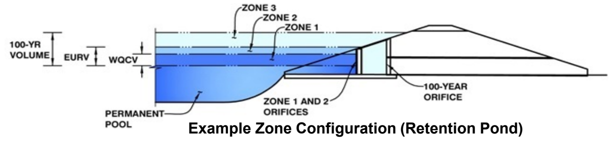
Project: **Paintbrush Hills Scenic View Detention Pond**

Basin ID: **Pond #2**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	19.72	acres
Watershed Length =	1,000	ft
Watershed Length to Centroid =	500	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	60.50%	percent
Percentage Hydrologic Soil Group A =	2.0%	percent
Percentage Hydrologic Soil Group B =	98.0%	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) =	0.391	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.298	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.94 in.) =	0.843	acre-feet	0.94	inches
5-yr Runoff Volume (P1 = 1.22 in.) =	1.180	acre-feet	1.22	inches
10-yr Runoff Volume (P1 = 1.47 in.) =	1.534	acre-feet	1.47	inches
25-yr Runoff Volume (P1 = 1.85 in.) =	2.204	acre-feet	1.85	inches
50-yr Runoff Volume (P1 = 2.17 in.) =	2.715	acre-feet	2.17	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.340	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	4.364	acre-feet		inches
Approximate 2-yr Detention Volume =	0.786	acre-feet		
Approximate 5-yr Detention Volume =	1.092	acre-feet		
Approximate 10-yr Detention Volume =	1.450	acre-feet		
Approximate 25-yr Detention Volume =	1.729	acre-feet		
Approximate 50-yr Detention Volume =	1.882	acre-feet		
Approximate 100-yr Detention Volume =	2.128	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.391	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.907	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.830	acre-feet
Total Detention Basin Volume =	2.128	acre-feet

Depth Increment = 1.00 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)
Top of Micropool	--	0.00	--	--	--	33	0.001		
7138	--	0.85	--	--	--	3,174	0.073	1,363	0.031
7139	--	2.00	--	--	--	6,012	0.138	6,645	0.153
7140	--	3.00	--	--	--	8,153	0.187	13,727	0.315
7141	--	4.00	--	--	--	10,260	0.236	22,934	0.526
7142	--	5.00	--	--	--	12,558	0.288	34,343	0.788
7143	--	6.00	--	--	--	15,009	0.345	48,126	1.105
7144	--	7.00	--	--	--	17,647	0.405	64,454	1.480
7145	--	8.00	--	--	--	20,403	0.468	83,479	1.916
7146	--	9.00	--	--	--	23,274	0.534	105,318	2.418
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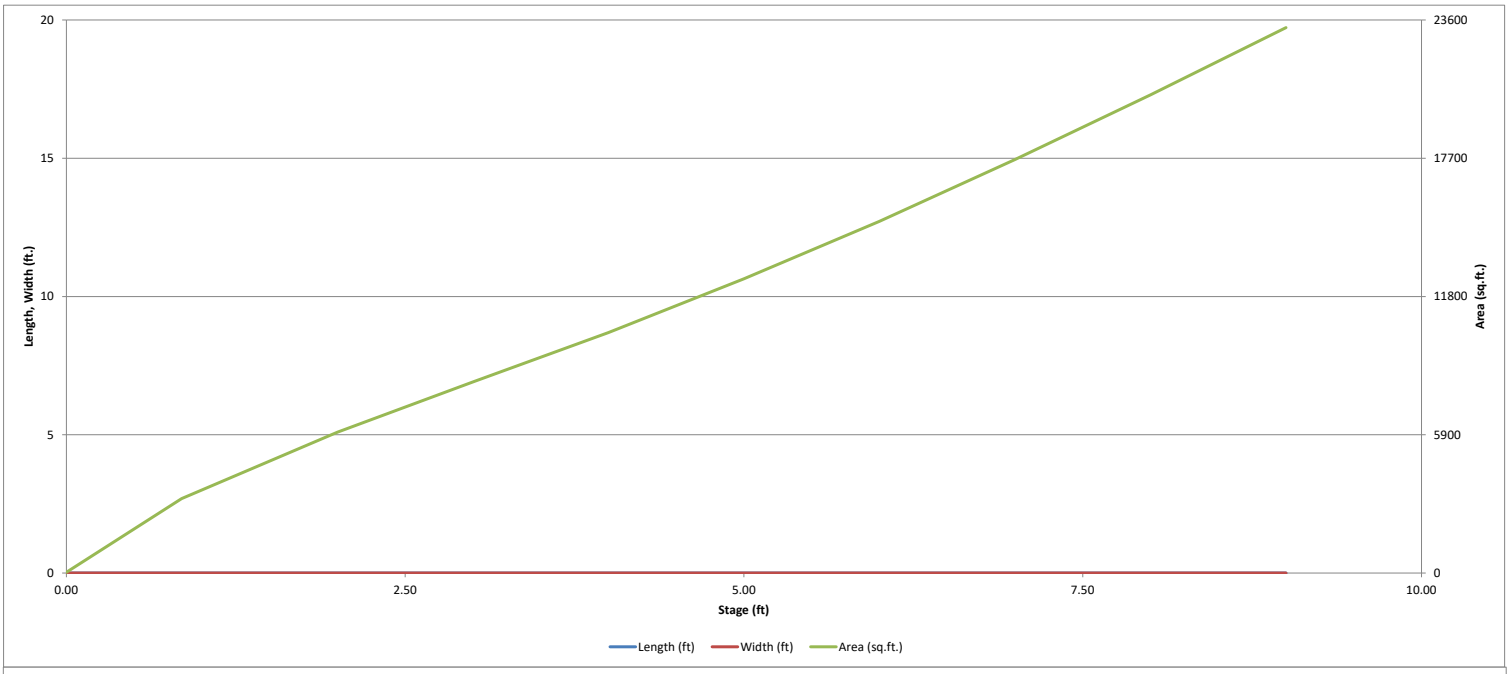
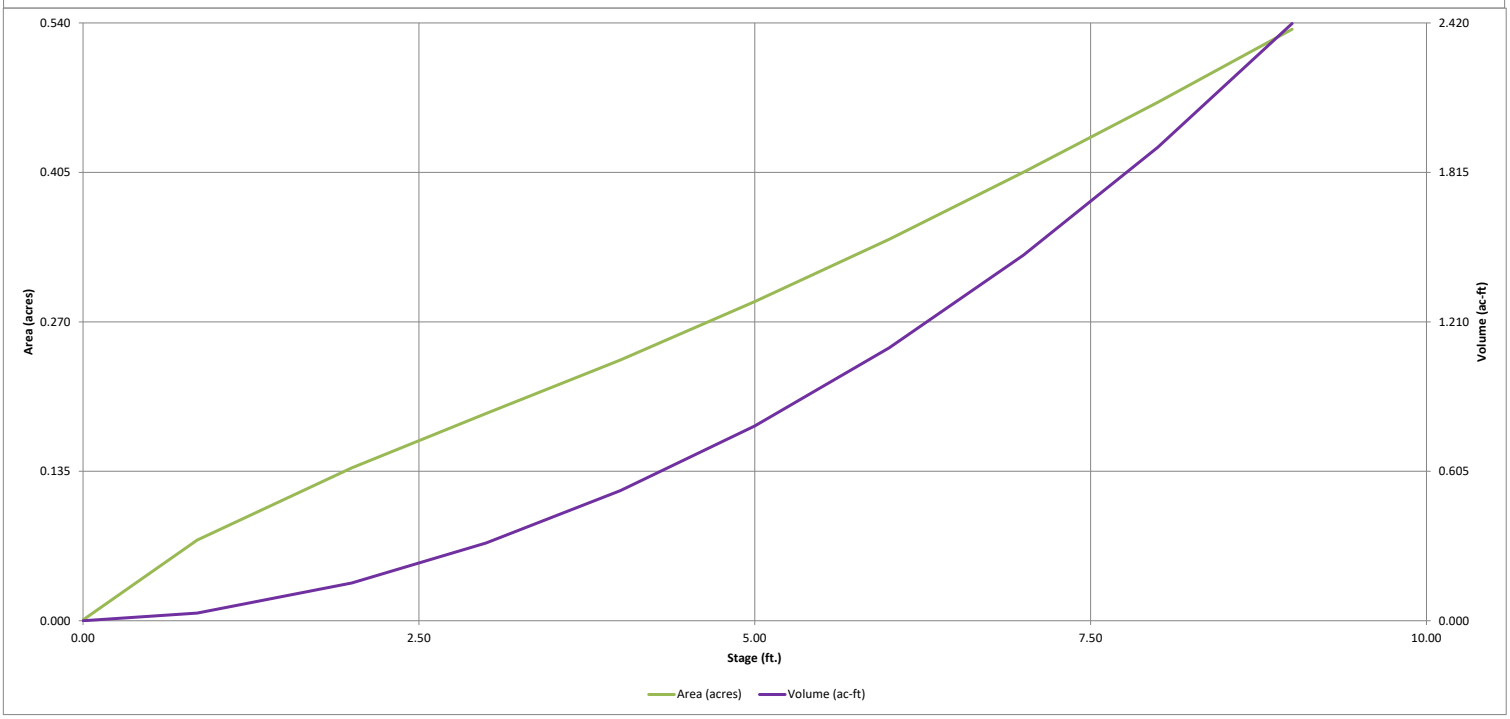

20
15
10
5
0
23600
17700
11800
5900
0
Length, Width (ft.)
Area (sq.ft.)
0.00
2.50
5.00
7.50
10.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

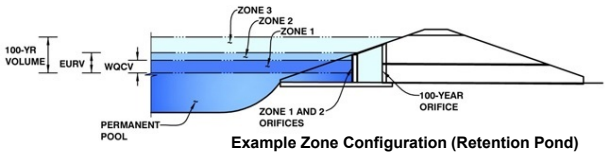

0.540
0.405
0.270
0.135
0.000
2.420
1.815
1.210
0.605
0.000
Area (acres)
Volume (ac-ft)
0.00
2.50
5.00
7.50
10.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Paintbrush Hills Scenic View Detention Pond**

Basin ID: **Pond #2**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.39	0.391	Orifice Plate
Zone 2 (EURV)	6.54	0.907	Orifice Plate
Zone 3 (100-year)	8.44	0.830	Weir&Pipe (Circular)
Total (all zones)		2.128	

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^2

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)

Invert of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)

Depth at top of Zone using Orifice Plate = 6.57 ft (relative to basin bottom at Stage = 0 ft)

Orifice Plate: Orifice Vertical Spacing = 18.00 inches

Orifice Plate: Orifice Area per Row = 1.83 sq. inches (diameter = 1-1/2 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row = 1.271E-02 ft^2

Elliptical Half-Width = N/A feet

Elliptical Slot Centroid = N/A feet

Elliptical Slot Area = N/A ft^2

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	1.50	3.00	4.50	6.00			
Orifice Area (sq. inches)	1.83	1.83	1.83	1.83	1.83			

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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	
Overflow Weir Front Edge Height, Ho =	6.57	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	38%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	6.57	N/A	feet
Overflow Weir Slope Length =	3.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	2.60	N/A	
Overflow Grate Open Area w/o Debris =	6.26	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.92	N/A	ft^2

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

	Zone 3 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	0.75	N/A	ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =	21.00	N/A	inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Circular	Not Selected	
Outlet Orifice Area =	2.41	N/A	ft^2
Outlet Orifice Centroid =	0.88	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage= 8.07 ft (relative to basin bottom at Stage = 0 ft)

Spillway Crest Length = 29.00 feet

Spillway End Slopes = 4.00 H:V

Freeboard above Max Water Surface = 1.00 feet

Calculated Parameters for Spillway

Spillway Design Flow Depth= 0.81 feet

Stage at Top of Freeboard = 9.88 feet

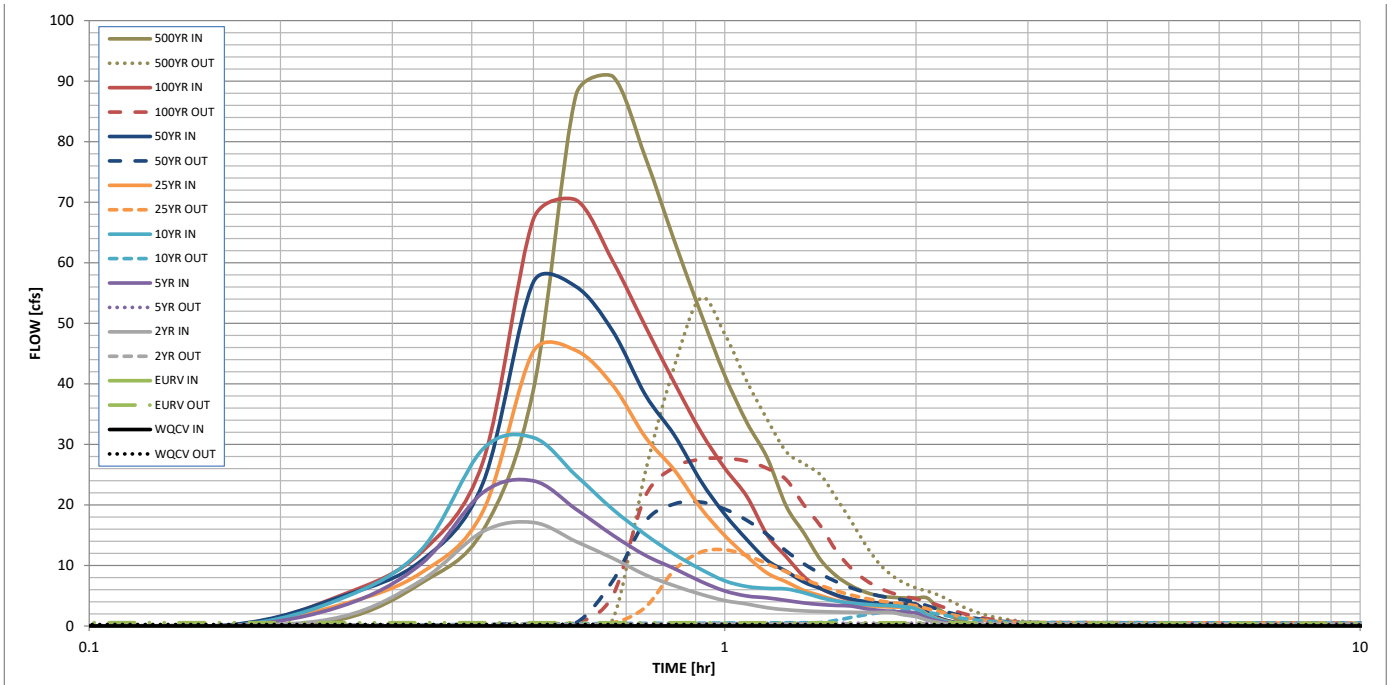
Basin Area at Top of Freeboard = 0.53 acres

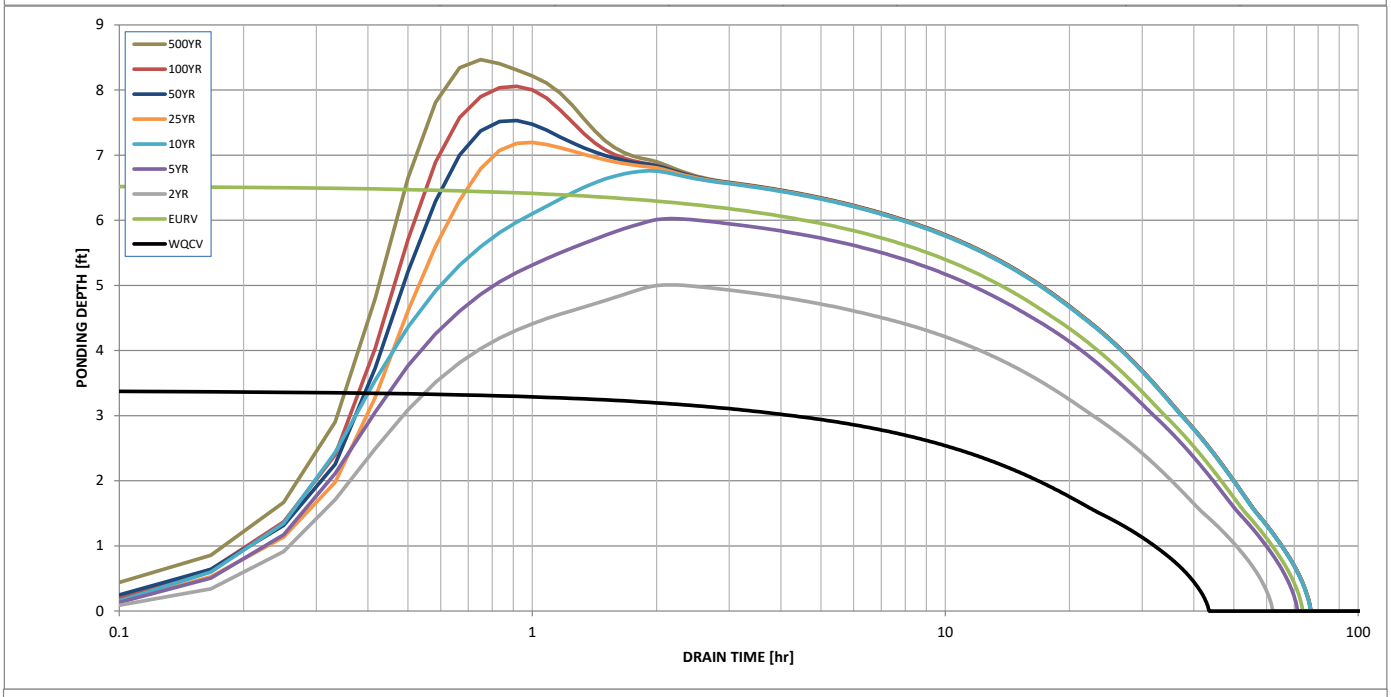
Basin Volume at Top of Freeboard = 2.42 acre-ft

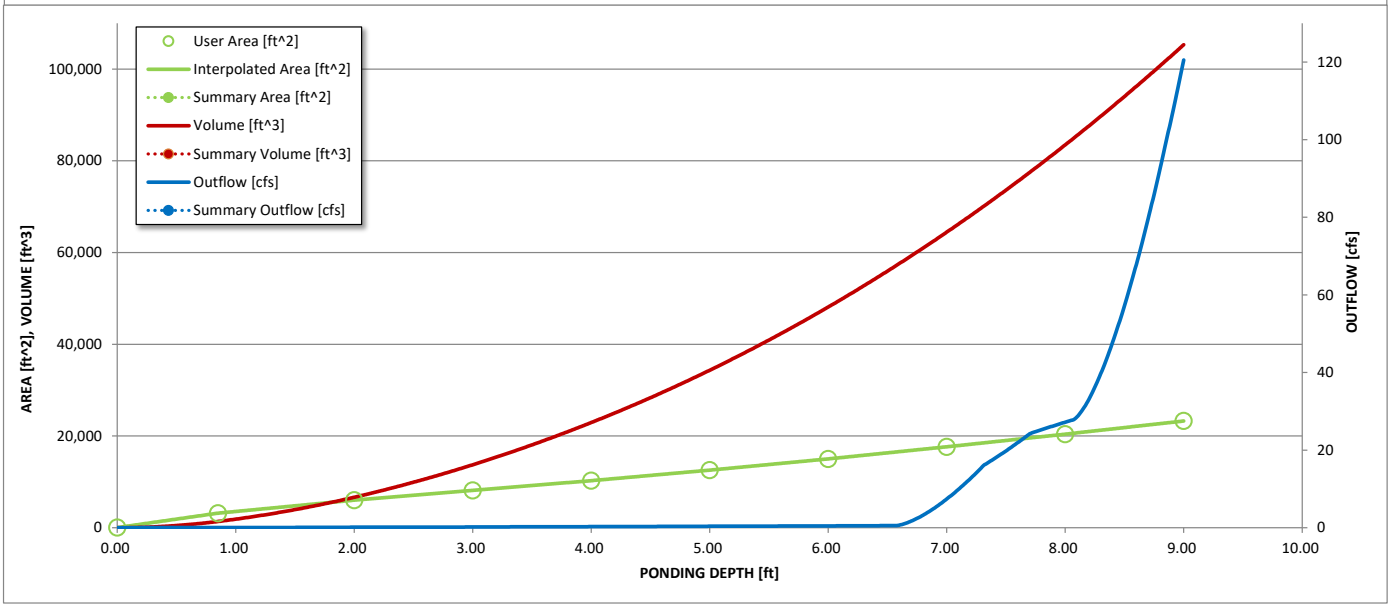
Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through 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	0.94	1.22	1.47	1.85	2.17	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.391	1.298	0.843	1.180	1.534	2.204	2.715	3.340	4.364
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.843	1.180	1.534	2.204	2.715	3.340	4.364
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.3	2.5	6.6	17.9	24.7	33.1	46.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.02	0.12	0.34	0.91	1.25	1.68	2.34
Peak Inflow Q (cfs) =	N/A	N/A	17.1	24.0	31.1	45.5	56.8	70.4	90.8
Peak Outflow Q (cfs) =	0.2	0.5	0.4	0.5	2.6	12.6	20.5	27.7	54.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.4	0.7	0.8	0.8	1.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.3	1.9	3.2	4.3	4.9
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) =	39	63	54	61	65	61	58	56	52
Time to Drain 99% of Inflow Volume (hours) =	**42**	69	59	67	71	70	69	67	65
Maximum Ponding Depth (ft) =	3.39	6.54	5.01	6.03	6.76	7.20	7.53	8.06	8.47
Area at Maximum Ponding Depth (acres) =	0.21	0.38	0.29	0.35	0.39	0.42	0.44	0.47	0.50
Maximum Volume Stored (acre-ft) =	0.392	1.300	0.788	1.112	1.384	1.558	1.703	1.940	2.139


500YR IN
500YR OUT
100YR IN
100YR OUT
50YR IN
50YR OUT
25YR IN
25YR OUT
10YR IN
10YR OUT
5YR IN
5YR OUT
2YR IN
2YR OUT
EURV IN
EURV OUT
WQCV IN
WQCV OUT
FLOW [cfs]
TIME [hr]


500YR
100YR
50YR
25YR
10YR
5YR
2YR
EURV
WQCV
PONDING DEPTH [ft]
DRAIN TIME [hr]


User Area [ft^2]
Interpolated Area [ft^2]
Summary Area [ft^2]
Volume [ft^3]
Summary Volume [ft^3]
Outflow [cfs]
Summary Outflow [cfs]
AREA [ft^2], VOLUME [ft^3]
OUTFLOW [cfs]
PONDING DEPTH [ft]

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: GEW
Company: RGA
Date: June 29, 2021
Project: Scenic View Detention Pond Modifications
Location: Paint Brush Hills

1. Basin Storage Volume		
A) Effective Imperviousness of Tributary Area, I_a	I_a = 60.5	%
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.605	
C) Contributing Watershed Area	Area = 19.720	ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.43	in
E) Design Concept (Select EURV when also designing for flood control)	Choose One: ○ Water Quality Capture Volume (WQCV) ◉ Excess Urban Runoff Volume (EURV)	
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)	V_{DESIGN}=	ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$)	$V_{DESIGN\ OTHER}$=	ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= 0.391	ac-ft
I) NRCS Hydrologic Soil Groups of Tributary Watershed		
i) Percentage of Watershed consisting of Type A Soils	HSG_A = 2	%
ii) Percentage of Watershed consisting of Type B Soils	HSG_B = 98	%
iii) Percentage of Watershed consisting of Type C/D Soils	$HSG_{C/D}$ = 0	%
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	$EURV_{DESIGN}$ =	ac-f t
K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)	$EURV_{DESIGN\ USER}$= 1.298	ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 3.0	: 1
3. Basin Side Slopes		
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00	ft / ft
4. Inlet		
A) Describe means of providing energy dissipation at concentrated inflow locations:		
5. Forebay		
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.01200	ac-ft
B) Actual Forebay Volume	V_F = 0.034	ac-ft
C) Forebay Depth (D_F = 18 inch maximum)	D_F = 18.0	in
D) Forebay Discharge		
i) Undetained 100-year Peak Discharge	Q_{100} = 68.50	cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 1.37	cfs
E) Forebay Discharge Design	Choose One: ○ Berm With Pipe ◉ Wall with Rect. Notch ○ Wall with V-Notch Weir	Flow too small for berm w/ pipe
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P =	in
G) Rectangular Notch Width	Calculated W_N = 6.3	in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: GEW
Company: RGA
Date: June 29, 2021
Project: Scenic View Detention Pond Modifications
Location: Paint Brush Hills

6. Trickle Channel

A) Type of Trickle Channel — Choose One: (●) Concrete ( ) Soft Bottom

F) Slope of Trickle Channel — S = 0.0050 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = sq ft

C) Outlet Type — Choose One: ( ) Orifice Plate ( ) Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = inches

E) Total Outlet Area — A_{ot} = square inches

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches) — D_{IS} = in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV) — V_{IS} = 51 cu ft

C) Initial Surcharge Provided Above Micropool — V_s = cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ni} * 38.5*(e^{-0.095D})$ — A_t = square inches

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other') — User Ratio =

D) Total Water Quality Screen Area (based on screen type) — A_{total} = sq. in.

E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E) — H= feet

F) Height of Water Quality Screen (H_{TR}) — H_{TR}= inches

G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended) — $W_{opening}$ = inches

Worksheet for Trickle Channel

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.5	%
Normal Depth	0.50	ft
Bottom Width	4.00	ft

Results

Discharge	8.78	ft^3/s
Flow Area	2.00	ft^2
Wetted Perimeter	5.00	ft
Hydraulic Radius	0.40	ft
Top Width	4.00	ft
Critical Depth	0.53	ft
Critical Slope	0.00416	ft/ft
Velocity	4.39	ft/s
Velocity Head	0.30	ft
Specific Energy	0.80	ft
Froude Number	1.09	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.50	ft
Critical Depth	0.53	ft
Channel Slope	0.5	%
Critical Slope	0.00416	ft/ft

Worksheet for Forebay Overflow

Project Description

Solve For	Headwater Elevation

Input Data

Discharge		68.50	ft^3/s
Crest Elevation		0.00	ft
Tailwater Elevation		0.00	ft
Weir Coefficient		3.33	US
Crest Length		21.0	ft
Number Of Contractions	0		

Results

Headwater Elevation	0.99	ft
Headwater Height Above Crest	0.99	ft
Tailwater Height Above Crest	0.00	ft
Flow Area	20.71	ft^2
Velocity	3.31	ft/s
Wetted Perimeter	22.97	ft
Top Width	21.00	ft