

El Paso County
Engineering Development Review Team
2880 International Circle
Colorado Springs, CO 80910

February 2023

RE: MDG Project No. 20.1105.004 – Grandwood Ranch: Certification Letter

Dear Sir or Madam,

The site and adjacent properties (as affected by work performed under the County permit) are stable with respect to settlement and subsidence, sloughing of cut and fill slopes, revegetation and other ground cover. The improvements (public improvements, common development improvements, site grading and paving) meet or exceed the minimum design requirements.

This letter certifies substantial compliance for dimensions, elevations and volumes of the Grandwood Ranch Pond 1 and Pond 2 within the west side of the development and Pond 3 and Pond 4 within the east side of the development. This certification letter is to confirm the full spectrum detention basins substantially comply with the approved plan documents and Final Drainage Report (FDR: Approved April 16, 2021).

As-built survey of the four ponds by a third-party Professional Land Surveyor and a detention pond site walkthrough indicate that the pond volume, trickle channels, two forebays, emergency spillway and outlet structure, as constructed and surveyed, are in substantial conformance with the construction plans.

Caveats: Because the certifier was not involved with construction administration of the pond, the compaction of earthwork in the pond embankment, placement of buried rip rap in the emergency spillway, and/or any other items not specifically mentioned are not certified in this letter. Submittal reviews during the construction phase of the project indicate that the appropriate material submittals were made, but do not certify that these actual materials were placed or whether appropriate means of storage were utilized prior to installation.

From the Colorado Springs Pond certification checklist (“Yes” indicates substantial compliance):

	<u>Pond 1, 2, 3, &4</u>
Grading	
• Grading and Slopes Completed per approved plans	Yes
Soil Mixes	
• Proper storage of soil mix prior to placement (<i>see above</i>)	N/A
• Soil Mix Correct per approved plans (<i>See above</i>)	N/A

Forebay

- Built per approved plans Yes
- Forebay Volume per approved plans Yes

Outlet Works

- Built per approved plans Yes

Spillway structure

- Built per approved plans Yes

WQCV and Elevations

- WQCV per approved plans Yes
- All elevations per approved plans Yes

As built Plans for Permanent BMP

- Built per approved plans Yes

If there are any questions regarding this certification, please feel free to contact me by phone: 719-575-0100 or email: corey.petersen@matrixdesigngroup.com.

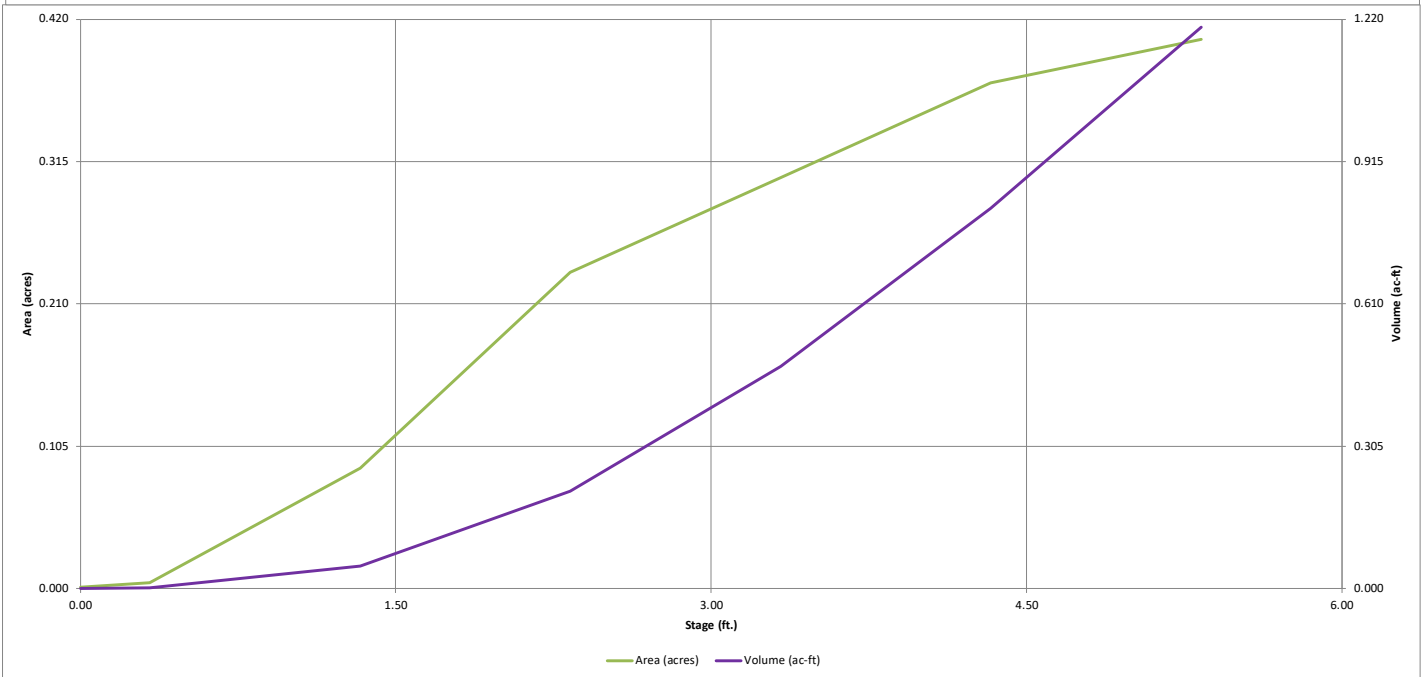
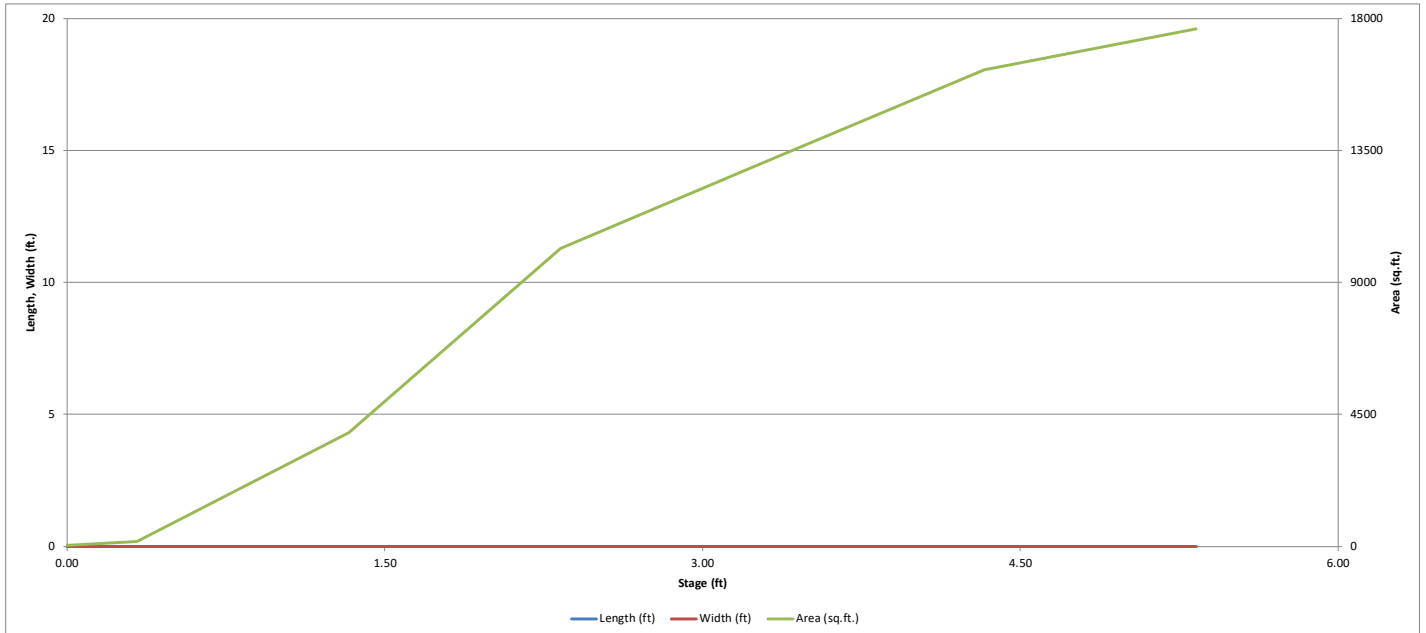
Thank you,



Corey Petersen, P.E. 56571

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

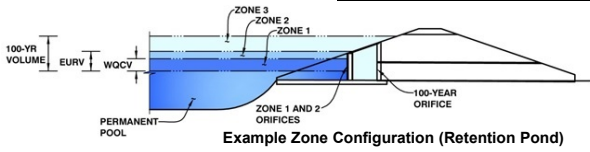
MHFD-Detention, Version 4.02 (February 2020)



DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Grandwood Ranch
Basin ID: Pond 1 (Lot 41) - As Built



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.64	0.082	
Zone 2 (EURV)	2.15	0.087	
Zone 3 (100-year)	3.23	0.276	
Total (all zones)		0.445	

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 = ft²
 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 = 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 = inches

Calculated Parameters for Plate

WQ Orifice Area per Row = ft²
 Elliptical Half-Width = feet
 Elliptical Slot Centroid = feet
 Elliptical Slot Area = ft²

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

	Row 1 (optional)	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	0.70	1.40					
Orifice Area (sq. inches)	0.45	0.45	0.45					

	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)

Invert of Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
 Depth at top of Zone using Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
 Vertical Orifice Diameter = inches

Calculated Parameters for Vertical Orifice

Vertical Orifice Area = ft²
 Vertical Orifice Centroid = feet

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

Overflow Weir Front Edge Height, Ho = ft (relative to basin bottom at Stage = 0 ft)
 Overflow Weir Front Edge Length = feet
 Overflow Weir Gate Slope = H:V
 Horiz. Length of Weir Sides = feet
 Overflow Gate Open Area % = %, gate open area/total area
 Debris Clogging % = %

Calculated Parameters for Overflow Weir

Height of Gate Upper Edge, H₁ = feet
 Overflow Weir Slope Length = feet
 Gate Open Area / 100-yr Orifice Area =
 Overflow Gate Open Area w/o Debris = ft²
 Overflow Gate Open Area w/ Debris = ft²

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

Depth to Invert of Outlet Pipe = ft (distance below basin bottom at Stage = 0 ft)
 Circular Orifice Diameter = inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Outlet Orifice Area = ft²
 Outlet Orifice Centroid = feet
 Half-Central Angle of Restrictor Plate on Pipe = radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

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

Routed Hydrograph Results

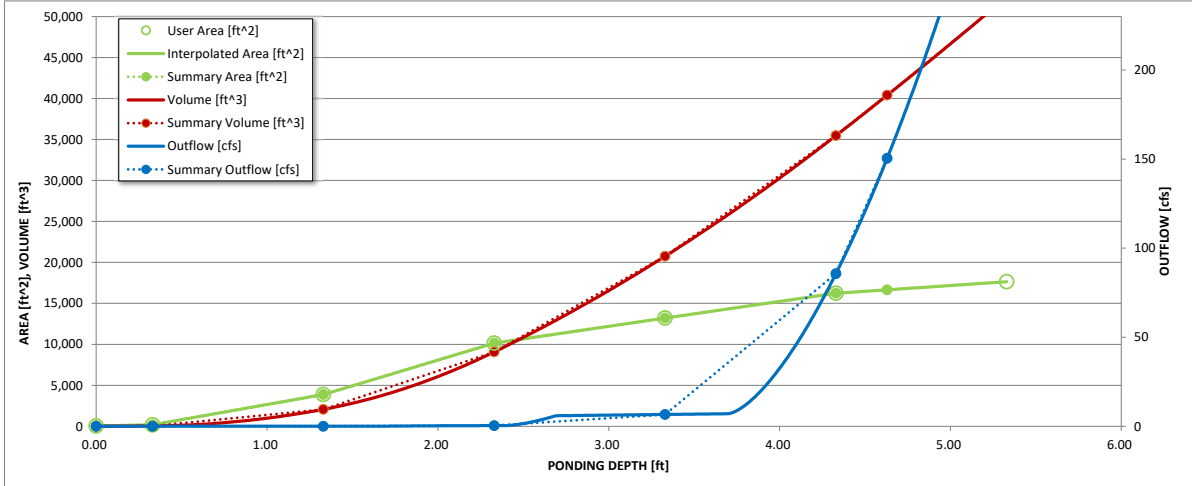
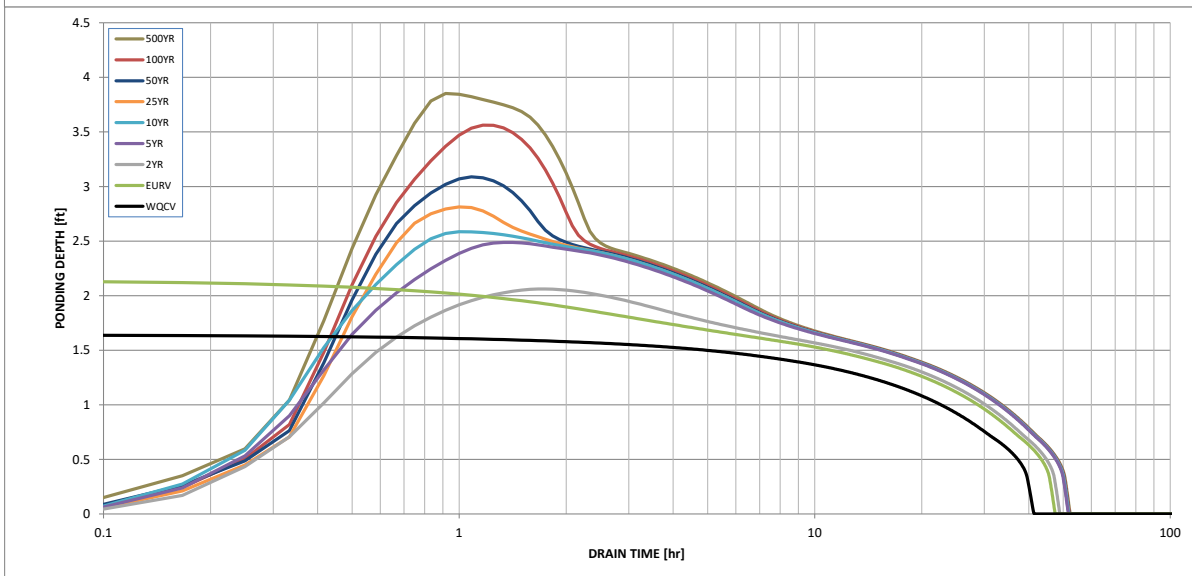
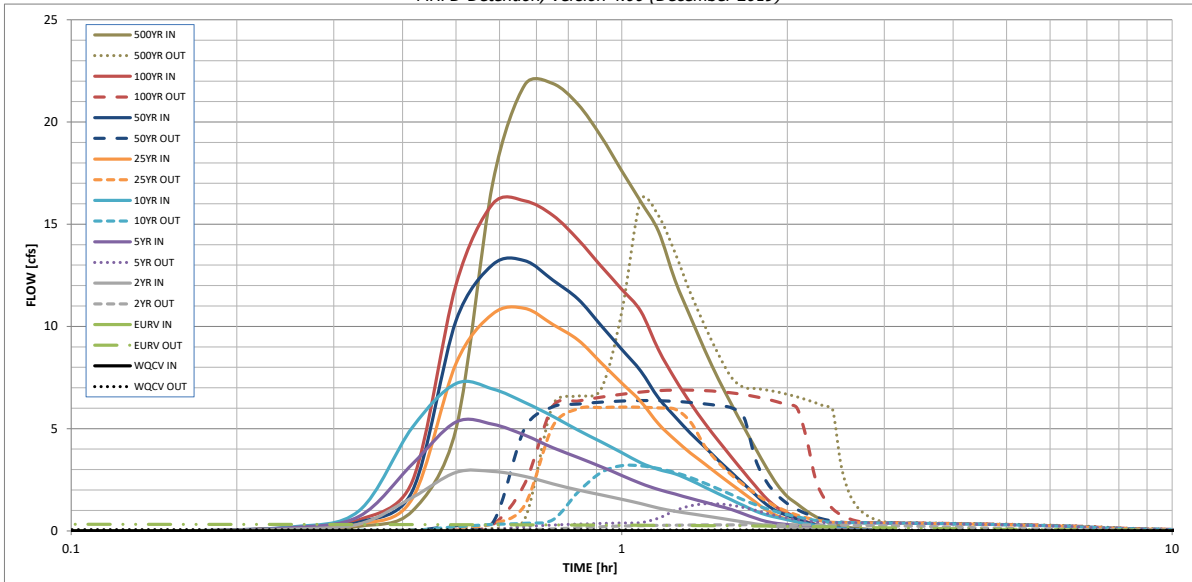
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period									
One-Hour Rainfall Depth (in)	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft)	0.082	0.168	0.181	0.330	0.471	0.702	0.867	1.096	1.525
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.181	0.330	0.471	0.702	0.867	1.096	1.525
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	1.3	3.4	5.1	9.0	11.3	14.1	19.6
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.15	0.41	0.60	1.06	1.33	1.66	2.31
Peak Inflow Q (cfs)	N/A	N/A	2.9	5.3	7.2	10.9	13.2	16.1	21.9
Peak Outflow Q (cfs)	0.1	0.3	0.3	1.3	3.2	6.1	6.4	6.9	16.2
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.4	0.6	0.7	0.6	0.5	0.8
Structure Controlling Flow	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Gate 1 (fps)	N/A	N/A	N/A	0.1	0.2	0.5	0.5	0.6	0.6
Max Velocity through Gate 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)	38	41	42	41	38	34	32	29	23
Time to Drain 99% of Inflow Volume (hours)	40	45	46	47	46	43	42	40	38
Maximum Ponding Depth (ft)	1.65	2.15	2.06	2.49	2.58	2.81	3.09	3.56	3.85
Area at Maximum Ponding Depth (acres)	0.14	0.21	0.19	0.24	0.25	0.27	0.29	0.32	0.34
Maximum Volume Stored (acre-ft)	0.083	0.169	0.151	0.244	0.269	0.328	0.403	0.548	0.644

Per approved FDR, existing discharge is shown at 6.9 cfs. As-Built pond meets existing discharge.

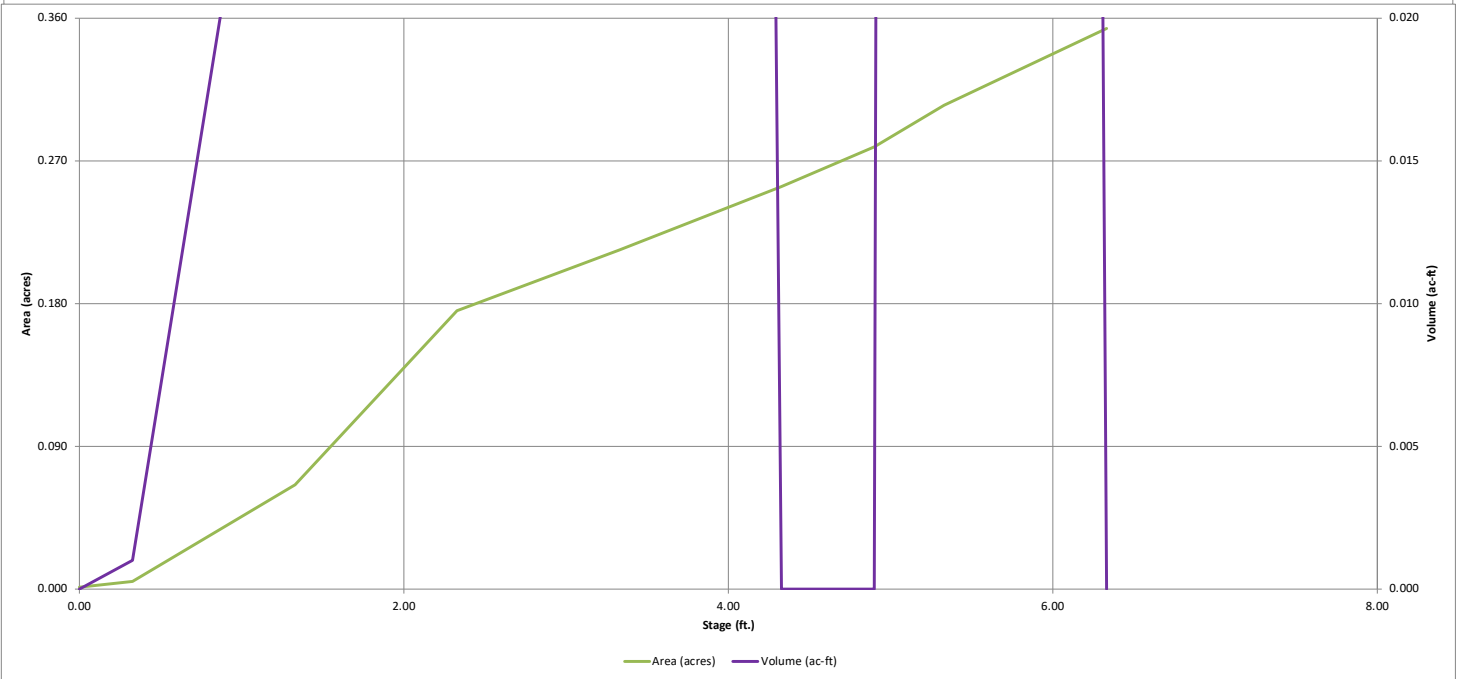
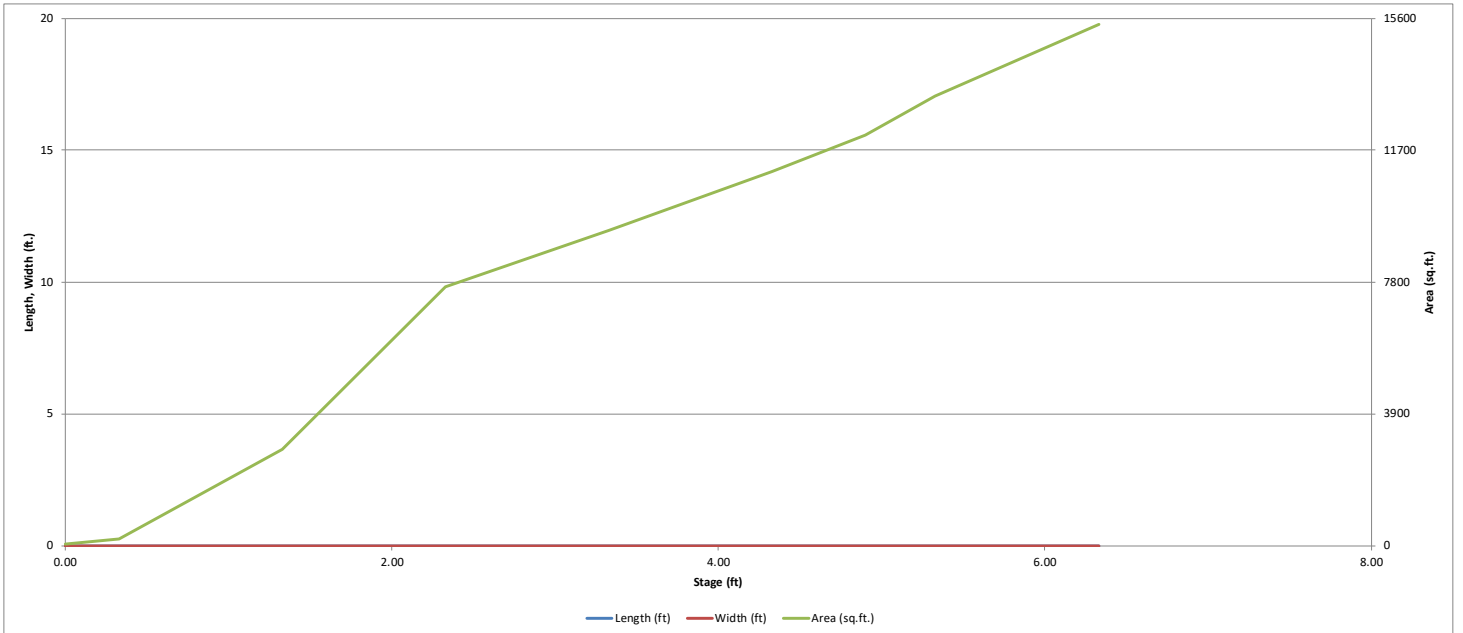
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

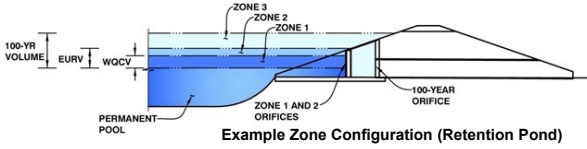
MHFD-Detention, Version 4.02 (February 2020)



DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Grandwood Ranch
Basin ID: Pond 2 (West) - As Built



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.22	0.138	Orifice Plate
Zone 2 (EURV)	3.69	0.292	Circular Orifice
Zone 3 (100-year)	4.96	0.322	Weir&Pipe (Restrict)
Total (all zones)		0.752	

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 = ft²
 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 = 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 = 7/8 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row = ft²
 Elliptical Half-Width = feet
 Elliptical Slot Centroid = feet
 Elliptical Slot Area = ft²

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	1.00	2.00					
Orifice Area (sq. inches)	0.60	0.60	0.60					

	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	
Invert of Vertical Orifice =	2.17	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.54	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	6.00	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.20	N/A	ft ²
Vertical Orifice Centroid =	0.25	N/A	feet

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 =	4.40	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 Open Area % =	64%	N/A	%, gate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Gate Upper Edge, H _t =	4.40	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Gate Open Area / 100-yr Orifice Area =	13.86	N/A	
Overflow Gate Open Area w/o Debris =	10.18	N/A	ft ²
Overflow Gate Open Area w/ Debris =	5.09	N/A	ft ²

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 =	0.00	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 =	7.80	N/A	inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.73	N/A	ft ²
Outlet Orifice Centroid =	0.38	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.44	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

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

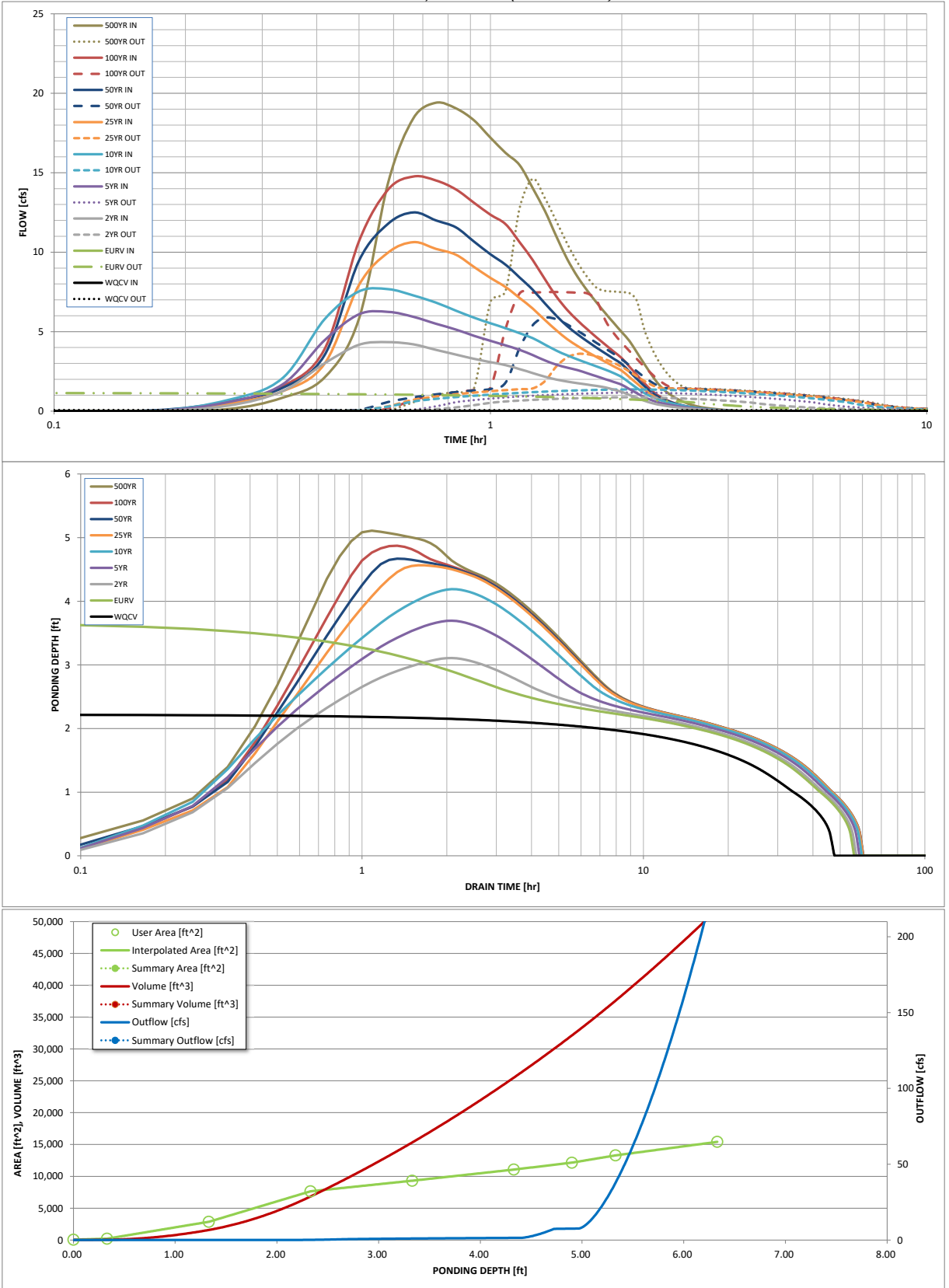
Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.138	0.430	0.409	0.584	0.738	0.945	1.113	1.325	1.758
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.409	0.584	0.738	0.945	1.113	1.325	1.758
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.5	1.5	2.3	4.3	5.3	6.9	9.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.07	0.18	0.28	0.53	0.66	0.85	1.20
Peak Inflow Q (cfs) =	N/A	N/A	4.3	6.2	7.7	10.6	12.5	14.8	19.4
Peak Outflow Q (cfs) =	0.1	1.2	0.9	1.2	1.4	3.6	5.9	7.5	14.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.6	0.8	1.1	1.1	1.5
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Gate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.2	0.4	0.6	0.6
Max Velocity through Gate 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) =	43	46	47	45	44	42	40	38	34
Time to Drain 99% of Inflow Volume (hours) =	46	52	53	53	53	52	51	50	47
Maximum Ponding Depth (ft) =	2.22	3.69	3.11	3.69	4.19	4.56	4.67	4.87	5.11
Area at Maximum Ponding Depth (acres) =	0.16	0.23	0.21	0.23	0.25	0.26	0.27	0.28	0.29
Maximum Volume Stored (acre-ft) =	0.138	0.431	0.303	0.431	0.548	0.645	0.672	0.729	0.794

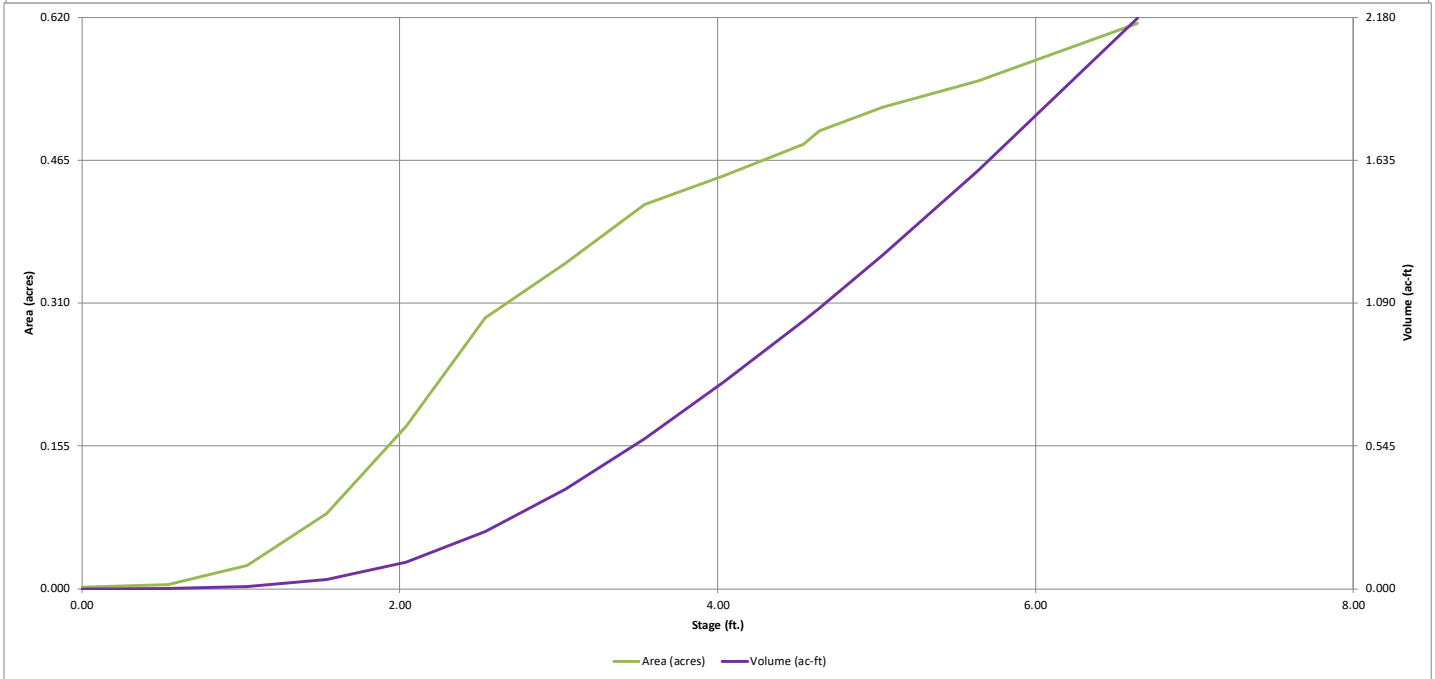
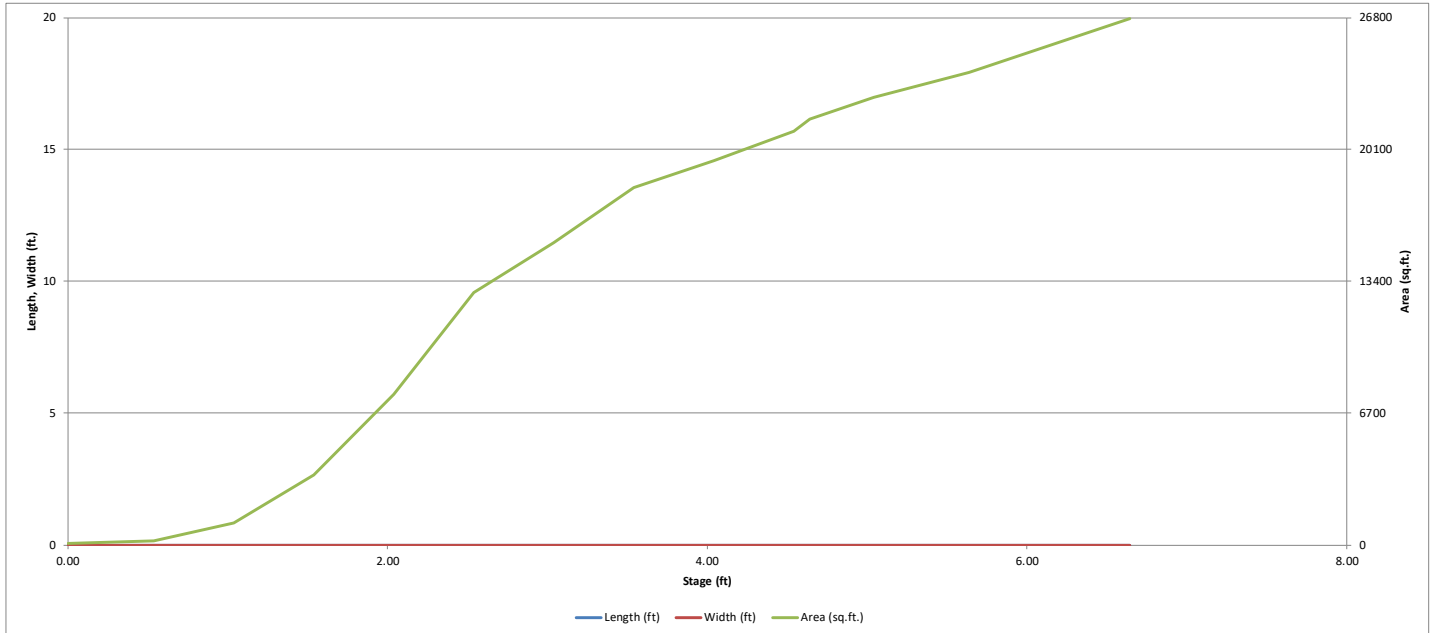
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MHFD-Detention, Version 4.00 (December 2019)



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

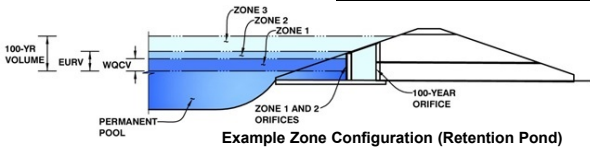
MHFD-Detention, Version 4.02 (February 2020)



DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Grandwood Ranch
Basin ID: Pond 3 (Adjacent to Lot 1) (Includes Sub-basins E-1 and D-3) - As Built



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.46	0.195	Orifice Plate
Zone 2 (EURV)	3.00	0.170	Circular Orifice
Zone 3 (100-year)	4.76	0.764	Weir&Pipe (Restrict)
Total (all zones)		1.130	

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 = ft²
 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 = 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 = 15/16 inch)

Calculated Parameters for Plate
 WQ Orifice Area per Row = ft²
 Elliptical Half-Width = feet
 Elliptical Slot Centroid = feet
 Elliptical Slot Area = ft²

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	1.00	2.00					
Orifice Area (sq. inches)	0.75	0.75	0.75					

	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	
Invert of Vertical Orifice =	2.35	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	2.86	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	5.00	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.14	N/A	ft ²
Vertical Orifice Centroid =	0.21	N/A	feet

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 =	2.80	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 Open Area % =	70%	N/A	%, gate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Gate Upper Edge, H ₁ =	2.80	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Gate Open Area / 100-yr Orifice Area =	4.20	N/A	
Overflow Gate Open Area w/o Debris =	11.20	N/A	ft ²
Overflow Gate Open Area w/ Debris =	5.60	N/A	ft ²

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 =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	19.00	N/A	inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	2.67	N/A	ft ²
Outlet Orifice Centroid =	0.87	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	2.19	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	4.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	60.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth =	0.35	feet
Stage at Top of Freeboard =	5.85	feet
Basin Area at Top of Freeboard =	0.56	acres
Basin Volume at Top of Freeboard =	1.71	acre-ft

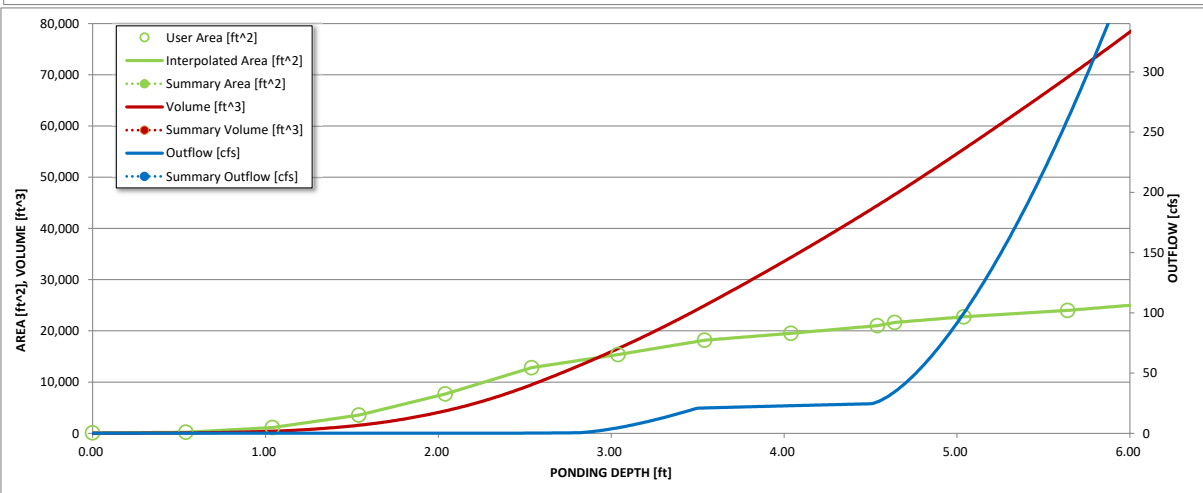
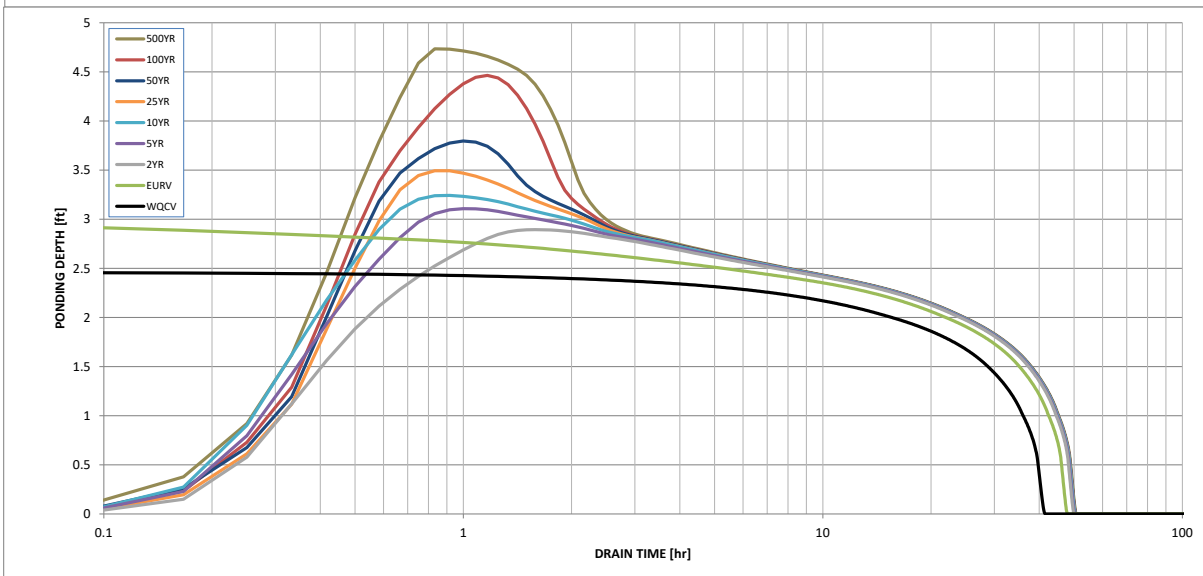
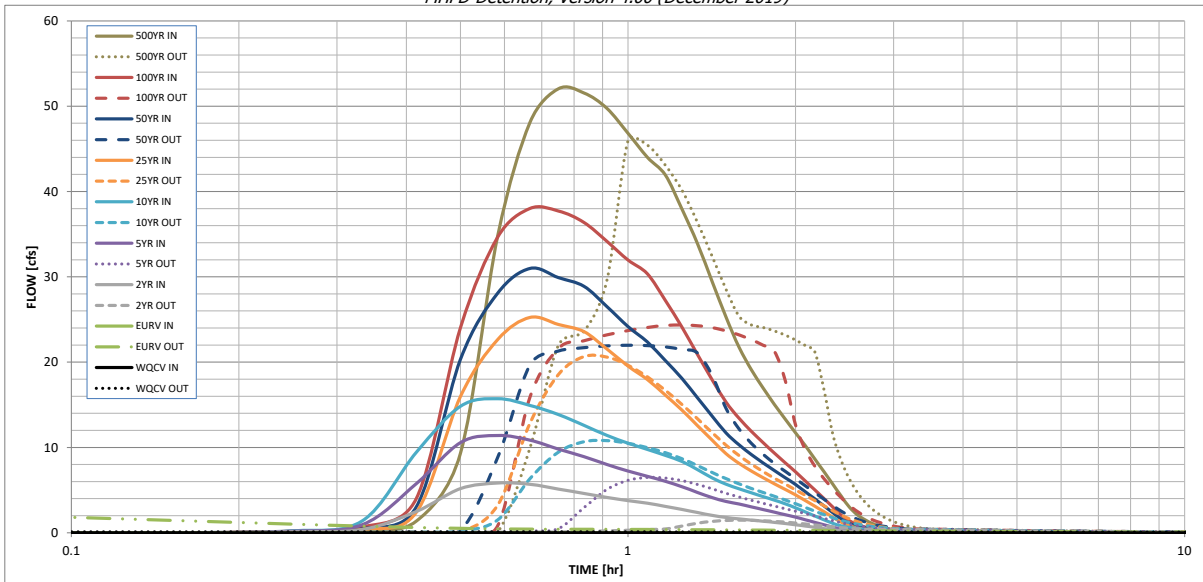
Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.195	0.366	0.439	0.867	1.284	1.992	2.487	3.187	4.480
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.439	0.867	1.284	1.992	2.487	3.187	4.480
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	2.9	8.1	12.3	21.6	27.2	34.5	48.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.12	0.32	0.49	0.86	1.08	1.38	1.92
Peak Inflow Q (cfs) =	N/A	N/A	5.8	11.4	15.7	25.2	31.0	38.0	52.0
Peak Outflow Q (cfs) =	0.1	3.0	1.5	6.5	10.8	20.6	22.0	24.4	46.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.9	1.0	0.8	0.7	1.0
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Gate 1 (fps) =	N/A	0.30	0.08	0.5	0.9	1.8	1.9	2.1	2.2
Max Velocity through Gate 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	42	43	39	36	32	29	24	18
Time to Drain 99% of Inflow Volume (hours) =	40	45	47	45	43	41	40	38	35
Maximum Ponding Depth (ft) =	2.46	3.01	2.89	3.11	3.24	3.49	3.80	4.46	4.73
Area at Maximum Ponding Depth (acres) =	0.28	0.35	0.34	0.36	0.38	0.41	0.43	0.48	0.50
Maximum Volume Stored (acre-ft) =	0.195	0.369	0.328	0.401	0.453	0.552	0.679	0.983	1.115

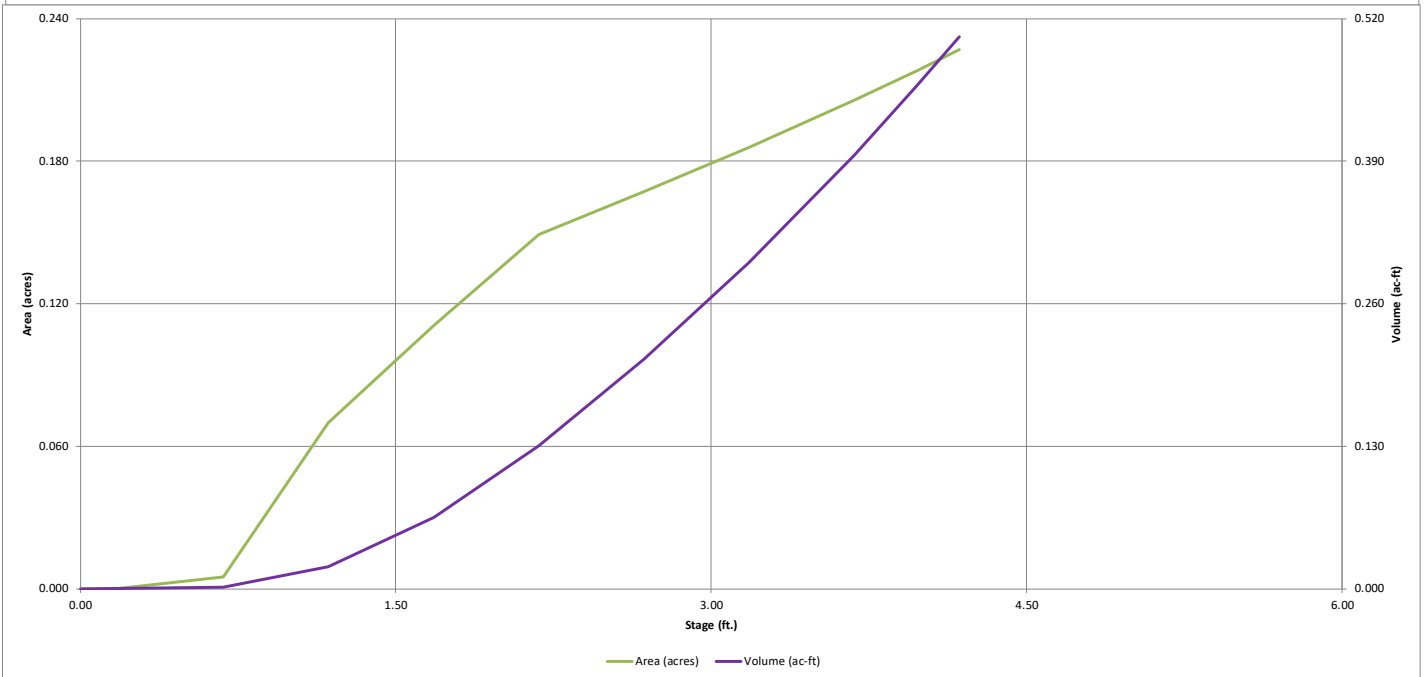
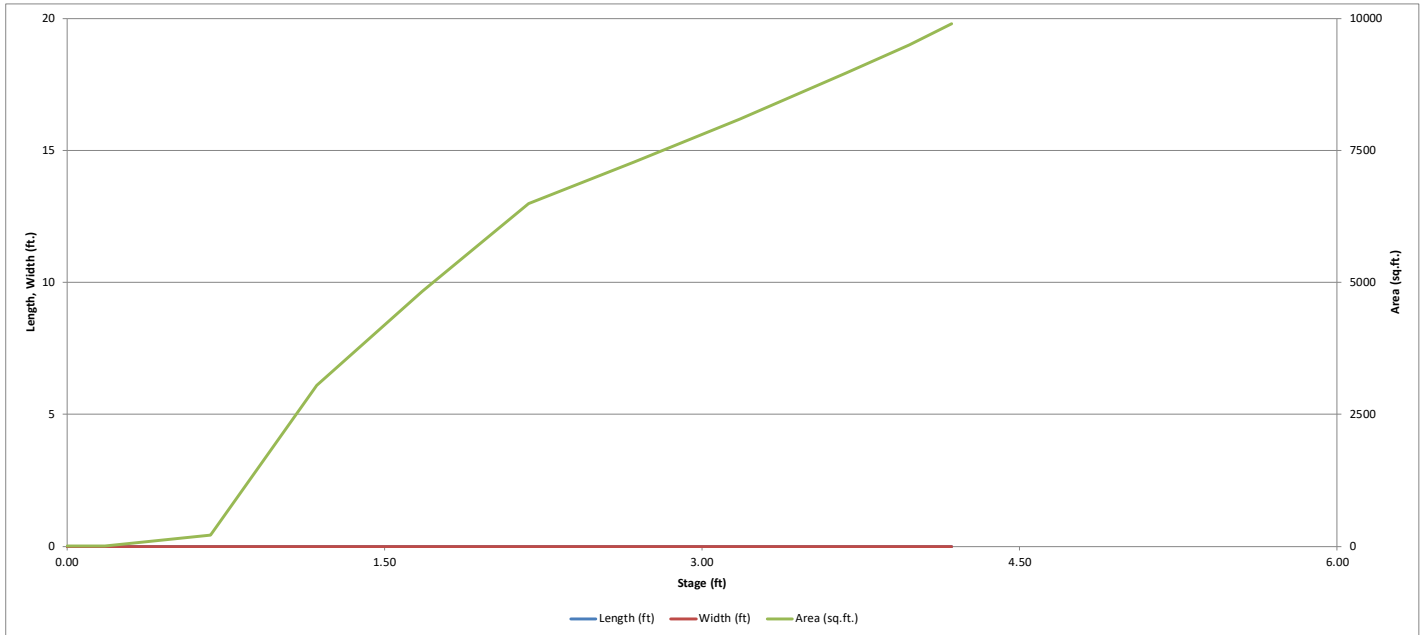
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

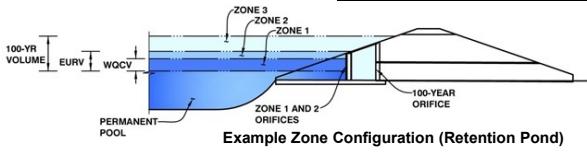
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DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Grandwood Ranch
Basin ID: Pond 4 (East) - As Built



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.63	0.059	Orifice Plate
Zone 2 (EURV)	2.02	0.047	Circular Orifice
Zone 3 (100-year)	3.50	0.251	Weir&Pipe (Restrict)
Total (all zones)		0.357	

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 = ft²
 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 = 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 = 5/8 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row = ft²
 Elliptical Half-Width = feet
 Elliptical Slot Centroid = feet
 Elliptical Slot Area = ft²

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)	0.30	0.30	0.30					

	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	
Invert of Vertical Orifice =	1.78	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	2.18	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	6.00	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.20	N/A	ft ²
Vertical Orifice Centroid =	0.25	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 =	3.30	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H ₁ =	3.30	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	12.86	N/A	
Overflow Grate Open Area w/o Debris =	11.20	N/A	ft ²
Overflow Grate Open Area w/ Debris =	5.60	N/A	ft ²

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 =	0.00	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 =	8.90		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.87	N/A	ft ²
Outlet Orifice Centroid =	0.43	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.56	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

Spillway Design Flow Depth = feet
 Stage at Top of Freeboard = feet
 Basin Area at Top of Freeboard = acres
 Basin Volume at Top of Freeboard = 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).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period									
One-Hour Rainfall Depth (in)	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft)	0.059	0.106	0.133	0.273	0.411	0.650	0.816	1.051	1.483
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.133	0.273	0.411	0.650	0.816	1.051	1.483
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	1.1	3.2	4.7	8.4	10.5	13.1	18.2
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.13	0.37	0.55	0.98	1.23	1.54	2.14
Peak Inflow Q (cfs)	N/A	N/A	2.1	4.1	5.7	9.3	11.5	14.1	19.3
Peak Outflow Q (cfs)	0.0	0.1	0.2	0.8	1.1	5.1	7.5	8.0	10.2
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.2	0.2	0.6	0.7	0.6	0.6
Structure Controlling Flow	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps)	N/A	N/A	N/A	N/A	N/A	0.3	0.6	0.6	0.6
Max Velocity through Grate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	40	53	55	53	51	46	42	38	30
Time to Drain 99% of Inflow Volume (hours)	42	56	58	58	58	56	54	53	49
Maximum Ponding Depth (ft)	1.63	2.02	2.08	2.63	3.18	3.53	3.63	4.04	4.18
Area at Maximum Ponding Depth (acres)	0.11	0.14	0.14	0.16	0.19	0.20	0.20	0.22	0.23
Maximum Volume Stored (acre-ft)	0.060	0.107	0.114	0.199	0.298	0.365	0.385	0.472	0.504

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

