Drainage Report

FOR

Salisbury Park North Phase 1

AT

11700 N MOTSENBOCKER RD

PARKER CO 80134

FOR

Town of Parker

November 20, 2024

JVA, Incorporated
1319 Spruce Street
Boulder, CO 80302
303.444.1951
info@jvajva.com

www.jvajva.com

November 20th, 2024

Mr. Michael Walton, PE, CFM, Senior Development Review Engineer
Town of Parker
Engineering and Development
20120 E. Main Street
Parker, CO 80138

RE: Drainage Report for Salisbury Park North Phase 1
JVA, Inc. Project No. 3752c

Dear Michael:

The following Drainage Report has been prepared for the for Lutheran High School Athletic Fields project. The stormwater report and drainage maps have been produced in accordance with the Storm Drainage and Environmental Policies for Parker, Colorado and the latest Mile High Flood Control District recommendations.

It is our understanding that the information provided herein meets the requirements specified in the Storm Drainage and Environmental Criterial Manual.

Please contact us if you have any questions regarding this submission.

Sincerely,

JVA, Inc.

____

Jacob A. Zeigler, P.E.
Project Engineer

JVA CONSULTING ENGINEERS

Engineer's Statement:

This report for Salisbury Park North Phase 1 was prepared by me (or under my direct supervision) in accordance with the provisions of the Storm Drainage and Environmental Criterial Manual for the owners thereof. I understand that the City of Parker does not and will not assume liability for drainage facilities designed by others.

____

Cody F. Gratny
Registered Professional Engineer
State of Colorado No. 45353

____

Seal and Date

Drainage Report

FOR

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PARKER CO 80134

FOR

Town of Parker

JVA, Inc.

Consulting Engineers

1319 Spruce Street

Boulder, CO 80302

(303) 444-1951

JVA, Inc. Project No. 3350c
November 20, 2024

TABLE OF CONTENTS

DRAINAGE REPORT

Salisbury Park North Phase 1

I. General Location and Description

The following report details the drainage design for Phase 1 of the Salisbury Park North Project. As described in the Salisbury Park North Master Drainage Report, this project will be constructed in four phases. Phase 1 of the project will include the construction of four baseball fields with supporting dugouts, bull pens, and batting cages. A centralized plaza will be constructed within the center of the four baseball fields that will contain bleachers and facilities buildings. In addition to the baseball fields, that are two proposed multipurpose fields. Parking will be built south of the multipurpose fields and east of the northeast baseball diamond. Five detention ponds will be built to provide WQCV for this portion of the site.

In general, the proposed development of Phase 1 will result in a 37.2% overall increase in site imperviousness. A summary of the historic and developed impervious values is shown in Table 1 below:

Table 1 - Impervious Surface Summary

	Site Area (acres)	Imperviousness
Historic	75.57	5.8%
Phase 1 Developed	38.86	43%
Master Plan Developed	46.62	51.4%

II. Drainage Basins and Sub-basins

A. Major Basin Description

The project site is located within the Cherry Creek Watershed. In general, the proposed development will match historic drainage patterns. Stormwater generally flows from the south to the north across the site. A network of proposed water quality basins will be constructed along the northern extents of the proposed site. Stormwater will be treated for water quality in these basins before it is discharged along historic drainage paths into Cherry Creek via storm sewer and overland flow.

B. Site Sub-Basin Description

The proposed site has been divided into major basins with minor sub-basins. The basin delineations are shown within the Developed Drainage Map with corresponding design points for each basin. The naming convention for these basins generally matches the naming convention established in the Master Drainage Report. The pond that receives flows from Major Basin B in the Master Drainage Report will not be constructed in Phase 1; therefore, no basins in this report are labeled Basin B. The Developed Drainage Map is included in Appendix D.

Basins A1-A8 (13.96 acres) are onsite disturbed areas which comprise the east half of the proposed site. Contained within these basins are proposed baseball fields, batting cages, the HQ building, pickleball courts, and associated parking. Runoff generated within these basins is tributary to proposed WQCV Pond A. Conveyance to this pond is achieved with a network of overland flow channels, storm lines, and culverts. Outfall from Pond A is directed to the north along a proposed swale into an existing drainage culvert, and ultimately into Cherry Creek. Major Basin A in this report is contained entirely within Major Basin A in the Master Drainage Plan.

Basins C1-C4 (11.40 acres) are onsite disturbed areas that contain the drainage channel along the southern extent of the site, the two western baseball fields, and a parking area. Runoff generated within these basins is tributary to the proposed WQCV Pond C. A network of storm sewer and overland drainage channels will convey runoff to the Pond. Outfall from Pond C is directed along a proposed swale to an existing drainage culvert, and ultimately into Cherry Creek. Major Basin C in this report is contained entirely within Major Basin C in the Master Drainage Plan.

Basins D1-D2 (7.70 acres) are onsite disturbed areas that contain two multi-purpose fields, a basketball court, a workout area, and associated walks and open spaces. Runoff generated within these basins is tributary to proposed WQCV Pond D. A network of storm lines will provide conveyance to the Pond. Outfall from Pond D is directed to the north along a proposed swale into an existing drainage culvert, and ultimately into Cherry Creek. Major Basin D in this report is contained entirely within Basins B1 and B2 the Master Drainage Plan.

Basin E1 (1.92 acres) contains a drive isle and associated parking stalls along the west side of the site. In the phase one condition, runoff generated within this basin will flow to the north via curb & gutter into proposed WQCV Pond E. Outfall from Pond E will be directed into a bypass swale which runs to the north into an existing drainage culvert, and ultimately into Cherry Creek. This basin is contained within Basin A7 on the Master Drainage Plan.

Basin ALT 1 (1.02 acres) contains the proposed Alternate 1, which includes a community hub building and concrete walks. Runoff in this basin will flow to the proposed storm sewer which will convey flows to the WQCV Alt 1 Detention Pond. Basin ALT 1 in this report is equivalent to Basin B4 in the Master Drainage Plan.

Basin OS1 (2.87 acres) contains a portion of the site which is flowing offsite, untreated. This basin contains some undisturbed native grasses, and some landscaped areas. A swale has been constructed in the northeastern portion of this basin which will capture all flows and convey it to a culvert passing under the road. Major Basin OS1 in this report is contained within Major Basin A in the Master Drainage Plan.

III. Drainage Design Criteria

A. Regulations

It is JVA's understanding that the work presented within this drainage report complies with all applicable Town of Parker and Mile High Flood District design standards. Point rainfall data that was used for design was taken from the Storm Drainage and Environmental Criteria Manual from the Town of Parker and the calculation methods specified are used.

B. Hydrology

The Rational Method (Q=CIA) was used to determine the storm runoff (Q) from the areas tributary to the new storm system, with composite runoff coefficients (C) and contributing areas (A) given for design points in sub-basins. More information about hydrologic calculation methods can be found in the Master Drainage Report.

C. Hydraulics

Design storm recurrence intervals are consistent with the City of Parker requirements: the minor storm analysis is the 5-year event, and the major storm is the 100-year event. Water surface profiles and pipe hydraulic grade line computations are performed using Autodesk Civil 3D Hydraflow Storm Sewers Extension, version 2024.

D. Water Quality Enhancement

Detention and water quality for the site's developed basins is provided through a network of proposed extended detention basins located generally along the north extents of the site improvements. These facilities will slow down runoff and encourage infiltration, sedimentation, and filtration, thus aiding in the removal of excess sediment, solids, nutrients, metals and grit, and other typical pollutants from stormwater.

IV. Drainage Facility Design

A. Stormwater Conveyance Facilities

A network of new storm sewers and drainage swales will convey captured runoff northward towards a series of proposed extended detention basins and water quality treatment facilities. These basins will discharge stormwater to the north along historic drainage paths. All proposed storm sewers and drainage swales will be maintained by the Town of Parker. The swale calculations for the proposed drainage swales have been included in Appendix C.

A series of swales and culverts will bypass offsite flows on the west side of the site. The exact amount of flow received by this bypass system is unclear, as it is receiving outflow from two upstream detention ponds. In this report, the flow was approximated by summing the release flows of the two upstream detention ponds. The Horseshoe Ridge Detention Ponds 1 and 2 have a peak outflow of 137.7 cfs and Salisbury Heights Pond C has a peak outflow of 7.24 cfs. Therefore, this bypass system was assumed to receive a 100-yr flow of 144.94 cfs. This system has a capacity of 74 cfs, with the remainder of the runoff safely overflowing to a parking lot located south of our site.

Note: 5-year and 100-year HGL's have been provided with calculations for on-site pipes. However, due to limited available historic information, the storm sewers associated with the bypass flow along the west side of the site have been modeled with 2-year and 100-year flows.

B. Stormwater Storage Facilities

The Town of Parker's Storm Drainage and Environmental Criteria Manual requires the implementation of full-spectrum detention. This approach is designed to control peak discharge across all runoff events, from frequent storms to the 100-year event, effectively replicating pre-development conditions. Due to site constraints onsite water quality ponds are proposed instead of full-spectrum detention. This variance along with any others is discussed in the Master Drainage Report.

The Water Quality Basin designs include one of two outlet structure designs. The first design is an outlet structure with a water quality orifice plate and overflow pipe. The second design is a weir with a water quality orifice plate and an overflow weir. This approach meets the Town's stormwater management requirements for water quality and keeps fill within the adjacent floodplain as minimal as possible.

Ponds D, E and ALT 1 will only be constructed for Phase 1 and Phase 2. In Phase 3, these ponds will be removed, and runoff will be redirected to a different pond. Ponds A and C will exist in their current condition in the final condition, and therefore have been sized for a larger flow than they will receive in this phase. A summary of the proposed detention basin volumes is shown in Table 2 below:

Table 2 – Detention Basin Volumes

Basin ID	Watershed Area (ac)	Provided Volume (ac-ft)	Required Volume (ac-ft)	WQ Peak Outflow Q (cfs)
Pond A	13.96	0.777	0.222	0.2
Pond C	11.40	0.384	0.169	0.1
Pond D	7.70	0.229	0.134	0.1
Pond E	1.92	0.100	0.038	0.0
ALT 1	1.00	0.039	0.020	0.0

C. Water Quality & Permanent Best Management Practices

This development is classified as a Tier 3 Development under the Town's Permanent BMP (PBMP) requirements, subjecting it to the most comprehensive PBMP standards outlined in the Town's regulations.

The PBMP proposed for this project includes multiple water quality control volume ponds, as specified in Section 7.2.1.2 of the Town of Parker’s Storm Drainage and Environmental Criteria Manual. The design calculations given in this report, including outlet design, strictly adhere to the procedure outlined in Volume 3 of the Urban Storm Drainage Criteria Manual.

The design considers the site's soil conditions and geologic features, notably Type B soils with moderate infiltration potential, and aligns with the Town of Parker's regional drainage and stormwater quality plans.

Long-term operation and maintenance of the PBMPs will be the sole responsibility of the Town of Parker, with easements and legal provisions included in the final design to ensure access for operation, maintenance, and inspection.

This PBMP plan has been developed in full compliance with the Town of Parker's requirements for New Development, as defined in Section 1.4 of the Town's regulations, and meets all applicable standards for Tier 3 Developments.

V. Conclusions

A. Compliance with Standards

The stormwater facilities and design proposed for the Salisbury Park North have been designed and analyzed in accordance with the City of Parker Storm Drainage and Environmental Criteria Manual, the Mile High Flood District recommendations set forth in the Urban Storm Drainage Criteria Manuals and engineering best practices within the State of Colorado. The proposed drainage design will maintain existing runoff conditions by attenuating and treating developed flows and reduce the potential for adverse effects downstream.

B. Drainage Concept

The proposed stormwater management infrastructure and techniques are in substantial compliance with all applicable regulations and will improve existing site drainage conditions. The design incorporates strategic grading, Best Management Practices, and control measures to provide stormwater quality treatment and attenuate developed flows to mimic historic flows for a variety of return events. The improvements presented in this report are intended to improve existing conditions and minimize flood risk. It is believed that the proposed improvements will not adversely impact properties upstream or downstream, and do not adversely impact drainageways downstream.

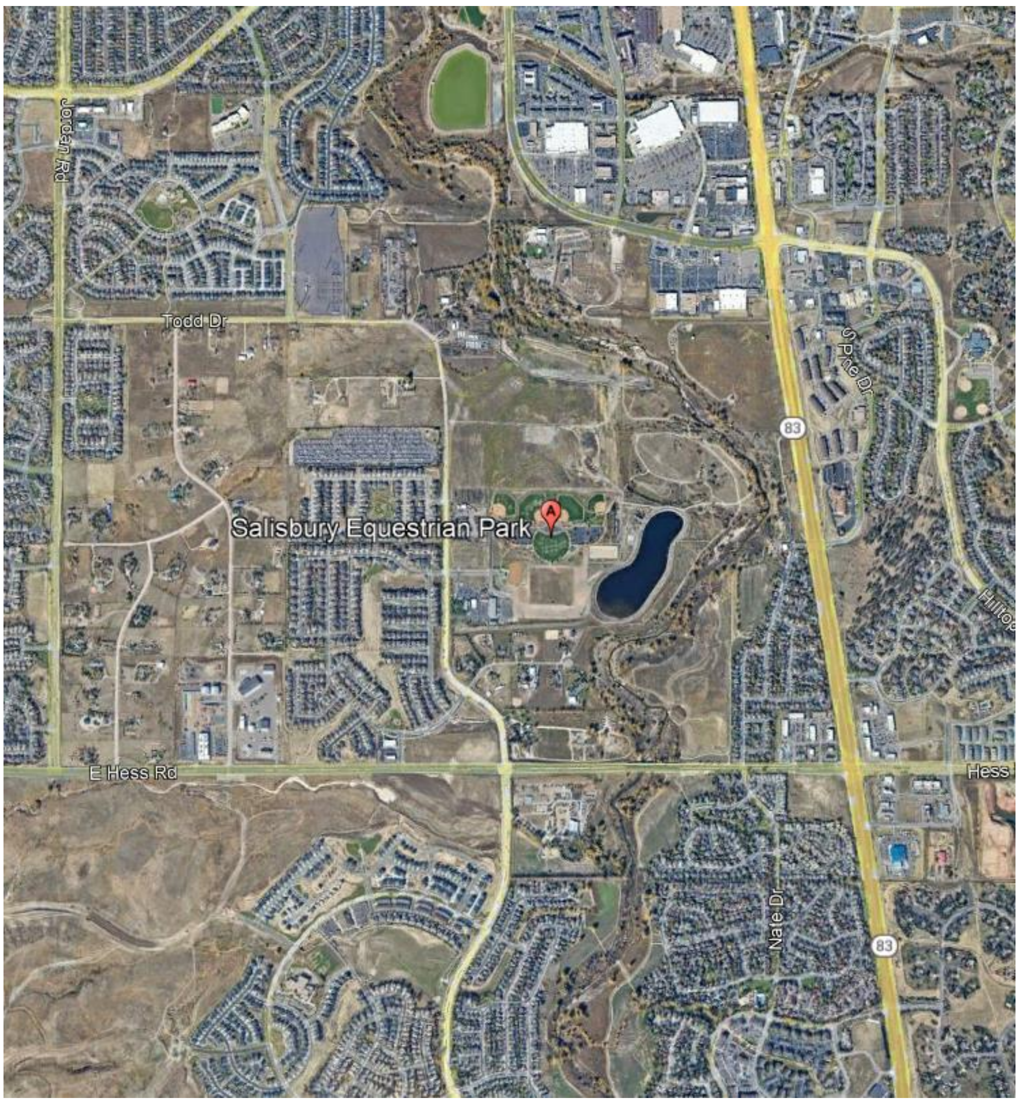
VI. References

1. “Final Roadway Drainage Report for Dransfeldt Road Extension” Douglas County, Colorado, August 2023.
2. “Salisbury Park North Phase 1 Floodplain Development Permit Application” City of Parker, Colorado, November 2023.
3. “Storm Drainage and Environmental Criteria Manual”, Town of Parker, Colorado, February 2014.
4. “Urban Storm Drainage Criteria Manual”, Mile High Flood District, Latest Edition.
5. https://www.fema.gov/flood-maps. Accessed 14 May 2024.
6. https://websoilsurvey.nrcs.usda.gov/app/. Accessed 14 May 2024.
7. https://fwsprimary.wim.usgs.gov/wetlands/apps/wetlands-mapper/. Accessed 14 May 2024.

APPENDIX A – LOCATION INFORMATION

Salisbury Park North Development

AT
11700 Motsenbocker Road
Parker, CO

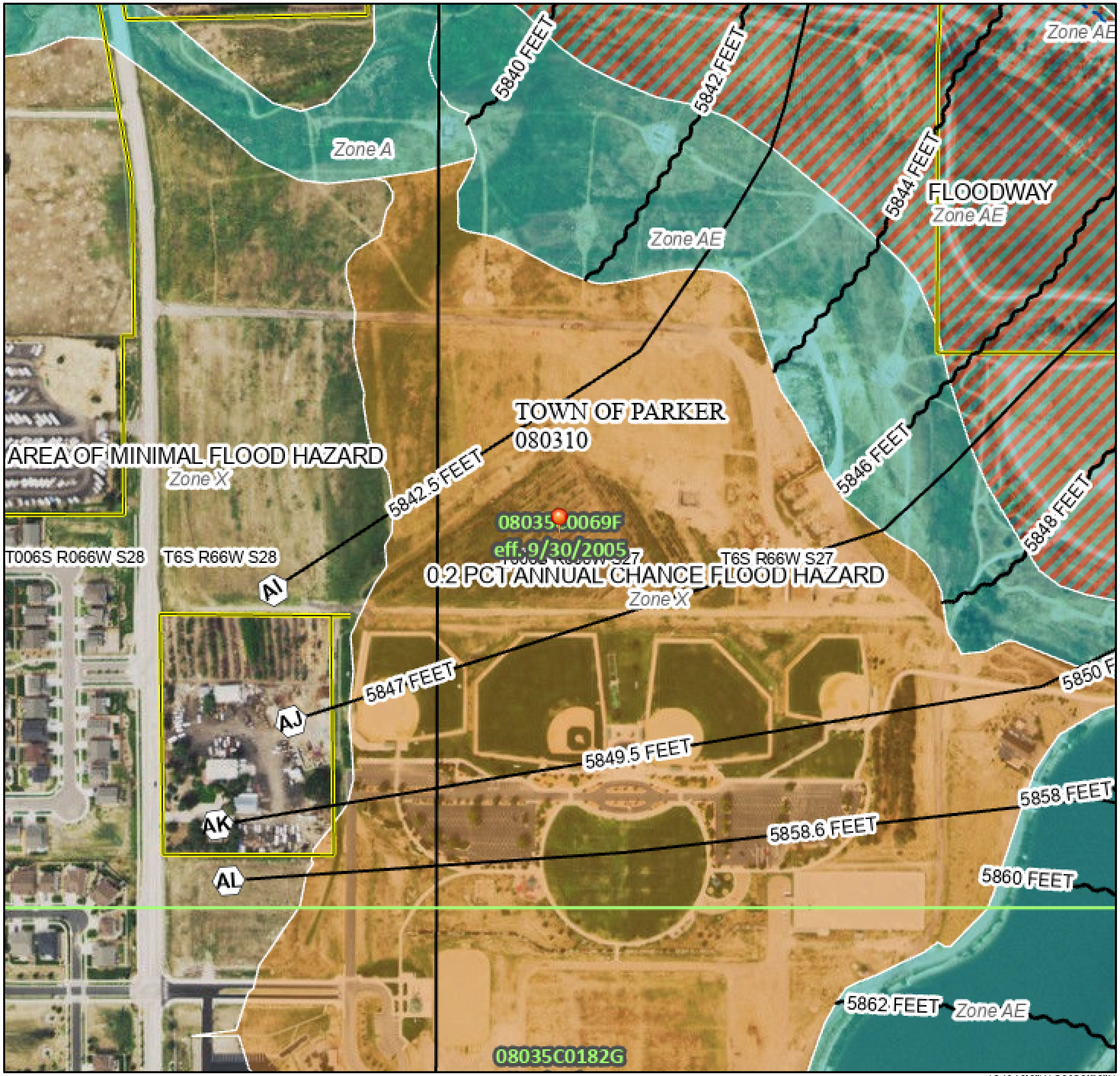


VICINITY MAP NOT TO SCALE

National Flood Hazard Layer FIRMette

FEMA

104°46'43"W 39°30'24"N



Feet

0 250 500 1,000 1,500 2,000

1:6,000

104°46'6"W 39°29'56"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- B 20.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

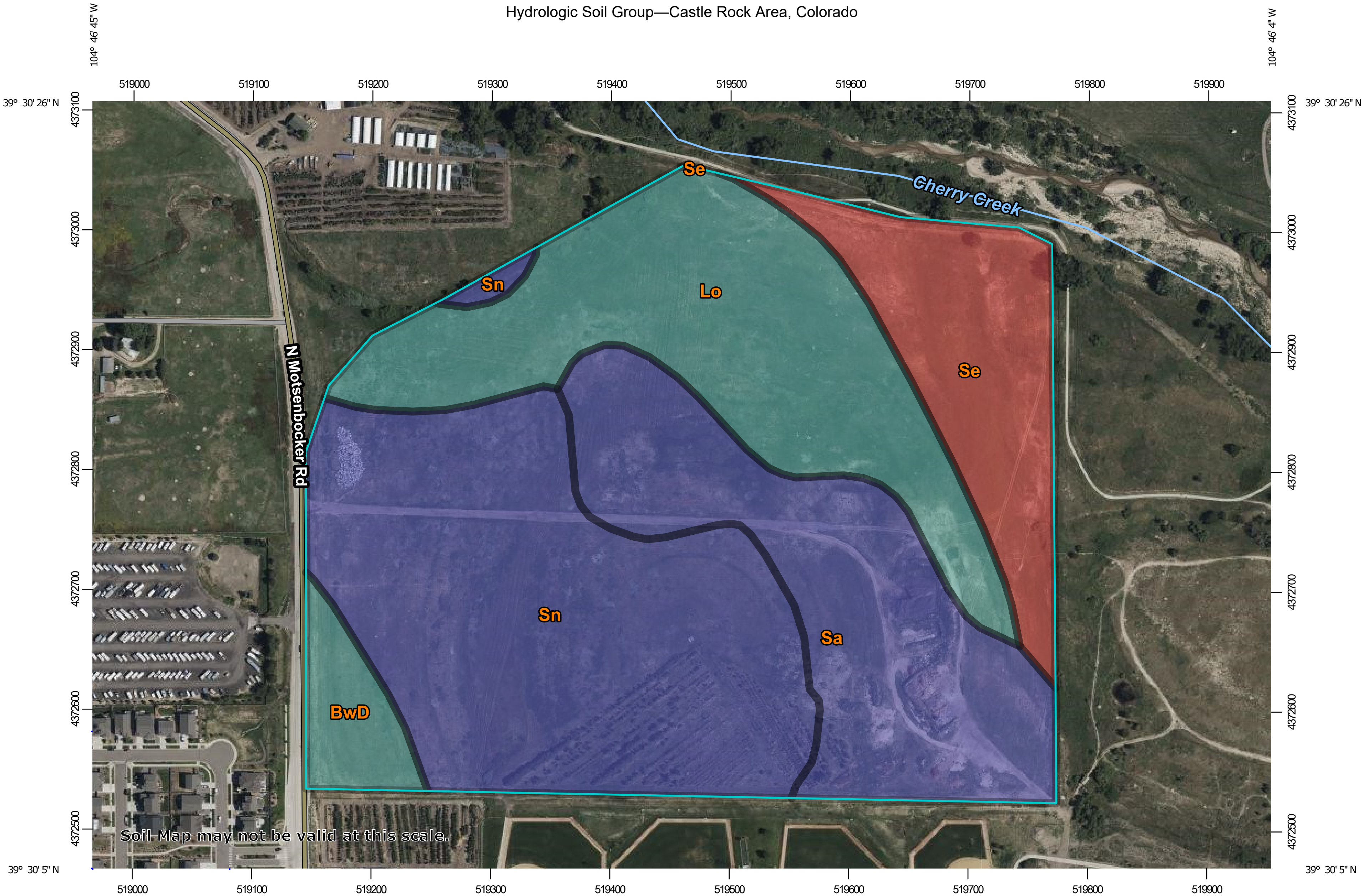
N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

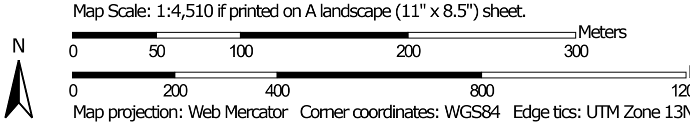
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/16/2023 at 4:40 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



Map Scale: 1:4,510 if printed on A landscape (11" x 8.5") sheet.



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 Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

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 1:20,000.

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: Castle Rock Area, Colorado
Survey Area Data: Version 17, Aug 29, 2024

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

Date(s) aerial images were photographed: Mar 1, 2023—Sep 1, 2023

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BwD	Buick-Satanta loams, 3 to 9 percent slopes	C	2.6	3.7%
Lo	Loamy alluvial land	C	18.0	24.9%
Sa	Sampson loam	B	16.0	22.2%
Se	Sandy wet alluvial land	D	9.4	13.1%
Sn	Satanta loam	B	26.0	36.1%
Totals for Area of Interest			**72.1**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

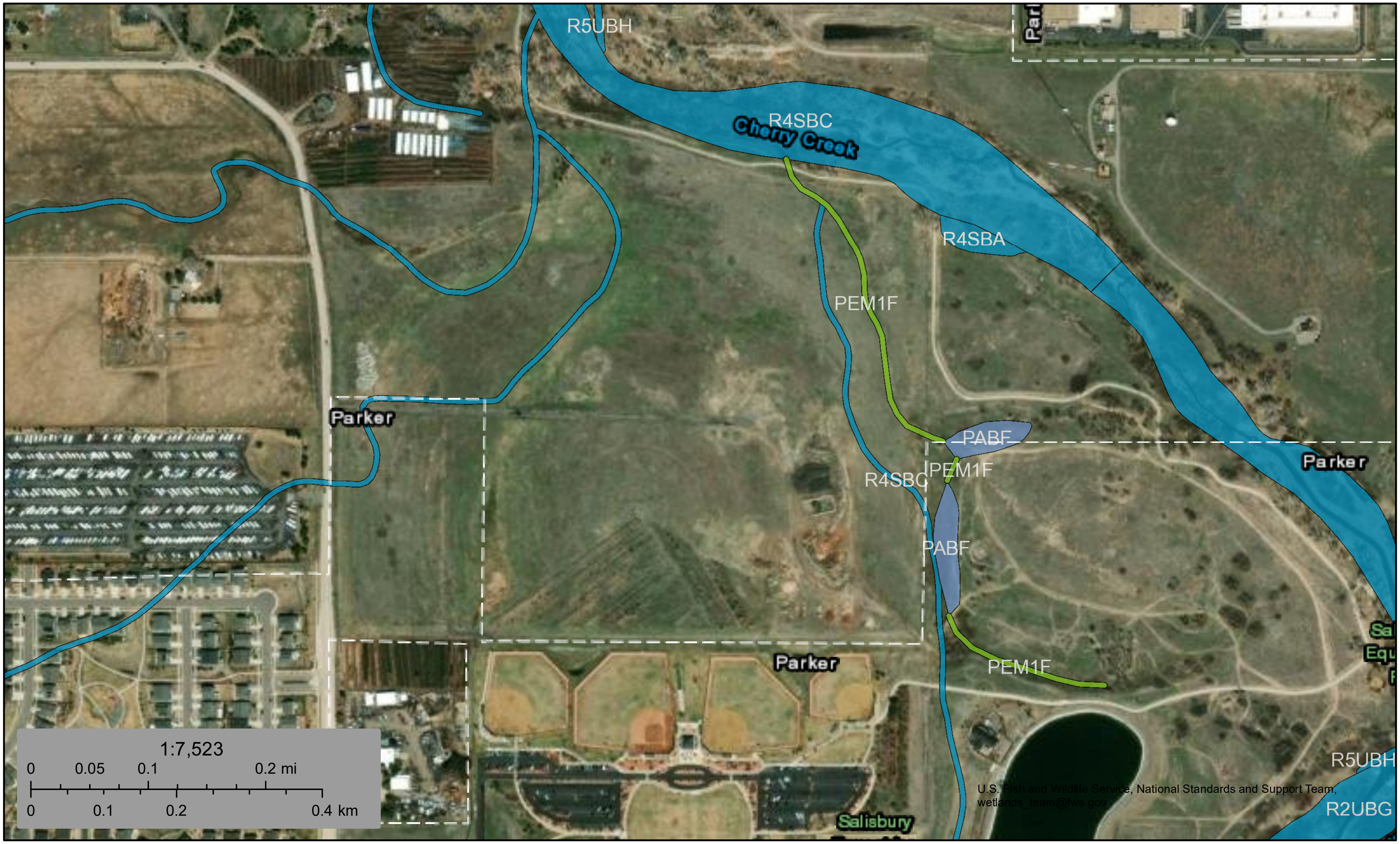
Component Percent Cutoff: None Specified

Tie-break Rule: Higher

U.S. Fish and Wildlife Service

National Wetlands Inventory

Salisbury Park North Wetlands Inventory



November 14, 2024

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

National Wetlands Inventory (NWI)
This page was produced by the NWI mapper

APPENDIX B – HYDROLOGIC COMPUTATIONS

JVA Incorporated
1319 Spruce Street
Boulder, CO 80302
Ph: (303) 444 1951

Project Information:

Job Name:	Salisbury Park North Phase 1
Job Number:	3752c
Date:	11/19/2024
Designed by:	KAM
Municipality :	Parker

Runoff Calculations:

Minor Design Storm:	5	year
Major Design Storm:	100	year

Detention Calculations:

Minor Storm Detention:	EURV	year
Major Storm Detention:	100	year
Detention Volume by:	EURV (MHFD)	

Allowable Release Rates (if applicable):

Max release rate 1 cfs / acre? Yes

Enter Offsite flows to bypass site (these will be added to the allowable release ra

Qminor =	0.00	cfs (bypass flows)
Q100 =	0.00	cfs (bypass flows)

Rainfall Data Information:

Enter City, Town, or County: Parker

Frequency of Design Event	One Hour Point Rainfall P1	
2 yr	0.99	in
5 yr	1.39	in
10 yr	1.64	in
100 yr	2.60	in

Runoff Coefficient Calculations:

Use MHFD Equations? Yes

Intensity Duration Values:

I-D-F Calculate

JVA Incorp| Job Name: Salisbury Park North Phase 1
1319 Spruce| Job Number: 3752c
Boulder, CO | Date: 11/19/24
Ph: (303) 44 | By: KAM

Municipality: Parker

Salisbury Park North Phase 1

Historic Runoff Coefficient & Time of Concentration Calculations

Municipality: Parker
Impervious Values: MHFD
Runoff Coefficients: MHFD Formulae
Major Design Storm: 100
Minor Design Storm: 5

Basin Design Data																									
		I (%) =	5%	95%			I (%)	Runoff Coefficients (MHFD Forumulae Table 6-5)				Initial Overland Time (t_i) MHFD Eq 6-3			Channelized Travel Time (t_t) MHFD Eq 6-4						t_c Comp	Regional Check ($t_{regional}$) MHFD Eq 6-5			t_c Final
			Area (sf)	Area (sf)																					
Basin Name	Soil Type	Design Point	Undisturbed Native	Concrete Drives/Walks	A_{Total} (sf)	A_{Total} (ac)	Imp (%)	C2	C5	C10	C100	Length (ft)	Slope (%)	t_i (min)	Length (ft)	Slope (%)	Type of Land Surface	K	Velocity (fps)	t_t (min)	Time of Conc $t_i + t_t = t_c$	Channelized Length (ft)	Channelized Slope (ft/ft)	$t_{regional}$	t_c or $t_{regional}$
H1	C/D	1	759,288	5,897	765,185	17.57	5.7%	0.03	0.08	0.17	0.51	500	1.4%	37.8			Paved areas & shallow paved	20	0.0	0.0	37.8	0	0.000	N/A	37.8
H2	C/D	2	1,951,339		1,951,339	44.80	5.0%	0.03	0.08	0.17	0.50	500	1.0%	42.6			Paved areas & shallow paved	20	0.0	0.0	42.6	0	0.000	N/A	42.6
H3	C/D	3	35,811	970	36,780	0.84	7.4%	0.04	0.10	0.19	0.51	19	25.0%	2.7	163	1.8%	Paved areas & shallow paved	20	2.7	1.0	3.8	163	0.018	26.8	5.0
H4	C/D	4	516304.11	22422.37	538,726	12.37	8.7%	0.05	0.11	0.20	0.52	438	1.4%	34.1	570	0.5%	Grassed waterway	15	1.1	9.0	43.0	570	0.005	37.7	37.7
		TOTAL SITE	3,262,742	29,289	3,292,031	75.57	5.8%	0.03	0.08	0.17	0.51														

I = (28.5 P1) / ((10 + TC) 0.786)

			Runoff Coeff's				Rainfall Intensities (in/hr)				Area		Flow Rates (cfs)			
Basin Name	Design Point	Time of Conc (tc)	C2	C5	C10	C100	2	5	10	100	A_{Total} (sf)	A_{Total} (ac)	Q2	Q5	Q10	Q100
H1	1	37.8	0.03	0.08	0.17	0.51	1.35	1.90	2.24	3.55	765,185	17.57	0.79	2.71	6.83	31.61
H2	2	42.6	0.03	0.08	0.17	0.50	1.25	1.76	2.08	3.29	1,951,339	44.80	1.62	5.97	15.69	74.37
H3	3	5.0	0.04	0.10	0.19	0.51	3.36	4.71	5.56	8.82	36,780	0.84	0.13	0.38	0.87	3.83
H4	4	37.7	0.05	0.11	0.20	0.52	1.35	1.90	2.24	3.55	538,726	12.37	0.91	2.50	5.44	22.85
										TOTAL SITE	3,292,031	75.57	3.45	11.56	28.84	132.66

JVA Incorporated
1319 Spruce Street
Boulder, CO 80302
Ph: (303) 444 1951

Job Name: Salisbury Park North Phase 1
Job Number: 3752c
Date: 11/19/24
By: KAM

Salisbury Park North Phase 1

Composite Runoff Coefficient Calculations

Municipality: Parker
Impervious Values: MHFD
Runoff Coefficients: MHFD Formulae

Basin Design Data												Runoff Coefficients (MHFD Forumulae Table 6-5)			
		I (%) =	95%	95%	95%	20%	60%	5%			I (%)				
			Area (sf)	Area (sf)	Area (sf)	Area (sf)	Area (sf)	Area (sf)							
Basin Name	Soil Type	Design Point	Streets Paved	Concrete Drives/Walks	Roof	Landscaping	Artificial Turf (Sports Fields)	Undisturbed Native	A_{Total} (sf)	A_{Total} (ac)	Imp (%)	C2	C5	C10	C100
A1	C/D	1		28,471	3,467	11,513			43,451	1.00	75.1%	0.61	0.65	0.68	0.79
A2	C/D	2		16,852		118,288			135,140	3.10	29.4%	0.21	0.27	0.35	0.60
A3	C/D	3		41,552		191,216			232,768	5.34	33.4%	0.24	0.31	0.38	0.62
A4	C/D	4	26,219	12,784		28,084			67,088	1.54	63.6%	0.50	0.55	0.60	0.74
A5	C/D	5	14,455						14,455	0.33	95.0%	0.79	0.81	0.83	0.87
A6	C/D	6	14,203						14,203	0.33	95.0%	0.79	0.81	0.83	0.87
A7	C/D	7	34,562	2,630		63,598			100,790	2.31	47.7%	0.36	0.42	0.48	0.68
C1	C/D	8	31,860	7,024		64,739			103,623	2.38	48.1%	0.37	0.43	0.49	0.68
C2	C/D	9	30,714	5,552		6,425			42,691	0.98	83.7%	0.68	0.72	0.75	0.83
C3	C/D	10		22,578		152,490			175,068	4.02	29.7%	0.21	0.28	0.35	0.61
C4	C/D	11		28,629		146,505			175,134	4.02	32.3%	0.23	0.30	0.37	0.62
D1	C/D	12		27,166		30,105	217,308		274,579	6.30	59.1%	0.46	0.52	0.57	0.73
D2	C/D	13				40,653		20,327	60,980	1.40	15.0%	0.10	0.16	0.24	0.55
E1	C/D	14	31,290	14,149		38,103			83,543	1.92	60.8%	0.48	0.53	0.58	0.73
ALT 1	C/D	15		17,719	6,765	19,858			44,342	1.02	61.4%	0.48	0.54	0.58	0.74
OS1	C/D	16				60,712		64,360	125,072	2.87	12.3%	0.08	0.14	0.22	0.53
		TOTAL SITE	183,303	225,104	10,232	972,291	217,308	84,686	1,692,924	38.86	42.9%	0.33	0.38	0.45	0.66

JVA Incorporated
1319 Spruce Street
Boulder, CO 80302
Ph: (303) 444 1951

Municipality: Parker

Job Name: Salisbury Park North Phase 1
Job Number: 3752c
Date: 11/19/24
By: KAM

Salisbury Park North Phase 1
Time of Concentration Calculations

Municipality: Parker
Impervious Values: MHFD
Runoff Coefficients: MHFD Formulae

Sub-Basin Data				Initial Overland Time (t_i) MHFD Eq 6-3			Channelized Travel Time (t_t) MHFD Eq 6-4						t_c Comp	Regional Check ($t_{regional}$) MHFD Eq 6-5			t_c Final
Basin Name	Design Point	A_{Total} (ac)	C5	Length (ft)	Slope (%)	t_i (min)	Length (ft)	Slope (%)	Type of Land Surface	C_v	Velocity (fps)	t_t (min)	Time of Conc $t_i + t_t = t_c$	Channelized Length (ft)	Channelized Slope (ft/ft)	$t_{regional}$	t_c or $t_{regional}$
A1	1	1.00	0.65	21	2.00%	3.0			Paved areas & shallow paved swales	20	0.0	0.0	3.0	0	0.000	N/A	5.0
A2	2	3.10	0.27	110	1.00%	15.9	583	0.50%	Grassed waterway	15	1.1	9.2	25.0	583	0.005	31.5	25.0
A3	3	5.34	0.31	300	1.20%	23.7	442	0.60%	Grassed waterway	15	1.2	6.3	30.0	442	0.006	27.3	27.3
A4	4	1.54	0.55	106	2.40%	7.7	31	2.40%	Paved areas & shallow paved swales	20	3.1	0.2	7.9	31	0.024	15.4	7.9
A5	5	0.33	0.81	12	2.00%	1.5	1136	1.40%	Paved areas & shallow paved swales	20	2.4	8.0	9.5	1136	0.014	17.0	9.5
A6	6	0.33	0.81	12	2.00%	1.5	1152	1.40%	Paved areas & shallow paved swales	20	2.4	8.1	9.6	1152	0.014	17.1	9.6
A7	7	2.31	0.42	221	2.20%	14.2	304	0.50%	Paved areas & shallow paved swales	20	1.4	3.6	17.8	304	0.005	22.5	17.8
C1	8	2.38	0.43	118	2.10%	10.5	554	0.70%	Paved areas & shallow paved swales	20	1.7	5.5	16.0	554	0.007	24.8	16.0
C2	9	0.98	0.72	76	1.60%	5.2	201	0.50%	Paved areas & shallow paved swales	20	1.4	2.4	7.6	201	0.005	14.1	7.6
C3	10	4.02	0.28	120	1.00%	16.5	795	0.40%	Grassed waterway	15	0.9	14.0	30.5	795	0.004	36.9	30.5
C4	11	4.02	0.30	143	1.00%	17.6	685	0.50%	Grassed waterway	15	1.1	10.8	28.3	685	0.005	32.5	28.3
D1	12	6.30	0.52	308	0.50%	23.7			Paved areas & shallow paved swales	20	0.0	0.0	23.7	0	0.000	N/A	23.7
D2	13	1.40	0.16	275	1.90%	23.1			Paved areas & shallow paved swales	20	0.0	0.0	23.1	0	0.000	N/A	23.1
E1	14	1.92	0.53	39	2.70%	4.7	661	1.90%	Paved areas & shallow paved swales	20	2.8	4.0	8.7	661	0.019	20.2	8.7
ALT 1	15	1.02	0.54	88	1.90%	7.8			Paved areas & shallow paved swales	20	0.0	0.0	7.8	0	0.000	N/A	7.8
OS1	16	2.87	0.14	287	2.00%	23.8	186	1.10%	Paved areas & shallow paved swales	20	2.1	1.5	25.3	186	0.011	26.7	25.3

JVA Incorporated
1319 Spruce Street
Boulder, CO 80302
Ph: (303) 444 1951

Job Name: Salisbury Park North Phase 1
Job Number: 3752c
Date: 11/19/24
By: KAM

Salisbury Park North Phase 1

Developed Storm Runoff Calculations

Design Storm : **100 Year**

Point Hour Rainfall (P_1) : **2.60**

I = (28.5 P1) / ((10 + TC)^0.786)

	Direct Runoff							Total Runoff				Inlets				Pipe					Pipe/Swale Travel Time				
Basin Name	Design Point	Area (ac)	C100	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Total tc (min)	ΣC*A (ac)	I (in/hr)	Q (cfs)	Inlet Type	Q intercepted	Q carryover	Q bypass	Pipe Size (in) or equivalent	Pipe Material	Slope (%)	Pipe Flow (cfs)	Max Pipe Capacity (cfs)	Length (ft)	Velocity (fps)	tt (min)	Total Time (min)	Notes
A1	1	1.00	0.79	5.0	0.79	8.81	6.95	5.00	0.79	8.82	6.96	Perforated Drains	6.96	0.00	0.00	12 in	PVC	0.5%	**7.0**	3.5	487	4.2	1.95	6.95	Basin A1
A2	2	3.10	0.60	25.0	1.87	4.52	8.47	25.04	1.87	4.53	8.48														Basin A2
	TOTAL TO DP2							25.04	2.66	4.53	12.06	Flared End Section	12.06	0.00	0.00	18 in	RCP	0.4%	**12.1**	7.1	180	3.8	0.80	25.84	Basin A1 + A2
A3	3	5.34	0.62	27.3	3.32	4.31	14.29	27.28	3.32	4.31	14.30														Basin A3
	TOTAL TO DP3							27.28	5.98	4.31	25.78	Flared End Section	25.78	0.00	0.00	24 in	RCP	0.5%	**25.8**	17.2	298	5.1	0.98	28.25	DP2 + Basin A3
A4	4	1.54	0.74	7.9	1.15	7.68	8.80	7.87	1.15	7.68	8.81	Area Inlet	8.81	0.00	0.00	18 in	RCP	0.5%	**8.8**	8.0	14	4.2	0.06	7.93	Basin A4
A5	5	0.33	0.87	9.5	0.29	7.18	2.08	9.47	0.29	7.19	2.08														Basin A5
	TOTAL TO DP5							9.47	1.44	7.19	10.32	Combination Inlet	10.32	0.00	0.00	18 in	RCP	0.5%	**10.3**	8.0	24	4.2	0.10	9.56	Basin A4 + A5
A6	6	0.33	0.87	9.6	0.28	7.15	2.03	9.58	0.28	7.15	2.03														Basin A6
	TOTAL TO DP6							9.58	1.72	7.15	12.30	Combination Inlet	12.30	0.00	0.00	18 in	RCP	0.5%	**12.3**	8.0	11	4.2	0.04	9.62	DP5 + A6
A7	7	2.31	0.68	17.8	1.57	5.43	8.53	17.76	1.57	5.44	8.54	Sheet Flow to Pond	8.54	0.00	0.00										Basin A7
C1	8	2.38	0.68	16.0	1.62	5.72	9.27	15.98	1.62	5.73	9.28	Combination Inlet	9.28	0.00	0.00	18 in	RCP	0.5%	**9.3**	8.0	273	4.2	1.08	17.06	Basin C1
C2	9	0.98	0.83	7.6	0.81	7.77	6.29	7.60	0.81	7.78	6.30														Basin C2
	TOTAL TO DP9							17.06	2.43	5.55	13.48	Combination Inlet	13.48	0.00	0.00	18 in	RCP	0.5%	**13.5**	8.0	107	4.2	0.42	17.49	Basin C1 + C2
C3	10	4.02	0.61	30.5	2.43	4.03	9.80	30.50	2.43	4.04	9.83														Basin C3
	TOTAL TO DP10							30.50	4.86	4.04	19.64	Flared End Section	19.64	0.00	0.00	24 in	RCP	0.5%	**19.6**	17.2	123	5.1	0.40	30.90	DP9 + Basin C3
C4	11	4.02	0.62	28.3	2.48	4.21	10.43	28.35	2.48	4.22	10.44														Basin C4
	TOTAL TO DP11							30.90	7.34	4.01	29.42														DP10 + Basin C4
D1	12	6.30	0.73	23.7	4.57	4.67	21.36	23.66	4.57	4.67	21.37	Underdrain	21.37	0.00	0.00	24 in	RCP	0.5%	**21.4**	17.2	118	5.1	0.39	24.04	Basin D1
D2	13	1.40	0.55	23.1	0.76	4.72	3.60	23.14	0.76	4.73	3.61	Sheet Flow to Pond	3.61	0.00	0.00										Basin D2
E1	14	1.92	0.73	8.7	1.41	7.42	10.43	8.68	1.41	7.42	10.43	Sheet Flow to Pond	10.43	0.00	0.00										Basin E1
ALT 1	15	1.02	0.74	7.8	0.75	7.69	5.76	7.84	0.75	7.70	5.76	Area Inlet	5.76	0.00	0.00	8 in	PVC	2.0%	**5.8**	2.4	105	6.3	0.28	8.11	Basin ALT 1
OS1	16	2.87	0.53	25.3	1.53	4.50	6.90	25.27	1.53	4.50	6.91	Flared End Section	6.91	0.00	0.00	18 in	RCP	2.4%	6.9	17.4	110	8.6	0.21	25.48	Basin OS1

JVA Inco Name: Salisbury Park North Phase 1
1319 Spr Number: 3752c
Boulder, (Date: 11/19/24
Ph: (303) By: KAM

Salisbury Park North Phase 1

Developed Storm Runoff Calculations

Design Storm : **5 Year** fall (P_1) : **1.39**

I = (28.5 P1) / ((10 + TC)^0.786)

	Direct Runoff				Total Runoff				Inlets				Pipe					Pipe/Swale Travel Time				
Basin Name	Design Point	Area (ac)	C5	tc (min)	Total tc (min)	ΣC*A (ac)	I (in/hr)	Q (cfs)	Inlet Type	Q intercepted	Q carryover	Q bypass	Pipe Size (in) or equivalent	Pipe Material	Slope (%)	Pipe Flow (cfs)	Max Pipe Capacity (cfs)	Length (ft)	Velocity (fps)	tt (min)	Total Time (min)	Notes
A1	1	1.00	0.65	5.00	5.00	0.65	4.71	3.04	Perforated Drains	3.04	0.00	0.00	12 in	PVC	0.5%	3.0	3.5	487	4.7	1.74	6.74	Basin A1
A2	2	3.10	0.27	25.04	25.04	0.85	2.42	2.06														Basin A2
	TOTAL TO DP2				25.04	1.50	2.42	3.62	Flared End Section	3.62	0.00	0.00	18 in	RCP	0.4%	3.6	7.1	180	3.8	0.80	25.84	Basin A1 + A2
A3	3	5.34	0.31	27.28	27.28	1.64	2.31	3.78														Basin A3
	TOTAL TO DP3				27.28	3.14	2.31	7.23	Flared End Section	7.23	0.00	0.00	24 in	RCP	0.5%	7.2	17.2	298	4.9	1.02	28.30	DP2 + Basin A3
A4	4	1.54	0.55	7.87	7.87	0.85	4.11	3.50	Area Inlet	3.50	0.00	0.00	18 in	RCP	0.5%	3.5	8.0	14	4.1	0.06	7.93	Basin A4
A5	5	0.33	0.81	9.47	9.47	0.27	3.84	1.03														Basin A5
	TOTAL TO DP5				9.47	1.12	3.84	4.31	Combination Inlet	4.31	0.00	0.00	18 in	RCP	0.5%	4.3	8.0	24	4.3	0.09	9.56	Basin A4 + A5
A6	6	0.33	0.81	9.58	9.58	0.26	3.82	1.01														Basin A6
	TOTAL TO DP6				9.58	1.38	3.82	5.29	Combination Inlet	5.29	0.00	0.00	18 in	RCP	0.5%	5.3	8.0	11	4.5	0.04	9.62	DP5 + A6
A7	7	2.31	0.42	17.76	17.76	0.98	2.91	2.85	Sheet Flow to Pond	2.85	0.00	0.00										Basin A7
C1	8	2.38	0.43	15.98	15.98	1.02	3.06	3.11	Combination Inlet	3.11	0.00	0.00	18 in	RCP	0.5%	3.1	8.0	273	3.9	1.16	17.14	Basin C1
C2	9	0.98	0.72	7.60	7.60	0.70	4.16	2.92														Basin C2
	TOTAL TO DP9				17.14	1.72	2.96	5.09	Combination Inlet	5.09	0.00	0.00	18 in	RCP	0.5%	5.1	8.0	107	4.5	0.40	17.54	Basin C1 + C2
C3	10	4.02	0.28	30.50	30.50	1.11	2.16	2.40														Basin C3
	TOTAL TO DP10				30.50	2.83	2.16	6.12	Flared End Section	6.12	0.00	0.00	24 in	RCP	0.5%	6.1	17.2	123	4.6	0.44	30.94	DP9 + Basin C3
C4	11	4.02	0.30	28.35	28.35	1.20	2.25	2.70														Basin C4
	TOTAL TO DP11				30.94	4.03	2.14	8.63														DP10 + Basin C4
D1	12	6.30	0.52	23.66	23.66	3.26	2.50	8.13	Underdrain	8.13	0.00	0.00	24 in	RCP	0.5%	8.1	17.2	118	5.0	0.39	24.05	Basin D1
D2	13	1.40	0.16	23.14	23.14	0.22	2.53	0.56	Sheet Flow to Pond	0.56	0.00	0.00										Basin D2
E1	14	1.92	0.53	8.68	8.68	1.02	3.97	4.04	Sheet Flow to Pond	4.04	0.00	0.00										Basin E1
ALT 1	15	1.02	0.54	7.84	7.84	0.55	4.11	2.24	Area Inlet	2.24	0.00	0.00	8 in	PVC	2.0%	2.2	2.4	105	6.3	0.28	8.11	Basin ALT 1
OS1	16	2.87	0.14	25.27	25.27	0.39	2.41	0.93	Flared End Section	0.93	0.00	0.00	18 in	RCP	2.4%	0.9	17.4	110	4.7	0.39	25.65	Basin OS1

APPENDIX C – HYDRAULIC COMPUTATIONS

SWALE CALCULATIONS

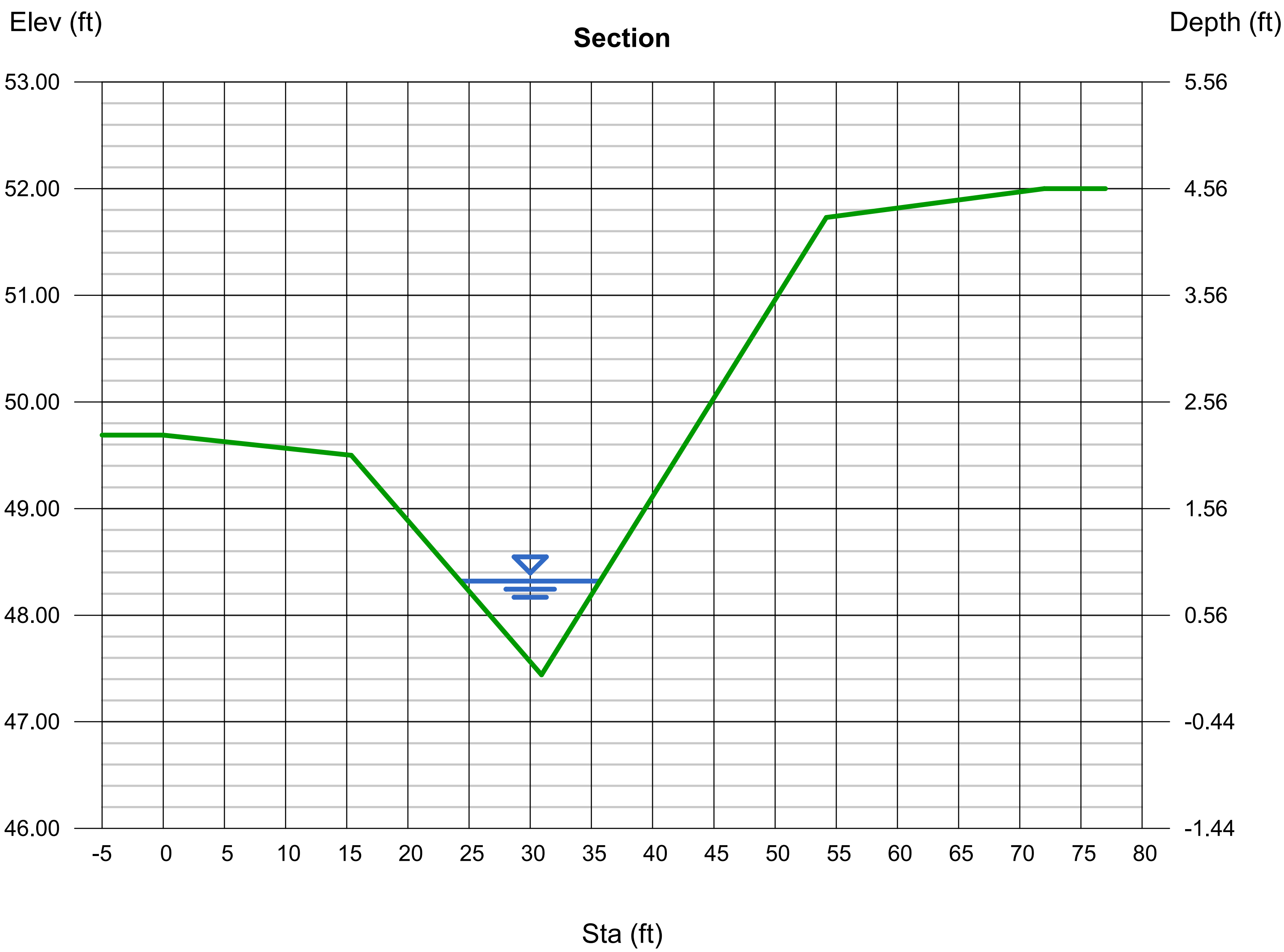
Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Nov 20 2024

SWALE DP2

User-defined		**Highlighted**	
Invert Elev (ft)	= 47.44	Depth (ft)	= 0.88
Slope (%)	= 0.50	Q (cfs)	= 12.06
N-Value	= 0.025	Area (sqft)	= 5.02
		Velocity (ft/s)	= 2.40
Calculations		Wetted Perim (ft)	= 11.55
Compute by:	Known Q	Crit Depth, Yc (ft)	= 0.74
Known Q (cfs)	= 12.06	Top Width (ft)	= 11.41
		EGL (ft)	= 0.97

(Sta, El, n)-(Sta, El, n)...
(0.00, 49.69)-(15.38, 49.50, 0.025)-(30.92, 47.44, 0.025)-(54.20, 51.73, 0.025)-(72.00, 52.00, 0.025)



Channel Report

SWALE DP3

User-defined

Invert Elev (ft)	=	43.50
Slope (%)	=	0.50
N-Value	=	0.025

Calculations

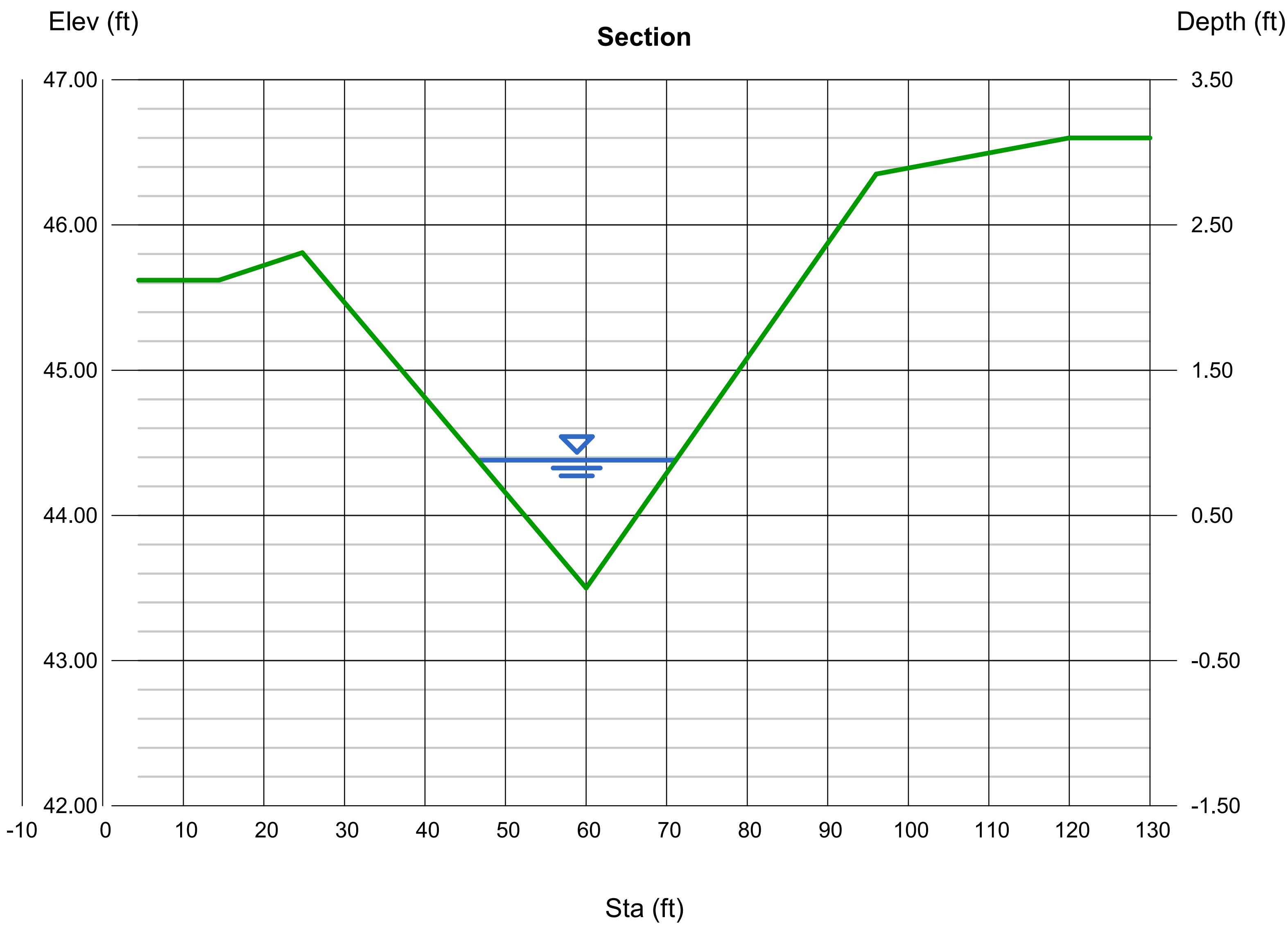
Compute by:		Known Q
Known Q (cfs)	=	25.78

Highlighted

Depth (ft)	=	0.88
Q (cfs)	=	25.78
Area (sqft)	=	10.80
Velocity (ft/s)	=	2.39
Wetted Perim (ft)	=	24.60
Crit Depth, Yc (ft)	=	0.74
Top Width (ft)	=	24.54
EGL (ft)	=	0.97

(Sta, El, n)-(Sta, El, n)...

(14.45, 45.62)-(24.78, 45.81, 0.025)-(60.00, 43.50, 0.025)-(96.01, 46.35, 0.025)-(120.00, 46.60, 0.025)



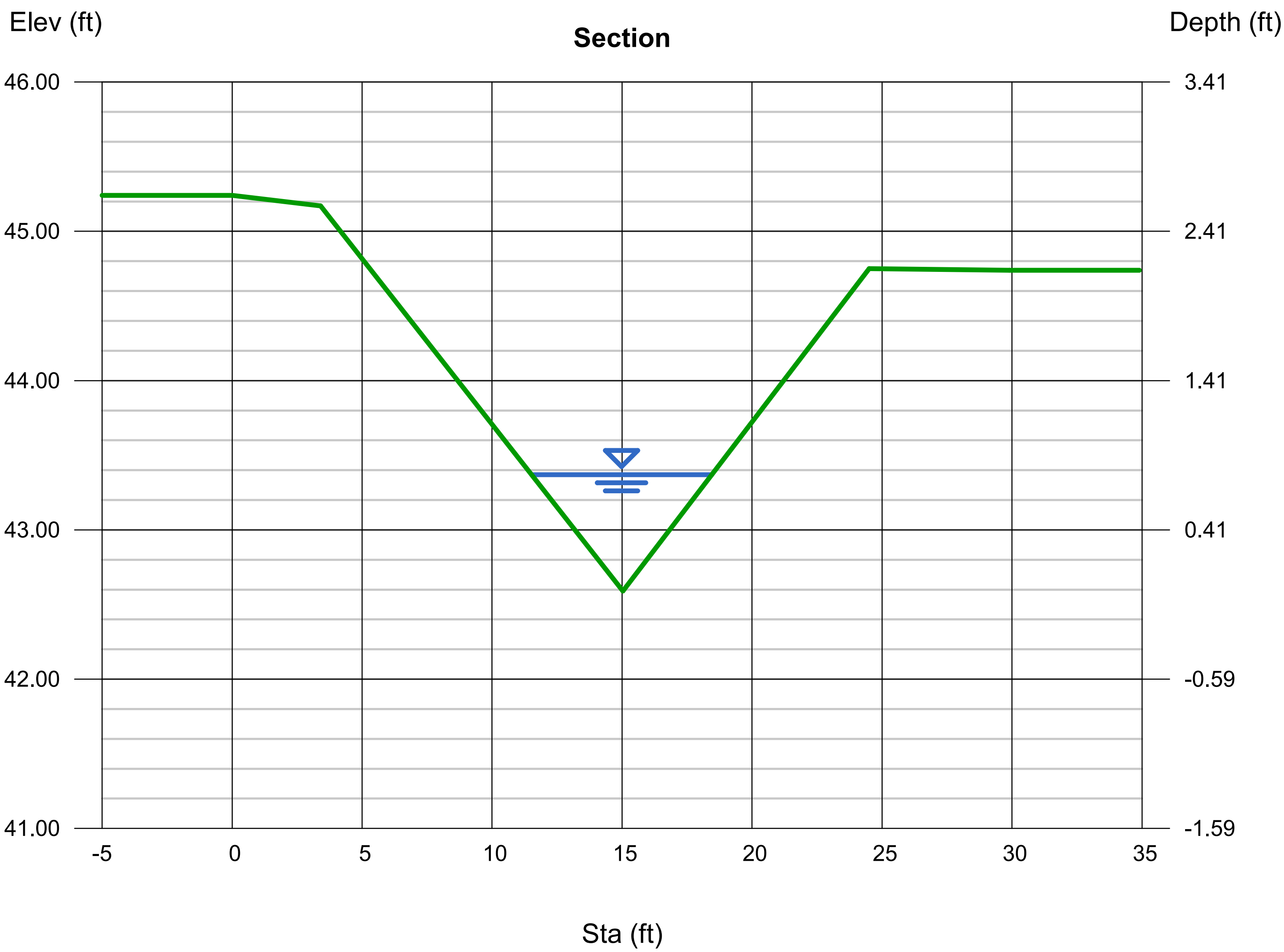
Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Nov 20 2024

SWALE DP4

User-defined		**Highlighted**	
Invert Elev (ft)	= 42.59	Depth (ft)	= 0.78
Slope (%)	= 1.10	Q (cfs)	= 8.810
N-Value	= 0.025	Area (sqft)	= 2.70
		Velocity (ft/s)	= 3.26
Calculations		Wetted Perim (ft)	= 7.11
Compute by:	Known Q	Crit Depth, Yc (ft)	= 0.76
Known Q (cfs)	= 8.81	Top Width (ft)	= 6.94
		EGL (ft)	= 0.94

(Sta, El, n)-(Sta, El, n)...
(0.00, 45.24)-(3.40, 45.17, 0.025)-(15.03, 42.59, 0.025)-(24.50, 44.75, 0.025)-(29.90, 44.74, 0.025)



Channel Report

SWALE DP10

User-defined

Invert Elev (ft)	=	47.25
Slope (%)	=	0.50
N-Value	=	0.025

Calculations

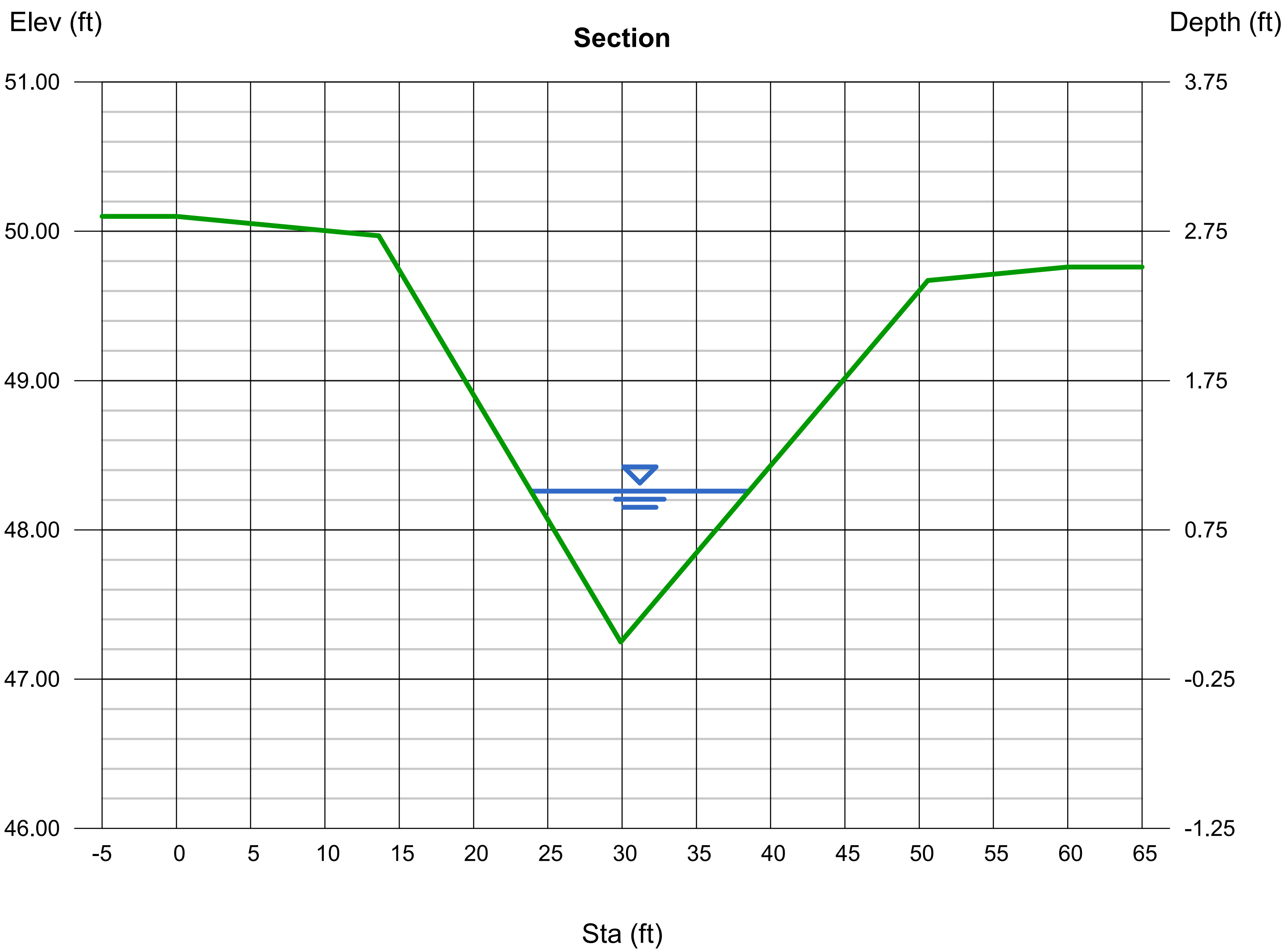
Compute by:	Known Q
Known Q (cfs)	= 19.64

Highlighted

Depth (ft)	=	1.01
Q (cfs)	=	19.64
Area (sqft)	=	7.41
Velocity (ft/s)	=	2.65
Wetted Perim (ft)	=	14.81
Crit Depth, Yc (ft)	=	0.86
Top Width (ft)	=	14.67
EGL (ft)	=	1.12

(Sta, El, n)-(Sta, El, n)...

(0.00, 50.10)-(13.63, 49.97, 0.025)-(29.91, 47.25, 0.025)-(50.58, 49.67, 0.025)-(60.00, 49.76, 0.025)



MHFD INLET CALCULATIONS

MHFD-Inlet, Version 5.03 (August 2023)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	INLET A5	INLET A6	Inlet C1	INLET C2
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	In Sump	In Sump
Inlet Type	Denver No. 16 Combination	Denver No. 16 Combination	Denver No. 16 Combination	Denver No. 16 Combination

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	1.0	1.0	3.1	2.9
Major Q_{Known} (cfs)	2.1	2.0	9.3	6.3

Bypass (Carry-Over) Flow from Upstream Inlets must be organized from upstream (left) to downstream (right) in order for bypass flows to be linked.

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)				
Percent Impervious				
NRCS Soil Type				

Watershed Profile

Overland Slope (ft/ft)				
Overland Length (ft)				
Channel Slope (ft/ft)				
Channel Length (ft)				

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)				
One-Hour Precipitation, P_1 (inches)				

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)				
One-Hour Precipitation, P_1 (inches)				

CALCULATED OUTPUT

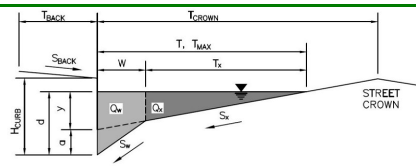
Minor Total Design Peak Flow, Q (cfs)	**1.0**	**1.0**	**3.1**	**2.9**
Major Total Design Peak Flow, Q (cfs)	**2.1**	**2.0**	**9.3**	**6.3**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	N/A	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0	N/A	N/A

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Salisbury Park North - Phase 1

Inlet ID: INLET A5



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

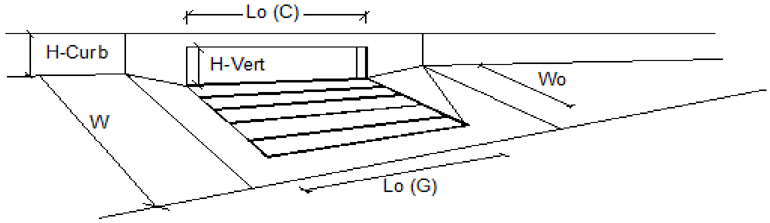
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**7.6**	**7.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 1.03 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.08 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)



Design Information (Input)	Denver No. 16 Combination		MINOR	MAJOR	
Type of Inlet		Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	

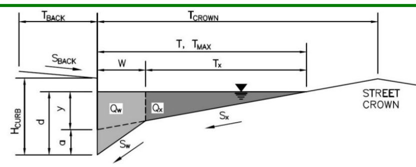
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.0**	**2.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**99**	**%**

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Salisbury Park North - Phase 1

Inlet ID: INLET A6



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.015	

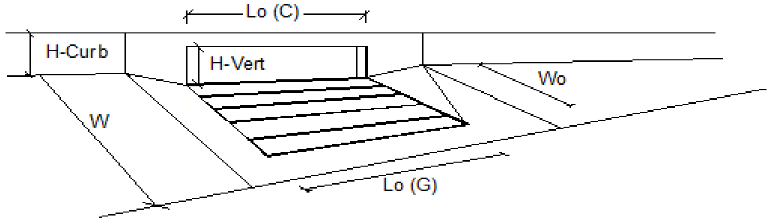
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**6.1**	**6.1**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 1.01 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.03 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)



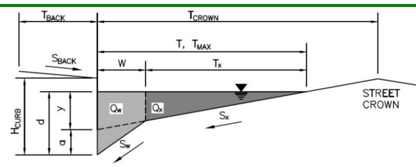
Design Information (Input)		MINOR	MAJOR	
Type of Inlet: Denver No. 16 Combination	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f (G) =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f (C) =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.0**	**2.0**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Salisbury Park North - Phase 1
Inlet ID: Inlet C1



Gutter Geometry:

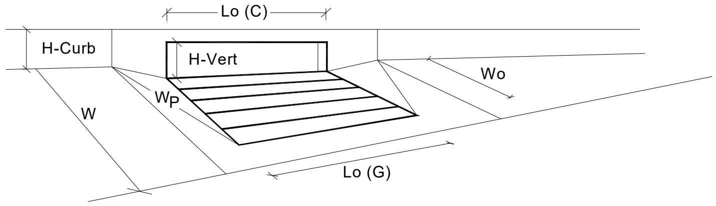
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.052	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	158.5	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.005	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

			Minor Storm	Major Storm	
	Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	158.5	158.5	ft
Warning 02	Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	8.0	8.0	inches
	Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition MAJOR STORM Allowable Capacity is not applicable to Sump Condition	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLEET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)

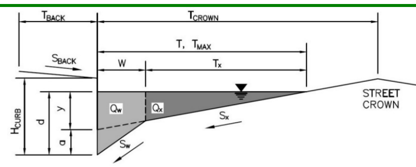


Design Information (Input)	Denver No. 16 Combination	MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	8.0	8.0	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.69	0.69	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.50	0.50	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.94	0.94	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	0.94	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**15.3**	**15.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	3.1	9.3	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Salisbury Park North - Phase 1
Inlet ID: INLET C2



Gutter Geometry:

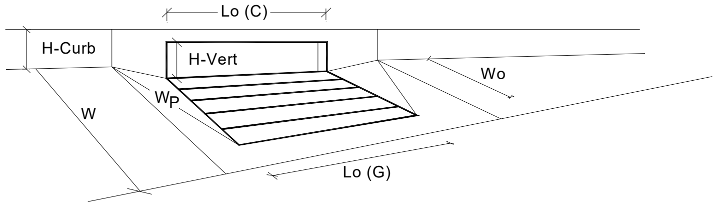
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	26.2	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.012	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.012	
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	159.3	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.005	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.012	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	159.0	159.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition MAJOR STORM Allowable Capacity is not applicable to Sump Condition	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



Design Information (Input)	Denver No. 16 Combination	MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	8.50	8.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.52	0.52	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.33	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.71	0.71	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.71	0.71	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	$\mathbf{Q_a}$ =	**7.7**	**7.7**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	2.9	6.3	cfs

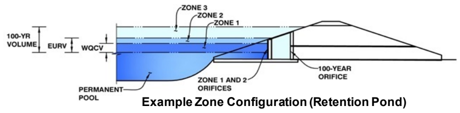
MHFD DETENTION POND CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Salisbury Park North**

Basin ID: **Pond A - Phase 1**



Example Zone Configuration (Retention Pond)

Depth Increment = 0.50 ft

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	13.96	acres
Watershed Length =	1,000	ft
Watershed Length to Centroid =	500	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	44.10%	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 =	40.0	hours
Location for 1-hr Rainfall Depths =	Parker - Town Hall	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.222	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.577	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.82 in.) =	0.367	acre-feet		inches
5-yr Runoff Volume (P1 = 1.1 in.) =	0.577	acre-feet		inches
10-yr Runoff Volume (P1 = 1.34 in.) =	0.813	acre-feet		inches
25-yr Runoff Volume (P1 = 1.69 in.) =	1.265	acre-feet		inches
50-yr Runoff Volume (P1 = 1.98 in.) =	1.598	acre-feet		inches
100-yr Runoff Volume (P1 = 2.29 in.) =	2.006	acre-feet		inches
500-yr Runoff Volume (P1 = 3.08 in.) =	2.953	acre-feet		inches
Approximate 2-yr Detention Volume =	0.349	acre-feet		
Approximate 5-yr Detention Volume =	0.567	acre-feet		
Approximate 10-yr Detention Volume =	0.676	acre-feet		
Approximate 25-yr Detention Volume =	0.814	acre-feet		
Approximate 50-yr Detention Volume =	0.881	acre-feet		
Approximate 100-yr Detention Volume =	1.054	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.222	acre-feet
Zone 2 Volume (10-year - Zone 1) =	0.454	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.676	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

Total detention volume is less than 100-year volume.

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	--	--	--	9	0.000		
5838.6	--	0.50	--	--	--	4,614	0.106	1,156	0.027
5839.1	--	1.00	--	--	--	9,313	0.214	4,637	0.106
5839.6	--	1.50	--	--	--	11,386	0.261	9,812	0.225
5840.1	--	2.00	--	--	--	13,984	0.321	16,154	0.371
5840.6	--	2.50	--	--	--	17,518	0.402	24,030	0.552
5841.1	--	3.00	--	--	--	21,723	0.499	33,840	0.777
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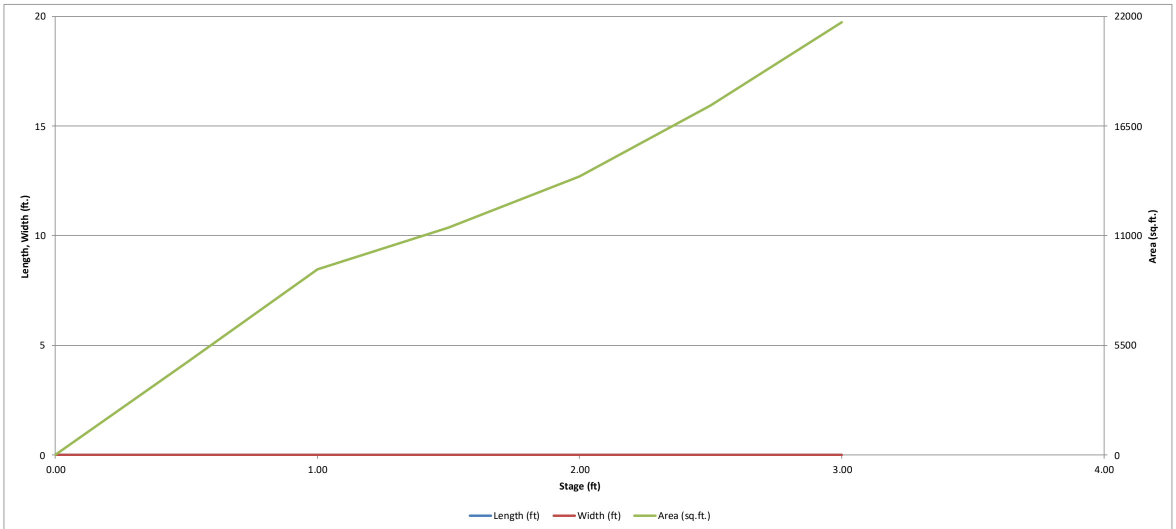
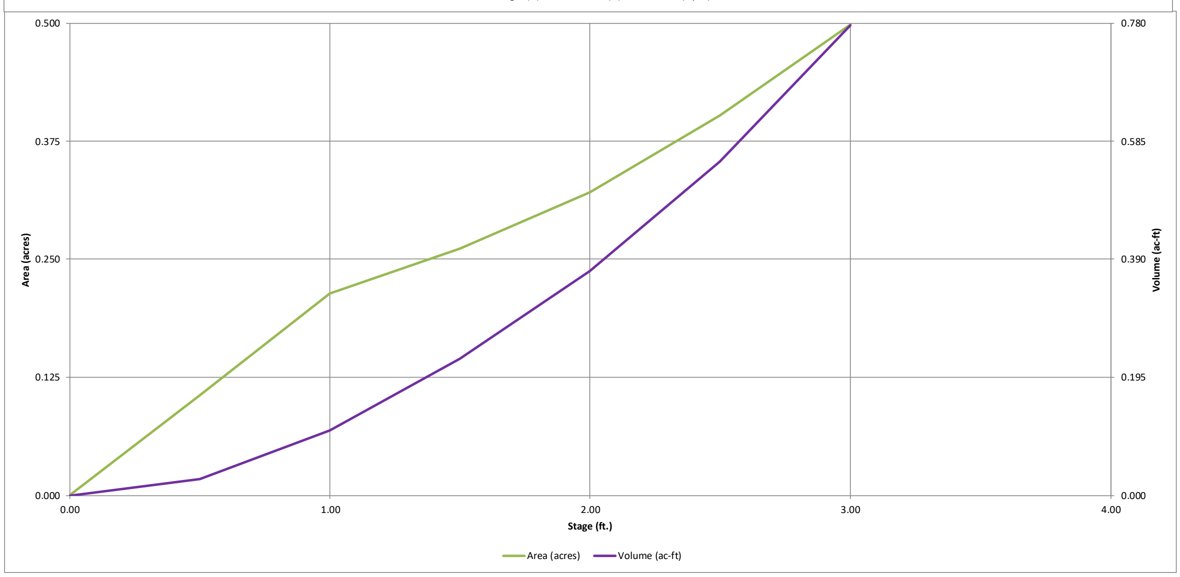
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



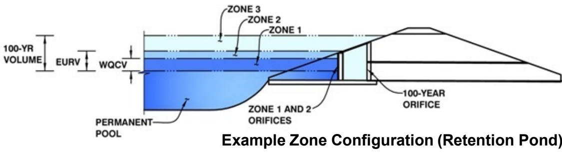


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Salisbury Park North

Basin ID: Pond A - Phase 1



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.49	0.222	Orifice Plate
Zone 2 (10-year)	2.79	0.454	Weir (No Pipe)
Zone 3			
Total (all zones)		0.676	

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

			Calculated Parameters for Underdrain		
Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

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

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	8.681E-03	ft^2
Depth at top of Zone using Orifice Plate =	1.50	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.25	sq. inches (diameter = 1-1/4 inches)	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	0.80	1.10	1.40			
Orifice Area (sq. inches)	1.25	1.25	1.25	1.25	1.25			

	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		Calculated Parameters for Vertical Orifice	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				

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

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

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

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	2.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.16	feet
Spillway Crest Length =	5.00	feet	Stage at Top of Freeboard =	4.16	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.50	acres
Freeboard above Max Water Surface =	0.50	feet	Basin Volume at Top of Freeboard =	0.78	acre-ft
Spillway position relative to Overflow Weir =	Overlapping				

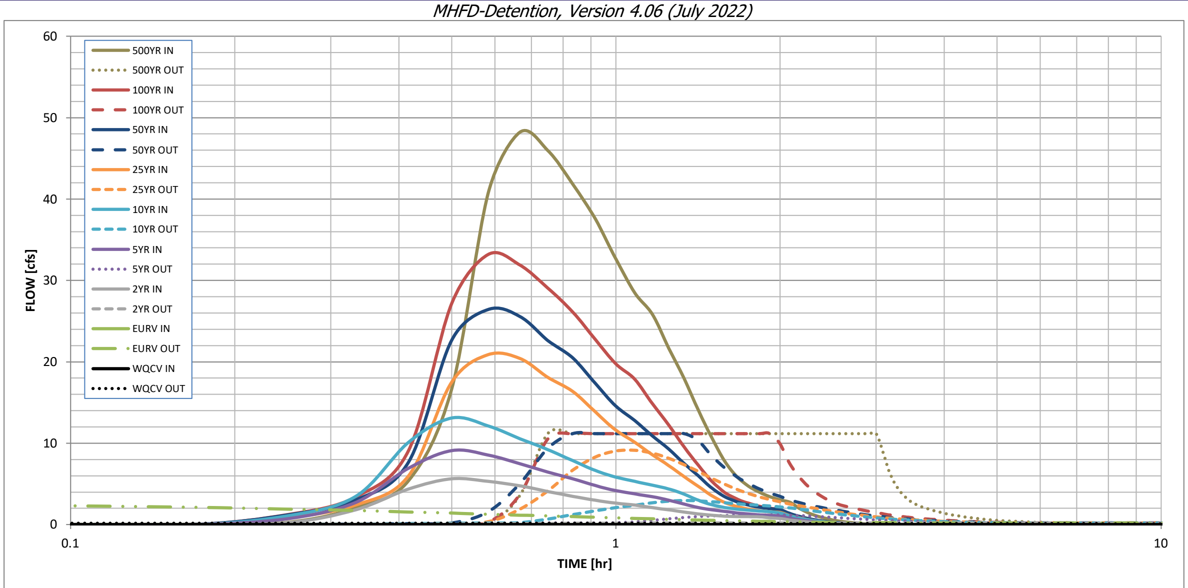
Routed Hydrograph Results

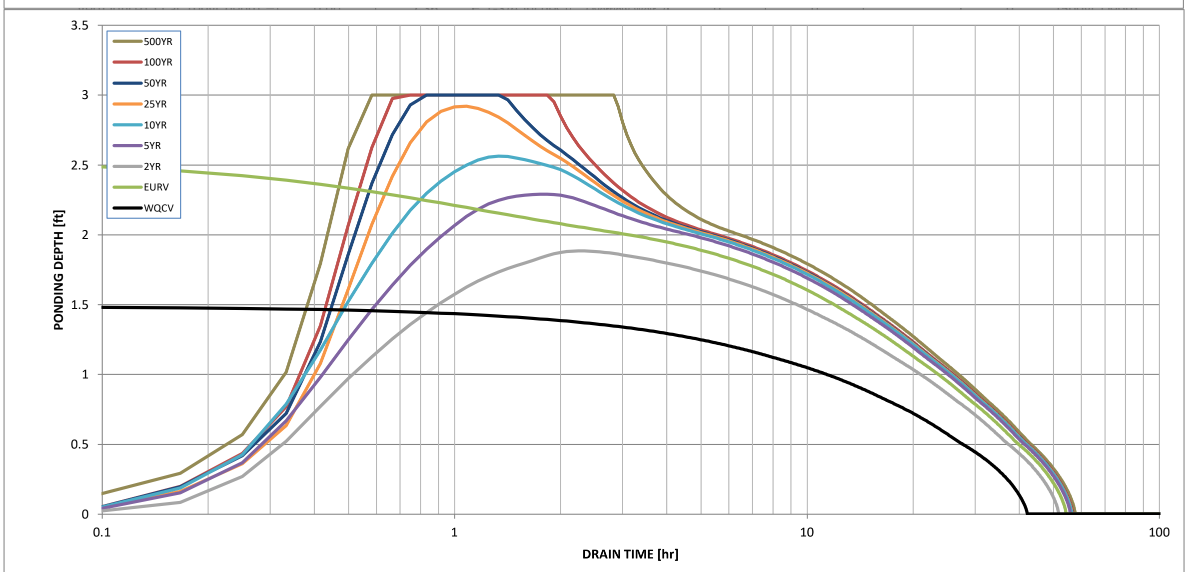
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

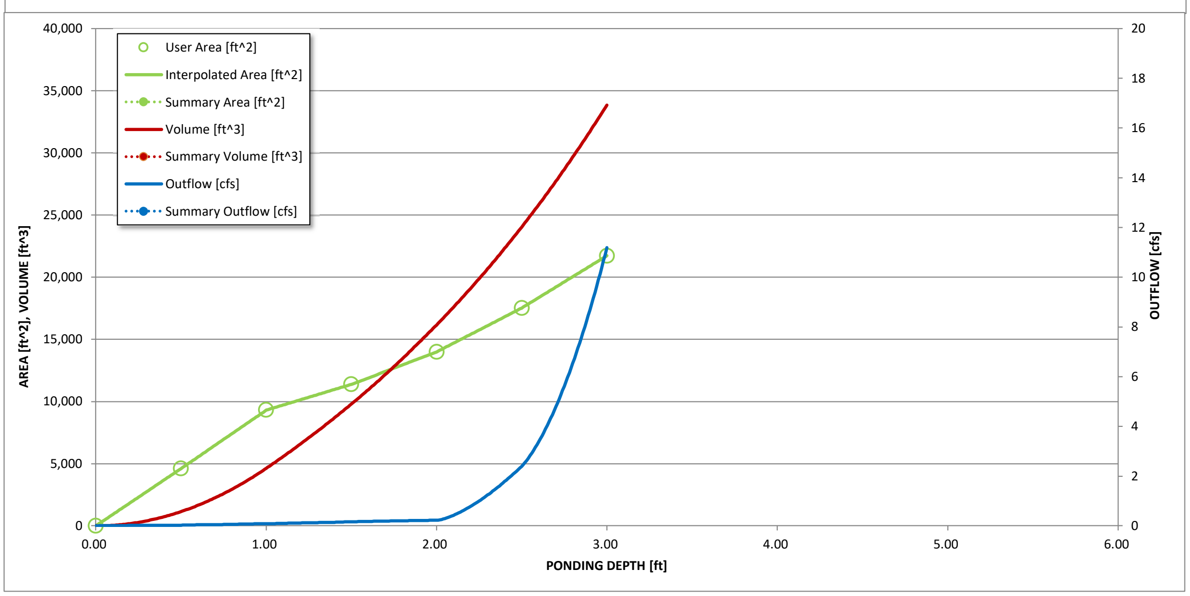
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.82	1.10	1.34	1.69	1.98	2.29	3.08
CUHP Runoff Volume (acre-ft) =	0.222	0.577	0.367	0.577	0.813	1.265	1.598	2.006	2.953
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.367	0.577	0.813	1.265	1.598	2.006	2.953
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	1.5	4.0	10.0	13.7	18.1	28.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.11	0.29	0.71	0.98	1.30	2.03
Peak Inflow Q (cfs) =	N/A	N/A	5.6	9.1	13.1	20.9	26.4	33.2	48.2
Peak Outflow Q (cfs) =	0.2	2.7	0.2	1.2	3.0	9.1	11.2	11.2	11.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.7	0.9	0.8	0.6	0.4
Structure Controlling Flow =	Plate	Spillway	Plate	Overflow Weir 1	Spillway	Spillway	N/A	N/A	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	37	44	44	45	43	39	36	34	30
Time to Drain 99% of Inflow Volume (hours) =	**40**	50	49	51	50	48	47	45	42
Maximum Ponding Depth (ft) =	1.49	2.57	1.88	2.29	2.56	2.92	3.00	3.00	3.00
Area at Maximum Ponding Depth (acres) =	0.26	0.42	0.31	0.37	0.41	0.48	0.50	0.50	0.50
Maximum Volume Stored (acre-ft) =	0.223	0.580	0.333	0.467	0.576	0.733	0.777	0.777	0.777
WSE =	5839.59	5840.67	5839.98	5840.39	5840.66	5841.02	5841.10	5841.10	5841.10

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







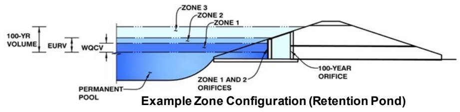
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Salisbury Park North**

Basin ID: **Pond C - Phase 1**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	11.40	acres
Watershed Length =	1,000	ft
Watershed Length to Centroid =	500	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	39.10%	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 =	40.0	hours
Location for 1-hr Rainfall Depths =	Parker - Town Hall	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.169	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.413	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.82 in.) =	0.262	acre-feet		inches
5-yr Runoff Volume (P1 = 1.1 in.) =	0.424	acre-feet		inches
10-yr Runoff Volume (P1 = 1.34 in.) =	0.613	acre-feet		inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.985	acre-feet		inches
50-yr Runoff Volume (P1 = 1.98 in.) =	1.257	acre-feet		inches
100-yr Runoff Volume (P1 = 2.29 in.) =	1.594	acre-feet		inches
500-yr Runoff Volume (P1 = 3.08 in.) =	2.369	acre-feet		inches
Approximate 2-yr Detention Volume =	0.249	acre-feet		
Approximate 5-yr Detention Volume =	0.415	acre-feet		
Approximate 10-yr Detention Volume =	0.496	acre-feet		
Approximate 25-yr Detention Volume =	0.603	acre-feet		
Approximate 50-yr Detention Volume =	0.653	acre-feet		
Approximate 100-yr Detention Volume =	0.796	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.169	acre-feet
Zone 2 Volume (2-year - Zone 1) =	0.080	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.249	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

Total detention volume is less than 100-year volume.

Depth Increment = 0.50 ft

5844

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	--	--	--	107	0.002		
5844.5	--	0.50	--	--	--	3,894	0.089	1,000	0.023
5845	--	1.00	--	--	--	7,897	0.181	3,948	0.091
5845.5	--	1.50	--	--	--	12,464	0.286	9,038	0.207
5846	--	2.00	--	--	--	18,311	0.420	16,732	0.384
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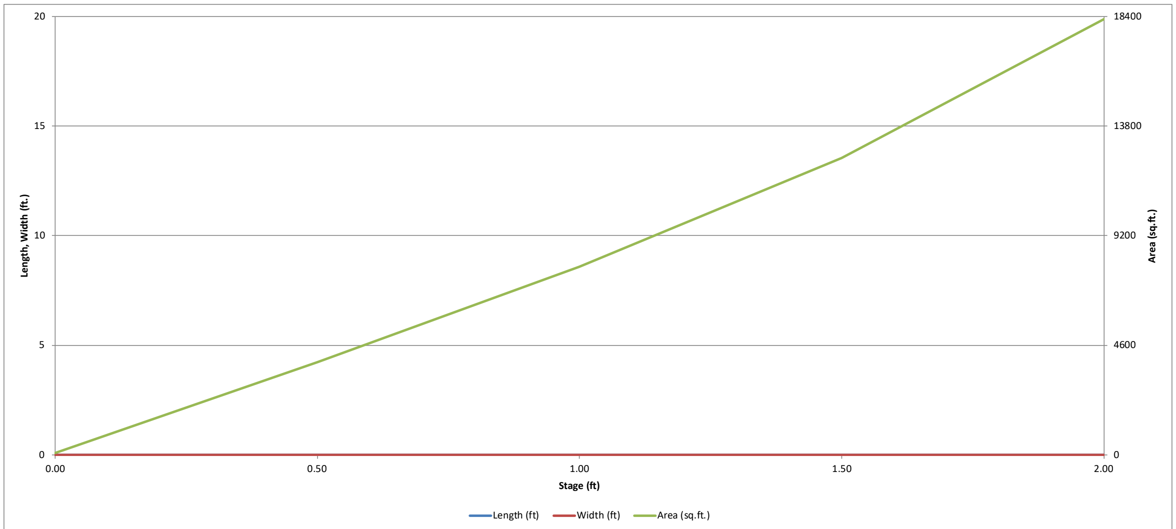
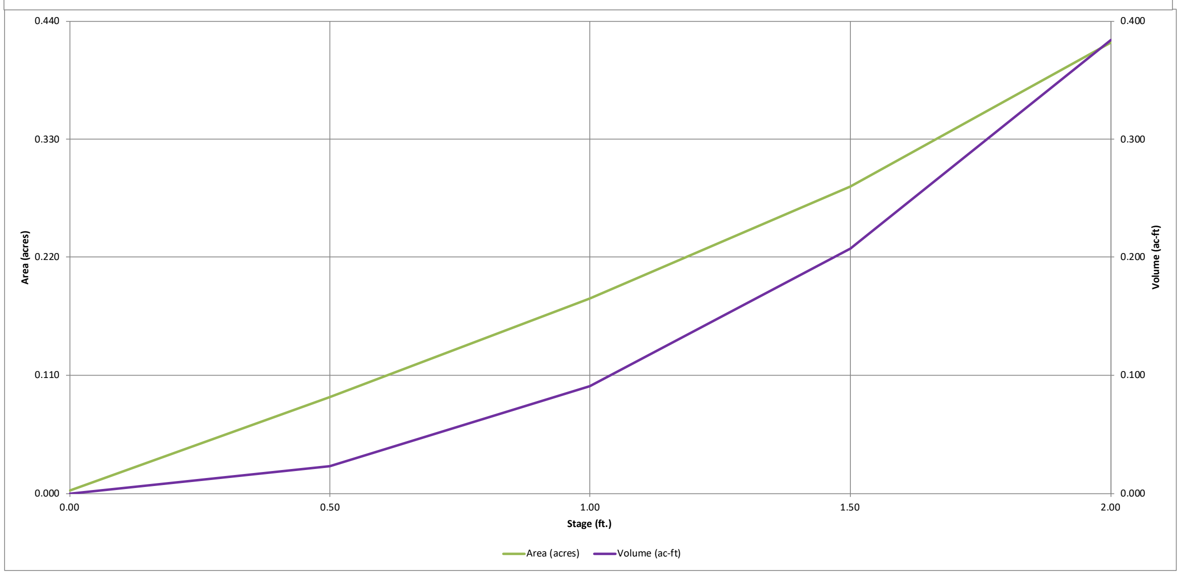
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

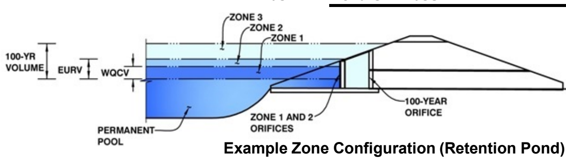




DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Salisbury Park North
Basin ID: Pond C - Phase 1



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.36	0.169	Orifice Plate
Zone 2 (2-year)	1.64	0.080	Weir&Pipe (Restrict)
Zone 3			
Total (all zones)		0.249	

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)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.36	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	4.00	inches
Orifice Plate: Orifice Area per Row =	1.02	sq. inches (diameter = 1-1/8 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	7.083E-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	0.80	1.10				
Orifice Area (sq. inches)	1.02	1.02	1.02	1.02				

	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 with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.40		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00		feet
Overflow Weir Grate Slope =	0.00		H:V
Horiz. Length of Weir Sides =	3.00		feet
Overflow Grate Type =	Type C Grate		
Debris Clogging % =	50%		%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	1.40		feet
Overflow Weir Slope Length =	3.00		feet
Grate Open Area / 100-yr Orifice Area =	31.90		
Overflow Grate Open Area w/o Debris =	6.26		ft^2
Overflow Grate Open Area w/ Debris =	3.13		ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50		ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	6.00		inches
Restrictor Plate Height Above Pipe Invert =	10.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.20		ft^2
Outlet Orifice Centroid =	0.25		feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	1.75	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	3.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	0.50	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	1.11	feet
Stage at Top of Freeboard =	3.36	feet
Basin Area at Top of Freeboard =	0.42	acres
Basin Volume at Top of Freeboard =	0.38	acre-ft

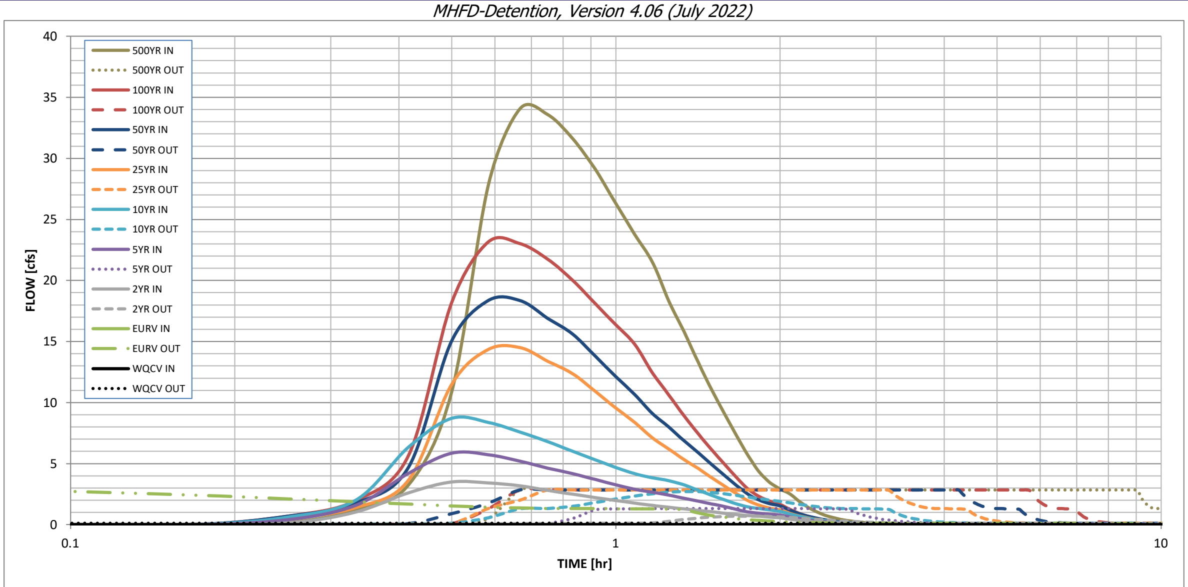
Routed Hydrograph Results

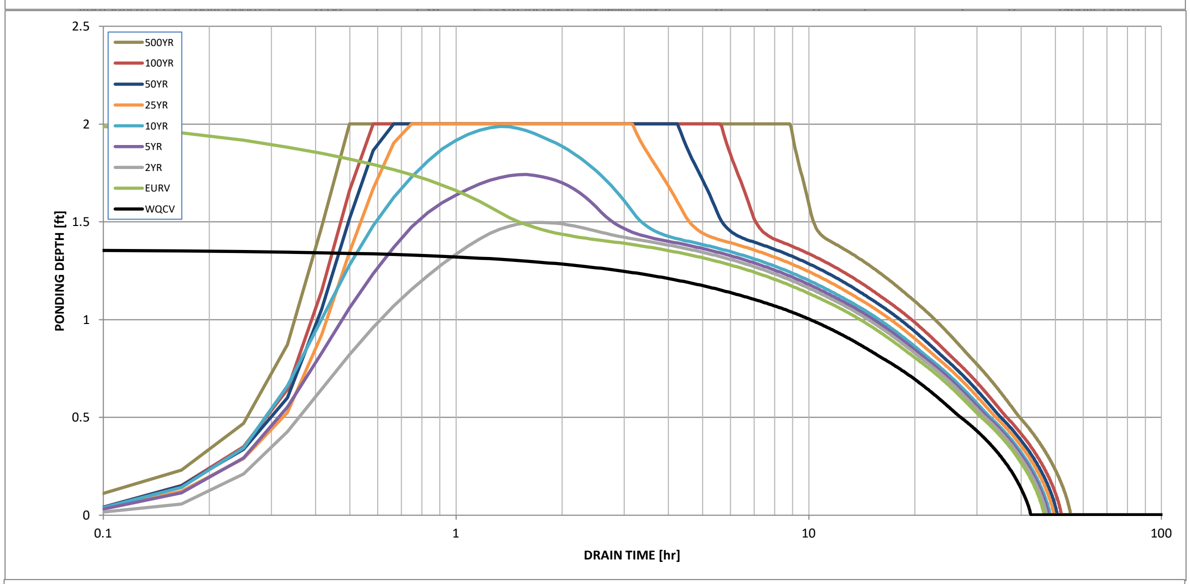
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

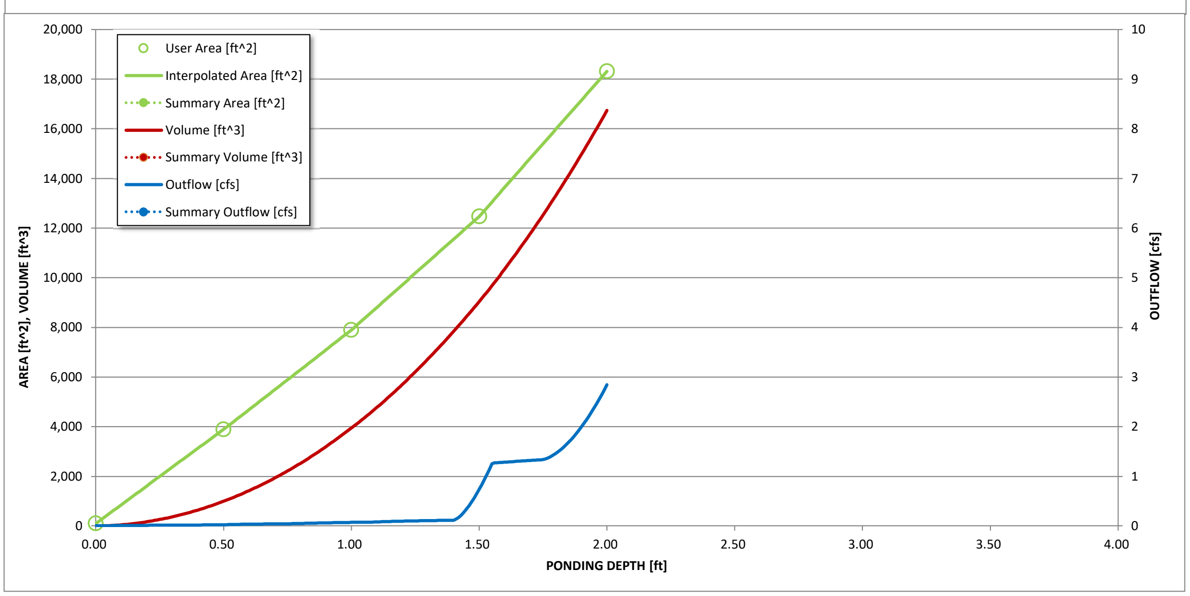
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.82	1.10	1.34	1.69	1.98	2.29	3.08
CUHP Runoff Volume (acre-ft) =	0.169	0.413	0.262	0.424	0.613	0.985	1.257	1.594	2.369
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.262	0.424	0.613	0.985	1.257	1.594	2.369
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	1.1	3.0	7.5	10.3	13.9	21.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.10	0.27	0.66	0.90	1.22	1.90
Peak Inflow Q (cfs) =	N/A	N/A	3.5	5.8	8.7	14.5	18.4	23.1	34.1
Peak Outflow Q (cfs) =	0.1	2.8	0.7	1.3	2.7	2.8	2.8	2.8	2.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.2	0.9	0.4	0.3	0.2	0.1
Structure Controlling Flow =	Plate	N/A	Overflow Weir 1	Outlet Plate 1	Spillway	N/A	N/A	N/A	N/A
Max Velocity through Grate 1 (fps) =	N/A	0.20	0.10	0.2	0.2	0.2	0.2	0.2	0.2
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	37	40	38	35	31	30	28	26
Time to Drain 99% of Inflow Volume (hours) =	**40**	42	44	43	42	41	41	40	39
Maximum Ponding Depth (ft) =	1.36	2.00	1.50	1.74	1.99	2.00	2.00	2.00	2.00
Area at Maximum Ponding Depth (acres) =	0.26	0.42	0.28	0.35	0.41	0.42	0.42	0.42	0.42
Maximum Volume Stored (acre-ft) =	0.169	0.380	0.205	0.284	0.376	0.384	0.384	0.384	0.384

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







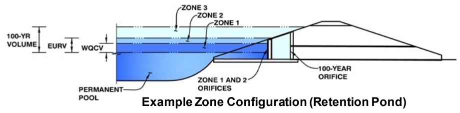
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Salisbury Park North**

Basin ID: **Pond D - Phase 1**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	7.70	acres
Watershed Length =	1,000	ft
Watershed Length to Centroid =	500	ft
Watershed Slope =	0.015	ft/ft
Watershed Imperviousness =	51.10%	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 =	40.0	hours
Location for 1-hr Rainfall Depths =	Parker - Town Hall	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.134	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.373	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.82 in.) =	0.240	acre-feet		inches
5-yr Runoff Volume (P1 = 1.1 in.) =	0.366	acre-feet		inches
10-yr Runoff Volume (P1 = 1.34 in.) =	0.502	acre-feet		inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.751	acre-feet		inches
50-yr Runoff Volume (P1 = 1.98 in.) =	0.938	acre-feet		inches
100-yr Runoff Volume (P1 = 2.29 in.) =	1.163	acre-feet		inches
500-yr Runoff Volume (P1 = 3.08 in.) =	1.692	acre-feet		inches
Approximate 2-yr Detention Volume =	0.228	acre-feet		
Approximate 5-yr Detention Volume =	0.358	acre-feet		
Approximate 10-yr Detention Volume =	0.427	acre-feet		
Approximate 25-yr Detention Volume =	0.509	acre-feet		
Approximate 50-yr Detention Volume =	0.549	acre-feet		
Approximate 100-yr Detention Volume =	0.642	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.134	acre-feet
Zone 2 Volume (2-year - Zone 1) =	0.093	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.228	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

~~Total detention volume is less than 100-year volume.~~

Depth Increment = 0.50 ft

5845.3

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	--	--	--	155	0.004		
5845.8	--	0.50	--	--	--	1,944	0.045	525	0.012
5846.3	--	1.00	--	--	--	2,345	0.054	1,597	0.037
5846.8	--	1.50	--	--	--	2,767	0.064	2,875	0.066
5847.3	--	2.00	--	--	--	3,230	0.074	4,374	0.100
5847.8	--	2.50	--	--	--	3,738	0.086	6,116	0.140
5848.3	--	3.00	--	--	--	4,297	0.099	8,125	0.187
5848.6	--	3.30	--	--	--	8,000	0.184	9,969	0.229
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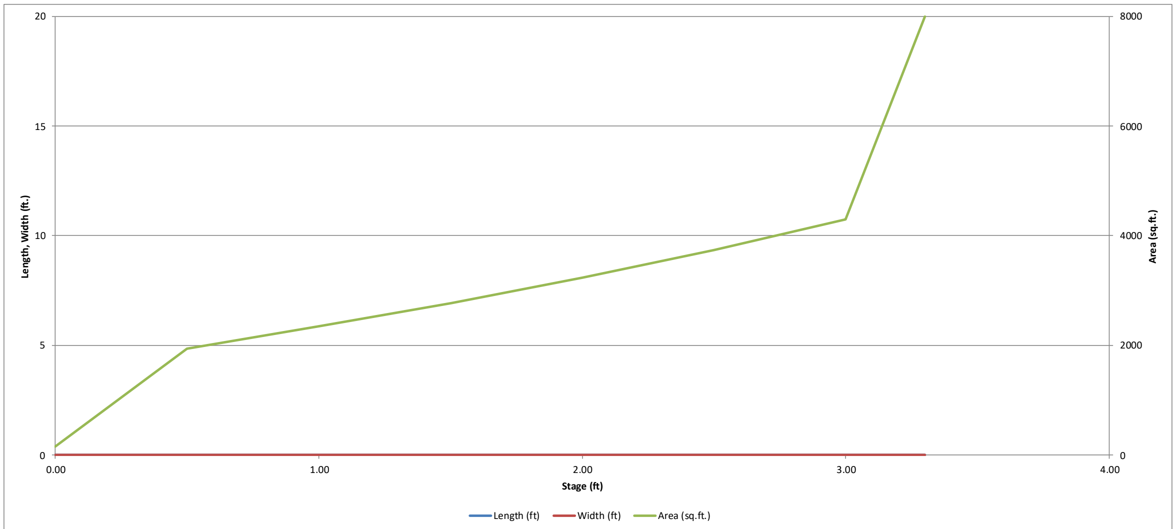
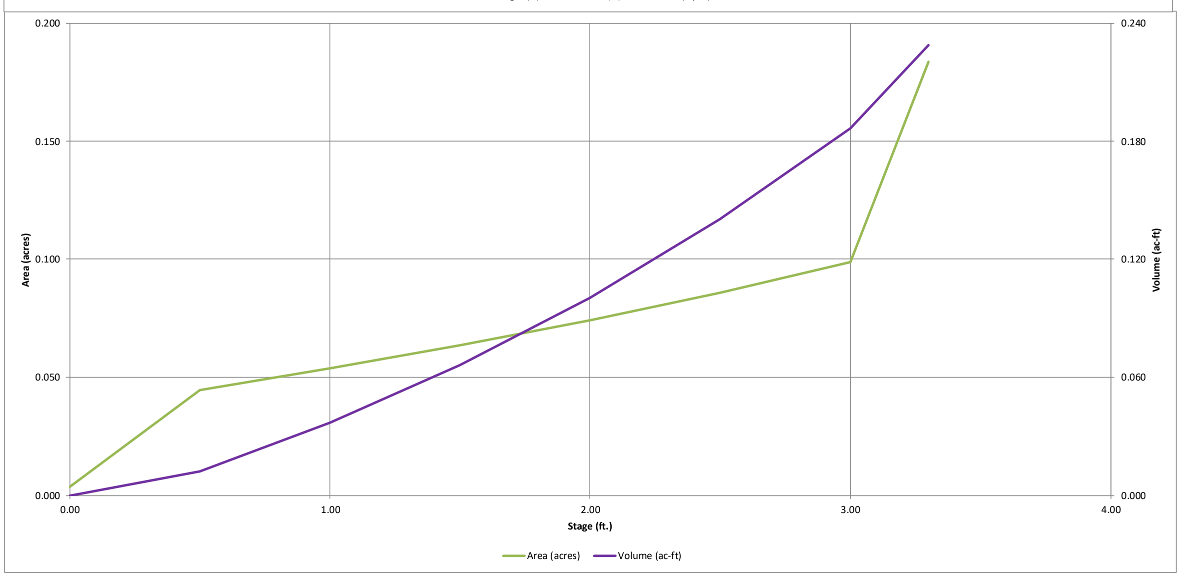
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

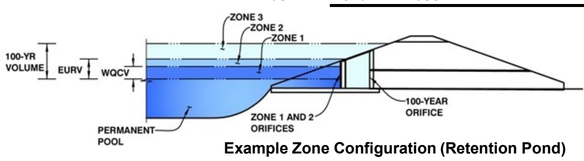




DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Salisbury Park North**
Basin ID: **Pond D - Phase 1**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.43	0.134	Orifice Plate
Zone 2 (2-year)	3.30	0.093	Weir (No Pipe)
Zone 3			
Total (all zones)		0.228	

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

			Calculated Parameters for Underdrain		
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

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.903E-03	ft^2
Depth at top of Zone using Orifice Plate =	2.43	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	12.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.85	sq. inches (diameter = 1 inch)	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.00	2.00					
Orifice Area (sq. inches)	0.85	0.85	0.85					

	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		Calculated Parameters for Vertical Orifice	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				

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

	Zone 2 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.50		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	N/A		feet
Overflow Weir Bottom Length =	0.50		feet	Overflow Weir Slope Length =	N/A		feet
Overflow Weir Side Slopes =	0.00		H:V	Grate Open Area / 100-yr Orifice Area =	N/A		
Horiz. Length of Weir Sides =	N/A		feet	Overflow Grate Open Area w/o Debris =	N/A		ft^2
Overflow Grate Type =	N/A			Overflow Grate Open Area w/ Debris =	N/A		ft^2
Debris Clogging % =	N/A		%				

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

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	2.80	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.26	feet
Spillway Crest Length =	0.75	feet	Stage at Top of Freeboard =	4.56	feet
Spillway End Slopes =	3.00	H:V	Basin Area at Top of Freeboard =	0.18	acres
Freeboard above Max Water Surface =	0.50	feet	Basin Volume at Top of Freeboard =	0.23	acre-ft
Spillway position relative to Overflow Weir =					

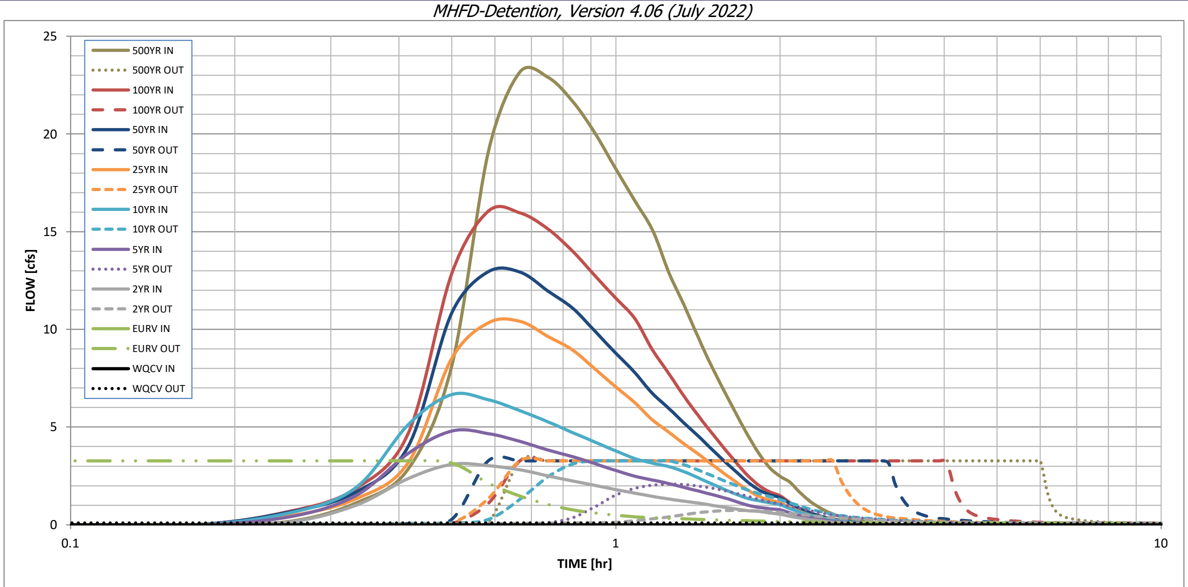
Routed Hydrograph Results

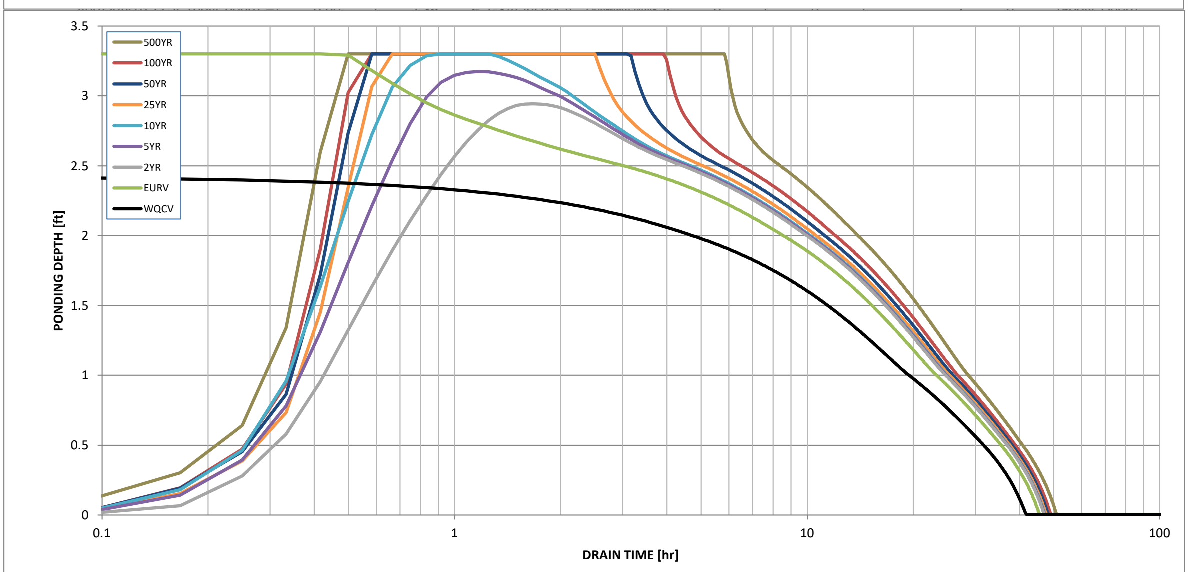
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

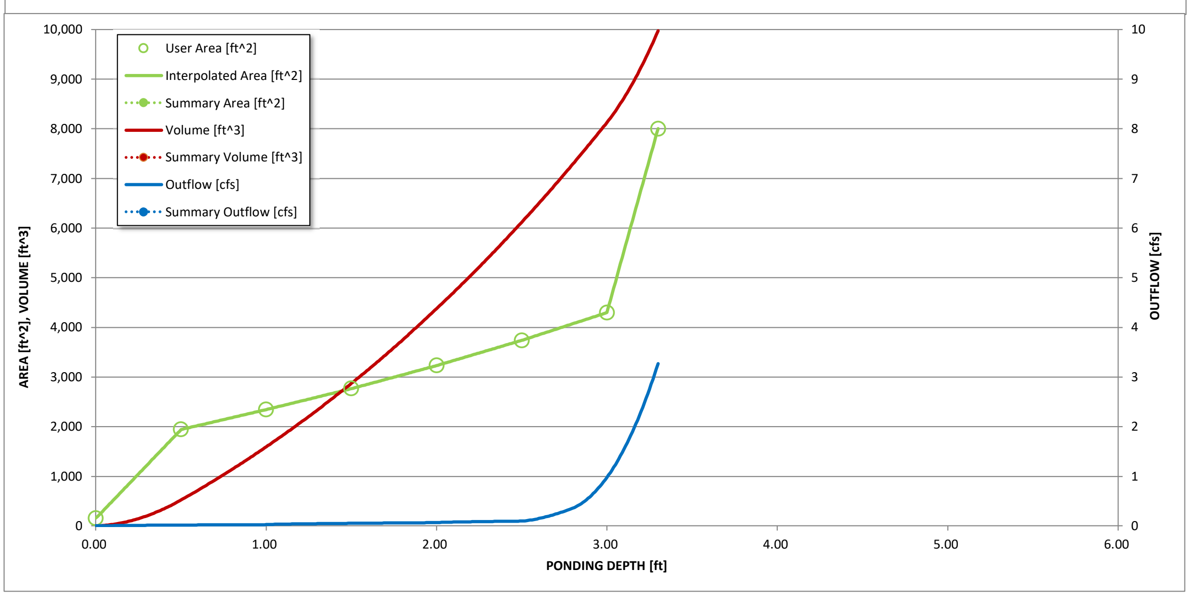
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.82	1.10	1.34	1.69	1.98	2.29	3.08
CUHP Runoff Volume (acre-ft) =	0.134	0.373	0.240	0.366	0.502	0.751	0.938	1.163	1.692
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.240	0.366	0.502	0.751	0.938	1.163	1.692
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.6	1.7	4.2	5.8	7.8	12.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.08	0.22	0.55	0.75	1.02	1.59
Peak Inflow Q (cfs) =	N/A	N/A	3.1	4.8	6.7	10.4	12.9	16.1	23.2
Peak Outflow Q (cfs) =	0.1	3.3	0.7	2.1	3.3	3.3	3.3	3.3	3.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	3.4	2.0	0.8	0.6	0.4	0.3
Structure Controlling Flow =	Plate	N/A	Spillway	Spillway	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	37	36	40	38	35	32	30	28	24
Time to Drain 99% of Inflow Volume (hours) =	**40**	41	44	43	42	41	40	39	38
Maximum Ponding Depth (ft) =	2.43	3.30	2.94	3.17	3.30	3.30	3.30	3.30	3.30
Area at Maximum Ponding Depth (acres) =	0.08	0.18	0.10	0.15	0.18	0.18	0.18	0.18	0.18
Maximum Volume Stored (acre-ft) =	0.134	0.229	0.181	0.207	0.229	0.229	0.229	0.229	0.229
WSE =	5842.03	5842.90	5842.54	5842.77	5842.90	5842.90	5842.90	5842.90	5842.90

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







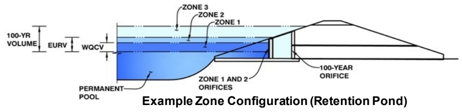
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Salisbury Park North**

Basin ID: **Pond E - Phase 1**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	1.92	acres
Watershed Length =	770	ft
Watershed Length to Centroid =	383	ft
Watershed Slope =	0.018	ft/ft
Watershed Imperviousness =	60.80%	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 =	40.0	hours
Location for 1-hr Rainfall Depths =	Parker - Town Hall	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.038	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.112	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.82 in.) =	0.073	acre-feet		inches
5-yr Runoff Volume (P1 = 1.1 in.) =	0.107	acre-feet		inches
10-yr Runoff Volume (P1 = 1.34 in.) =	0.143	acre-feet		inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.204	acre-feet		inches
50-yr Runoff Volume (P1 = 1.98 in.) =	0.251	acre-feet		inches
100-yr Runoff Volume (P1 = 2.29 in.) =	0.307	acre-feet		inches
500-yr Runoff Volume (P1 = 3.08 in.) =	0.439	acre-feet		inches
Approximate 2-yr Detention Volume =	0.069	acre-feet		
Approximate 5-yr Detention Volume =	0.105	acre-feet		
Approximate 10-yr Detention Volume =	0.125	acre-feet		
Approximate 25-yr Detention Volume =	0.148	acre-feet		
Approximate 50-yr Detention Volume =	0.159	acre-feet		
Approximate 100-yr Detention Volume =	0.181	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.038	acre-feet
Zone 2 Volume (2-year - Zone 1) =	0.031	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.069	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

Total detention volume is less than 100-year volume.

Depth Increement = ft

5845.9

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	--	--	--	56	0.001		
5846	--	0.10	--	--	--	526	0.012	29	0.001
5846.5	--	0.60	--	--	--	1,227	0.028	467	0.011
5847	--	1.10	--	--	--	1,550	0.036	1,162	0.027
5847.5	--	1.60	--	--	--	1,911	0.044	2,027	0.047
5848	--	2.10	--	--	--	2,309	0.053	3,082	0.071
5848.5	--	2.60	--	--	--	2,813	0.065	4,362	0.100
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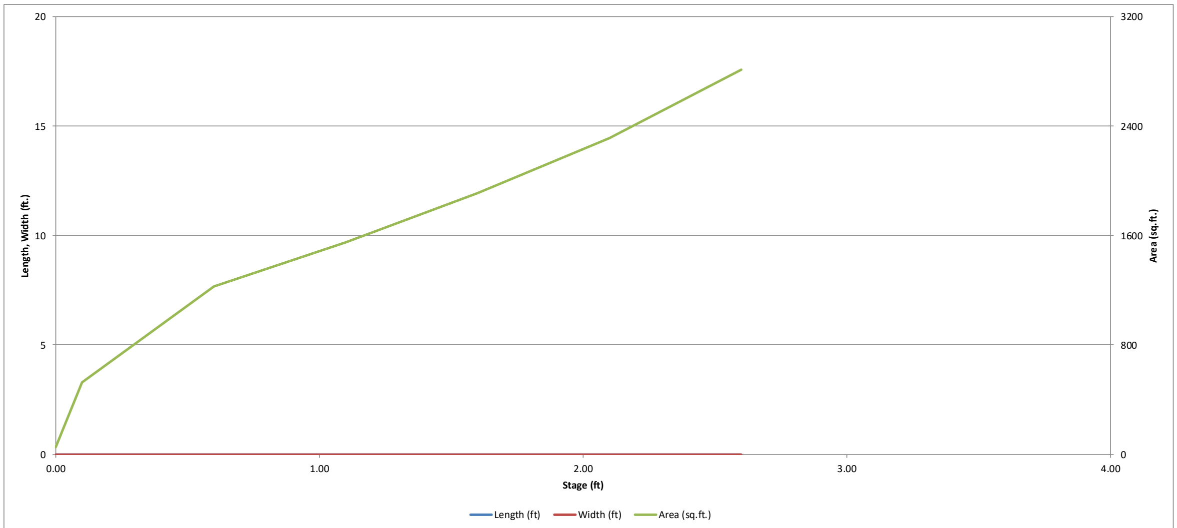
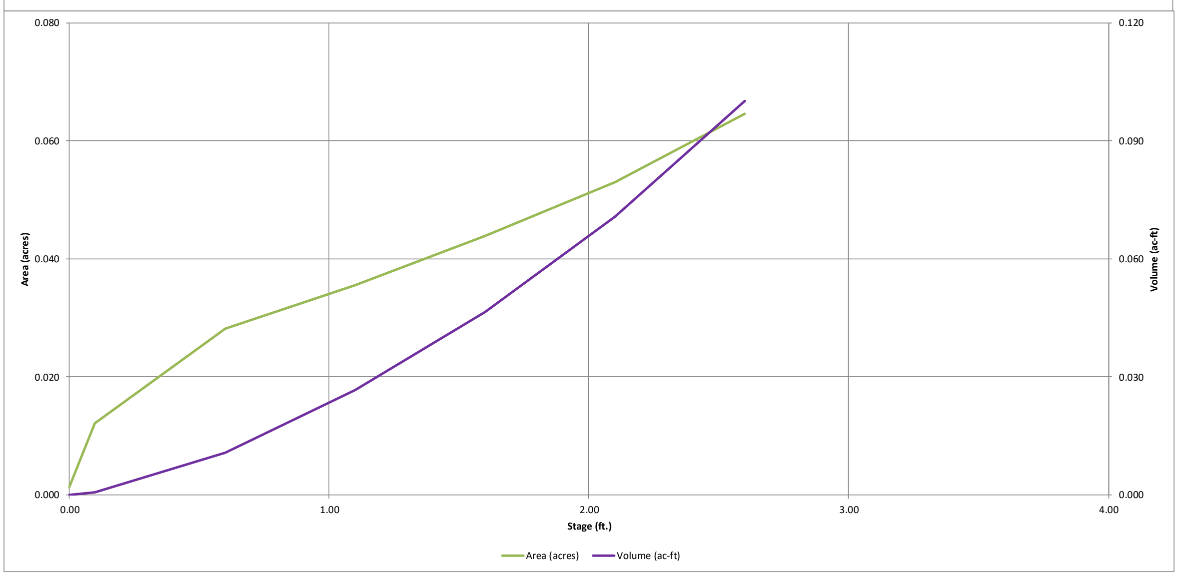
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



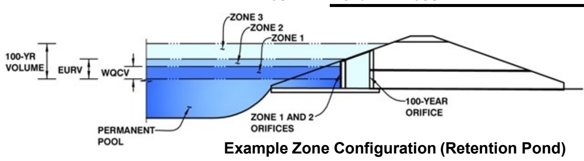


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Salisbury Park North

Basin ID: Pond E - Phase 1



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.41	0.038	Orifice Plate
Zone 2 (2-year)	2.07	0.031	Weir (No Pipe)
Zone 3			
	Total (all zones)	0.069	

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)

Calculated Parameters for Plate

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.014E-03	ft^2
Depth at top of Zone using Orifice Plate =	1.41	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	5.60	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.29	sq. inches (diameter = 5/8 inch)	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	0.47	0.94					
Orifice Area (sq. inches)	0.29	0.29	0.29					

	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)

Calculated Parameters for Vertical Orifice

	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				

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

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected			Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.75		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	N/A		feet
Overflow Weir Bottom Length =	0.50		feet	Overflow Weir Slope Length =	N/A		feet
Overflow Weir Side Slopes =	0.00		H:V	Grate Open Area / 100-yr Orifice Area =	N/A		
Horiz. Length of Weir Sides =	N/A		feet	Overflow Grate Open Area w/o Debris =	N/A		ft^2
Overflow Grate Type =	N/A			Overflow Grate Open Area w/ Debris =	N/A		ft^2
Debris Clogging % =	N/A		%				

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage=	2.10	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.48	feet
Spillway Crest Length =	2.00	feet	Stage at Top of Freeboard =	3.08	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.06	acres
Freeboard above Max Water Surface =	0.50	feet	Basin Volume at Top of Freeboard =	0.10	acre-ft
Spillway position relative to Overflow Weir =	Overlapping				

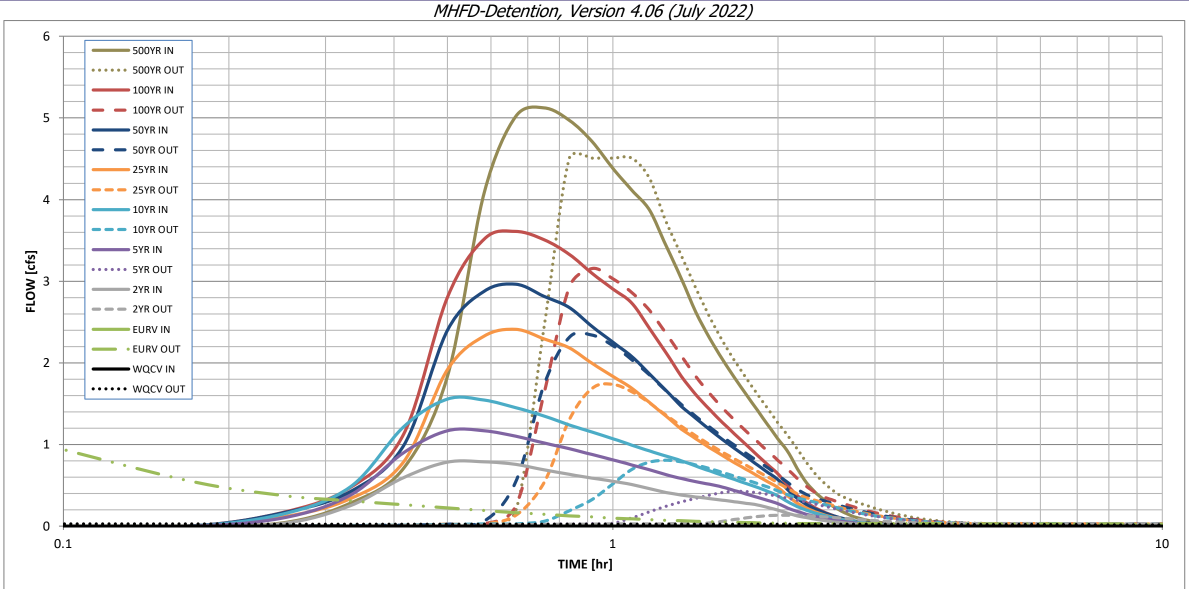
Routed Hydrograph Results

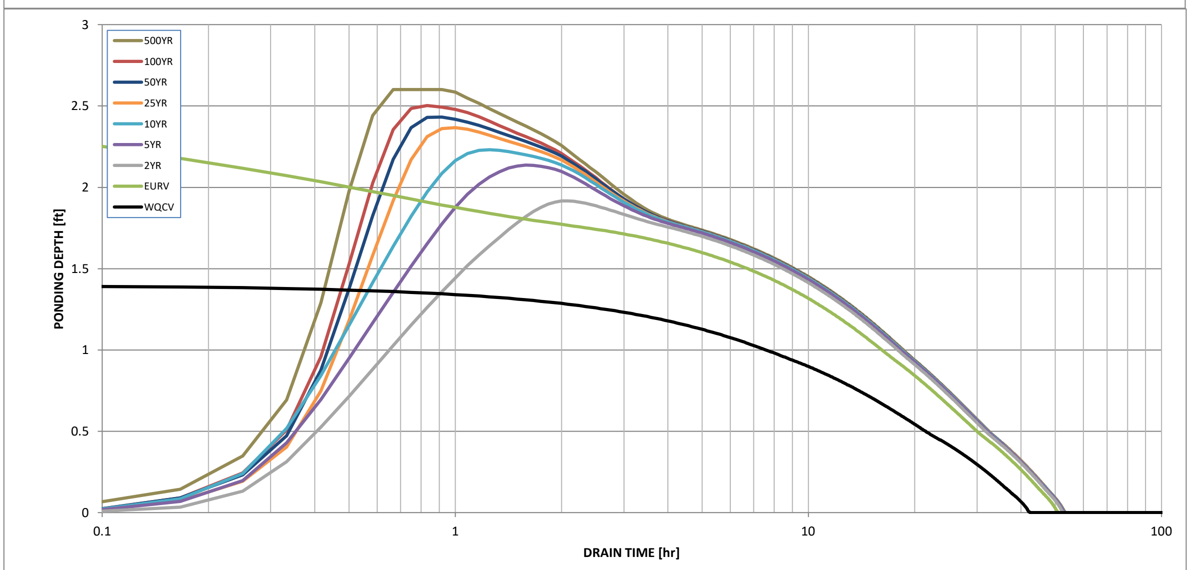
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

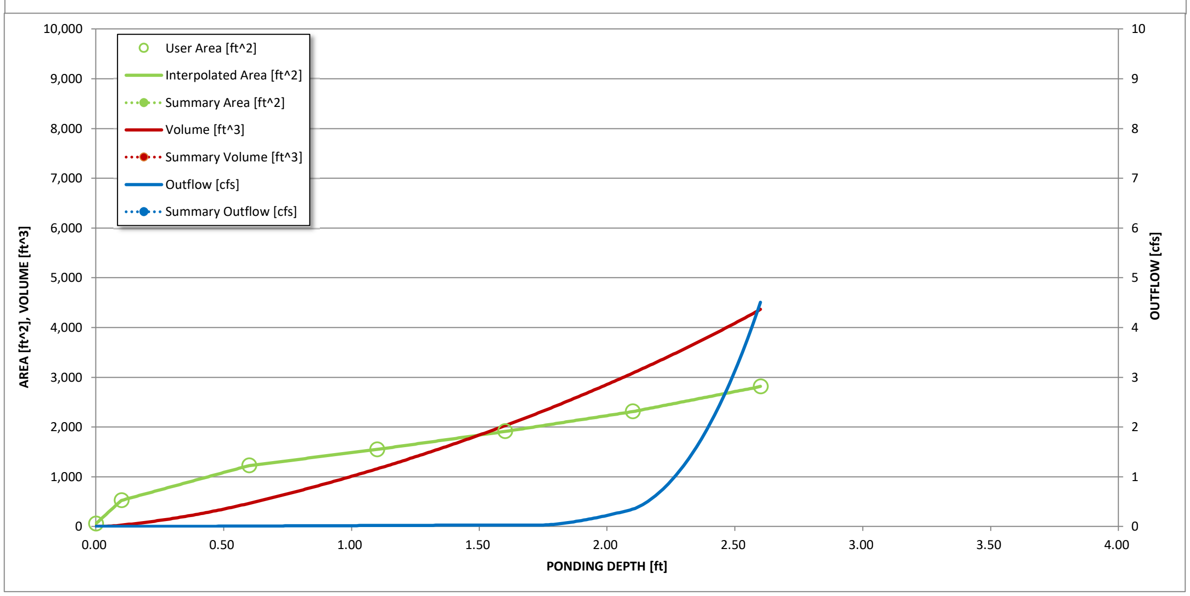
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.82	1.10	1.34	1.69	1.98	2.29	3.08
CUHP Runoff Volume (acre-ft) =	0.038	0.112	0.073	0.107	0.143	0.204	0.251	0.307	0.439
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.073	0.107	0.143	0.204	0.251	0.307	0.439
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.1	0.3	0.8	1.1	1.5	2.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.06	0.16	0.42	0.58	0.78	1.23
Peak Inflow Q (cfs) =	N/A	N/A	0.8	1.2	1.6	2.4	3.0	3.6	5.1
Peak Outflow Q (cfs) =	0.0	4.0	0.1	0.4	0.8	1.7	2.3	3.2	4.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	3.8	2.6	2.1	2.1	2.1	1.9
Structure Controlling Flow =	Plate	Spillway	Overflow Weir 1	Spillway	Spillway	Spillway	Spillway	Spillway	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	37	40	44	42	39	36	33	31	27
Time to Drain 99% of Inflow Volume (hours) =	**40**	46	49	48	47	45	44	42	39
Maximum Ponding Depth (ft) =	1.40	2.28	1.92	2.13	2.23	2.37	2.43	2.50	2.60
Area at Maximum Ponding Depth (acres) =	0.04	0.06	0.05	0.05	0.06	0.06	0.06	0.06	0.06
Maximum Volume Stored (acre-ft) =	0.038	0.080	0.061	0.072	0.078	0.085	0.090	0.094	0.100
WSE =	5847.30	5848.18	5847.82	5848.03	5848.13	5848.27	5848.33	5848.40	5848.50

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

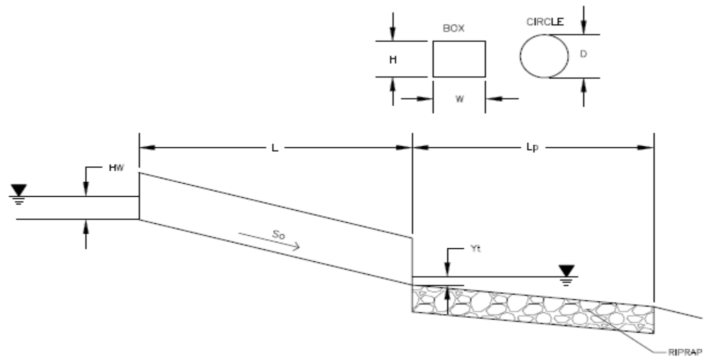
MHFD CULVERT ANALYSIS

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1

ID: Bypass - 2 Year



Soil Type:

Choose One:

- ○ Sandy
- ◉ Non-Sandy

Design Information:

Design Discharge	Q =	15	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	36	inches
Inlet Edge Type (Choose from pull-down list)		Grooved Edge Projecting	
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	2	
Inlet Elevation	Elev IN =	5850.15	ft
Outlet Elevation **OR** Slope	Elev OUT =	5847.11	ft
Culvert Length	L =	1045	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	1.32	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	7.07	ft^2
Culvert Normal Depth	Y_n =	0.93	ft
Culvert Critical Depth	Y_c =	0.86	ft
Froude Number	Fr =	0.87	
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	7.52	
Sum of All Loss Coefficients	k_s =	10.04	ft
Headwater:			
Inlet Control Headwater	HW_I =	1.17	ft
Outlet Control Headwater	HW_O =	N/A	ft
Design Headwater Elevation	**HW =**	**N/A**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**N/A**	

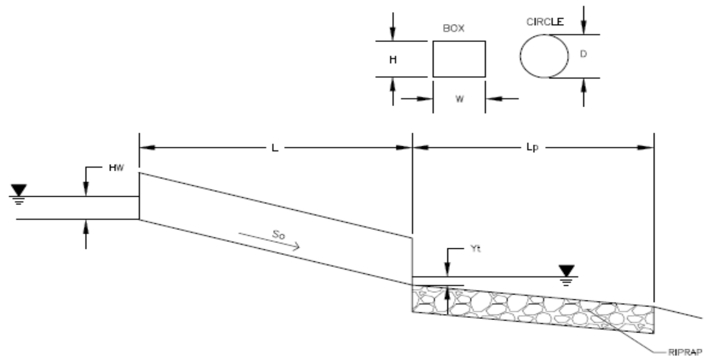
Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	0.48	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	1.20	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow Area at Max Channel Velocity	A_t =	3.00	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	6.00	ft
Length of Riprap Protection	$\mathbf{L_p}$ **=**	**9**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**8**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	-	ft
Minimum Theoretical Riprap Size	d_{50} min=	1	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1
ID: Bypass - 100 Year



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Design Information:

Design Discharge	Q =	74	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	36	inches
Inlet Edge Type (Choose from pull-down list)	Grooved Edge Projecting		
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	2	
Inlet Elevation	Elev IN =	5850.15	ft
Outlet Elevation **OR** Slope	Elev OUT =	5847.11	ft
Culvert Length	L =	1045	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	1.32	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

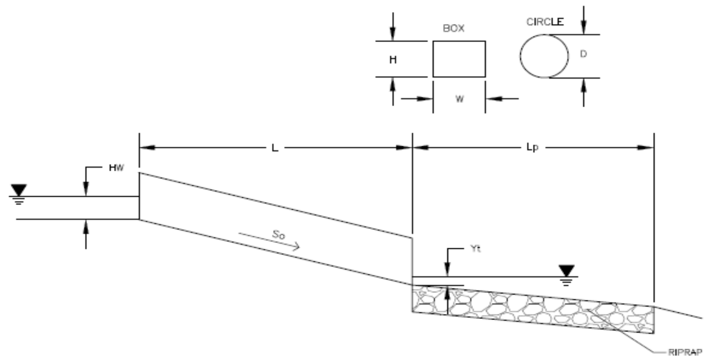
Calculated Results:

Culvert Cross Sectional Area Available	A =	7.07	ft^2
Culvert Normal Depth	Y_n =	2.53	ft
Culvert Critical Depth	Y_c =	1.98	ft
Froude Number	Fr =	0.60	
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	7.52	
Sum of All Loss Coefficients	k_s =	10.04	ft
Headwater:			
Inlet Control Headwater	HW_I =	2.93	ft
Outlet Control Headwater	HW_O =	3.72	ft
Design Headwater Elevation	**HW =**	**5853.87**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.24**	
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	2.37	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	1.20	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	5.23	
Flow Area at Max Channel Velocity	A_t =	14.80	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	6.00	ft
Length of Riprap Protection	**L_p =**	**30**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**12**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	-	ft
Minimum Theoretical Riprap Size	d_{50} min=	6	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1
ID: Bypass 2 - 2 Year



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	15	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	36	inches
Inlet Edge Type (Choose from pull-down list)		Grooved Edge Projecting	
OR:			
Box Culvert:		OR	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	2	
Inlet Elevation	Elev IN =	5845.15	ft
Outlet Elevation **OR** Slope	Elev OUT =	5843.63	ft
Culvert Length	L =	160	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	1.32	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	7.07	ft^2
Culvert Normal Depth	Y_n =	0.69	ft
Culvert Critical Depth	Y_c =	0.86	ft
Froude Number	Fr =	1.56	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	1.15	
Sum of All Loss Coefficients	k_s =	3.67	ft
Headwater:			
Inlet Control Headwater	HW_I =	1.17	ft
Outlet Control Headwater	HW_O =	N/A	ft
Design Headwater Elevation	**HW =**	**N/A**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**N/A**	

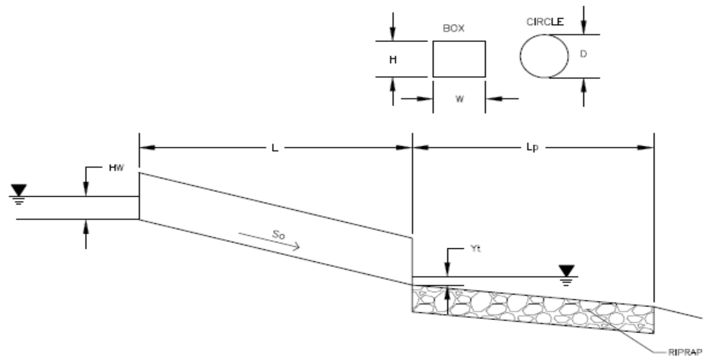
Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	0.48	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	1.20	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow Area at Max Channel Velocity	A_t =	3.00	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	6.00	ft
Length of Riprap Protection	**L_p =**	**9**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**8**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	1.84	ft
Minimum Theoretical Riprap Size	d_{50} min=	1	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1
ID: Bypass 2 - 100 Year



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	74	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	36	inches
Inlet Edge Type (Choose from pull-down list)		Grooved Edge Projecting	
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	2	
Inlet Elevation	Elev IN =	5845.15	ft
Outlet Elevation **OR** Slope	Elev OUT =	5843.63	ft
Culvert Length	L =	160	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	1.32	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

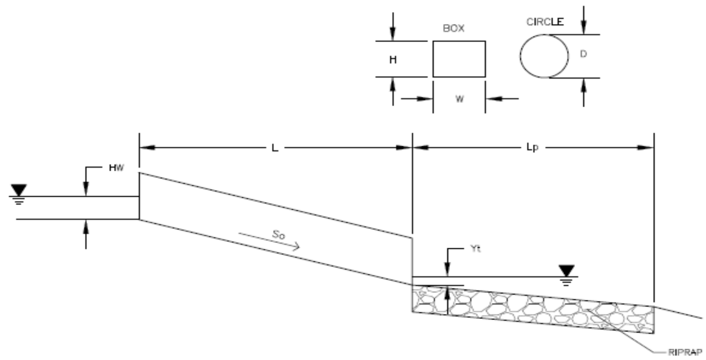
Calculated Results:

Culvert Cross Sectional Area Available	A =	7.07	ft^2
Culvert Normal Depth	Y_n =	1.62	ft
Culvert Critical Depth	Y_c =	1.98	ft
Froude Number	Fr =	1.47	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	1.15	
Sum of All Loss Coefficients	k_s =	3.67	ft
Headwater:			
Inlet Control Headwater	HW_I =	2.92	ft
Outlet Control Headwater	HW_O =	2.53	ft
Design Headwater Elevation	**HW =**	**5848.07**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.97**	
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	2.37	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	1.20	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	5.23	
Flow Area at Max Channel Velocity	A_t =	14.80	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	6.00	ft
Length of Riprap Protection	L_p **=**	**30**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**12**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	2.31	ft
Minimum Theoretical Riprap Size	d_{50} min=	6	in
Nominal Riprap Size	d_{50} nominal=	9	in
MHFD Riprap Type	**Type =**	**L**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1
ID: DP2 - Basin A2 Culvert (Upstream) - 5 Year



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	0.31	cfs

Circular Culvert:

Barrel Diameter in Inches	D =	18	inches
Inlet Edge Type (Choose from pull-down list)		Square Edge with Headwall	

OR:

Box Culvert: **OR**

Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	5848.77	ft
Outlet Elevation **OR** Slope	Elev OUT =	4848.63	ft
Culvert Length	L =	31	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	1.77	ft^2
Culvert Normal Depth	Y_n =	0.03	ft
Culvert Critical Depth	Y_c =	0.21	ft
Froude Number	Fr =	58.16	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	0.56	
Sum of All Loss Coefficients	k_s =	2.06	ft

Headwater:

Inlet Control Headwater	HW_I =	0.19	ft
Outlet Control Headwater	HW_O =	N/A	ft
Design Headwater Elevation	**HW =**	**N/A**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**N/A**	

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:

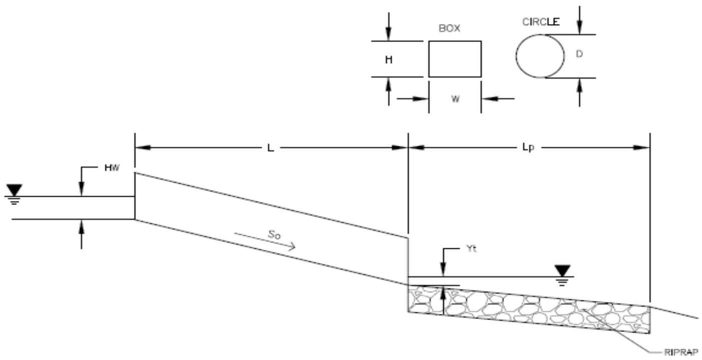
Flow/(Diameter^2.5)	Q/D^2.5 =	0.11	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.60	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow Area at Max Channel Velocity	A_t =	0.06	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**5**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**3**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	0.76	ft
Minimum Theoretical Riprap Size	d_{50} min=	0	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1

ID: DP2 - Basin A2 Culvert (Upstream) - 100 Year



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	1.27	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	18	inches
Inlet Edge Type (Choose from pull-down list)		Square Edge with Headwall	
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	5848.77	ft
Outlet Elevation **OR** Slope	Elev OUT =	4848.63	ft
Culvert Length	L =	31	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	1.77	ft^2
Culvert Normal Depth	Y_n =	0.05	ft
Culvert Critical Depth	Y_c =	0.42	ft
Froude Number	Fr =	64.43	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	0.56	
Sum of All Loss Coefficients	k_s =	2.06	ft
Headwater:			
Inlet Control Headwater	HW_I =	0.40	ft
Outlet Control Headwater	HW_O =	N/A	ft
Design Headwater Elevation	**HW =**	**N/A**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**N/A**	

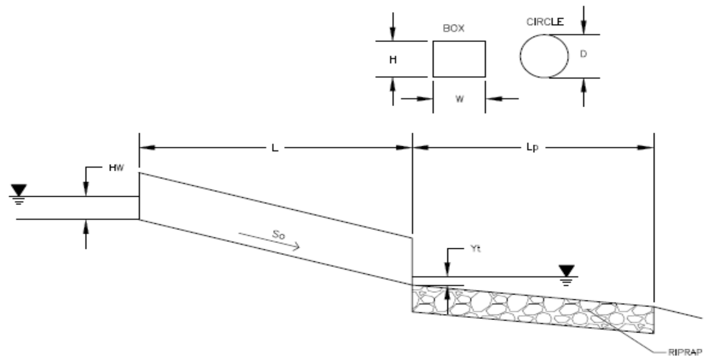
Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	0.46	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.60	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow Area at Max Channel Velocity	A_t =	0.25	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**5**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**3**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	0.78	ft
Minimum Theoretical Riprap Size	d_{50} min=	1	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1
ID: DP2 - Basin A2 Culvert (Downstream) - 5 Year



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	1.75	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	18	inches
Inlet Edge Type (Choose from pull-down list)		Square Edge with Headwall	
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	5846.52	ft
Outlet Elevation **OR** Slope	Elev OUT =	4845.88	ft
Culvert Length	L =	180	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t, Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	1.77	ft^2
Culvert Normal Depth	Y_n =	0.09	ft
Culvert Critical Depth	Y_c =	0.50	ft
Froude Number	Fr =	29.04	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	3.26	
Sum of All Loss Coefficients	k_s =	4.76	ft
Headwater:			
Inlet Control Headwater	HW_I =	0.41	ft
Outlet Control Headwater	HW_O =	N/A	ft
Design Headwater Elevation	**HW =**	**N/A**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**N/A**	

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

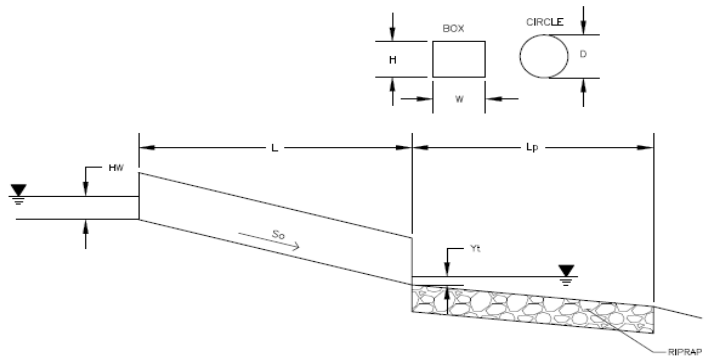
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	0.64	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.60	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow Area at Max Channel Velocity	A_t =	0.35	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	L_p **=**	**5**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**3**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	0.79	ft
Minimum Theoretical Riprap Size	d_{50} min=	1	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1

ID: DP2 - Basin A2 Culvert (Downstream) - 100 Year



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	7.2	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	18	inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall		
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	5846.52	ft
Outlet Elevation **OR** Slope	Elev OUT =	4845.88	ft
Culvert Length	L =	180	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t, Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	1.77	ft^2
Culvert Normal Depth	Y_n =	0.18	ft
Culvert Critical Depth	Y_c =	1.04	ft
Froude Number	Fr =	31.66	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	3.26	
Sum of All Loss Coefficients	k_s =	4.76	ft
Headwater:			
Inlet Control Headwater	HW_I =	0.83	ft
Outlet Control Headwater	HW_O =	N/A	ft
Design Headwater Elevation	**HW =**	**N/A**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**N/A**	

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

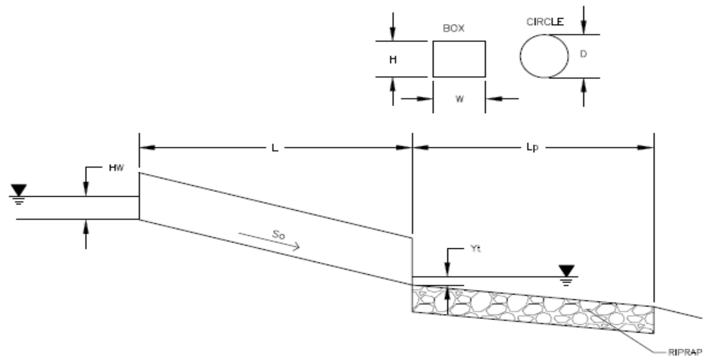
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	2.61	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.60	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	4.91	
Flow Area at Max Channel Velocity	A_t =	1.44	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**5**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**3**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	0.84	ft
Minimum Theoretical Riprap Size	d_{50} min=	4	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1

ID: DP10 - Basin C3 Culvert (Upstream) - 5 Year



Soil Type:

Choose One:
- ○ Sandy
- ◉ Non-Sandy

Design Information:

Design Discharge	Q =	0.36	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	12	inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall		
OR:			
Box Culvert:		OR	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	5849.5	ft
Outlet Elevation **OR** Slope	Elev OUT =	5849.36	ft
Culvert Length	L =	38	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t, Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	0.79	ft^2
Culvert Normal Depth	Y_n =	0.28	ft
Culvert Critical Depth	Y_c =	0.25	ft
Froude Number	Fr =	0.81	
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	1.18	
Sum of All Loss Coefficients	k_s =	2.68	ft
Headwater:			
Inlet Control Headwater	HW_I =	0.34	ft
Outlet Control Headwater	HW_O =	N/A	ft
Design Headwater Elevation	**HW =**	**N/A**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**N/A**	

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

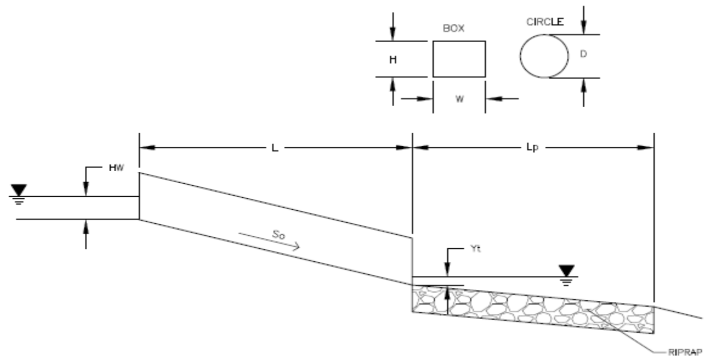
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	0.36	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.40	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow Area at Max Channel Velocity	A_t =	0.07	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**3**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**2**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	-	ft
Minimum Theoretical Riprap Size	d_{50} min=	0	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1

ID: DP 10 - Basin C3 Culvert (Upstream) - 100 Year



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Design Information:

Design Discharge	Q =	1.47	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	12	inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall		
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	5849.5	ft
Outlet Elevation **OR** Slope	Elev OUT =	5849.36	ft
Culvert Length	L =	38	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t, Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

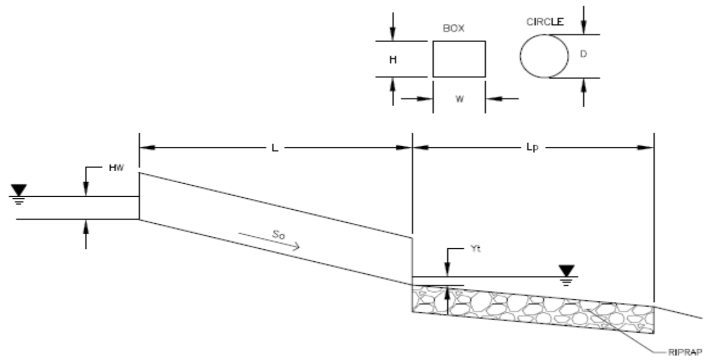
Culvert Cross Sectional Area Available	A =	0.79	ft^2
Culvert Normal Depth	Y_n =	0.60	ft
Culvert Critical Depth	Y_c =	0.51	ft
Froude Number	Fr =	0.73	
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	1.18	
Sum of All Loss Coefficients	k_s =	2.68	ft
Headwater:			
Inlet Control Headwater	HW_I =	0.76	ft
Outlet Control Headwater	HW_O =	0.76	ft
Design Headwater Elevation	**HW =**	**5850.26**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.76**	
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	1.47	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.40	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	6.25	
Flow Area at Max Channel Velocity	A_t =	0.29	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**3**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**2**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	-	ft
Minimum Theoretical Riprap Size	d_{50} min=	1	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1

ID: DP10 - Basin C3 Culvert (Downstream) - 5 Year



Soil Type:

Choose One:
- ○ Sandy
- ◉ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	2.03	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)		Square Edge with Headwall	
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	5847.01	ft
Outlet Elevation **OR** Slope	Elev OUT =	4846.4	ft
Culvert Length	L =	123	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	3.14	ft^2
Culvert Normal Depth	Y_n =	0.08	ft
Culvert Critical Depth	Y_c =	0.49	ft
Froude Number	Fr =	34.88	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	1.52	
Sum of All Loss Coefficients	k_s =	3.02	ft
Headwater:			
Inlet Control Headwater	HW_I =	0.43	ft
Outlet Control Headwater	HW_O =	N/A	ft
Design Headwater Elevation	**HW =**	**N/A**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**N/A**	

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

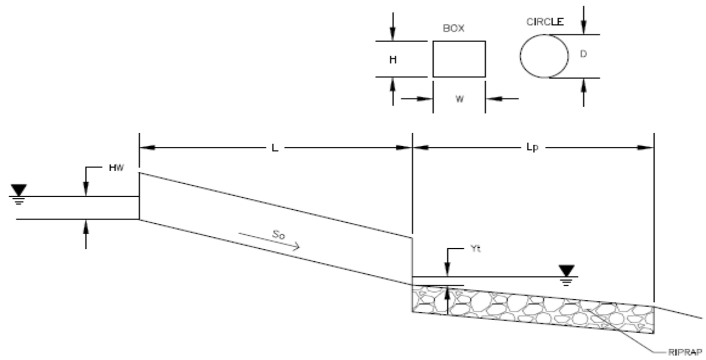
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	0.36	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.80	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow Area at Max Channel Velocity	A_t =	0.41	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**6**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**3**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	1.04	ft
Minimum Theoretical Riprap Size	d_{50} min=	1	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1

ID: DP10 - Basin C3 Culvert (Downstream) - 100 Year



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

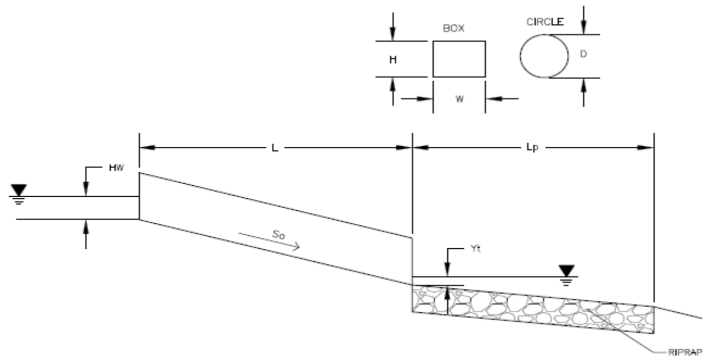
Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:				
	Design Discharge	Q =	8.33	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	24	inches
	Inlet Edge Type (Choose from pull-down list)		Square Edge with Headwall	
OR:				
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	H (Rise) =		ft
	Barrel Width (Span) in Feet	W (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	# Barrels =	1	
	Inlet Elevation	Elev IN =	5847.01	ft
	Outlet Elevation **OR** Slope	Elev OUT =	4846.4	ft
	Culvert Length	L =	123	ft
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
	Max Allowable Channel Velocity	V =	5	ft/s
Calculated Results:				
	Culvert Cross Sectional Area Available	A =	3.14	ft^2
	Culvert Normal Depth	Y_n =	0.16	ft
	Culvert Critical Depth	Y_c =	1.03	ft
	Froude Number	Fr =	38.31	**Supercritical!**
	Entrance Loss Coefficient	k_e =	0.50	
	Friction Loss Coefficient	k_f =	1.52	
	Sum of All Loss Coefficients	k_s =	3.02	ft
Headwater:				
	Inlet Control Headwater	HW_I =	0.90	ft
	Outlet Control Headwater	HW_O =	N/A	ft
	Design Headwater Elevation	**HW =**	**N/A**	**ft**
	Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**N/A**	
	Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required			
Outlet Protection:				
	Flow/(Diameter^2.5)	Q/D^2.5 =	1.47	$ft^{0.5}/s$
	Tailwater Surface Height	Y_t =	0.80	ft
	Tailwater/Diameter	Yt/D =	0.40	
	Expansion Factor	1/(2*tan(Θ)) =	6.25	
	Flow Area at Max Channel Velocity	A_t =	1.67	ft^2
	Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
	Length of Riprap Protection	**L_p =**	**6**	**ft**
	Width of Riprap Protection at Downstream End	**T =**	**3**	**ft**
	Adjusted Diameter for Supercritical Flow	Da =	1.08	ft
	Minimum Theoretical Riprap Size	d_{50} min=	3	in
	Nominal Riprap Size	d_{50} nominal=	6	in
	MHFD Riprap Type	**Type =**	**VL**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1
ID: DP16 - Basin OS1 Culvert - 5 Year



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	2.51	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall		
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	5843	ft
Outlet Elevation **OR** Slope	Elev OUT =	5840.4	ft
Culvert Length	L =	109	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t, Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	3.14	ft^2
Culvert Normal Depth	Y_n =	0.36	ft
Culvert Critical Depth	Y_c =	0.55	ft
Froude Number	Fr =	2.27	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	1.35	
Sum of All Loss Coefficients	k_s =	2.85	ft
Headwater:			
Inlet Control Headwater	HW_I =	0.74	ft
Outlet Control Headwater	HW_O =	N/A	ft
Design Headwater Elevation	**HW =**	**N/A**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**N/A**	

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

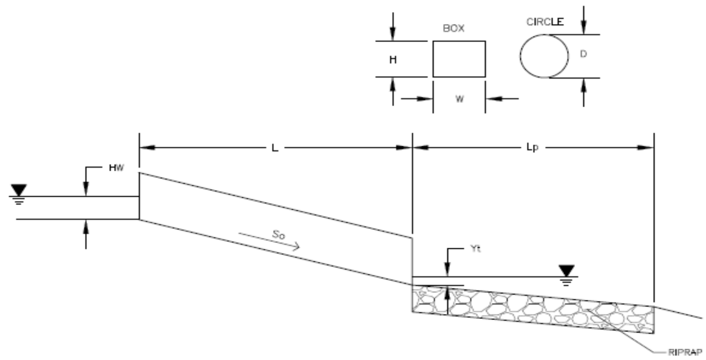
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	0.44	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.80	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow Area at Max Channel Velocity	A_t =	0.50	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**6**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**3**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	1.18	ft
Minimum Theoretical Riprap Size	d_{50} min=	1	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Salisbury Park North Phase 1

ID: DP16 - Basin OS1 Culvert - 100 Year



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	18.59	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)	Grooved Edge Projecting		
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	5843	ft
Outlet Elevation **OR** Slope	Elev OUT =	5840.4	ft
Culvert Length	L =	109	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t, Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	3.14	ft^2
Culvert Normal Depth	Y_n =	1.04	ft
Culvert Critical Depth	Y_c =	1.55	ft
Froude Number	Fr =	2.20	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	1.35	
Sum of All Loss Coefficients	k_s =	2.55	ft
Headwater:			
Inlet Control Headwater	HW_I =	2.47	ft
Outlet Control Headwater	HW_O =	N/A	ft
Design Headwater Elevation	**HW =**	**5845.47**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.23**	

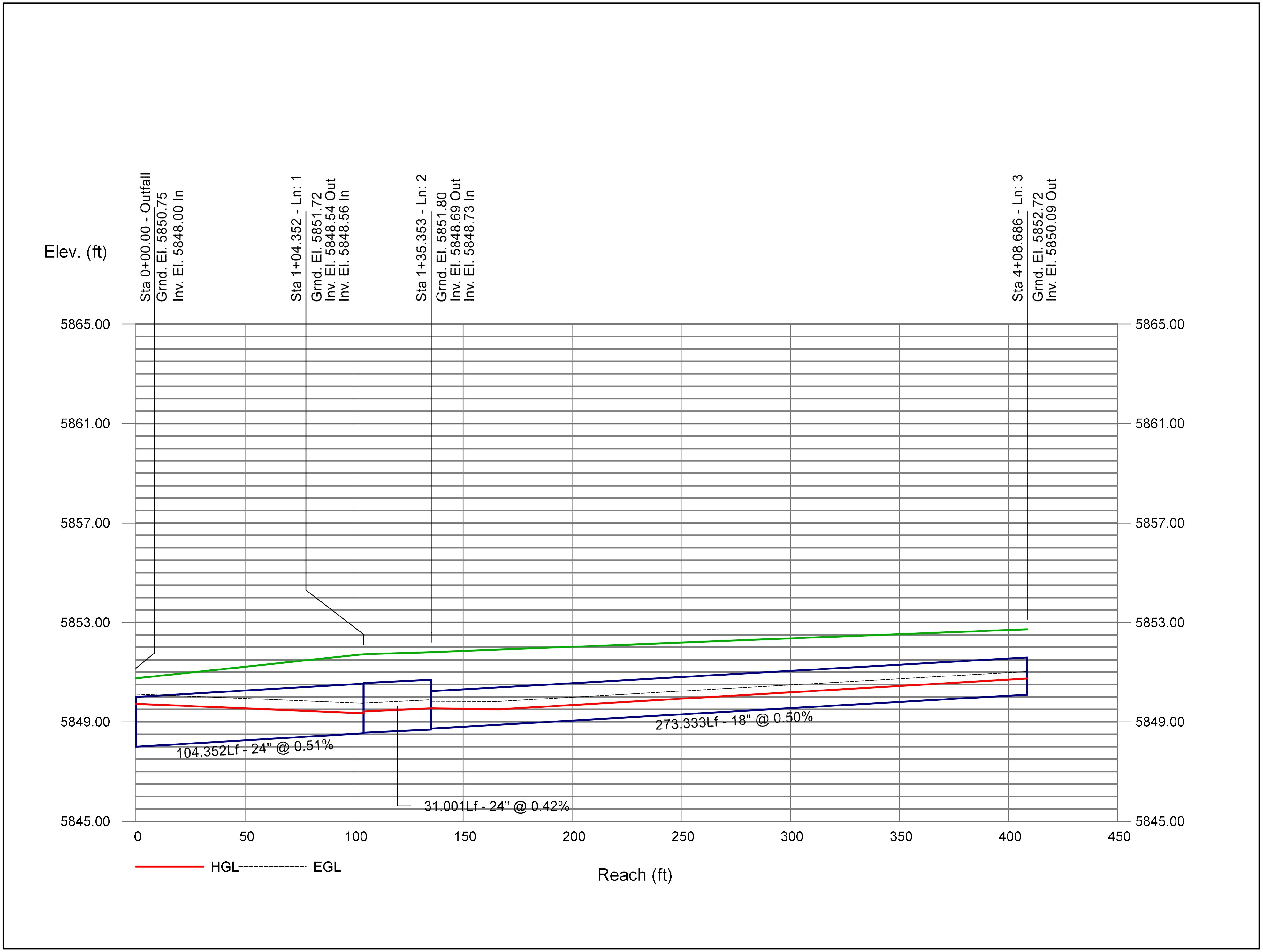
Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	3.29	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.80	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	4.13	
Flow Area at Max Channel Velocity	A_t =	3.72	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**11**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**5**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	1.52	ft
Minimum Theoretical Riprap Size	d_{50} min=	6	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

HYDRAULIC PIPE ANALYSIS

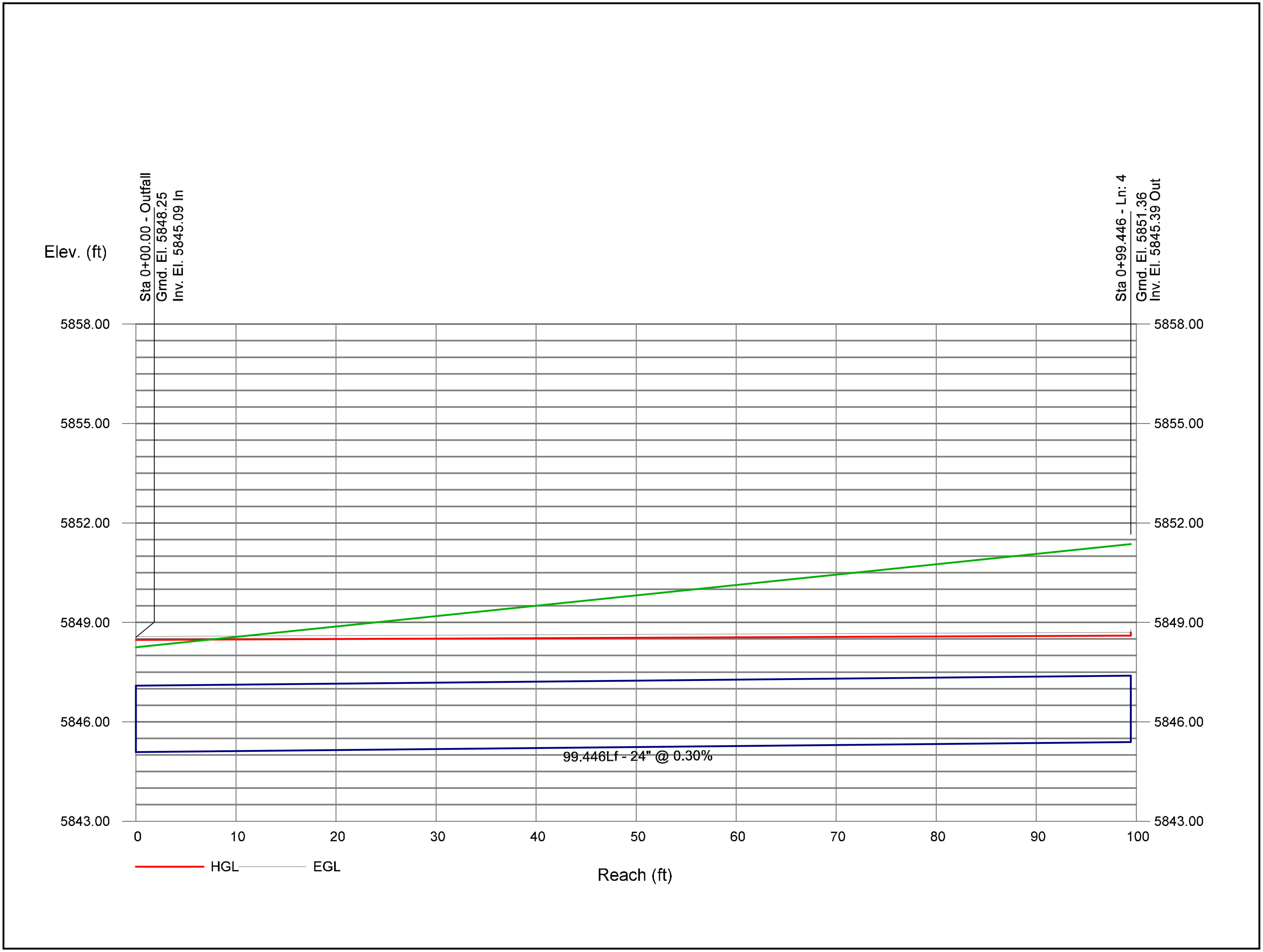
Storm Sewer Profile

Proj. file: Salisbury_Phase1_Storm-5yr.stm



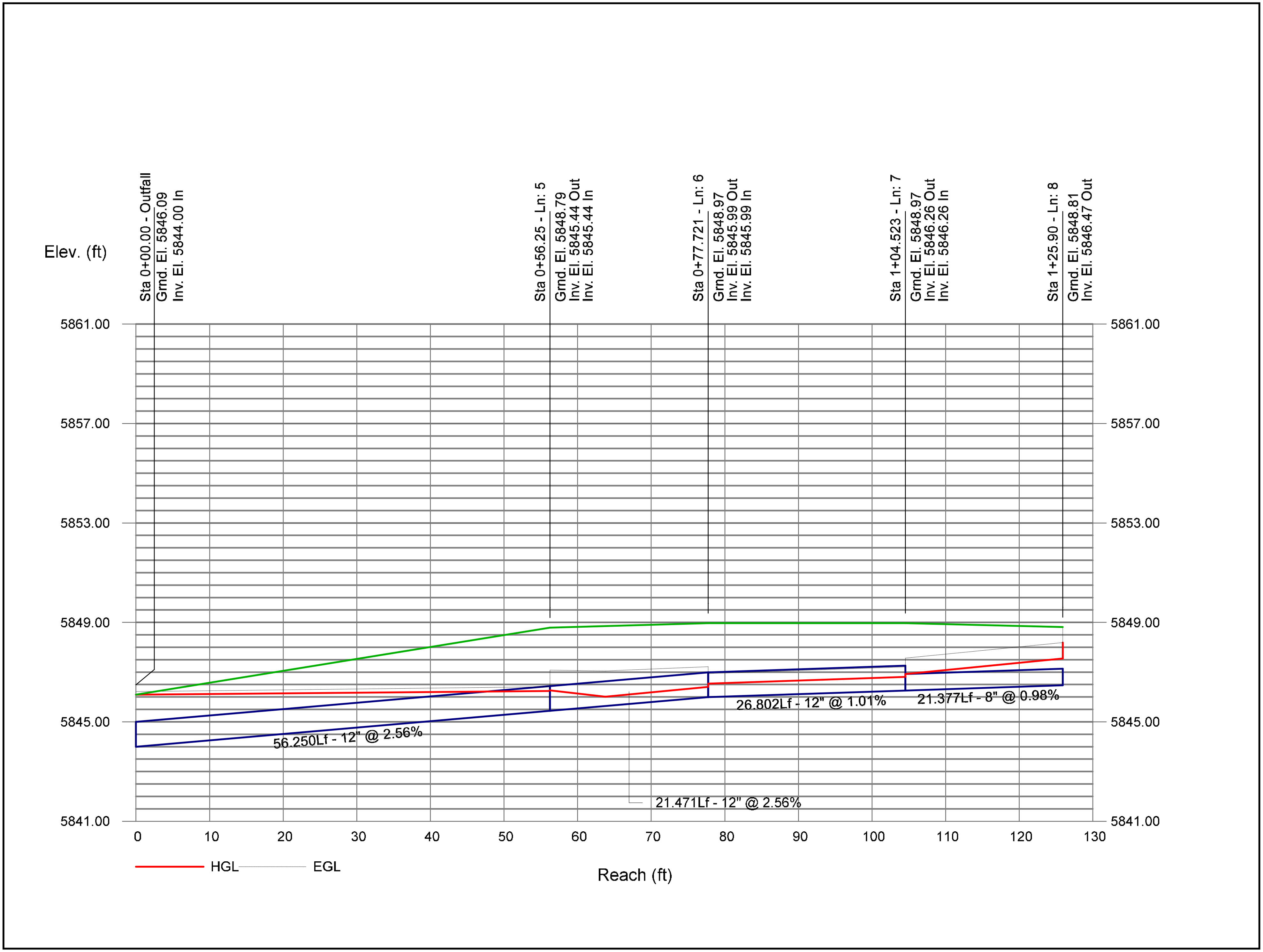
Storm Sewer Profile

Proj. file: Salisbury_Phase1_Storm-5yr.stm



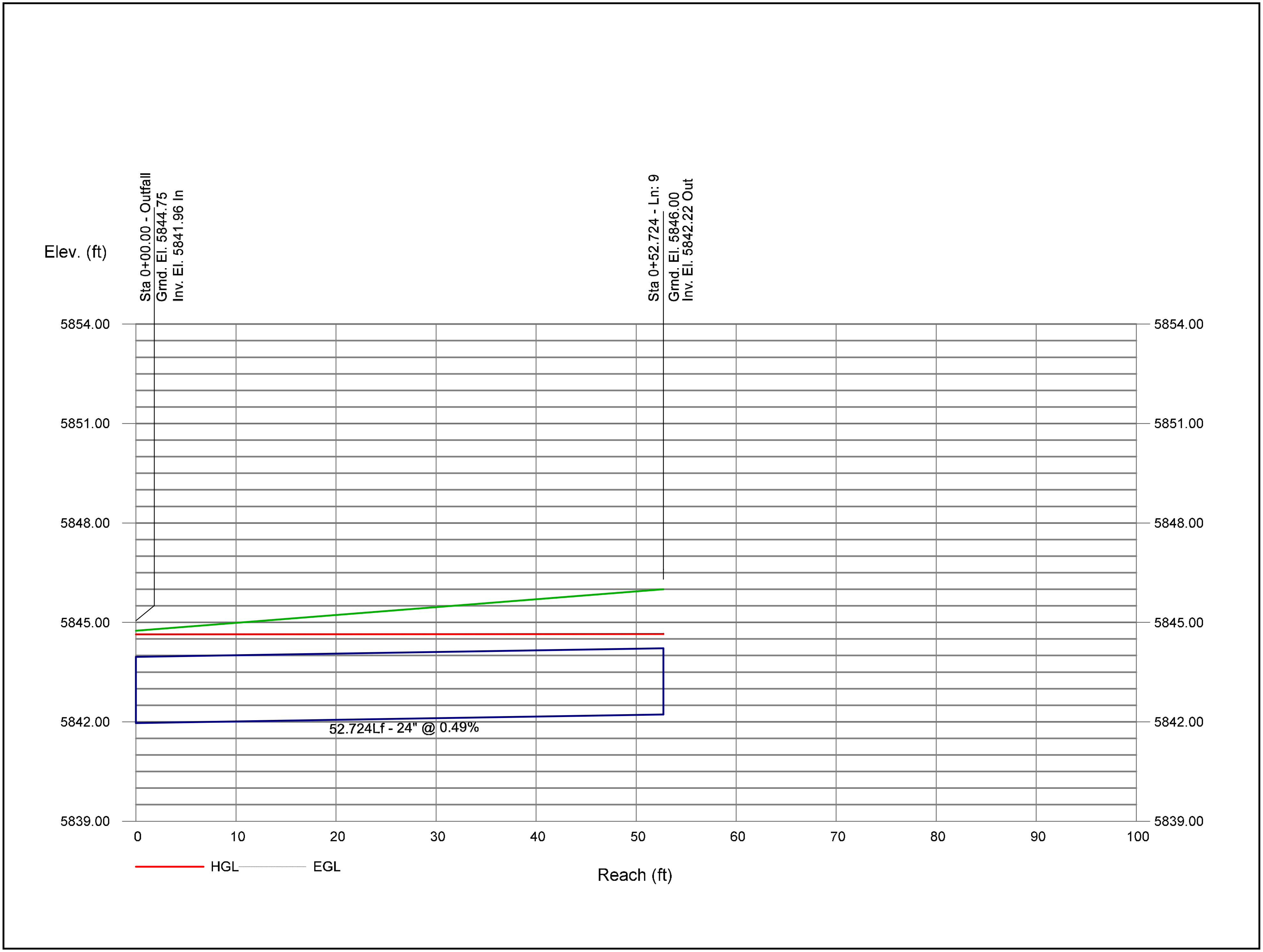
Storm Sewer Profile

Proj. file: Salisbury_Phase1_Storm-5yr.stm



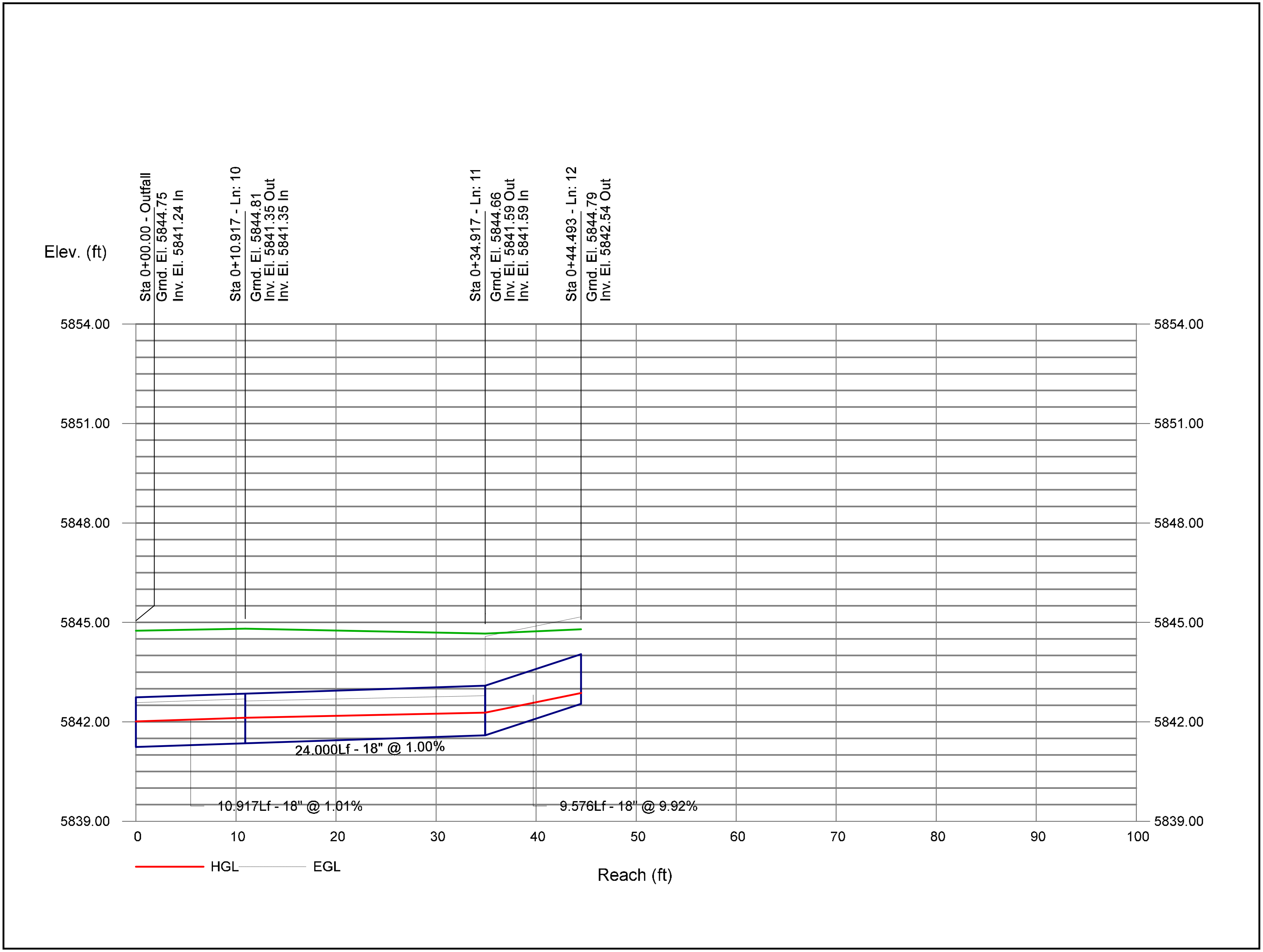
Storm Sewer Profile

Proj. file: Salisbury_Phase1_Storm-5yr.stm



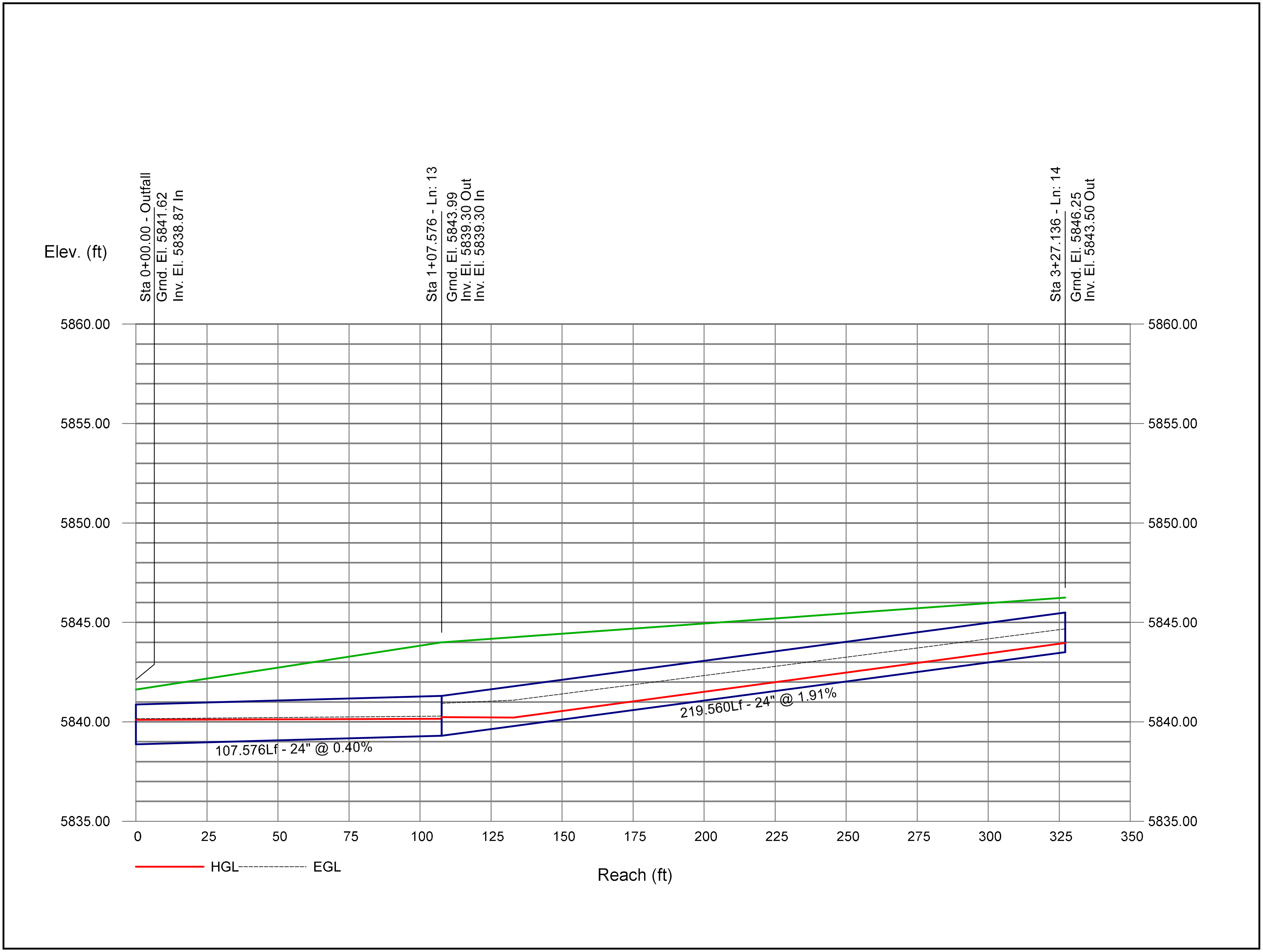
Storm Sewer Profile

Proj. file: Salisbury_Phase1_Storm-5yr.stm



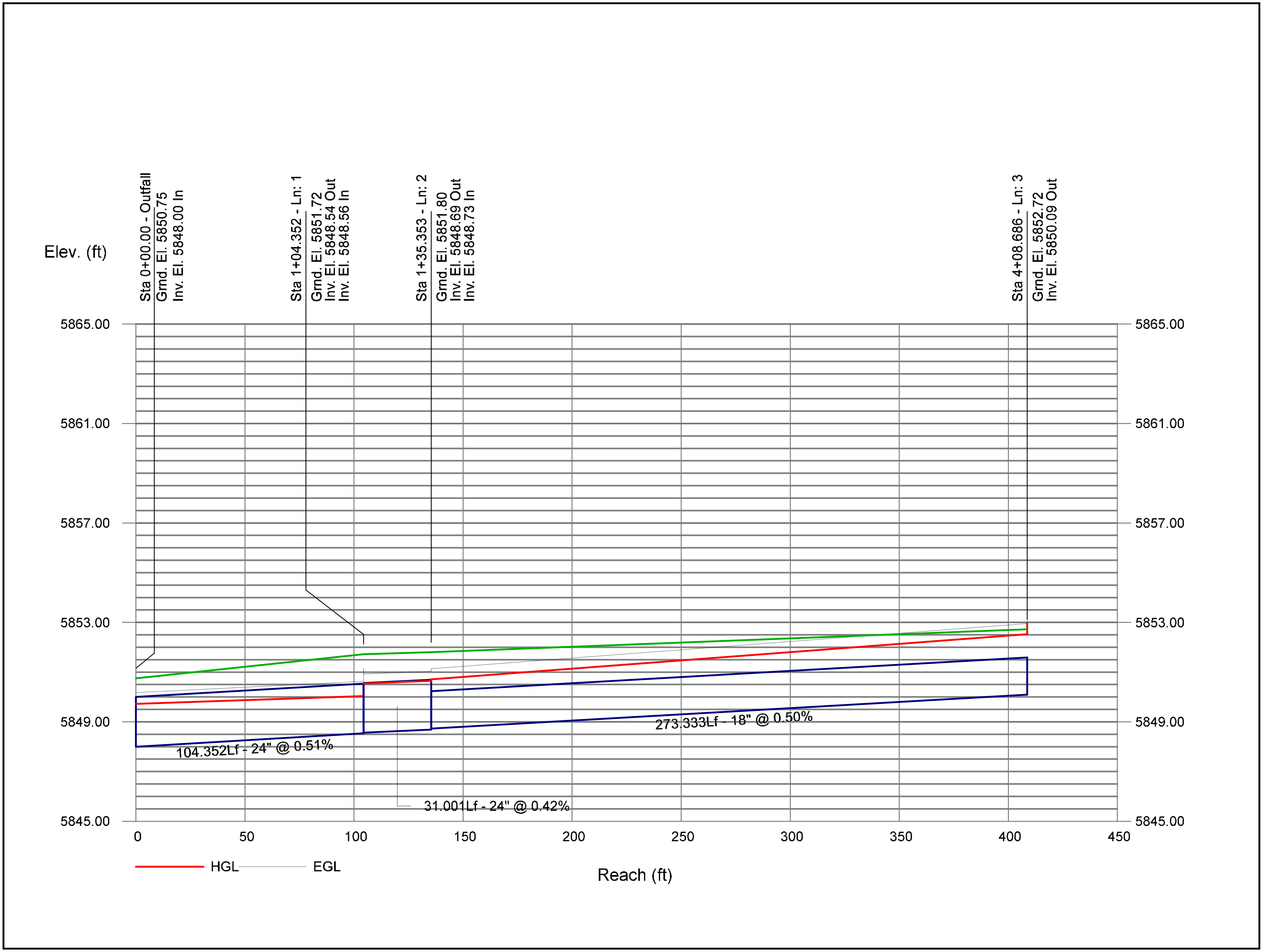
Storm Sewer Profile

Proj. file: Salisbury_Phase1_Storm-5yr.stm



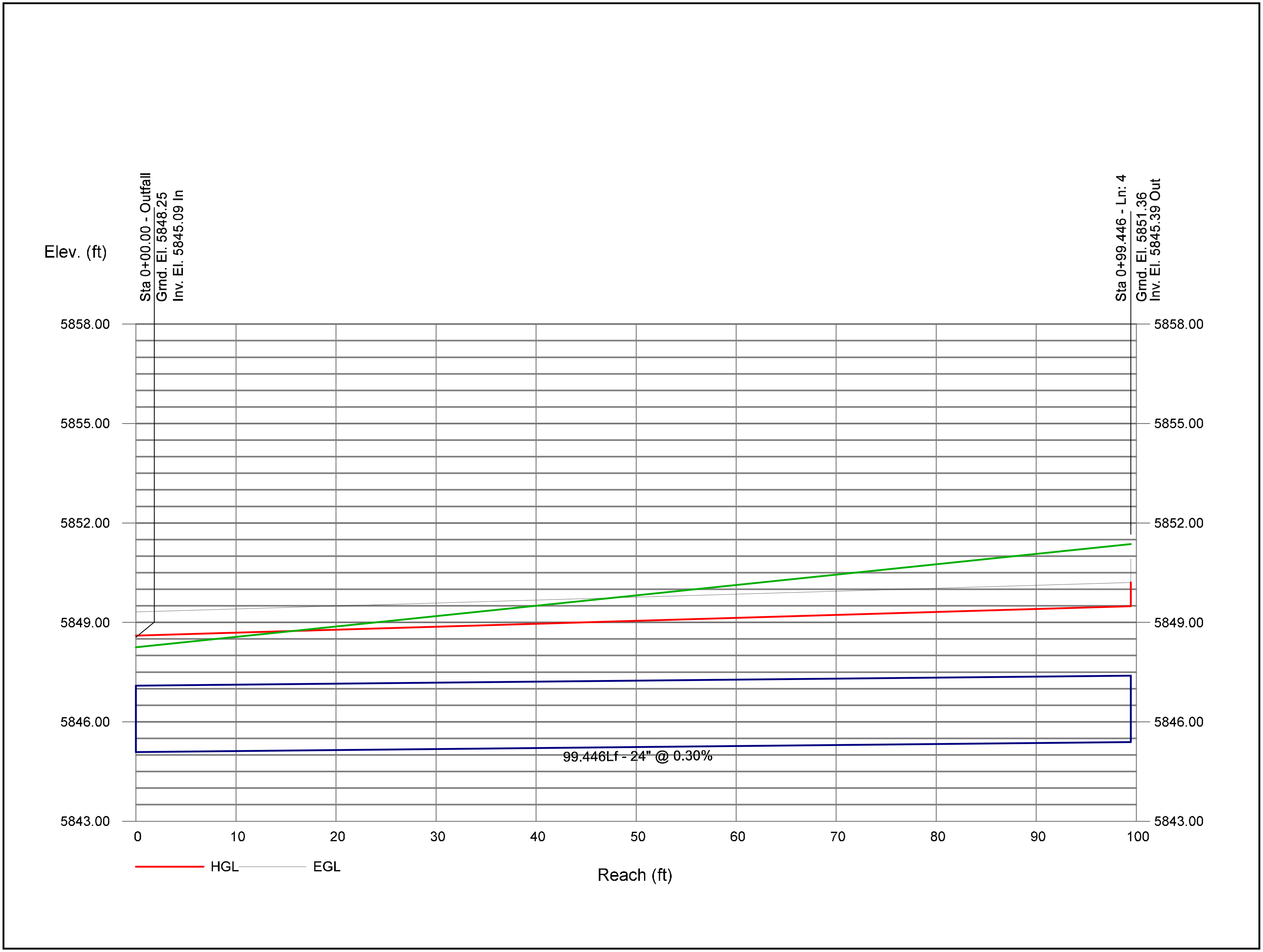
Storm Sewer Profile

Proj. file: Salisbury_Phase1_Storm-100yr.stm



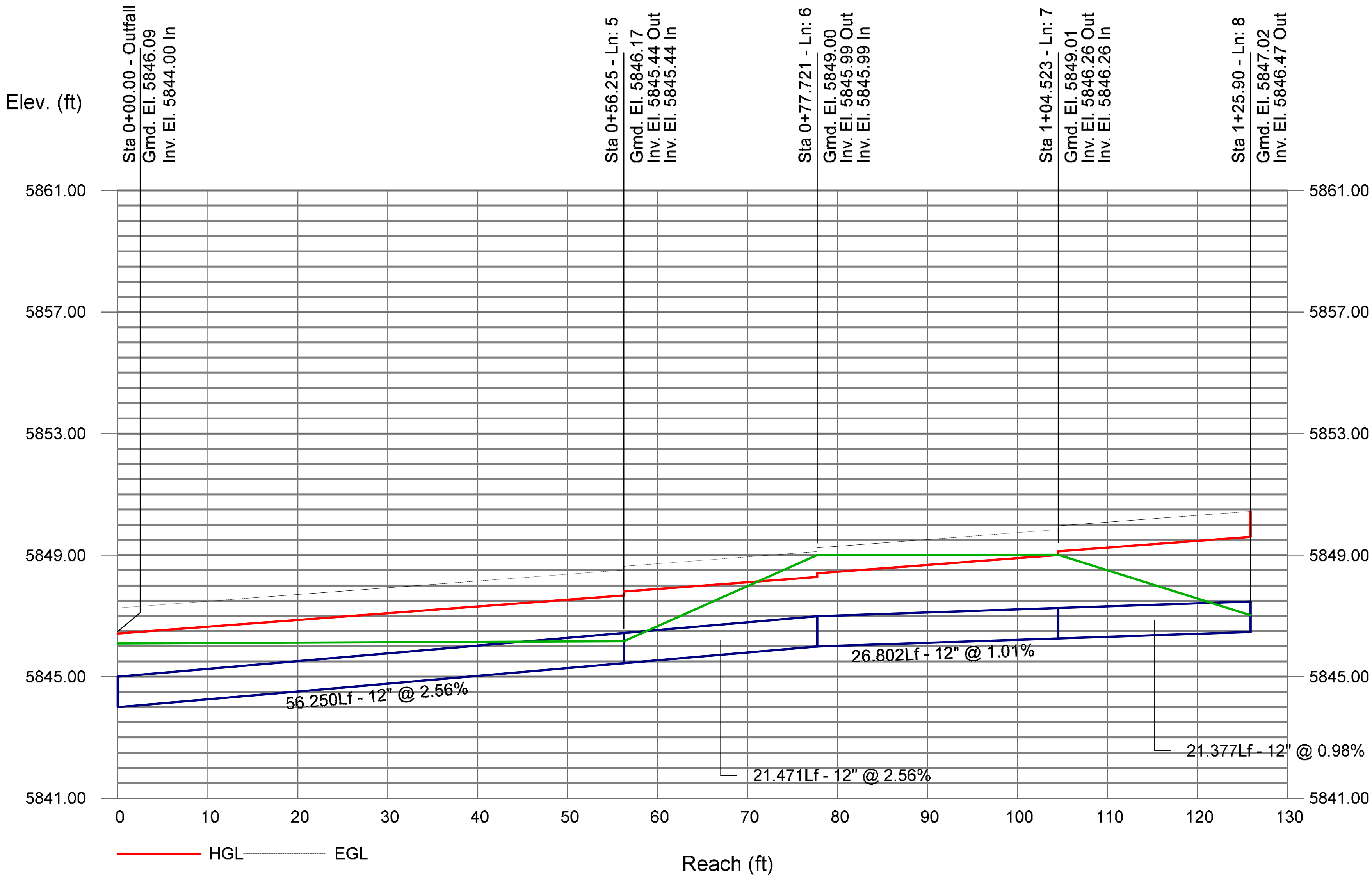
Storm Sewer Profile

Proj. file: Salisbury_Phase1_Storm-100yr.stm



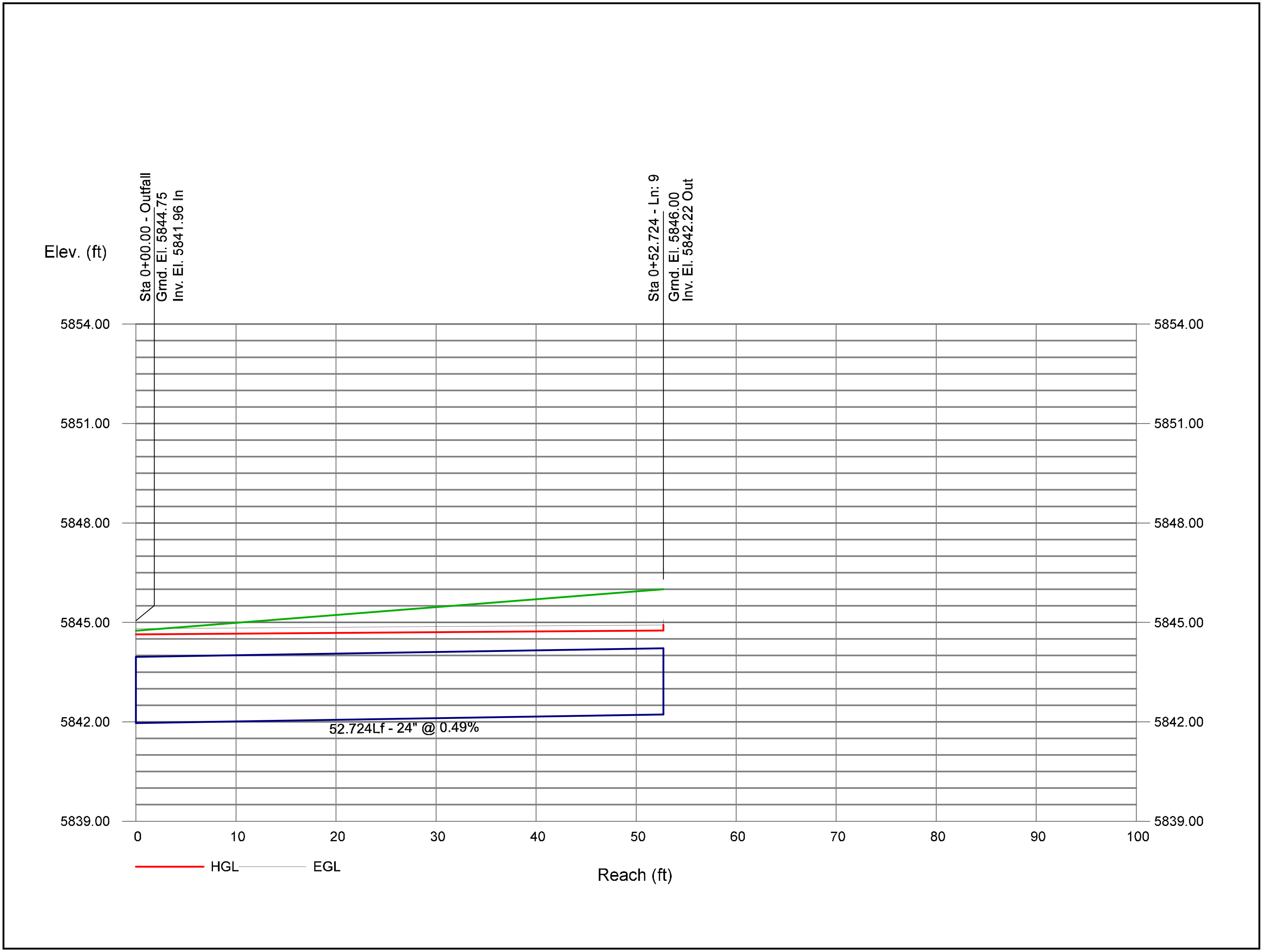
Storm Sewer Profile

Proj. file: Salisbury_Phase1_Storm-100yr.stm



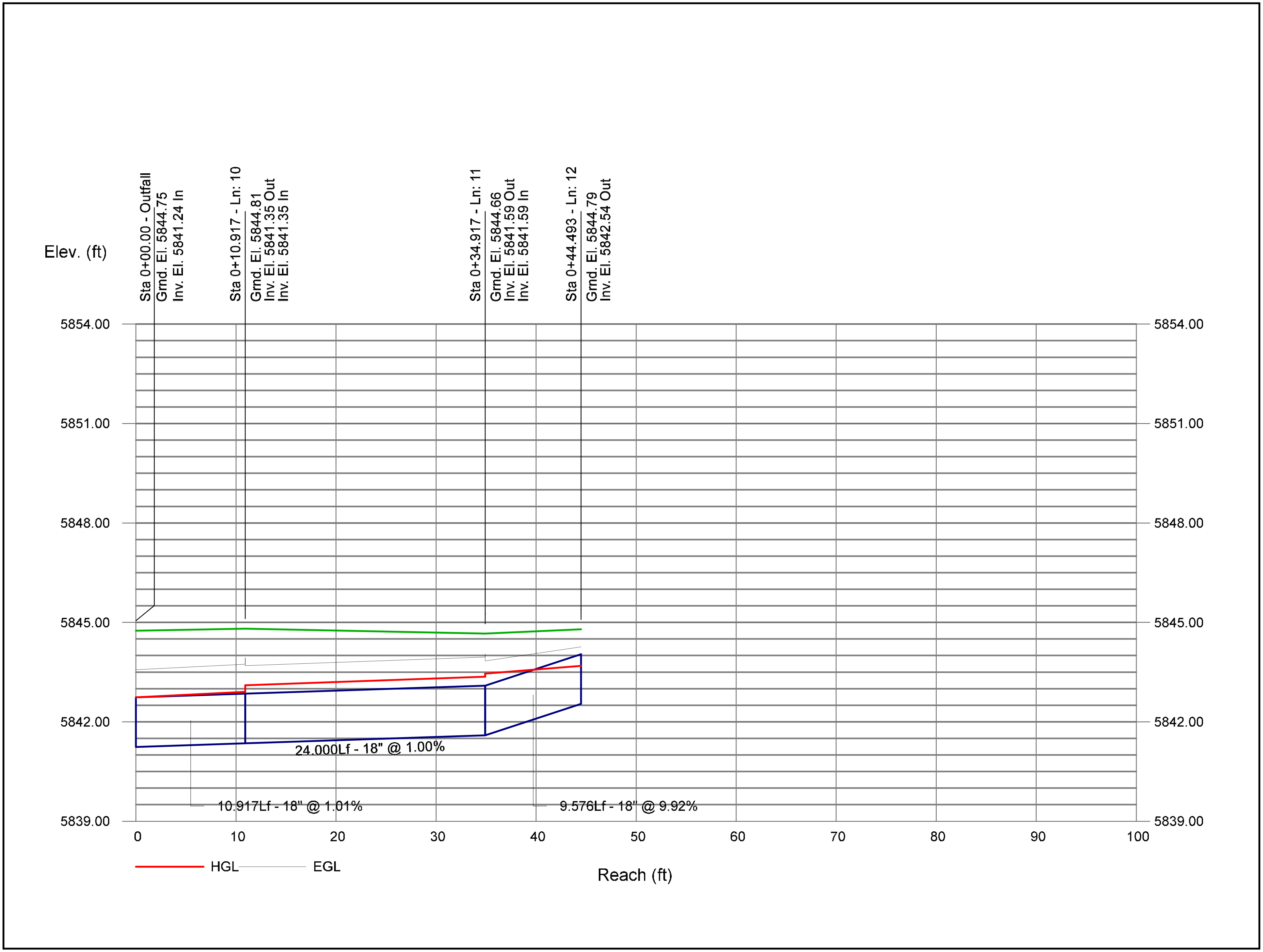
Storm Sewer Profile

Proj. file: Salisbury_Phase1_Storm-100yr.stm



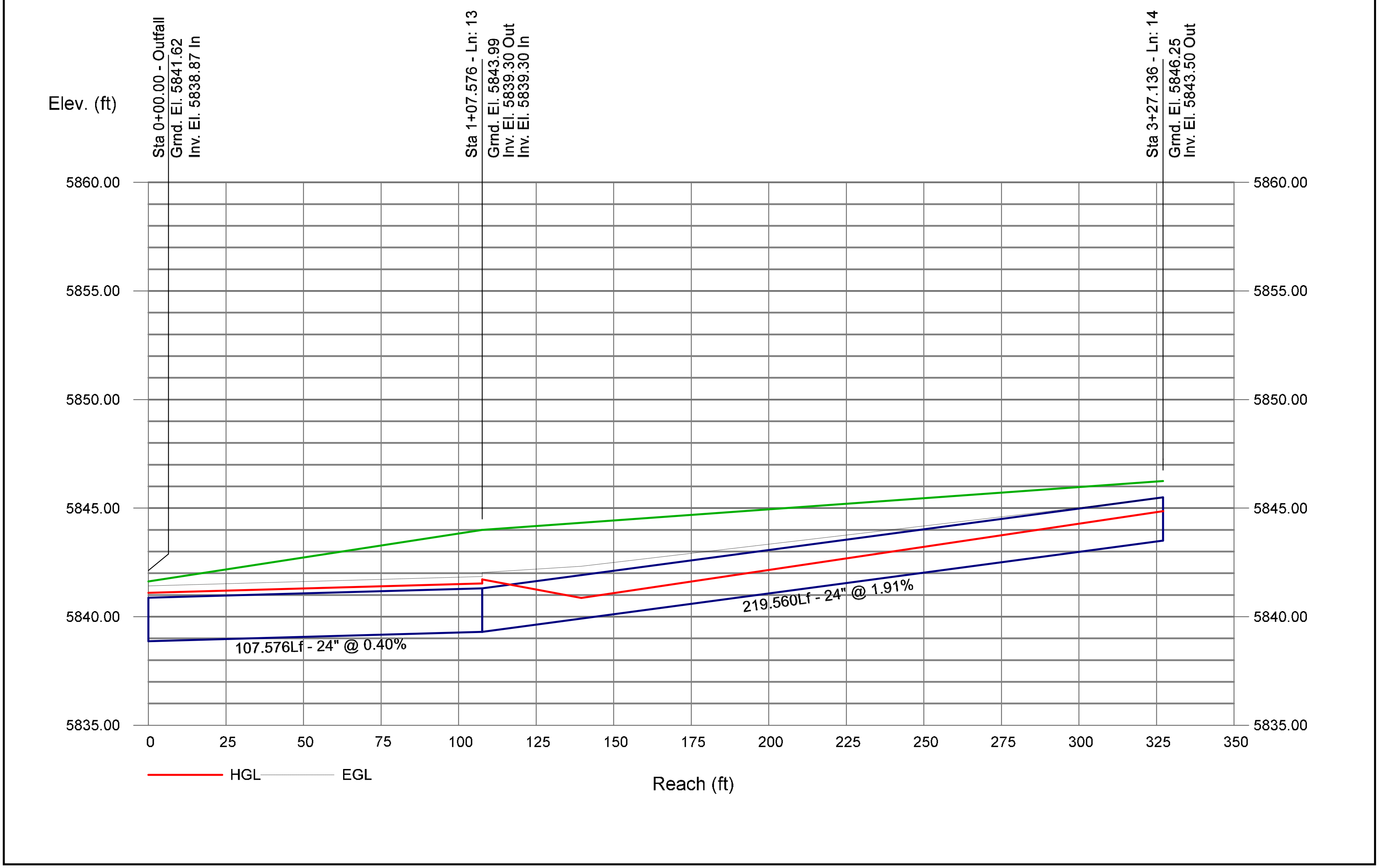
Storm Sewer Profile

Proj. file: Salisbury_Phase1_Storm-100yr.stm

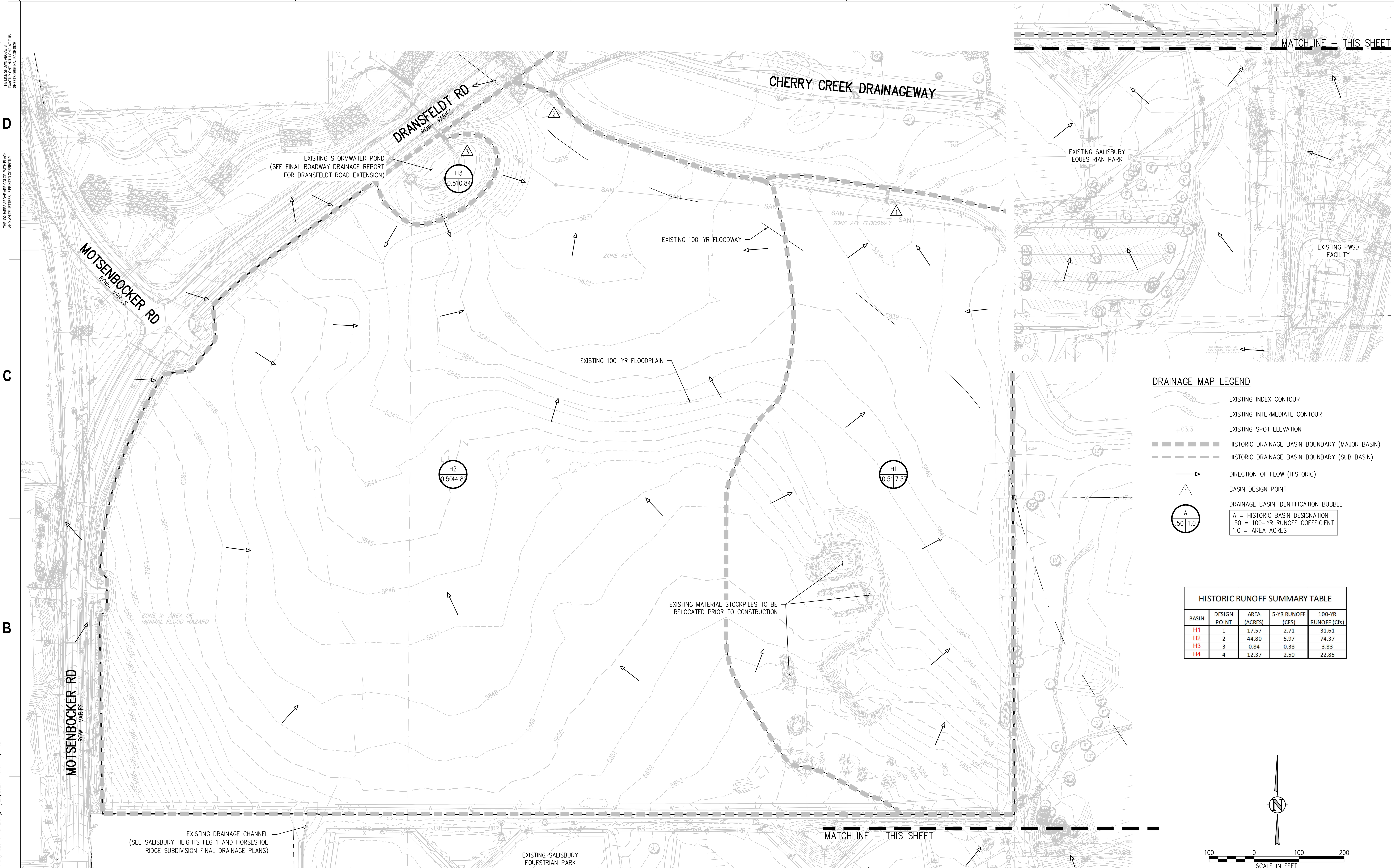


Storm Sewer Profile

Proj. file: Salisbury_Phase1_Storm-100yr.stm



APPENDIX D – MAPPING



HISTORIC RUNOFF SUMMARY TABLE

BASIN	DESIGN POINT	AREA (ACRES)	5-YR RUNOFF (CFS)	100-YR RUNOFF (Cfs)
H1	1	17.57	2.71	31.61
H2	2	44.80	5.97	74.37
H3	3	0.84	0.38	3.83
H4	4	12.37	2.50	22.85

CALL 811 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE OR EXCAVATE FOR MARKING OF UNDERGROUND MEMBER UTILITIES

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LANDSCAPE ARCHITECT / ARCHITECT
1800 Wazee Street, Suite 450
Denver, CO 80202
p. 303.607.0977

CIVIL ENGINEER / STRUCTURAL ENGINEER
JVA Incorporated
1675 Larimer Street, #550
Denver, CO 80202
p. 303.444.1951

ELECTRICAL ENGINEER
Ackerman Engineering, Inc.
3000 Youngfield Street, #264
Wheat Ridge, CO 80215
p. 303.278.7297

IRRIGATION
Avocet Irrigation
11757 W. Ken Caryl Ave., Suite F-509
Littleton, CO 80127
p. 303.986.2175

MECHANICAL ENGINEER
ENVISION Mechanical Engineers, Inc.
9777 Pyramid Court, #260
Englewood, CO 80112
p. 303.688.0223

Town of Parker
SALISBURY PARK NORTH - PHASE 1
11700 MOTSENBOCKER RD
PARKER, CO 80134

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ARCHITECTURE
LANDSCAPE ARCHITECTURE
PLANNING
INTERIOR DESIGN

DATE	DESCRIPTION

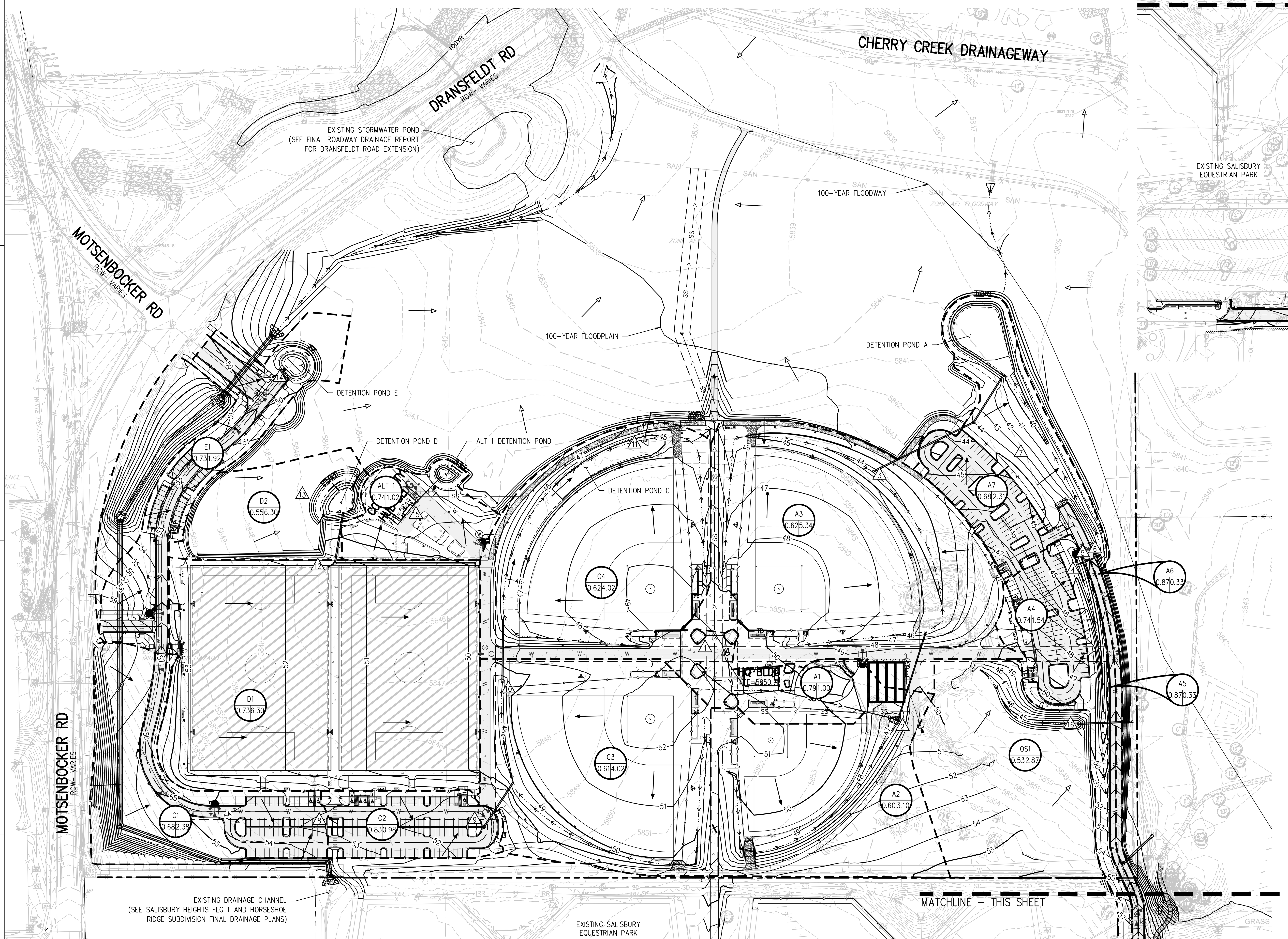
Project Number:	223072.00
Sheet Issue Date:	2024-11-22
Drawn By:	AMF/MGG/MJS
Checked By:	WTP/CWK/CFG

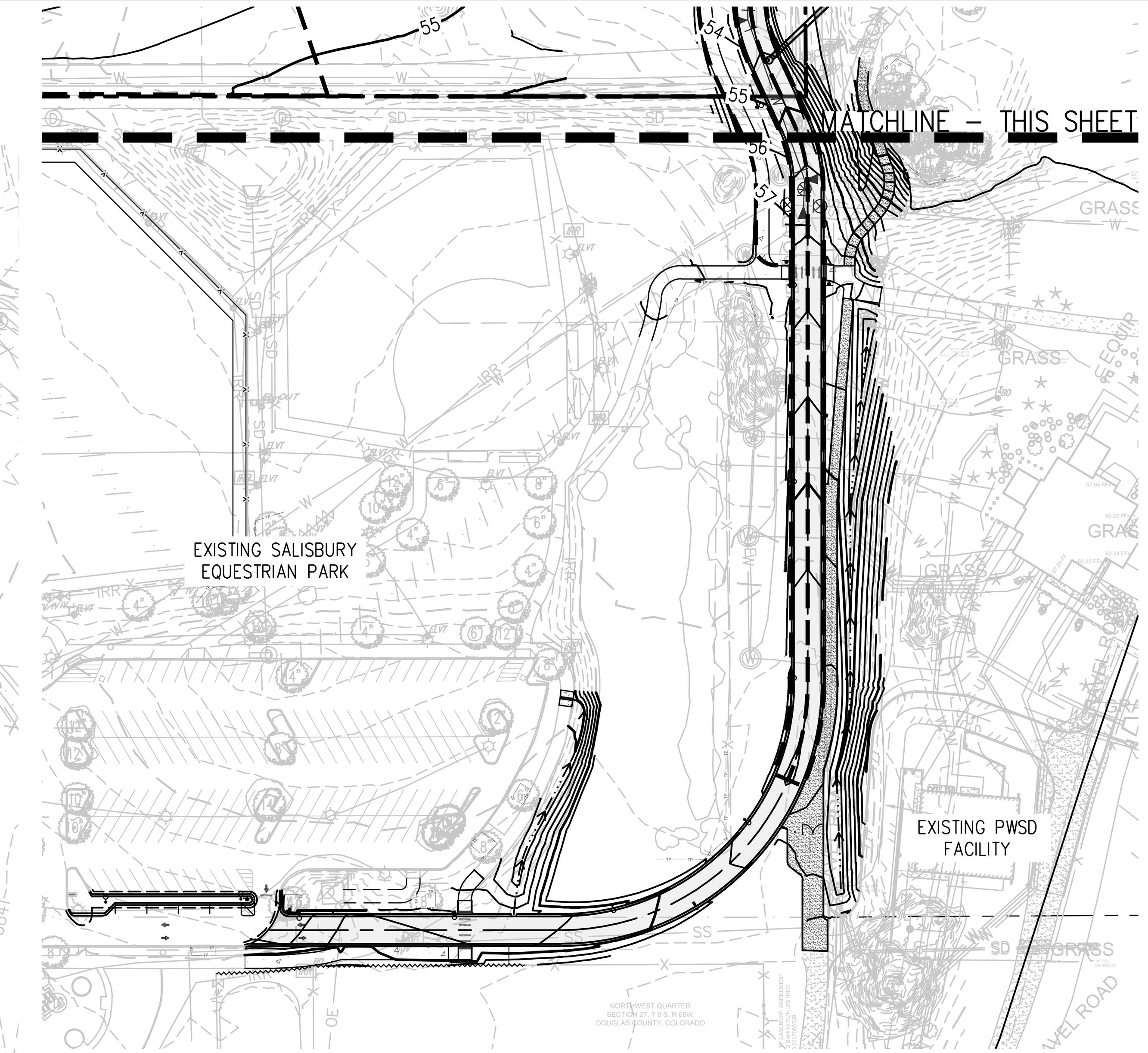
Key Map

Drawing
HISTORIC DRAINAGE MAP

FIG. 1

SITE PLAN SUBMITTAL





DRAINAGE MAP LEGEND

- EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- EXISTING SPOT ELEVATION
- PROPOSED SPOT ELEVATION
- HISTORIC DRAINAGE BASIN BOUNDARY (MAJOR BASIN)
- HISTORIC DRAINAGE BASIN BOUNDARY (SUB BASIN)
- DEVELOPED DRAINAGE BASIN BOUNDARY (MAJOR BASIN)
- DEVELOPED DRAINAGE BASIN BOUNDARY (SUB BASIN)
- DIRECTION OF FLOW (HISTORIC)
- DIRECTION OF FLOW (DEVELOPED)
- OVERFLOW PATH
- BASIN DESIGN POINT
- DRAINAGE BASIN IDENTIFICATION BUBBLE

A = DEVELOPED BASIN DESIGNATION
.50 = 100-YR RUNOFF COEFFICIENT
1.0 = AREA ACRES

DEVELOPED RUNOFF SUMMARY TABLE

BASIN	DESIGN POINT	AREA (ACRES)	5-YR RUNOFF (CFS)	100-YR RUNOFF (Cfs)
A1	1	1.00	3.04	6.96
A2	2	3.10	2.06	8.48
A3	3	5.34	3.78	14.30
A4	4	1.54	3.50	8.81
A5	5	0.33	1.03	2.08
A6	6	0.33	1.01	2.03
A7	7	2.31	2.85	8.54
C1	8	2.38	3.11	9.28
C2	9	0.98	2.92	6.30
C3	10	4.02	2.40	9.83
C4	11	4.02	2.70	10.44
D1	12	6.30	8.13	21.37
D2	13	1.40	0.56	3.61
E1	14	1.92	4.04	10.43
ALT 1	15	1.02	2.24	5.76
OS1	16	2.87	0.93	6.91

100 0 100 200
SCALE IN FEET

COLORADO 811
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Project Number: 223072.00
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Drawn By: AMF/MGG/MJS
Checked By: WTP/CWK/CFG

Key Map

Drawing
DEVELOPED PHASE 1 DRAINAGE MAP

FIG. 2.1

SITE PLAN SUBMITTAL

Q:\3752c - Salisbury Park North\Drawings\Exhibits-Figures\DRAINAGE MAPS\3752c-01-DPP-01_PHASE 1.dwg, 11/20/2024 - 1:49 PM, KAM