Bayfield Tractor Supply
Lot 32, Bayfield Center Drive
Bayfield, CO

DRAINAGE REPORT

February 19, 2024

Prepared for:

TSC: Tractor Supply Company West, LLC
Tractor Supply Company, A Delaware Corporation

Prepared by:

Michal D. Valencia, P.E.

Site Development Solutions
LLC

PO Box 997
Bayfield, CO 81122
970-749-6767

TABLE OF CONTENTS:

LIST OF TABLES:

I. Project Overview

The Bayfield Tractor Supply Company project includes asphalt parking, 21,9130 sf building, outdoor display areas and utilities. It is the intent of this report to show the stormwater runoff from the developed site, including all existing and proposed structures, will be reduced to the historic amounts or less for the 100-year storm event and the required detention volume will be provided.

A. Existing Conditions

The site is Lot 32 of Bayfield Center Subdivision in Bayfield, Colorado. The site generally slopes down from the northeast to the southwest. The site currently drains to the southwest property line where it exits the site as sheet flow into a vegetated drainage.

B. Developed Conditions

The site will continue to drain from the new detention pond that will be located at the southwestern corner of the development. The detention pond will be sized to detain the difference between the 100-year historic and developed flows for the entire site, while releasing at or below the 100-year historic flow rate during the respective storm event for the basin.

C. Methodology

The analysis of storm runoff was based upon the rainfall data taken from the *National Oceanic and Atmospheric Administration*. The *Rational Method* was used to determine the quantity of storm runoff. The methodology shown in the Mile High Flood District (formerly known as *Urban Drainage and Flood Control District) Drainage Criteria Manual* was used in sizing detention pond and the outlet structure. The detention pond provides storage for the difference between the 100-year historic and developed storm runoff. The outlet structure limits the rate of runoff from the site to less than the 100-year storm historic amount.

II. Hydrology

A. Existing Hydrology

1. Soil Type

There is one soil type expected within the drainage basin. The soils at the site are described by the National Resources Conservation Service (NRCS) as Corta loam. (Please see the Appendices.) This soil type is characterized by the NRCS as having the hydrologic group rating "D", which is associated with having a high runoff potential.

2. Historic Drainage Basin

The historic drainage basin for the project generally encompasses the project property and is 7.6 acres. The site slopes down to the south and west.

3. Precipitation

The NOAA Atlas 2 Volume III 6-hour and 24-hour rainfall depths for Zone 2 in Colorado were input into the Drainage Criteria Manual IDF Table to determine the rainfall intensity, duration and frequency for Bayfield, Colorado.

Table 1: Rainfall Intensity-Duration-Frequency

Intensity (in/hr)		*Duration (Minutes)*					
		5	***10***	***15***	***30***	***60***	***120***
Frequency (Years)	**2**	2.04	1.58	1.33	.92	**.60**	.36
	5	3.00	2.33	1.97	1.36	**0.91**	0.51
	10	3.64	2.82	2.38	1.65	**1.11**	0.61
	25	4.44	3.44	2.91	2.01	**1.36**	0.75
	50	5.19	4.03	3.40	2.36	**1.61**	0.86
	100	5.90	4.58	3.87	2.68	**1.83**	0.96

B. Developed Hydrology

1. Developed Drainage Basin

The developed drainage basin was determined using the finished grading for the site. The developed drainage basin is essentially unchanged from the historic basin.

2. Watershed Imperviousness

To determine the watershed imperviousness, the weighted-area method was used. Each area of imperviousness in the watershed was measured and multiplied by the imperviousness to determine its percentage of the entire site.

The following table is an excerpt from the *Drainage Criteria Manual* Table RO-3 which shows the recommended percentage impervious values.

Table 2: Percentage Imperviousness Values

Land Use or Surface Characteristics	Recommended Value Imperviousness, i
Building	90
Streets, Paved	100
Lawns, Clay or Sand	0

These values were used to determine the area-weighted imperviousness value for the developed site including the proposed parking, building and native areas. The percentage impervious for the developed site is therefore **i=34.92%**.

3. Watershed Length & Slope

To determine the length and slope for the basin, the flow line to the furthest point in the basin was measured on the developed site. The watershed length of the developed site is 750 feet. The slope was determined by determining the difference in elevation of the watershed length. For this basin, the slope was 3.9%, expressed as a decimal in the worksheet as 0.039 ft/ft.

III. Design Criteria

A. General Concepts

It was the intent of the detention sizing to account for all proposed development on the parcel. The detention pond is needed to capture developed runoff and detain the difference between the 100-year historic and developed runoff. The detention pond is located at the southern edge of the site and captures the runoff from the site while providing enough volume to account for all improvements and increases in runoff. There is no off site run on due to its location near a high point in Bayfield Center Drive. The northern edge is controlled by Bayfield Center Drive, and the east side has an existing ridge that follows near the property line.

B. Detention Requirements

The maximum allowable release rate for the detention pond is the 100-year predevelopment discharge for the basin. The MHFD Detention Basin Outlet Structure Design worksheet calculates the flows for all the storm events and determines the peak outflow based on the outlet structure specified.

The pond is sized to accommodate the 100-year developed stormwater runoff from the site while accounting for the increase from the entire basin. The pond outlet structure was sized to release at the 100-year historic flow during the 100-year event. The spillway elevation was set by the 100-year storm volume requirement being met.

IV. Recommended Design

A. Detention Pond Storage Volume

The required storage volume was determined using the MHFD *Drainage Criteria Manual* Design Form Worksheet, UD-*Detention (v4.05)*. The detention pond was then fitted to the site avoiding wetlands with a reasonable depth. To fit into the available area on site, the pond was fitted near the southern edge of the project outside the wetlands. Please see the Appendices for the pond stage-storage curve. The pond floor will be approximately 10,500 square feet with 3:1 side slopes and a depth of 1.5 feet.

Table 3: Detention Volume Requirements

Basin	100-Yr. Volume (cu. ft.)	100-Yr. Level (ft.)
Detention	17,191	1.5

B. Detention Pond Outlet Structure

The MHFD *Drainage Criteria Manual* Design Form Worksheet, *Detention Design (v4.05)* was used to determine the size of the detention pond outlet structure. The outlet for the pond was sized to restrict the outflow for the 100-year storm events to the historic flows during the 100-year storm event.

The flow from the pond is restricted by an outlet pipe. It is a fifteen-inch (15") outlet pipe through the pond berm. The height of the berm is set to detain the 100-year event volume and release at a rate slower than the 100-year historic flow. The Design Form Worksheet and detention pond outlet structure detail can be seen in the Appendices. The results are tabulated below.

Table 4: Detention Pond Flow

Basin	*100-Year Pre-Development Peak Flow Rate* (cfs)	*100-Year Post-Development Peak Flow Rate* (cfs)
Tractor Supply	12.2	5.3

C. Spillway Sizing

The detention pond is designed with a spillway. The spillway height is determined by the 100-year water surface elevation. The invert is set at or above the 100-year maximum ponding depth. The maximum ponding depth during the 100-year event for this site will be 1.44 feet. Therefore, the spillway elevation was set at 1.5 feet. The spillway crest length is sized to pass the 100-year peak flow from the undetained design flood.

Table 5: Emergency Spillway

Detention Pond	Depth (feet)	Width (feet)
Tractor Supply	0.87	5

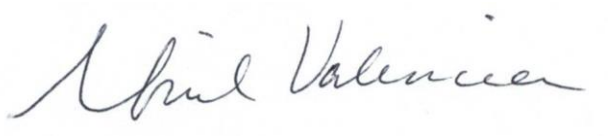
D. Driveway Culvert & West Drainage Swale

The driveway culvert was sized for the 100-year peak flow for the small basin it services, Q100=1.8 cfs. The west drainage swale was sized for the 100-year peak flow for the basin, Q100=4.07 cfs. The Rational Method was used to determine the peak flow with the imperviousness of the basin determined by the weighted-

area method. The worksheets can be seen in the Appendices. The culvert worksheet and channel design worksheets are also included in the Appendices.

V. Conclusions

The stormwater runoff from the developed site will be detained to release the flows at less than historic rates for the 100-year storm event. The detention pond has been sized to provide storage volume for the difference in runoff between the 100-year historic and developed storm events. It is felt that the development of this site will not be a detriment to downstream properties.



Michal D. Valencia, P.E.
Site Development Solutions, LLC
PO Box 997, Bayfield, CO 81122
970-749-6767

References

National Oceanic and Atmospheric Administration (NOAA). 1973. Precipitation-Frequency Atlas of the Western United States, Volume III, Colorado

USDA Natural Resources Conservation Service. *Soil Survey of La Plata County, Colorado.*

Urban Drainage and Flood Control District. 2001. *Urban Storm Drainage Criteria Manual, volumes1-3.*

Appendices

- Soil Survey Information
- Developed Drainage Basin
- Bayfield Rainfall IDF Information
- Developed Area-Weighted Imperviousness Worksheet
- Detention Basin Stage-Storage Design Form Worksheet
- Detention Basin Outlet Structure Design Form Worksheet
- West Channel Rational Method Design Form Worksheet
- West Channel Runoff Coefficient Calculation
- West Channel Design Form Worksheet
- Driveway Culvert Basin Ration Method Design Form Worksheet
- Driveway Culvert Design Form Worksheet

Soil Map—La Plata County Area, Colorado
(Bayfield Tractor Supply, Lot 32 Bayfield Center)

Map Scale: 1:1,540 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: La Plata County Area, Colorado
Survey Area Data: Version 21, Aug 22, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 6, 2021—Sep 17, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
22	Corta loam, 1 to 3 percent slopes	7.5	100.0%
Totals for Area of Interest		**7.5**	**100.0%**

La Plata County Area, Colorado

22—Corta loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 1yn1
Elevation: 6,700 to 7,200 feet
Mean annual precipitation: 18 to 22 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 110 to 130 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Corta and similar soils: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Corta

Setting

Landform: Pediments, mesas, ridges
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Fine-textured alluvium derived from shale and/or loess

Typical profile

H1 - 0 to 6 inches: loam
H2 - 6 to 60 inches: clay

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low (0.01 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: D
Ecological site: F048AY925CO - Ponderosa Pine Forest
Hydric soil rating: No

Minor Components

Falfa

Percent of map unit: 20 percent
Hydric soil rating: No

Plome

Percent of map unit: 5 percent
Hydric soil rating: No

Data Source Information

Soil Survey Area: La Plata County Area, Colorado
Survey Area Data: Version 21, Aug 22, 2023

IDF TABLE FOR ZONE TWO IN THE STATE OF COLORADO

Zone 2: San Juan, Upper Rio Grande, Upper Colorado, and Gunnison River Basins, and Green River Basin below Confluence with the Yampa River

Project: Bayfield, Colorado

Enter the elevation at the center of the watershed: Elev = 7,025 (input)

1. Rainfall Depth-Duration-Frequency Table

Enter the 6-hour and 24-hour rainfall depths from the NOAA Atlas 2 Volume III in rightmost blue columns

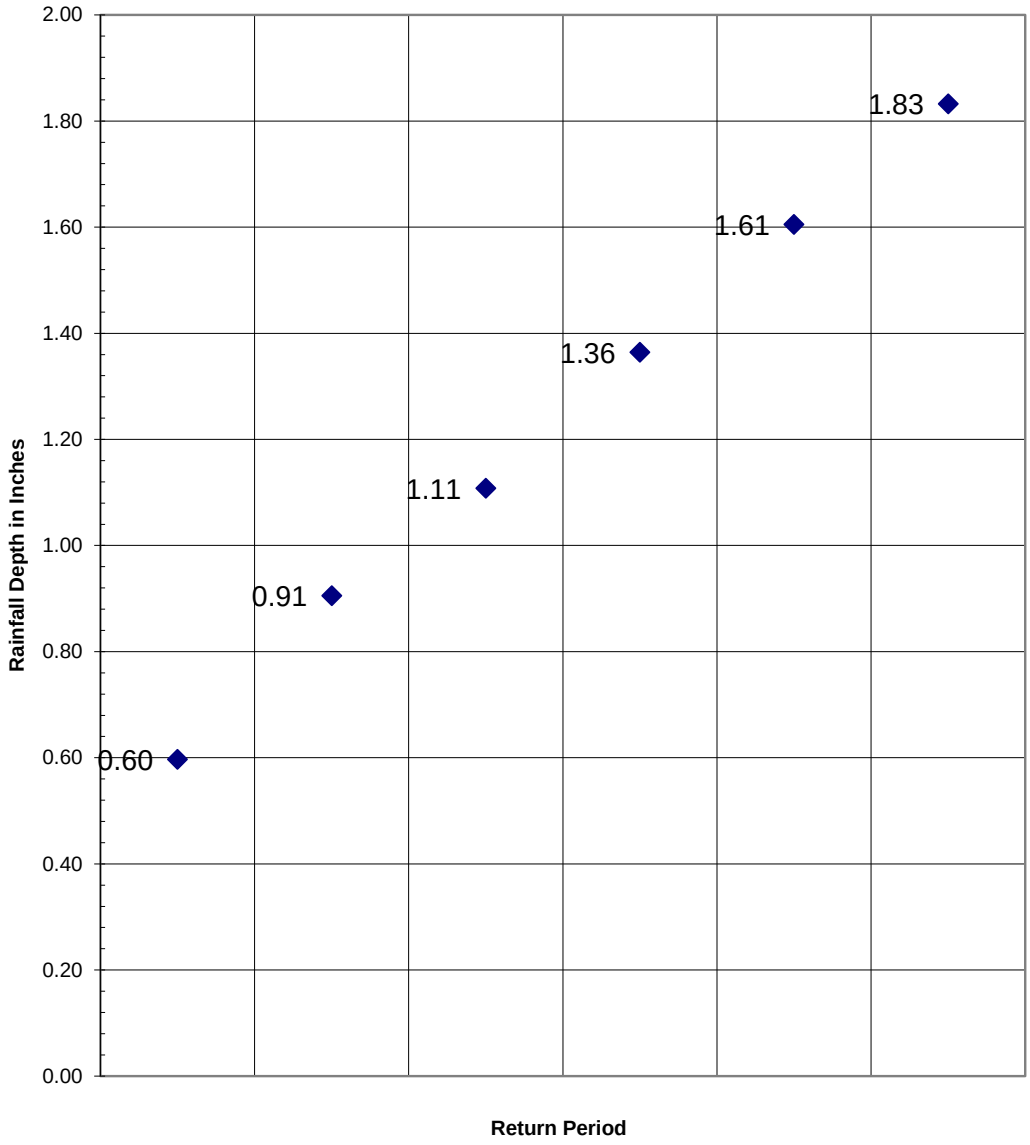
Return Period	Rainfall Depth in Inches at Time Duration								
	5-min	*10-min*	*15-min*	*30-min*	*1-hr*	*2-hr*	*3-hr*	*6-hr*	*24-hr*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
	output	*output*	*output*	*output*	*output*	*output*	*output*	*input*	*input*
2-yr	0.17	0.27	0.34	0.47	0.60	0.73	0.83	1.00	1.55
5-yr	0.26	0.41	0.52	0.72	0.91	1.06	1.16	1.35	1.95
10-yr	0.32	0.50	0.63	0.88	1.11	1.28	1.39	1.60	2.25
25-yr	0.40	0.61	0.78	1.08	1.36	1.55	1.67	1.90	2.60
50-yr	0.47	0.72	0.91	1.27	1.61	1.81	1.94	2.20	3.00
100-yr	0.53	0.82	1.04	1.45	1.83	2.03	2.16	2.40	3.25

Note: Refer to NOAA Atlas 2 Volume III isopluvial maps for 6-hr and 24-hr rainfall depths.

2. Rainfall Intensity-Duration-Frequency Table

Return Period	Rainfall Intensity in Inches Per Hour at Time Duration								
	5-min	*10-min*	*15-min*	*30-min*	*1-hr*	*2-hr*	*3-hr*	*6-hr*	*24-hr*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
	output	*output*	*output*	*output*	*output*	*output*	*output*	*output*	*output*
2-yr	2.08	1.61	1.36	0.94	0.60	0.37	0.28	0.17	0.06
5-yr	3.15	2.44	2.06	1.43	0.91	0.53	0.39	0.23	0.08
10-yr	3.86	2.99	2.53	1.75	1.11	0.64	0.46	0.27	0.09
25-yr	4.75	3.68	3.11	2.16	1.36	0.77	0.56	0.32	0.11
50-yr	5.59	4.33	3.66	2.54	1.61	0.90	0.65	0.37	0.13
100-yr	6.38	4.95	4.18	2.89	1.83	1.01	0.72	0.40	0.14

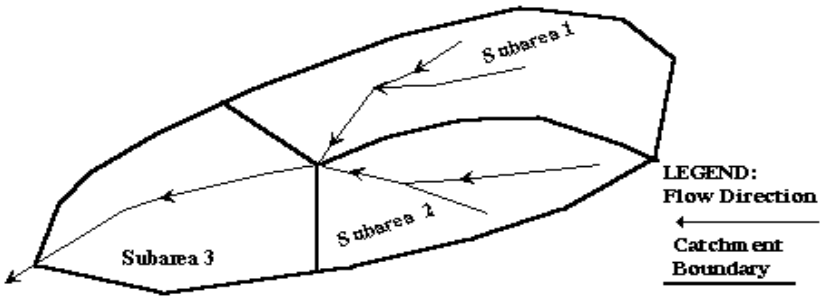
One-Hour Rainfall Depth Design Chart



Area-Weighting for Runoff Coefficient Calculation

Project Title: Bayfield Tractor Supply
Catchment ID: Lot 32, Bayfield Center, Bayfield, CO

Illustration

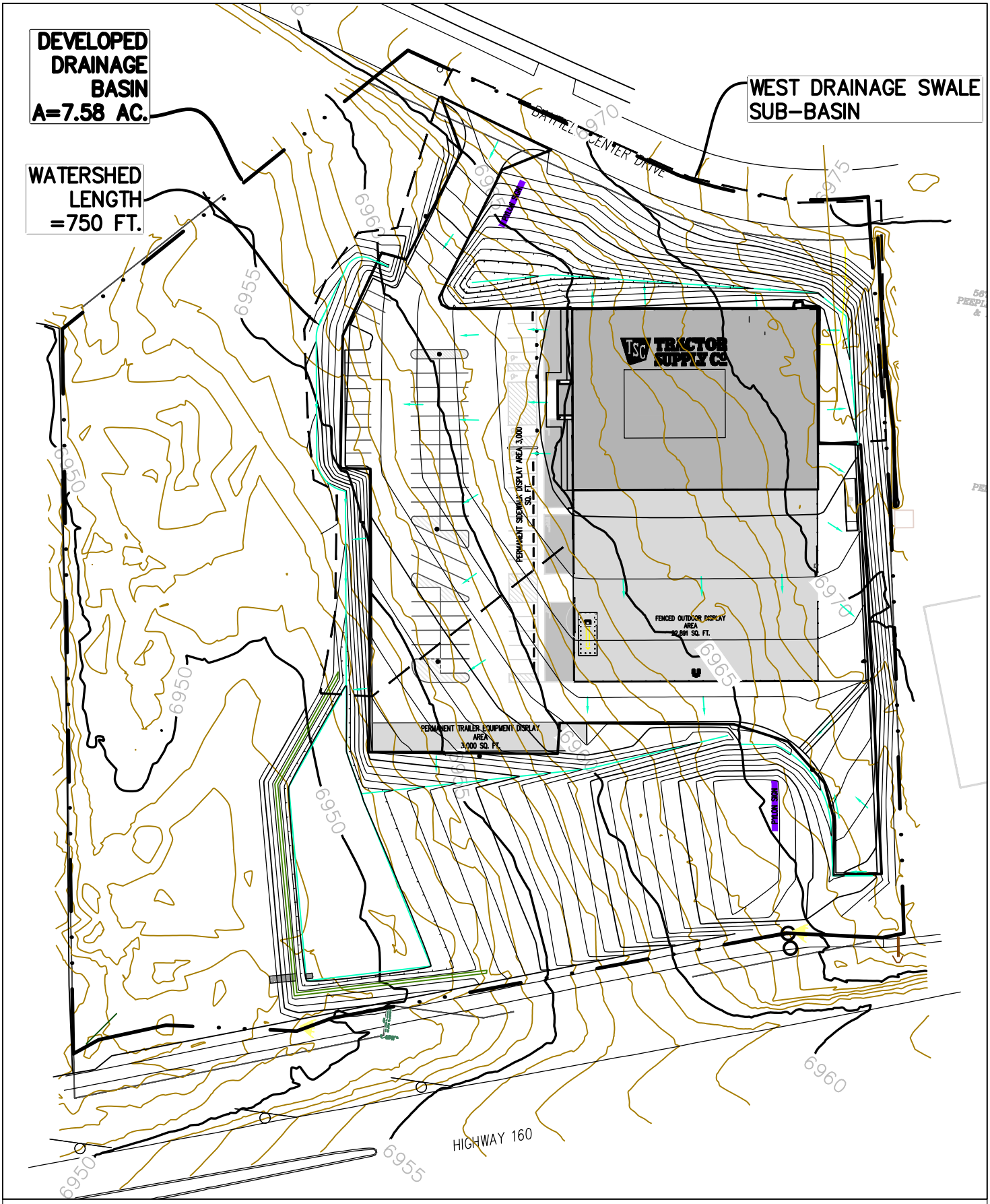


Instructions: For each catchment subarea, enter values for A and C.

Subarea ID	Area acres A	Runoff Coeff. C*	Product CA
input	input	input	output
Gravel	0.00	40.00	0.00
Conc Pave	2.09	100.00	209.44
Building	0.50	90.00	45.31
Landscape	4.98	2.00	9.96
Sum:	**7.58**	**Sum:**	**264.72**

Area-Weighted Runoff Coefficient (sum CA/sum A) = **34.92**

***See sheet "Design Info" for inperviousness-based runoff coefficient values.**



Site Development Solutions LLC

PO Box 997
Bayfield, CO 81122
970-749-6767 ph.
mikie.sds@gmail.com

Drainage Report
Tractor Supply Company
Lot 32, Bayfield Center Sub.
Bayfield, Colorado

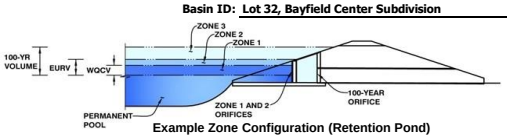
ISSUE	DATE
TOB Review	2/19/24

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: Bayfield Tractor Supply

Basin ID: Lot 32, Bayfield Center Subdivision



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	No BMP	
Watershed Area =	7.58	acres
Watershed Length =	750	ft
Watershed Length to Centroid =	350	ft
Watershed Slope =	0.039	ft/ft
Watershed Imperviousness =	35.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	N/A	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Flood Control Only

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	0.105	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.244	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.6 in.) =	0.091	acre-feet	0.60 inches
5-yr Runoff Volume (P1 = 0.91 in.) =	0.171	acre-feet	0.91 inches
10-yr Runoff Volume (P1 = 1.11 in.) =	0.247	acre-feet	1.11 inches
25-yr Runoff Volume (P1 = 1.36 in.) =	0.421	acre-feet	1.36 inches
50-yr Runoff Volume (P1 = 1.61 in.) =	0.567	acre-feet	1.61 inches
100-yr Runoff Volume (P1 = 1.83 in.) =	0.727	acre-feet	1.83 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.553	acre-feet	inches
Approximate 2-yr Detention Volume =	0.106	acre-feet	
Approximate 5-yr Detention Volume =	0.206	acre-feet	
Approximate 10-yr Detention Volume =	0.248	acre-feet	
Approximate 25-yr Detention Volume =	0.295	acre-feet	
Approximate 50-yr Detention Volume =	0.324	acre-feet	
Approximate 100-yr Detention Volume =	0.395	acre-feet	

Define Zones and Basin Geometry

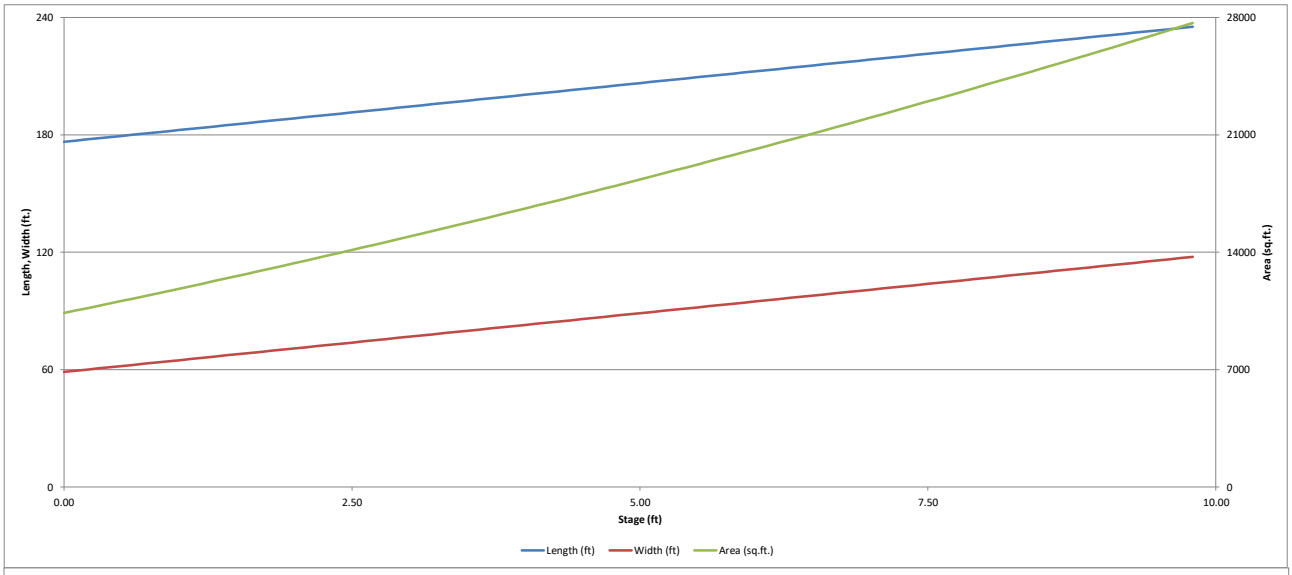
Zone 1 Volume (100-year) =	0.395	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.395	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	1.50	ft
Depth of Trickle Channel (H_{TC}) =	0.00	ft
Slope of Trickle Channel (S_{TC}) =	0.000	ft/ft
Slopes of Main Basin Sides (S_{main}) =	3	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	3	
Initial Surcharge Area (A_{ISV}) =	0	ft^2
Surcharge Volume Length (L_{ISV}) =	0.0	ft
Surcharge Volume Width (W_{ISV}) =	0.0	ft
Depth of Basin Floor (H_{FLOOR}) =	0.00	ft
Length of Basin Floor (L_{FLOOR}) =	176.5	ft
Width of Basin Floor (W_{FLOOR}) =	58.8	ft
Area of Basin Floor (A_{FLOOR}) =	10,379	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	1.50	ft
Length of Main Basin (L_{MAIN}) =	185.5	ft
Width of Main Basin (W_{MAIN}) =	67.8	ft
Area of Main Basin (A_{MAIN}) =	12,577	ft^2
Volume of Main Basin (V_{MAIN}) =	17,191	ft^3
Calculated Total Basin Volume (V_{total}) =	**0.395**	acre-feet

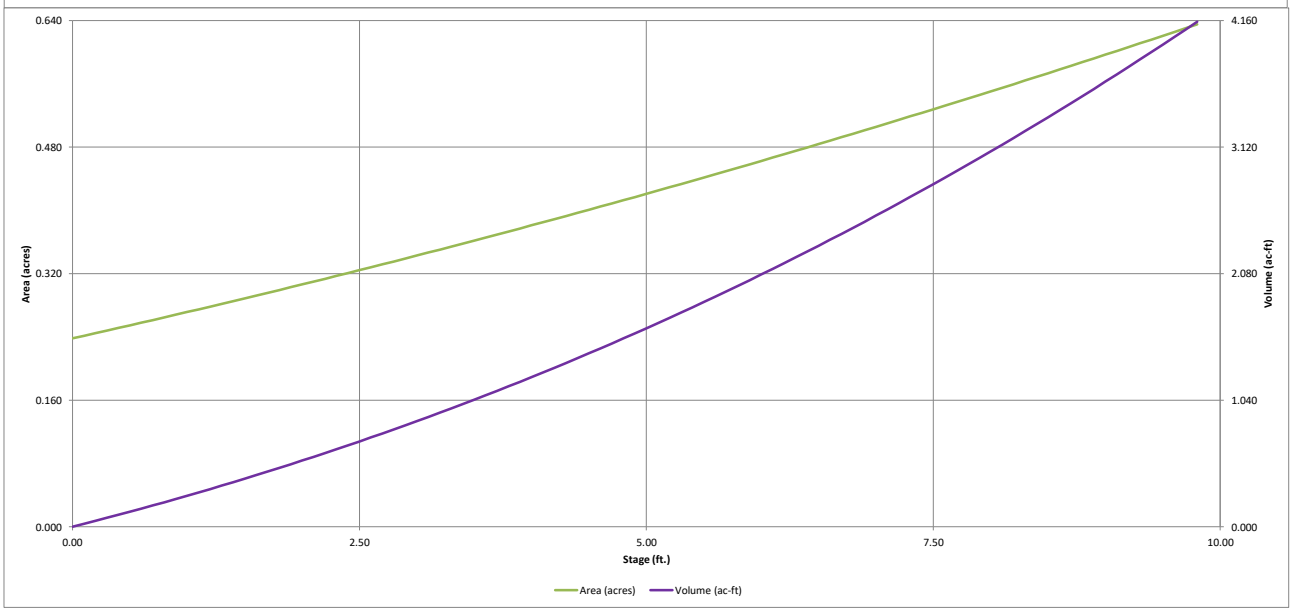
Depth Increment = 0.10 ft

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)
Media Surface	0.00		176.5	58.8	10,379		0.238		
	0.10		177.1	59.4	10,520		0.242	1,045	0.024
	0.20		177.7	60.0	10,663		0.245	2,104	0.048
	0.30		178.3	60.6	10,806		0.248	3,178	0.073
	0.40		178.9	61.2	10,949		0.251	4,265	0.098
	0.50		179.5	61.8	11,094		0.255	5,367	0.123
	0.60		180.1	62.4	11,239		0.258	6,484	0.149
	0.70		180.7	63.0	11,385		0.261	7,615	0.175
	0.80		181.3	63.6	11,531		0.265	8,761	0.201
	0.90		181.9	64.2	11,678		0.268	9,921	0.228
	1.00		182.5	64.8	11,826		0.271	11,097	0.255
	1.10		183.1	65.4	11,975		0.275	12,287	0.282
	1.20		183.7	66.0	12,125		0.278	13,492	0.310
	1.30		184.3	66.6	12,275		0.282	14,712	0.338
	1.40		184.9	67.2	12,426		0.285	15,947	0.366
Zone 1 (100-year)	1.50		185.5	67.8	12,577		0.289	17,197	0.395
	1.60		186.1	68.4	12,730		0.292	18,462	0.424
	1.70		186.7	69.0	12,883		0.296	19,743	0.453
	1.80		187.3	69.6	13,036		0.299	21,039	0.483
	1.90		187.9	70.2	13,191		0.303	22,350	0.513
	2.00		188.5	70.8	13,346		0.306	23,677	0.544
	2.10		189.1	71.4	13,502		0.310	25,019	0.574
	2.20		189.7	72.0	13,659		0.314	26,377	0.606
	2.30		190.3	72.6	13,816		0.317	27,751	0.637
	2.40		190.9	73.2	13,974		0.321	29,141	0.669
	2.50		191.5	73.8	14,133		0.324	30,546	0.701
	2.60		192.1	74.4	14,292		0.328	31,967	0.734
	2.70		192.7	75.0	14,453		0.332	33,405	0.767
	2.80		193.3	75.6	14,614		0.335	34,858	0.800
	2.90		193.9	76.2	14,775		0.339	36,327	0.834
	3.00		194.5	76.8	14,938		0.343	37,813	0.868
	3.10		195.1	77.4	15,101		0.347	39,315	0.903
	3.20		195.7	78.0	15,265		0.350	40,833	0.937
	3.30		196.3	78.6	15,429		0.354	42,368	0.973
	3.40		196.9	79.2	15,595		0.358	43,919	1.008
	3.50		197.5	79.8	15,761		0.362	45,487	1.044
	3.60		198.1	80.4	15,927		0.366	47,071	1.081
	3.70		198.7	81.0	16,095		0.369	48,672	1.117
	3.80		199.3	81.6	16,263		0.373	50,290	1.155
	3.90		199.9	82.2	16,432		0.377	51,925	1.192
	4.00		200.5	82.8	16,601		0.381	53,577	1.230
	4.10		201.1	83.4	16,772		0.385	55,245	1.268
	4.20		201.7	84.0	16,943		0.389	56,931	1.307
	4.30		202.3	84.6	17,115		0.393	58,634	1.346
	4.40		202.9	85.2	17,287		0.397	60,354	1.386
	4.50		203.5	85.8	17,460		0.401	62,091	1.425
	4.60		204.1	86.4	17,634		0.405	63,846	1.466
	4.70		204.7	87.0	17,809		0.409	65,618	1.506
	4.80		205.3	87.6	17,984		0.413	67,408	1.547
	4.90		205.9	88.2	18,160		0.417	69,215	1.589
	5.00		206.5	88.8	18,337		0.421	71,040	1.631
	5.10		207.1	89.4	18,515		0.425	72,882	1.673
	5.20		207.7	90.0	18,693		0.429	74,743	1.716
	5.30		208.3	90.6	18,872		0.433	76,621	1.759
	5.40		208.9	91.2	19,051		0.437	78,517	1.803
	5.50		209.5	91.8	19,232		0.442	80,431	1.846
	5.60		210.1	92.4	19,413		0.446	82,364	1.891
	5.70		210.7	93.0	19,595		0.450	84,314	1.936
	5.80		211.3	93.6	19,777		0.454	86,283	1.981
	5.90		211.9	94.2	19,961		0.458	88,269	2.026
	6.00		212.5	94.8	20,145		0.462	90,275	2.072
	6.10		213.1	95.4	20,329		0.467	92,298	2.119
	6.20		213.7	96.0	20,515		0.471	94,341	2.166
	6.30		214.3	96.6	20,701		0.475	96,401	2.213
	6.40		214.9	97.2	20,888		0.480	98,481	2.261
	6.50		215.5	97.8	21,076		0.484	100,579	2.309
	6.60		216.1	98.4	21,264		0.488	102,696	2.358
	6.70		216.7	99.0	21,453		0.492	104,832	2.407
	6.80		217.3	99.6	21,643		0.497	106,987	2.456
	6.90		217.9	100.2	21,833		0.501	109,160	2.506
	7.00		218.5	100.8	22,024		0.506	111,353	2.556
	7.10		219.1	101.4	22,216		0.510	113,565	2.607
	7.20		219.7	102.0	22,409		0.514	115,796	2.658
	7.30		220.3	102.6	22,602		0.519	118,047	2.710
	7.40		220.9	103.2	22,796		0.523	120,317	2.762
	7.50		221.5	103.8	22,991		0.528	122,606	2.815
	7.60		222.1	104.4	23,187		0.532	124,915	2.868
	7.70		222.7	105.0	23,383		0.537	127,244	2.921
	7.80		223.3	105.6	23,580		0.541	129,592	2.975
	7.90		223.9	106.2	23,778		0.546	131,960	3.029
	8.00		224.5	106.8	23,976		0.550	134,347	3.084
	8.10		225.1	107.4	24,175		0.555	136,755	3.139
	8.20		225.7	108.0	24,375		0.560	139,182	3.195
	8.30		226.3	108.6	24,576		0.564	141,630	3.251
	8.40		226.9	109.2	24,777		0.569	144,098	3.308
	8.50		227.5	109.8	24,979		0.573	146,585	3.365
	8.60		228.1	110.4	25,182		0.578	149,093	3.423
	8.70		228.7	111.0	25,385		0.583	151,622	3.481
	8.80		229.3	111.6	25,589		0.587	154,170	3.539
	8.90		229.9	112.2	25,794		0.592	156,740	3.598
	9.00		230.5	112.8	26,000		0.597	159,329	3.658
	9.10		231.1	113.4	26,206		0.602	161,939	3.718
	9.20		231.7	114.0	26,413		0.606	164,570	3.778
	9.30		232.3	114.6	26,621		0.611	167,222	3.839
	9.40		232.9	115.2	26,829		0.616	169,895	3.900
	9.50		233.5	115.8	27,038		0.621	172,588	3.962
	9.60		234.1	116.4	27,248		0.626	175,302	4.024
	9.70		234.7	117.0	27,459		0.630	178,038	4.087
	9.80		235.3	117.6	27,670		0.635	180,794	4.150

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)



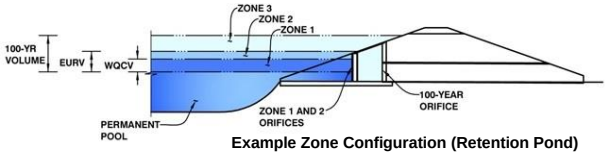


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: **Bayfield Tractor Supply**

Basin ID: **Lot 32, Bayfield Center Subdivision**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (100-year)	1.50	0.395	Circular Orifice
Zone 2			
Zone 3			
Total (all zones)		0.395	

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

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

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	N/A	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 1 Circular	Not Selected			Zone 1 Circular	Not Selected	
Invert of Vertical Orifice =	0.00		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	1.23		ft^2
Depth at top of Zone using Vertical Orifice =	1.50		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.63		feet
Vertical Orifice Diameter =	15.00		inches				

Calculated Parameters for Vertical Orifice

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

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

Calculated Parameters for Overflow Weir

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

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	1.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.87	feet
Spillway Crest Length =	5.00	feet	Stage at Top of Freeboard =	3.37	feet
Spillway End Slopes =	0.00	H:V	Basin Area at Top of Freeboard =	0.36	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.00	acre-ft

Calculated Parameters for Spillway

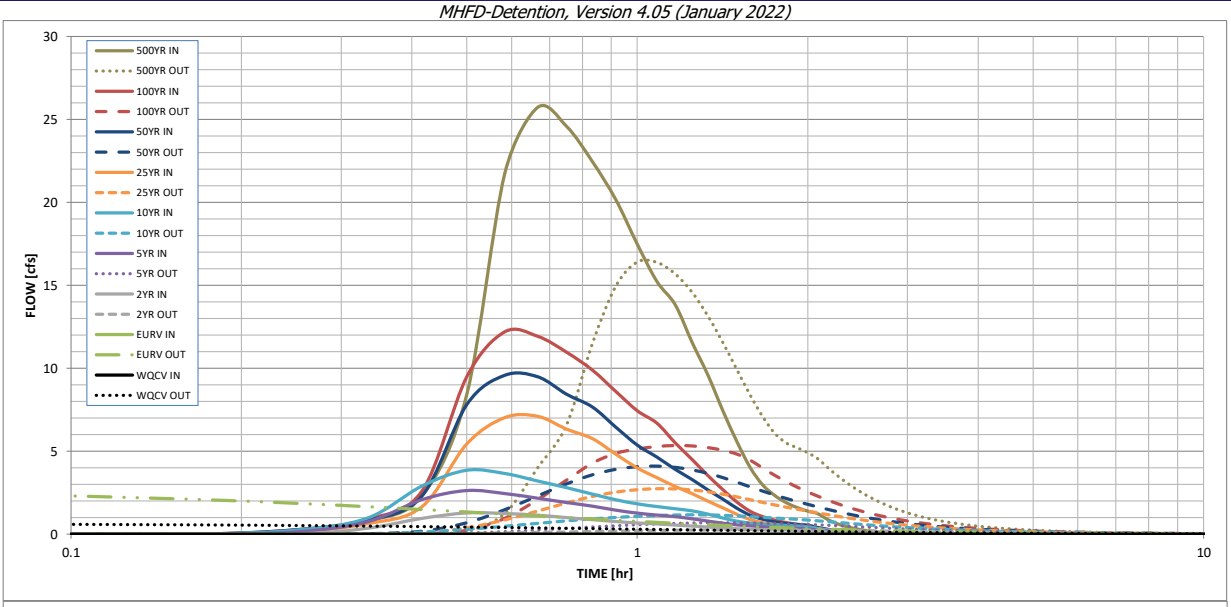
Routed Hydrograph Results

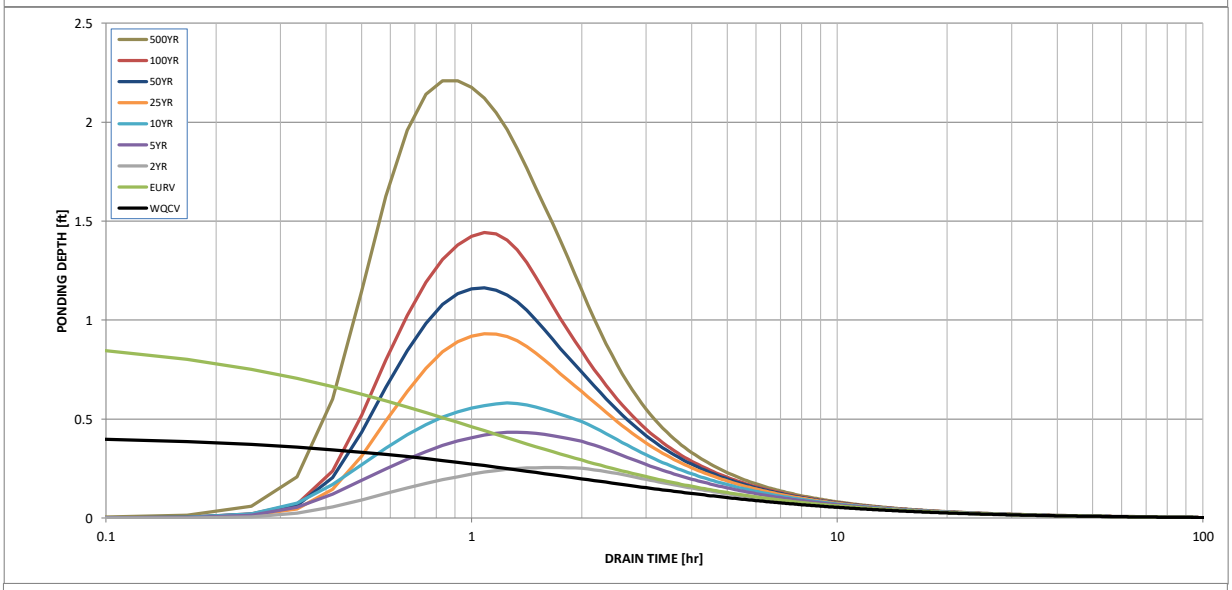
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

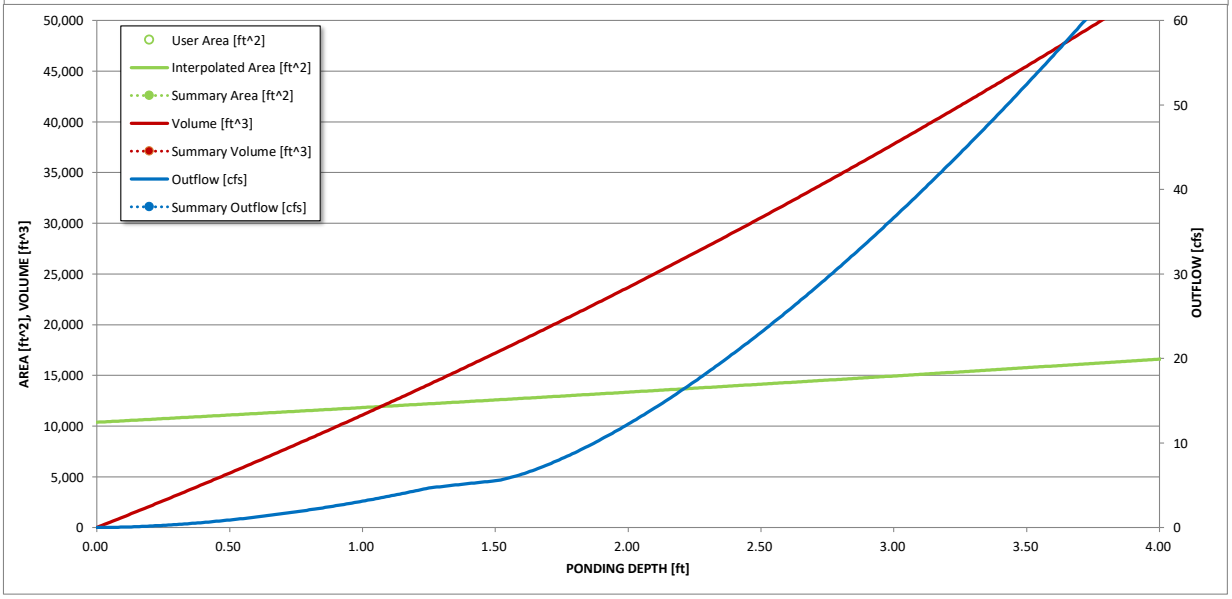
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.60	0.91	1.11	1.36	1.61	1.83	3.14
CUHP Runoff Volume (acre-ft) =	0.105	0.244	0.091	0.171	0.247	0.421	0.567	0.727	1.553
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.091	0.171	0.247	0.421	0.567	0.727	1.553
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.1	0.8	3.7	5.6	7.6	18.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.11	0.48	0.74	1.00	2.37
Peak Inflow Q (cfs) =	N/A	N/A	1.3	2.6	3.9	7.1	9.6	12.2	25.7
Peak Outflow Q (cfs) =	0.6	2.7	0.3	0.7	1.2	2.7	4.1	5.3	16.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	6.2	1.4	0.7	0.7	0.7	0.9
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	36	19	41	25	19	13	11	9	6
Time to Drain 99% of Inflow Volume (hours) =	**77**	46	82	59	45	31	24	20	12
Maximum Ponding Depth (ft) =	0.43	0.97	0.25	0.43	0.58	0.93	1.16	1.44	2.21
Area at Maximum Ponding Depth (acres) =	0.25	0.27	0.25	0.25	0.26	0.27	0.28	0.29	0.31
Maximum Volume Stored (acre-ft) =	0.105	0.247	0.061	0.105	0.144	0.236	0.299	0.378	0.606

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
	0:15:00	0.00	0.00	0.00	0.14	0.24	0.15	0.26	0.26	0.78
	0:20:00	0.00	0.00	0.35	0.74	0.96	0.62	0.81	0.90	2.31
	0:25:00	0.00	0.00	0.95	2.08	2.90	1.65	2.31	2.60	8.43
	0:30:00	0.00	0.00	1.28	2.63	3.85	5.44	7.81	9.49	21.73
	0:35:00	0.00	0.00	1.24	2.45	3.66	7.02	9.58	12.20	25.72
	0:40:00	0.00	0.00	1.14	2.17	3.20	7.10	9.49	11.93	24.59
	0:45:00	0.00	0.00	1.00	1.91	2.80	6.33	8.43	10.97	22.46
	0:50:00	0.00	0.00	0.87	1.69	2.41	5.76	7.66	9.89	20.16
	0:55:00	0.00	0.00	0.76	1.44	2.07	4.82	6.45	8.60	17.49
	1:00:00	0.00	0.00	0.67	1.27	1.83	3.99	5.37	7.44	15.23
	1:05:00	0.00	0.00	0.62	1.15	1.66	3.40	4.64	6.69	13.83
	1:10:00	0.00	0.00	0.55	1.05	1.53	2.88	3.91	5.51	11.56
	1:15:00	0.00	0.00	0.49	0.92	1.40	2.44	3.29	4.50	9.58
	1:20:00	0.00	0.00	0.43	0.79	1.21	1.99	2.66	3.53	7.44
	1:25:00	0.00	0.00	0.38	0.66	0.97	1.58	2.11	2.68	5.57
	1:30:00	0.00	0.00	0.33	0.56	0.78	1.19	1.56	1.93	4.01
	1:35:00	0.00	0.00	0.29	0.50	0.67	0.88	1.14	1.37	2.95
	1:40:00	0.00	0.00	0.27	0.44	0.60	0.69	0.89	1.05	2.32
	1:45:00	0.00	0.00	0.26	0.40	0.55	0.58	0.74	0.84	1.89
	1:50:00	0.00	0.00	0.26	0.37	0.52	0.51	0.64	0.70	1.60
	1:55:00	0.00	0.00	0.23	0.34	0.48	0.47	0.57	0.60	1.39
	2:00:00	0.00	0.00	0.20	0.32	0.44	0.44	0.53	0.53	1.23
	2:05:00	0.00	0.00	0.16	0.24	0.33	0.33	0.40	0.38	0.89
	2:10:00	0.00	0.00	0.12	0.18	0.25	0.25	0.29	0.27	0.64
	2:15:00	0.00	0.00	0.09	0.14	0.18	0.18	0.22	0.20	0.47
	2:20:00	0.00	0.00	0.07	0.10	0.13	0.13	0.16	0.15	0.35
	2:25:00	0.00	0.00	0.05	0.07	0.10	0.10	0.11	0.11	0.25
	2:30:00	0.00	0.00	0.04	0.05	0.07	0.07	0.08	0.08	0.18
	2:35:00	0.00	0.00	0.03	0.04	0.05	0.05	0.06	0.06	0.13
	2:40:00	0.00	0.00	0.02	0.03	0.04	0.04	0.04	0.04	0.09
	2:45:00	0.00	0.00	0.01	0.02	0.02	0.02	0.03	0.03	0.06
	2:50:00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.03
	2:55:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: TRACTOR SUPPLY COMPANY BAYFIELD, CO
Catchment ID: WEST CHANNEL

I. Catchment Hydrologic Data

Catchment ID = NW
Area = 1.91 Acres
Percent Imperviousness = 0.54 %
NRCS Soil Type = D A, B, C, or D

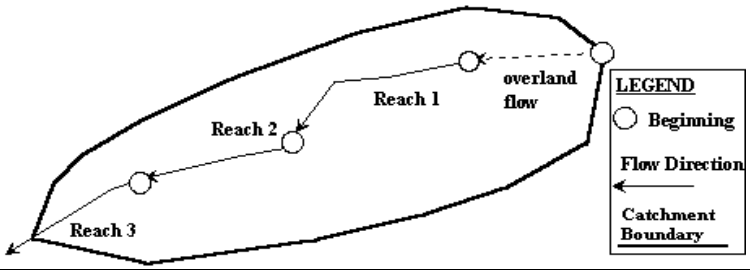
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	1.83	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.50
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.15
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0200	150	0.15	N/A	0.15	16.65
1	0.0200	630			0.00	#DIV/0!
2						
3						
4						
5						
		Sum 780			Computed Tc =	#DIV/0!
					Regional Tc =	14.33
					User-Entered Tc =	14.33

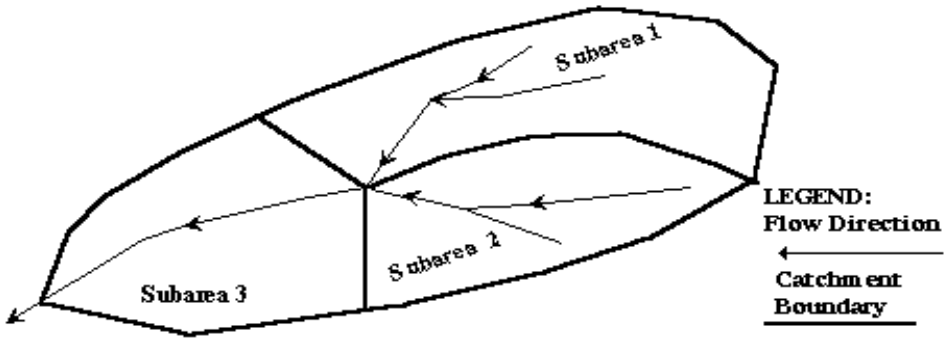
IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	#DIV/0!	inch/hr	Peak Flowrate, Qp =	#DIV/0! cfs
Rainfall Intensity at Regional Tc, I =	4.24	inch/hr	Peak Flowrate, Qp =	4.07 cfs
Rainfall Intensity at User-Defined Tc, I =	4.24	inch/hr	Peak Flowrate, Qp =	4.07 cfs

Area-Weighting for Runoff Coefficient Calculation

Project Title: TRACTOR SUPPLY COMPANY BAYFIELD, CO
Catchment ID: WEST CHANNEL BASIN

Illustration



Instructions: For each catchment subarea, enter values for A and C.

Subarea ID	Area acres A	Runoff Coeff. C*	Product CA
input	input	input	output
PAVING	1.01	1.00	1.01
NATIVE	0.91	0.02	0.02
Sum:	1.91	Sum:	1.02

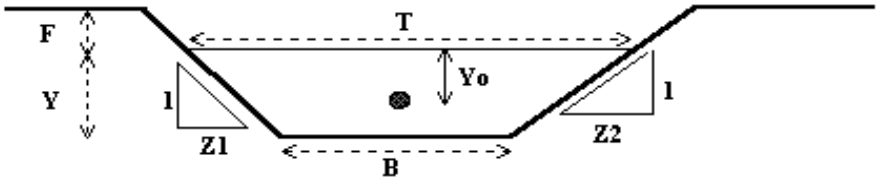
Area-Weighted Runoff Coefficient (sum CA/sum A) = **0.54**

***See sheet "Design Info" for inperviousness-based runoff coefficient values.**

Normal Flow Analysis - Trapezoidal Channel

Project: TRACTOR SUPPLY CO BAYFIELD, CO

Channel ID: WEST CHANNEL



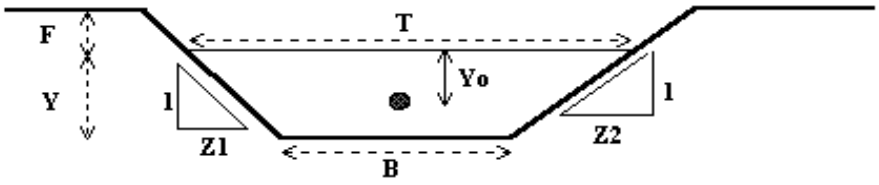
Design Information (Input)			
Channel Invert Slope	So =	0.0200	ft/ft
Manning's n	n =	0.040	
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**1.00**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**9.61**	cfs
Froude Number	**Fr =**	**0.80**	
Flow Velocity	**V =**	**3.20**	fps
Flow Area	A =	3.00	sq ft
Top Width	T =	6.00	ft
Wetted Perimeter	P =	6.32	ft
Hydraulic Radius	R =	0.47	ft
Hydraulic Depth	D =	0.50	ft
Specific Energy	Es =	1.16	ft
Centroid of Flow Area	Yo =	0.33	ft
Specific Force	Fs =	0.12	kip

Critical Flow Analysis - Trapezoidal Channel

Project: TRACTOR SUPPLY CO BAYFIELD, CO

Channel ID: WEST CHANNEL



Design Information (Input)			
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft
Design Discharge	Q =	**4.07**	cfs

Critical Flow Condition (Calculated)			
Critical Flow Depth	**Y =**	**0.65**	ft
Critical Flow Area	A =	1.25	sq ft
Critical Top Width	T =	3.87	ft
Critical Hydraulic Depth	D =	0.32	ft
Critical Flow Velocity	V =	3.26	fps
Froude Number	**Fr =**	**1.01**	
Critical Wetted Perimeter	P =	4.08	ft
Critical Hydraulic Radius	R =	0.31	ft
Critical (min) Specific Energy	Esc =	0.81	ft
Centroid on the Critical Flow Area	Yoc =	0.11	ft
Critical (min) Specific Force	Fsc =	0.03	kip

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: TRACTOR SUPPLY COMPANY BAYFIELD, CO
Catchment ID: DRIVEWAY CULVERT

I. Catchment Hydrologic Data

Catchment ID = NW
Area = 0.75 Acres
Percent Imperviousness = 1.34 %
NRCS Soil Type = D A, B, C, or D

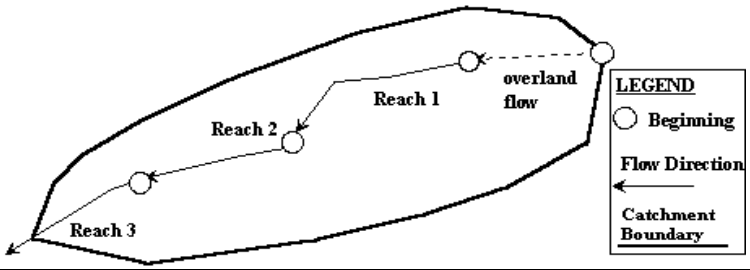
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	1.83	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.51
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.16
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0200	20	0.16	N/A	0.06	6.05
1	0.0200	135			0.00	#DIV/0!
2						
3						
4						
5						
	Sum	155			Computed Tc =	#DIV/0!
					Regional Tc =	10.86
					User-Entered Tc =	11.00

IV. Peak Runoff Prediction

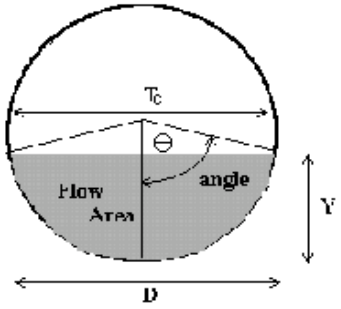
Rainfall Intensity at Computed Tc, I =	#DIV/0!	inch/hr	Peak Flowrate, Qp =	#DIV/0!	cfs
Rainfall Intensity at Regional Tc, I =	4.79	inch/hr	Peak Flowrate, Qp =	1.80	cfs
Rainfall Intensity at User-Defined Tc, I =	4.76	inch/hr	Peak Flowrate, Qp =	1.80	cfs

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Bayfield Tractor Supply

Pipe ID: Driveway Culvert



Design Information (Input)			
Pipe Invert Slope	So =	0.0200	ft/ft
Pipe Manning's n-value	n =	0.0240	*
Pipe Diameter	D =	12.00	inches
Design discharge	Q =	2.00	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	0.79	sq ft
Full-flow wetted perimeter	Pf =	3.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	2.74	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	2.23	radians
Flow area	An =	0.68	sq ft
Top width	Tn =	0.79	ft
Wetted perimeter	Pn =	2.23	ft
Flow depth	Yn =	0.81	ft
Flow velocity	Vn =	3.97	fps
Discharge	Qn =	2.70	cfs
Percent of Full Flow	Flow =	98.7%	of full flow
Normal Depth Froude Number	Fr_n =	0.75	subcritical

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.99	radians
Critical flow area	Ac =	0.59	sq ft
Critical top width	Tc =	0.91	ft
Critical flow depth	Yc =	0.70	ft
Critical flow velocity	Vc =	3.38	fps
Critical Depth Froude Number	Fr_c =	0.74	

*** Unexpected value for Manning's n**