Monument Hill CM, LLC
1864 Woodmoor Drive – Suite 100
Monument, Colorado 80132
719-476-0800 | admin@Monumenthillcm.com

July 12, 2022

Mr. Charlie Williams
Winsome, LLC
1864 Woodmoor Drive, Suite 100
Monument, CO 80132

RE: Winsome Filing No 1 – Detention Pond Certification

Dear Mr. Williams:

The drainage facilities, including water quality ponds B, C, & D and detention pond 3 were installed in conformance with the construction documents for Winsome Filing No 1 approved by El Paso County 12/29/2020. This certification is based on periodic site visits and as-built surveys performed by Edward James Surveying dated 11/08/2021. The results are as follows:

Volume (AF)	Design	Asbuilt	Comment
Pond B	0.462	0.447	new model
Pond C	1.037	1.091	revised plate
Pond D	1.329	3.405	revised plate
Pond 3	10.237	9.922	new model

Pond B was short on volume, so we ran a new model using asbuilt conditions which shows the pond is adequate. Pond C orifice plate was revised to match asbuilt conditions (7/16" diameter holes at 0.70' spacing). Pond D orifice plate was revised to match asbuilt conditions (11/16" diameter holes at 0.50' spacing). Pond 3 was short on volume, so we ran a new model using asbuilt conditions which shows the pond is adequate.

The pond bottoms were graded to be approximately 3" below the trickle channel curbs, to trap additional sediment. If the trickle channels are compromised at time of Final Acceptance, the County will not accept the ponds until the trickle channels have been repaired and pond bottom(s) raised to meet the top of trickle channel curb.

Please let me know if you have any questions or need further assistance.

Sincerely,

Joseph W. DesJardin, PE
Director of Entitlements
Monument Hill CM, LLC

COLORADO LICENSED
JOSEPH W DESJARDIN
7/12/22
0024207
PROFESSIONAL ENGINEER

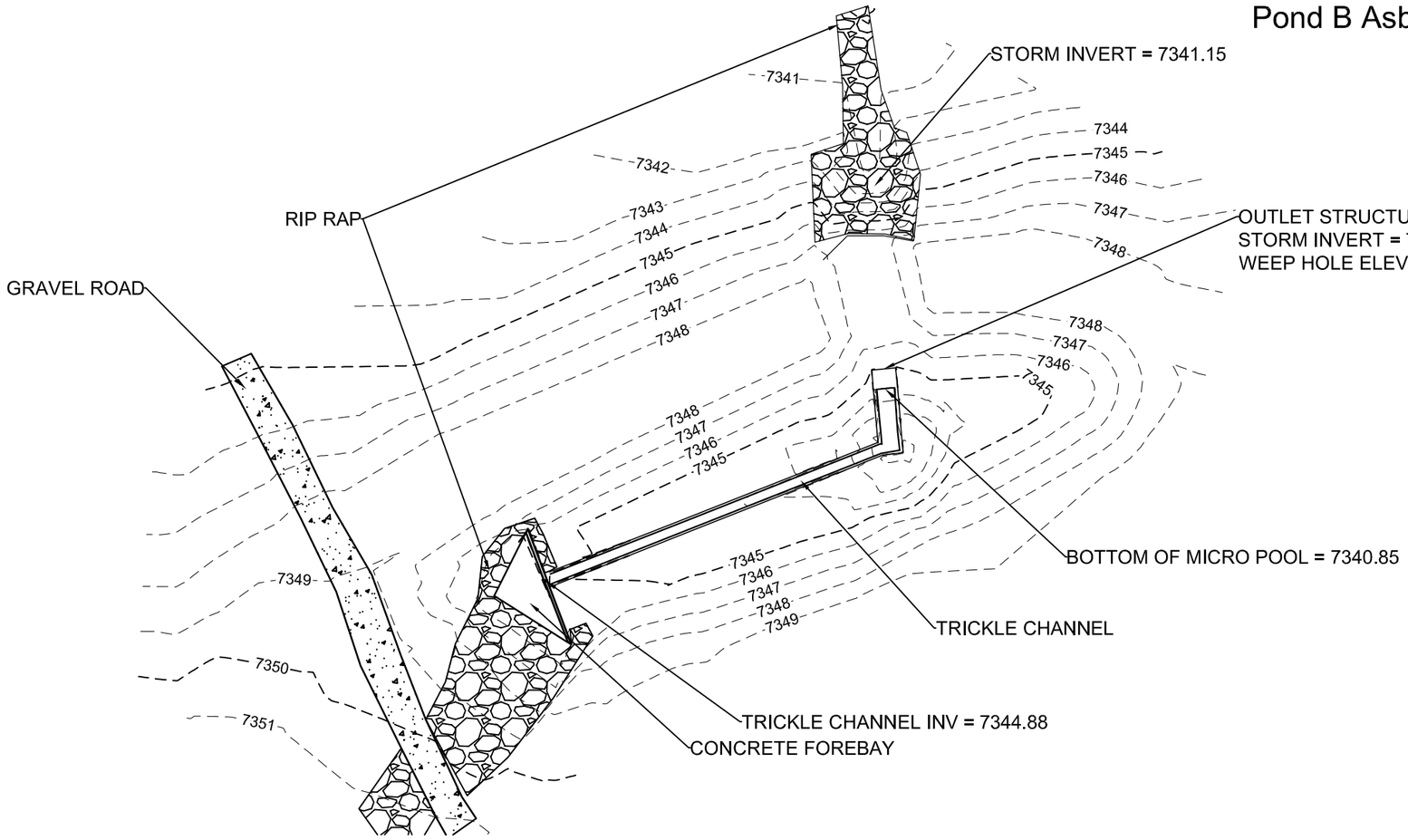
Joseph W. DesJardin, Colorado PE 24207

N

0 15' 30' 60'

SCALE: 1" = 30'

Winsome Filing 1
Pond B Asbuilt 11-05-21



N

0 15' 30' 60'

SCALE: 1" = 30'

Winsome Filing 1
Pond C Asbuilt 8-05-21

STORM INVERT = 7328.59

RIPRAP

OUTLET STRUCTURE TOP OF CONCRETE = 7334.05
STORM INVERT = 7329.85
WEEP HOLES ELEVATION = 7332.95
7332.55
7332.15

RIP RAP

MIRCO POOL FLOOR = 7329.32

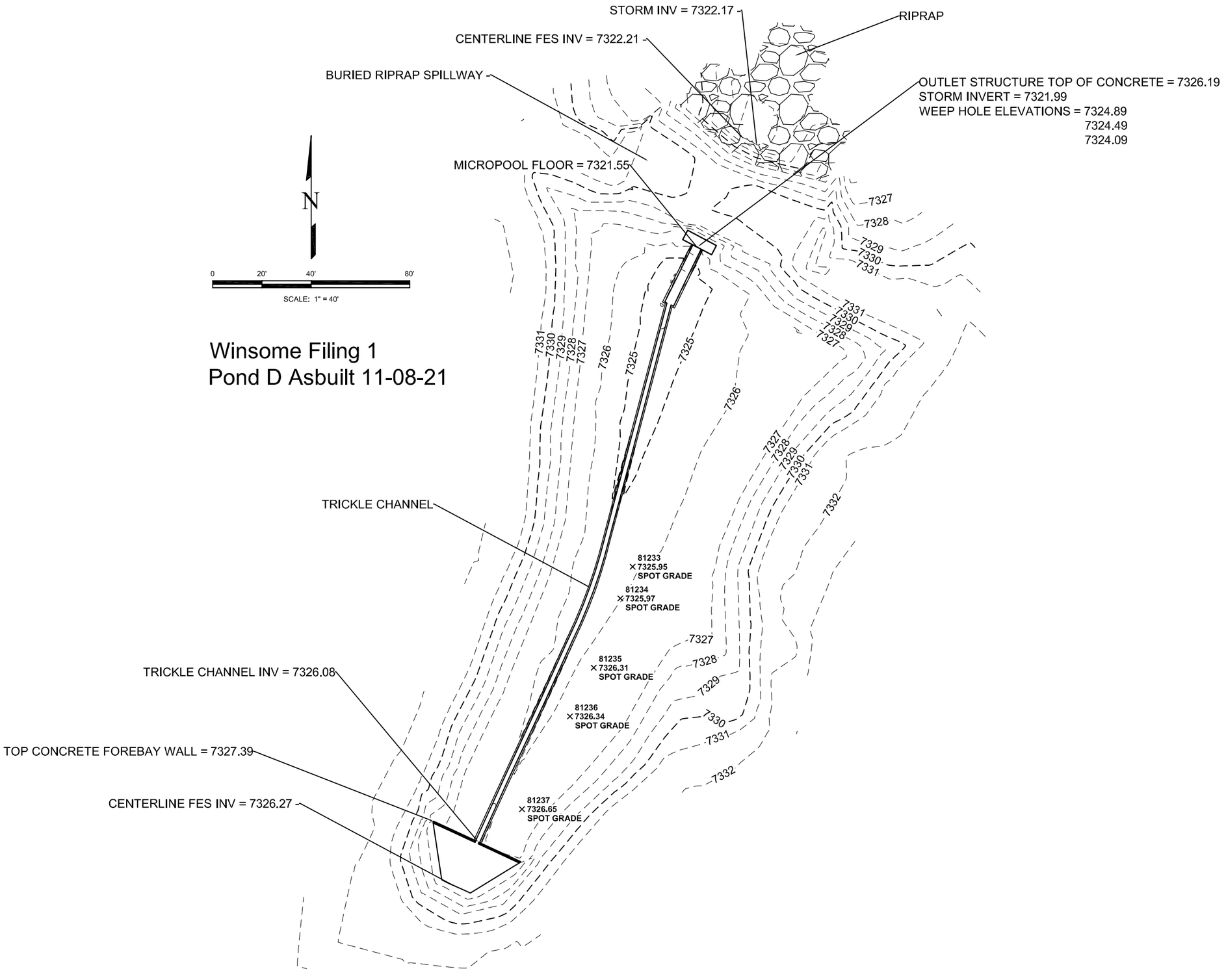
TOP CONCRETE FOREBAY = 7335.48

TRICKLE CHANNEL

CENTERLINE FES INV = 7334.32

TRICKLE CHANNEL INV = 7334.26

GRAVEL ROAD


STORM INV = 7322.17
RIPRAP
CENTERLINE FES INV = 7322.21
BURIED RIPRAP SPILLWAY
OUTLET STRUCTURE TOP OF CONCRETE = 7326.19
STORM INVERT = 7321.99
WEEP HOLE ELEVATIONS = 7324.89
7324.49
7324.09
MICROPOOL FLOOR = 7321.55
N
0
20'
40'
80'
SCALE: 1" = 40'
Winsome Filing 1
Pond D Asbuilt 11-08-21
7327
7328
7329
7330
7331
7326
7325
TRICKLE CHANNEL
81233
7325.95
SPOT GRADE
81234
7325.97
SPOT GRADE
81235
7326.31
SPOT GRADE
81236
7326.34
SPOT GRADE
81237
7326.65
SPOT GRADE
7332
TRICKLE CHANNEL INV = 7326.08
TOP CONCRETE FOREBAY WALL = 7327.39
CENTERLINE FES INV = 7326.27

Winsome Filing 1
Pond 3 Asbuilt 11-08-21

N

0 20' 40' 80'

SCALE: 1" = 40'

STORM INV = 7286.11

BURIED RIPRAP SPILLWAY

OUTLET STRUCTURE TOP OF CONCRETE = 7292.00
STORM INVERT = 7286.56
WEEP HOLE ELEVATIONS = 7289.3
7289.2
7289.0

TRICKLE CHANNEL
INV = 7290.42

MICRO POOL FLOOR = 7286.53

TRICKLE CHANNEL INV = 7289.82

TRICKLE CHANNEL INV = 7288.89

GRAVEL ROAD

TRICKLE CHANNEL INV = 7290.15

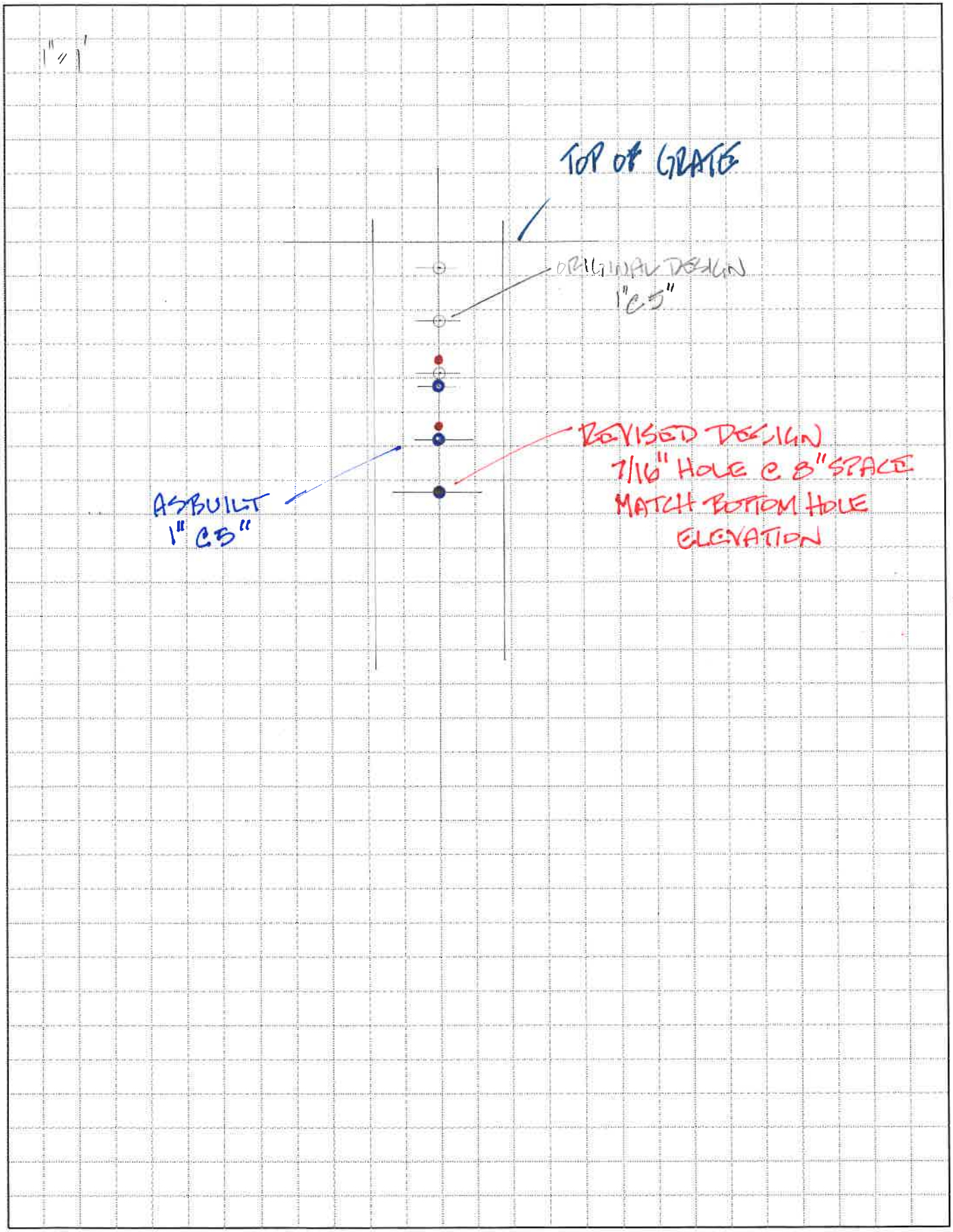
CONCRETE FOREBAY WALL = 7291.25

RIPRAP

7295
7291
7290
7300
7305
7310
7315

VERTEX®
2420 W. 26th AVE, SUITE 100-D
DENVER, COLORADO 80211
PH. (303) 623-9116
FAX (303) 623-9118

JOB WINSOME FILING No 1
SHEET NO.
CALCULATED BY DATE 11/11/21
CHECKED BY DATE
SCALE POND C



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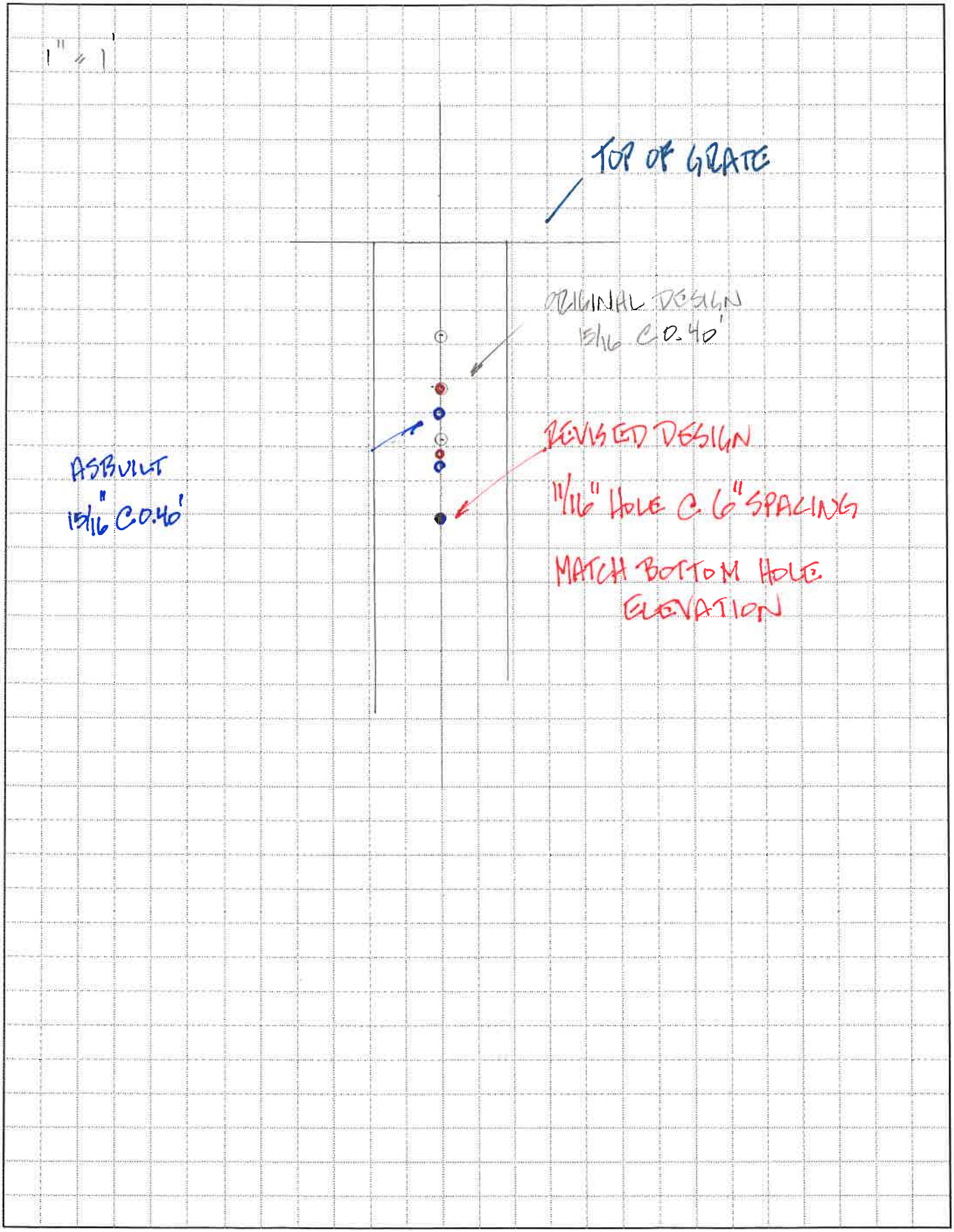
2420 W. 26th AVE, SUITE 100-D
DENVER, COLORADO 80211
PH. (303) 623-9116
FAX (303) 623-9118

JOB WINSOME FILING No 1
SHEET NO.
CALCULATED BY DATE 12/11/21
CHECKED BY DATE
SCALE POND D



DETENTION BASIN DESIGN WORKBOOK

UD-Detention, Version 3.07 (February 2017)

Urban Drainage and Flood Control District
Denver, Colorado
www.udfcd.org

Purpose:

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

Function:

1. **Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.**

2. **Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.**

Content:

This workbook consists of the following sheets:

Basin	Tabulates stage-area-volume relationship estimates based on watershed parameters
Outlet Structure	Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).
Reference	Provides reference equations and figures.
User Tips and Tools	Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.
BMP Zone Images	Provides images of typical BMP zone confirgurations corresponding with Zone pulldown selections.

Acknowledgements:

Spreadsheet Development Team:
Ken MacKenzie, P.E., Holly Piza, P.E.
Urban Drainage and Flood Control District

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

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

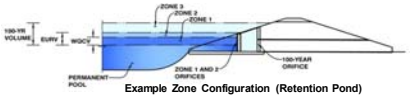
Comments?	Direct all comments regarding this spreadsheet workbook to:	**UDFCD email**
Revisions?	Check for revised versions of this or any other workbook at:	Downloads

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Winsome Filing 1 - Water Quality Pond B

Basin ID: WQ Pond B



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	11.00	acres
Watershed Length =	1,048	ft
Watershed Slope =	0.019	ft/ft
Watershed Imperviousness =	11.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.067	acre-feet
Excess Urban Runoff Volume (EURV) =	0.115	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.080	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.123	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.268	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.680	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	0.939	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	1.277	acre-feet
500-yr Runoff Volume (P1 = 0 in.) =	0.000	acre-feet
Approximate 2-yr Detention Volume =	0.074	acre-feet
Approximate 5-yr Detention Volume =	0.115	acre-feet
Approximate 10-yr Detention Volume =	0.229	acre-feet
Approximate 25-yr Detention Volume =	0.315	acre-feet
Approximate 50-yr Detention Volume =	0.330	acre-feet
Approximate 100-yr Detention Volume =	0.425	acre-feet

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

Stage-Storage Calculation

Zone 1 Volume (User Defined) =	0.017	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.017	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

WQCV not provided!

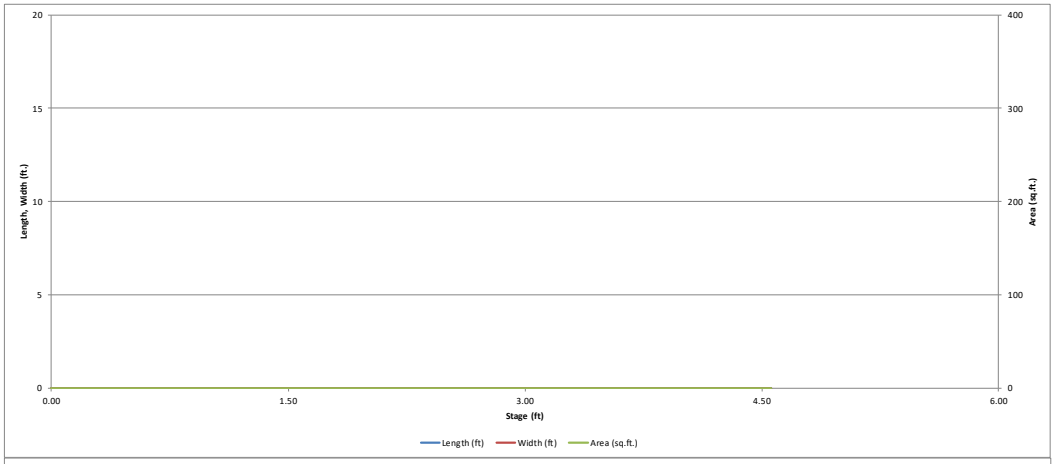
Total detention volume is less than 100-year volume.

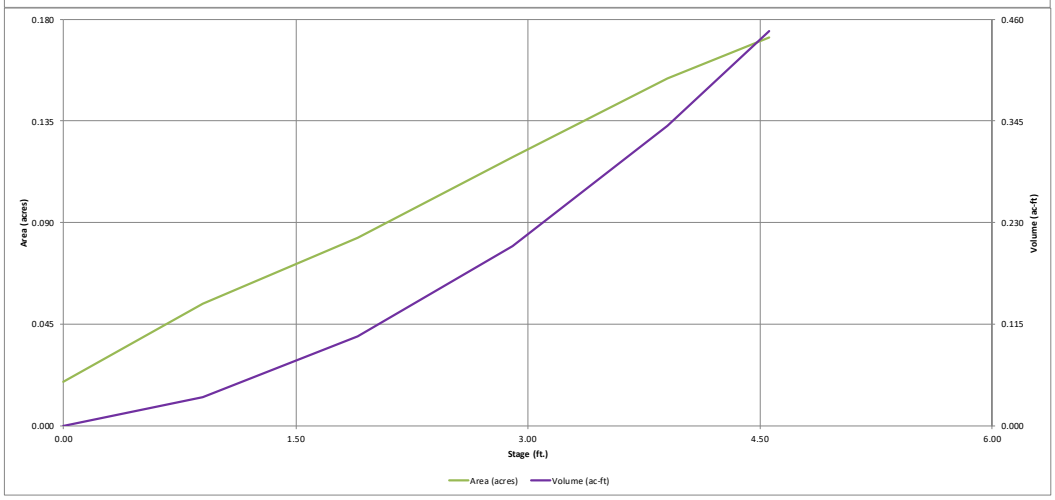
Depth Increment = ft

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)
Top of Micropool	--	0.00	--	--	--	852	0.020		
7345	--	0.90	--	--	--	2,356	0.054	1,420	0.033
7346	--	1.90	--	--	--	3,627	0.083	4,399	0.101
7347	--	2.90	--	--	--	5,182	0.119	8,840	0.203
7348	--	3.90	--	--	--	6,697	0.154	14,779	0.339
7348.66	--	4.56	--	--	--	7,491	0.172	19,461	0.447

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



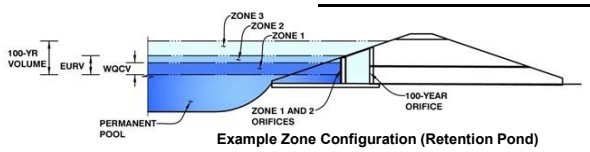


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Winsome Filing 1 - Water Quality Pond B

Basin ID: WQ Pond B



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (User)	0.57	0.017	Orifice Plate
Zone 2			Weir&Pipe (Circular)
Zone 3			
		0.017	Total

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)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.083E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.95	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	5.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.30	sq. inches (diameter = 5/8 inch)	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	0.40	0.80					
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)

	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) and Grate (Flat or Sloped)

	Zone 2 Weir	Not Selected			Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	0.95		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	0.95		feet
Overflow Weir Front Edge Length =	4.00		feet	Over Flow Weir Slope Length =	3.00		feet
Overflow Weir Slope =	0.00		H:V (enter zero for flat grate)	Grate Open Area / 100-yr Orifice Area =	5.77		should be $\geq$ 4
Horiz. Length of Weir Sides =	3.00		feet	Overflow Grate Open Area w/o Debris =	10.20		ft^2
Overflow Grate Open Area % =	85%		%, grate open area/total area	Overflow Grate Open Area w/ Debris =	5.10		ft^2
Debris Clogging % =	50%		%				

Calculated Parameters for Overflow Weir

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

	Zone 2 Circular	Not Selected			Zone 2 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	3.05		ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.77		ft^2
Circular Orifice Diameter =	18.00		inches	Outlet Orifice Centroid =	0.75		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=	2.52	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.70	feet
Spillway Crest Length =	9.00	feet	Stage at Top of Freeboard =	4.22	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.16	acres
Freeboard above Max Water Surface =	1.00	feet			

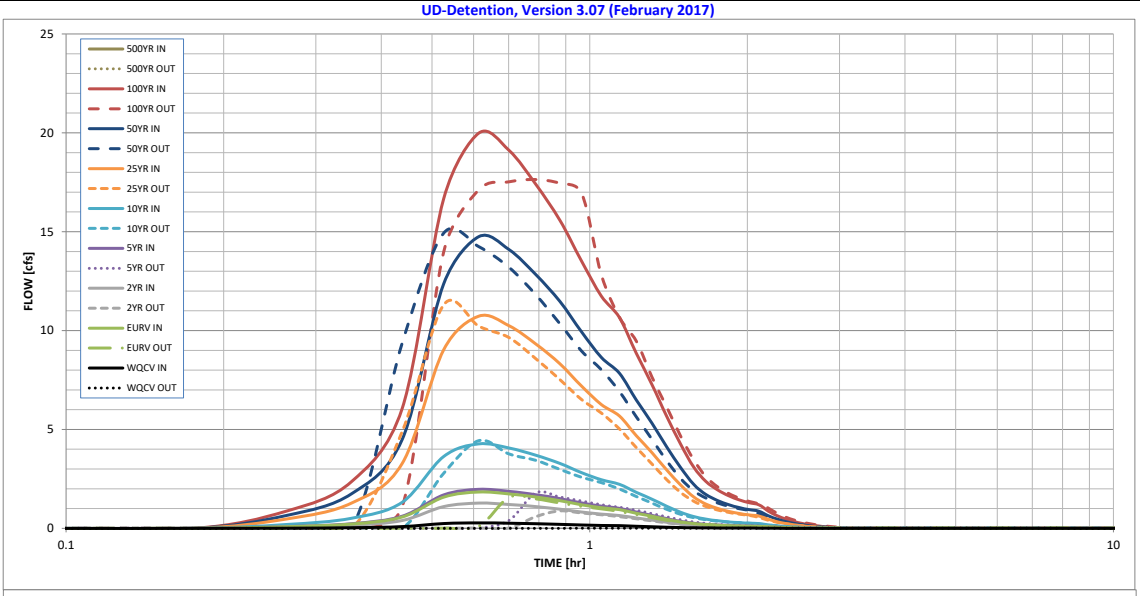
Calculated Parameters for Spillway

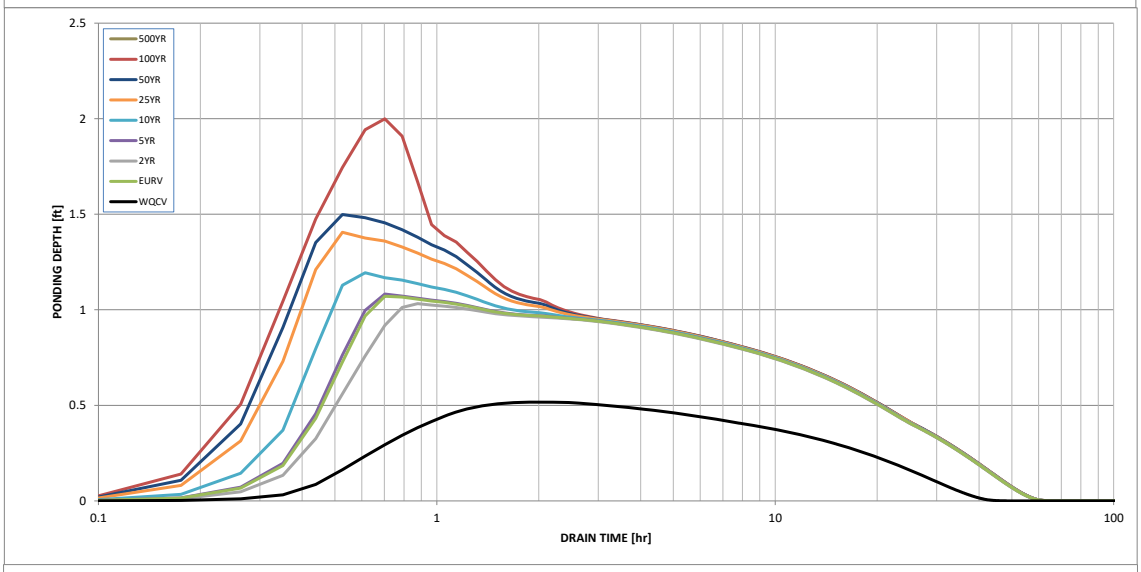
Routed Hydrograph Results

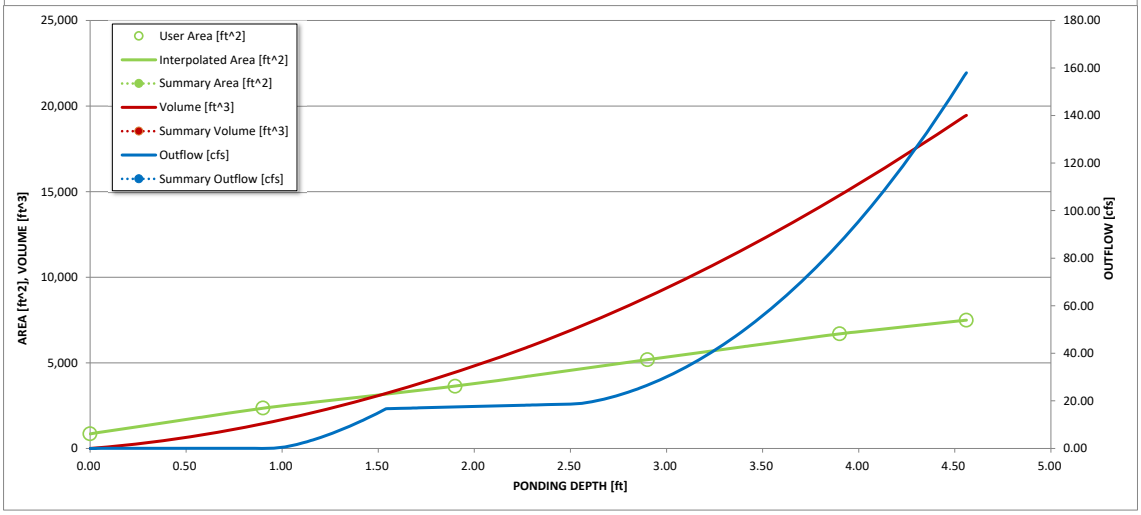
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	0.00
Calculated Runoff Volume (acre-ft) =	0.067	0.115	0.080	0.123	0.268	0.680	0.939	1.277	0.000
OPTIONAL Override Runoff Volume (acre-ft) =	0.017								
Inflow Hydrograph Volume (acre-ft) =	0.017	0.114	0.079	0.122	0.268	0.680	0.939	1.276	#N/A
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.19	0.63	0.87	1.17	0.00
Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	0.2	2.1	6.9	9.5	12.8	0.0
Peak Inflow Q (cfs) =	0.3	1.8	1.3	2.0	4.3	10.7	14.8	20.0	#N/A
Peak Outflow Q (cfs) =	0.0	1.6	0.9	1.8	4.4	11.3	14.9	17.6	#N/A
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	8.4	2.2	1.6	1.6	1.4	#N/A
Structure Controlling Flow =	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	#N/A
Max Velocity through Grate 1 (fps) =	N/A	0.13	0.07	0.1	0.4	1.1	1.4	1.7	#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) =	38	43	46	42	31	15	8	3	#N/A
Time to Drain 99% of Inflow Volume (hours) =	**42**	52	54	51	46	34	29	23	#N/A
Maximum Ponding Depth (ft) =	0.52	1.07	1.03	1.08	1.19	1.41	1.50	2.00	#N/A
Area at Maximum Ponding Depth (acres) =	0.04	0.06	0.06	0.06	0.06	0.07	0.07	0.09	#N/A
Maximum Volume Stored (acre-ft) =	0.015	0.043	0.040	0.043	0.050	0.064	0.070	0.109	#N/A

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	#N/A
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]
5.26 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	0:05:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
Hydrograph	0:10:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
Constant	0:15:47	0.01	0.08	0.06	0.09	0.19	0.48	0.65	0.87	#N/A
0.951	0:21:02	0.03	0.22	0.16	0.24	0.51	1.28	1.75	2.36	#N/A
	0:26:18	0.09	0.57	0.40	0.62	1.32	3.29	4.50	6.07	#N/A
	0:31:34	0.24	1.58	1.10	1.70	3.64	9.04	12.36	16.67	#N/A
	0:36:49	0.28	1.84	1.28	1.97	4.27	10.73	14.75	19.99	#N/A
	0:42:05	0.26	1.74	1.21	1.87	4.07	10.24	14.09	19.11	#N/A
	0:47:20	0.24	1.59	1.10	1.70	3.70	9.33	12.83	17.40	#N/A
	0:52:36	0.21	1.40	0.97	1.51	3.29	8.33	11.48	15.59	#N/A
	0:57:52	0.17	1.20	0.83	1.29	2.82	7.20	9.94	13.52	#N/A
	1:03:07	0.15	1.05	0.72	1.13	2.46	6.27	8.65	11.75	#N/A
	1:08:23	0.14	0.95	0.65	1.02	2.23	5.68	7.84	10.66	#N/A
	1:13:38	0.11	0.77	0.53	0.82	1.82	4.69	6.49	8.85	#N/A
	1:18:54	0.08	0.61	0.42	0.66	1.48	3.83	5.32	7.27	#N/A
	1:24:10	0.06	0.46	0.31	0.49	1.12	2.95	4.12	5.66	#N/A
	1:29:25	0.04	0.33	0.22	0.36	0.82	2.20	3.09	4.27	#N/A
	1:34:41	0.03	0.24	0.17	0.26	0.60	1.59	2.23	3.11	#N/A
	1:39:56	0.03	0.19	0.13	0.21	0.47	1.23	1.72	2.38	#N/A
	1:45:12	0.02	0.16	0.11	0.17	0.39	1.01	1.41	1.95	#N/A
	1:50:28	0.02	0.14	0.09	0.15	0.33	0.86	1.20	1.65	#N/A
	1:55:43	0.02	0.12	0.08	0.13	0.29	0.76	1.05	1.45	#N/A
	2:00:59	0.02	0.11	0.07	0.12	0.26	0.68	0.95	1.30	#N/A
	2:06:14	0.01	0.10	0.07	0.11	0.24	0.63	0.87	1.19	#N/A
	2:11:30	0.01	0.07	0.05	0.08	0.18	0.46	0.64	0.88	#N/A
	2:16:46	0.01	0.05	0.04	0.06	0.13	0.34	0.47	0.64	#N/A
	2:22:01	0.01	0.04	0.03	0.04	0.10	0.25	0.34	0.47	#N/A
	2:27:17	0.00	0.03	0.02	0.03	0.07	0.18	0.25	0.35	#N/A
	2:32:32	0.00	0.02	0.01	0.02	0.05	0.13	0.18	0.25	#N/A
	2:37:48	0.00	0.01	0.01	0.02	0.03	0.09	0.13	0.18	#N/A
	2:43:04	0.00	0.01	0.01	0.01	0.02	0.07	0.09	0.13	#N/A
	2:48:19	0.00	0.01	0.00	0.01	0.02	0.04	0.06	0.09	#N/A
	2:53:35	0.00	0.00	0.00	0.00	0.01	0.03	0.04	0.05	#N/A
	2:58:50	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	#N/A
	3:04:06	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	#N/A
	3:09:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:14:37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:19:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:25:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:30:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:35:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:40:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:46:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:51:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:56:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:01:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:07:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:12:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:17:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:23:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:28:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:33:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:38:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:44:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:49:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:54:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:59:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:05:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:10:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:15:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:20:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:26:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:31:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:36:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:41:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:47:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:52:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:57:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:02:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:08:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:13:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:18:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

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).

DETENTION BASIN DESIGN WORKBOOK

UD-Detention, Version 3.07 (February 2017)

Urban Drainage and Flood Control District
Denver, Colorado
www.udfcd.org

Purpose:

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

Function:

1. **Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.**

2. **Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.**

Content:

This workbook consists of the following sheets:

Basin	Tabulates stage-area-volume relationship estimates based on watershed parameters
Outlet Structure	Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).
Reference	Provides reference equations and figures.
User Tips and Tools	Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.
BMP Zone Images	Provides images of typical BMP zone confirgurations corresponding with Zone pulldown selections.

Acknowledgements:

Spreadsheet Development Team:
Ken MacKenzie, P.E., Holly Piza, P.E.
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Peak Stormwater Engineering, LLC

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Professor, Department of Civil Engineering, University of Colorado at Denver

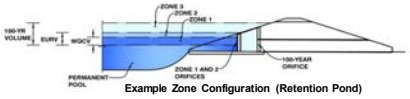
Comments? Direct all comments regarding this spreadsheet workbook to: **UDFCD email**
Revisions? Check for revised versions of this or any other workbook at: Downloads

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Winsome Filing 1 - Water Quality Pond C

Basin ID: WQ Pond C



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	136.50	acres
Watershed Length =	6,193	ft
Watershed Slope =	0.026	ft/ft
Watershed Imperviousness =	3.70%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.310	acre-feet
Excess Urban Runoff Volume (EURV) =	0.438	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.273	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.461	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	1.910	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	7.188	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	10.442	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	14.689	acre-feet
500-yr Runoff Volume (P1 = 0 in.) =	0.000	acre-feet
Approximate 2-yr Detention Volume =	0.252	acre-feet
Approximate 5-yr Detention Volume =	0.430	acre-feet
Approximate 10-yr Detention Volume =	1.559	acre-feet
Approximate 25-yr Detention Volume =	2.421	acre-feet
Approximate 50-yr Detention Volume =	2.420	acre-feet
Approximate 100-yr Detention Volume =	3.266	acre-feet

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

Stage-Storage Calculation

Zone 1 Volume (User Defined) =	0.048	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.048	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

WQCV not provided!

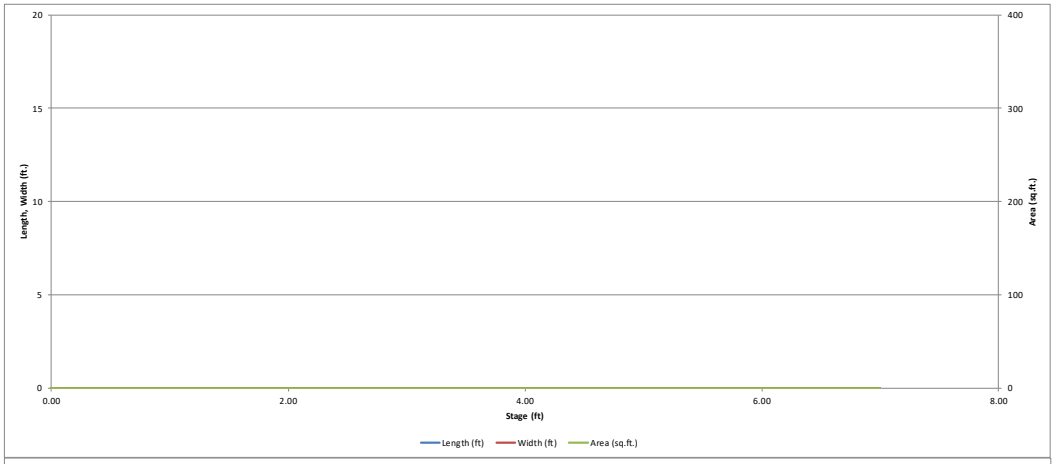
Total detention volume is less than 100-year volume.

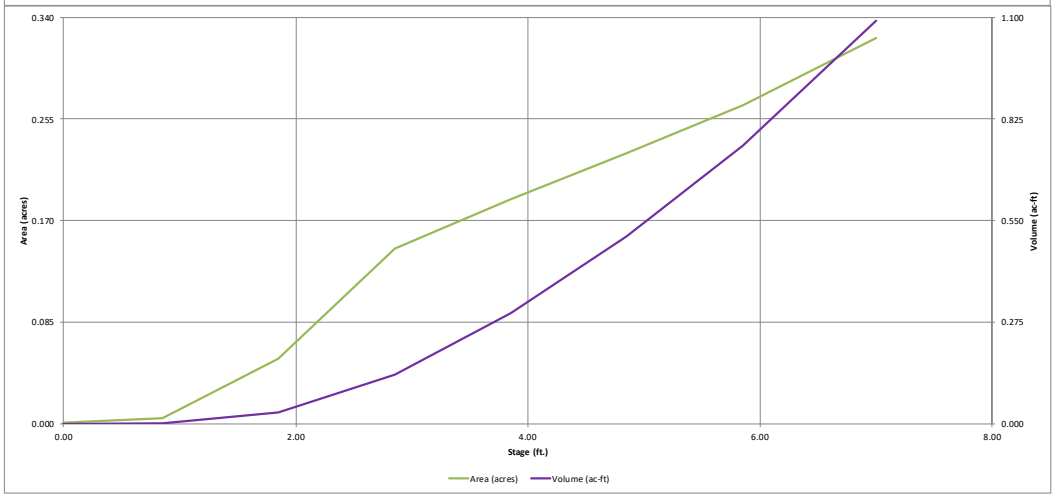
Depth Increment = ft

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)
Top of Micropool	--	0.00	--	--	--	40	0.001		
7333	--	0.85	--	--	--	212	0.005	105	0.002
7334	--	1.85	--	--	--	2,362	0.054	1,371	0.031
7335	--	2.85	--	--	--	6,372	0.146	5,761	0.132
7336	--	3.85	--	--	--	8,176	0.188	13,035	0.299
7337	--	4.85	--	--	--	9,844	0.226	22,045	0.506
7338	--	5.85	--	--	--	11,605	0.266	32,770	0.752
7339	--	7.00	--	--	--	14,060	0.323	47,527	1.091

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



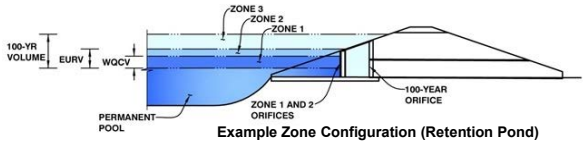


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Winsome Filing 1 - Water Quality Pond C

Basin ID: WQ Pond C



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (User)	2.10	0.048	Orifice Plate
Zone 2			Weir&Pipe (Circular)
Zone 3			
		0.048	Total

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 Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	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 =	2.10	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	0.15	sq. inches (diameter = 7/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.042E-03	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	0.70	1.40					
Orifice Area (sq. inches)	0.15	0.15	0.15					

	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 =			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

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.90		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	14.00		feet
Overflow Weir Slope =	0.00		H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	3.00		feet
Overflow Grate Open Area % =	85%		%, grate open area/total area
Debris Clogging % =	50%		%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	1.90		feet
Over Flow Weir Slope Length =	3.00		feet
Grate Open Area / 100-yr Orifice Area =	2.24		should be ≥ 4
Overflow Grate Open Area w/o Debris =	35.70		ft^2
Overflow Grate Open Area w/ Debris =	17.85		ft^2

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

	Zone 2 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	2.30		ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =	54.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Circular	Not Selected	
Outlet Orifice Area =	15.90		ft^2
Outlet Orifice Centroid =	2.25		feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.41	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	56.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.96	feet
Stage at Top of Freeboard =	7.37	feet
Basin Area at Top of Freeboard =	0.32	acres

Routed Hydrograph Results

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) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	0.00
Calculated Runoff Volume (acre-ft) =	0.310	0.438	0.273	0.461	1.910	7.188	10.442	14.689	0.000
OPTIONAL Override Runoff Volume (acre-ft) =	0.048								
Inflow Hydrograph Volume (acre-ft) =	0.048	0.438	0.272	0.460	1.909	7.179	10.433	14.682	#N/A
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.01	0.13	0.46	0.64	0.88	0.00
Predevelopment Peak Q (cfs) =	0.0	0.0	1.1	1.9	17.8	63.0	87.5	119.5	0.0
Peak Inflow Q (cfs) =	0.6	5.3	3.3	5.6	22.8	83.6	120.1	166.9	#N/A
Peak Outflow Q (cfs) =	0.3	6.7	3.2	7.0	22.8	84.1	120.6	163.5	#N/A
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	3.6	1.3	1.3	1.4	1.4	#N/A
Structure Controlling Flow =	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	#N/A
Max Velocity through Grate 1 (fps) =	0.00	0.19	0.08	0.2	0.6	2.3	3.4	4.6	#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) =	39	23	29	22	1	1	1	1	#N/A
Time to Drain 99% of Inflow Volume (hours) =	**43**	34	37	34	17	2	2	2	#N/A
Maximum Ponding Depth (ft) =	1.92	2.08	2.01	2.08	2.30	2.88	3.30	4.51	#N/A
Area at Maximum Ponding Depth (acres) =	0.06	0.07	0.07	0.08	0.10	0.15	0.16	0.21	#N/A
Maximum Volume Stored (acre-ft) =	0.036	0.046	0.041	0.047	0.066	0.137	0.202	0.429	#N/A

Detention Basin Outlet Structure Design

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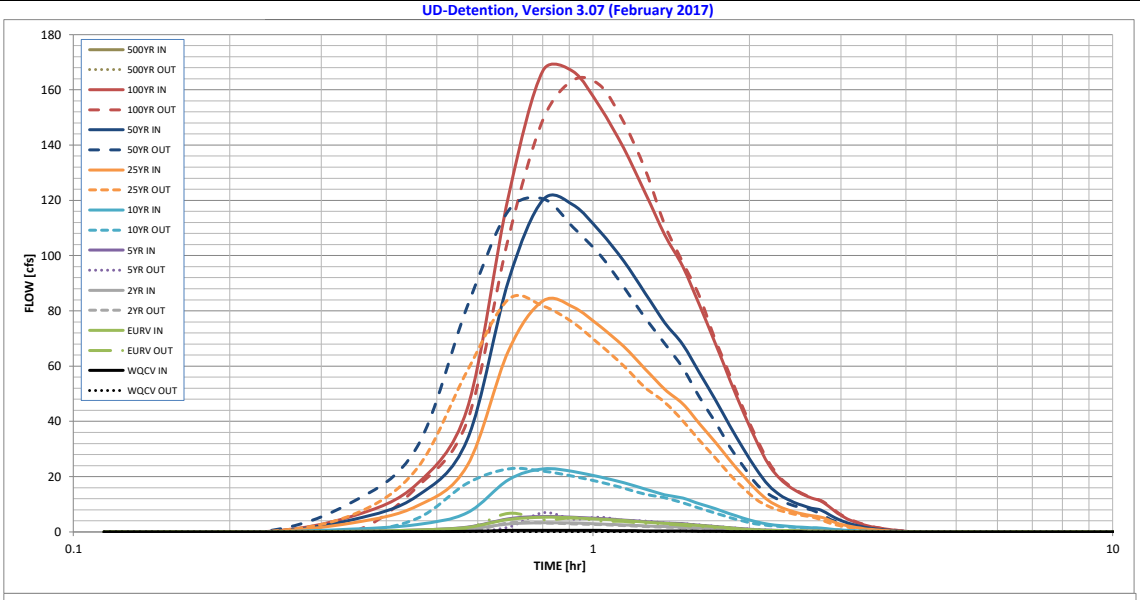

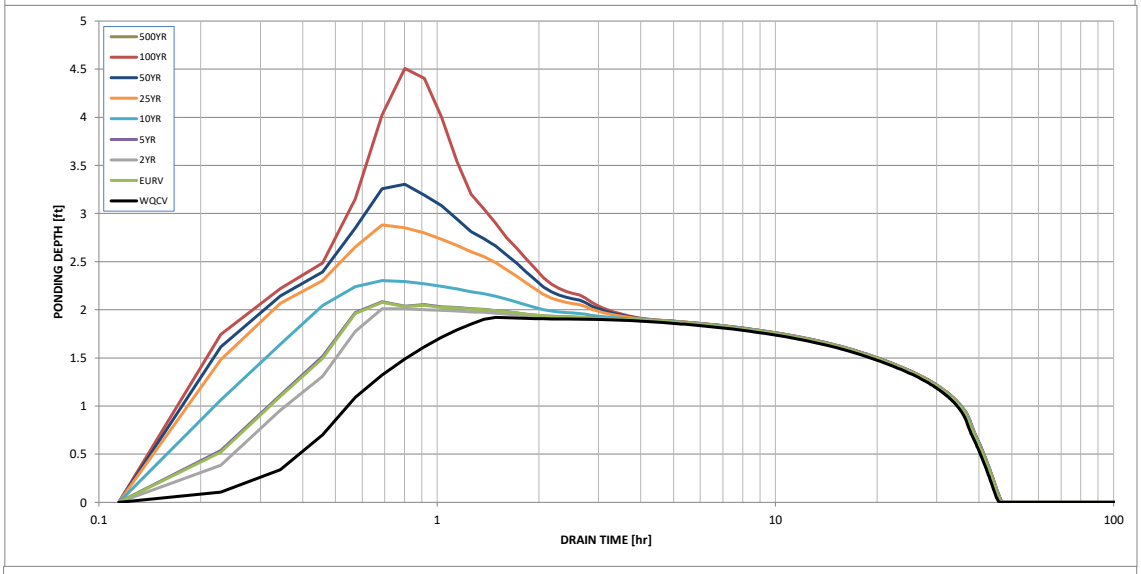

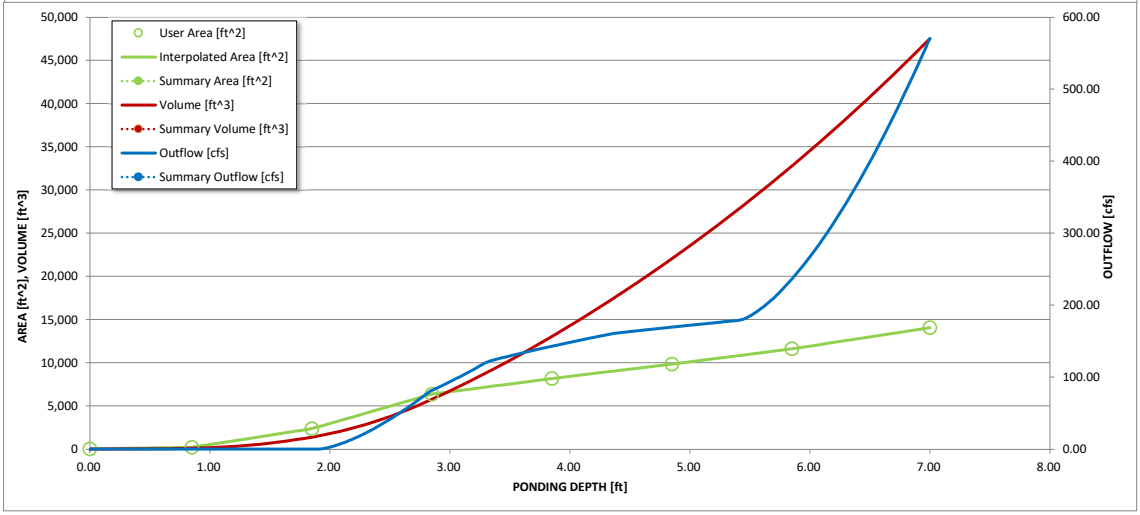

S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

Time Interval	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	#N/A
	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]
6.87 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	0:06:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
Hydrograph	0:13:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
Constant	0:20:37	0.03	0.24	0.15	0.25	0.98	3.25	4.38	5.63	#N/A
0.728	0:27:29	0.07	0.64	0.40	0.67	2.68	9.32	12.95	17.32	#N/A
	0:34:21	0.19	1.64	1.03	1.72	6.88	23.94	33.29	44.55	#N/A
	0:41:13	0.52	4.50	2.83	4.72	18.87	65.53	90.94	121.46	#N/A
	0:48:05	0.60	5.32	3.33	5.58	22.78	83.58	120.14	166.93	#N/A
	0:54:58	0.56	5.07	3.17	5.32	21.81	81.34	118.29	166.62	#N/A
	1:01:50	0.51	4.61	2.88	4.84	19.85	74.43	108.69	153.81	#N/A
	1:08:42	0.45	4.11	2.56	4.32	17.82	67.12	98.10	138.91	#N/A
	1:15:34	0.38	3.54	2.20	3.72	15.49	58.96	86.41	122.70	#N/A
	1:22:26	0.33	3.09	1.92	3.24	13.45	51.58	75.68	107.54	#N/A
	1:29:19	0.30	2.80	1.74	2.94	12.20	46.36	67.78	95.95	#N/A
	1:36:11	0.24	2.30	1.42	2.42	10.17	39.13	57.57	82.03	#N/A
	1:43:03	0.19	1.87	1.15	1.97	8.38	32.51	47.91	68.36	#N/A
	1:49:55	0.14	1.43	0.87	1.51	6.57	25.98	38.51	55.26	#N/A
	1:56:47	0.10	1.06	0.64	1.12	5.00	20.21	30.09	43.33	#N/A
	2:03:40	0.07	0.77	0.47	0.81	3.68	15.24	22.81	33.05	#N/A
	2:10:32	0.06	0.60	0.37	0.63	2.79	11.33	16.84	24.45	#N/A
	2:17:24	0.05	0.49	0.30	0.52	2.27	9.03	13.35	19.21	#N/A
	2:24:16	0.04	0.42	0.26	0.44	1.92	7.58	11.18	16.01	#N/A
	2:31:08	0.04	0.37	0.23	0.39	1.68	6.57	9.66	13.79	#N/A
	2:38:01	0.03	0.33	0.20	0.35	1.50	5.86	8.60	12.25	#N/A
	2:44:53	0.03	0.31	0.19	0.32	1.38	5.35	7.85	11.15	#N/A
	2:51:45	0.02	0.23	0.14	0.24	1.02	4.06	6.04	8.74	#N/A
	2:58:37	0.02	0.17	0.10	0.17	0.74	2.93	4.35	6.30	#N/A
	3:05:29	0.01	0.12	0.07	0.13	0.55	2.17	3.23	4.67	#N/A
	3:12:22	0.01	0.09	0.05	0.09	0.41	1.61	2.40	3.46	#N/A
	3:19:14	0.01	0.06	0.04	0.07	0.29	1.19	1.77	2.57	#N/A
	3:26:06	0.00	0.04	0.03	0.05	0.21	0.86	1.28	1.86	#N/A
	3:32:58	0.00	0.03	0.02	0.03	0.15	0.62	0.93	1.35	#N/A
	3:39:50	0.00	0.02	0.01	0.02	0.10	0.44	0.66	0.97	#N/A
	3:46:43	0.00	0.01	0.01	0.01	0.06	0.29	0.44	0.65	#N/A
	3:53:35	0.00	0.01	0.00	0.01	0.04	0.17	0.26	0.40	#N/A
	4:00:27	0.00	0.00	0.00	0.00	0.01	0.08	0.13	0.20	#N/A
	4:07:19	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.07	#N/A
	4:14:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	#N/A
	4:21:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:27:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:34:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:41:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:48:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:55:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:02:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:09:09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:16:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:22:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:29:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:36:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:43:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:50:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:57:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:04:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:10:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:17:51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:24:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:31:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:38:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:45:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:52:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:59:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:05:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:12:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:19:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:26:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:33:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:40:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:47:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:54:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	8:00:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	8:07:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	8:14:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

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).

DETENTION BASIN DESIGN WORKBOOK

UD-Detention, Version 3.07 (February 2017)

Urban Drainage and Flood Control District
Denver, Colorado
www.udfcd.org

Purpose:

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

Function:

1. **Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.**

2. **Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.**

Content:

This workbook consists of the following sheets:

Basin	Tabulates stage-area-volume relationship estimates based on watershed parameters
Outlet Structure	Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).
Reference	Provides reference equations and figures.
User Tips and Tools	Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.
BMP Zone Images	Provides images of typical BMP zone confirgurations corresponding with Zone pulldown selections.

Acknowledgements:

Spreadsheet Development Team:
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Peak Stormwater Engineering, LLC

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

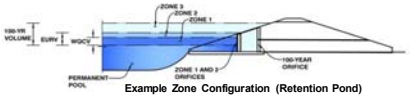
Comments? Direct all comments regarding this spreadsheet workbook to: **UDFCD email**
Revisions? Check for revised versions of this or any other workbook at: Downloads

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Winsome Filing 1 - Water Quality Pond D

Basin ID: Basin D1.1+D2 with Manual WQ Area



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	127.00	acres
Watershed Length =	4,370	ft
Watershed Slope =	0.034	ft/ft
Watershed Imperviousness =	7.60%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.559	acre-feet
Excess Urban Runoff Volume (EURV) =	0.887	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.594	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.945	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	2.479	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	7.312	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	10.317	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	14.240	acre-feet
500-yr Runoff Volume (P1 = 0 in.) =	0.000	acre-feet
Approximate 2-yr Detention Volume =	0.550	acre-feet
Approximate 5-yr Detention Volume =	0.884	acre-feet
Approximate 10-yr Detention Volume =	2.088	acre-feet
Approximate 25-yr Detention Volume =	3.038	acre-feet
Approximate 50-yr Detention Volume =	3.149	acre-feet
Approximate 100-yr Detention Volume =	4.132	acre-feet

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

Stage-Storage Calculation

Zone 1 Volume (User Defined) =	0.051	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.051	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

WQCV not provided!

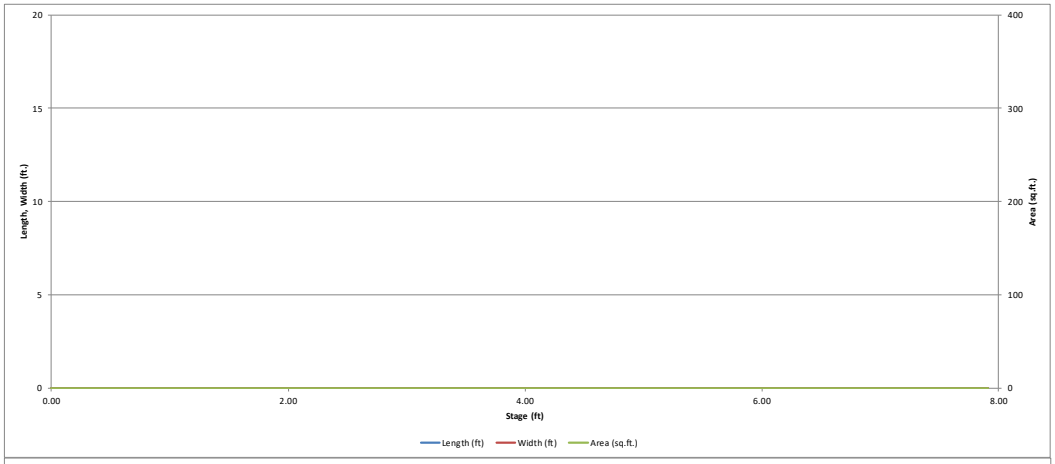
Total detention volume is less than 100-year volume.

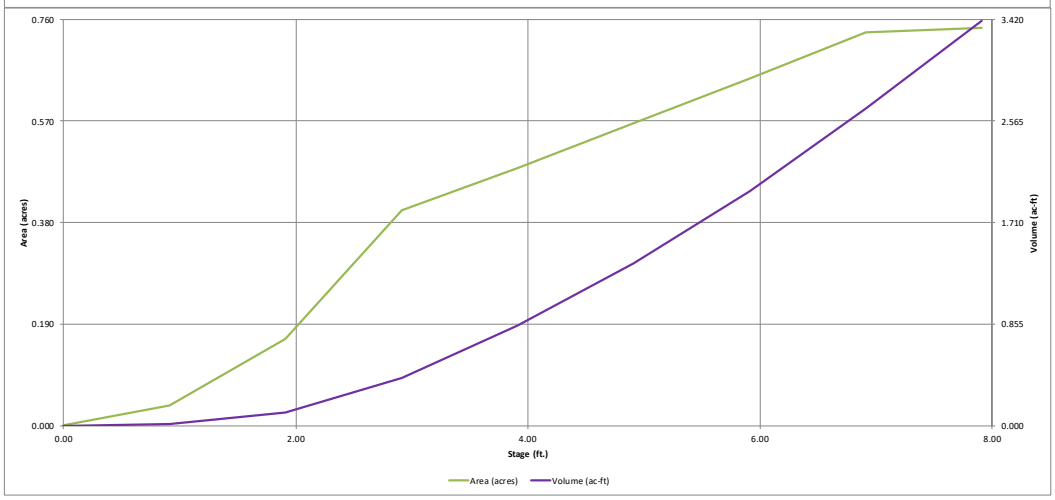
Depth Increment = ft

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)
Top of Micropool	--	0.00	--	--	--	64	0.001		
7325	--	0.91	--	--	--	1,677	0.038	775	0.018
7326	--	1.91	--	--	--	7,079	0.163	5,100	0.117
7327	--	2.91	--	--	--	17,549	0.403	17,484	0.401
7328	--	3.91	--	--	--	20,953	0.481	36,735	0.843
7329	--	4.91	--	--	--	24,621	0.565	59,522	1.366
Spillway	--	5.91	--	--	--	28,289	0.649	85,977	1.974
7331	--	6.91	--	--	--	31,993	0.734	116,118	2.666
7332	--	7.91	--	--	--	32,388	0.744	148,309	3.405

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



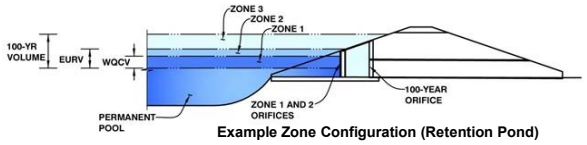


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Winsome Filing 1 - Water Quality Pond

Basin ID: Basin D1.1+D2



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (User)	1.40	0.051	Orifice Plate
Zone 2			Weir&Pipe (Circular)
Zone 3			
		0.051	Total

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 Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	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 =	1.40	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	6.00	inches
Orifice Plate: Orifice Area per Row =	0.40	sq. inches (diameter = 11/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	2.778E-03	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	0.50	1.00					
Orifice Area (sq. inches)	0.40	0.40	0.40					

	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 =			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

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.10		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	12.00		feet
Overflow Weir Slope =	0.00		H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	3.00		feet
Overflow Grate Open Area % =	85%		%, grate open area/total area
Debris Clogging % =	50%		%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	2.10		feet
Over Flow Weir Slope Length =	3.00		feet
Grate Open Area / 100-yr Orifice Area =	1.92		should be ≥ 4
Overflow Grate Open Area w/o Debris =	30.60		ft^2
Overflow Grate Open Area w/ Debris =	15.30		ft^2

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

	Zone 2 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	2.10		ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =	54.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Circular	Not Selected	
Outlet Orifice Area =	15.90		ft^2
Outlet Orifice Centroid =	2.25		feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.80	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	68.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

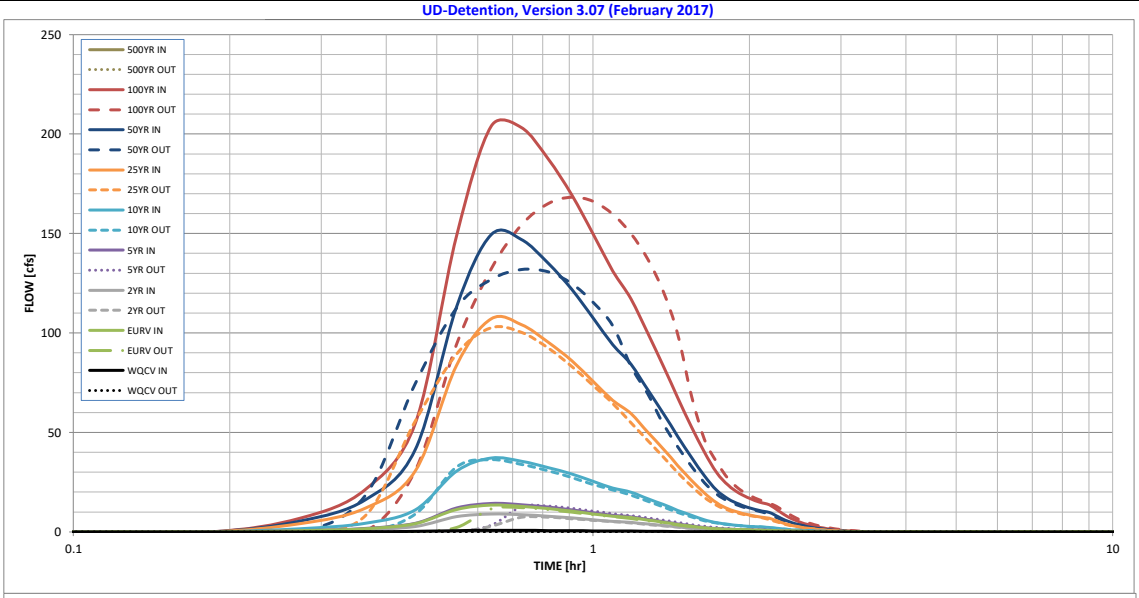
Spillway Design Flow Depth=	0.97	feet
Stage at Top of Freeboard =	7.77	feet
Basin Area at Top of Freeboard =	0.74	acres

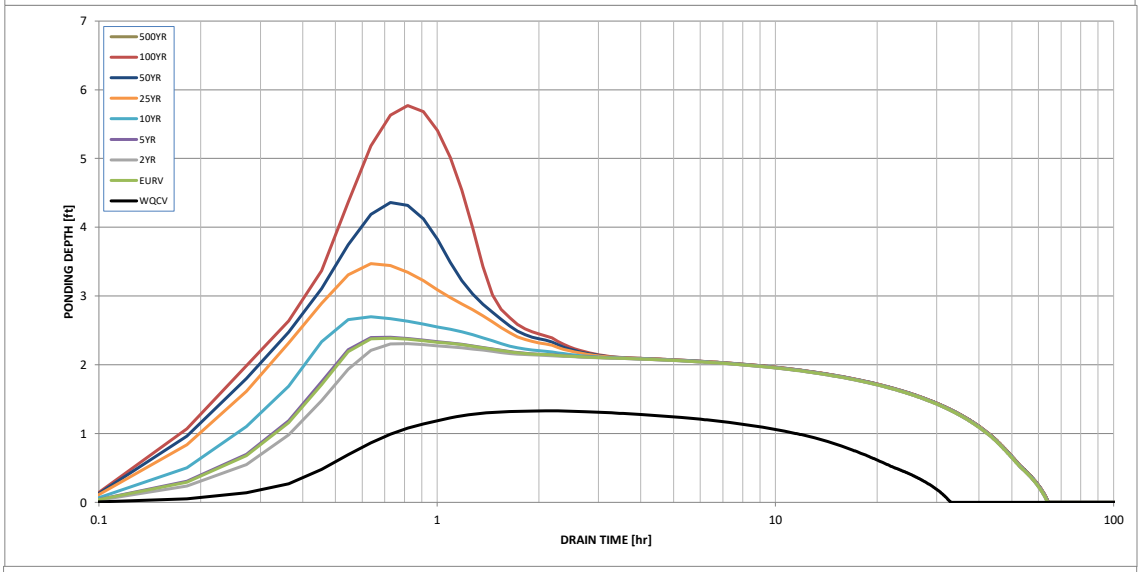
Routed Hydrograph Results

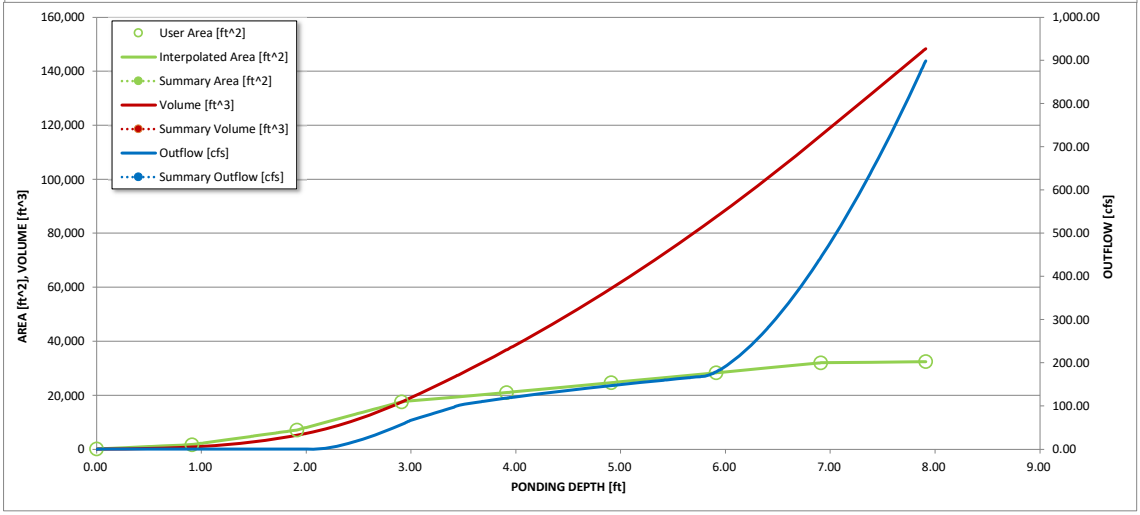
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	0.00
Calculated Runoff Volume (acre-ft) =	0.559	0.887	0.594	0.945	2.479	7.312	10.317	14.240	0.000
OPTIONAL Override Runoff Volume (acre-ft) =	0.051								
Inflow Hydrograph Volume (acre-ft) =	0.050	0.887	0.594	0.944	2.479	7.310	10.306	14.238	#N/A
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.18	0.60	0.82	1.11	0.00
Predevelopment Peak Q (cfs) =	0.0	0.0	1.4	2.4	22.3	75.6	104.6	141.5	0.0
Peak Inflow Q (cfs) =	0.8	13.4	9.0	14.3	37.1	107.0	149.4	203.9	#N/A
Peak Outflow Q (cfs) =	0.0	12.2	7.4	13.0	36.3	102.6	131.9	168.2	#N/A
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	5.5	1.6	1.4	1.3	1.2	#N/A
Structure Controlling Flow =	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	#N/A
Max Velocity through Grate 1 (fps) =	N/A	0.40	0.25	0.4	1.2	3.3	4.3	5.5	#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) =	29	40	45	40	24	2	2	2	#N/A
Time to Drain 99% of Inflow Volume (hours) =	31	51	53	50	41	25	17	7	#N/A
Maximum Ponding Depth (ft) =	1.33	2.39	2.31	2.40	2.70	3.47	4.36	5.77	#N/A
Area at Maximum Ponding Depth (acres) =	0.09	0.28	0.26	0.28	0.35	0.45	0.52	0.64	#N/A
Maximum Volume Stored (acre-ft) =	0.044	0.222	0.200	0.227	0.319	0.639	1.063	1.884	#N/A

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

Time Interval	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	#N/A
	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]
5.46 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	0:05:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
Hydrograph	0:10:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
Constant	0:16:23	0.04	0.59	0.40	0.63	1.58	4.16	5.46	6.93	#N/A
0.916	0:21:50	0.10	1.60	1.08	1.70	4.34	11.92	16.13	21.24	#N/A
	0:27:18	0.25	4.11	2.77	4.36	11.14	30.62	41.44	54.63	#N/A
	0:32:46	0.69	11.28	7.62	11.98	30.57	83.80	113.23	148.96	#N/A
	0:38:13	0.80	13.45	9.04	14.29	37.08	107.04	149.38	203.94	#N/A
	0:43:41	0.75	12.84	8.62	13.66	35.54	104.21	147.01	203.29	#N/A
	0:49:08	0.68	11.69	7.85	12.43	32.34	95.38	135.07	187.58	#N/A
	0:54:36	0.60	10.46	7.01	11.13	29.07	86.02	121.90	169.39	#N/A
	1:00:04	0.51	9.05	6.05	9.63	25.32	75.56	107.37	149.59	#N/A
	1:05:31	0.45	7.88	5.27	8.38	22.04	66.11	94.03	131.10	#N/A
	1:10:59	0.40	7.14	4.77	7.60	19.95	59.41	84.22	117.01	#N/A
	1:16:26	0.32	5.91	3.94	6.29	16.66	50.16	71.52	99.98	#N/A
	1:21:54	0.26	4.84	3.21	5.15	13.76	41.68	59.52	83.30	#N/A
	1:27:22	0.19	3.75	2.47	3.99	10.82	33.32	47.83	67.31	#N/A
	1:32:49	0.13	2.80	1.84	2.99	8.28	25.93	37.37	52.76	#N/A
	1:38:17	0.10	2.02	1.33	2.16	6.12	19.55	28.32	40.21	#N/A
	1:43:44	0.08	1.56	1.03	1.67	4.63	14.53	20.92	29.74	#N/A
	1:49:12	0.07	1.28	0.85	1.37	3.75	11.58	16.58	23.38	#N/A
	1:54:40	0.06	1.09	0.72	1.16	3.17	9.71	13.88	19.50	#N/A
	2:00:07	0.05	0.96	0.63	1.02	2.76	8.42	12.00	16.81	#N/A
	2:05:35	0.05	0.86	0.57	0.92	2.48	7.51	10.69	14.93	#N/A
	2:11:02	0.04	0.79	0.53	0.84	2.27	6.86	9.75	13.59	#N/A
	2:16:30	0.03	0.58	0.39	0.62	1.68	5.21	7.50	10.63	#N/A
	2:21:58	0.02	0.43	0.28	0.45	1.22	3.76	5.41	7.66	#N/A
	2:27:25	0.02	0.31	0.21	0.33	0.90	2.79	4.01	5.68	#N/A
	2:32:53	0.01	0.23	0.15	0.25	0.67	2.07	2.98	4.21	#N/A
	2:38:20	0.01	0.17	0.11	0.18	0.49	1.53	2.20	3.12	#N/A
	2:43:48	0.01	0.12	0.08	0.13	0.35	1.10	1.59	2.27	#N/A
	2:49:16	0.00	0.08	0.05	0.09	0.25	0.80	1.15	1.64	#N/A
	2:54:43	0.00	0.06	0.04	0.06	0.17	0.56	0.82	1.18	#N/A
	3:00:11	0.00	0.03	0.02	0.04	0.11	0.37	0.55	0.79	#N/A
	3:05:38	0.00	0.02	0.01	0.02	0.06	0.22	0.33	0.48	#N/A
	3:11:06	0.00	0.01	0.00	0.01	0.03	0.11	0.16	0.24	#N/A
	3:16:34	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.09	#N/A
	3:22:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	#N/A
	3:27:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:32:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:38:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:43:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:49:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	3:54:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:00:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:05:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:11:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:16:37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:22:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:27:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:33:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:38:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:43:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:49:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:54:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:00:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:05:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:11:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:16:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:22:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:27:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:33:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:38:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:43:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:49:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:54:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:00:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:05:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:11:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:16:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:22:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:27:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:33:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

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).

DETENTION BASIN DESIGN WORKBOOK

UD-Detention, Version 3.07 (February 2017)

Urban Drainage and Flood Control District
Denver, Colorado
www.udfcd.org

Purpose:

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

Function:

1. **Approximates the stage-area-volume relationship for a detention basin based on watershed parameters and basin geometry parameters. Also evaluates existing user-defined basin stage-area relationships.**

2. **Sizes filtration media orifice, outlet orifices, elliptical slots, weirs, trash racks, and develops stage-discharge relationships. Uses the Modified Puls method to route a series of hydrographs (i.e., 2-, 5-, 10-, 25-, 50-, 100- and 500-year) and calibrates the peak discharge out of the basin to match the pre-development peak discharges for the watershed.**

Content:

This workbook consists of the following sheets:

Basin	Tabulates stage-area-volume relationship estimates based on watershed parameters
Outlet Structure	Tabulates a stage-discharge relationship for the user-defined outlet structure (inlet control).
Reference	Provides reference equations and figures.
User Tips and Tools	Provides instructions and video links to assist in using this workbook. Includes a stage-area calculator.
BMP Zone Images	Provides images of typical BMP zone confirgurations corresponding with Zone pulldown selections.

Acknowledgements:

Spreadsheet Development Team:
Ken MacKenzie, P.E., Holly Piza, P.E.
Urban Drainage and Flood Control District

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Peak Stormwater Engineering, LLC

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Professor, Department of Civil Engineering, University of Colorado at Denver

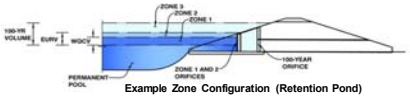
Comments? Direct all comments regarding this spreadsheet workbook to: **UDFCD email**
Revisions? Check for revised versions of this or any other workbook at: Downloads

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Winsome Filing 1 - Pond 3

Basin ID: Pond 3



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB		
Watershed Area =	101.00	acres	Note: L / W Ratio > 8
Watershed Length =	6,480	ft	L / W Ratio = 9.5
Watershed Slope =	0.029	ft/ft	
Watershed Imperviousness =	6.60%	percent	
Percentage Hydrologic Soil Group A =	0.0%	percent	
Percentage Hydrologic Soil Group B =	97.5%	percent	
Percentage Hydrologic Soil Groups C/D =	2.5%	percent	
Desired WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	User Input		
Water Quality Capture Volume (WQCV) =	0.392	acre-feet	Optional User Override 1-hr Precipitation
Excess Urban Runoff Volume (EURV) =	0.604	acre-feet	
2-yr Runoff Volume (P1 = 1.19 in.) =	0.401	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.659	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.857	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	5.716	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	8.114	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	11.244	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 0 in.) =	0.000	acre-feet	inches
Approximate 2-yr Detention Volume =	0.372	acre-feet	
Approximate 5-yr Detention Volume =	0.617	acre-feet	
Approximate 10-yr Detention Volume =	1.536	acre-feet	
Approximate 25-yr Detention Volume =	2.263	acre-feet	
Approximate 50-yr Detention Volume =	2.332	acre-feet	
Approximate 100-yr Detention Volume =	3.087	acre-feet	

Stage-Storage Calculation

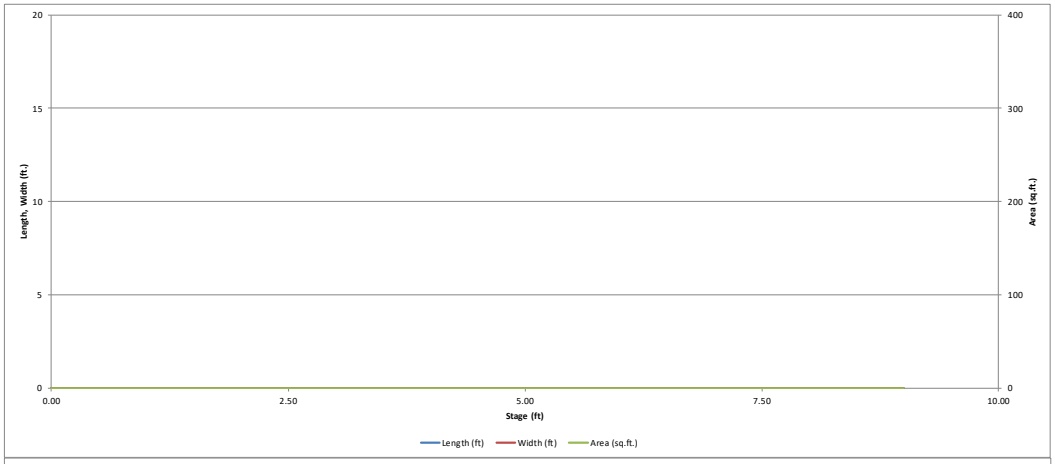
Zone 1 Volume (User Defined) =	0.048	acre-feet	WQCV not provided!
Zone 2 Volume (EURV - Zone 1) =	0.556	acre-feet	
Zone 3 Volume (100-year - Zones 1 & 2) =	2.482	acre-feet	
Total Detention Basin Volume =	3.087	acre-feet	
Initial Surcharge Volume (ISV) =	user	ft^3	
Initial Surcharge Depth (ISD) =	user	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	

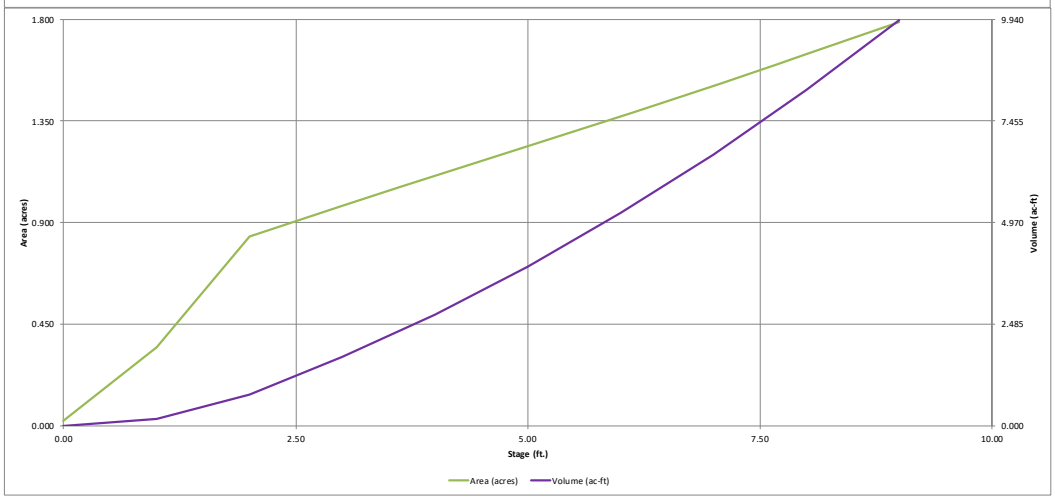
Depth Increment = ft

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)
Top of Micropool	--	0.00	--	--	--	933	0.021		
7290	--	1.00	--	--	--	15,158	0.348	7,894	0.181
7291	--	2.00	--	--	--	36,406	0.836	33,464	0.768
7292	--	3.00	--	--	--	42,429	0.974	73,245	1.681
7293	--	4.00	--	--	--	48,162	1.106	118,540	2.721
7294	--	5.00	--	--	--	53,868	1.237	169,555	3.892
7295	--	6.00	--	--	--	59,631	1.369	226,305	5.195
7296	--	7.00	--	--	--	65,493	1.504	288,867	6.631
7297	--	8.00	--	--	--	71,638	1.645	357,432	8.206
7298	--	9.00	--	--	--	77,888	1.788	432,195	9.922

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



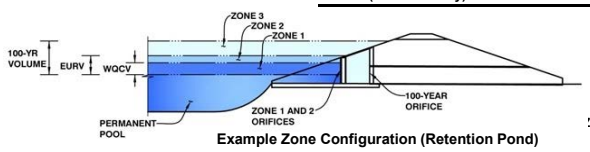


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Winsome Filing 1 - Pond 3 (Water Quality Area)

Basin ID: Pond 3 (WQ Area Only)



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (User)	0.49	0.048	Orifice Plate
Zone 2 (EURV)	1.78	0.556	Rectangular Orifice
Zone 3 (100-year)	4.33	2.482	Weir&Pipe (Circular)
		3.087	Total

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)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.431E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.25	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	2.40	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.35	sq. inches (diameter = 5/8 inch)	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	0.20						
Orifice Area (sq. inches)	0.35	0.35						

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected		Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	0.25	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.06	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	1.50	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.04	N/A	feet
Vertical Orifice Height =	1.00	N/A	inches				
Vertical Orifice Width =	8.00		inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected		Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.00	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Over Flow Weir Slope Length =	3.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)	Grate Open Area / 100-yr Orifice Area =	2.08	N/A	should be ≥ 4
Horiz. Length of Weir Sides =	3.00	N/A	feet	Overflow Grate Open Area w/o Debris =	10.20	N/A	ft^2
Overflow Grate Open Area % =	85%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	5.10	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 Circular	Not Selected		Zone 3 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	2.44	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	4.91	N/A	ft^2
Circular Orifice Diameter =	30.00	N/A	inches	Outlet Orifice Centroid =	1.25	N/A	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=	6.20	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.80	feet
Spillway Crest Length =	51.00	feet	Stage at Top of Freeboard =	8.00	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.64	acres
Freeboard above Max Water Surface =	1.00	feet			

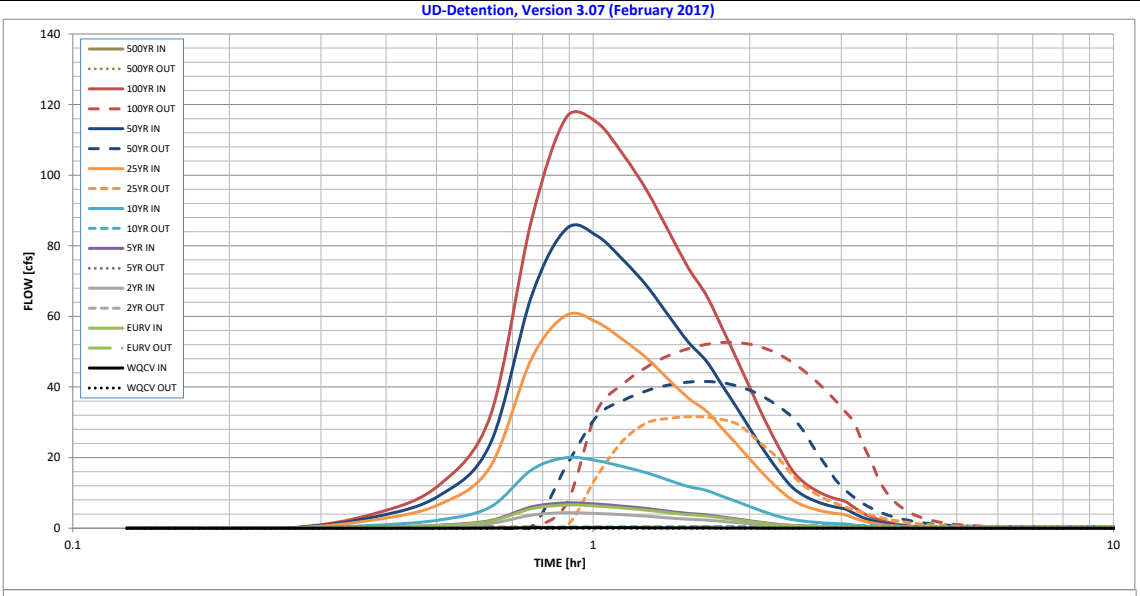
Calculated Parameters for Spillway

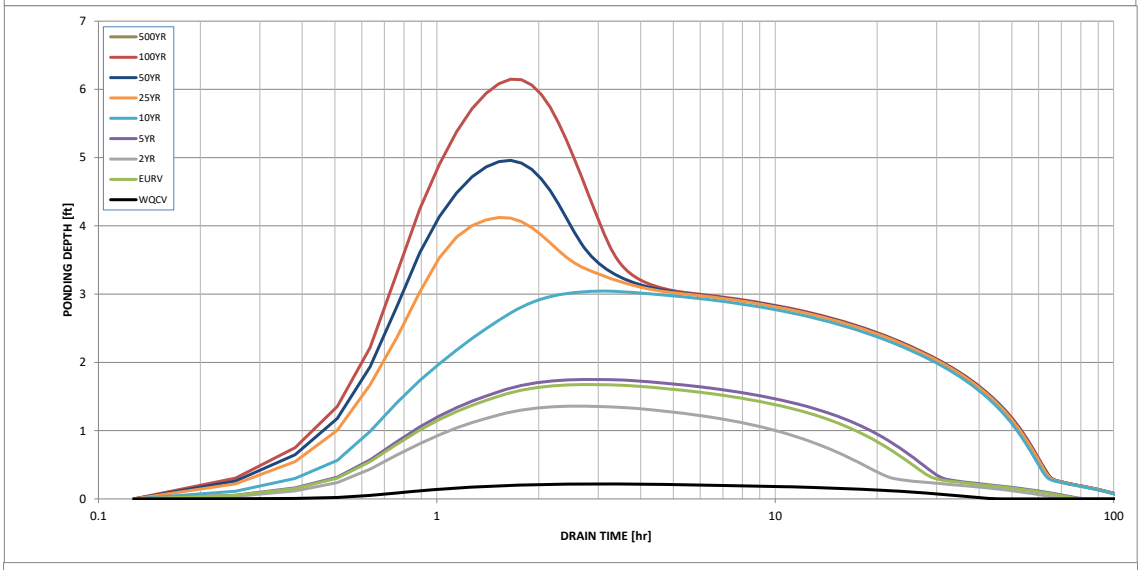
Routed Hydrograph Results

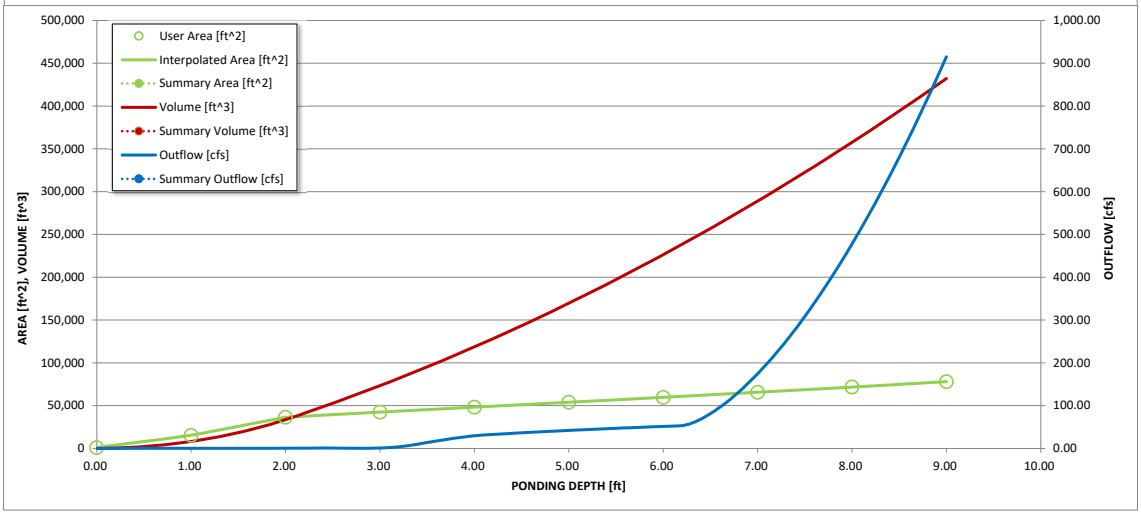
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	0.00
Calculated Runoff Volume (acre-ft) =	0.392	0.604	0.401	0.659	1.857	5.716	8.114	11.244	0.000
OPTIONAL Override Runoff Volume (acre-ft) =	0.014								
Inflow Hydrograph Volume (acre-ft) =	0.014	0.604	0.401	0.659	1.858	5.715	8.114	11.247	#N/A
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.14	0.47	0.66	0.89	0.00
Predevelopment Peak Q (cfs) =	0.0	0.0	0.8	1.6	13.7	47.8	66.2	90.3	0.0
Peak Inflow Q (cfs) =	0.2	6.6	4.4	7.2	20.0	60.3	84.9	116.5	#N/A
Peak Outflow Q (cfs) =	0.0	0.3	0.3	0.4	0.9	31.6	41.6	52.6	#N/A
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.1	0.7	0.6	0.6	#N/A
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	#N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	3.0	4.0	5.1	#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) =	40	31	33	32	60	54	50	47	#N/A
Time to Drain 99% of Inflow Volume (hours) =	**43**	54	53	55	66	61	59	57	#N/A
Maximum Ponding Depth (ft) =	0.22	1.68	1.36	1.75	3.05	4.12	4.96	6.15	#N/A
Area at Maximum Ponding Depth (acres) =	0.09	0.67	0.52	0.71	0.98	1.12	1.23	1.39	#N/A
Maximum Volume Stored (acre-ft) =	0.012	0.527	0.336	0.583	1.721	2.855	3.843	5.402	#N/A

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	#N/A
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]
7.62 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	0:07:37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
Hydrograph	0:15:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
Constant	0:22:52	0.01	0.29	0.20	0.32	0.86	2.42	3.24	4.18	#N/A
0.657	0:30:29	0.02	0.79	0.53	0.86	2.35	6.84	9.37	12.46	#N/A
	0:38:06	0.05	2.02	1.35	2.20	6.04	17.57	24.07	32.03	#N/A
	0:45:43	0.14	5.55	3.72	6.05	16.58	48.12	65.86	87.47	#N/A
	0:53:20	0.16	6.58	4.39	7.18	20.00	60.34	84.88	116.48	#N/A
	1:00:58	0.15	6.28	4.18	6.85	19.15	58.39	82.88	114.99	#N/A
	1:08:35	0.14	5.72	3.81	6.24	17.43	53.32	75.94	105.77	#N/A
	1:16:12	0.12	5.11	3.39	5.57	15.64	48.06	68.50	95.47	#N/A
	1:23:49	0.10	4.41	2.92	4.81	13.59	42.14	60.22	84.15	#N/A
	1:31:26	0.09	3.84	2.55	4.19	11.80	36.84	52.71	73.71	#N/A
	1:39:04	0.08	3.48	2.31	3.80	10.70	33.17	47.32	65.96	#N/A
	1:46:41	0.06	2.87	1.89	3.14	8.92	27.91	40.02	56.11	#N/A
	1:54:18	0.05	2.34	1.54	2.56	7.35	23.17	33.27	46.70	#N/A
	2:01:55	0.03	1.80	1.18	1.97	5.76	18.45	26.64	37.59	#N/A
	2:09:32	0.02	1.34	0.87	1.47	4.38	14.31	20.75	29.39	#N/A
	2:17:10	0.02	0.97	0.63	1.06	3.22	10.75	15.68	22.30	#N/A
	2:24:47	0.02	0.75	0.49	0.82	2.45	8.02	11.63	16.45	#N/A
	2:32:24	0.01	0.62	0.41	0.68	1.99	6.42	9.25	13.02	#N/A
	2:40:01	0.01	0.53	0.35	0.58	1.68	5.39	7.76	10.89	#N/A
	2:47:38	0.01	0.46	0.30	0.51	1.47	4.68	6.72	9.41	#N/A
	2:55:16	0.01	0.42	0.27	0.46	1.32	4.18	5.99	8.38	#N/A
	3:02:53	0.01	0.38	0.25	0.42	1.21	3.82	5.47	7.64	#N/A
	3:10:30	0.01	0.28	0.19	0.31	0.89	2.88	4.17	5.90	#N/A
	3:18:07	0.00	0.21	0.14	0.23	0.65	2.08	3.00	4.25	#N/A
	3:25:44	0.00	0.15	0.10	0.17	0.48	1.54	2.23	3.16	#N/A
	3:33:22	0.00	0.11	0.07	0.12	0.36	1.14	1.66	2.34	#N/A
	3:40:59	0.00	0.08	0.05	0.09	0.26	0.84	1.22	1.73	#N/A
	3:48:36	0.00	0.06	0.04	0.06	0.18	0.61	0.88	1.26	#N/A
	3:56:13	0.00	0.04	0.03	0.04	0.13	0.44	0.64	0.91	#N/A
	4:03:50	0.00	0.03	0.02	0.03	0.09	0.31	0.45	0.65	#N/A
	4:11:28	0.00	0.02	0.01	0.02	0.06	0.20	0.30	0.43	#N/A
	4:19:05	0.00	0.01	0.00	0.01	0.03	0.12	0.18	0.26	#N/A
	4:26:42	0.00	0.00	0.00	0.00	0.01	0.06	0.09	0.13	#N/A
	4:34:19	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.04	#N/A
	4:41:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:49:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	4:57:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:04:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:12:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:20:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:27:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:35:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:42:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:50:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	5:58:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:05:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:13:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:21:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:28:37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:36:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:43:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:51:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	6:59:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:06:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:14:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:21:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:29:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:37:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:44:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	7:52:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	8:00:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	8:07:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	8:15:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	8:22:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	8:30:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	8:38:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	8:45:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	8:53:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	9:01:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A
	9:08:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	#N/A

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

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]

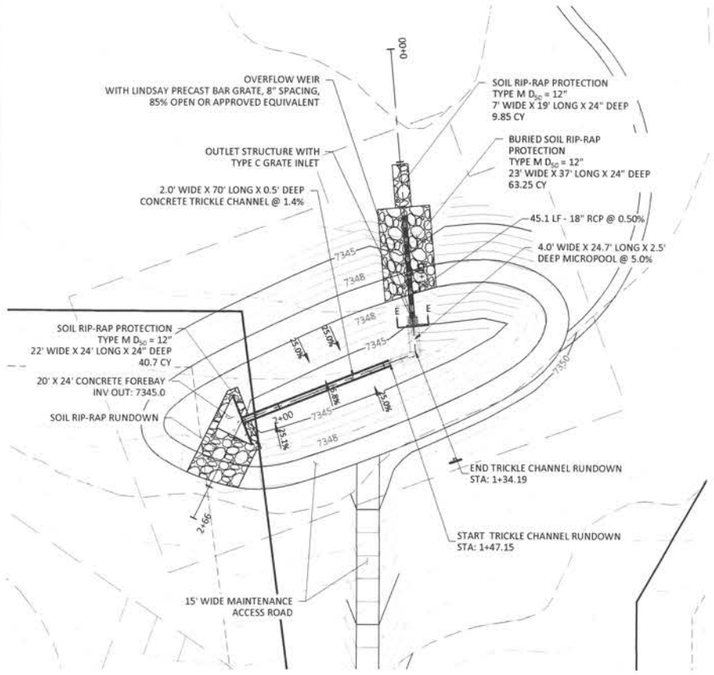
For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

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

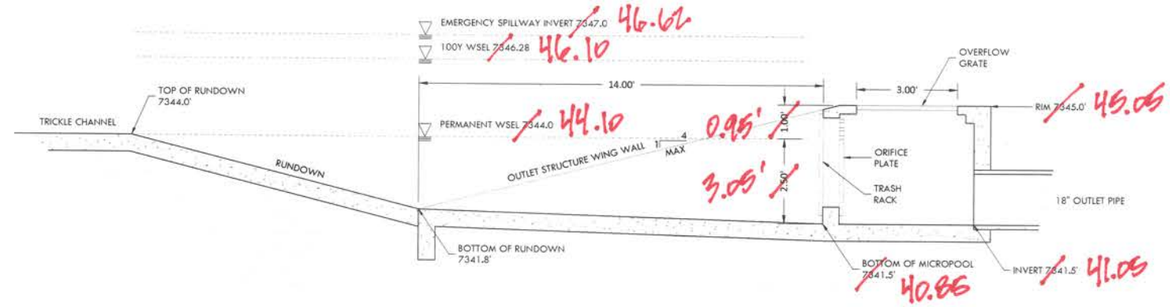
CONSTRUCTION DOCUMENTS

WINSOME FILING NO 1

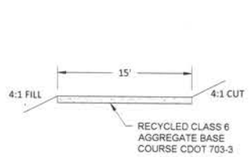
A TRACT OF LAND BEING A PORTION OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST,
OF THE 6TH PRINCIPAL MERIDIAN, COUNTY OF EL PASO, STATE OF COLORADO



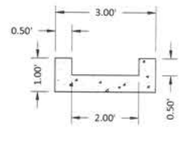
POND B OUTLET STRUCTURE PLAN
SCALE 1" = 30'



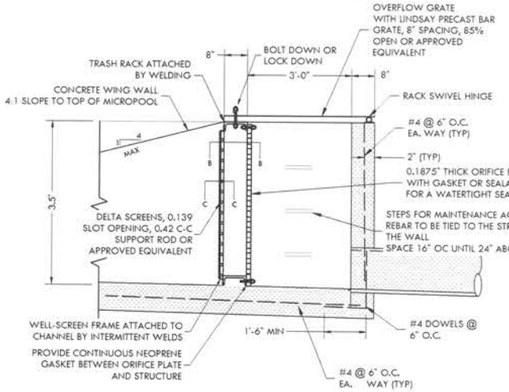
OUTLET STRUCTURE SIDE VIEW
SCALE 1" = 2'

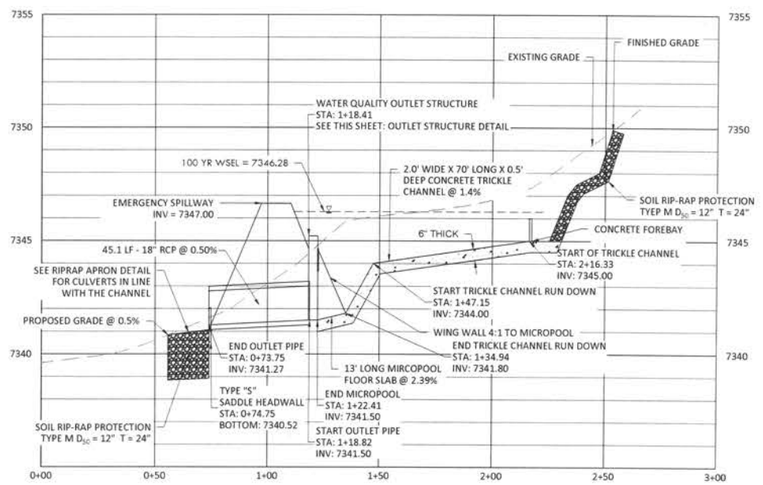


MAINTENANCE ACCESS ROAD
SCALE 1" = 2'

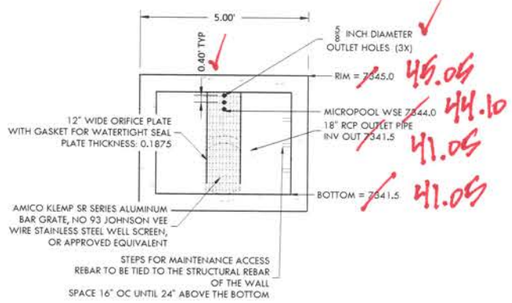


CONCRETE TRICKLE CHANNEL
SCALE 1" = 2'

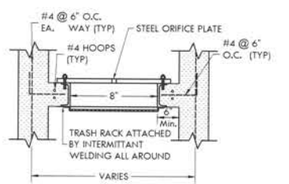




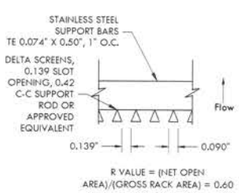
POND B OUTLET STRUCTURE PROFILE
HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 2'



OUTLET STRUCTURE DETAIL - SECTION E-E
SCALE 1" = 2'



SECTION B-B - PLAN VIEW



SECTION C-C

ORIFICE PLATE NOTES:

1. PROVIDE CONTINUOUS NEOPRENE GASKET MATERIAL BETWEEN THE ORIFICE PLATE AND CONCRETE.
2. BOLT PLATE TO CONCRETE 12" MAX. ON CENTER

EURV AND WQCV TRASH RACKS:

1. WELL-SCREEN TRASH RACKS SHALL BE STAINLESS STEEL AND SHALL BE ATTACHED BY INTERMITTENT WELDS ALONG THE EDGE OF THE MOUNTING FRAME.
2. BAR GRATE TRASH RACKS SHALL BE ALUMINUM AND SHALL BE BOLTED USING STAINLESS STEEL HARDWARE.

OUTLET STRUCTURE WITH TRASH RACK DETAIL
NTS

0' 30' 60' 90'
SCALE: 1" = 30'
EPC 12/29/2020
SF-20-003

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PROFESSIONAL ENGINEER

WATER QUALITY POND B - PLAN AND PROFILE

SITE: 17480 MERIDIAN ROAD
ELBERT, COLORADO 80106

FOR: WINSOME, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
1	SUBMITTAL 1
2	04.03.2020 REVISED PER COMMENTS
3	08.01.2020 REVISED PER COMMENTS
4	10.14.2020 REVISED PER COMMENTS
5	11.25.2020 REVISED PER COMMENTS
6	12.15.2020 FOR CONSTRUCTION
7	
8	
9	
10	

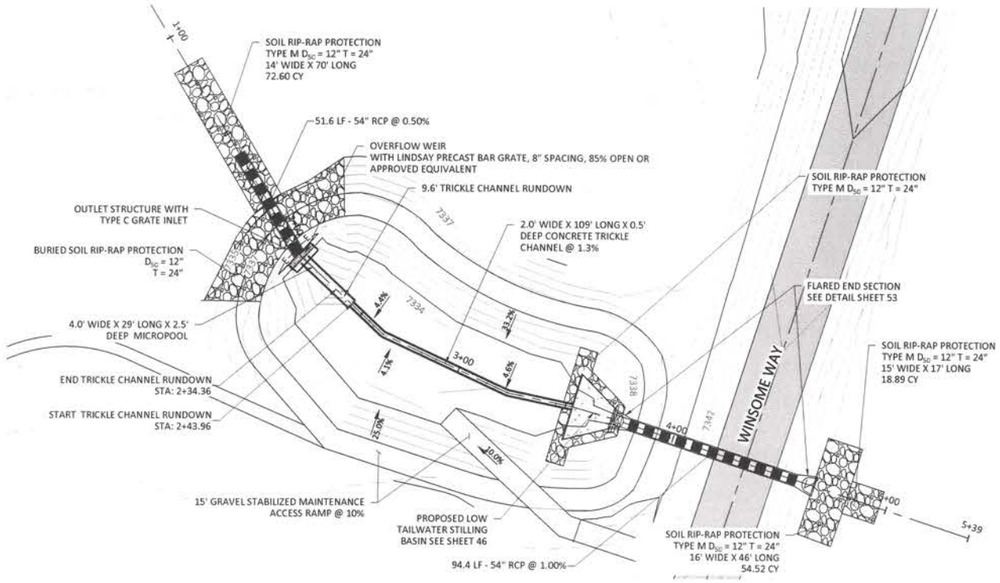
DATE: 01.22.20
DRAWN BY: JCP
CHECKED BY: LPV
JOB #: 49388.01

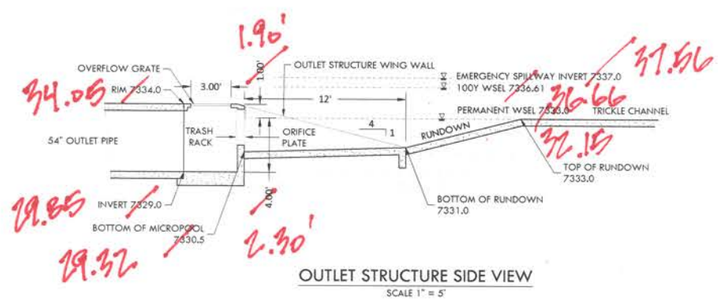
43

CONSTRUCTION DOCUMENTS

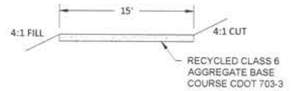
WINSOME FILING NO 1

A TRACT OF LAND BEING A PORTION OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST,
OF THE 6TH PRINCIPAL MERIDIAN, COUNTY OF EL PASO, STATE OF COLORADO

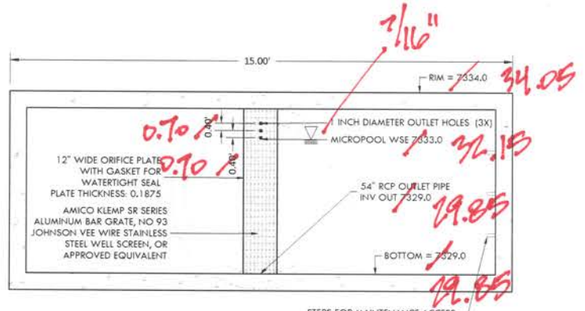




OUTLET STRUCTURE SIDE VIEW
SCALE 1" = 5'



MAINTENANCE ACCESS ROAD
SCALE 1" = 2'



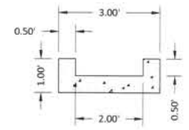
OUTLET STRUCTURE DETAIL - SECTION E-E
SCALE 1" = 2'

ORIFICE PLATE NOTES:

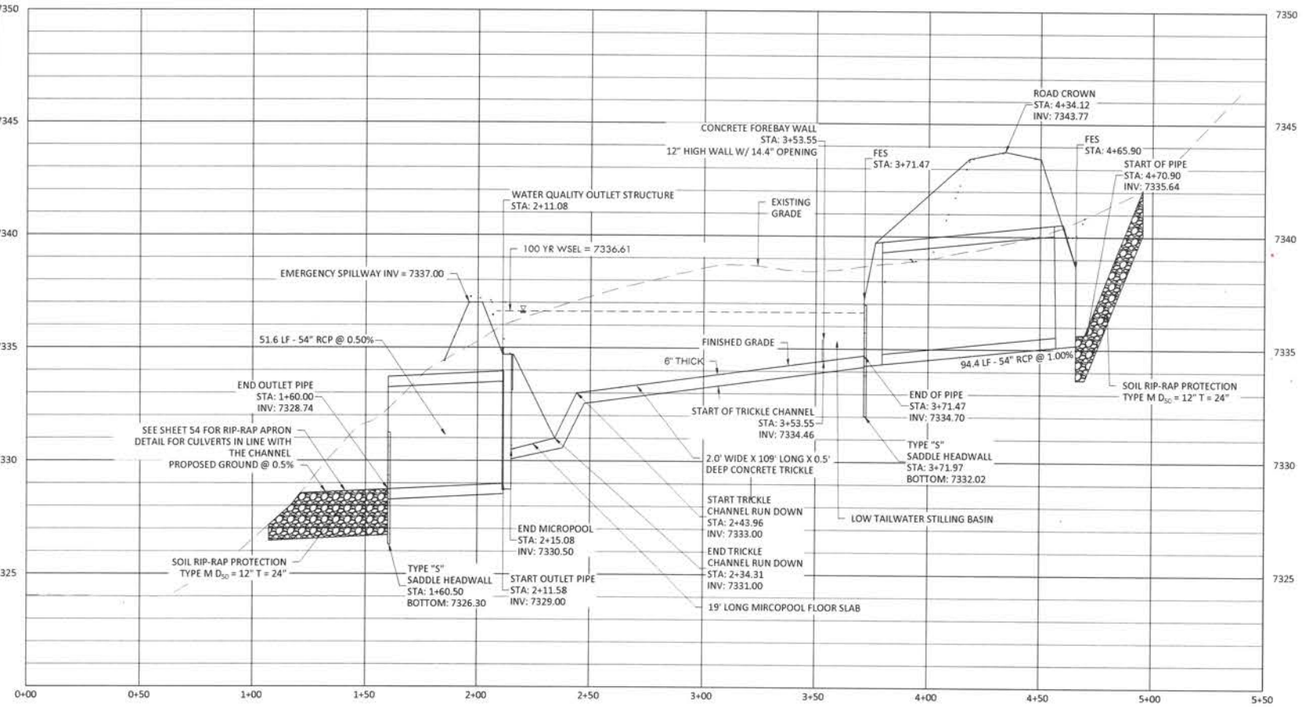
1. PROVIDE CONTINUOUS NEOPRENE GASKET MATERIAL BETWEEN THE ORIFICE PLATE AND CONCRETE.
2. BOLT PLATE TO CONCRETE 12" MAX. ON CENTER

EURV AND WQCV TRASH RACKS:

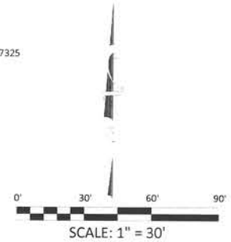
1. WELL-SCREEN TRASH RACKS SHALL BE STAINLESS STEEL AND SHALL BE ATTACHED BY INTERMITTENT WELDS ALONG THE EDGE OF THE MOUNTING FRAME.
2. BAR GRATE TRASH RACKS SHALL BE ALUMINUM AND SHALL BE BOLTED USING STAINLESS STEEL HARDWARE.



CONCRETE TRICKLE CHANNEL
SCALE 1" = 2'



WQ POND C PROFILE
HORIZONTAL SCALE: 1" = 2'
VERTICAL SCALE: 1" = 0'



SCALE: 1" = 30'

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43911
CHRISTOPHER PORTER
PROFESSIONAL ENGINEER

WATER QUALITY POND C - PLAN AND PROFILE

SITE: 17480 MERIDIAN ROAD
ELBERT, COLORADO 80106

FOR: WINSOME, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
1	SUBMITTAL 1
2	04.03.2020 REVISED PER COMMENTS
3	08.01.2020 REVISED PER COMMENTS
4	10.14.2020 REVISED PER COMMENTS
5	11.25.2020 REVISED PER COMMENTS
6	12.15.2020 FOR CONSTRUCTION
7	
8	
9	
10	

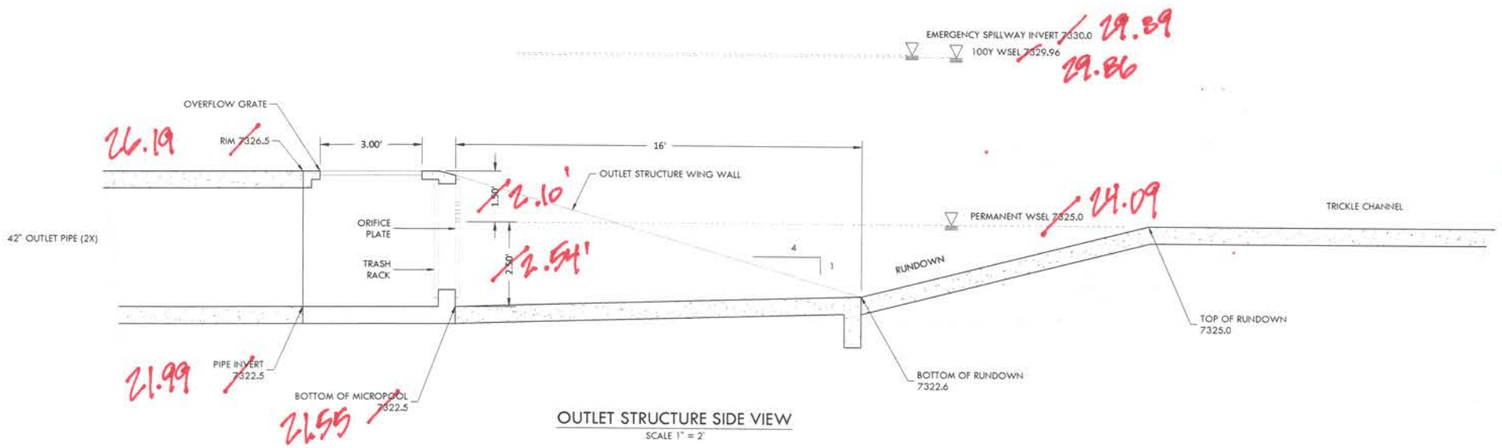
DATE: 01.22.20
DRAWN BY: JCP
CHECKED BY: LPV
JOB #: 49388.01

45

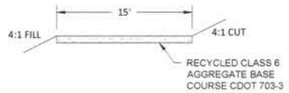
CONSTRUCTION DOCUMENTS

WINSOME FILING NO 1

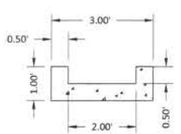
A TRACT OF LAND BEING A PORTION OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST,
OF THE 6TH PRINCIPAL MERIDIAN, COUNTY OF EL PASO, STATE OF COLORADO



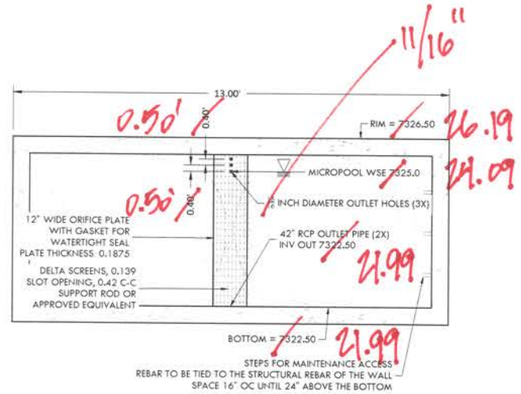
OUTLET STRUCTURE SIDE VIEW
SCALE 1" = 2'



MAINTENANCE ACCESS ROAD
SCALE 1" = 2'



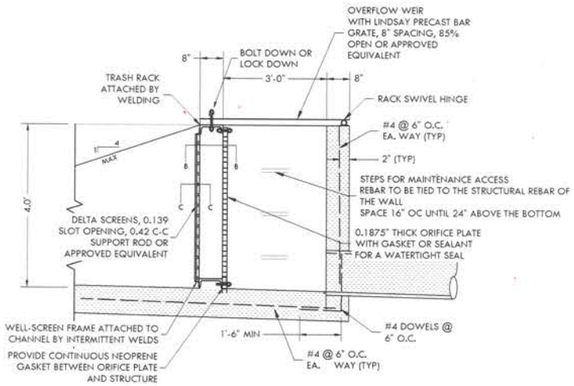
CONCRETE TRICKLE CHANNEL
CROSS SECTION DETAIL
SCALE 1" = 2'



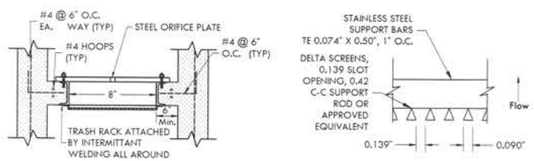
OUTLET STRUCTURE DETAIL - SECTION E-E
SCALE 1" = 2'

SOIL RIP-RAP NOTES:

1. ELEVATION TOLERANCES FOR THE SOIL RIP-RAP SHALL BE 0.10 FEET. THICKNESS OF SOIL RIP-RAP SHALL BE NO LESS THAN THICKNESS SHOWN AND NO MORE THAN 2-INCHES GREATER THAN THE THICKNESS SHOWN.
2. WHERE "SOIL RIP-RAP" IS DESIGNATED ON THE CONTRACT DRAWINGS, RIP-RAP VOIDS ARE TO BE FILLED WITH NATIVE SOIL. THE RIP-RAP SHALL BE PRE-MIXED WITH THE NATIVE SOIL AT THE FOLLOWING PROPORTIONS BY VOLUME. 65% RIP-RAP AND 35% SOIL. THE SOIL USED FOR MIXING SHALL BE NATIVE TOPSOIL AND SHALL HAVE A MINIMUM FINES CONTENT OF 15%. THE SOIL RIP-RAP SHALL BE INSTALLED IN A MANNER THAT RESULTS IN A DENSE INTERLOCKED LAYER OF RIP-RAP WITH RIP-RAP VOIDS FILLED COMPLETELY WITH SOIL. SEGREGATION OF MATERIALS SHALL BE AVOIDED AND IN NO CASE SHALL THE COMBINED MATERIAL CONSIST PRIMARILY OF SOIL; THE DENSITY AND INTERLOCKING NATURE OF RIP-RAP IN THE MIXED MATERIAL SHALL ESSENTIALLY BE THE SAME AS IF THE RIP-RAP WAS PLACED WITHOUT SOIL.
3. WHERE SPECIFIED (TYPICALLY AS "BURIED SOIL RIP-RAP"), A SURFACE LAYER OF TOPSOIL SHALL BE PLACED OVER THE SOIL RIP-RAP ACCORDING TO THE THICKNESS SPECIFIED ON THE CONTRACT DRAWINGS. THE TOPSOIL SURFACE LAYER SHALL BE COMPACTED TO APPROXIMATELY 85% OF MAXIMUM DENSITY AND WITHIN TWO PERCENTAGE POINTS OF OPTIMUM MOISTURE IN ACCORDANCE WITH ASTM D698. TOPSOIL SHALL BE ADDED TO ANY AREAS THAT SETTLE.
4. ALL SOIL RIP-RAP THAT IS BURIED WITH TOPSOIL SHALL BE REVIEWED AND APPROVED BY THE ENGINEER PRIOR TO ANY TOPSOIL PLACEMENT.



SECTION B-B - PLAN VIEW



R VALUE = (NET OPEN AREA)/(GROSS RACK AREA) = 0.60

SECTION C-C

OUTLET STRUCTURE WITH TRASH RACK DETAIL
NTS

ORIFICE PLATE NOTES:

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PROFESSIONAL ENGINEER

WATER QUALITY POND D - DETAILS

SITE: 17480 MERIDIAN ROAD
ELBERT, COLORADO 80106

FOR: WINSOME, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
1	SUBMITTAL 1
2	04.03.2020 REVISED PER COMMENTS
3	08.01.2020 REVISED PER COMMENTS
4	10.14.2020 REVISED PER COMMENTS
5	11.25.2020 REVISED PER COMMENTS
6	12.15.2020 FOR CONSTRUCTION
7	
8	
9	
10	

DATE:01.22.20	49
DRAWN BY:JCP	
CHECKED BY: LPV	
JOB #: 49388.01	

CONSTRUCTION DOCUMENTS

WINSOME FILING NO 1

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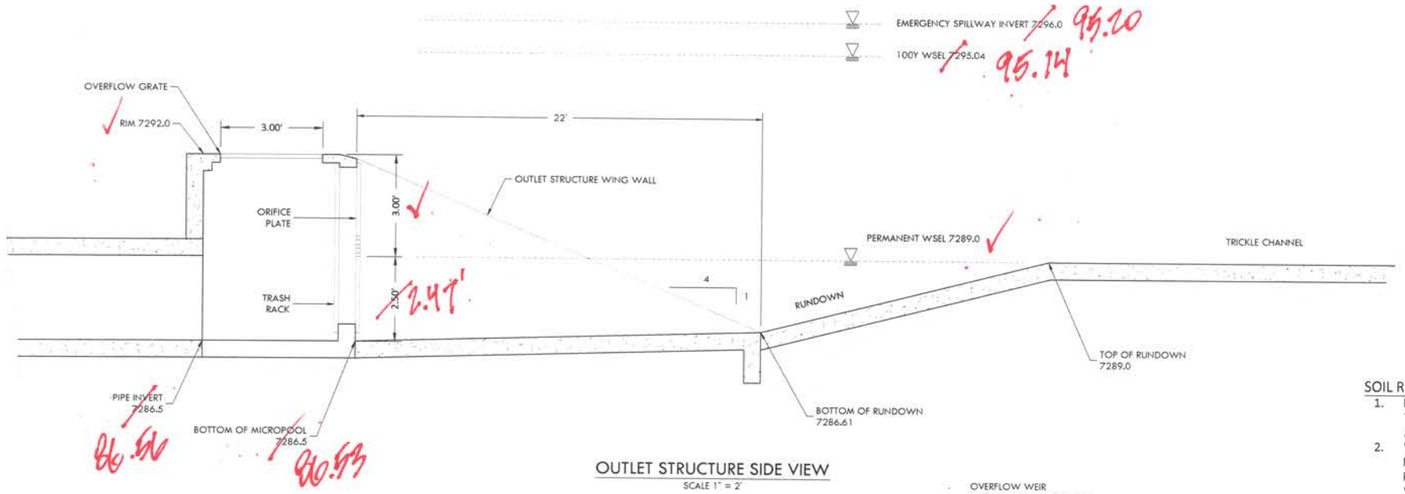
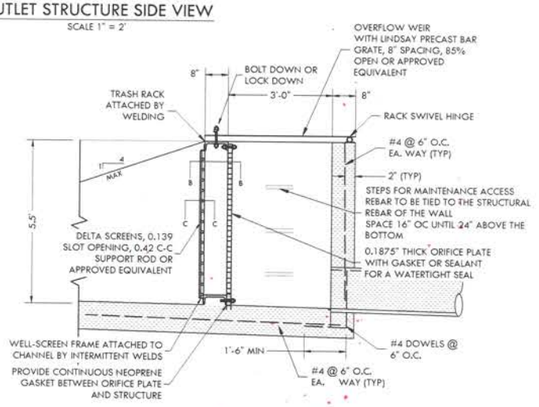
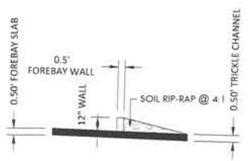


OUTLET STRUCTURE SIDE VIEW

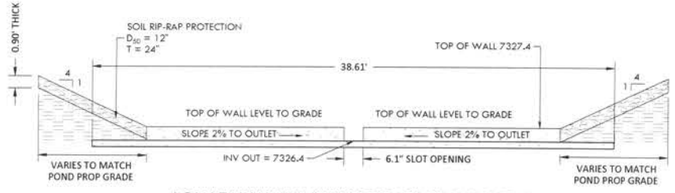
SCALE 1" = 2'





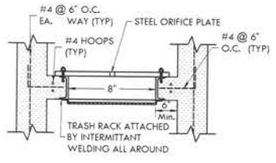
LOW TAILWATER STILLING BASIN WALL SECTION A-A

SCALE 1" = 5'

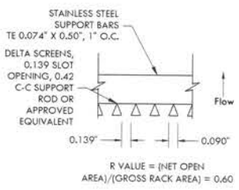


LOW TAILWATER STILLING BASIN WALL DETAIL

SCALE 1" = 5'



SECTION B-B - PLAN VIEW



SECTION C-C

OUTLET STRUCTURE WITH TRASH RACK DETAIL

NTS

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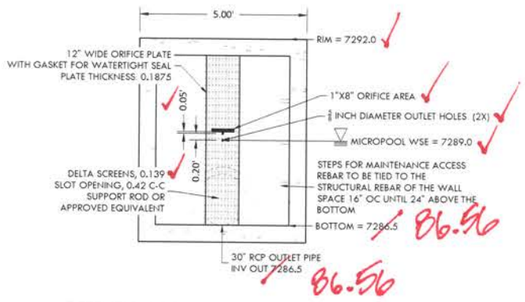

DETENTION POND OUTLET SECTION A-A

SCALE 1" = 2'

0' 30' 60' 90'

SCALE: 1" = 30'

SF-20-003

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DETENTION POND 3 - DETAILS

SITE: 17480 MERIDIAN ROAD ELBERT, COLORADO 80106

FOR: WINSOME, LLC 1864 WOODMORE DR, SUITE 100 MONUMENT, COLORADO 80132

NO.	REVISIONS
1	SUBMITTAL 1
2	04.03.2020 REVISED PER COMMENTS
3	08.01.2020 REVISED PER COMMENTS
4	10.14.2020 REVISED PER COMMENTS
5	11.25.2020 REVISED PER COMMENTS
6	12.15.2020 FOR CONSTRUCTION
7	
8	
9	
10	

DATE: 01.22.20

DRAWN BY: JCP

CHECKED BY: LPV

JOB #: 49388.01

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