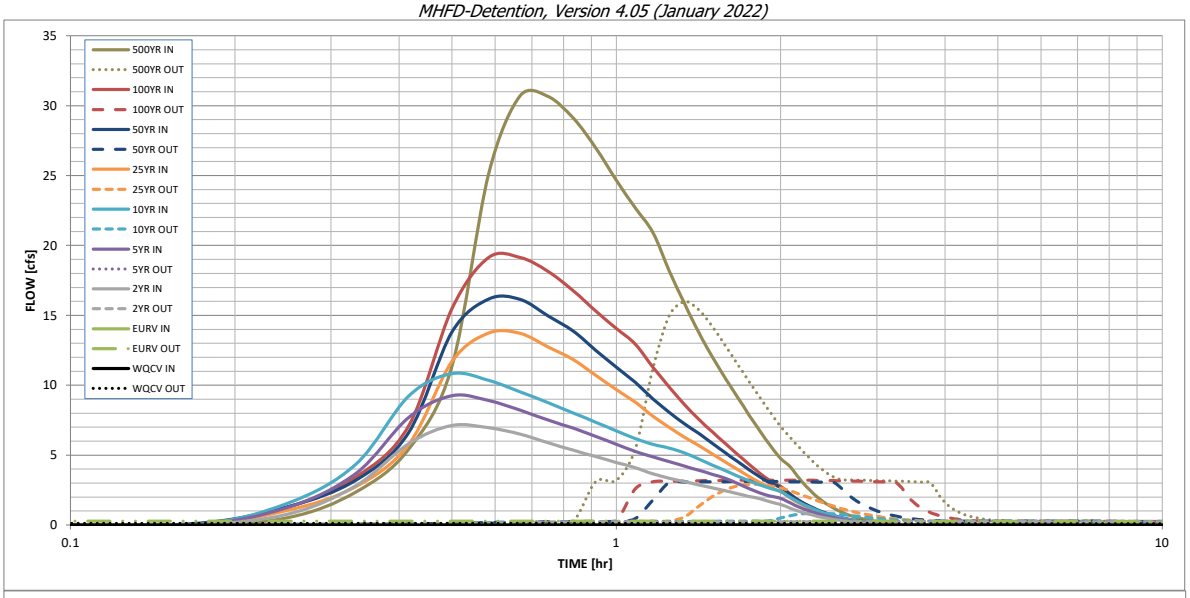
Calculated Parameters for Spillway

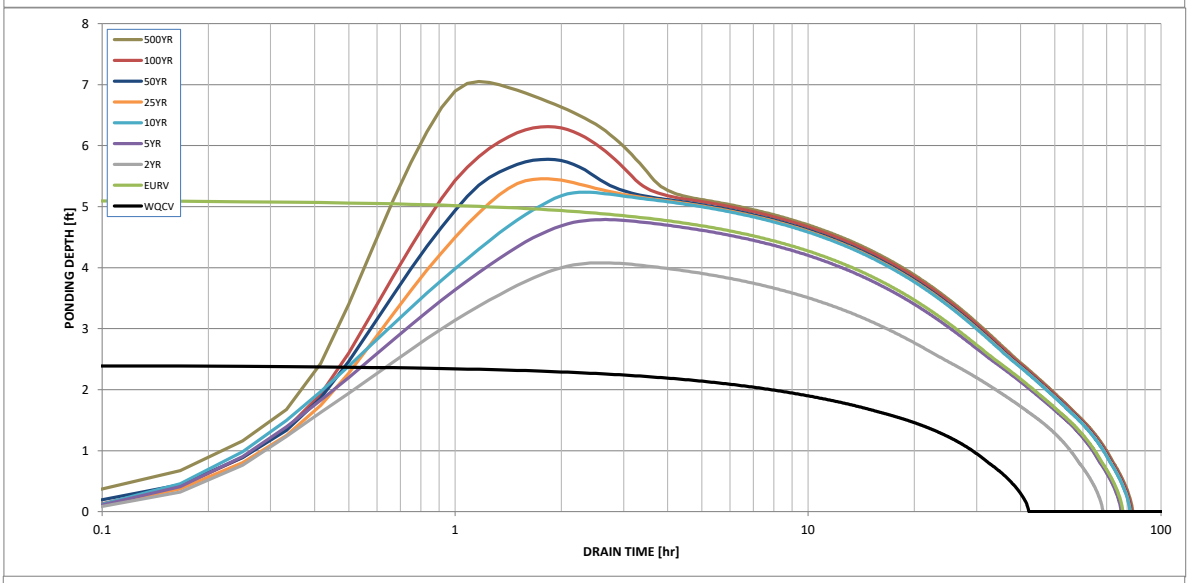
Routed Hydrograph Results *The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

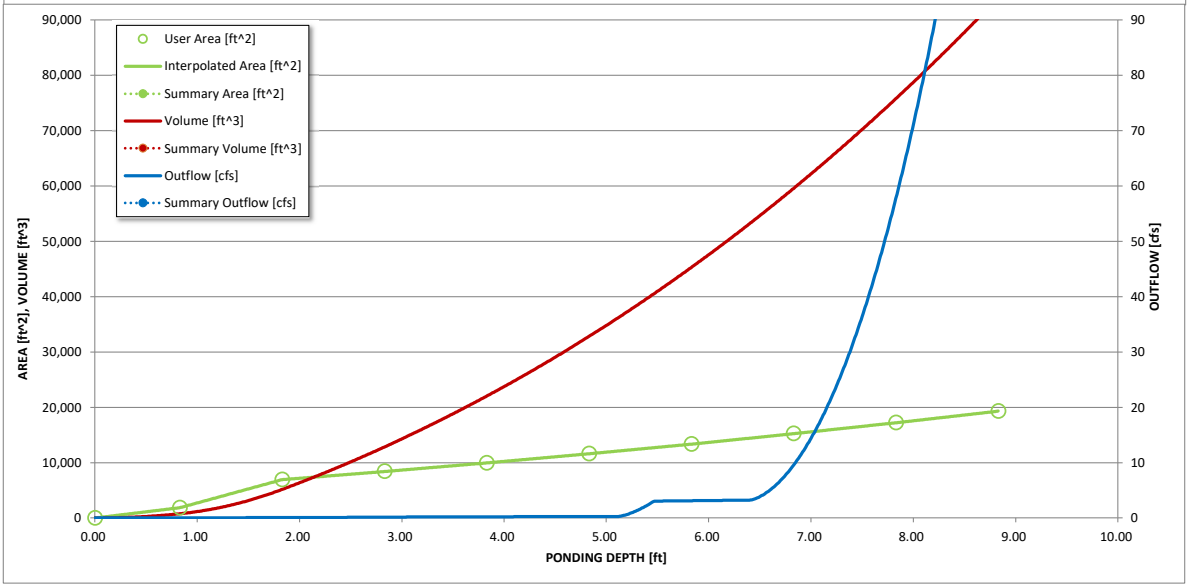
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.214	0.827	0.605	0.790	0.938	1.124	1.306	1.525	2.435
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.605	0.790	0.938	1.124	1.306	1.525	2.435
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.1	0.1	1.0	2.1	3.4	9.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.01	0.11	0.22	0.37	0.99
Peak Inflow Q (cfs) =	N/A	N/A	7.1	9.2	10.8	13.7	16.2	19.1	30.7
Peak Outflow Q (cfs) =	0.1	0.3	0.2	0.3	0.9	2.9	3.1	3.2	16.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	3.3	7.6	2.8	1.5	0.9	1.7
Structure Controlling Flow =	Plate	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.2	1.0	1.0	1.0	1.1
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) =	37	65	58	65	68	67	66	65	60
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	64	71	75	75	74	74	71
Maximum Ponding Depth (ft) =	2.40	5.11	4.08	4.79	5.24	5.46	5.77	6.31	7.05
Area at Maximum Ponding Depth (acres) =	0.18	0.28	0.24	0.26	0.28	0.29	0.30	0.33	0.36
Maximum Volume Stored (acre-ft) =	0.215	0.829	0.561	0.740	0.863	0.926	1.021	1.188	1.442

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 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.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	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	0.09	0.01	0.52
	0:15:00	0.00	0.00	0.78	1.26	1.56	1.05	1.32	1.28	2.36
	0:20:00	0.00	0.00	2.81	3.70	4.35	2.75	3.22	3.43	5.43
	0:25:00	0.00	0.00	5.83	7.70	9.23	5.78	6.63	7.10	11.35
	0:30:00	0.00	0.00	7.12	9.25	10.83	11.69	13.81	15.47	25.15
	0:35:00	0.00	0.00	6.95	8.90	10.35	13.73	16.17	19.13	30.70
	0:40:00	0.00	0.00	6.51	8.21	9.53	13.71	16.14	19.14	30.65
	0:45:00	0.00	0.00	5.88	7.50	8.74	12.73	14.96	18.14	29.11
	0:50:00	0.00	0.00	5.35	6.93	8.01	11.84	13.87	16.77	26.99
	0:55:00	0.00	0.00	4.90	6.34	7.36	10.71	12.50	15.31	24.66
	1:00:00	0.00	0.00	4.48	5.78	6.74	9.69	11.28	14.06	22.69
	1:05:00	0.00	0.00	4.09	5.27	6.19	8.78	10.21	12.95	20.93
	1:10:00	0.00	0.00	3.66	4.87	5.77	7.79	9.03	11.29	18.18
	1:15:00	0.00	0.00	3.35	4.54	5.50	6.99	8.07	9.87	15.83
	1:20:00	0.00	0.00	3.10	4.21	5.16	6.28	7.24	8.61	13.76
	1:25:00	0.00	0.00	2.87	3.91	4.72	5.69	6.55	7.57	12.02
	1:30:00	0.00	0.00	2.66	3.63	4.29	5.08	5.83	6.66	10.52
	1:35:00	0.00	0.00	2.46	3.36	3.89	4.51	5.17	5.84	9.16
	1:40:00	0.00	0.00	2.25	2.97	3.51	3.98	4.55	5.06	7.89
	1:45:00	0.00	0.00	2.05	2.60	3.16	3.48	3.97	4.34	6.71
	1:50:00	0.00	0.00	1.88	2.29	2.86	3.03	3.44	3.70	5.65
	1:55:00	0.00	0.00	1.64	2.07	2.62	2.65	2.99	3.15	4.76
	2:00:00	0.00	0.00	1.46	1.91	2.40	2.39	2.69	2.76	4.16
	2:05:00	0.00	0.00	1.20	1.57	1.98	1.93	2.17	2.20	3.30
	2:10:00	0.00	0.00	0.97	1.27	1.61	1.54	1.73	1.73	2.58
	2:15:00	0.00	0.00	0.79	1.03	1.30	1.23	1.38	1.36	2.02
	2:20:00	0.00	0.00	0.63	0.83	1.05	0.98	1.10	1.06	1.57
	2:25:00	0.00	0.00	0.50	0.66	0.84	0.78	0.87	0.83	1.21
	2:30:00	0.00	0.00	0.40	0.52	0.66	0.61	0.69	0.64	0.93
	2:35:00	0.00	0.00	0.32	0.41	0.51	0.48	0.53	0.50	0.72
	2:40:00	0.00	0.00	0.25	0.32	0.40	0.37	0.41	0.39	0.56
	2:45:00	0.00	0.00	0.19	0.24	0.31	0.28	0.32	0.30	0.44
	2:50:00	0.00	0.00	0.15	0.19	0.24	0.22	0.25	0.24	0.34
	2:55:00	0.00	0.00	0.11	0.14	0.18	0.17	0.19	0.18	0.26
	3:00:00	0.00	0.00	0.08	0.10	0.13	0.12	0.14	0.13	0.19
	3:05:00	0.00	0.00	0.05	0.07	0.09	0.09	0.10	0.09	0.13
	3:10:00	0.00	0.00	0.03	0.04	0.05	0.05	0.06	0.06	0.08
	3:15:00	0.00	0.00	0.02	0.02	0.03	0.03	0.03	0.03	0.04
	3:20:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	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

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft ^{2}]	Area [acres]	Volume [ft ^{3}]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

				Designer:	**NQJ**
				Company:	**HR GREEN**
***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches	**Date:**	**September 1, 2022**
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches	**Project:**	**EASTONVILLE ROAD**
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches	**Location:**	**TSB #1**
Optional User Defined Storm	CUHP				
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event				
Max Intensity for Optional User Defined Storm	0				

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**EA6**	**EA7**												
Receiving Pervious Area Soil Type	Sandy Loam	Sandy Loam												
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	0.700	0.650												
Directly Connected Impervious Area (DCIA, acres)	0.700	0.580												
Unconnected Impervious Area (UIA, acres)	0.000	0.000												
Receiving Pervious Area (RPA, acres)	0.000	0.000												
Separate Pervious Area (SPA, acres)	0.000	0.070												
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C	C												

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	0.700	0.650												
Directly Connected Impervious Area (DCIA, %)	100.0%	89.2%												
Unconnected Impervious Area (UIA, %)	0.0%	0.0%												
Receiving Pervious Area (RPA, %)	0.0%	0.0%												
Separate Pervious Area (SPA, %)	0.0%	10.8%												
A_R (RPA / UIA)	0.000	0.000												
I_a Check	1.000	1.000												
f / I for WQCV Event:	1.7	1.7												
f / I for 5-Year Event:	0.5	0.5												
f / I for 100-Year Event:	0.3	0.3												
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	1.00	1.00												
IRF for 5-Year Event:	1.00	1.00												
IRF for 100-Year Event:	1.00	1.00												
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	100.0%	89.2%												
Effective Imperviousness for WQCV Event:	100.0%	89.2%												
Effective Imperviousness for 5-Year Event:	100.0%	89.2%												
Effective Imperviousness for 100-Year Event:	100.0%	89.2%												
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	0.0%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	**94.8%**
Total Site Effective Imperviousness for WQCV Event:	**94.8%**
Total Site Effective Imperviousness for 5-Year Event:	**94.8%**
Total Site Effective Imperviousness for 100-Year Event:	**94.8%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

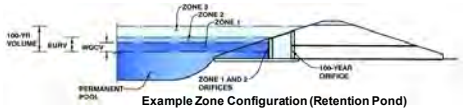
*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: EASTONVILLE ROAD

Basin ID: TSB #1



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	1.35	acres
Watershed Length =	500	ft
Watershed Length to Centroid =	50	ft
Watershed Slope =	0.010	ft/ft
Watershed Imperviousness =	94.80%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	0.050	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.177	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.114	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.146	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.172	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	0.200	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.227	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.256	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.68 in.) =	0.383	acre-feet	3.68 inches
Approximate 2-yr Detention Volume =	0.117	acre-feet	
Approximate 5-yr Detention Volume =	0.151	acre-feet	
Approximate 10-yr Detention Volume =	0.179	acre-feet	
Approximate 25-yr Detention Volume =	0.210	acre-feet	
Approximate 50-yr Detention Volume =	0.228	acre-feet	
Approximate 100-yr Detention Volume =	0.244	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.050	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.050	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Total detention volume is less than 100-year volume.

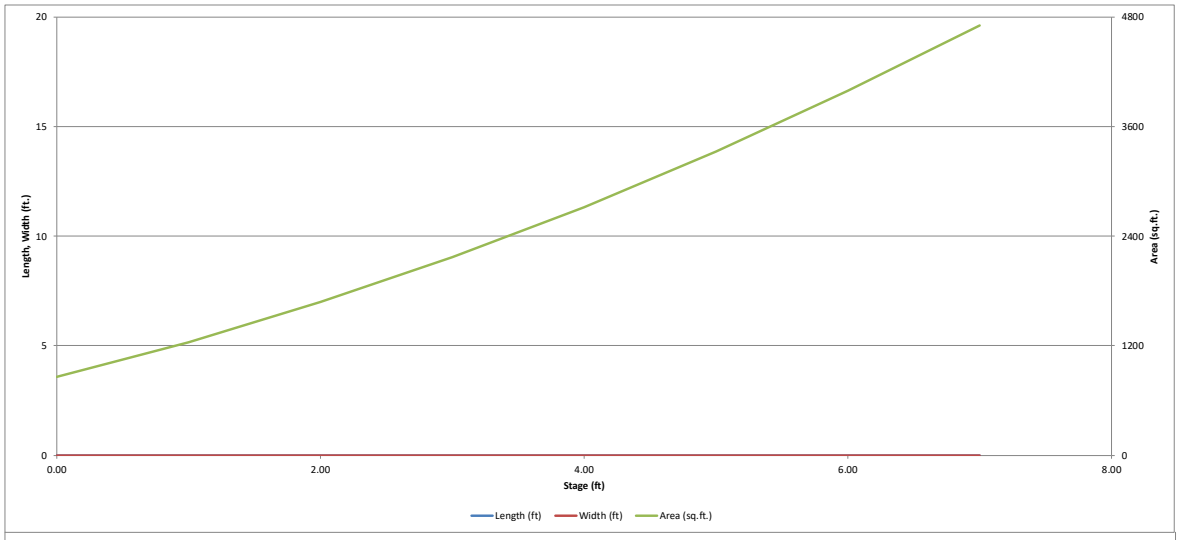
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

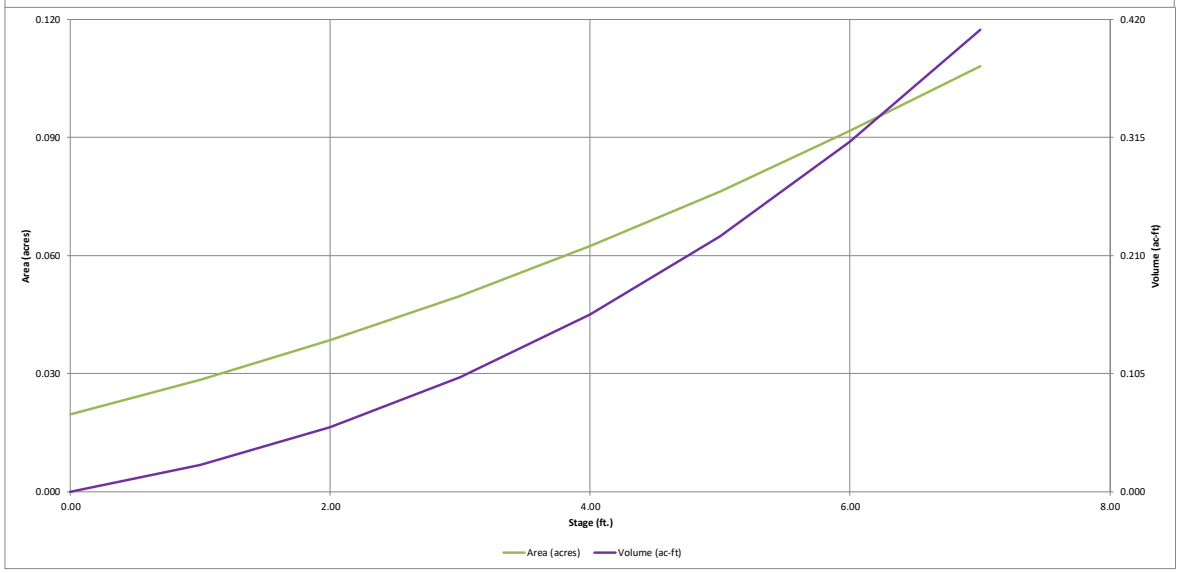
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
7009 **Top of Micropool**	--	0.00	--	--	--	860	0.020		
7010	--	1.00	--	--	--	1,239	0.028	1,049	0.024
7011	--	2.00	--	--	--	1,676	0.038	2,507	0.058
7012	--	3.00	--	--	--	2,169	0.050	4,429	0.102
7013	--	4.00	--	--	--	2,718	0.062	6,873	0.158
7014	--	5.00	--	--	--	3,323	0.076	9,893	0.227
7015	--	6.00	--	--	--	3,992	0.092	13,551	0.311
	--	7.00	--	--	--	4,711	0.108	17,902	0.411

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



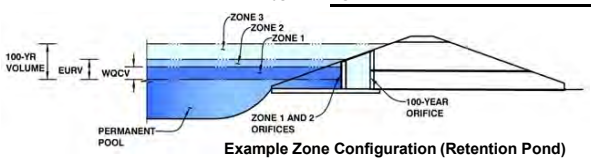


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: EASTONVILLE ROAD

Basin ID: TSB #1



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.81	0.050	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.050	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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 =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orific		
Depth at top of Zone using Orifice Plate =	2.42	ft (relative to basin bottom at Stage = 0 ft)	Ellip		
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptic		
Orifice Plate: Orifice Area per Row =	0.46	sq. inches (diameter = 3/4 inch)	Ell		

SEDIMENT BASIN WILL USE RISER PIPE WITH CORRESPONDING ORIFICES

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	0.81	1.75	2.25				
Orifice Area (sq. inches)	0.46	0.46	0.46	0.46				

	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			Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

Calculated Parameters for Vertical Orifice

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

	Not Selected	Not Selected			Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =			feet
Overflow Weir Front Edge Length =			feet	Overflow Weir Slope Length =			feet
Overflow Weir Grate Slope =			H:V	Grate Open Area / 100-yr Orifice Area =			
Horiz. Length of Weir Sides =			feet	Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Type =				Overflow Grate Open Area w/ Debris =			ft^2
Debris Clogging % =			%				

Calculated Parameters for Overflow Weir

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

	Not Selected	Not Selected			Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =			ft^2
Circular Orifice Diameter =			inches	Outlet Orifice Centroid =			feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.10	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.43	feet
Spillway Crest Length =	5.00	feet	Stage at Top of Freeboard =	6.53	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.10	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.36	acre-ft

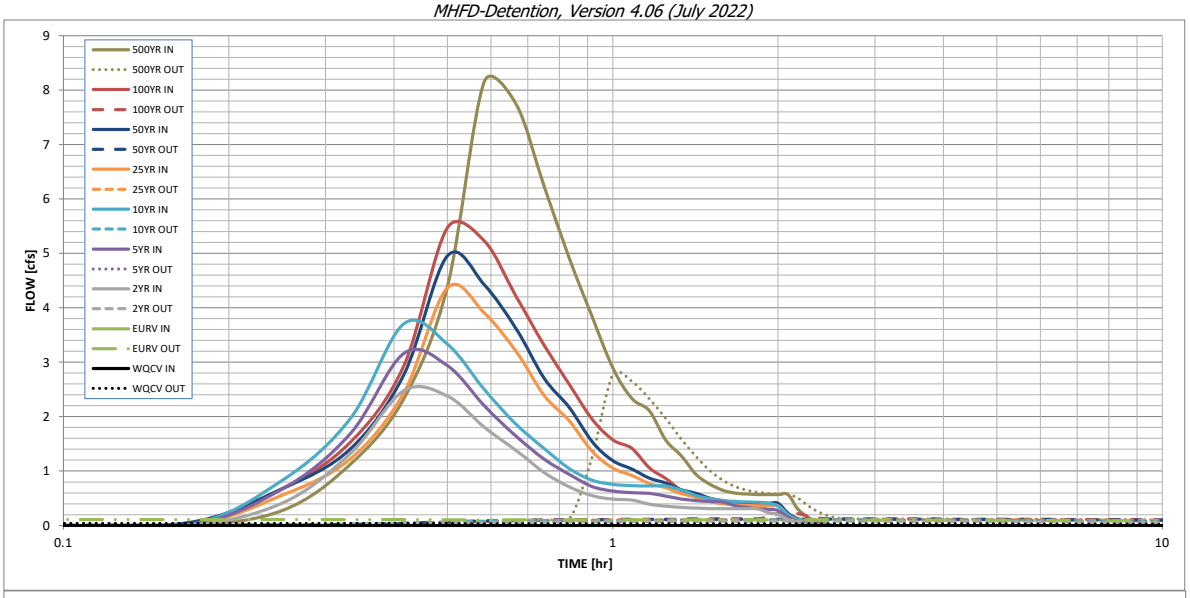
Calculated Parameters for Spillway

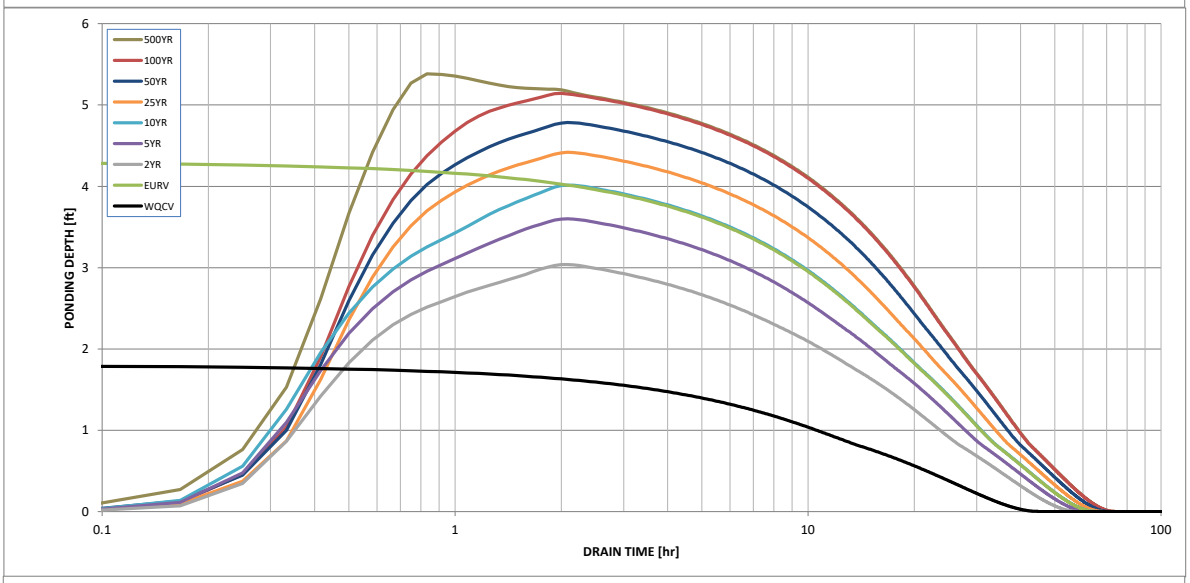
Routed Hydrograph Results *The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

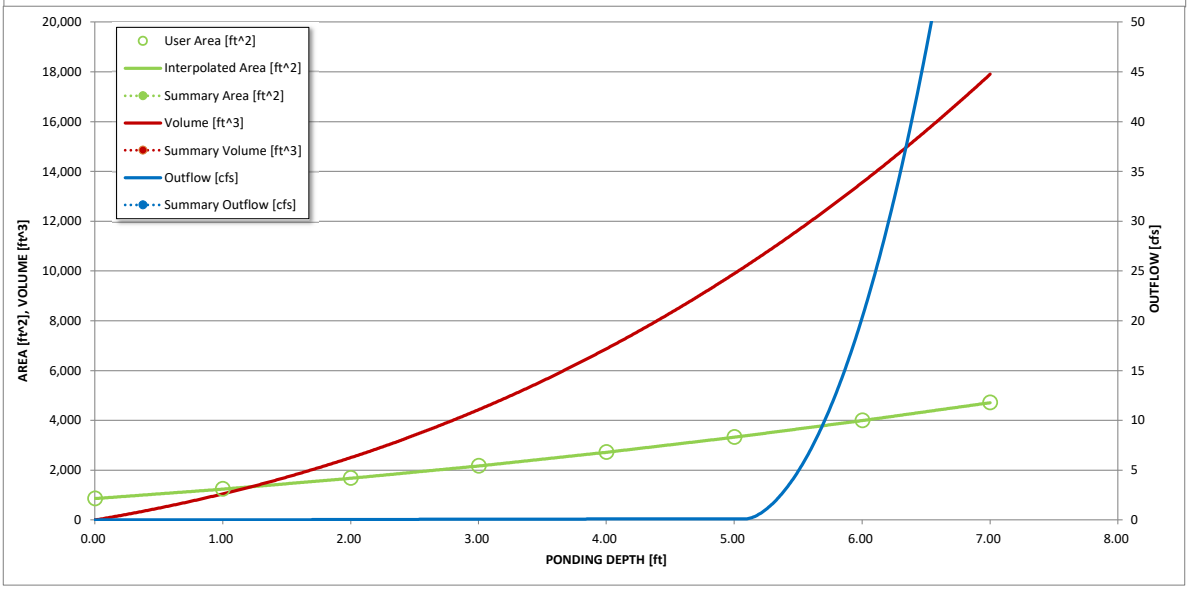
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.68
CUHP Runoff Volume (acre-ft) =	0.050	0.177	0.114	0.146	0.172	0.200	0.227	0.256	0.383
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.114	0.146	0.172	0.200	0.227	0.256	0.383
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.0	0.0	0.3	0.6	1.0	2.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.03	0.24	0.46	0.75	1.88
Peak Inflow Q (cfs) =	N/A	N/A	2.5	3.2	3.7	4.4	5.0	5.5	8.2
Peak Outflow Q (cfs) =	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	2.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	3.6	2.8	0.3	0.2	0.2	1.1
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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) =	37	49	45	48	50	51	53	54	50
Time to Drain 99% of Inflow Volume (hours) =	**40**	56	51	54	56	59	61	63	60
Maximum Ponding Depth (ft) =	1.80	4.30	3.04	3.60	4.01	4.42	4.78	5.14	5.38
Area at Maximum Ponding Depth (acres) =	0.04	0.07	0.05	0.06	0.06	0.07	0.07	0.08	0.08
Maximum Volume Stored (acre-ft) =	0.050	0.177	0.103	0.133	0.158	0.185	0.211	0.238	0.257

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.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	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	0.05	0.00	0.27
	0:15:00	0.00	0.00	0.41	0.67	0.83	0.55	0.67	0.67	1.13
	0:20:00	0.00	0.00	1.32	1.69	1.97	1.23	1.41	1.53	2.33
	0:25:00	0.00	0.00	2.48	3.16	3.71	2.44	2.77	2.94	4.39
	0:30:00	0.00	0.00	2.38	2.94	3.33	4.37	4.96	5.47	8.15
	0:35:00	0.00	0.00	1.81	2.20	2.50	3.91	4.43	5.23	7.75
	0:40:00	0.00	0.00	1.38	1.64	1.86	3.20	3.62	4.22	6.24
	0:45:00	0.00	0.00	0.97	1.22	1.42	2.39	2.71	3.32	4.91
	0:50:00	0.00	0.00	0.71	0.94	1.05	1.92	2.17	2.59	3.84
	0:55:00	0.00	0.00	0.55	0.72	0.83	1.37	1.54	1.95	2.90
	1:00:00	0.00	0.00	0.49	0.63	0.76	1.05	1.19	1.58	2.34
	1:05:00	0.00	0.00	0.47	0.60	0.73	0.92	1.04	1.42	2.10
	1:10:00	0.00	0.00	0.39	0.59	0.73	0.77	0.87	1.05	1.56
	1:15:00	0.00	0.00	0.35	0.54	0.72	0.69	0.78	0.86	1.28
	1:20:00	0.00	0.00	0.33	0.49	0.65	0.58	0.66	0.64	0.94
	1:25:00	0.00	0.00	0.32	0.46	0.55	0.53	0.59	0.52	0.76
	1:30:00	0.00	0.00	0.31	0.44	0.50	0.45	0.50	0.44	0.65
	1:35:00	0.00	0.00	0.31	0.43	0.46	0.40	0.45	0.41	0.60
	1:40:00	0.00	0.00	0.31	0.37	0.44	0.38	0.43	0.39	0.58
	1:45:00	0.00	0.00	0.31	0.33	0.43	0.37	0.41	0.39	0.57
	1:50:00	0.00	0.00	0.31	0.31	0.43	0.36	0.41	0.39	0.57
	1:55:00	0.00	0.00	0.24	0.30	0.41	0.36	0.41	0.39	0.57
	2:00:00	0.00	0.00	0.20	0.28	0.36	0.36	0.41	0.39	0.57
	2:05:00	0.00	0.00	0.11	0.15	0.20	0.20	0.22	0.22	0.31
	2:10:00	0.00	0.00	0.06	0.08	0.11	0.11	0.12	0.12	0.17
	2:15:00	0.00	0.00	0.03	0.04	0.05	0.06	0.06	0.06	0.09
	2:20:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.04
	2:25:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft ^{2}]	Area [acres]	Volume [ft ^{3}]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).