

**LILLY RUN WETLAND ENHANCEMENT**

**FINAL ENGINEERING REPORT:**  
**HYDROLOGY AND HYDRAULICS**

Report Prepared for:

**HAVRE DE GRACE DEPARTMENT OF  
PUBLIC WORKS**

Report Prepared by:

**AECOM**

4 North Park Drive

Hunt Valley, MD 21074

(August 2017)



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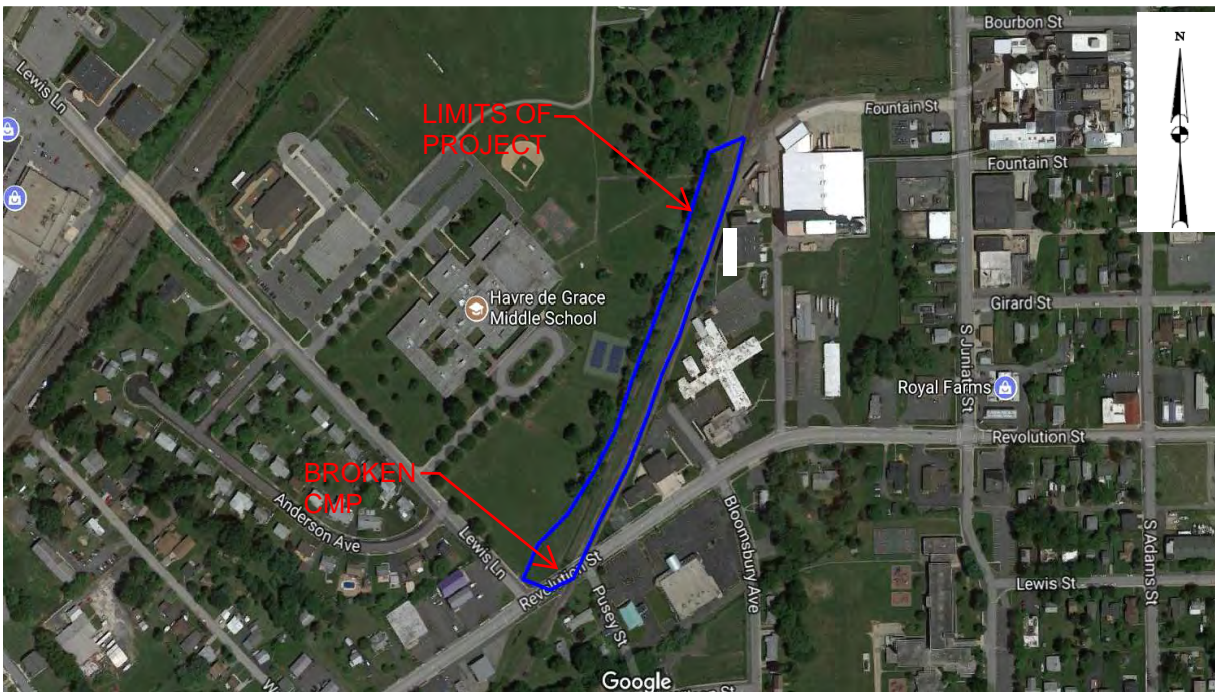
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# APPENDICES

TR-55 and HECRAS Analysis.....Appendix A  
Soil Map..... Appendix B  
Drainage Area Map..... Appendix C  
FEMA Flood Insurance Rate Map.....Appendix D  
Storage and Pollutant Removal Calculations..... Appendix E

## I. INTRODUCTION

As Phase I of a comprehensive Lilly Run Improvement Plan, the city of Havre de Grace Department of Public Works is proposing a wetland seepage system that will satisfy water quality treatment standards and provide effective surface conveyance along with slope and outfall stabilization. There will be increased storage and capacity, enhanced wetland vegetation and improved aquatic passage and habitat. The design includes wetland pools of varying shape and volume which will capture several low points where ponding has historically occurred. The combination of bioretention soil mix lining the banks and stream bed material lining the bottom of the channel will promote infiltration. The introduction of pools and wetland plant material will result in the removal of suspended particles and their associated nutrients and pollutants. The vicinity map below shows the project location.



Vicinity Map-Lilly Run Wetland Enhancement

Other components of the design include removing and replacing the broken CMP which outfalls to the existing ditch and realigning the asphalt path at the northern end of the project to allow for wide wetland pools. This design will result in a net removal of 0.01 acres of impervious surface.

## II. METHODOLOGY

### Hydrologic and Hydraulic Analysis

Drainage area and land uses were determined using aerial mapping, Harford County Geographic Information System (GIS) topography data, topographic survey, and site investigations. Runoff curve numbers and storm flows were developed using SCS TR-55 analyses procedures. HECRAS was used to model the 10-year water surface elevations for the existing and proposed geometric conditions. Distributed flow data was input to HECRAS to model the computed flow making its way to the channel downstream of the ditch outfall. The proposed conditions add storage and lower water surface elevations throughout the entire reach.

TR-55 and HECRAS analysis and results can be found in **Appendix A**. Drainage area summary table can be found below in Table 1. Soil mapping for the site was obtained from the National Resources Conservation Service Web Soil Survey and are located in **Appendix B**.

Drainage Summary			
Drainage Area (ac)	Runoff Curve Number	Time of Conc. (hrs)	Q <sub>10</sub> (cfs)
46.1	82	0.74	97

Table 1. Drainage summary for Lilly Run Wetland Enhancement

## III. BACKGROUND

### Land Use

The land use in the vicinity of the project consists of open space, commercial space, roadways, parking lots and low to medium density residential areas. The project is located on the campus of Havre de Grace Middle School. Detailed breakdown of land uses can be found in the TR-55 report, in **Appendix A**.

### Soils

The NRCS Web Soils for Harford County, Maryland was used to determine the hydrologic soil groups (HSG) for this project. The drainage area for the project is underlain primarily by Mattapex silt loam, Othello silt loam, Delanco silt loam and Elsinboro loam which are hydrologic soil group (HSG) type C and C/D soils. The portion of the project where land will be disturbed is underlain by Othello silt loam. There are no highly erodible soils in the project area. Three soil borings have been completed along the project site, they can be found in **Appendix B**. The proposed soil mixtures, streambed mix and wetland material will provide significant improvements over the C/D soil underlying the project site.

## **Drainage and Watersheds**

The limits of the project are approximately the intersection of Revolution Street and Lewis Lane and 1500 feet northeast of the intersection, along the existing ditch. The site and 46 acre drainage area lie within the Lower Suquenhanna River watershed (MDE 8 digit No. 02-12-02-01). The drainage area map can be found in **Appendix C**.

## **Environmental Features**

The subject site was checked for environmental features using desktop resources along with a site visit. According to “MERLIN – Maryland DNR Environmental Resource and Land Information Network”, the upstream half of the project site is designated as wetlands and the lower half is Waters of the United States. The wetland limits were field verified and are located on the project plans. The 100-year floodplain, according to the FEMA flood insurance rate map in **Appendix D**, impacts the project site at the upstream and downstream limits of the project. The proposed improvements will provide increased capacity and storage, reducing water surface elevations for the 10-year storm. Several trees will need to be removed as the design involves grading the existing ditch into wetland pools of varying width and eliminating several low points where water currently pools instead of flowing to the ditch which can be seen in the **Figure 1** below. Wetland planting plans have been developed and compensate for the removal of existing trees with proposed plantings more appropriate for a wetland setting.



**Figure 1. Facing up stream on the Lilly Run tributary ditch**

## **Utilities**

A storm drain system, collecting runoff through curb opening inlets, exists beneath Revolution St, outfalling at the start of the existing ditch from a damaged CMP. There is an underground telephone line near the existing ditch at approximately Station 15+70. The contractor will test pit the utility prior to any grading in the vicinity.

## Existing Treatment

There are no existing water quality facilities within the project limits. About 46 acres of land drain by sheet flow and a storm drain network beneath Revolution St which outfalls into an existing swale. The swale is, on average, 1.5 feet deep and 10 feet wide and is filled with brush and woody debris. A site photo can be seen below in Figure 2.



Figure 2. Facing downstream on the Lilly Run tributary ditch

## IV. Quality Control

The proposed wetland enhancement system will vary in width; have 4:1 or flatter side slopes and longitudinal slope less than 1%. The channel will have rock weirs to provide stable surface storage. A 1.5' deep stream bed mix will be located under the length of the channel. The proposed system will treat the 10 year storm and provide storage greater than the environmental site design volume. Nitrogen, phosphorus and suspended solid loads will be reduced by 56%, 65% and 70%, respectively. See **Appendix E** for calculations on storage and TMDL pollutant removal.



## **V. Erosion and Sediment Control Design**

This project will be constructed from upstream to downstream using erosion and sediment control measures approved by Harford Soil Conservation District. Silt fence, pump arounds and filter bags will be used to prevent sedimentation and minimize erosion. All E&S operations will follow the standard Harford County sediment control notes.

## **VI. Conclusion**

The Lilly Run Wetland Enhancement will provide several functional and environmental improvements to the existing ditch by increasing water storage, flow capacity and improving wetland habitat. In addition to those benefits, this project will serve as an educational opportunity for Havre de Grace Middle School to learn about the importance of wetlands in a coastal setting.

# APPENDIX A

WinTR-55 Current Data Description

--- Identification Data ---

User: Mark L Date: 8/9/2017  
 Project: Lilly Run Wetland Enhancement Units: English  
 SubTitle: Areal Units: Acres  
 State: Maryland  
 County: Harford NOAA\_C  
 Filename: U:\Projects\H\HvdGr\60531842\400-Technical\431-Technical Area - SWM\H&H\Lilly\_Run\_TR55\_10yr.w55

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Lilly Run		Outlet	46.08	82	.742
Lilly_EW-1	WS draining to Prop.	EW-1Outlet	30	82	0.742

Total area: 76.08 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.26	4.19	5.0	6.25	7.34	8.58	2.69

Storm Data Source: Harford NOAA\_C County, MD (NRCS)  
 Rainfall Distribution Type: Type II  
 Dimensionless Unit Hydrograph: <standard>

Mark L

Lilly Run Wetland Enhancement  
Harford NOAA\_C County, Maryland

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.26	4.19	5.0	6.25	7.34	8.58	2.69

Storm Data Source: Harford NOAA\_C County, MD (NRCS)  
Rainfall Distribution Type: Type II  
Dimensionless Unit Hydrograph: <standard>

Mark L

Lilly Run Wetland Enhancement  
Harford NOAA\_C County, Maryland  
Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period	
	2-Yr (cfs)	10-Yr (cfs)
-----		
SUBAREAS		
Lilly Run	49.57	97.43
Lilly_EW-1	32.27	63.44
REACHES		
OUTLET	81.84	160.87

Mark L

Lilly Run Wetland Enhancement

Harford NOAA\_C County, Maryland

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period	
	2-Yr (cfs) (hr)	10-Yr (cfs) (hr)

-----  
SUBAREAS

Lilly Run	49.57 12.34	97.43 12.33
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Lilly_EW-1	32.27 12.34	63.44 12.33
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REACHES

OUTLET	81.84	160.87
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Mark L

Lilly Run Wetland Enhancement

Harford NOAA\_C County, Maryland

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
Lilly Run	46.08	0.742	82	Outlet	
Lilly_EW-1	30.00	0.742	82	Outlet	WS draining to Prop. EW-1
Total Area:	76.08 (ac)				

Mark L

Lilly Run Wetland Enhancement

Harford NOAA\_C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
-----							
Lilly Run							
SHEET	100	0.0050	0.150				0.282
SHALLOW	1729	0.0050	0.050				0.421
SHALLOW	200	0.0050	0.025				0.039
CHANNEL	1384	0.0050					
						Time of Concentration	.742
							=====
Lilly_EW-1							
User-provided							0.742
						Time of Concentration	0.742
							=====



Mark L

Lilly Run Wetland Enhancement

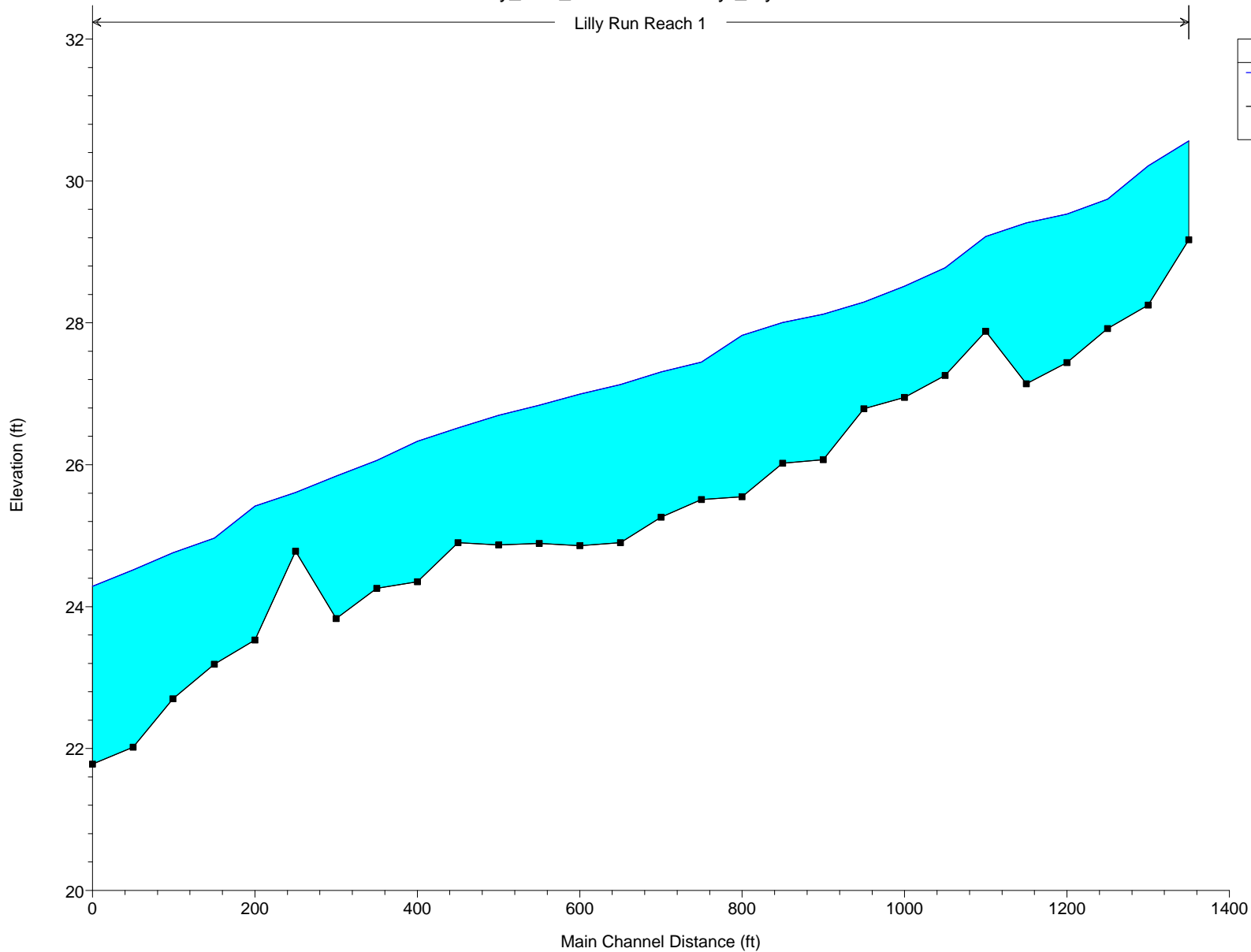
Harford NOAA\_C County, Maryland

Sub-Area Land Use and Curve Number Details

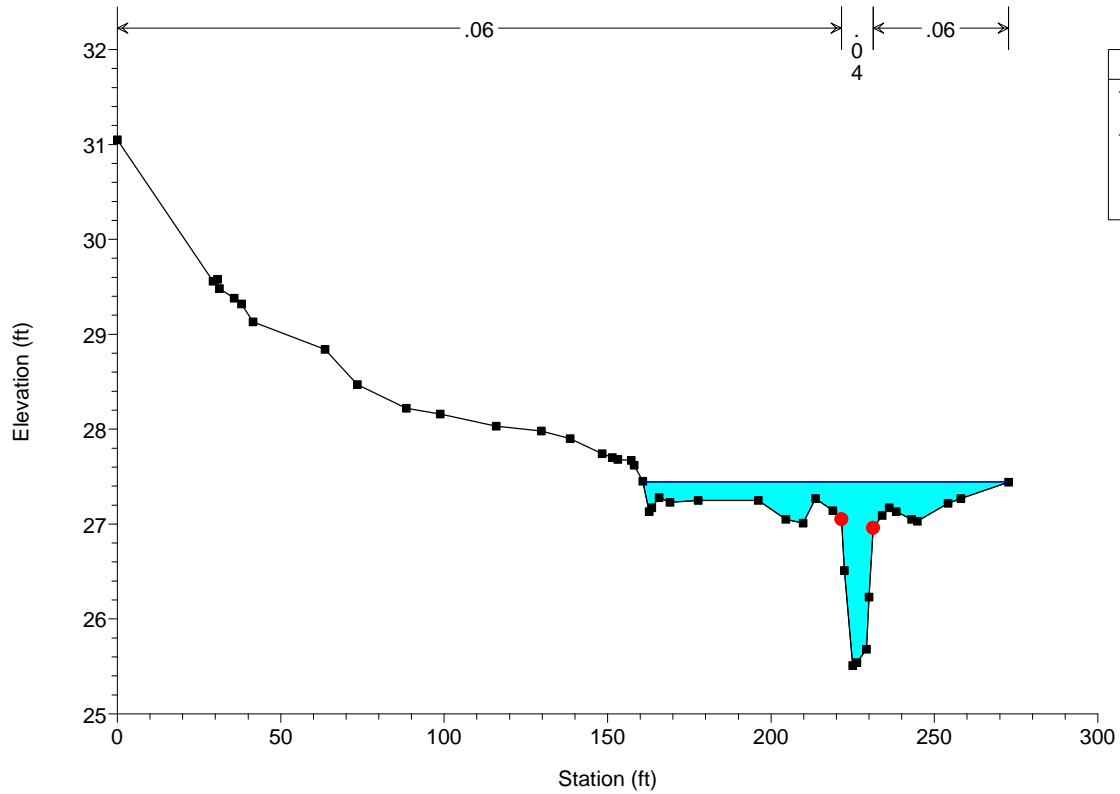
Sub-Area Identifier	Land Use	Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
Lilly Run	Open space; grass cover > 75%	(good) C	14.72	74
	Open space; grass cover > 75%	(good) D	1.92	80
	Paved parking lots, roofs, driveways	C	6.4	98
	Residential districts (1/4 acre)	C	23.68	83
	Total Area / Weighted Curve Number		46.08	82
			=====	==
Lilly_EW-1	Paved; open ditches (w/right-of-way)	B	5	89
	Commercial & business	C	5	94
	Residential districts (1/4 acre)	B	15	75
	Residential districts (1/4 acre)	C	5	83
	Total Area / Weighted Curve Number		30	82
			==	==

Lilly\_Run\_8-1 Plan: 10yr\_lilly 8/9/2017

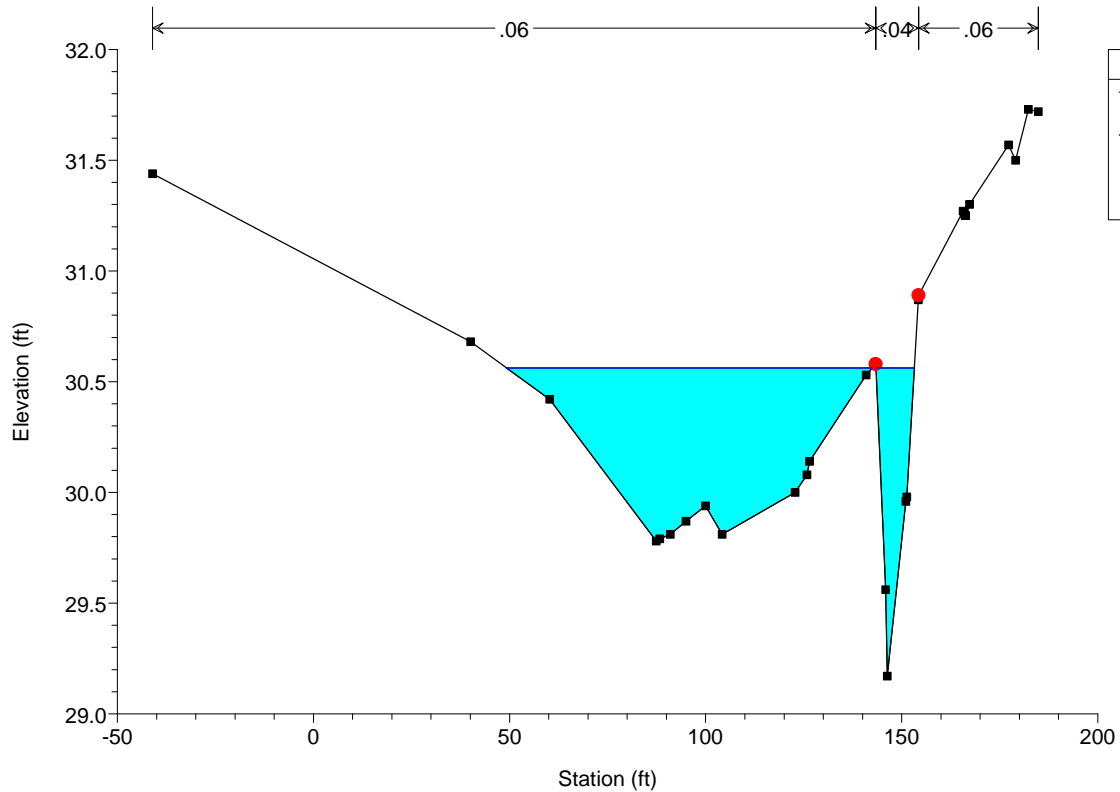
Lilly Run Reach 1

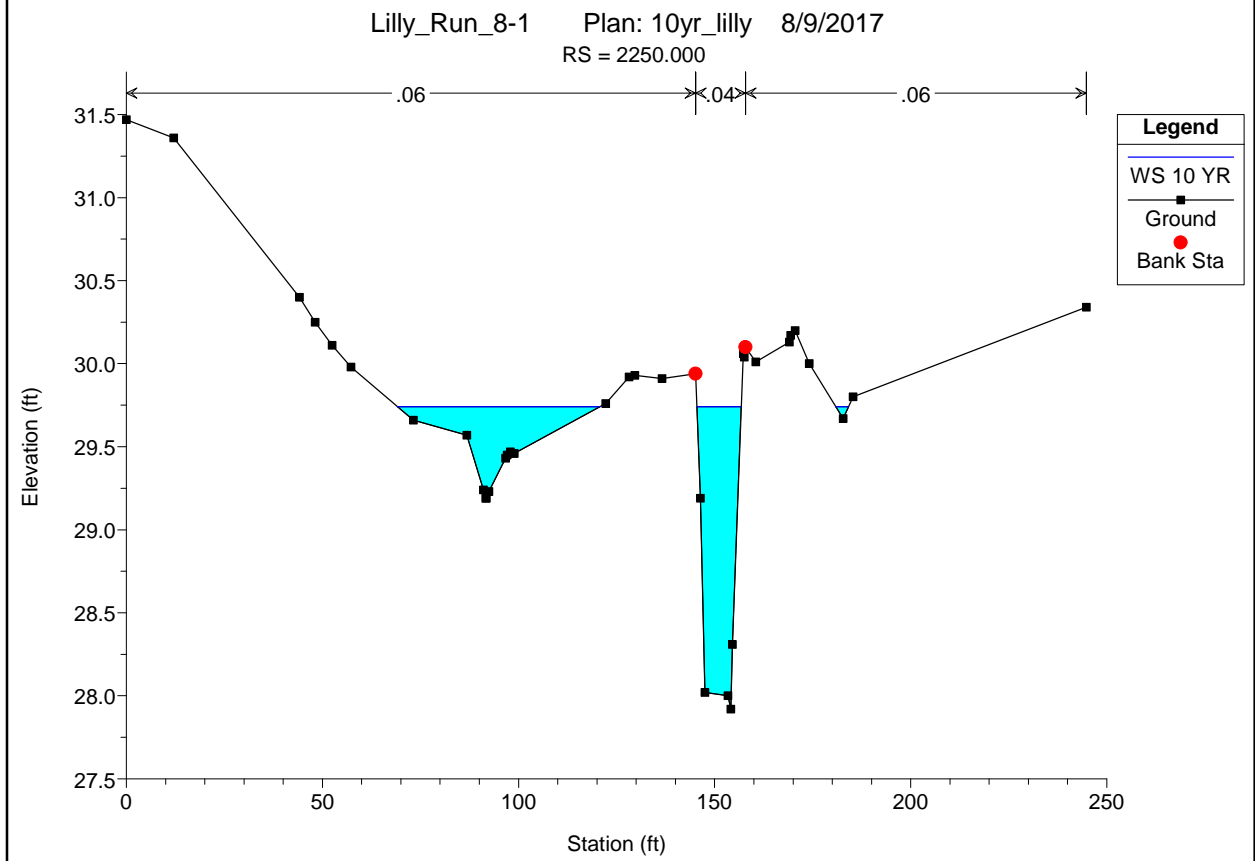
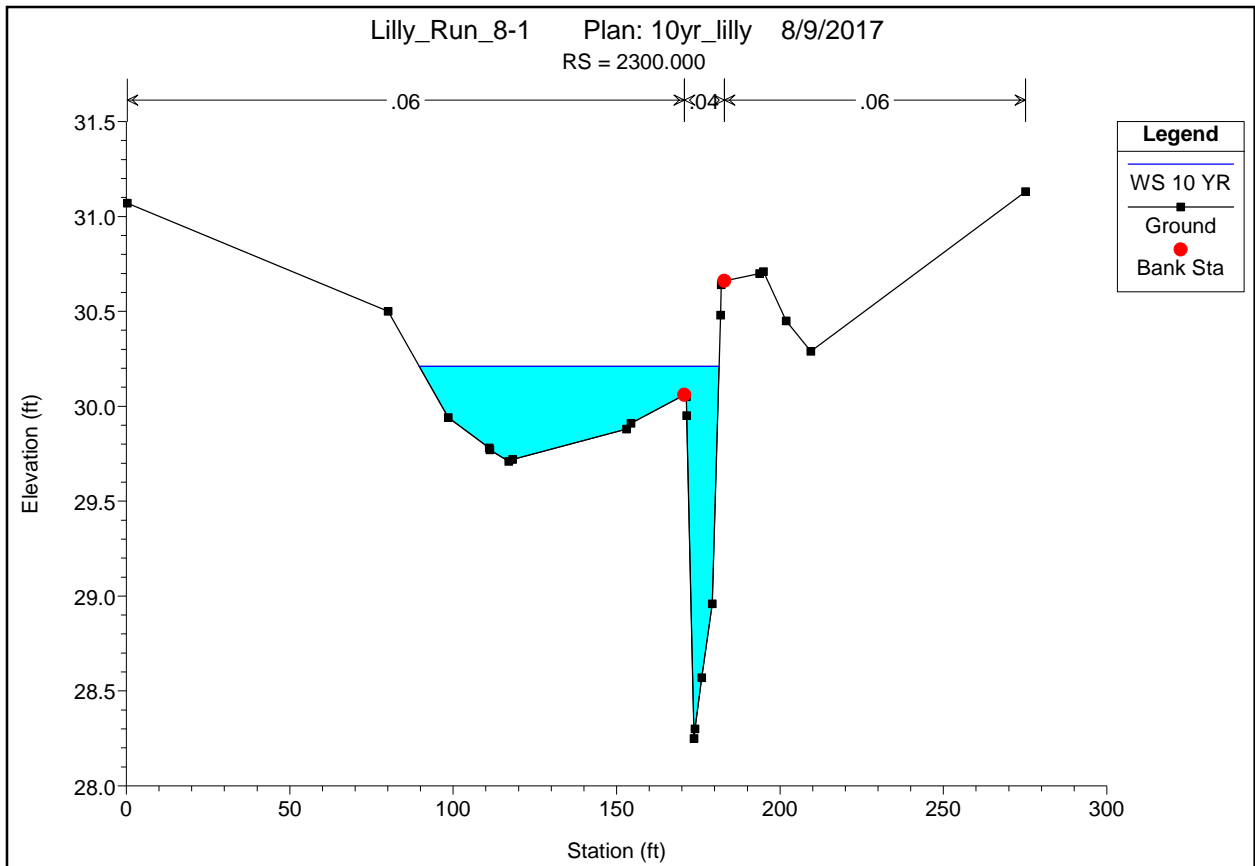


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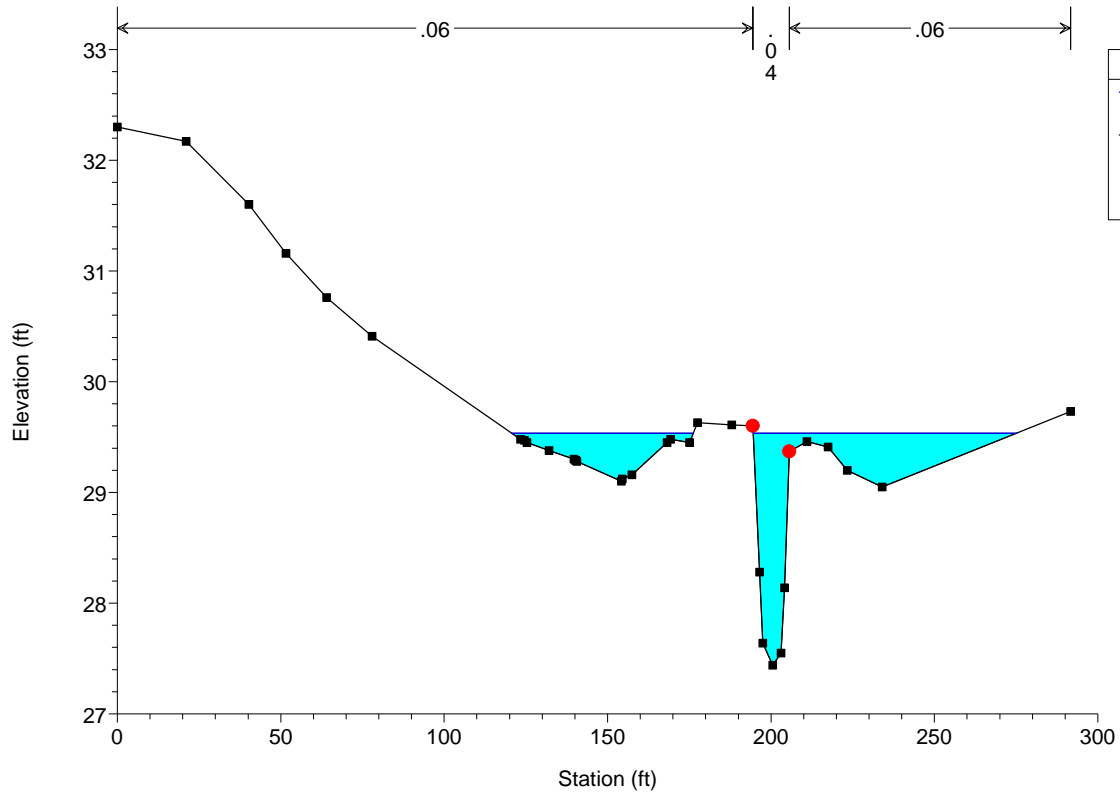


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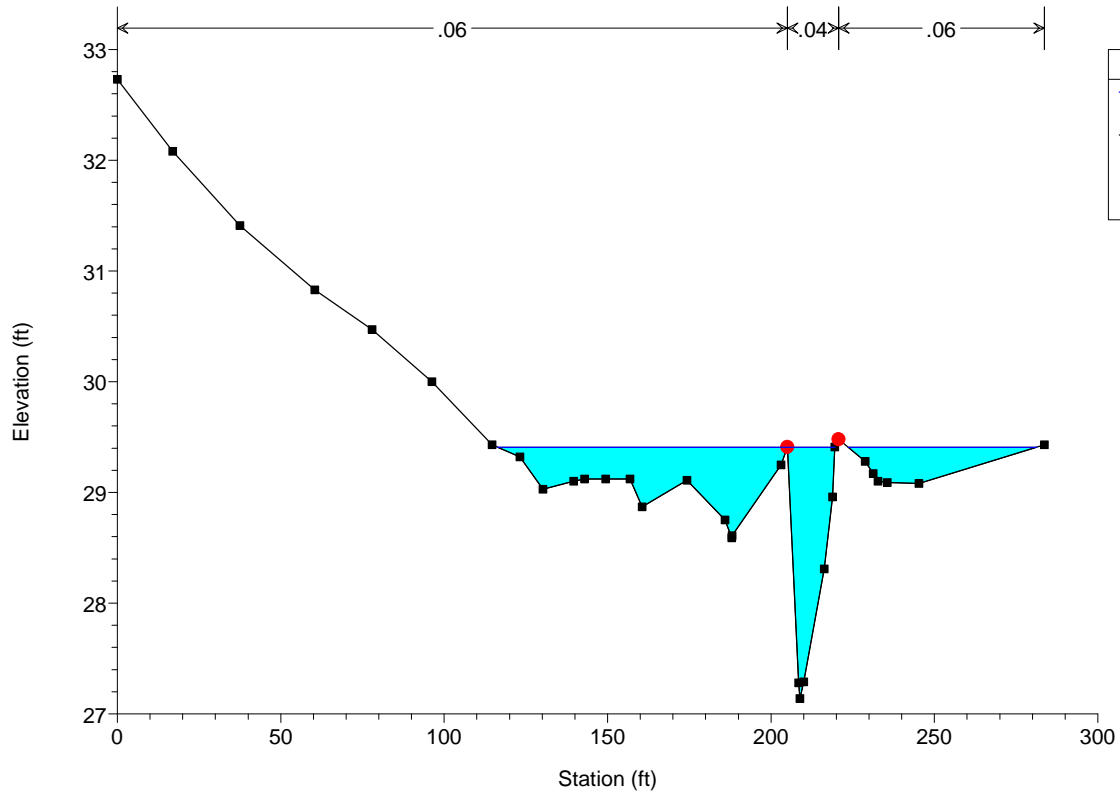


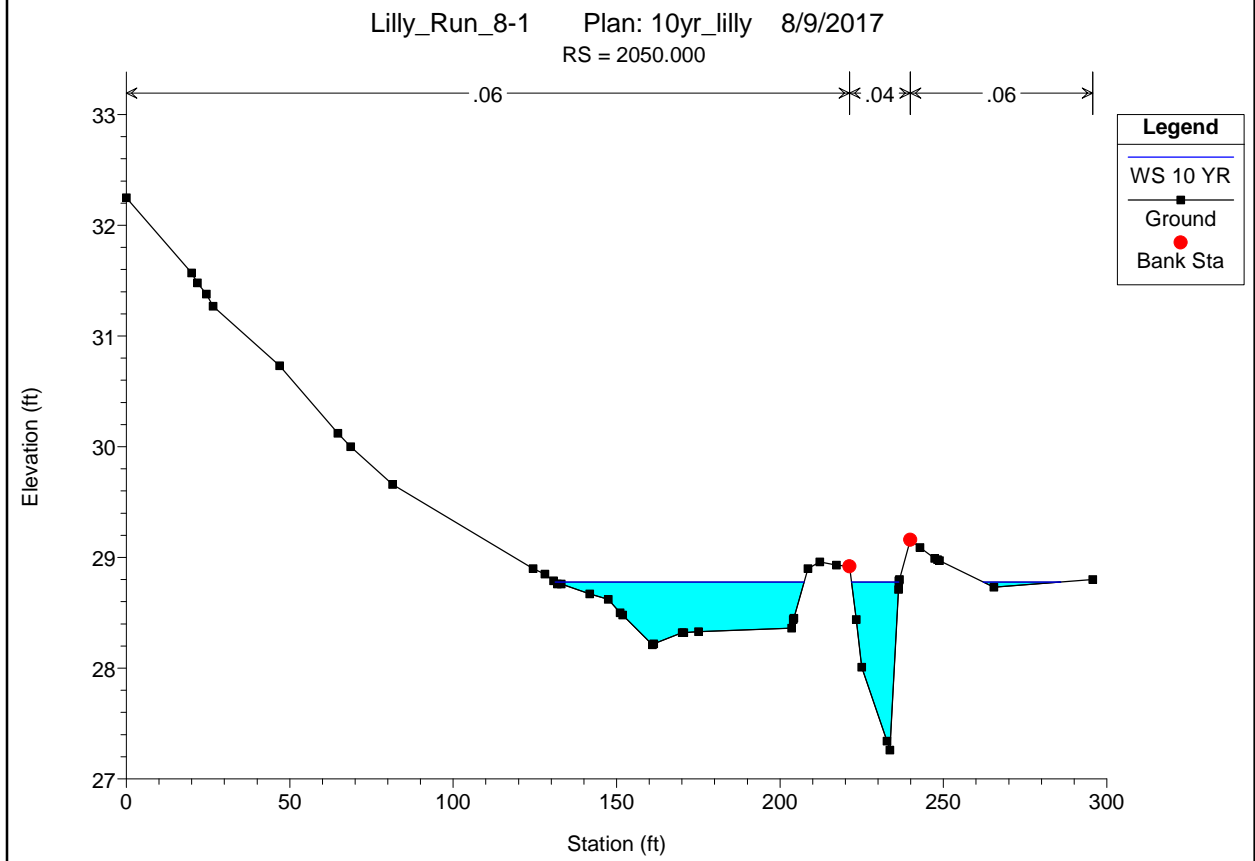
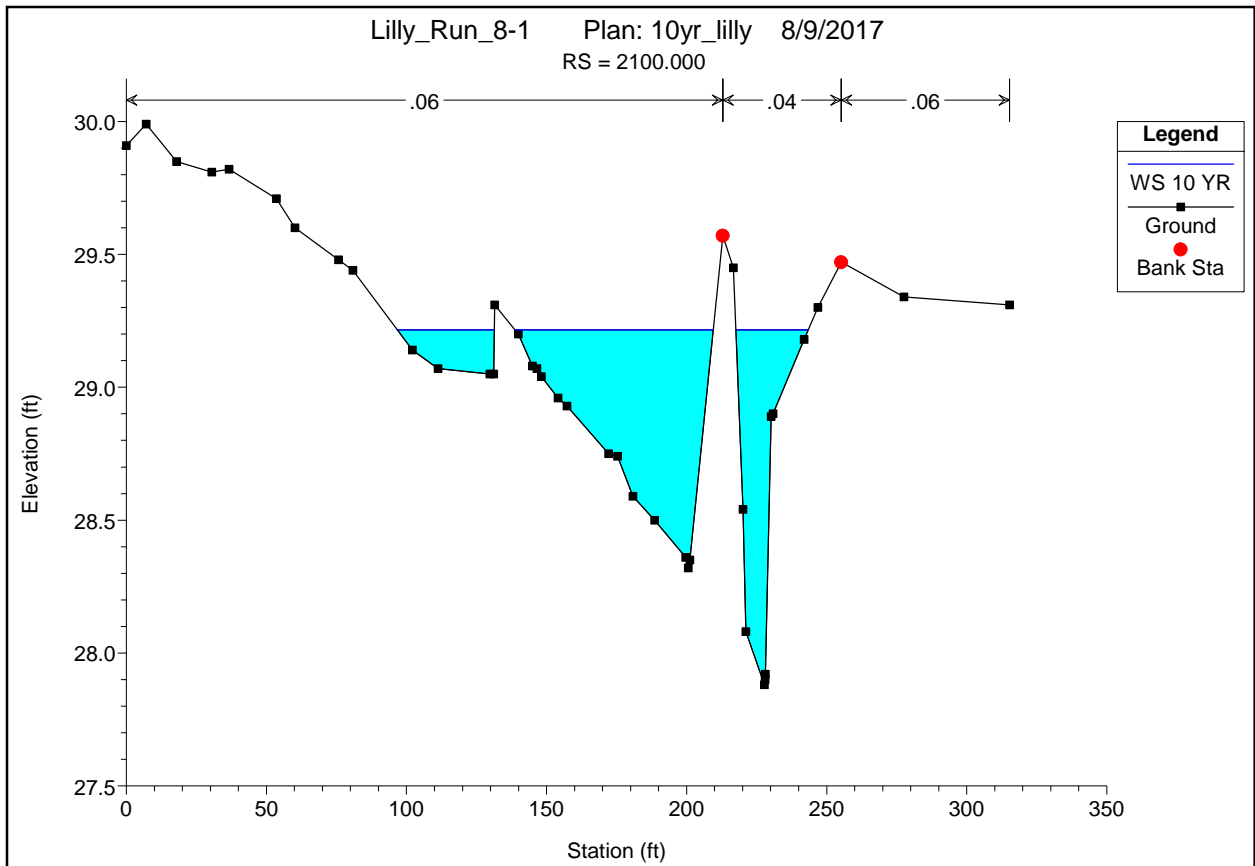


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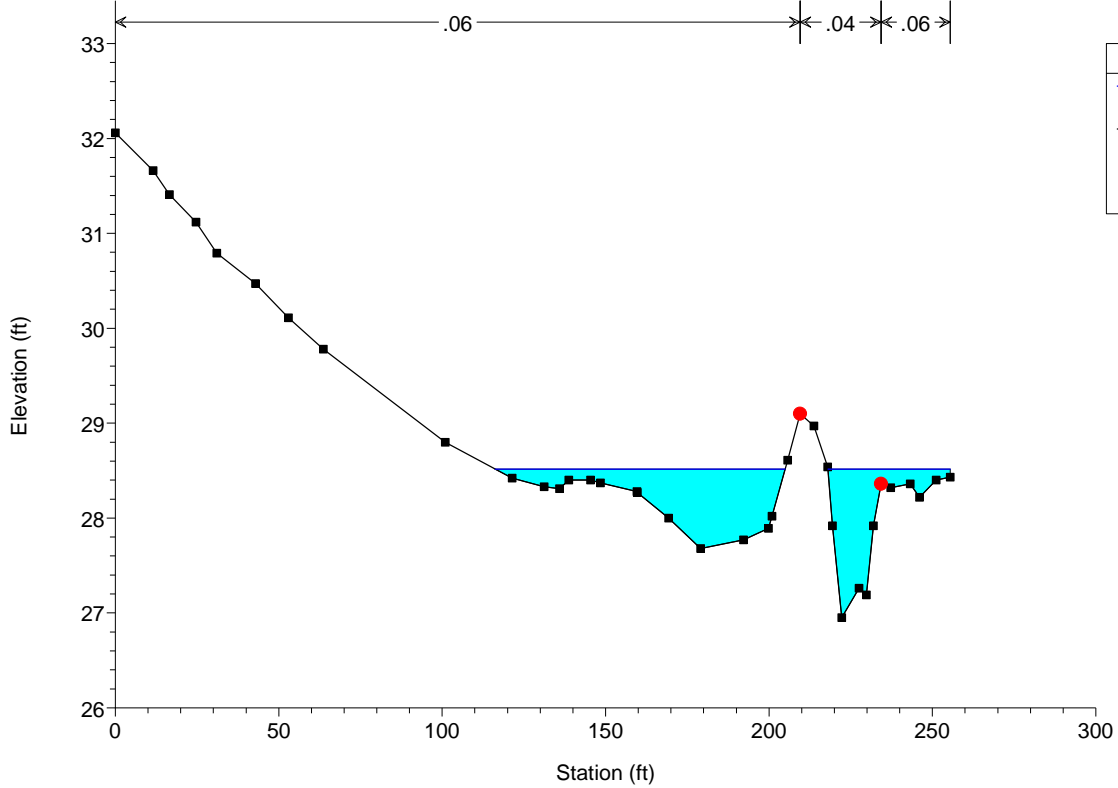


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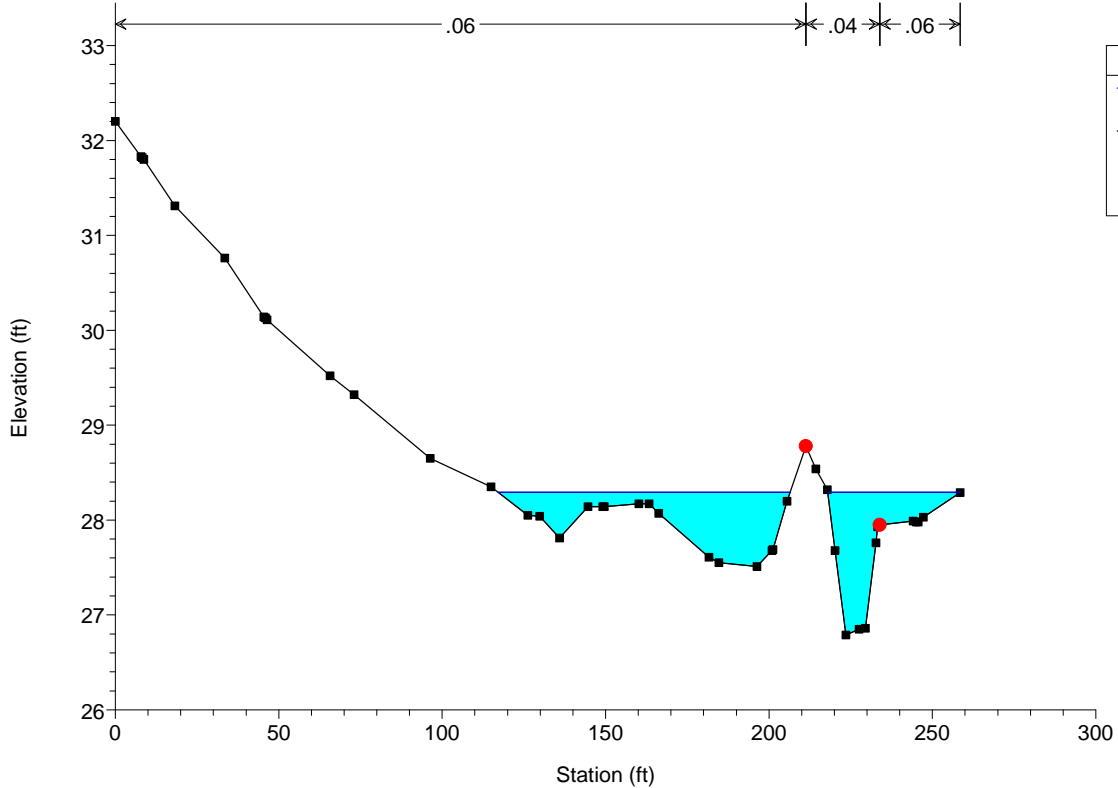




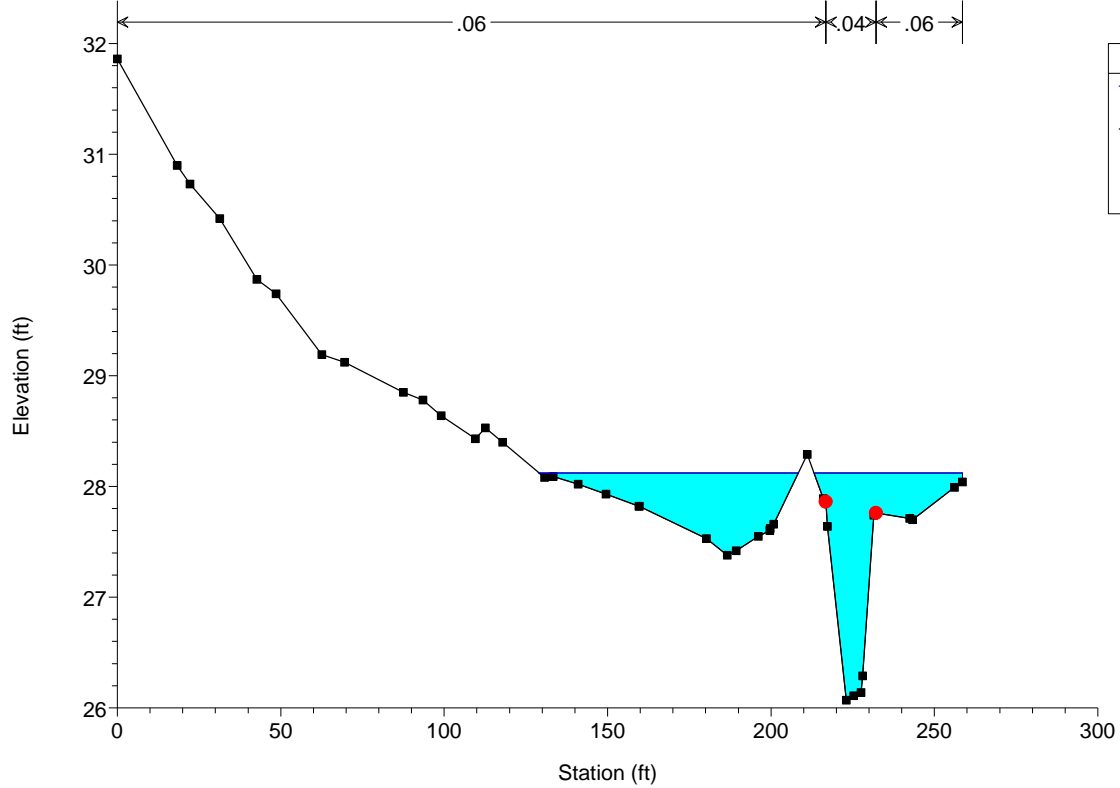
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RS = 2000.000



Lilly\_Run\_8-1 Plan: 10yr\_lilly 8/9/2017  
RS = 1950.000



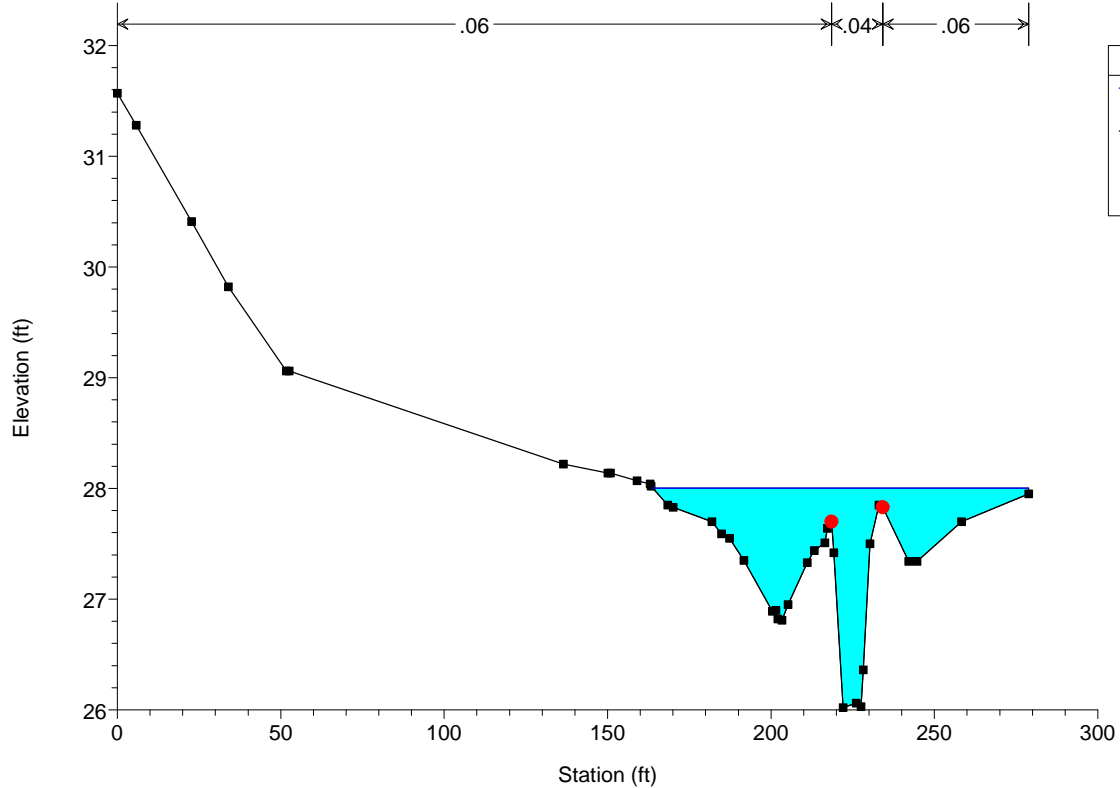
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**Legend**

- WS 10 YR
- Ground
- Bank Sta

Lilly\_Run\_8-1 Plan: 10yr\_lilly 8/9/2017  
RS = 1850.000

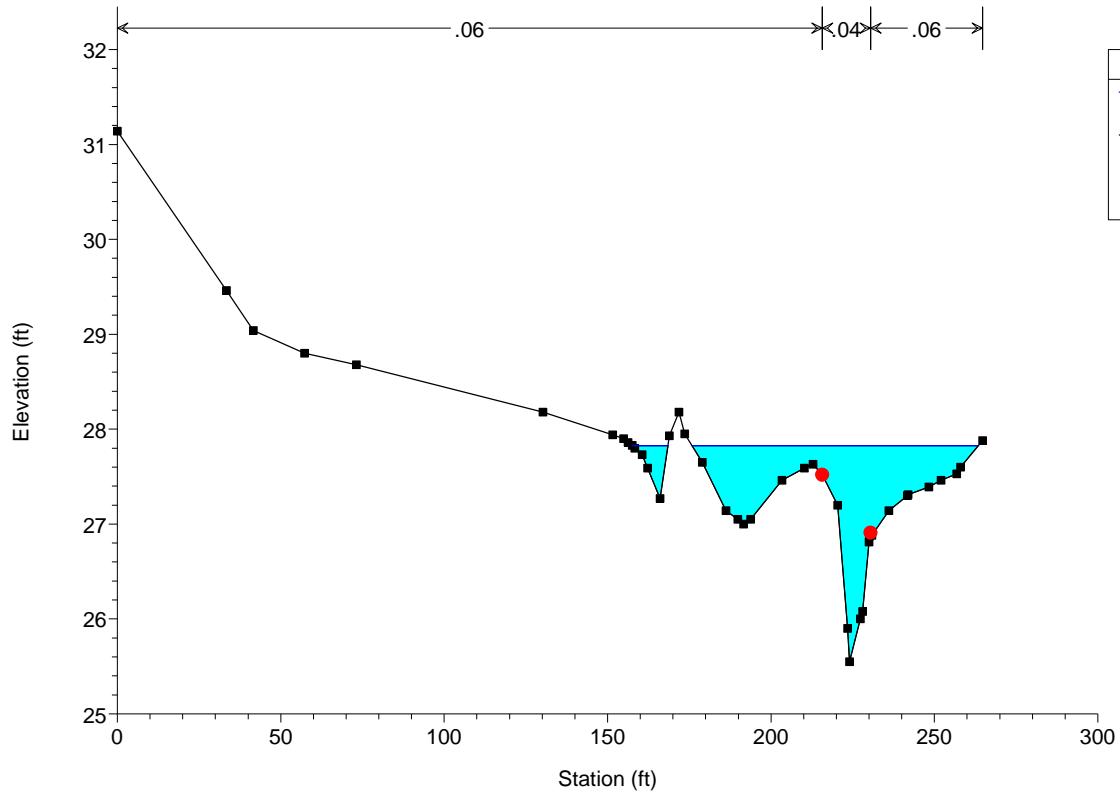


**Legend**

- WS 10 YR
- Ground
- Bank Sta

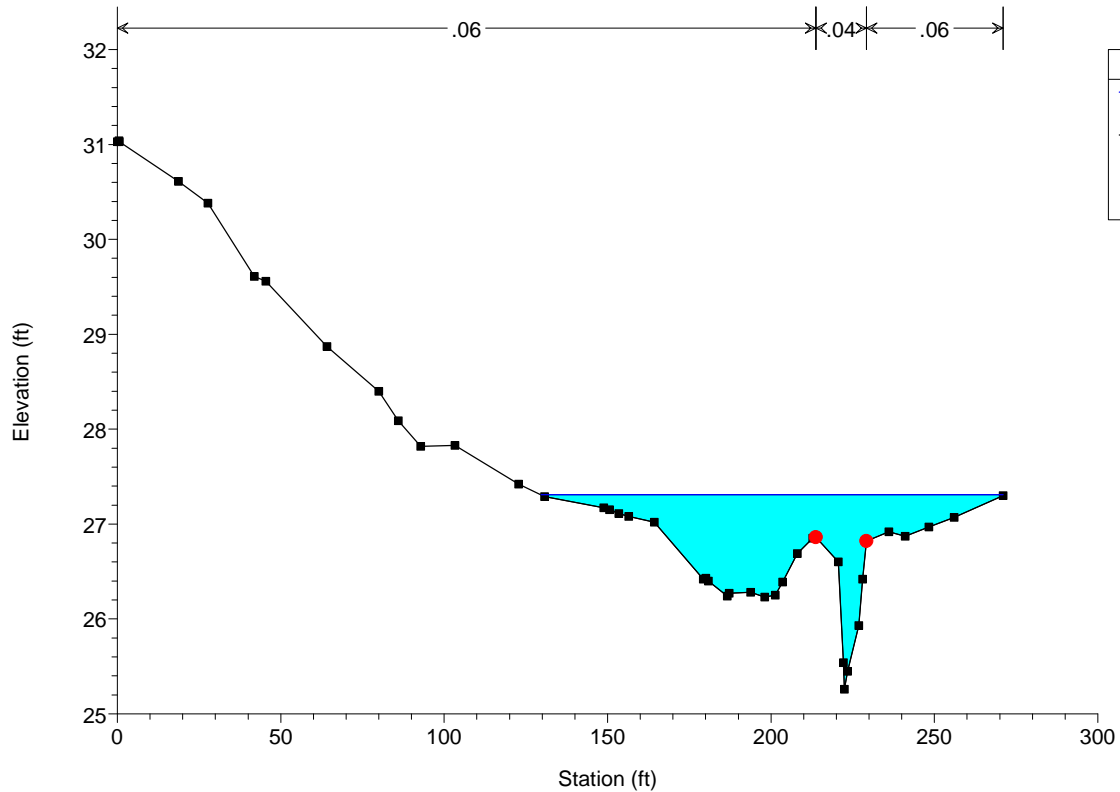


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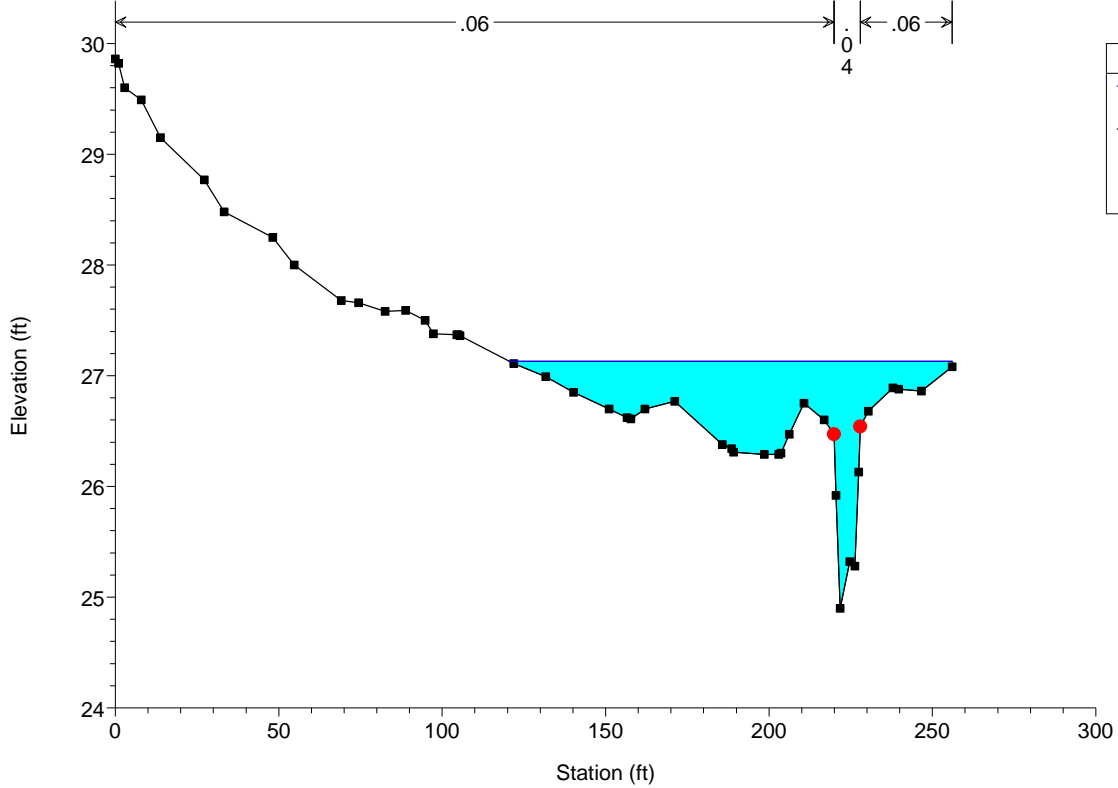
Legend	
WS 10 YR	—
Ground	■
Bank Sta	●

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RS = 1700.000

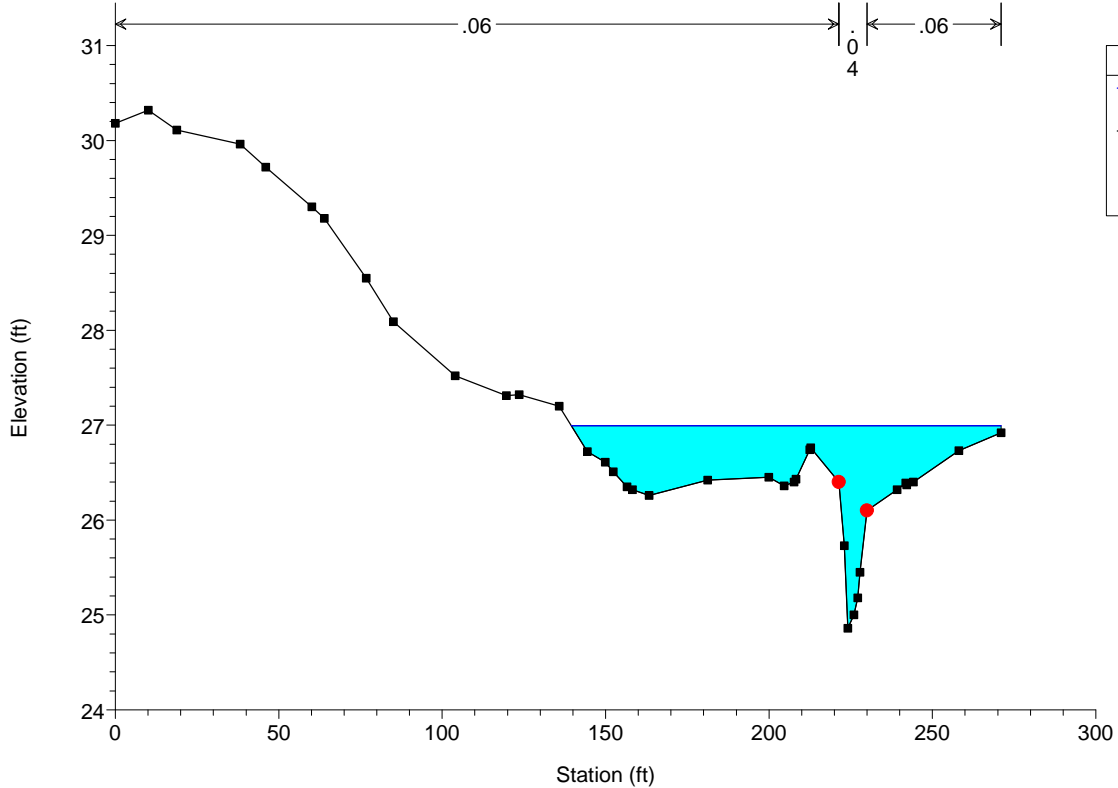


Legend	
WS 10 YR	—
Ground	■
Bank Sta	●

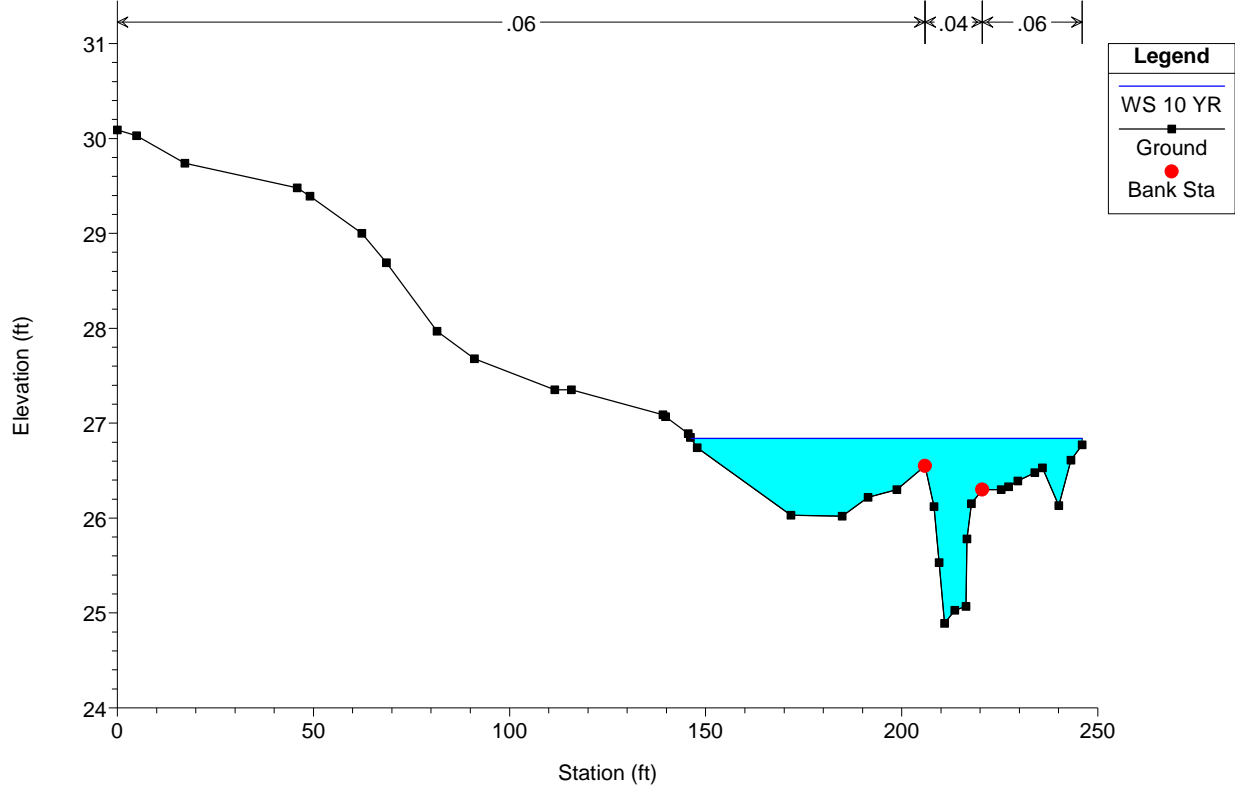
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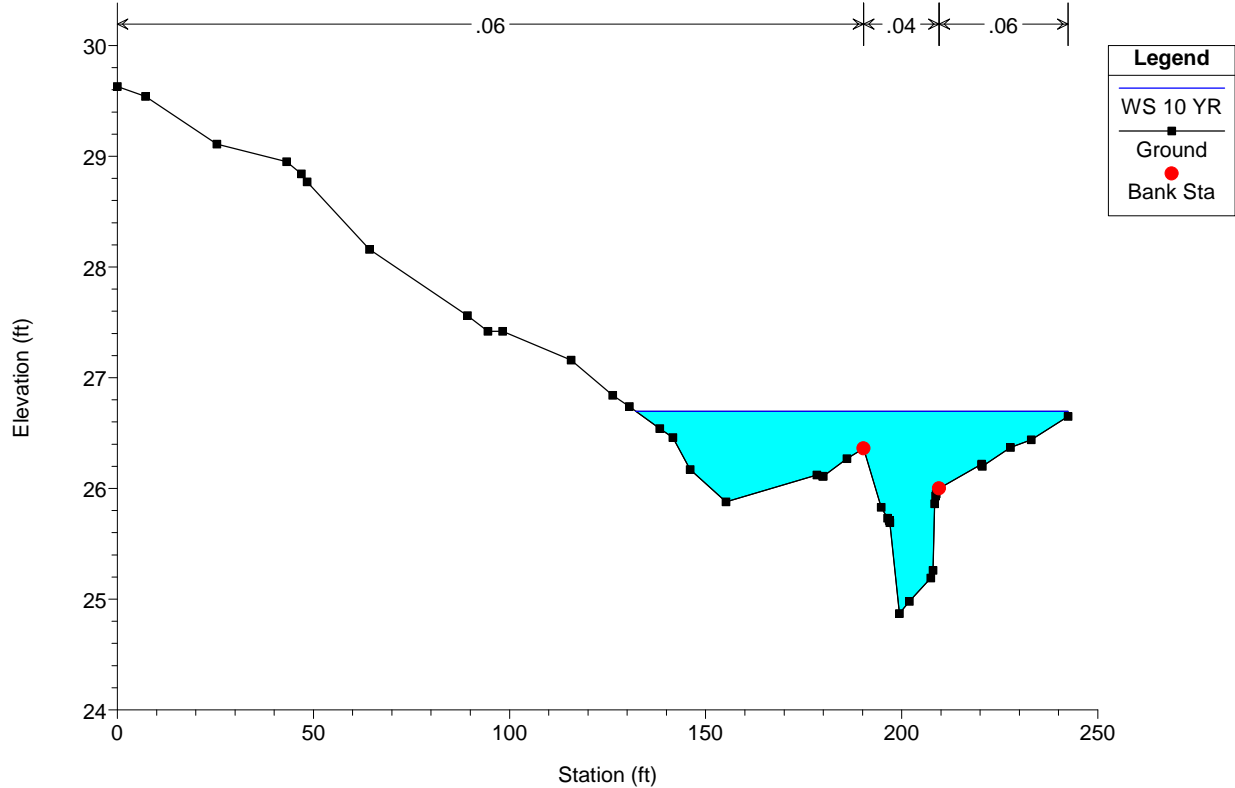
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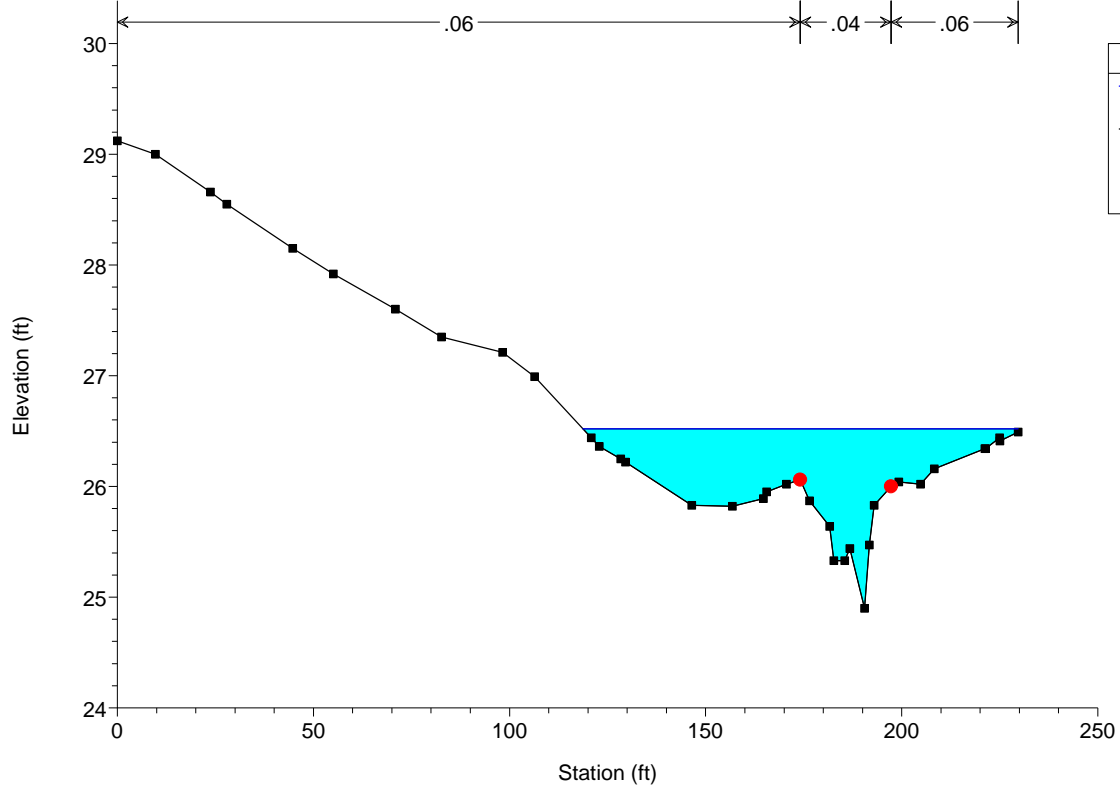
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Lilly\_Run\_8-1 Plan: 10yr\_lilly 8/9/2017  
RS = 1500.000



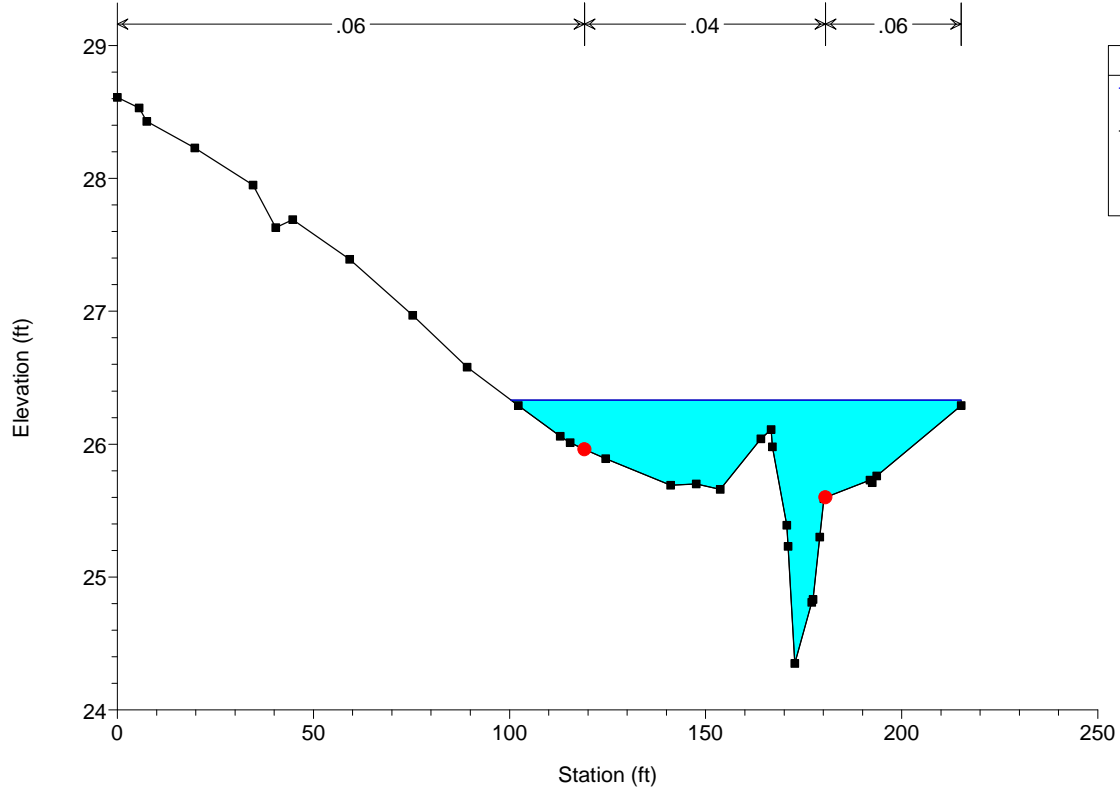
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**Legend**

- WS 10 YR
- Ground
- Bank Sta

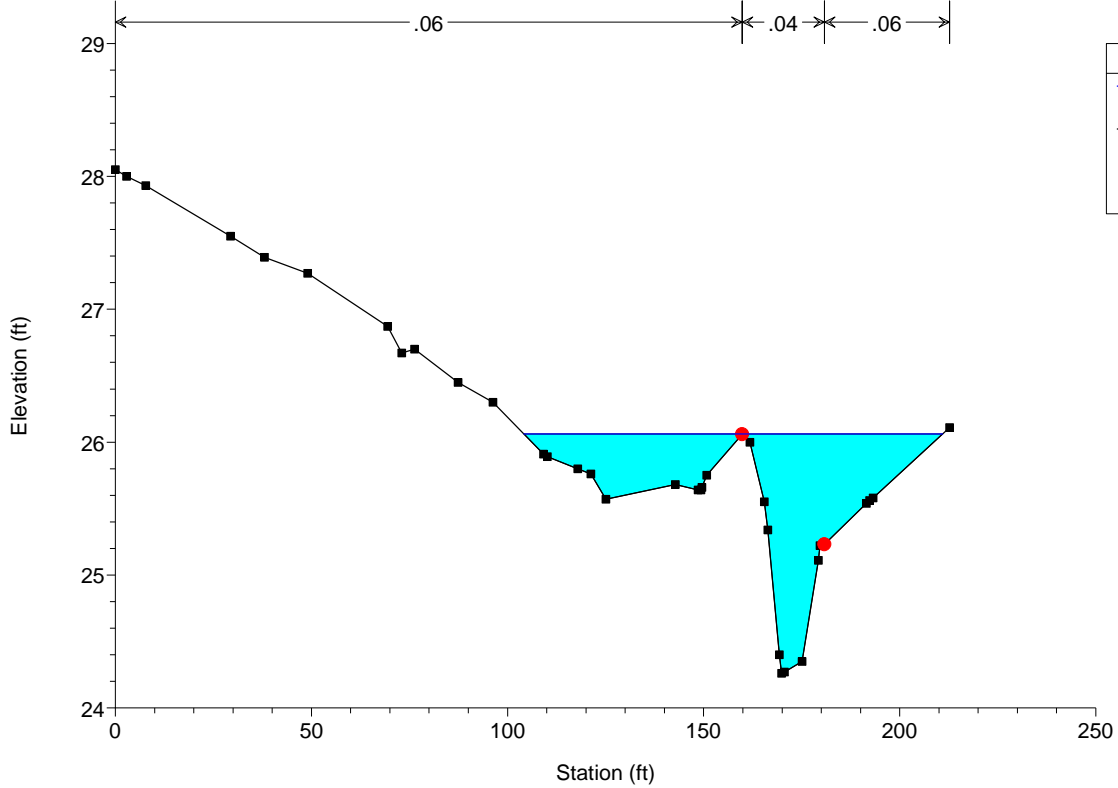
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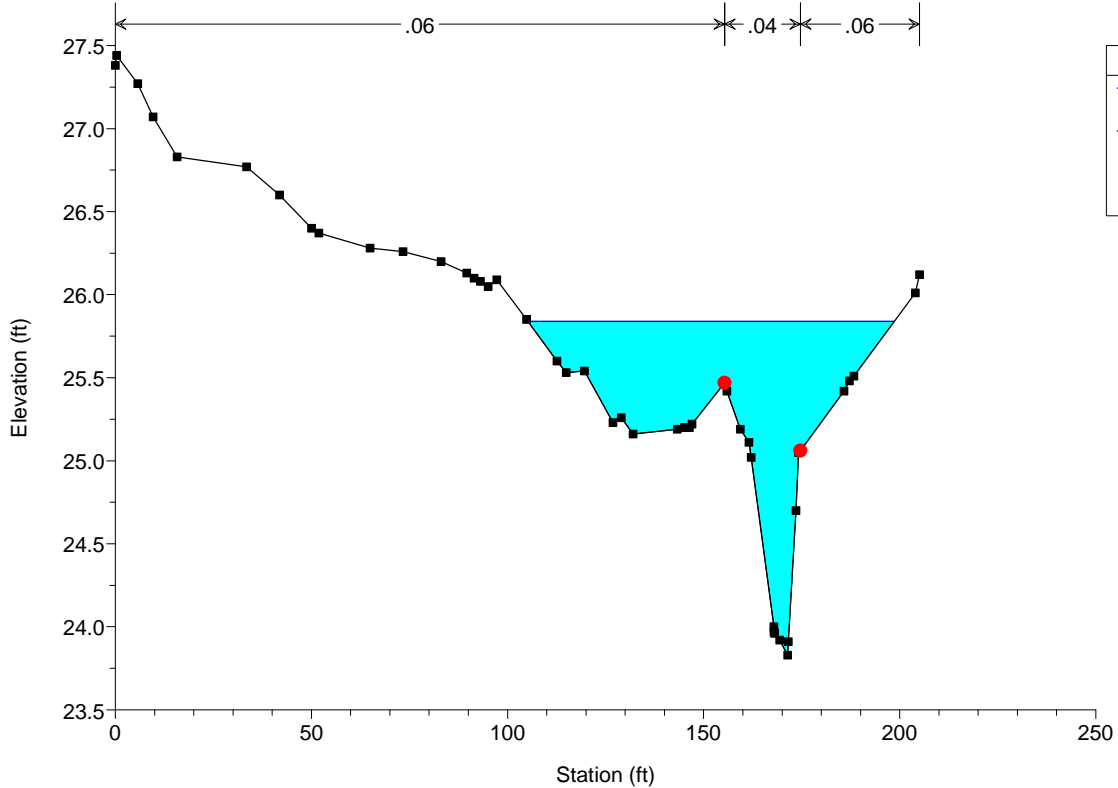
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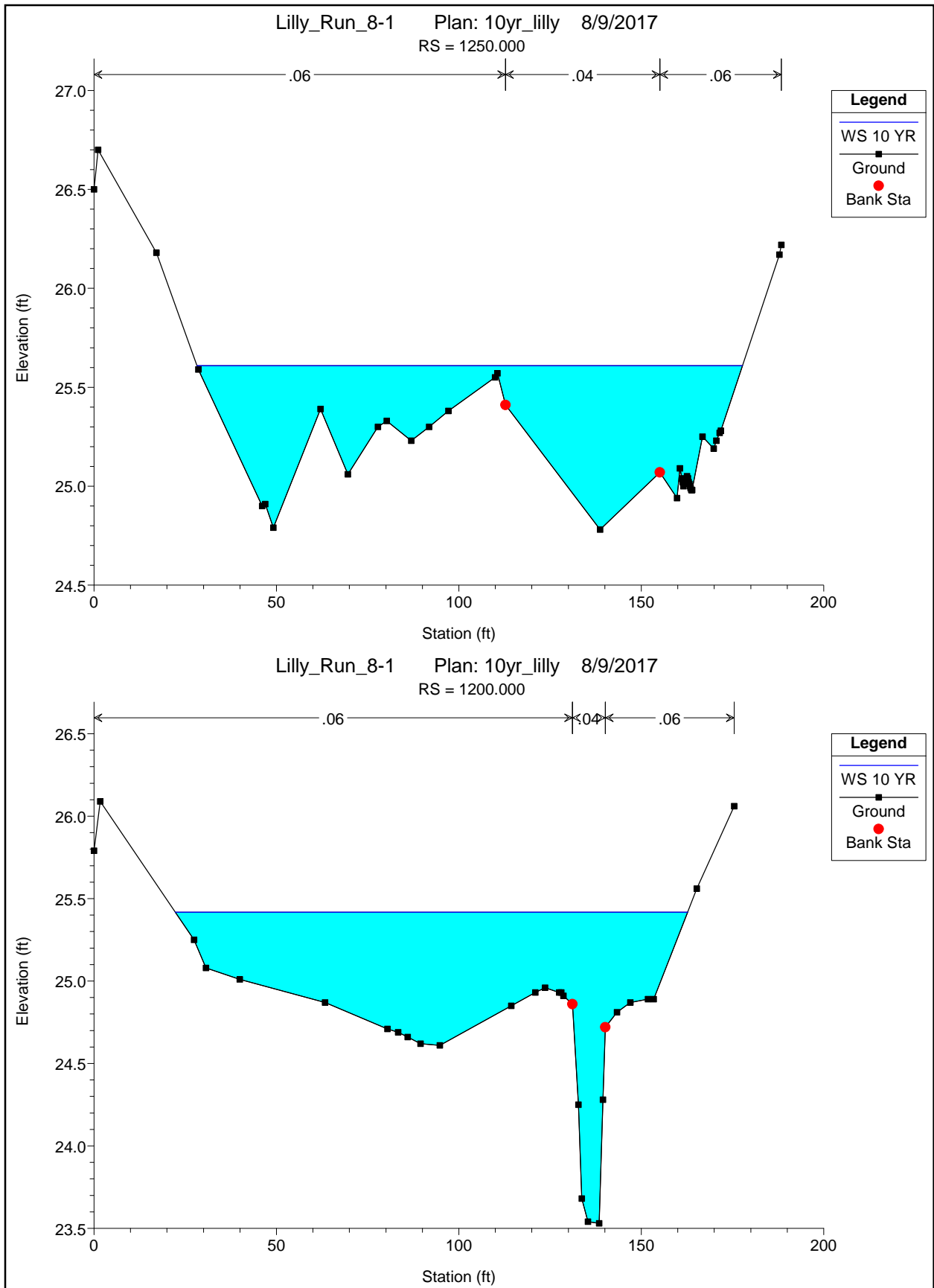
- WS 10 YR
- Ground
- Bank Sta

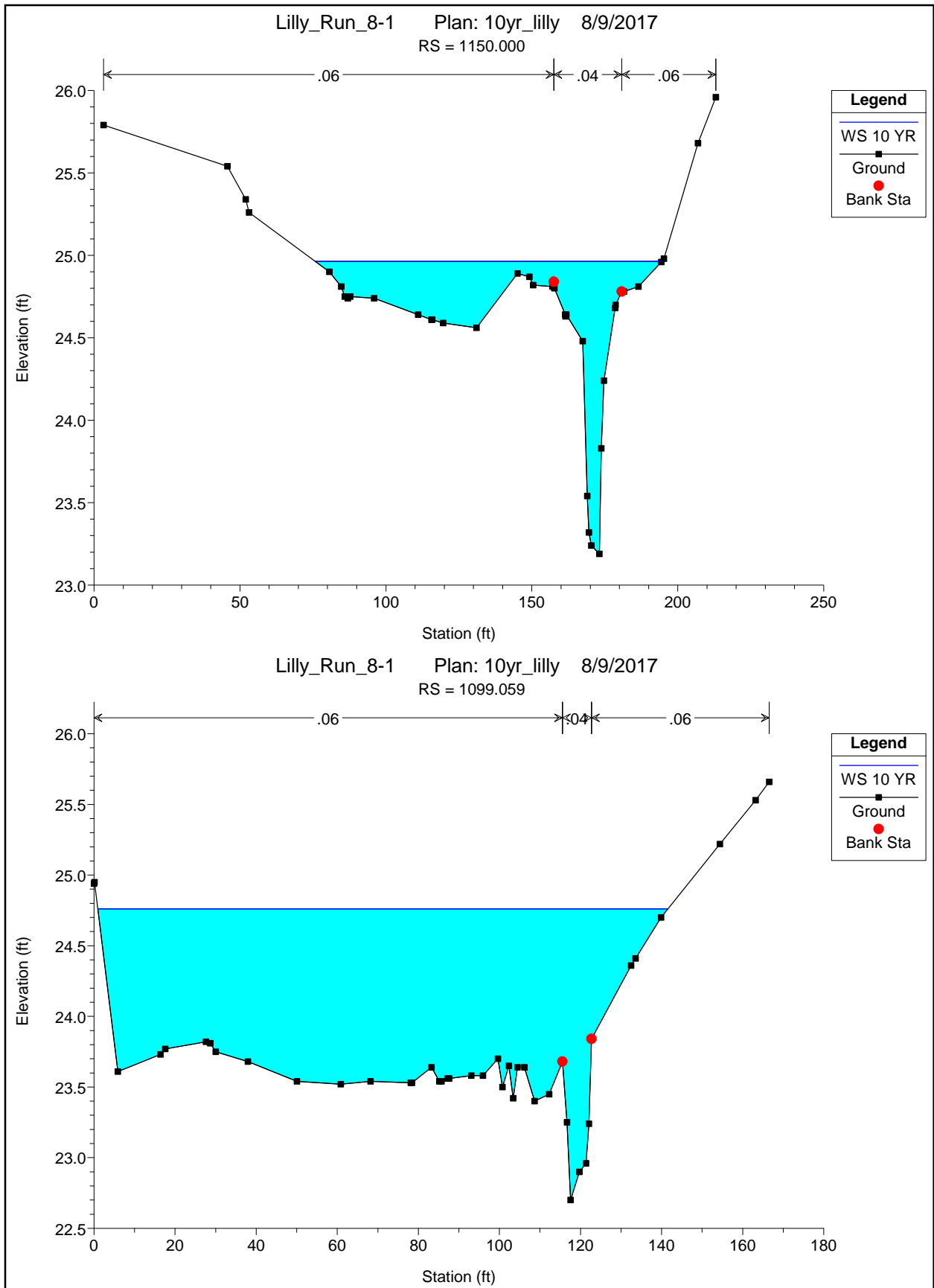
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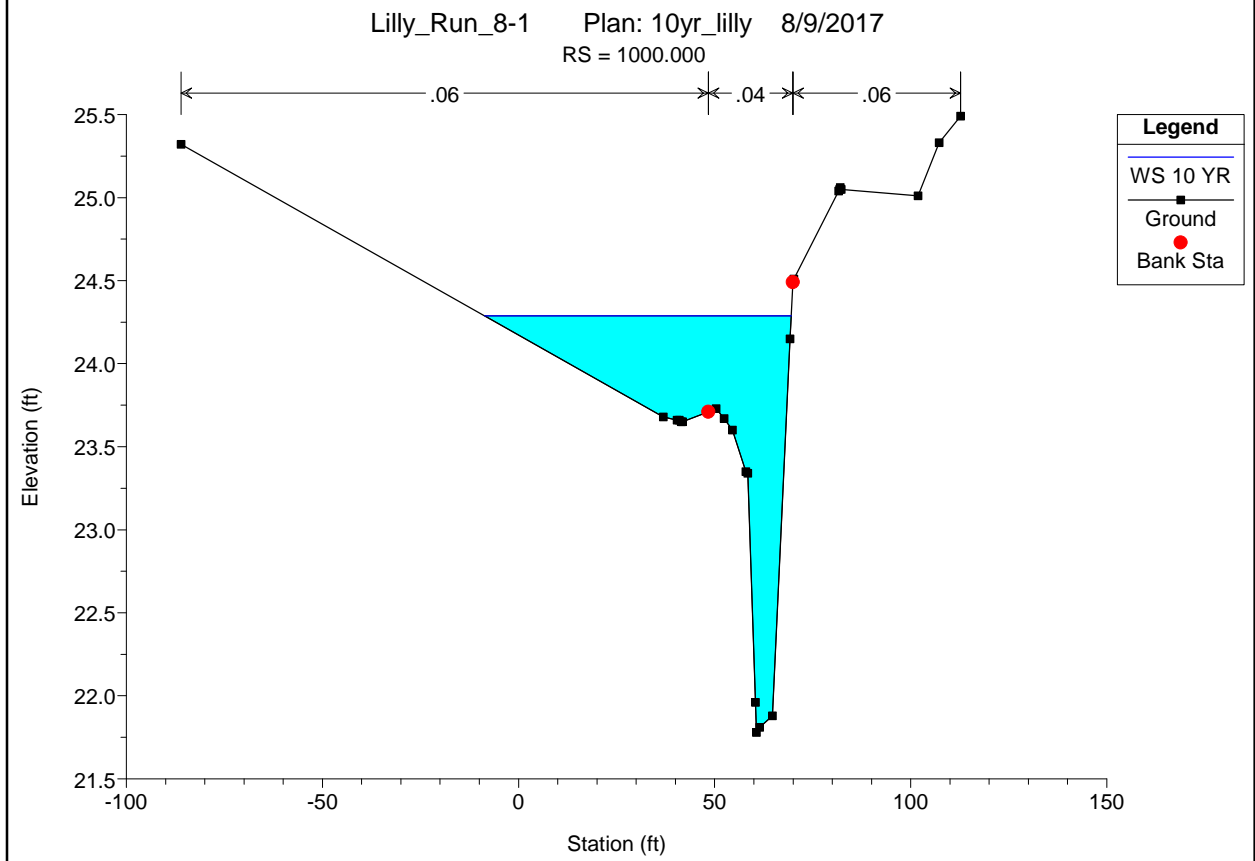
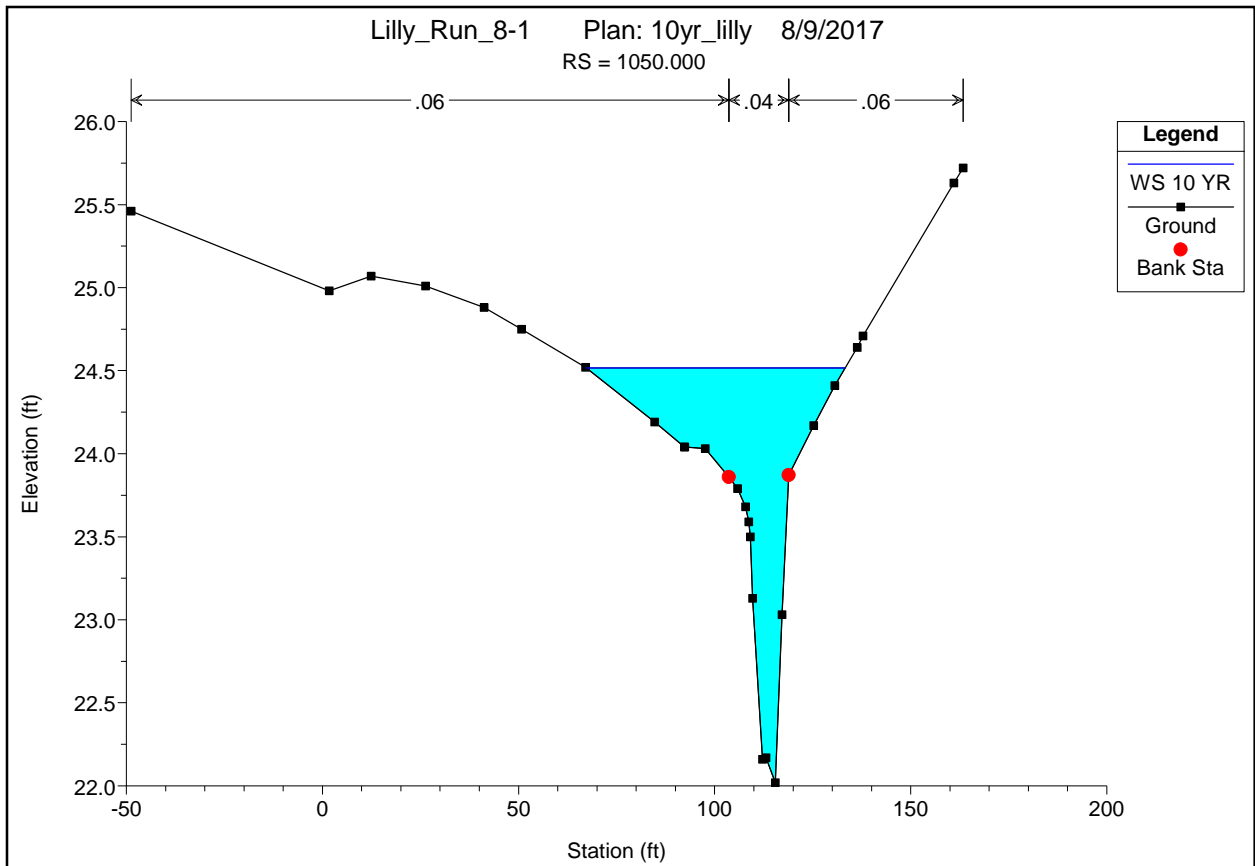


Lilly\_Run\_8-1 Plan: 10yr\_lilly 8/9/2017  
RS = 1300.000











HEC-RAS Plan: 10yr River: Lilly Run Reach: Reach 1 Profile: 10 YR

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
Reach 1	2350.000	10 YR	30.60	30.56	0.03	0.29	0.01	47.17	15.83		103.14
Reach 1	2300.000	10 YR	30.30	30.21	0.09	0.35	0.01	25.34	38.96		91.74
Reach 1	2250.000	10 YR	29.95	29.74	0.21	0.28	0.03	6.87	58.60	0.03	66.17
Reach 1	2200.000	10 YR	29.64	29.53	0.10	0.16	0.02	6.53	49.78	10.48	136.06
Reach 1	2150.000	10 YR	29.46	29.41	0.05	0.20	0.00	20.65	42.60	4.75	160.88
Reach 1	2100.000	10 YR	29.25	29.22	0.04	0.38	0.01	40.36	28.94		131.22
Reach 1	2050.000	10 YR	28.87	28.78	0.10	0.29	0.01	29.57	40.93	0.11	114.36
Reach 1	2000.000	10 YR	28.57	28.52	0.06	0.22	0.00	28.92	41.01	1.87	126.15
Reach 1	1950.000	10 YR	28.35	28.29	0.06	0.17	0.00	28.17	41.32	3.61	129.94
Reach 1	1900.000	10 YR	28.18	28.12	0.06	0.13	0.01	18.59	50.91	4.80	124.81
Reach 1	1850.000	10 YR	28.04	28.00	0.04	0.15	0.00	25.56	40.56	9.48	115.03
Reach 1	1800.000	10 YR	27.89	27.82	0.06	0.25	0.01	17.16	46.41	13.33	98.39
Reach 1	1750.000	10 YR	27.63	27.45	0.18	0.22	0.04	12.77	57.04	8.29	111.92
Reach 1	1700.000	10 YR	27.34	27.31	0.03	0.15	0.00	39.85	32.54	7.01	141.41
Reach 1	1650.000	10 YR	27.19	27.13	0.06	0.15	0.00	39.25	36.92	4.43	135.49
Reach 1	1600.000	10 YR	27.04	26.99	0.04	0.15	0.00	35.90	32.12	13.88	131.54
Reach 1	1550.000	10 YR	26.89	26.84	0.05	0.15	0.00	32.52	41.51	9.07	99.69
Reach 1	1500.000	10 YR	26.74	26.70	0.05	0.17	0.00	25.49	50.74	8.17	110.23
Reach 1	1450.000	10 YR	26.58	26.52	0.06	0.20	0.00	28.53	50.26	6.91	110.99
Reach 1	1400.000	10 YR	26.37	26.33	0.04	0.22	0.00	1.90	71.97	13.03	114.80
Reach 1	1350.000	10 YR	26.15	26.06	0.09	0.23	0.00	13.96	61.85	12.40	106.77
Reach 1	1300.000	10 YR	25.91	25.84	0.07	0.25	0.01	22.17	59.44	7.80	93.48
Reach 1	1250.000	10 YR	25.65	25.61	0.04	0.19	0.00	29.61	50.46	10.63	149.52
Reach 1	1200.000	10 YR	25.46	25.42	0.04	0.30	0.01	51.03	33.43	7.54	140.45
Reach 1	1150.000	10 YR	25.15	24.96	0.19	0.07	0.05	26.38	65.48	1.34	118.86
Reach 1	1099.059	10 YR	24.77	24.76	0.01	0.06	0.02	77.87	14.00	2.63	140.62
Reach 1	1050.000	10 YR	24.69	24.52	0.17	0.27	0.02	10.66	81.06	3.98	66.06
Reach 1	1000.000	10 YR	24.40	24.29	0.11			18.71	78.29		78.15

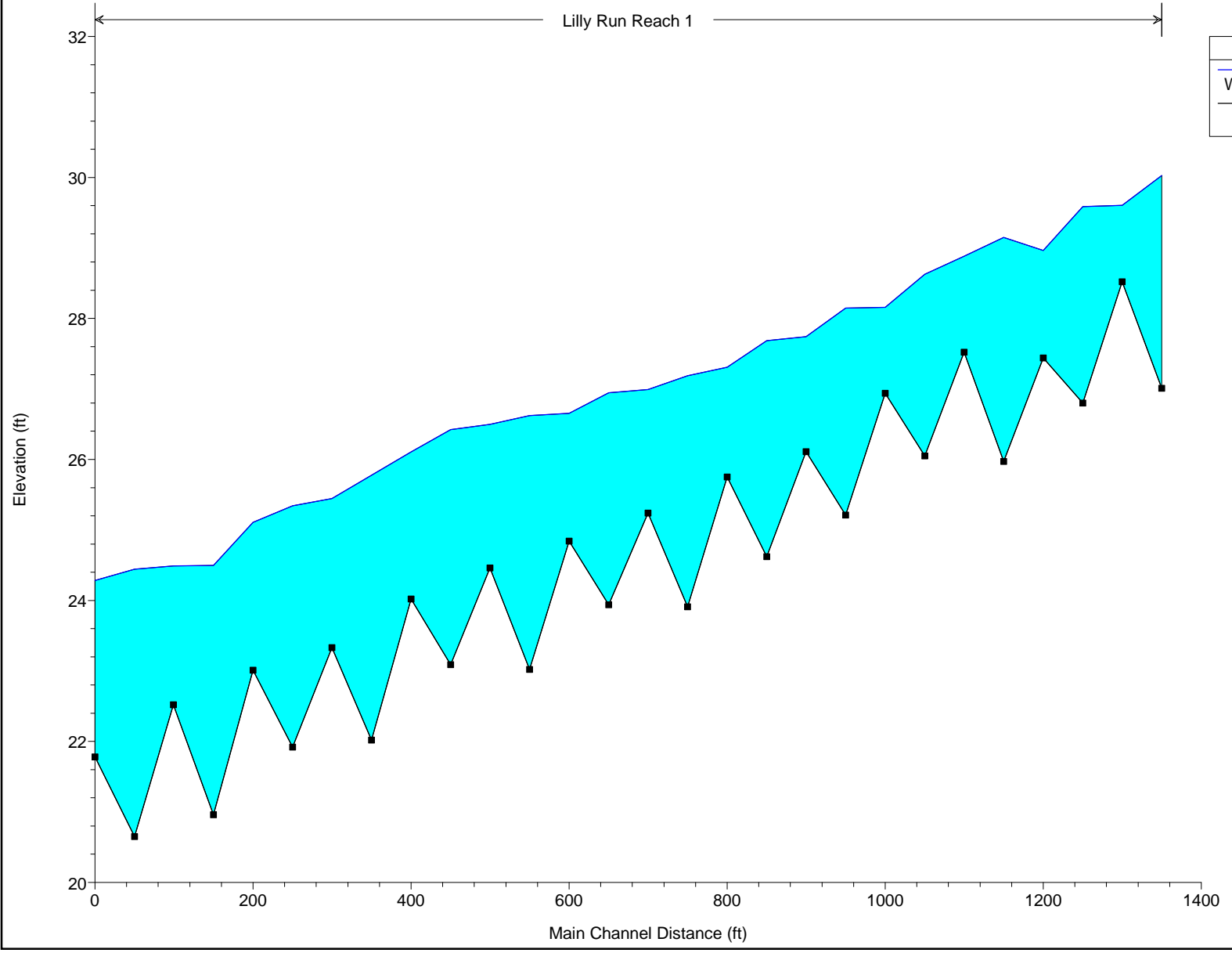
HEC-RAS Plan: 10yr River: Lilly Run Reach: Reach 1 Profile: 10 YR

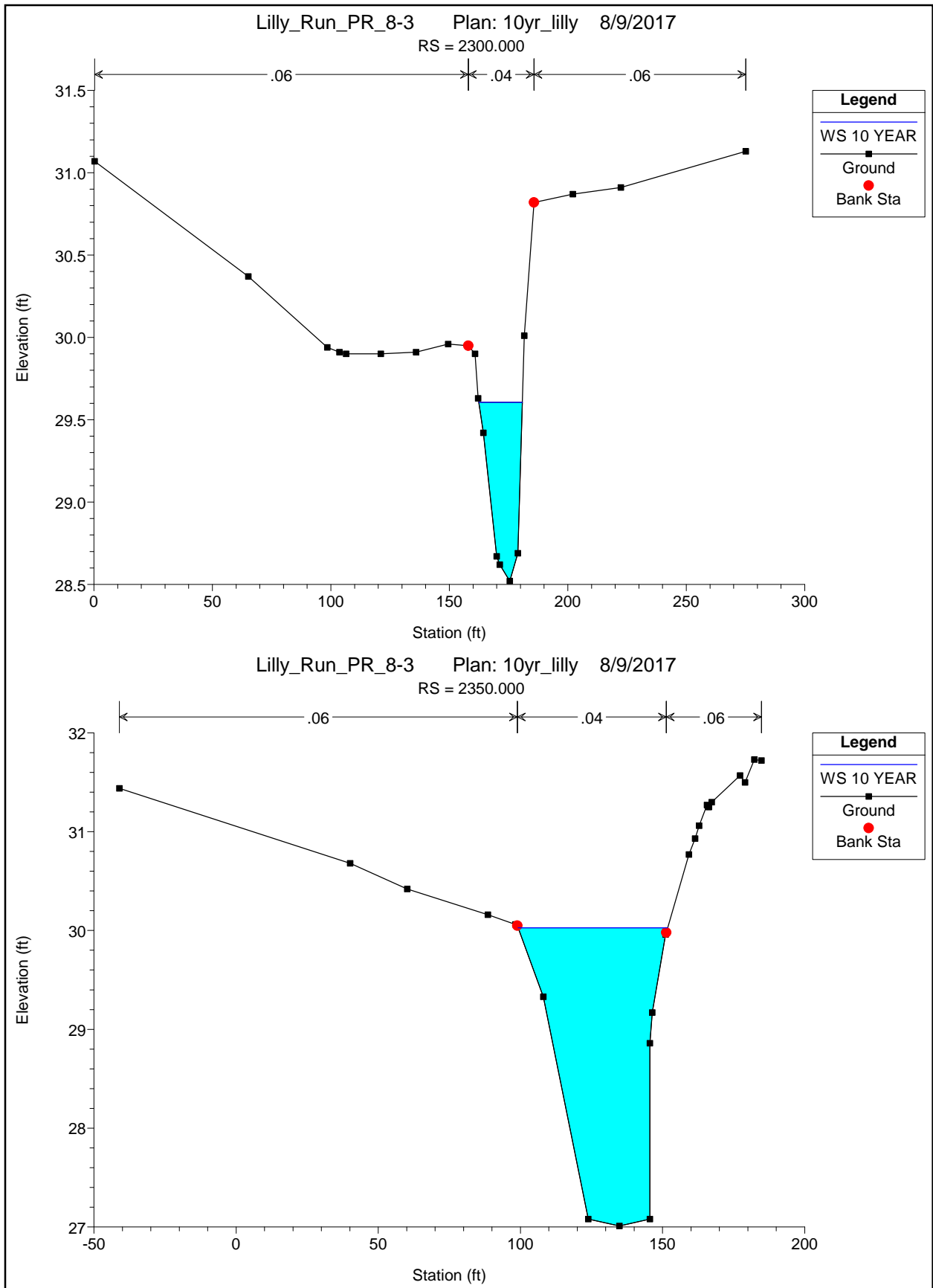
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	2350.000	10 YR	63.00	29.17	30.56		30.60	0.005684	2.21	49.80	103.14	0.45
Reach 1	2300.000	10 YR	64.30	28.25	30.21	30.10	30.30	0.005921	3.04	40.21	91.74	0.49
Reach 1	2250.000	10 YR	65.50	27.92	29.74	29.39	29.95	0.008168	3.83	24.90	66.17	0.58
Reach 1	2200.000	10 YR	66.80	27.44	29.53		29.64	0.004056	2.94	45.61	136.06	0.42
Reach 1	2150.000	10 YR	68.00	27.14	29.41		29.46	0.002659	2.22	62.29	160.88	0.34
Reach 1	2100.000	10 YR	69.30	27.88	29.22		29.25	0.006722	2.03	50.55	131.22	0.48
Reach 1	2050.000	10 YR	70.60	27.26	28.78		28.87	0.008558	3.13	39.88	114.36	0.58
Reach 1	2000.000	10 YR	71.80	26.95	28.52		28.57	0.004304	2.44	54.32	126.15	0.42
Reach 1	1950.000	10 YR	73.10	26.79	28.29		28.35	0.004411	2.50	55.50	129.94	0.43
Reach 1	1900.000	10 YR	74.30	26.07	28.12		28.18	0.002702	2.36	58.66	124.81	0.35
Reach 1	1850.000	10 YR	75.60	26.02	28.00		28.04	0.002643	2.12	64.41	115.03	0.34
Reach 1	1800.000	10 YR	76.90	25.55	27.82		27.89	0.003559	2.51	54.25	98.39	0.40
Reach 1	1750.000	10 YR	78.10	25.51	27.45	27.45	27.63	0.007450	3.97	39.47	111.92	0.58
Reach 1	1700.000	10 YR	79.40	25.26	27.31		27.34	0.002977	2.02	72.90	141.41	0.35
Reach 1	1650.000	10 YR	80.60	24.90	27.13		27.19	0.003081	2.71	68.33	135.49	0.37
Reach 1	1600.000	10 YR	81.90	24.86	26.99		27.04	0.002656	2.44	74.82	131.54	0.35
Reach 1	1550.000	10 YR	83.10	24.89	26.84		26.89	0.003282	2.34	62.51	99.69	0.37
Reach 1	1500.000	10 YR	84.40	24.87	26.70		26.74	0.002617	2.14	66.82	110.23	0.34
Reach 1	1450.000	10 YR	85.70	24.90	26.52		26.58	0.004451	2.34	58.52	110.99	0.43
Reach 1	1400.000	10 YR	86.90	24.35	26.33		26.37	0.003594	1.72	60.85	114.80	0.37
Reach 1	1350.000	10 YR	88.20	24.26	26.06		26.15	0.005374	2.80	51.46	106.77	0.48
Reach 1	1300.000	10 YR	89.40	23.83	25.84		25.91	0.004047	2.61	55.51	93.48	0.42
Reach 1	1250.000	10 YR	90.70	24.78	25.61		25.65	0.006353	2.06	64.06	149.52	0.48
Reach 1	1200.000	10 YR	92.00	23.53	25.42		25.46	0.002665	2.43	83.49	140.45	0.35
Reach 1	1150.000	10 YR	93.20	23.19	24.96	24.96	25.15	0.020064	4.05	37.32	118.86	0.86
Reach 1	1099.059	10 YR	94.50	22.70	24.76		24.77	0.000509	1.14	149.44	140.62	0.15
Reach 1	1050.000	10 YR	95.70	22.02	24.52		24.69	0.005798	3.57	39.18	66.06	0.52
Reach 1	1000.000	10 YR	97.00	21.78	24.29	23.94	24.40	0.005004	2.96	47.36	78.15	0.47

Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017

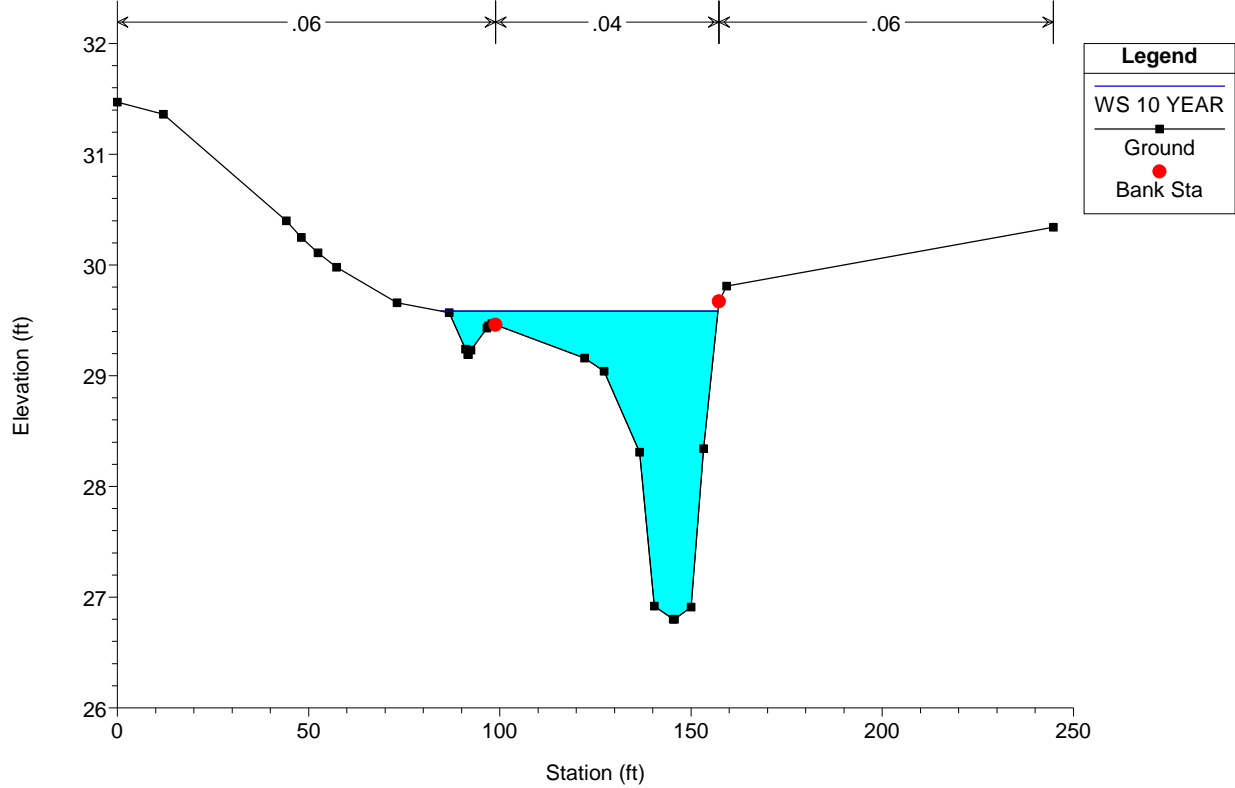
Lilly Run Reach 1

Legend	
WS 10 YEAR	—
Ground	■

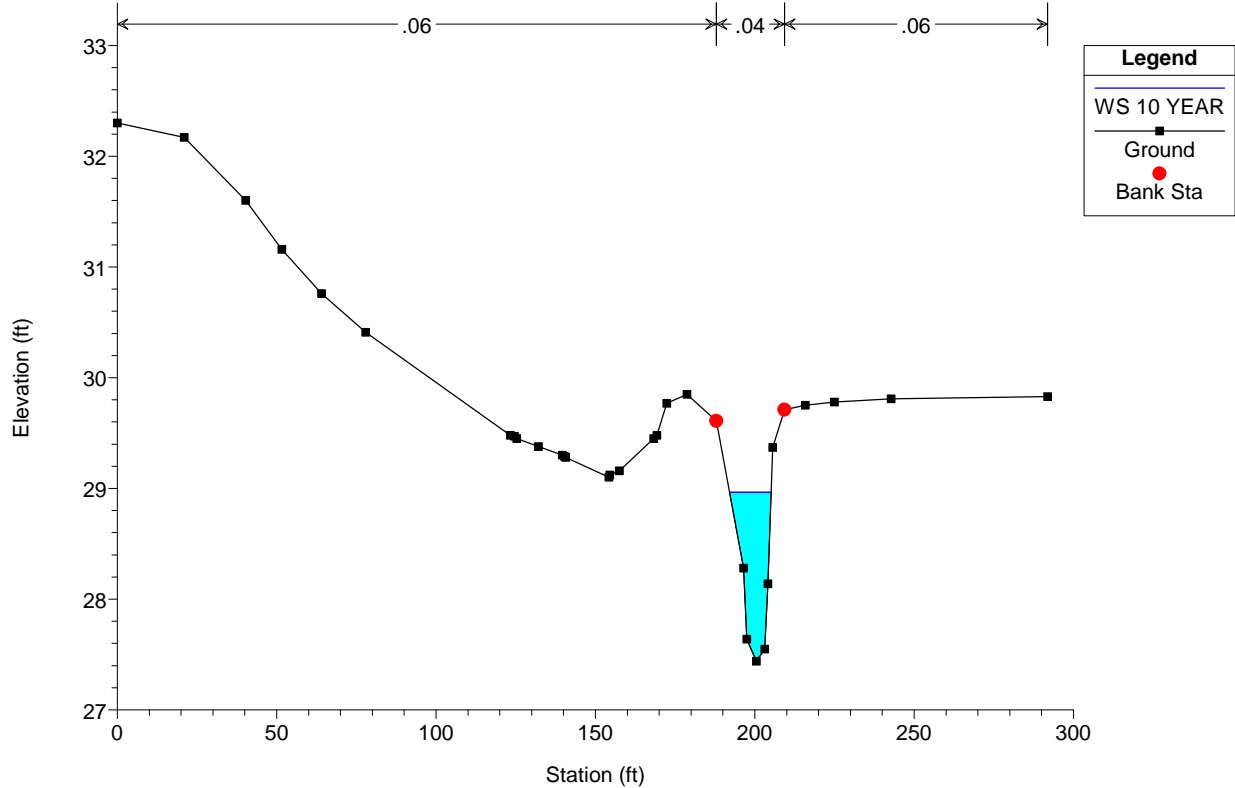




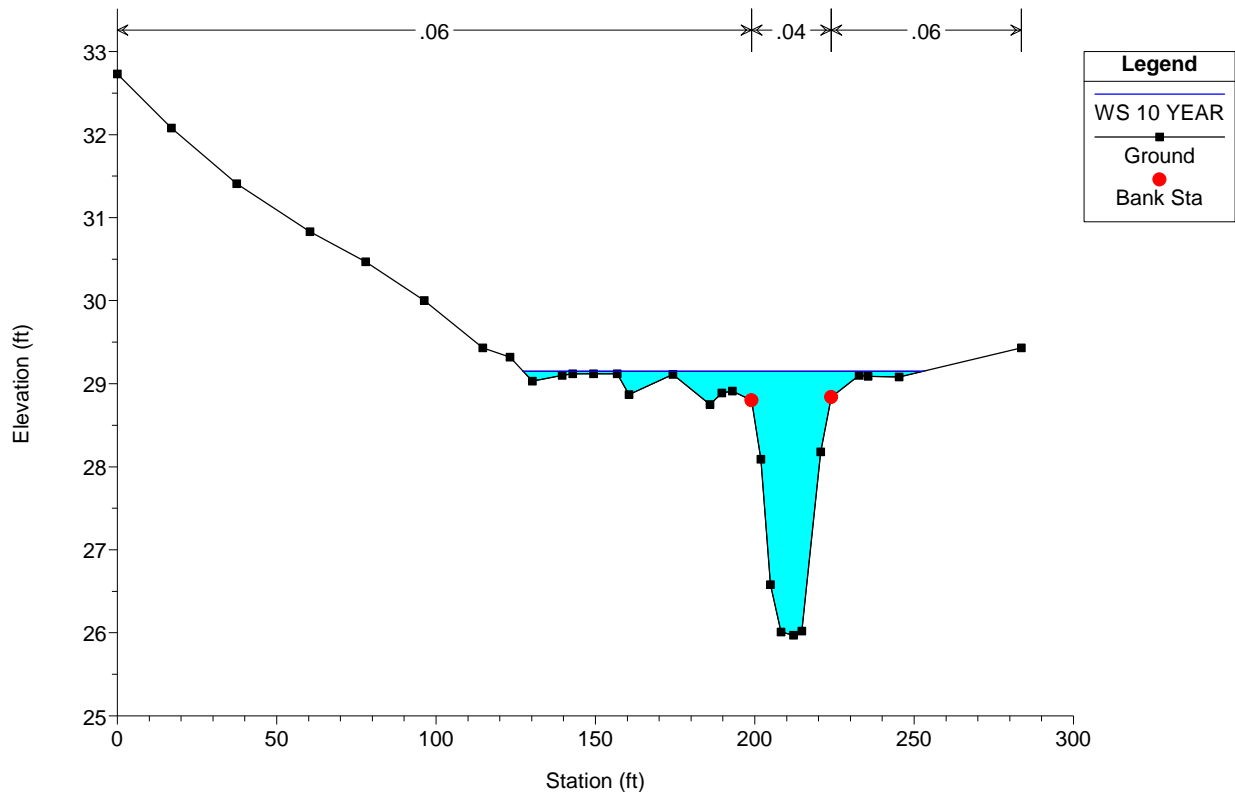
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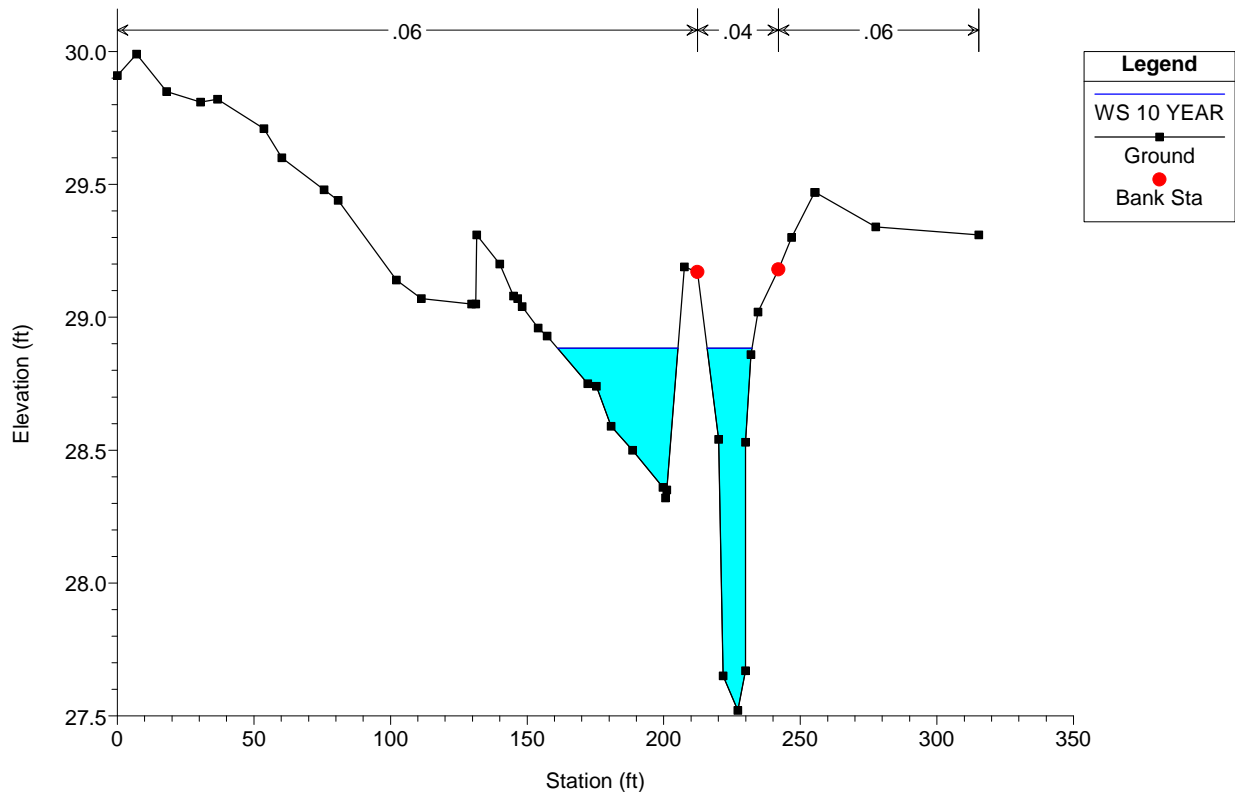
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RS = 2200.000



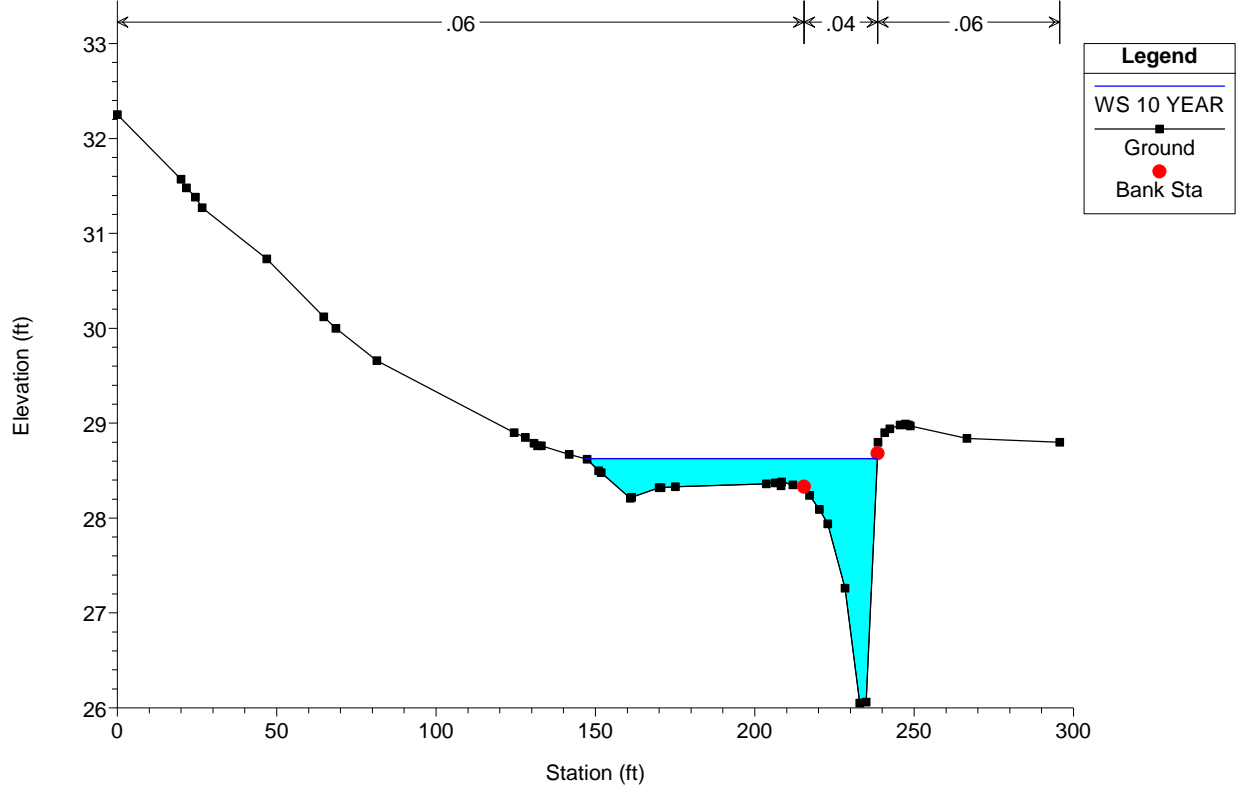
Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
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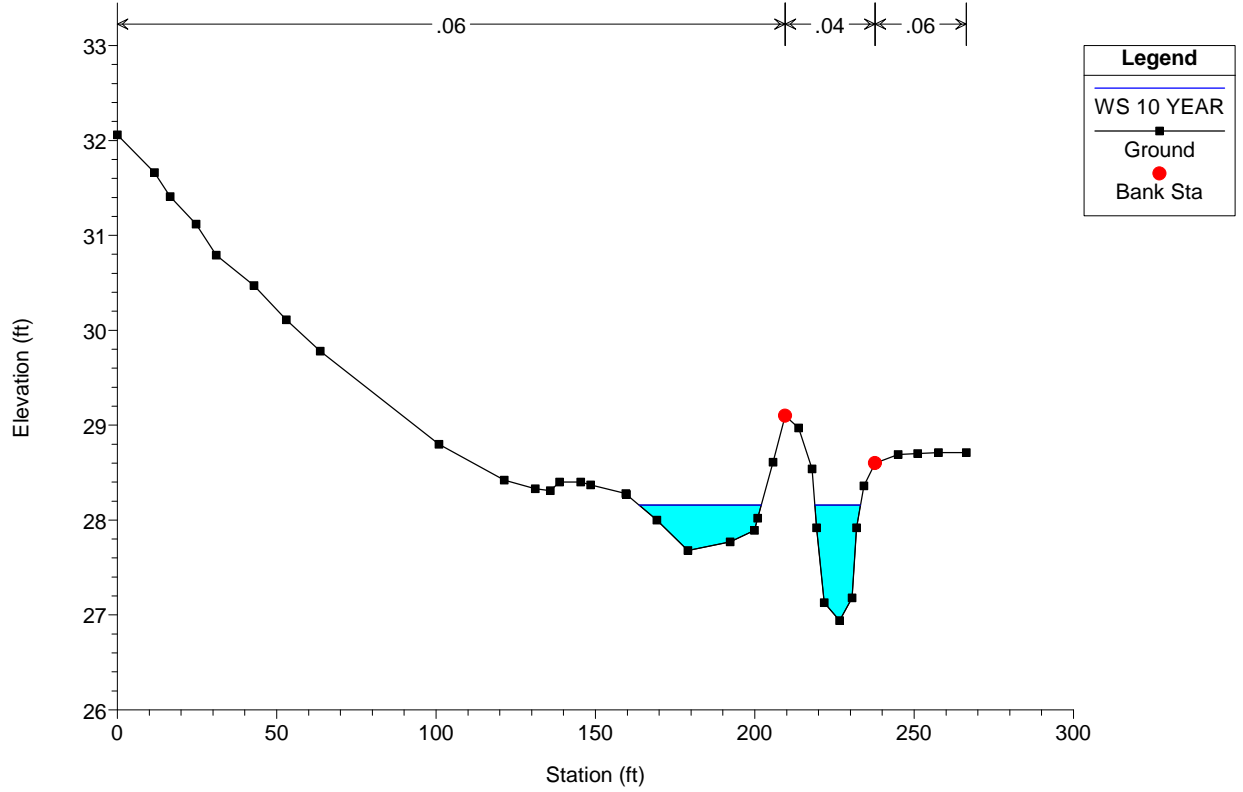
Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
RS = 2100.000



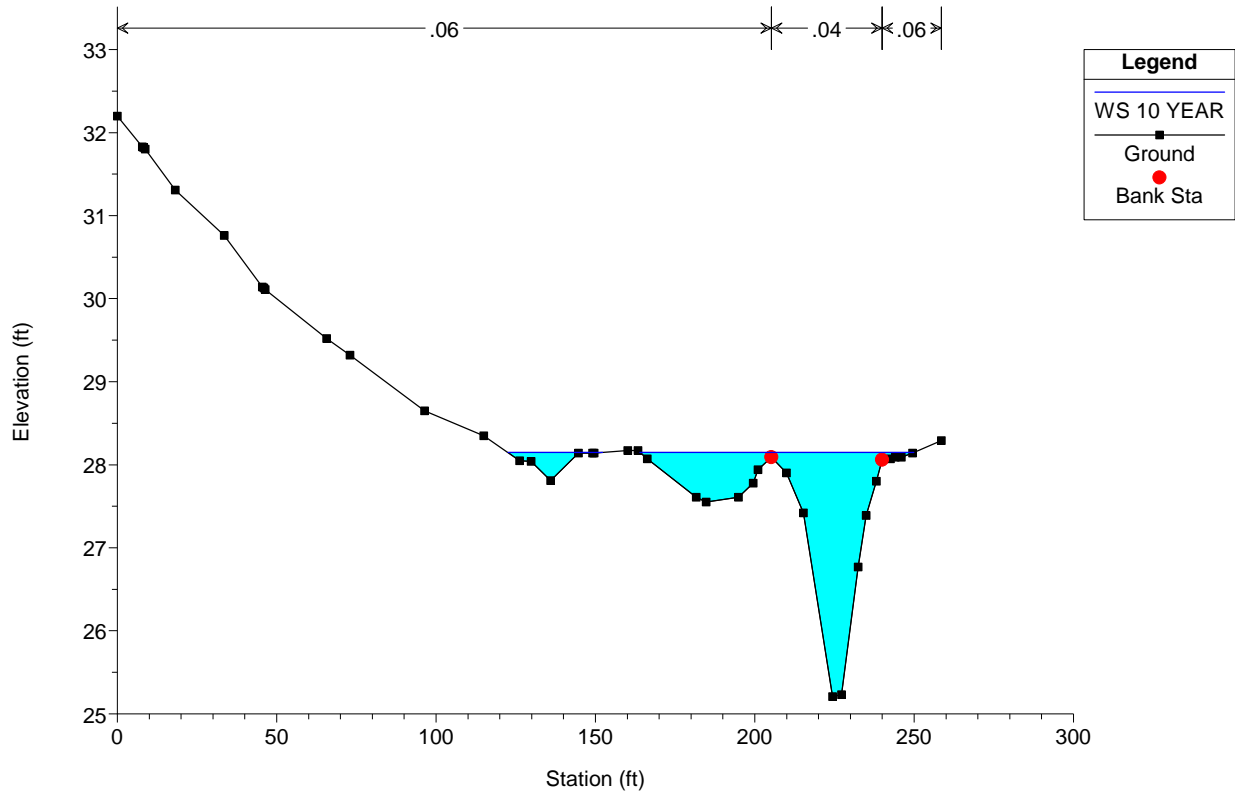
Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
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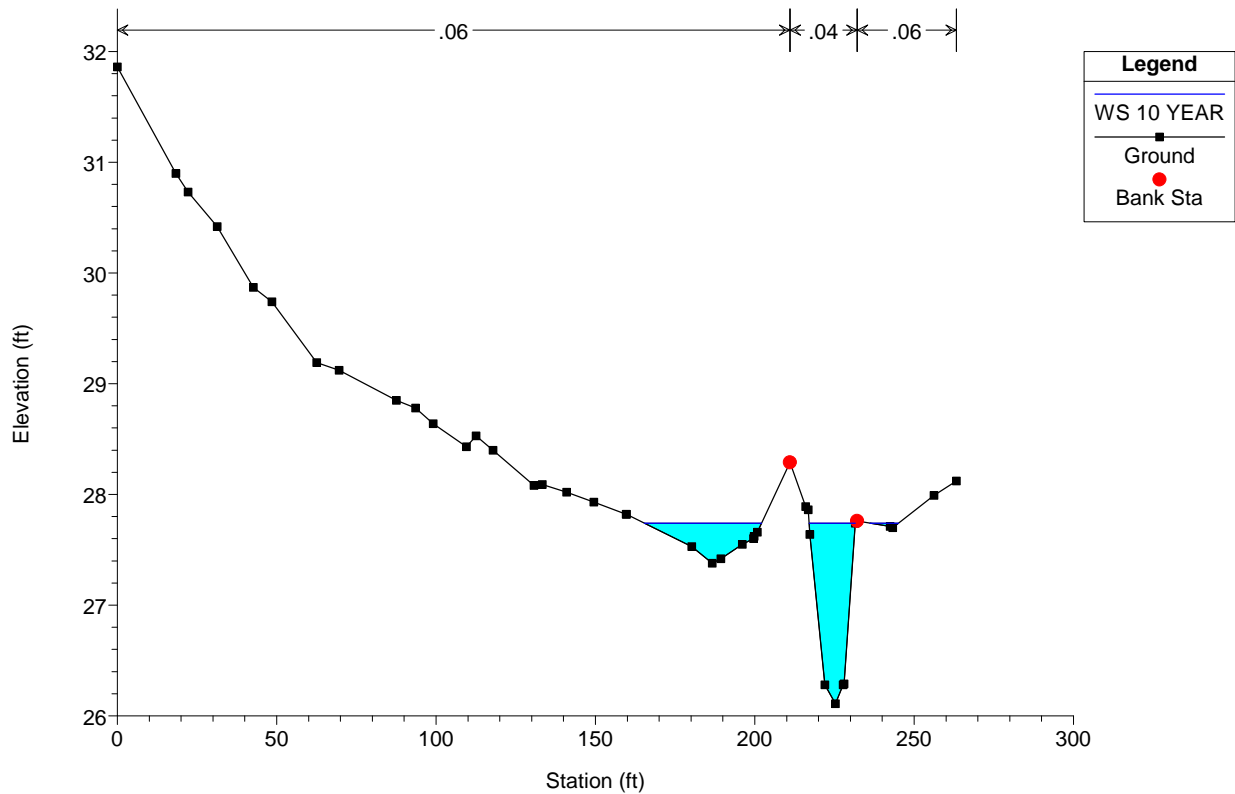
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RS = 2000.000



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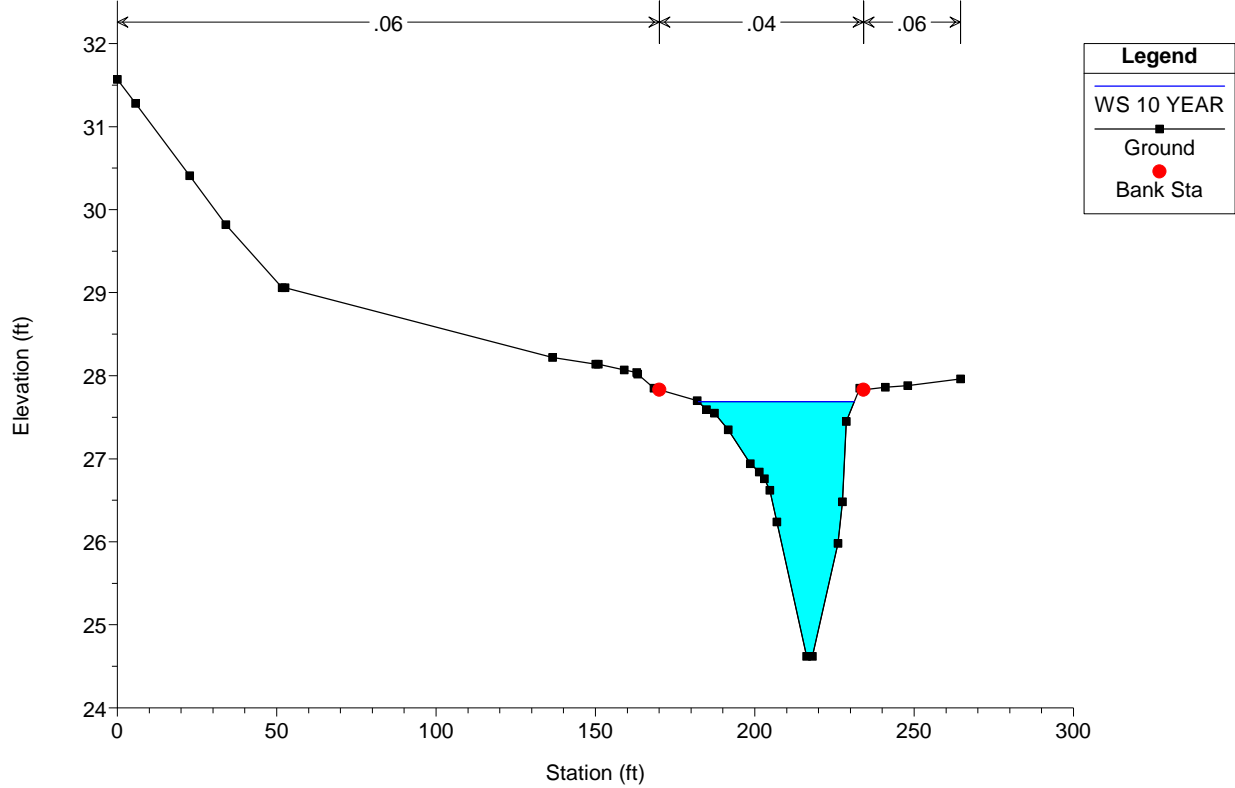


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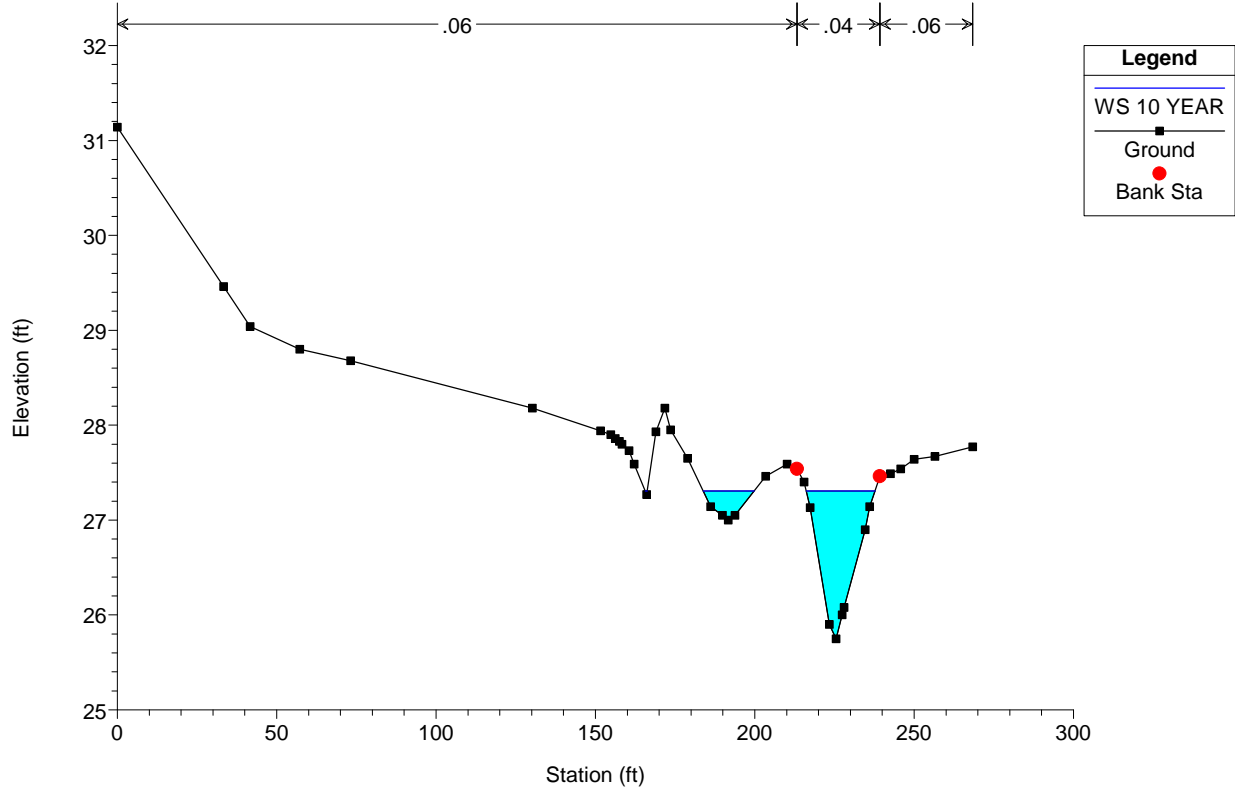




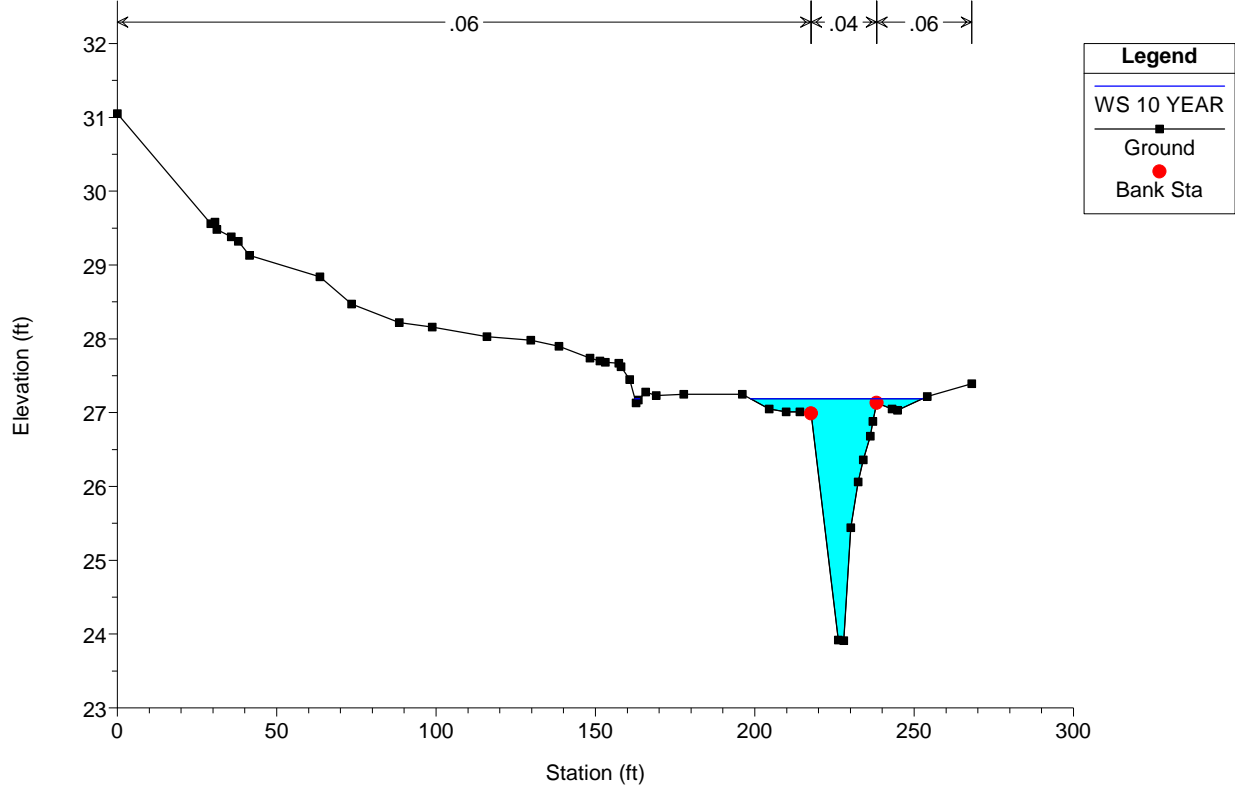
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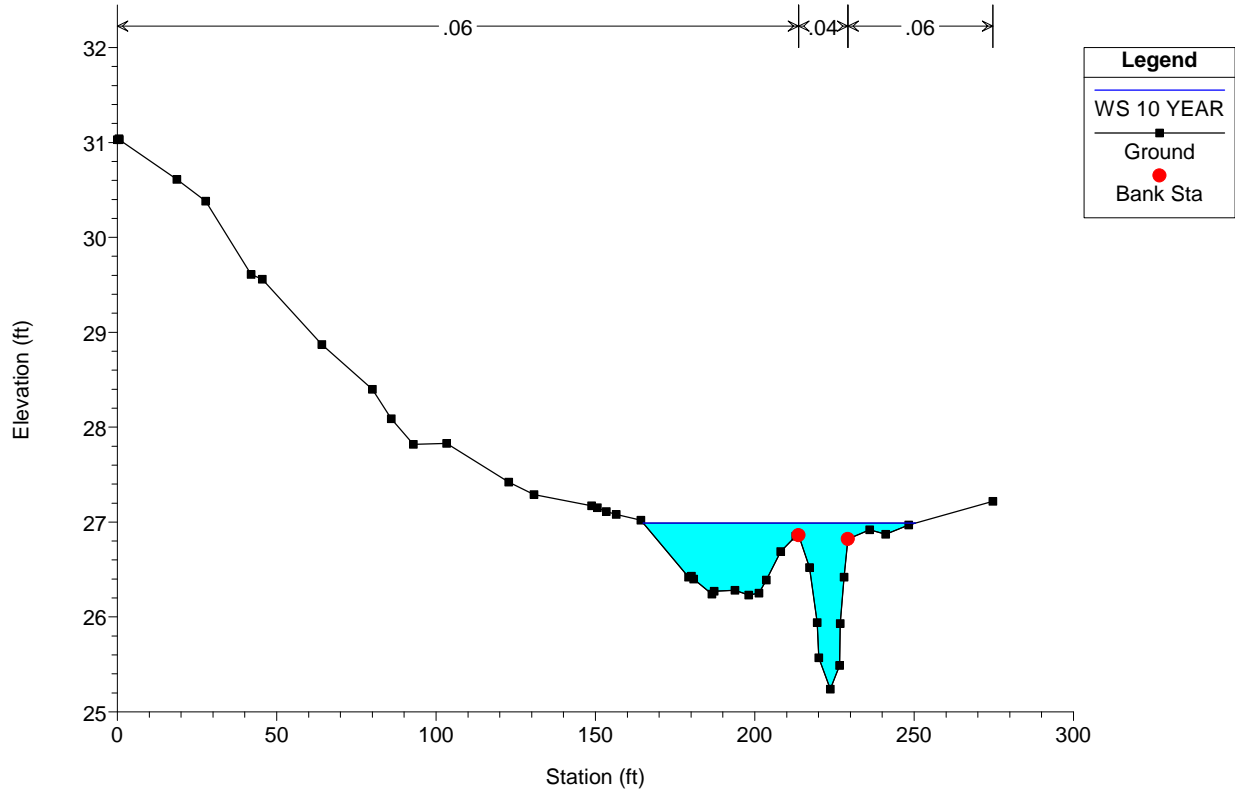
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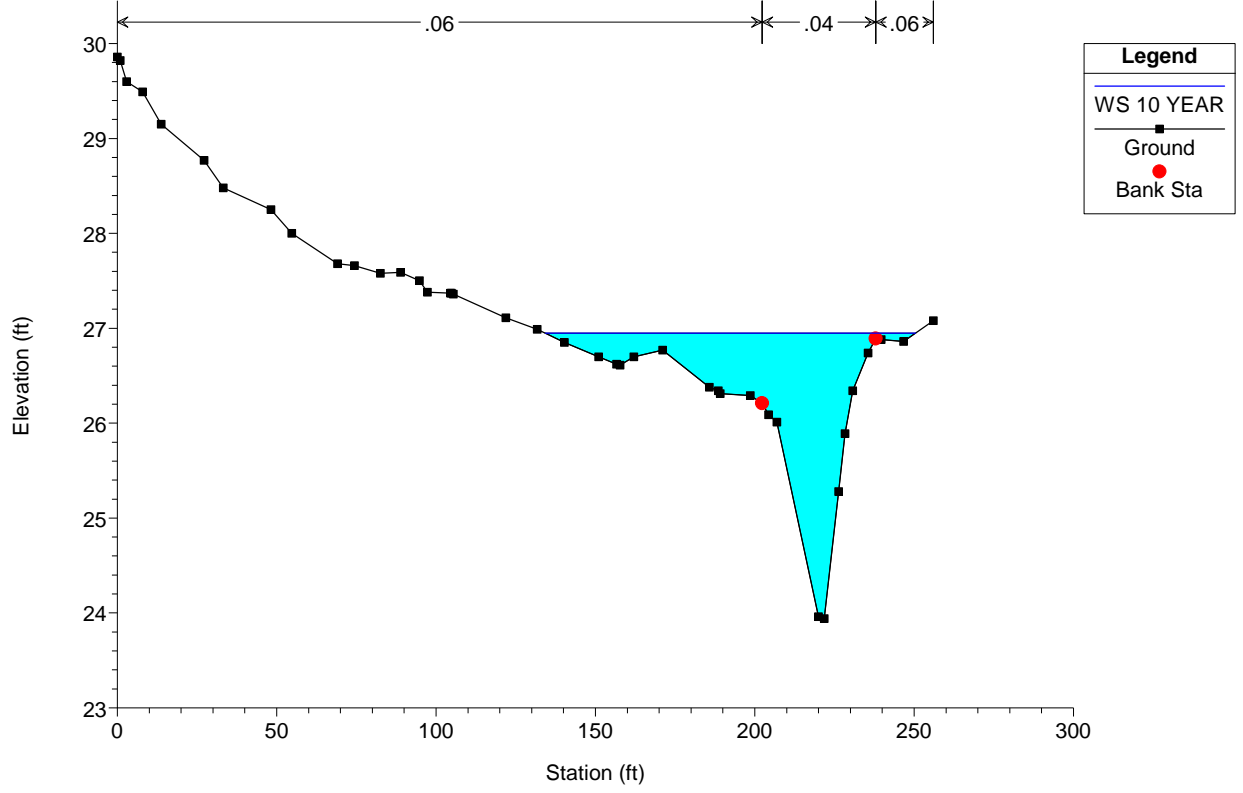
Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
RS = 1750.000



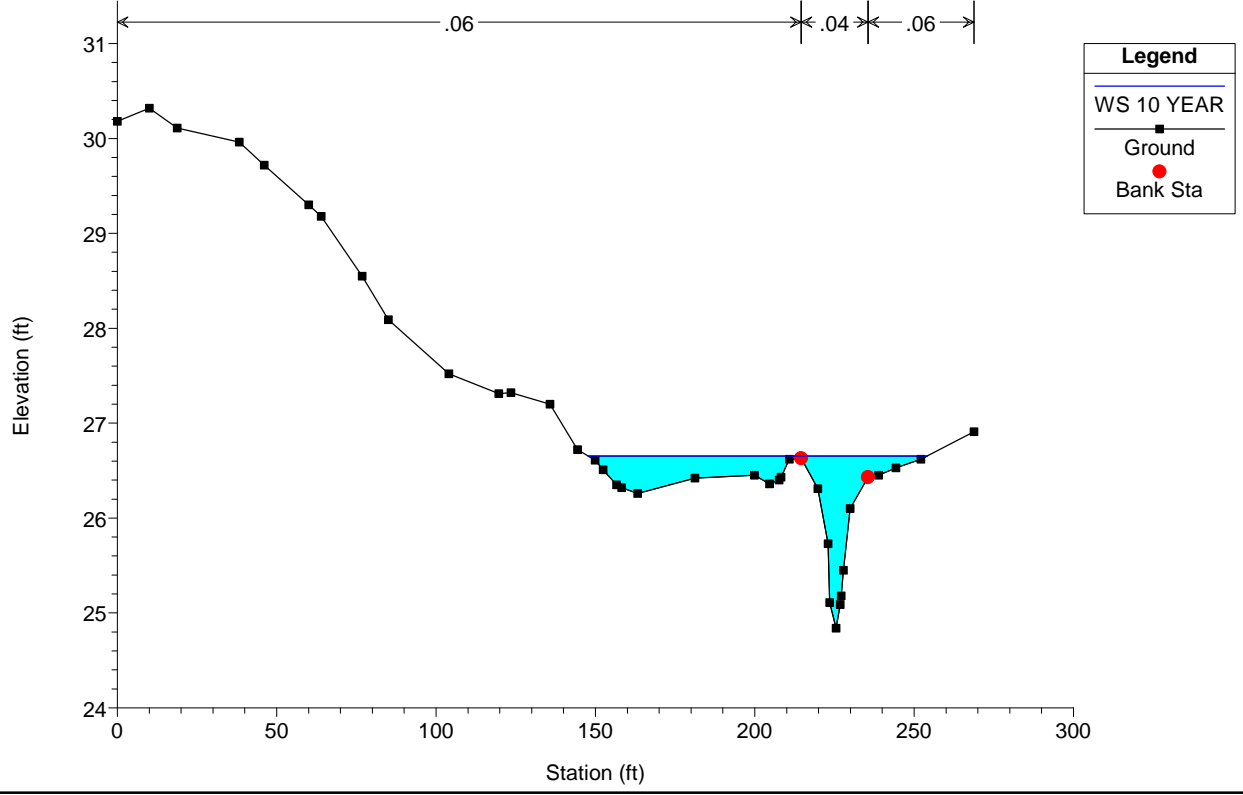
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RS = 1700.000



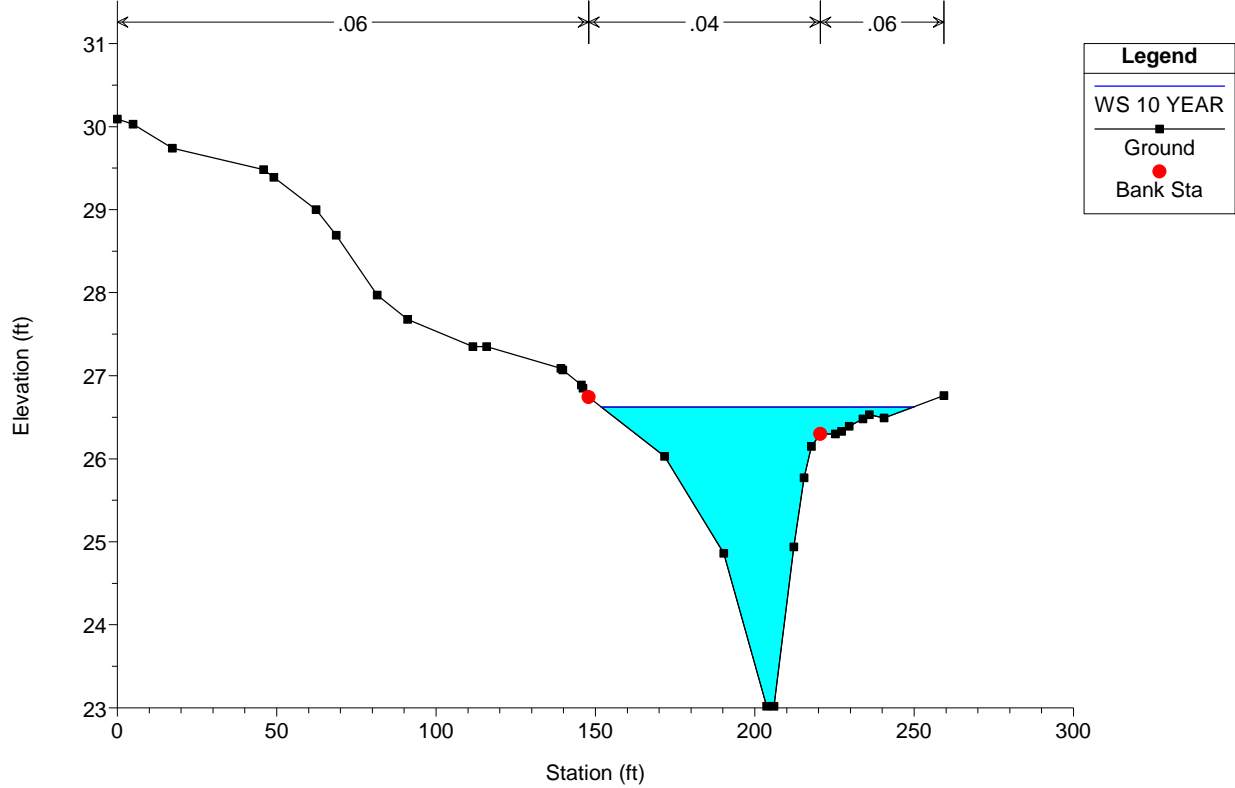
Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
RS = 1650.000



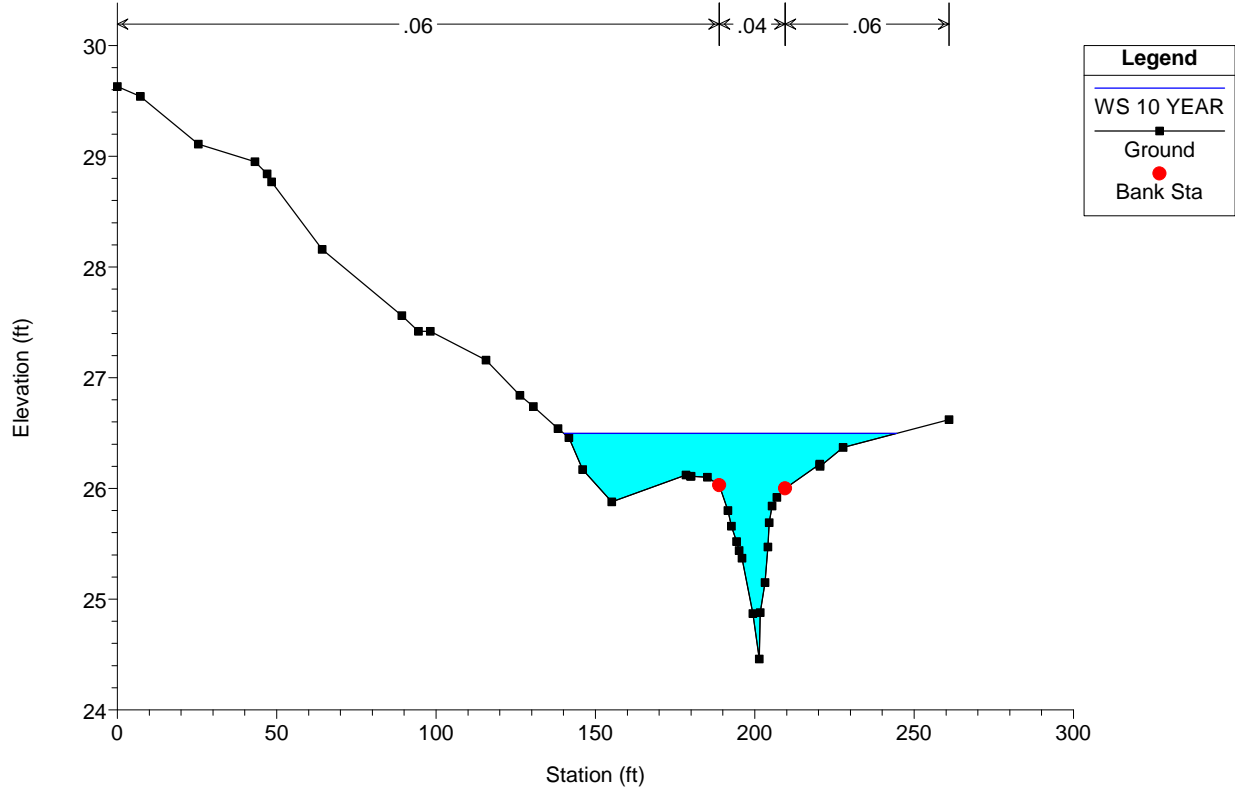
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RS = 1600.000



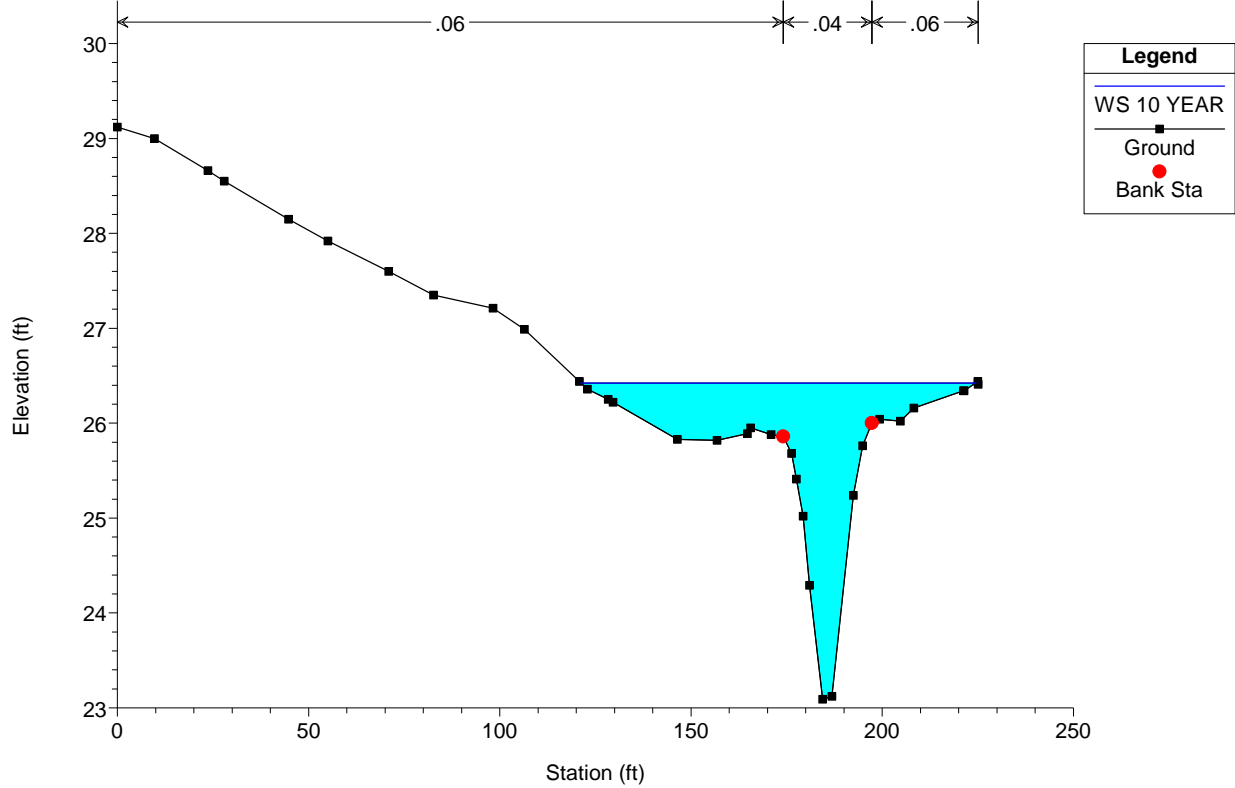
Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
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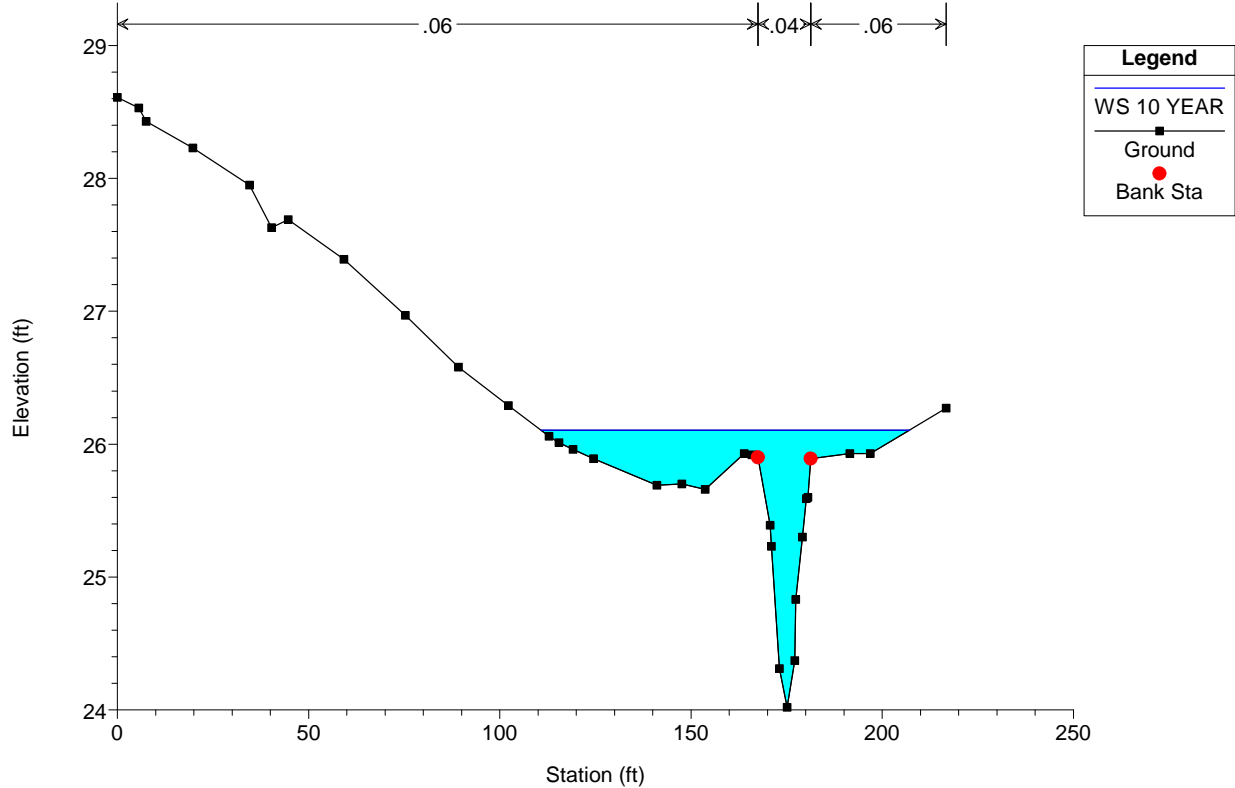
Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
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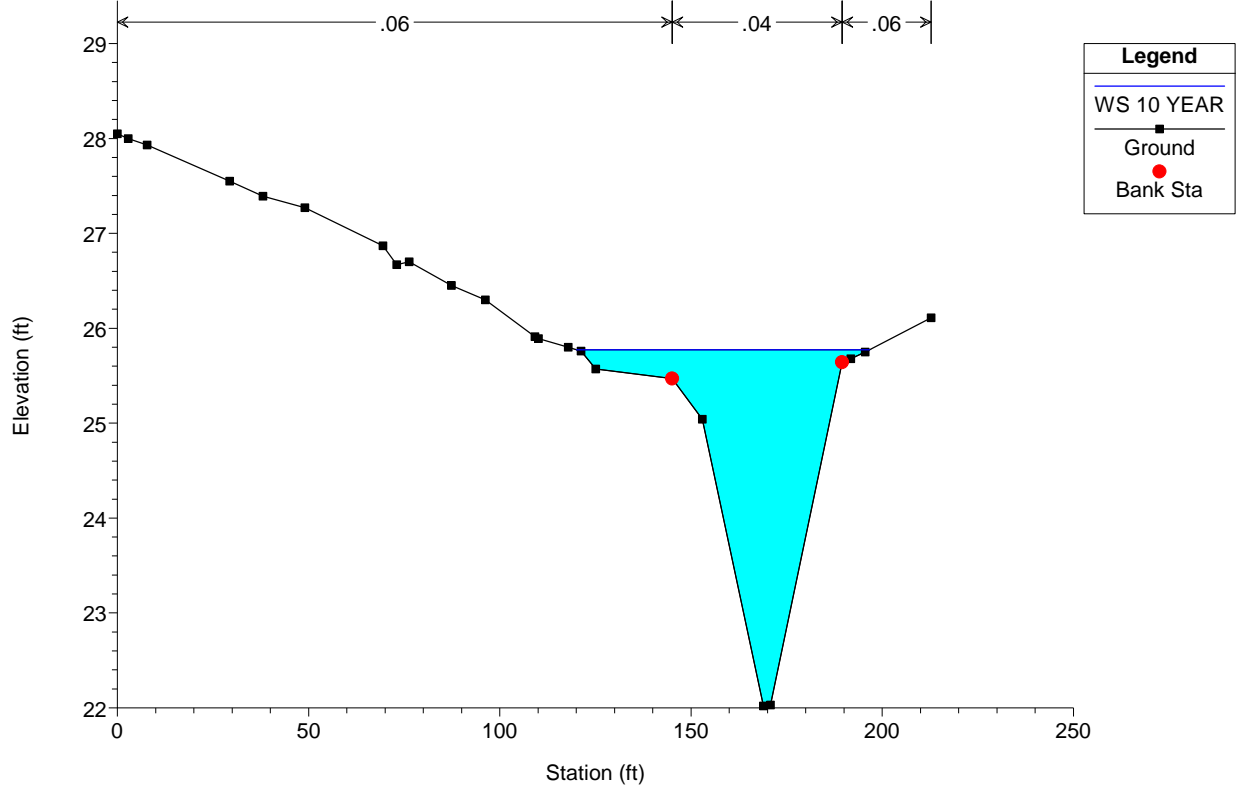
Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
RS = 1450.000



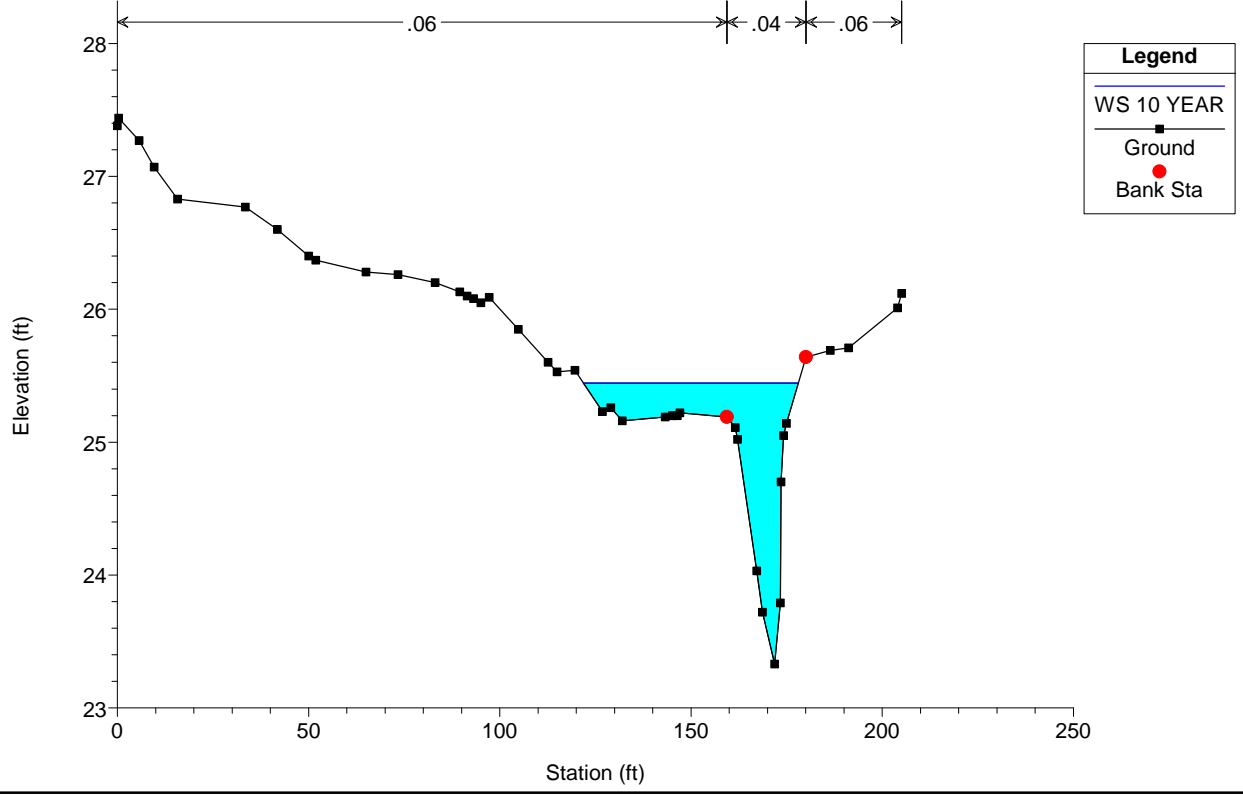
Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
RS = 1400.000



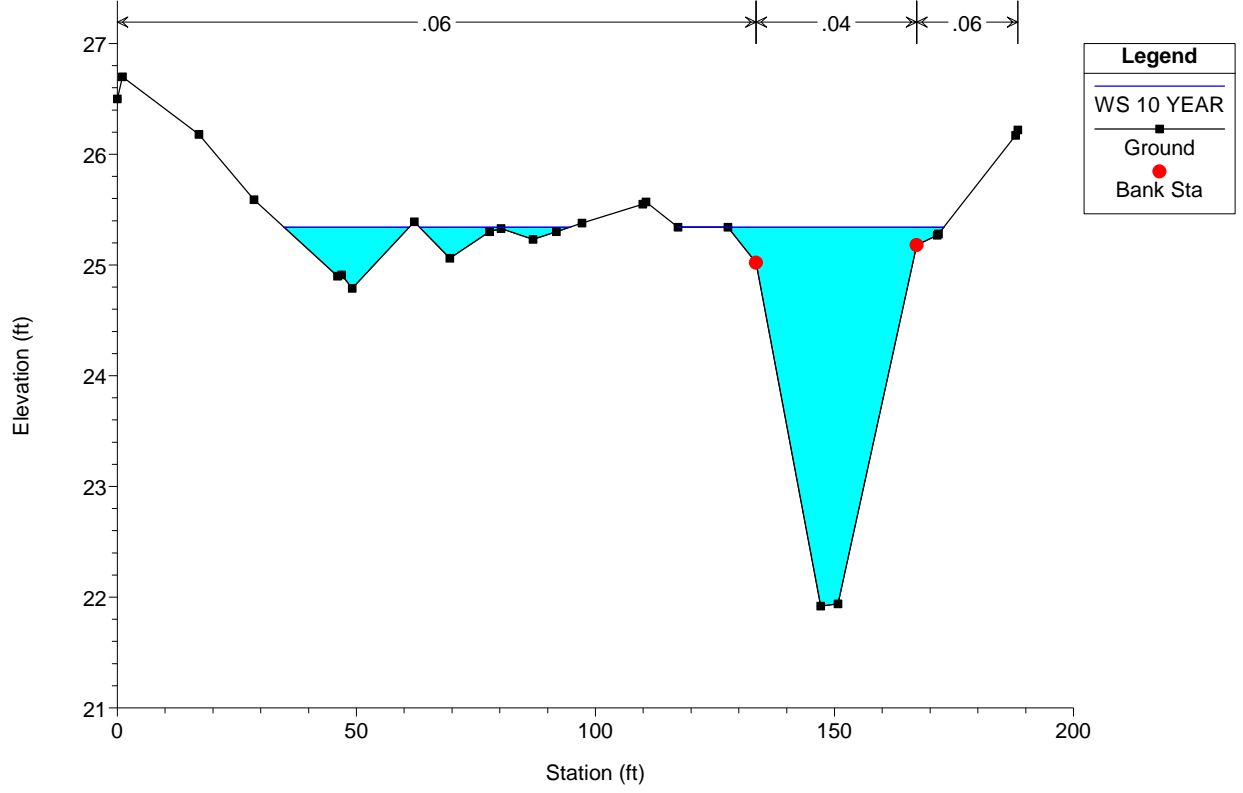
Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
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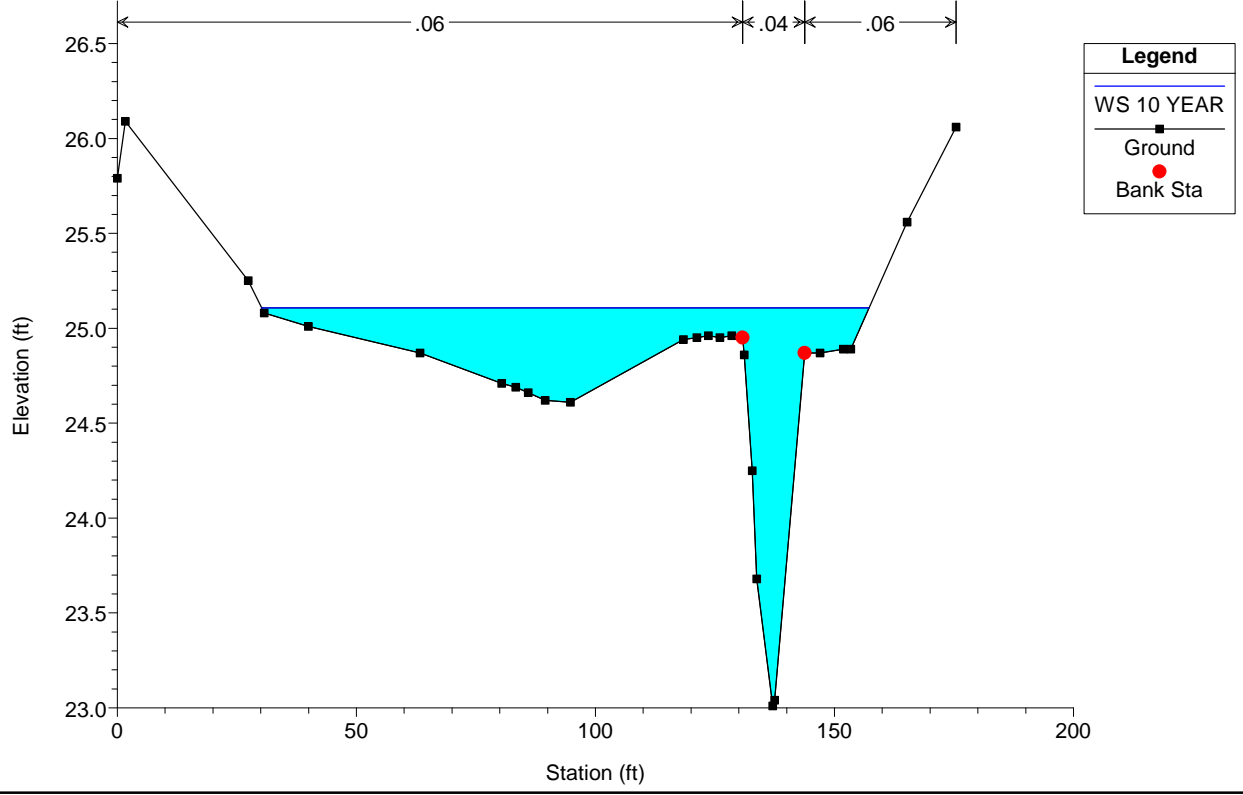
Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
RS = 1300.000

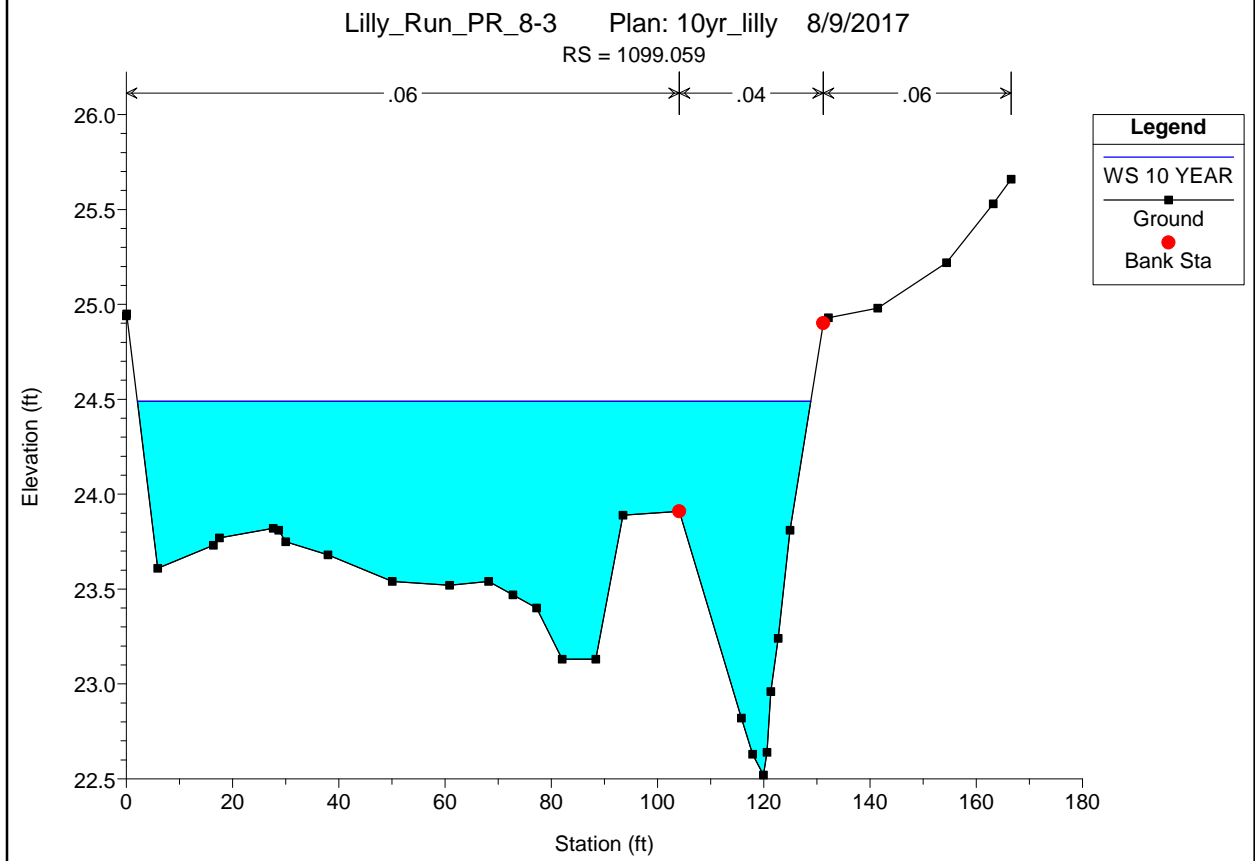
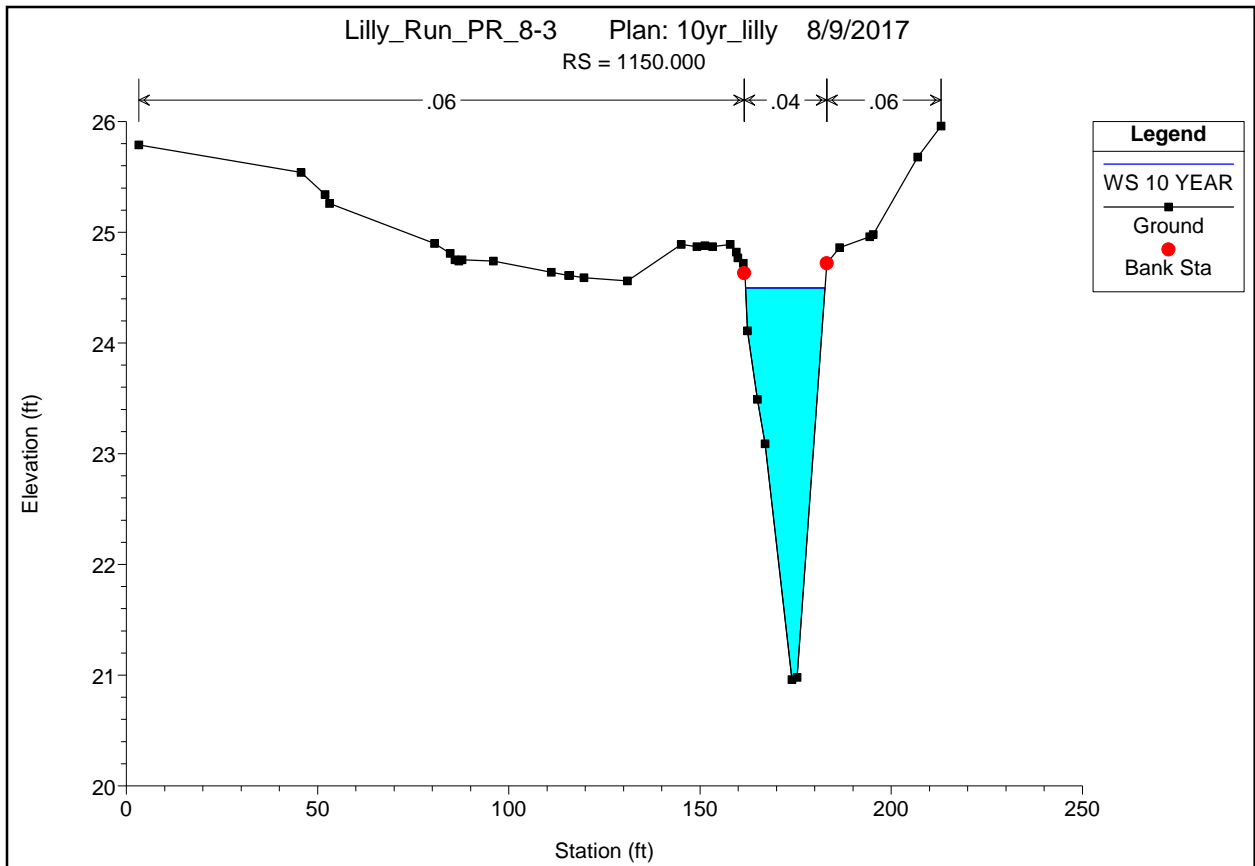


Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
RS = 1250.000

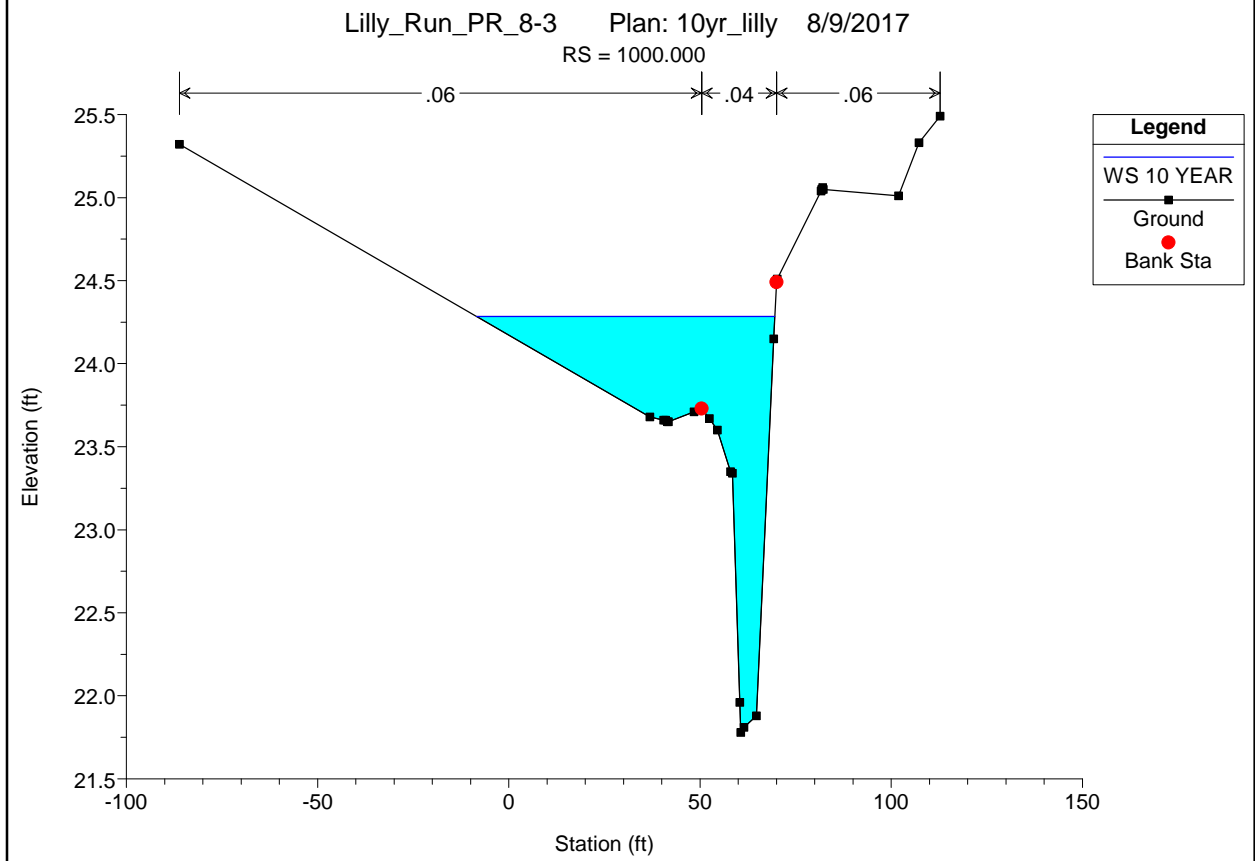
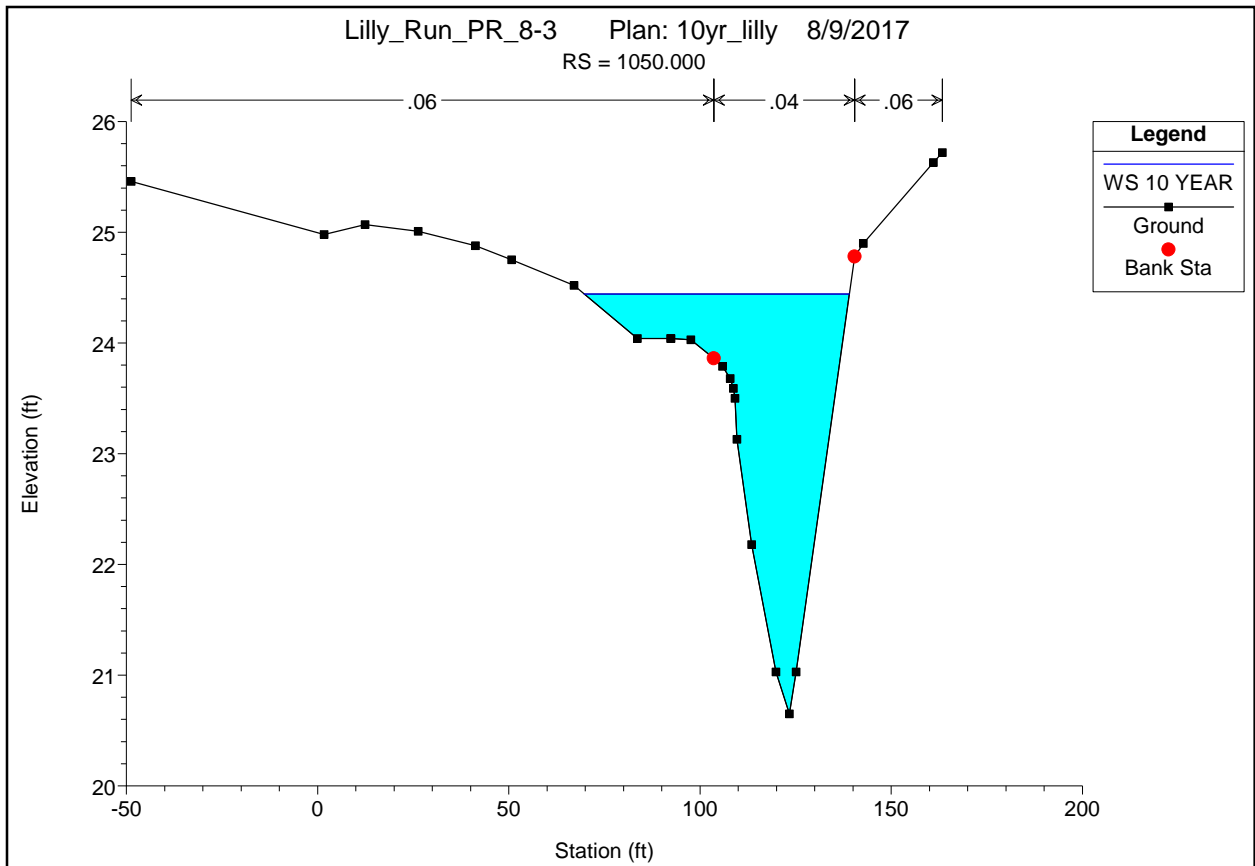


Lilly\_Run\_PR\_8-3 Plan: 10yr\_lilly 8/9/2017  
RS = 1200.000









HEC-RAS Plan: 10yr River: Lilly Run Reach: Reach 1 Profile: 10 YEAR

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
Reach 1	2350.000	10 YEAR	30.03	30.03	0.01	0.02	0.04		63.00	0.00	52.52
Reach 1	2300.000	10 YEAR	29.97	29.61	0.37	0.12	0.10		64.30		18.39
Reach 1	2250.000	10 YEAR	29.60	29.58	0.02	0.12	0.05	0.62	64.88		72.47
Reach 1	2200.000	10 YEAR	29.44	28.96	0.47	0.07	0.13		66.80		13.00
Reach 1	2150.000	10 YEAR	29.17	29.15	0.02	0.07	0.02	1.60	66.12	0.28	125.55
Reach 1	2100.000	10 YEAR	29.09	28.88	0.20	0.28	0.04	16.42	52.88		60.44
Reach 1	2050.000	10 YEAR	28.69	28.63	0.06	0.28	0.02	10.35	60.25		91.62
Reach 1	2000.000	10 YEAR	28.39	28.16	0.23	0.15	0.06	18.20	53.60		52.64
Reach 1	1950.000	10 YEAR	28.18	28.15	0.03	0.14	0.02	7.50	65.53	0.07	115.55
Reach 1	1900.000	10 YEAR	28.01	27.74	0.27	0.10	0.08	6.30	67.97	0.03	60.13
Reach 1	1850.000	10 YEAR	27.71	27.69	0.02	0.11	0.02		75.60		48.92
Reach 1	1800.000	10 YEAR	27.58	27.31	0.27	0.25	0.06	2.99	73.91		38.24
Reach 1	1750.000	10 YEAR	27.27	27.19	0.08	0.19	0.00	0.87	76.90	0.33	55.39
Reach 1	1700.000	10 YEAR	27.08	26.99	0.09	0.09	0.02	31.38	47.29	0.73	85.44
Reach 1	1650.000	10 YEAR	26.97	26.95	0.03	0.12	0.02	8.23	72.27	0.09	116.05
Reach 1	1600.000	10 YEAR	26.84	26.65	0.19	0.05	0.05	21.17	58.81	1.92	106.41
Reach 1	1550.000	10 YEAR	26.64	26.62	0.01	0.05	0.01		82.39	0.71	98.08
Reach 1	1500.000	10 YEAR	26.58	26.50	0.09	0.10	0.01	21.63	58.60	4.17	104.35
Reach 1	1450.000	10 YEAR	26.46	26.42	0.04	0.13	0.02	11.04	72.60	2.06	103.13
Reach 1	1400.000	10 YEAR	26.32	26.11	0.21	0.05	0.06	18.34	65.68	2.88	96.37
Reach 1	1350.000	10 YEAR	25.79	25.77	0.02	0.05	0.03	0.93	87.23	0.04	76.65
Reach 1	1300.000	10 YEAR	25.71	25.45	0.27	0.07	0.07	9.99	79.41		56.19
Reach 1	1250.000	10 YEAR	25.37	25.34	0.03	0.07	0.02	2.20	88.43	0.07	113.37
Reach 1	1200.000	10 YEAR	25.29	25.11	0.18	0.18	0.03	25.60	64.30	2.10	127.05
Reach 1	1150.000	10 YEAR	24.58	24.50	0.09	0.06	0.02		93.20		20.74
Reach 1	1099.059	10 YEAR	24.50	24.49	0.01	0.03	0.00	59.82	34.68		126.75
Reach 1	1050.000	10 YEAR	24.47	24.44	0.02	0.06	0.01	3.02	92.68		69.29
Reach 1	1000.000	10 YEAR	24.40	24.28	0.12			19.75	77.25		77.92

HEC-RAS Plan: 10yr River: Lilly Run Reach: Reach 1 Profile: 10 YEAR

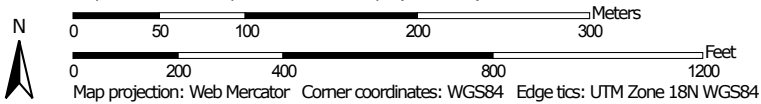
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach 1	2350.000	10 YEAR	63.00	27.01	30.03		30.03	0.000129	0.63	99.48	52.52	0.08
Reach 1	2300.000	10 YEAR	64.30	28.52	29.61	29.61	29.97	0.027187	4.87	13.21	18.39	1.01
Reach 1	2250.000	10 YEAR	65.50	26.80	29.58		29.60	0.000834	1.08	62.52	72.47	0.19
Reach 1	2200.000	10 YEAR	66.80	27.44	28.96	28.96	29.44	0.025908	5.51	12.12	13.00	1.01
Reach 1	2150.000	10 YEAR	68.00	25.97	29.15		29.17	0.000469	1.27	65.11	125.55	0.16
Reach 1	2100.000	10 YEAR	69.30	27.52	28.88	28.88	29.09	0.017786	4.06	24.91	60.44	0.80
Reach 1	2050.000	10 YEAR	70.60	26.05	28.63		28.69	0.002748	2.16	46.82	91.62	0.34
Reach 1	2000.000	10 YEAR	71.80	26.94	28.16	28.15	28.39	0.017683	4.37	24.25	52.64	0.83
Reach 1	1950.000	10 YEAR	73.10	25.21	28.15		28.18	0.001179	1.48	63.66	115.55	0.23
Reach 1	1900.000	10 YEAR	74.30	26.11	27.74	27.74	28.01	0.013317	4.39	22.45	60.13	0.75
Reach 1	1850.000	10 YEAR	75.60	24.62	27.69		27.71	0.000789	1.21	62.32	48.92	0.19
Reach 1	1800.000	10 YEAR	76.90	25.75	27.31	27.25	27.58	0.017594	4.24	20.32	38.24	0.83
Reach 1	1750.000	10 YEAR	78.10	23.91	27.19		27.27	0.002317	2.35	36.82	55.39	0.33
Reach 1	1700.000	10 YEAR	79.40	25.24	26.99		27.08	0.006903	3.02	41.74	85.44	0.53
Reach 1	1650.000	10 YEAR	80.60	23.94	26.95		26.97	0.000831	1.37	76.85	116.05	0.20
Reach 1	1600.000	10 YEAR	81.90	24.84	26.65	26.65	26.84	0.019365	4.00	32.92	106.41	0.84
Reach 1	1550.000	10 YEAR	83.10	23.02	26.62		26.64	0.000354	0.86	100.36	98.08	0.13
Reach 1	1500.000	10 YEAR	84.40	24.46	26.50		26.58	0.005429	2.75	48.97	104.35	0.48
Reach 1	1450.000	10 YEAR	85.70	23.09	26.42		26.46	0.001100	1.76	70.92	103.13	0.23
Reach 1	1400.000	10 YEAR	86.90	24.02	26.11	26.11	26.32	0.011584	4.20	35.48	96.37	0.70
Reach 1	1350.000	10 YEAR	88.20	22.02	25.77		25.79	0.000352	1.05	89.17	76.65	0.14
Reach 1	1300.000	10 YEAR	89.40	23.33	25.45	25.45	25.71	0.015644	4.38	26.73	56.19	0.78
Reach 1	1250.000	10 YEAR	90.70	21.92	25.34		25.37	0.000519	1.32	78.85	113.37	0.17
Reach 1	1200.000	10 YEAR	92.00	23.01	25.11	25.11	25.29	0.009331	4.00	44.89	127.05	0.64
Reach 1	1150.000	10 YEAR	93.20	20.96	24.50		24.58	0.001896	2.37	39.29	20.74	0.30
Reach 1	1099.059	10 YEAR	94.50	22.52	24.49		24.50	0.000887	1.21	117.62	126.75	0.20
Reach 1	1050.000	10 YEAR	95.70	20.65	24.44		24.47	0.000479	1.29	83.52	69.29	0.16
Reach 1	1000.000	10 YEAR	97.00	21.78	24.28	23.94	24.40	0.005005	3.05	47.13	77.92	0.47

# APPENDIX B

Soil Map—Harford County Area, Maryland




Map Scale: 1:4,390 if printed on A landscape (11" x 8.5") sheet.



## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

### Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

### Water Features



Streams and Canals

### Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

### Background



Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

**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: Harford County Area, Maryland

Survey Area Data: Version 10, Sep 20, 2016

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

Date(s) aerial images were photographed: Mar 26, 2011—Mar 2, 2012

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

## Map Unit Legend

Harford County Area, Maryland (MD600)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
DcB	Delanco silt loam, 3 to 8 percent slopes	2.0	4.6%
EsB2	Elsinboro loam, 2 to 5 percent slopes, moderately eroded	1.2	2.7%
EsC2	Elsinboro loam, 5 to 10 percent slopes, moderately eroded	3.4	7.5%
MlaB	Mattapex silt loam, 2 to 5 percent slopes, Northern Coastal Plain	31.5	70.7%
Ot	Othello silt loams, 0 to 2 percent slopes, Northern Coastal Plain	6.5	14.5%
<b>Totals for Area of Interest</b>		<b>44.5</b>	<b>100.0%</b>



## RECORD OF SOIL / ROCK EXPLORATION

Contracted With AECOM Boring # SB-1  
 Project Name Lilly Run Wetland Restoration - City of Havre De Grace Job # 17-0025  
 Location Havre De Grace, MD

### SAMPLER

Datum \_\_\_\_\_ Hammer Wt. 140 lb Hole Diameter 8 in Foreman M.F.  
 Surf. Elev. 30.0 ft Hammer Drop 30 in Rock Core Dia. N/A Inspector S.H.  
 Date Started 5/31/17 Spoon Size 2 in Boring Method HSA Date Completed 5/31/17

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE					BORING & SAMPLE NOTES
					Cond	Blows/6"	No.	Type	Rec (in)	
29.3	<b>7" TOPSOIL</b>	0.7								1. Water encountered at 4.0 ft.  2. Borehole offset 6 feet north for infiltration casing. Water encountered at infiltration location at a depth of 2.5 ft. Infiltraton casing not placed.
28.0	Brown and gray, moist, soft, silty <b>CLAY</b>	2.0		D/I	1-1-2-3	1	DS	18		
26.0	Brown and gray, moist to wet, loose, silty fine <b>SAND</b>	4.0		D/I	1-3-5-7	2	DS	24		
	Brown and gray, moist, stiff, lean <b>CLAY</b> , little fine sand			D/I	3-5-5-6	3	DS	18		
				D/I	3-6-8-10	4	DS	24		
				D/I	3-7-7-9	5	DS	22		
20.0	Bottom of Boring at 10.0 ft	10.0		10						
				15						
				20						

**SAMPLER TYPE**

DS - DRIVEN SPLIT SPOON  
 PT - PRESSED SHELBY TUBE  
 CA - CONTINUOUS FLIGHT AUGER  
 RC - ROCK CORE

**SAMPLE CONDITIONS**

D - DISINTEGRATED  
 I - INTACT  
 U - UNDISTURBED  
 L - LOST

**GROUNDWATER DEPTH**

AT COMPLETION Dry ft  
 AFTER \_\_\_\_\_ HRS. \_\_\_\_\_ ft  
 AFTER 24 HRS. \_\_\_\_\_ ft  
 CAVED AT 6.7 ft

**BORING METHOD**

HSA - HOLLOW STEM AUGERS  
 CFA - CONTINUOUS FLIGHT AUGERS  
 DC - DRIVING CASING  
 MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS





## RECORD OF SOIL / ROCK EXPLORATION

Contracted With AECOM Boring # SB-2  
 Project Name Lilly Run Wetland Restoration - City of Havre De Grace Job # 17-0025  
 Location Havre De Grace, MD

### SAMPLER

Datum \_\_\_\_\_ Hammer Wt. 140 lb Hole Diameter 8 in Foreman M.F.  
 Surf. Elev. 26.0 ft Hammer Drop 30 in Rock Core Dia. N/A Inspector S.H.  
 Date Started 5/30/17 Spoon Size 2 in Boring Method HSA Date Completed 5/30/17

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE					BORING & SAMPLE NOTES
					Cond	Blows/6"	No.	Type	Rec (in)	
25.5	<b>6" TOPSOIL</b>	0.5	[Symbol: Dotted pattern]	5						1. Water encountered at 4.0 ft.
	Brown and gray, moist, medium stiff, lean <b>CLAY</b> , little to some fine sand, some roots 1 ft to 2 ft		[Symbol: Diagonal lines]	4	D/I	2-3-2-2	1	DS	18	
22.0		4.0	[Symbol: Diagonal lines]	5	D/I	2-3-1-9	2	DS	17	
	Brown and red-brown, wet, dense, poorly graded coarse <b>SAND</b> , some gravel		[Symbol: Dotted pattern]	6.0	D/I	8-11-20-32	3	DS	15	
20.0		6.0	[Symbol: Diagonal lines]	10	D/I	4-3-4-7	4	DS	16	
	Brown, moist, medium stiff to stiff, lean <b>CLAY</b> , trace to little fine sand		[Symbol: Diagonal lines]	10	D/I	5-4-4-4	5	DS	18	
16.0	Bottom of Boring at 10.0 ft	10.0	[Symbol: Diagonal lines]	15						
			[Symbol: Diagonal lines]	20						

**SAMPLER TYPE**

DS - DRIVEN SPLIT SPOON  
 PT - PRESSED SHELBY TUBE  
 CA - CONTINUOUS FLIGHT AUGER  
 RC - ROCK CORE

**SAMPLE CONDITIONS**

D - DISINTEGRATED  
 I - INTACT  
 U - UNDISTURBED  
 L - LOST

**GROUNDWATER DEPTH**

AT COMPLETION 2.0 ft  
 AFTER \_\_\_\_\_ HRS. \_\_\_\_\_ ft  
 AFTER 24 HRS. 1.0 ft  
 CAVED AT 4.7 ft

**BORING METHOD**

HSA - HOLLOW STEM AUGERS  
 CFA - CONTINUOUS FLIGHT AUGERS  
 DC - DRIVING CASING  
 MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS



## RECORD OF SOIL / ROCK EXPLORATION

Contracted With AECOM Boring # SB-3  
 Project Name Lilly Run Wetland Restoration - City of Havre De Grace Job # 17-0025  
 Location Havre De Grace, MD

### SAMPLER

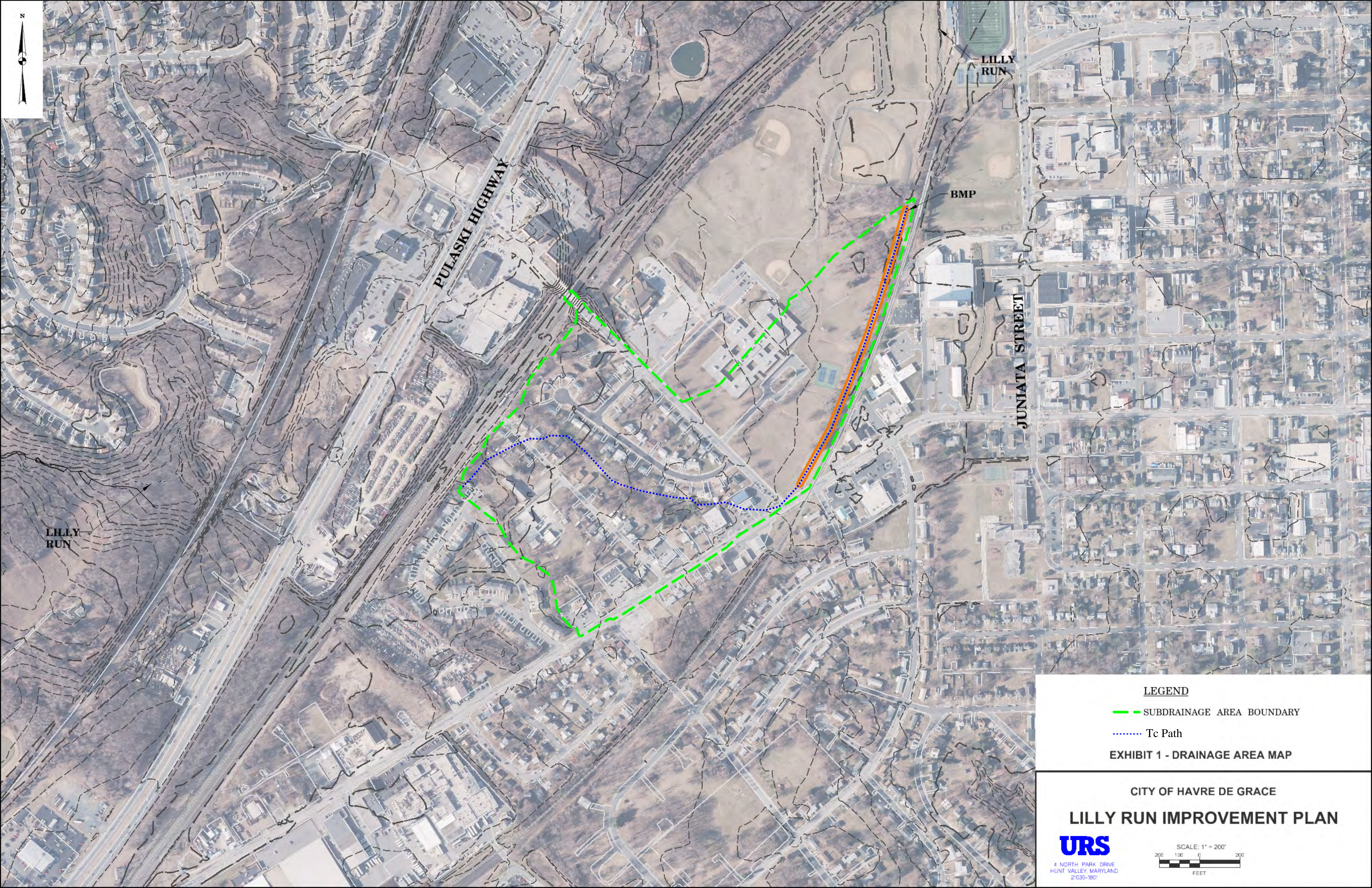
Datum \_\_\_\_\_ Hammer Wt. 140 lb Hole Diameter 8 in Foreman M.F.  
 Surf. Elev. 25.0 ft Hammer Drop 30 in Rock Core Dia. N/A Inspector S.H.  
 Date Started 5/30/17 Spoon Size 2 in Boring Method HSA Date Completed 5/30/17

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE					BORING & SAMPLE NOTES
					Cond	Blows/6"	No.	Type	Rec (in)	
24.5	<b>6" TOPSOIL</b>	0.5	[Symbol: Dotted pattern]	5						1. Water encountered at 6.0 ft.
	Brown and gray, moist, soft to stiff, lean <b>CLAY</b> , with sand		[Symbol: Diagonal lines]	5	D/I	3-2-1-2	1	DS	18	
			[Symbol: Diagonal lines]	5	D/I	3-5-5-6	2	DS	16	
			[Symbol: Diagonal lines]	5	D/I	3-5-6-6	3	DS	12	
19.0		6.0	[Symbol: Dotted pattern]	5	D/I	3-7-10-13	4	DS	15	
	Dark brown, wet, medium dense, poorly graded coarse <b>SAND AND GRAVEL</b>		[Symbol: Dotted pattern]	5	D/I	3-6-17-28	5	DS	15	
16.0		9.0	[Symbol: Diagonal lines]	10						
	Brown, moist, very stiff, sandy lean <b>CLAY</b>		[Symbol: Diagonal lines]	10						
15.0	Bottom of Boring at 10.0 ft	10.0	[Symbol: Diagonal lines]	10						
			[Symbol: Diagonal lines]	15						
			[Symbol: Diagonal lines]	20						



<b>SAMPLER TYPE</b>	<b>SAMPLE CONDITIONS</b>	<b>GROUNDWATER DEPTH</b>	<b>BORING METHOD</b>
DS - DRIVEN SPLIT SPOON PT - PRESSED SHELBY TUBE CA - CONTINUOUS FLIGHT AUGER RC - ROCK CORE	D - DISINTEGRATED I - INTACT U - UNDISTURBED L - LOST	AT COMPLETION <u>2.0</u> ft AFTER _____ HRS. _____ ft AFTER 24 HRS. <u>1.5</u> ft CAVED AT <u>3.8</u> ft	HSA - HOLLOW STEM AUGERS CFA - CONTINUOUS FLIGHT AUGERS DC - DRIVING CASING MD - MUD DRILLING
STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS			

RECORD OF SOIL EXPLORATION LILLY RUN BORING LOGS.GPJ TLB2010.GDT 6/7/17

# APPENDIX C



**LEGEND**

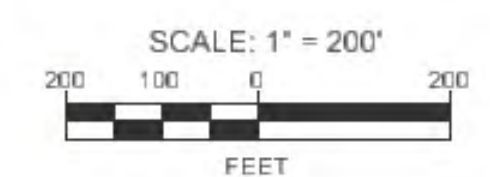
-  SUBDRAINAGE AREA BOUNDARY
-  Tc Path

**EXHIBIT 1 - DRAINAGE AREA MAP**

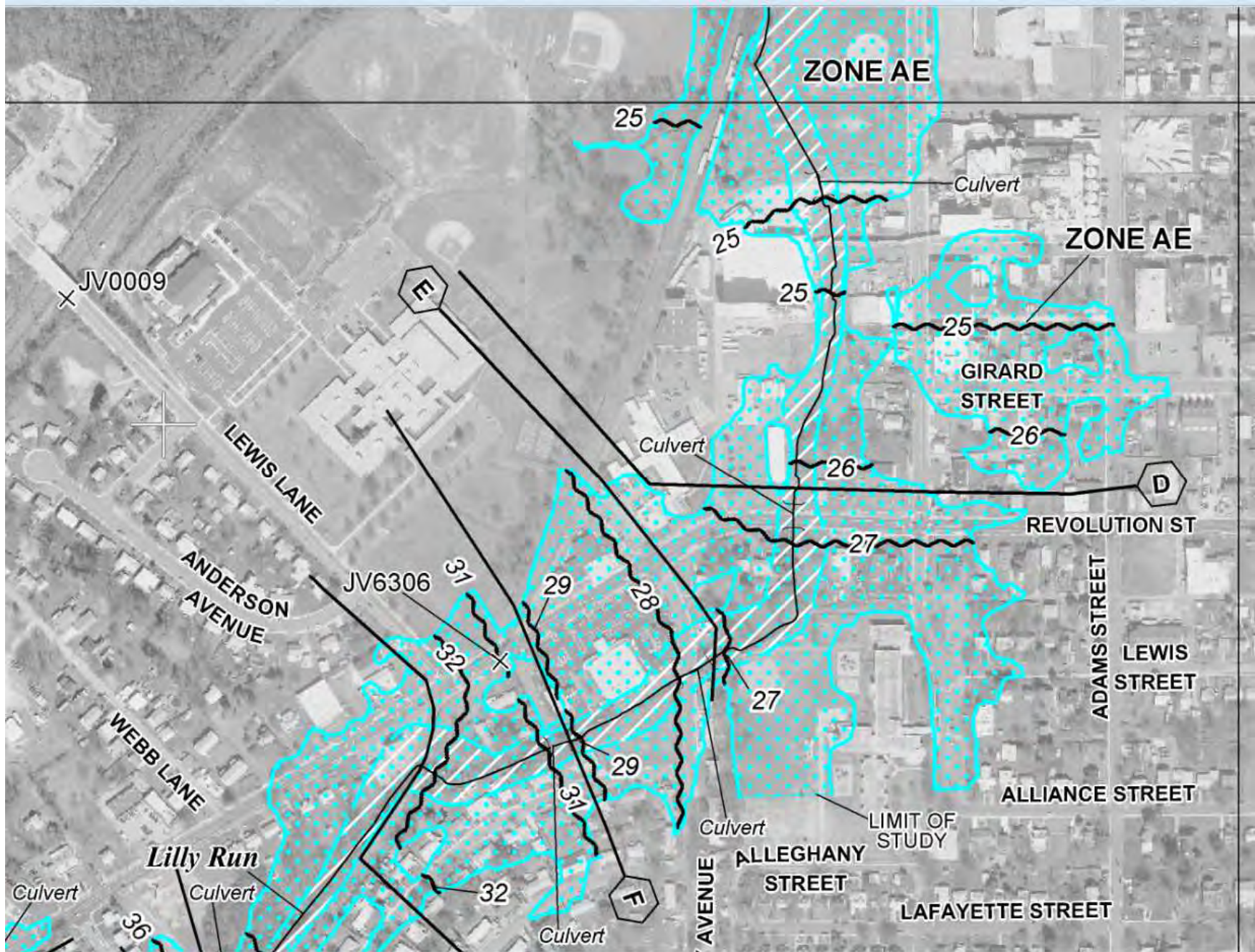
**CITY OF HAVRE DE GRACE**

**LILLY RUN IMPROVEMENT PLAN**

**URS**  
4 NORTH PARK DRIVE  
HUNT VALLEY, MARYLAND  
21030-1801



# APPENDIX D



# APPENDIX E

**Pre-Development Conditions:**

HSG	RCN	Area (ac)	Percent (%)
A	38		0.0%
B	55		0.0%
C	70	32.35	70.0%
D	77	13.87	30.0%

Total 46.22

Composite RCN

**RCN = 82**

**Target P<sub>E</sub> Using Table 5.3:**

Imp. Area = 13.63 ac  
 Total Area = 46.22 ac  
 I = 29.5%

P<sub>E</sub> by Soil Group

A = 0 in  
 B = 0 in  
 C = 1.6 in  
 D = 1.2 in

**Target P<sub>E</sub> = 1.0 in**

**Note:** System will be designed for the water quality storm event (1 inch storm).

**Environmental Site Design Volume:**

$R_v = 0.05 + 0.009(I)$   
 $= 0.32$   
 $Q_E = P_E \times R_v$   
 $= 0.316 \text{ in}$   
 $ESD_v = (Q_E \times A) / 12$   
 $= 52934 \text{ cf}$

**1 YR Storm (2.6 in) Runoff Volume**

V1 = 137629 cf

**Recharge Volume Runoff Volume**

Re<sub>v</sub> = 5928 cf

**Environmental Site Design Discharge:**

$CN = 1000 / (10 + 5P_E + 10Q_E - 10(Q_E^2 + 1.25Q_E P_E)^{1/2})$   
 $= 90$   
 $T_c = 42 \text{ min}$  (Assumption)  
 $I_a = 0.23$   
 $I_a / P_E = 0.23$   
 $q_u = 1000$  from Figure D.11.1  
 $Q_p = q_u \times A \times Q_E$   
 $= 22.79 \text{ cfs}$



**Wetland Properties:**

For bio-swale:  $P_E = 15" \times (A_f / A)$  therefore:  $A_f = (P_E \times A) / 15"$

$A_{f, target} = 134223 \text{ sf}$

$A_{f, min} = 2\% \times A$  Check Regulations. 2% Impervious area

$= 11874 \text{ sf}$

**Actual Facility Properties**

Filter Media Depth=	2	ft
Average Bottom Width=	8	ft
Length=	1490	ft
<b><math>A_{f, actual} =</math></b>	<b>11920</b>	<b>sf</b>

Channel Slope=	0.50%	
Side Slopes=	4:1	
Flow Depth=	1.00	ft = 12. in
Flow Velocity=	2	fps (Computed in FlowMaster)

For bio-swale: Swale must temporarily store 75% of ESDv  
**75% of ESD<sub>v</sub> = 39701 cf**

	Length (ft)	Average Bottom (ft)	Average Depth (ft)	Average End Area (sf)	Ponding (cf)
Bay 1	95	6	3	54	4860.0
...					
Bay 13	95	6	3	54	4860.0
				Subtotal	63180
				<b>Total</b>	<b>63180</b>

**Recharge Volume**

$Re_v = \text{Length} \times \text{Bottom Width} \times \text{Stone Depth} \times 0.4$

Stone Depth = 18 in

$Re_v = 7152 \text{ cf}$

**Total Storage Provided:**

Total Storage = Total Bay Volume + Recharge Volume

**Total Storage = 70332 cf**

**Equation 1. Calculate Urban Pre-BMP Load**

***Nitrogen***

Number of impervious acres in treatment area

13.63

impervious acre loading rate (FROM Step 3A)

17.7

Total Pre-BMP Load

241.251

***Phosphorus***

Number of impervious acres in treatment area

13.63

impervious acre loading rate (FROM Step 3A)

1.58

Total Pre-BMP Load

21.5354

***Sediment***

Number of impervious acres in treatment area

13.63

impervious acre loading rate (FROM Step 3A)

651

Total Pre-BMP Load

8873.13

**Equation 2. Calculate Urban Post-BMP Load**

***Nitrogen***

Number of pervious acres in treatment area

32.59

Pervious acre loading rate (FROM Step 3A)

11.6

Total Pervious Load

378.044

Total Load Reduction

619.295

***Phosphorus***

Number of pervious acres in treatment area

32.59

Pervious acre loading rate (FROM Step 3A)

0.27

Total Pervious Load

8.7993

Total Load Reduction

30.3347

***Sediment***

Number of pervious acres in treatment area

32.59

Pervious acre loading rate (FROM Step 3A)

97

Total Pervious Load

3161.23

Total Load Reduction

12034.36

BMP/Project Type (bioretention, expanded tree pit, etc.)	Surface area of practice (acres)	Impervious Acres in Drainage Area	Ponding depth (ft.)	Runoff storage volume (ac. Ft.)	runoff depth treated per impervious acres (inches)	TN % reduction	TP % reduction	TSS % reduction	TN Total Pre-BMP Load (from Step 3b)	TP Total Pre-BMP Load (from Step 3b)	TSS Total Pre-BMP Load (from Step 3b)	TN reduced (lbs/yr)	TP reduced (lbs/yr)	TSS reduced (lbs/yr)
Bioswale	0.27	13.63	3.30	0.90	0.80	56%	65%	70%	241.251	21.5354	8873.13	134.08	13.99	6176.84