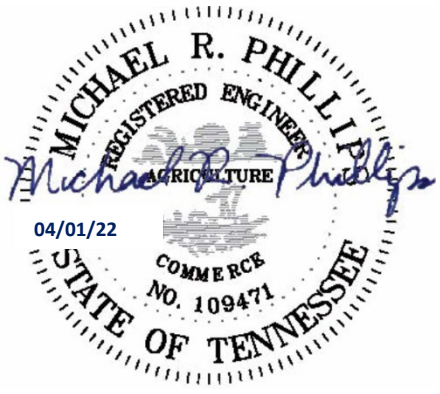
I-75 Interchange at I-24 Design-Build (Phase 2)
I-24 and Ramp 'O' Box Culverts over
Spring Creek Tributary
Floodplain Feasibility Study

Hamilton County, TN

Prepared for:

TN TDOT Department of Transportation

Prepared by:



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April 1, 2022

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1.1 INTRODUCTION

The project consists of roadway, bridge and drainage improvements associated with the widening of I-24 in Hamilton County, Tennessee.

This report documents potential floodplain impacts associated with Phase 2 of the project, which includes roadway widening and associated extensions of box culverts that cross over Spring Creek Tributary along the proposed project alignment, which is within a Detailed Zone AE Special Flood Hazard Area (SFHA), as designated on the FEMA Flood Insurance Rate Map (FIRM) for Hamilton County (see **Exhibit 1**). In addition to the box culvert extensions, this study documents impacts to the SFHA associated with widened roadway embankments. The overall purpose of this study is to determine the feasibility of constructing the roadway embankments and culvert extensions within the SFHA without causing a significant rise in the existing base flood elevations (BFEs) or requiring conditional FEMA revisions to the floodplain.

This report provides information on the preliminary hydraulic design for the box culvert crossings at Spring Creek Tribitary and associated potential floodplain impacts.

1.2 FEMA REGULATED FLOODPLAIN

Spring Creek Tributary is mapped within the regulatory Zone AE floodplain of Spring Creek, but the tributary has not been studied by FEMA (i.e., no Base Flood Elevations have been determined and no Floodway has been delineated). The subject tributary is within the backwater of Spring Creek and the floodplain for the tributary has been delineated based on the BFEs determined for Spring Creek. A copy of the effective FIRM is included in **Exhibit 1** (FIRM Panel Number 47065C0363G, February 3, 2016).

The proposed project will be subject to various local floodplain criteria as discussed in the following sections.

1.3 REGULATORY FLOODPLAIN CRITERIA

In the project area, the Spring Creek Tributary's floodplain lies within the Cities of Chattanooga and East Ridge. Any impacts to floodplain elevations, channel velocities or potential erosion will likely impact both communities. Both Chattanooga and East Ridge participate in the National Flood Insurance Program. Therefore, the local floodplain ordinances of both cities, as well as FEMA regulations, will be applicable to the proposed project.

It is advisable for the D-B team to make every effort to design the project to meet local floodplain ordinance requirements. It will be critical for the D-B team to coordinate closely with the Floodplain Administrators of Chattanooga and East Ridge to determine if coordination with FEMA in the form of a Conditional Letter of Map Revision (CLOMR) will be required prior to construction. If a CLOMR is required, coordination with FEMA in the form of a final LOMR based on as-built survey of the completed project will be required.

1.4 METHODOLOGY

The hydraulic analysis discussed in this study was performed in accordance with the TDOT Drainage Manual, the TDOT Design Procedures for Hydraulic Structures, and using standard engineering practice.

This portion of the project (Phase 2) is within a FEMA-designated floodplain along Spring Creek Tributary and is an interstate with four or more lanes. Therefore, in accordance with the TDOT Design Procedures for Hydraulic Structures, the 100-year storm was used as the design event. Because of FEMA flood zone and local floodplain ordinance implications, the 100-year headwater elevation was considered the primary design parameter. The official FEMA Flood Insurance Rate Map is included as Exhibit 1.

Exhibit 2 shows the locations of the two box culvert extensions studied for this report. Both are existing double 8-ft-wide by 7-ft-high reinforced concrete box culverts that must be extended to accommodate the proposed roadway improvements.

The best available data was used to compile the data necessary to evaluate the floodplain impacts of the proposed project, including topographic field survey data, field inspection/measurements, and effective FEMA data.

Field Inspection

The sites of the proposed box culvert crossings were visited and photographs and measurements were taken. Surveyed culvert geometry data was verified by field measurements. Photographs of the existing box culvert crossings on Spring Creek Tributary are included in **Appendix 1**.

FEMA Data

An order was made to the FEMA Project Library to request the effective hydraulic model for Spring Creek Tributary. However, no effective hydraulic model was available from the FEMA Project Library for use on this project. Therefore, an existing conditions model was developed from survey and available LiDAR data using HEC-RAS software and boundary conditions from the effective Flood Insurance Study.

Field Survey

Field survey for the project was conducted in 2017 by TDOT's consultant, Wiser Consultants. The survey data was used extensively in the hydraulic analysis of the Spring Creek Tributary by developing cross sections from the DTM. Refer to Section 1.6 for further discussion of hydraulic model development.

1.5 HYDROLOGY

Stream discharges for Spring Creek Tributary have not been studied by FEMA or included in the Hamilton County Flood Insurance Study. Therefore, Spring Creek Tributary's drainage area and associated discharges were determined using the online StreamStats application (https://streamstats.usgs.gov/), which indicated that the drainage area to the bridges is approximately 2.4 square miles and the 100-year stream discharge was determined to be approximately 1,000 cubic feet per second.

1.6 HYDRAULIC ANALYSES

As discussed in the following sections, hydraulic analyses were performed to evaluate potential floodplain impacts of the proposed roadway widening and box culvert extensions within the floodplain of the Spring Creek Tributary.

Existing Conditions Model

Cross-sectional geometry was developed for the Spring Creek Tributary to include updated topographic field survey data provided by the TDOT survey consultant in the vicinity of the culvert crossings to create the Existing Conditions Model. Refer to Section 1.4 Field Survey for more information. Existing structure geometry, such as road elevations, invert elevations, and up/downstream channel information was taken from the survey data. Surveyed stream cross sections did not span the entire floodplain, and therefore the overbank information was updated using LiDAR topography where necessary.

Proposed (Post-Project) Conditions Model

The Existing Conditions model cross sections and crossing structure information were then modified to account for the new roadway/ramp alignments, widening, and embankment fill material to determine the impacts of the proposed project. This is further discussed below in Section 1.7.

Floodway Analysis

A detailed floodway analysis was not performed as a part of this study since the FIRM does not include a floodway for Spring Creek Tributary.

1.7 PROPOSED ROADWAY AND BOX CULVERT IMPROVEMENTS

Fill within the 100-year Floodplain

As a part of the proposed roadway widening, the roadway embankment will also be widened. The construction of the new embankment will result in fill material being placed within the 100-year floodplain of Spring Creek Tributary. The extent of the fill was taken from the preliminary plans, and the HEC-RAS cross sections were modified where necessary.

The proposed roadway fill impacts nine existing hydraulic cross sections: River Stations 833, 1260 (upstream/downstream culvert sections for I-24), 1676, 1919, 1996 (upstream/downstream culvert sections for Ramp 'O'), 2142, and 2600. The extent of the proposed fill within the floodplain is shown in the following figures (pink lines represent fill material associated with the proposed project).

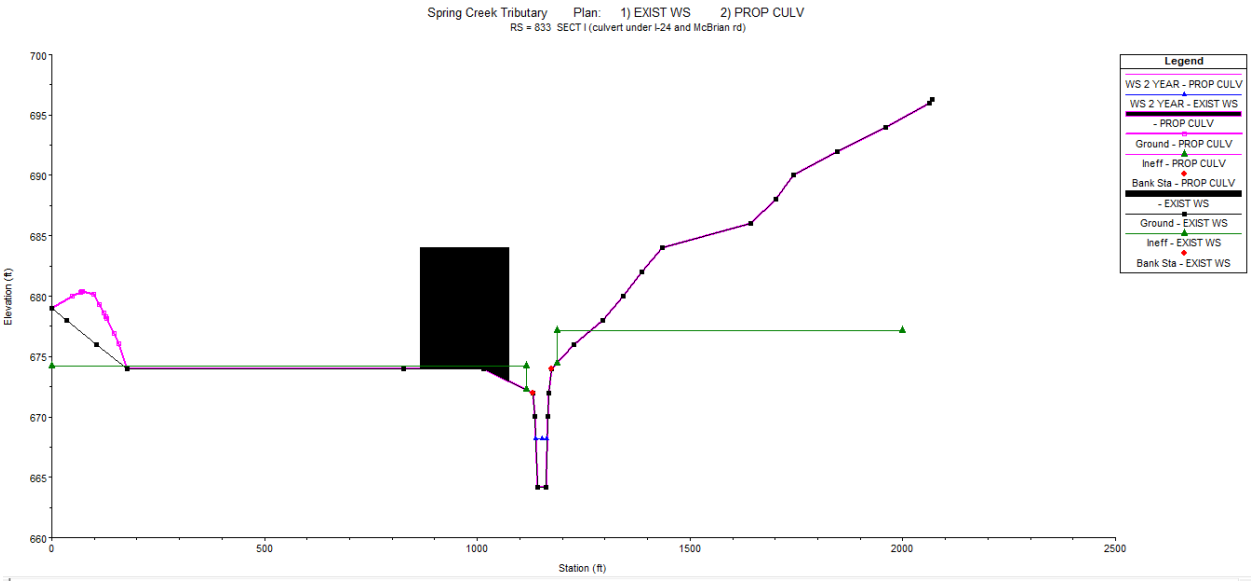


Figure 1. Fill in Floodplain at River Station 833

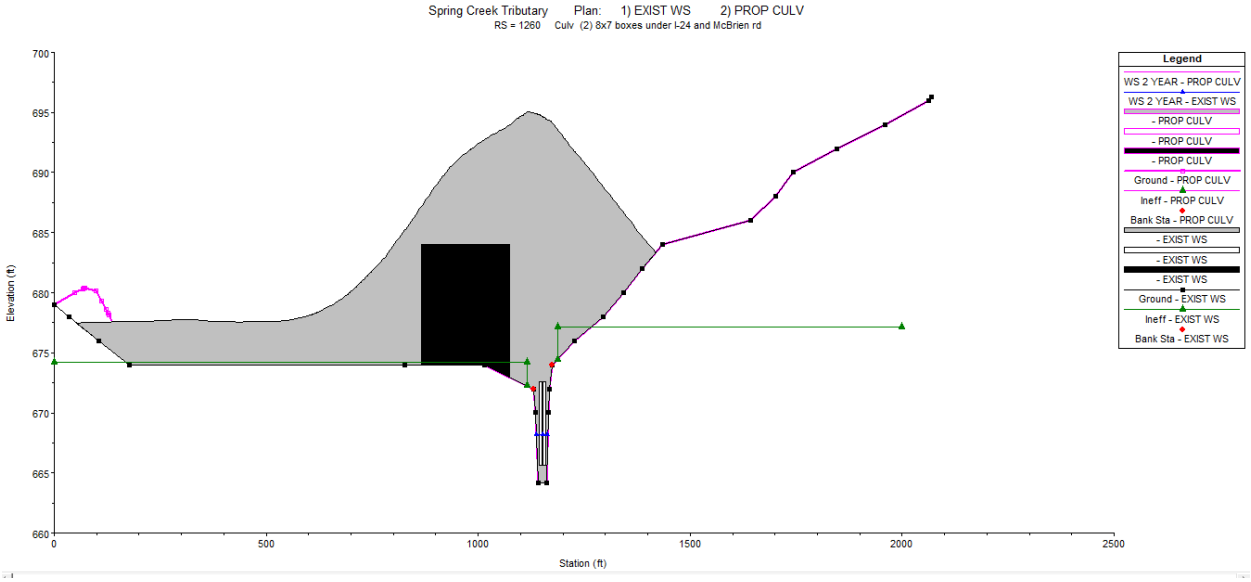


Figure 2. Fill in Floodplain at River Station 1260 (Downstream Culvert Face of I-24)

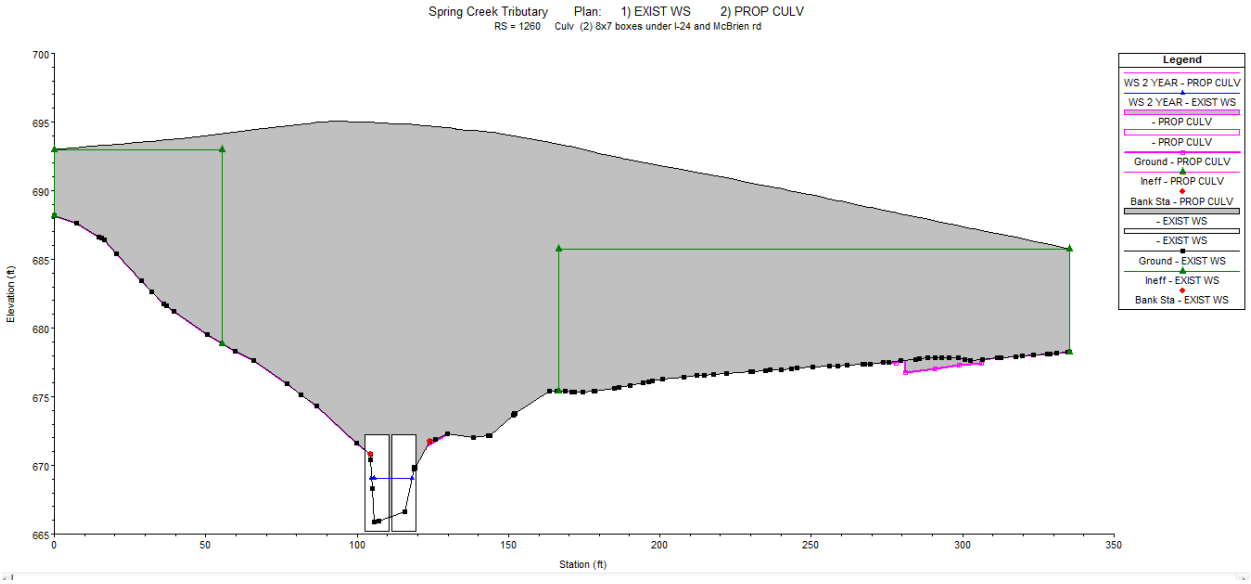


Figure 3. Fill in Floodplain at River Station 1260 (Upstream Culvert Face of I-24)

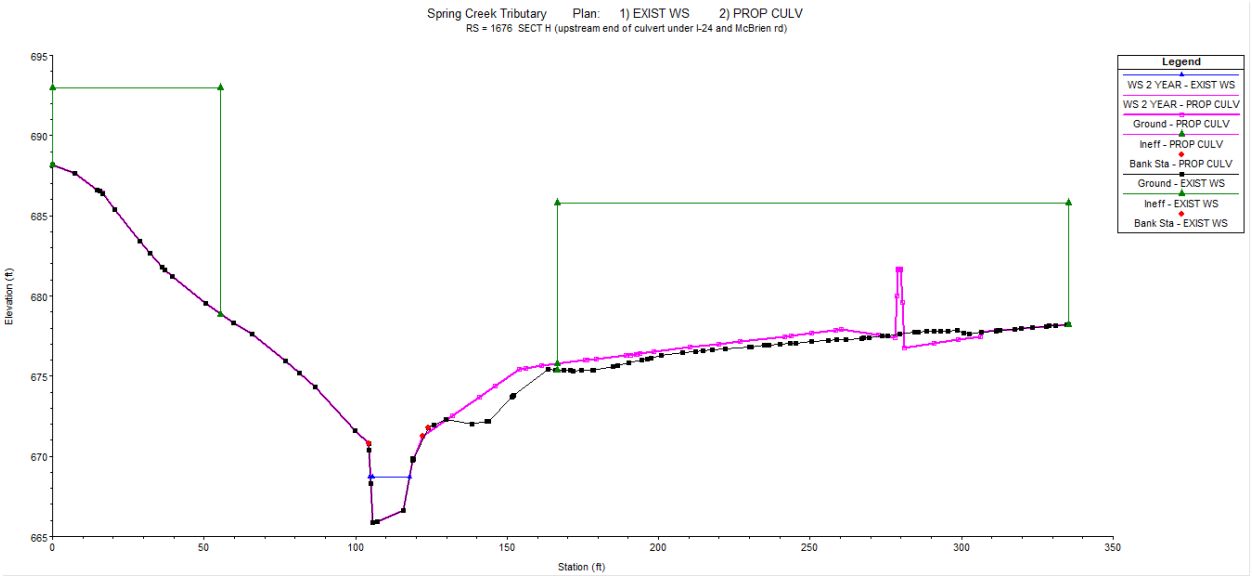


Figure 4. Fill in Floodplain at River Station 1676

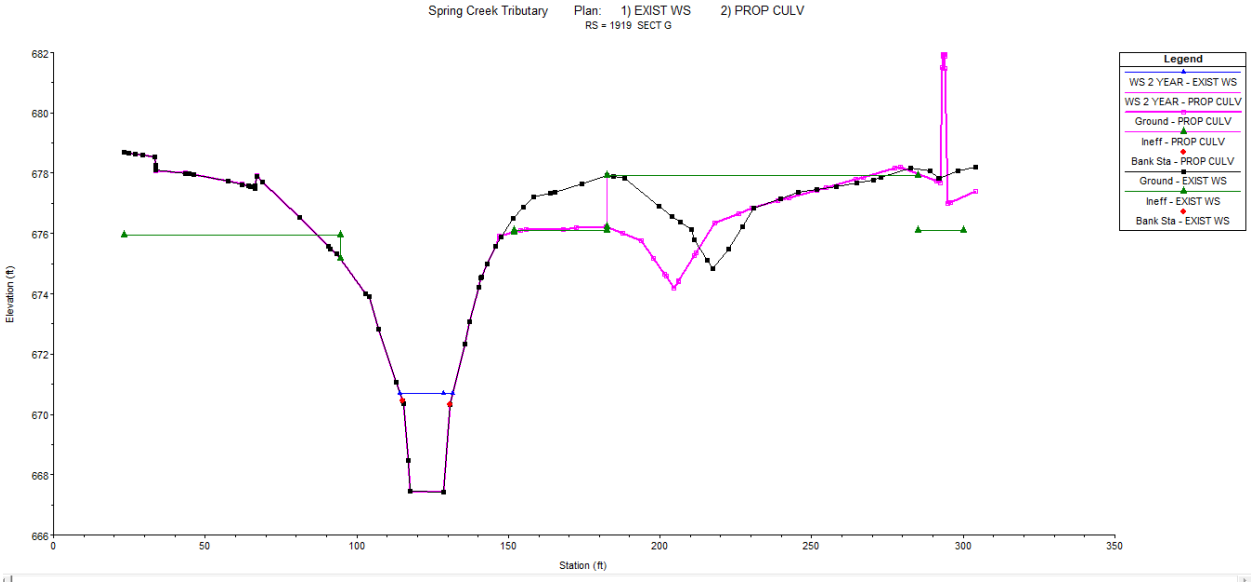


Figure 5. Fill in Floodplain at River Station 1919

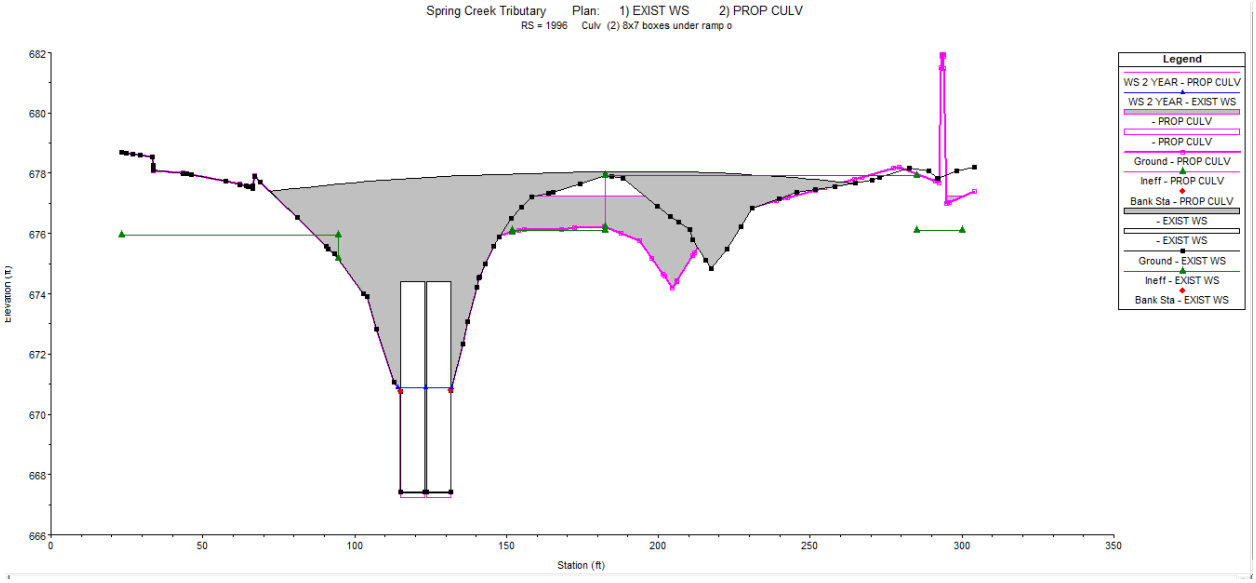


Figure 6. Fill in Floodplain at River Station 1996 (Downstream Culvert Face of Ramp 'O')

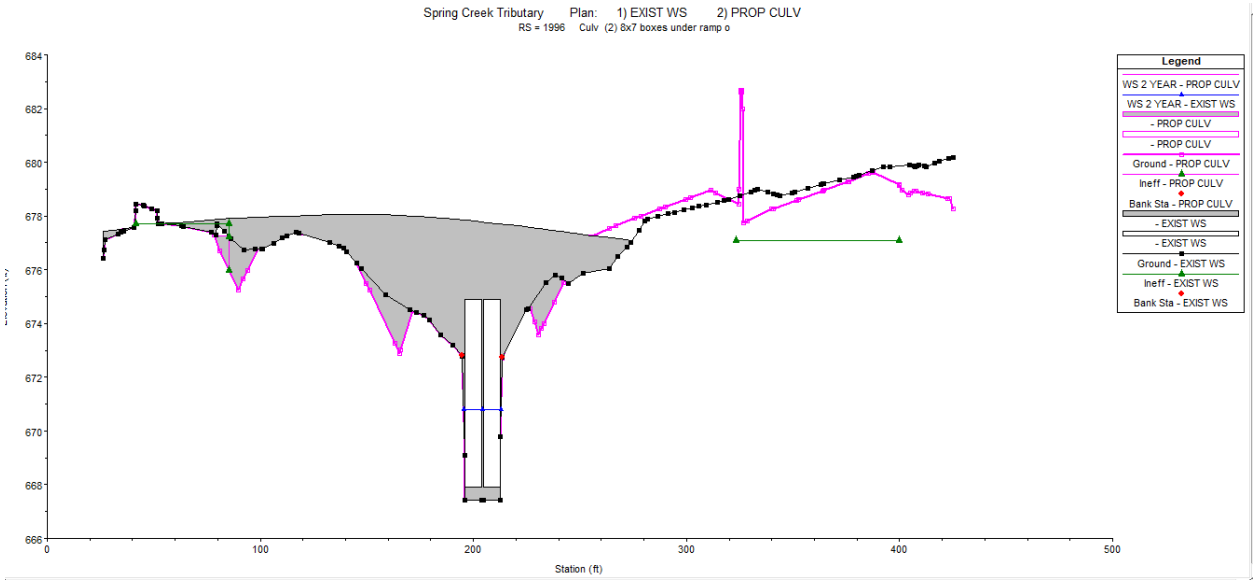


Figure 7. Fill in Floodplain at River Station 1996 (Upstream Culvert Face of Ramp 'O')

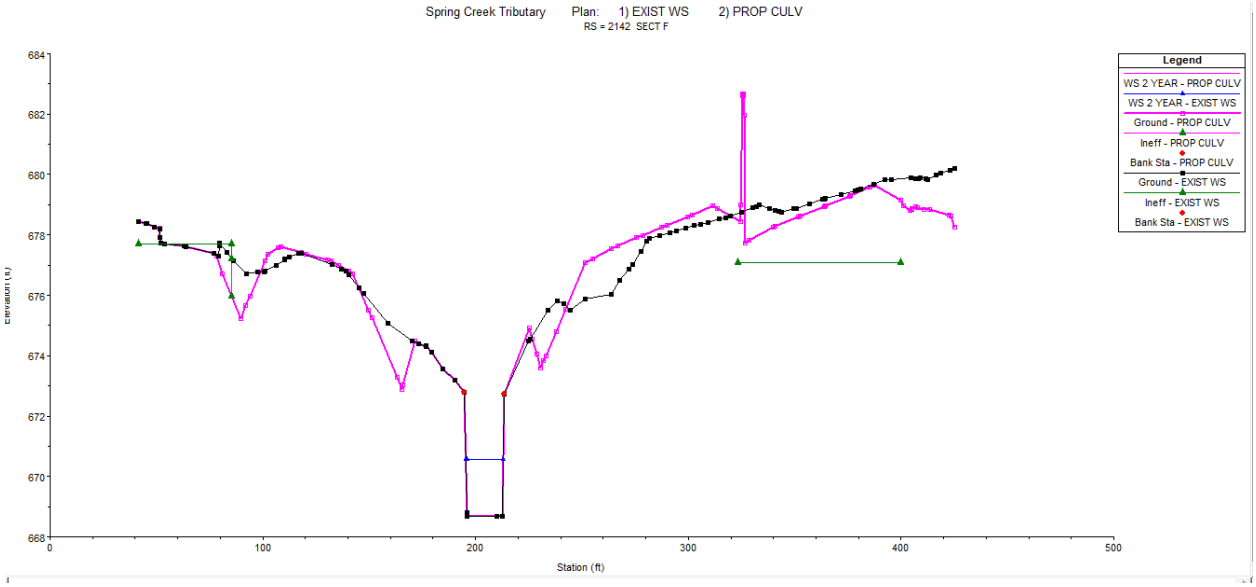


Figure 8. Fill in Floodplain at River Station 2142

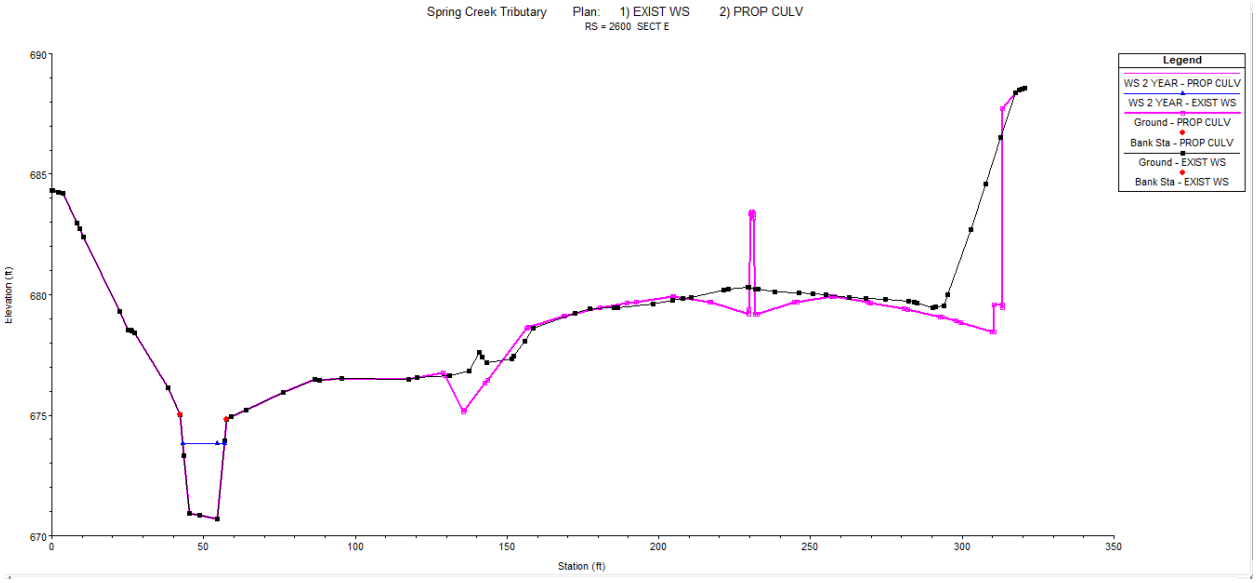


Figure 9. Fill in Floodplain at River Station 2600

Proposed Culvert Extensions

The proposed improvements of I-24 and ramps will result in the extensions of existing box culverts over Spring Creek Tributary. The following table of data shows the existing and proposed culverts that will be extended as a result of the project:

Table 1. Culvert Extension Data

	Existing Length	Proposed Length	Extension Length	US Invert	DS Invert
Ramp 'O' (Downstream Side Extended)	68.43	92.29	23.86	667.90	667.23
I-24/McBrien Road (Upstream Side Extended)	737.15	764.74	27.59	665.19*	665.60*

*Note: Existing survey indicates an adverse culvert slope.

The figures on the following pages show the proposed culvert extensions. Refer to the Functional Plans for details of the culverts and roadways.

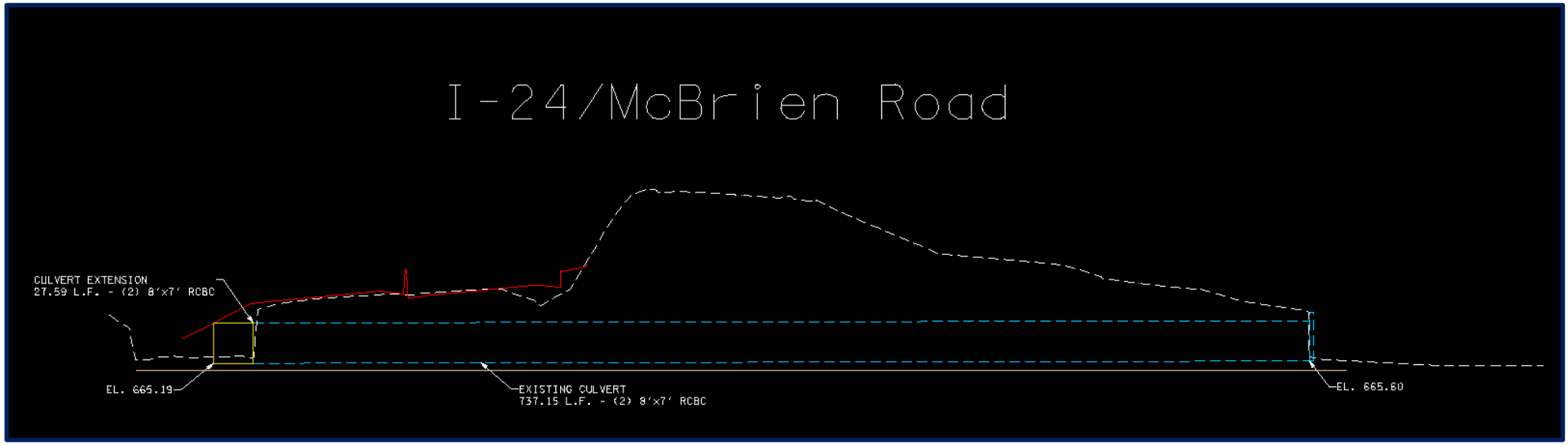


Figure 10. I-24/McBrien Road Box Culvert Extension (Upstream Side Extended 27.59 Feet)

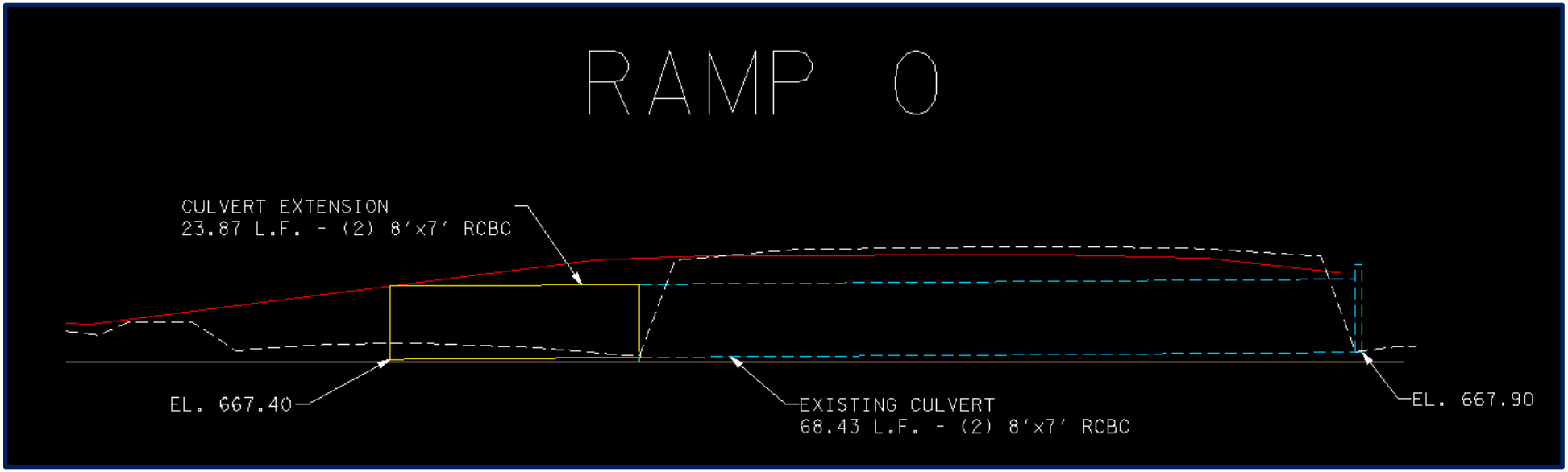


Figure 11. Ramp 'O' Box Culvert Extension (Downstream Side Extended 23.86 Feet)

1.8 RESULTS OF HYDRAULIC ANALYSES

Hydraulic model (HEC-RAS) output and results are included in Appendix 2 (Existing Conditions) and Appendix 3 (Proposed Conditions).

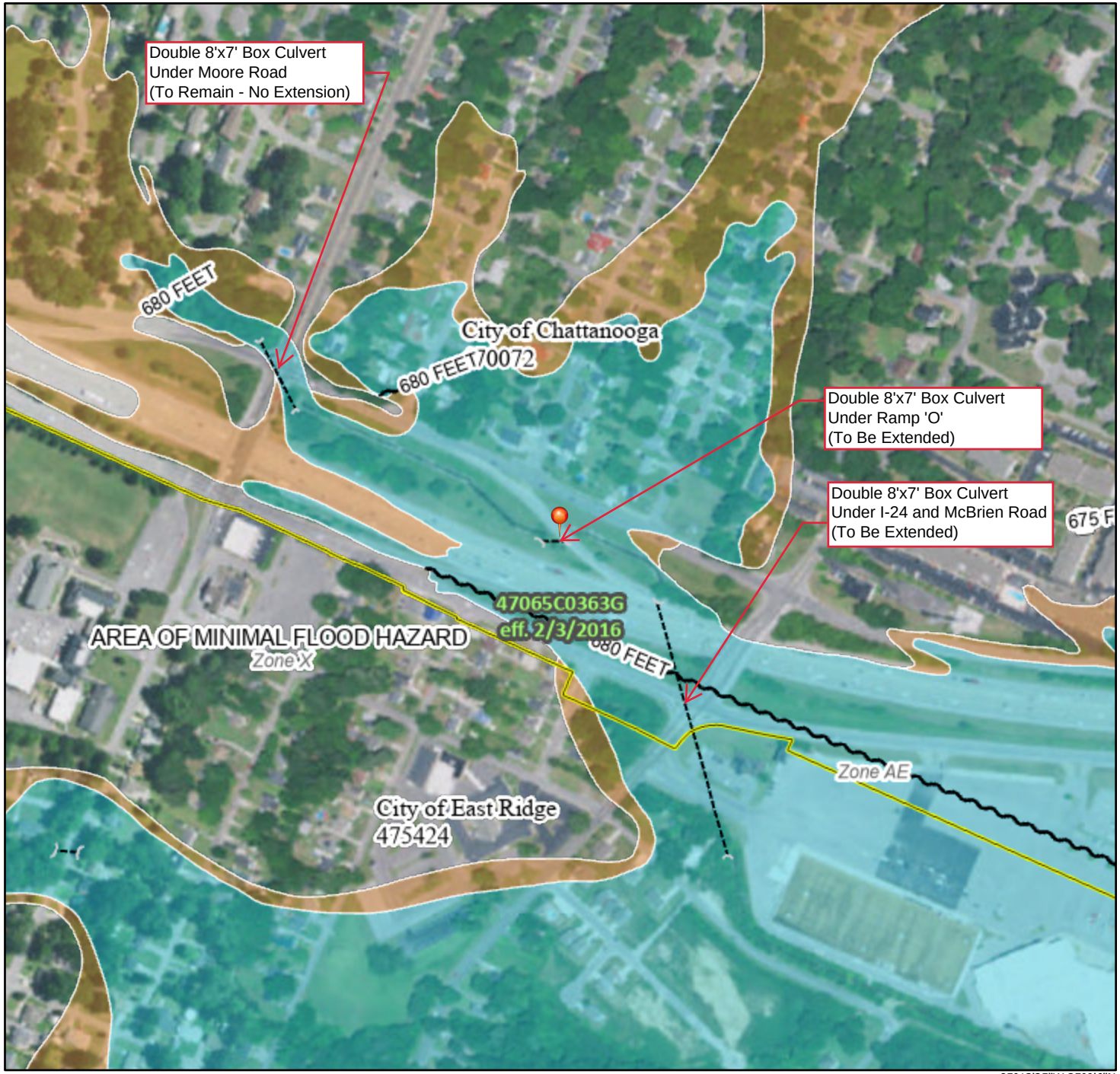
Comparison of 100-year flood results indicates that the proposed fill material and box culvert extension at I-24/McBrien Road will cause very slight increases in base flood elevations ranging from 0.04' to 0.07' immediately upstream of I-24. Upstream of Ramp 'O', 100-year flood elevations will be slightly decreased between 0.15' and 0.18'.

The Design-Builder will be required to develop an updated hydraulic analysis based on final design plans and submit a flood study report to the local Floodplain Administrators for East Ridge and Chattanooga.

The Design-Builder will also be responsible for development of a Hydraulic Design File submittal meeting the requirements of the TDOT Drainage Manual and containing all required elements as described in the TDOT Design Procedures for Hydraulic Structures.

EXHIBIT 1 - NATIONAL FLOOD HAZARD LAYER FIRMETTE

FEMA



0 250 500 1,000 1,500 2,000 Feet 1:6,000

85°13'25"W 35°0'6"N

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

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
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- 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 4/1/2022 at 4:10 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.

Ramp O

Proposed 23.87 L.F.
of (2) 8'x7' RCBC

Proposed 27.59 L.F.
of (2) 8'x7' RCBC

Existing 68.43 L.F.
of (2) 8'x7' RCBC

Existing 737.15 L.F.
of (2) 8'x7' RCBC

McBrien Road

N

Legend

- Proposed Culvert Extensions
- Existing Culverts
- Spring Creek Tributary
- Roadway Linework

FEMA Flood Zones

- AE,
- AE, FLOODWAY
- X, 0.2 PCT ANNUAL CHANCE FLOOD HAZARD
- X, AREA OF MINIMAL FLOOD HAZARD

I-75/I-24 Interchange Reconstruction
Hamilton County, Tennessee

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0 300 600 Feet

Exhibit 2 - Spring Creek Tributary
Proposed Culvert Extensions

Appendix 1 – Site Photographs (Taken March 23, 2018)

Downstream Face of I-24/McBrien Road Box Culvert)

Looking Downstream From I-24/McBrien Road Box Culvert

Upstream Face of I-24/McBrien Road Box Culvert)

Looking Upstream From I-24/McBrien Road Box Culvert)

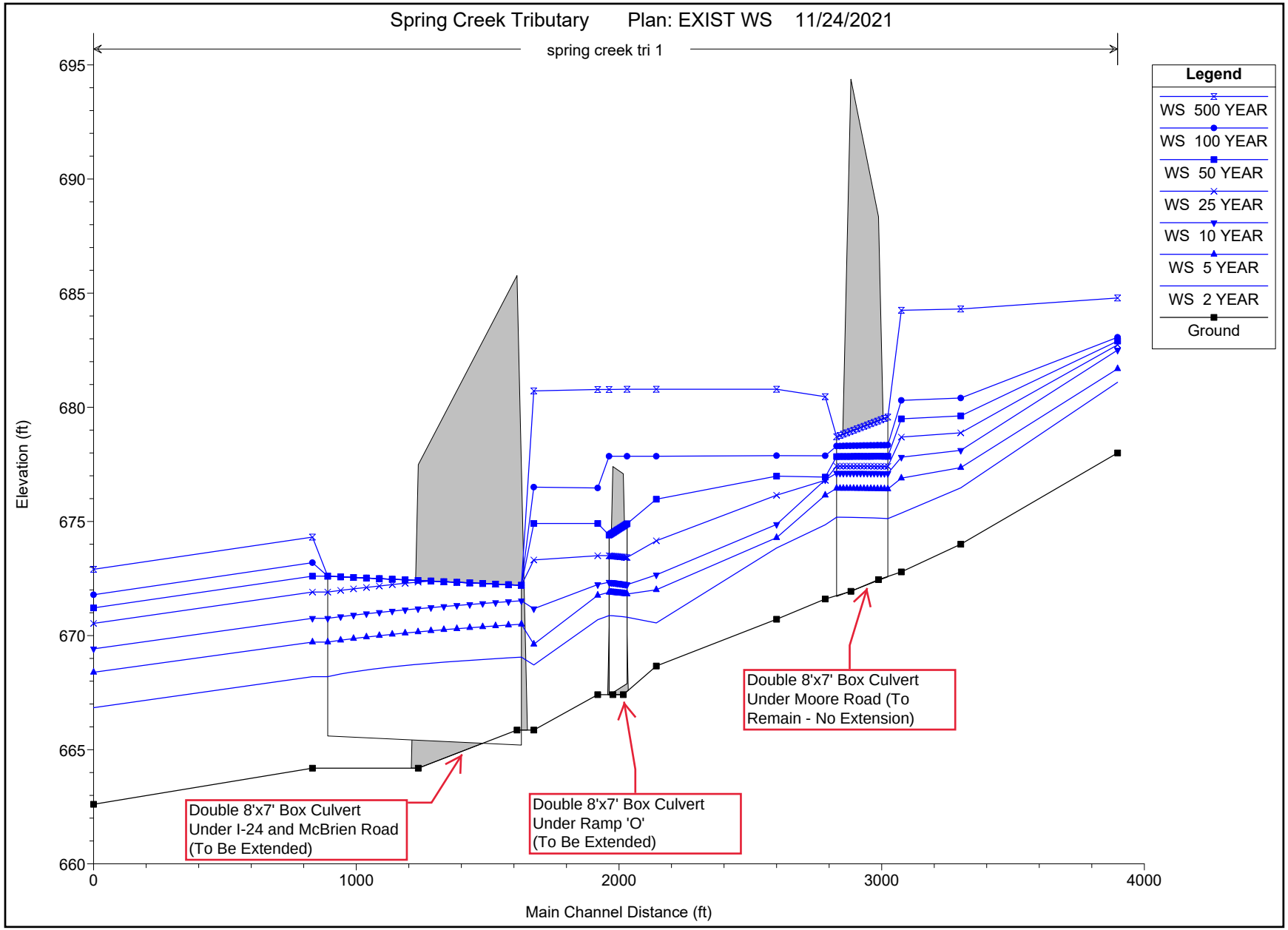
Downstream Face of Ramp ‘O’ Box Culvert

Looking Downstream From Ramp ‘O’ Box Culvert

Upstream Face of Ramp ‘O’ Box Culvert

Looking Upstream From Ramp ‘O’ Box Culvert

Appendix 2 – Existing Conditions HEC-RAS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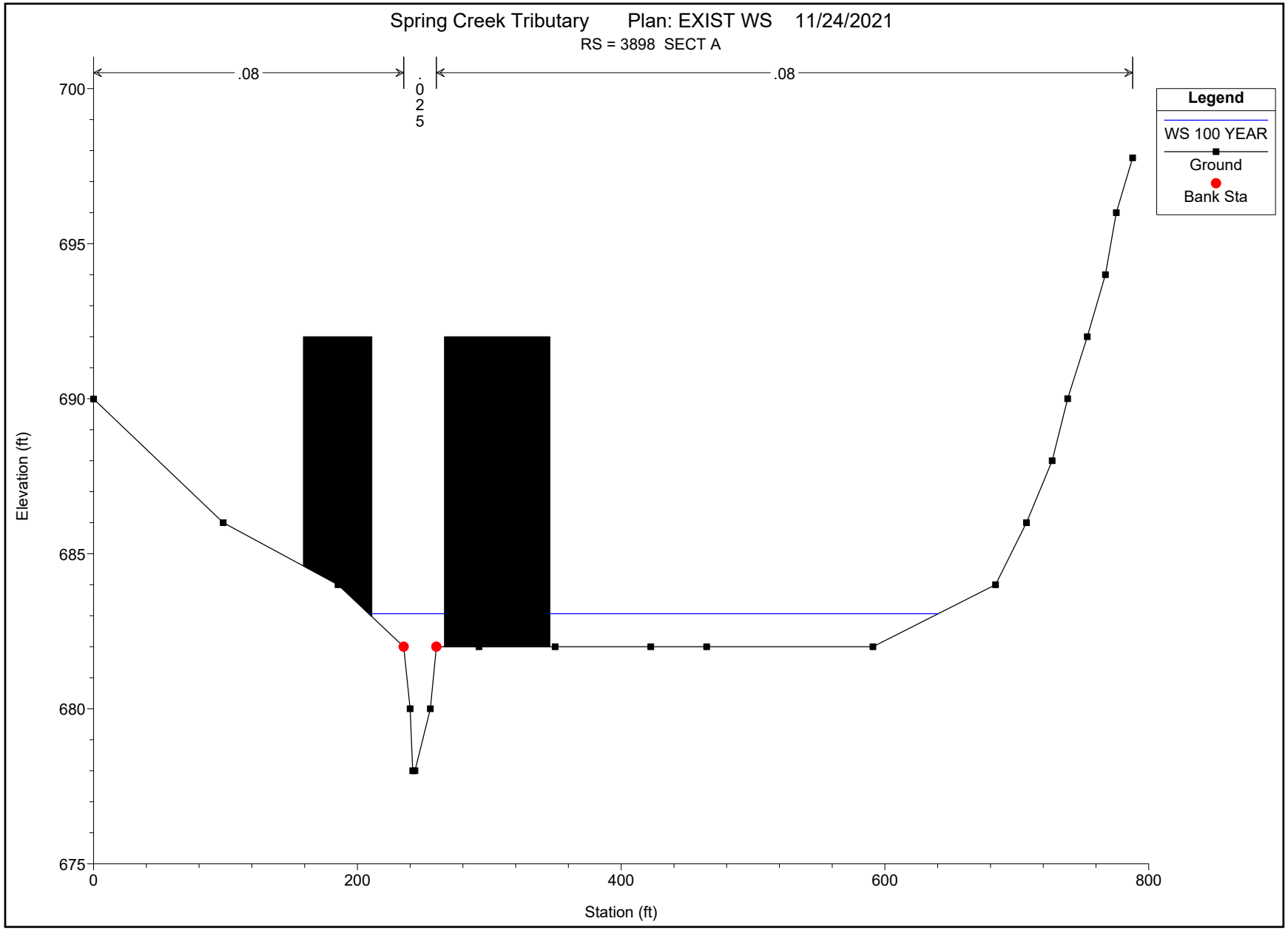
spring creek tri 1
Legend
WS 500 YEAR
WS 100 YEAR
WS 50 YEAR
WS 25 YEAR
WS 10 YEAR
WS 5 YEAR
WS 2 YEAR
Ground
Elevation (ft)
695
690
685
680
675
670
665
660
0
1000
2000
3000
4000
Main Channel Distance (ft)
Double 8'x7' Box Culvert
Under I-24 and McBrien Road
(To Be Extended)
Double 8'x7' Box Culvert
Under Ramp 'O'
(To Be Extended)
Double 8'x7' Box Culvert
Under Moore Road (To
Remain - No Extension)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WS 100 YEAR
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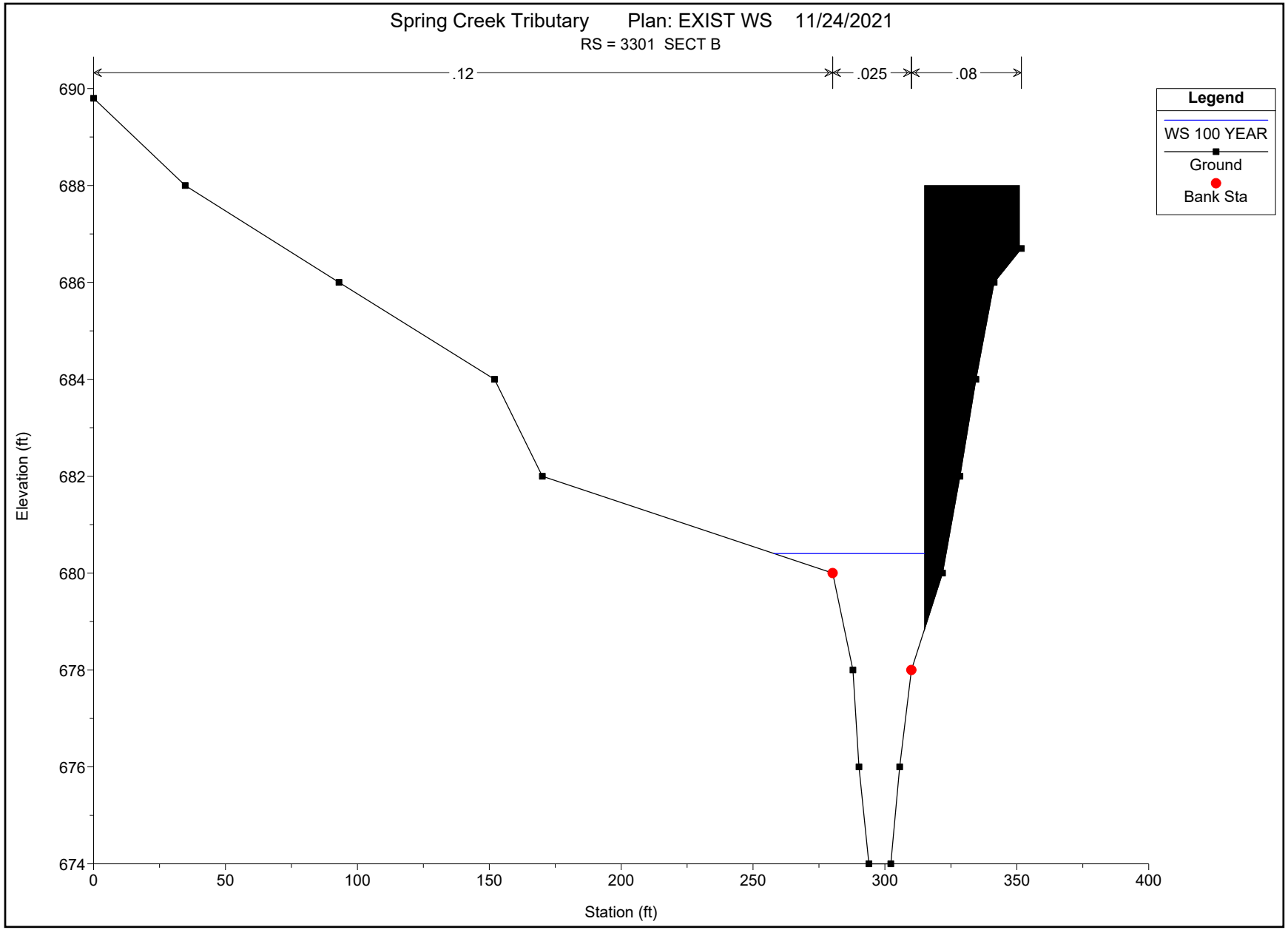
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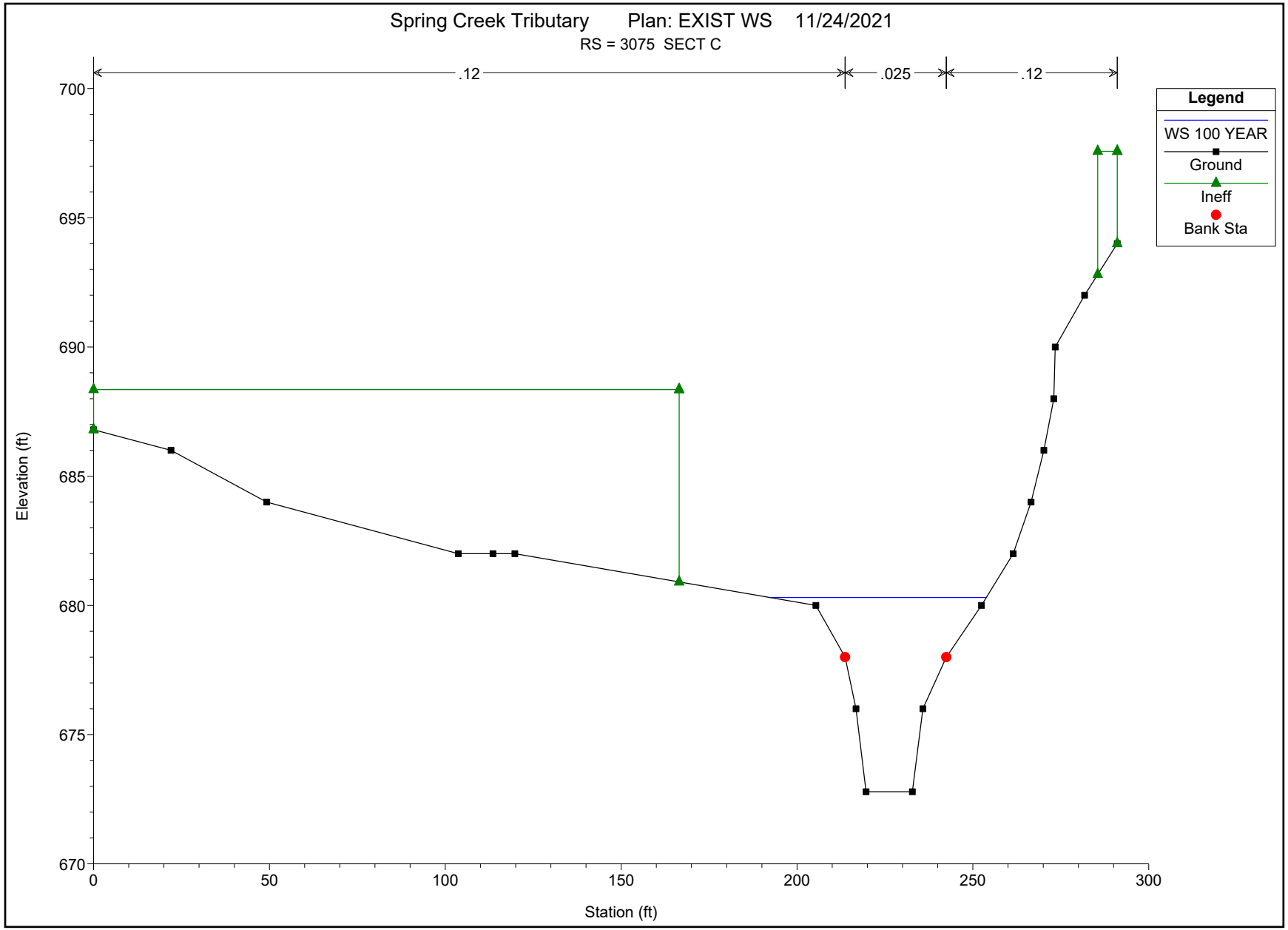
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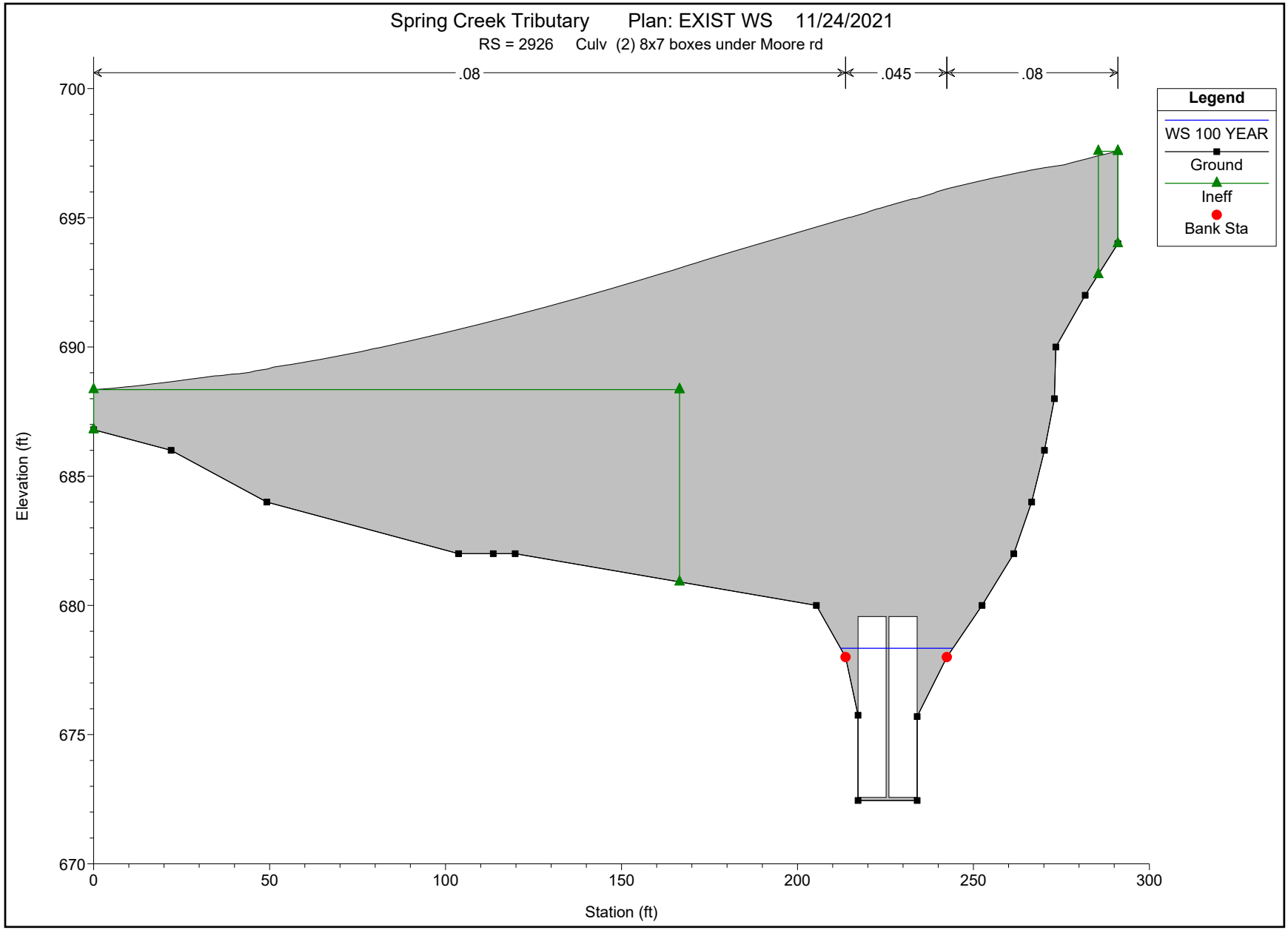
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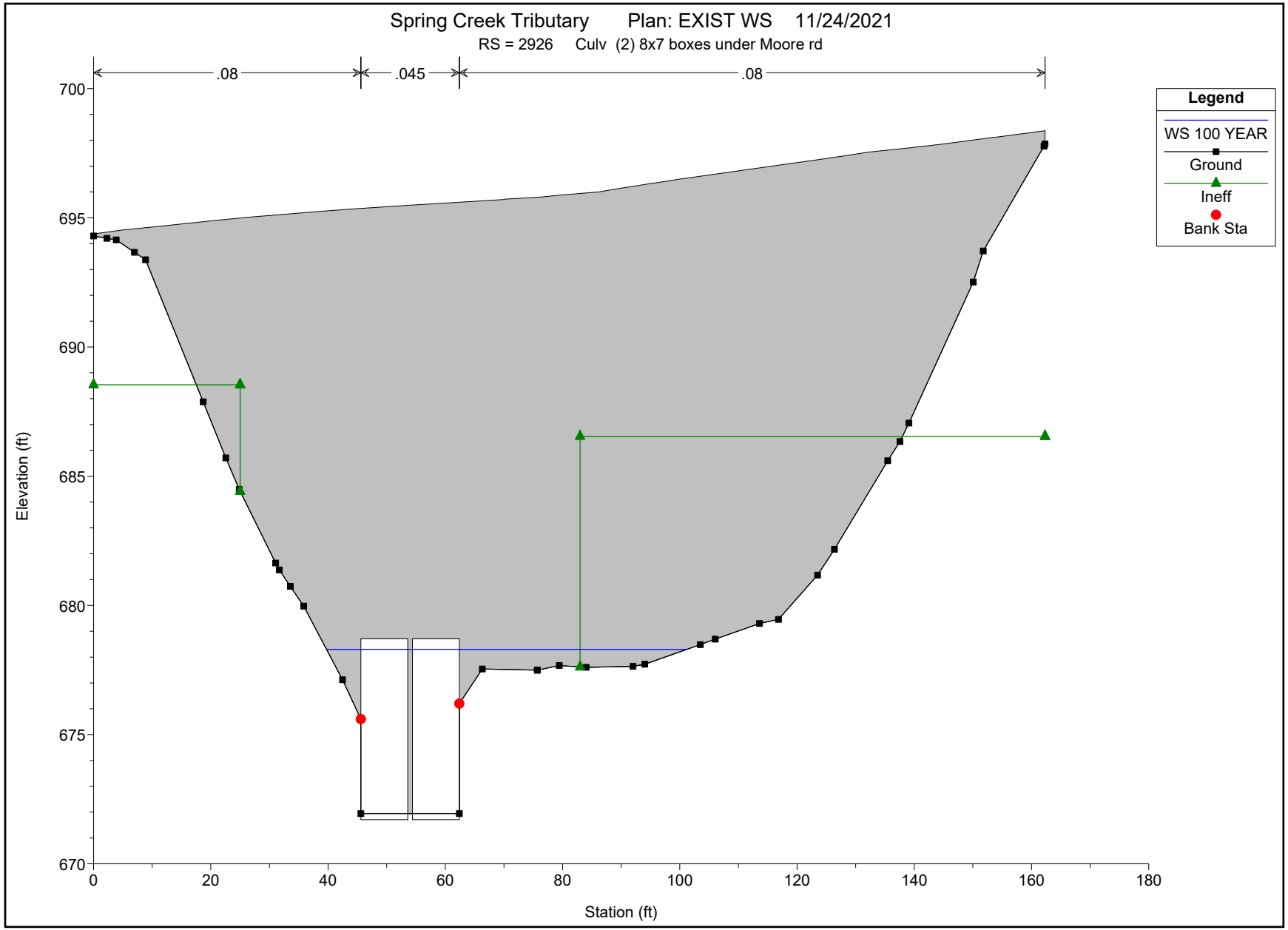
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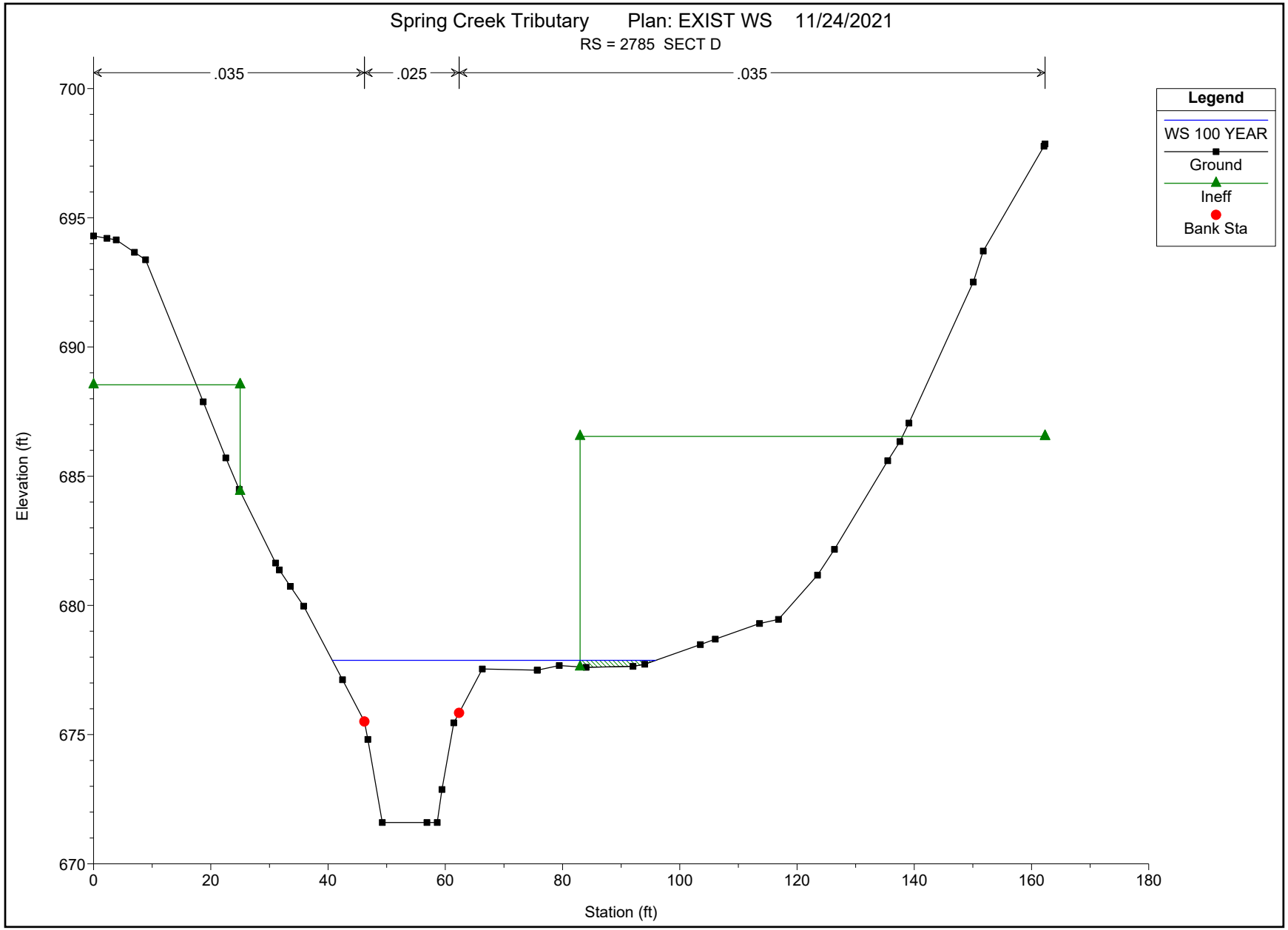
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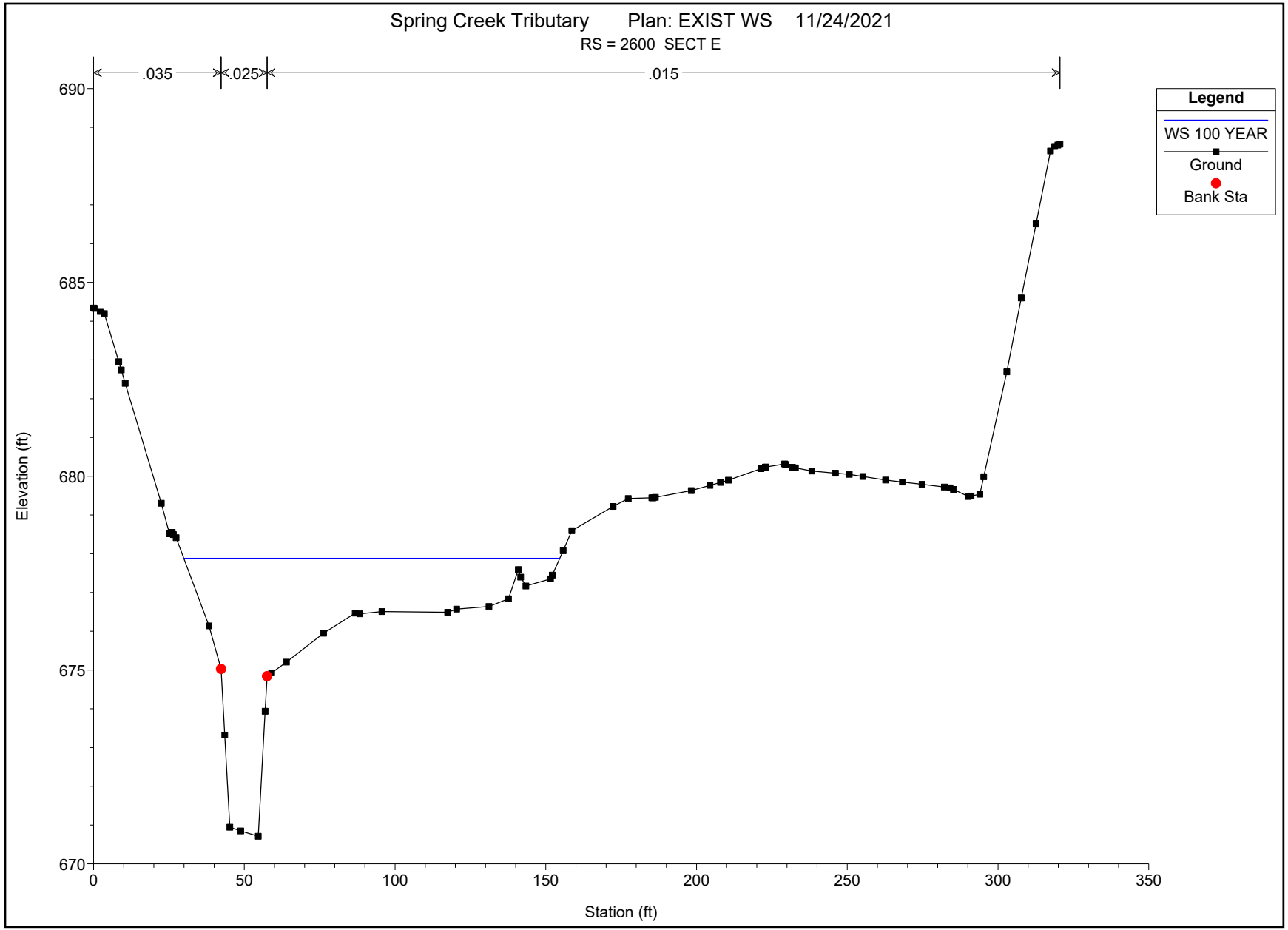
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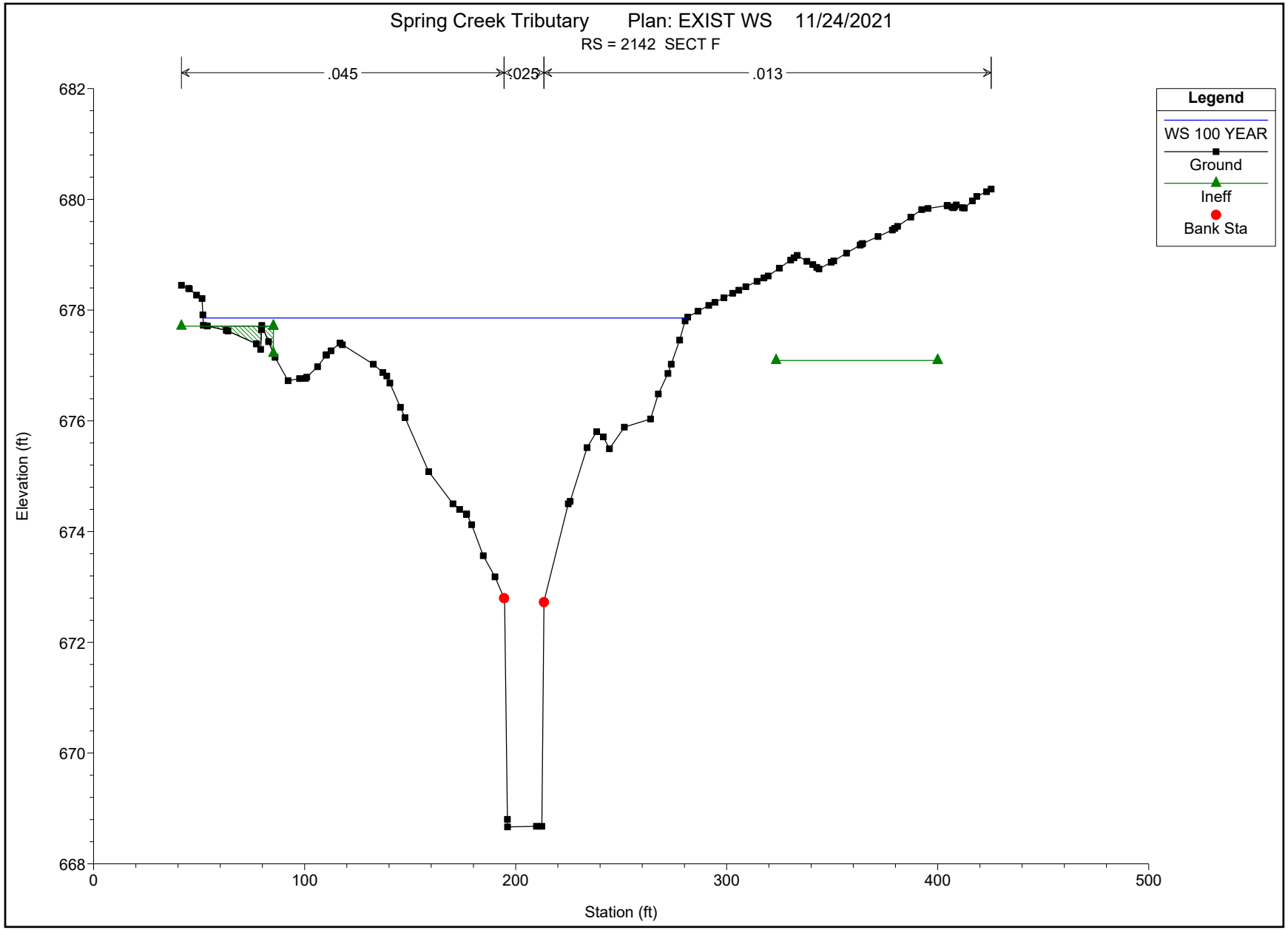
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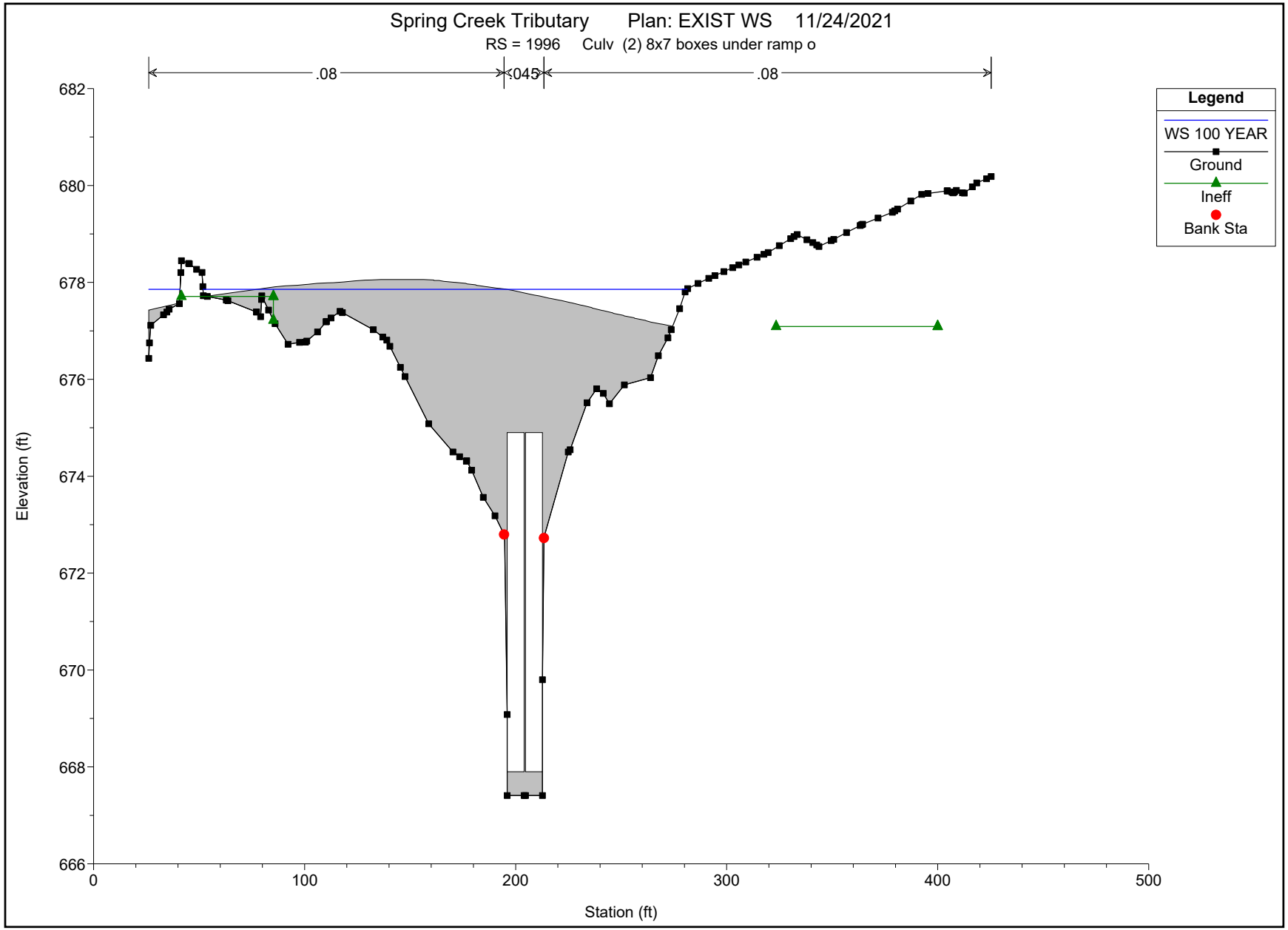
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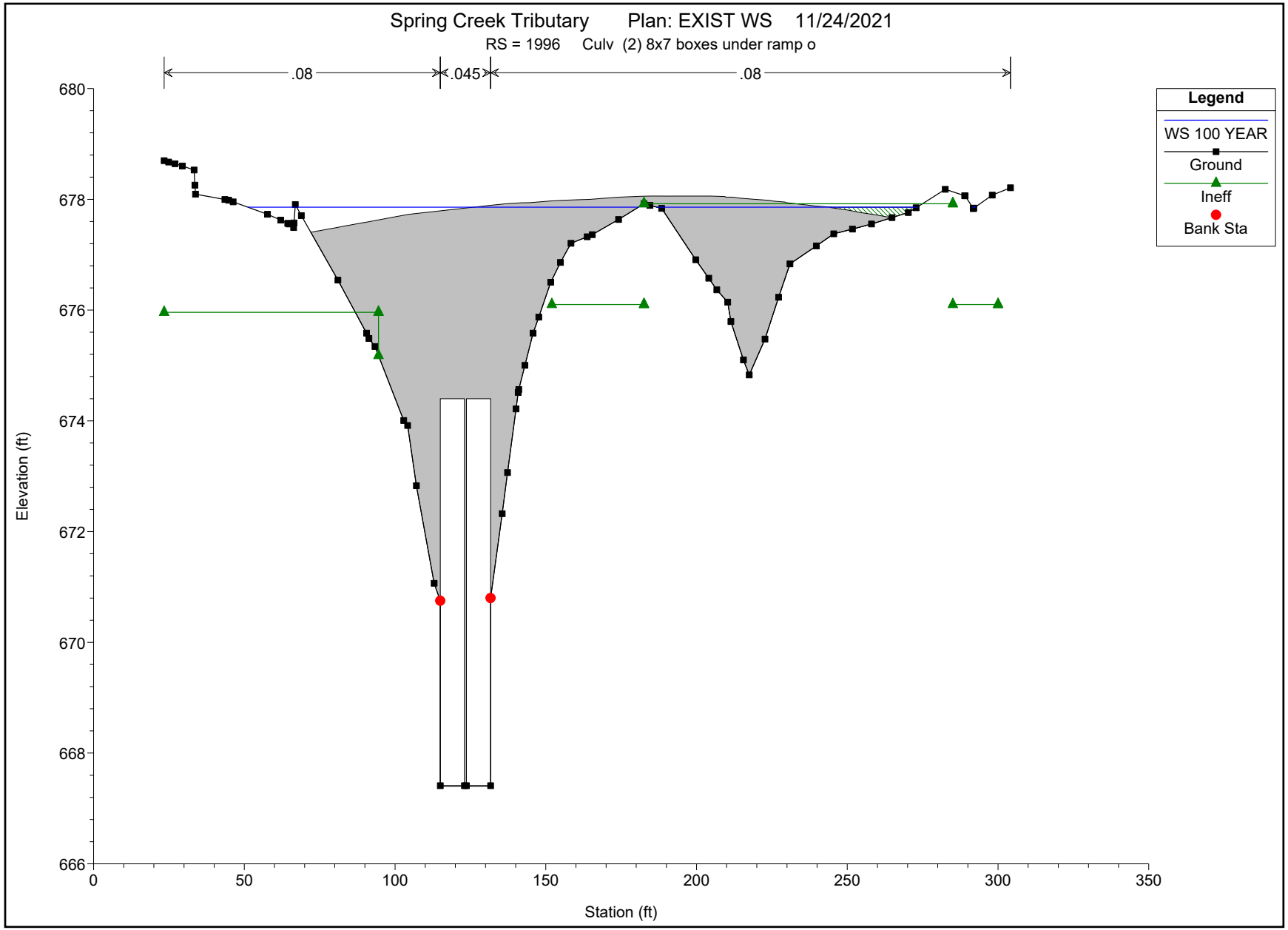
Station (ft)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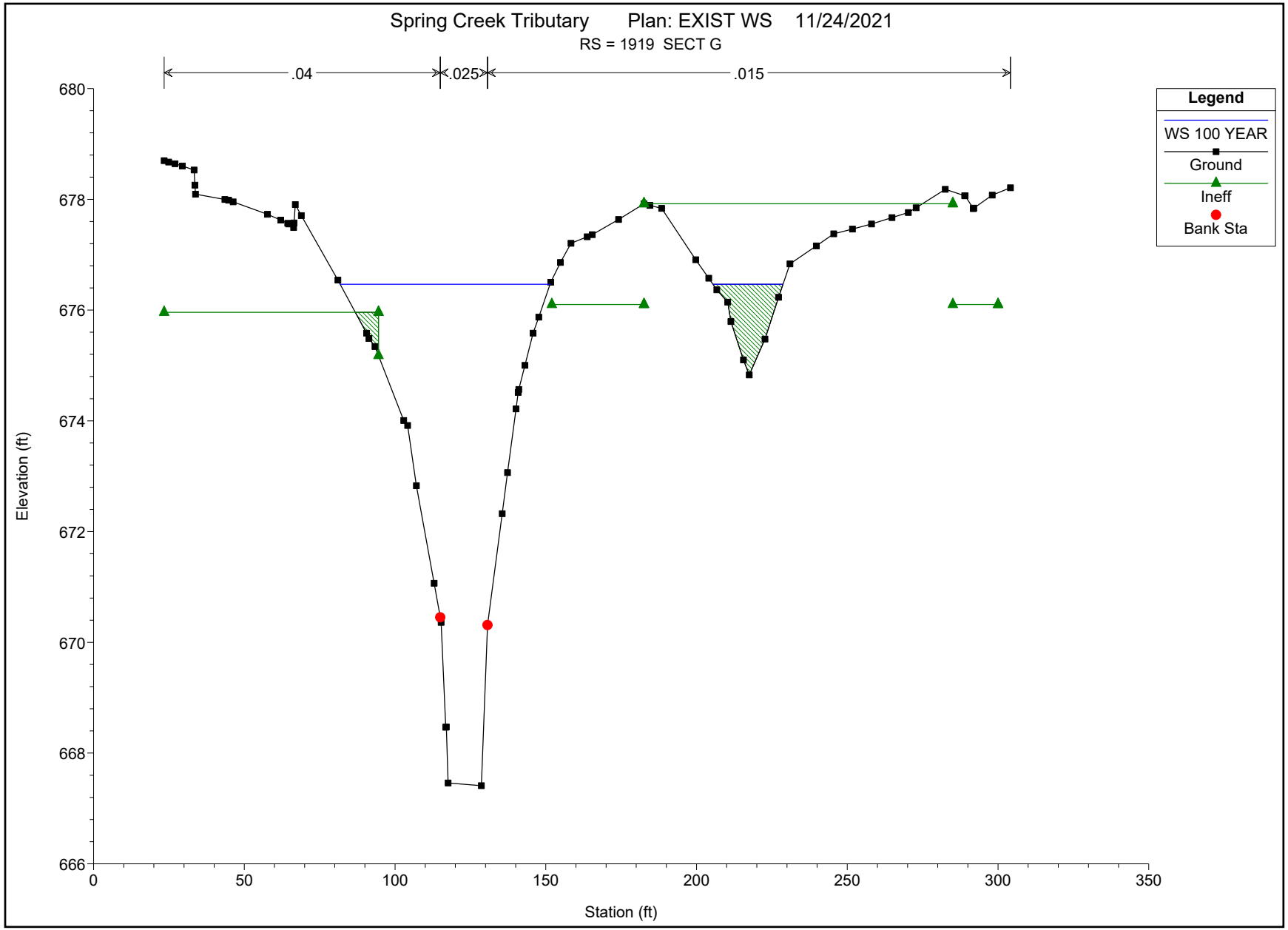
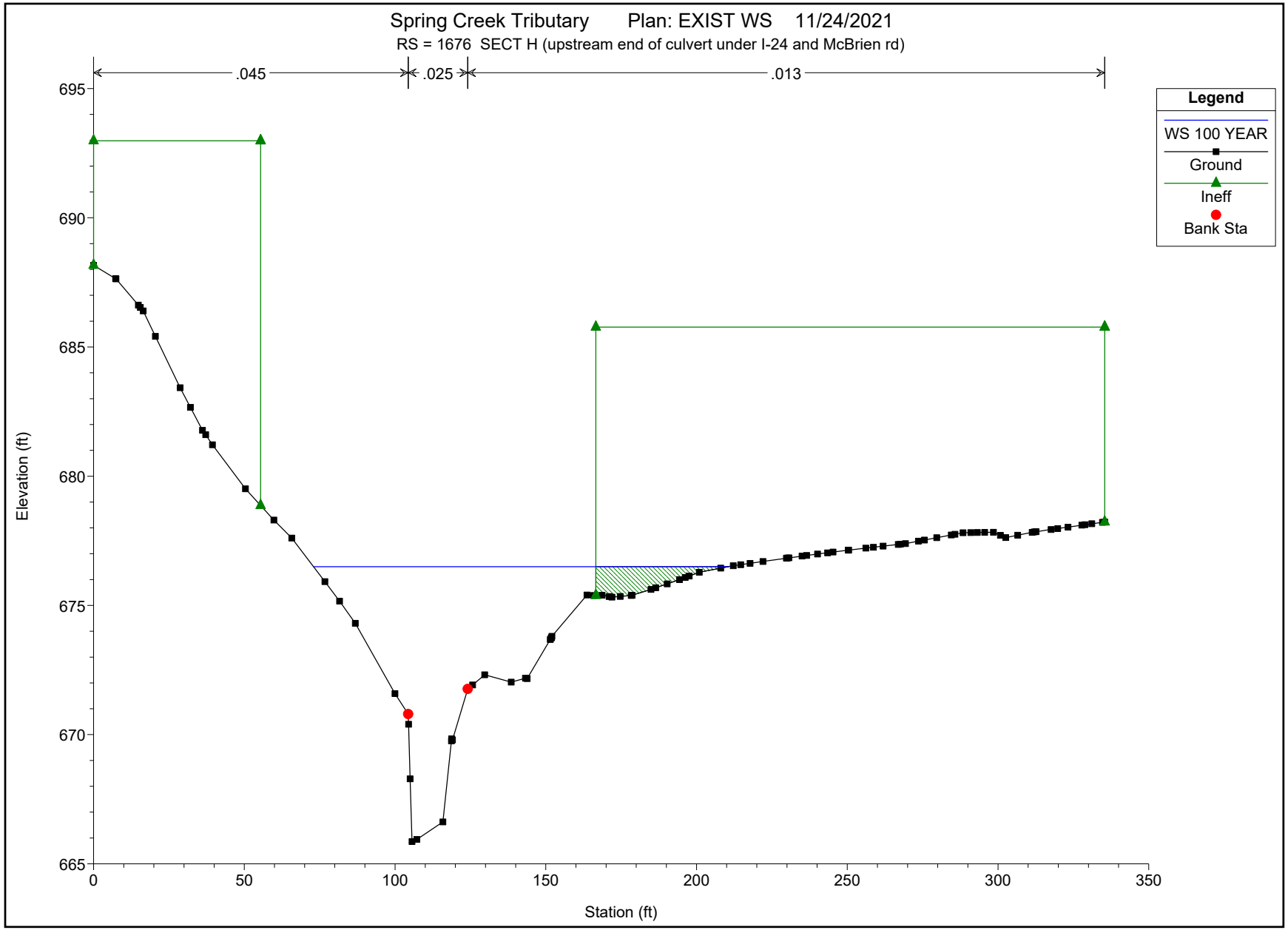
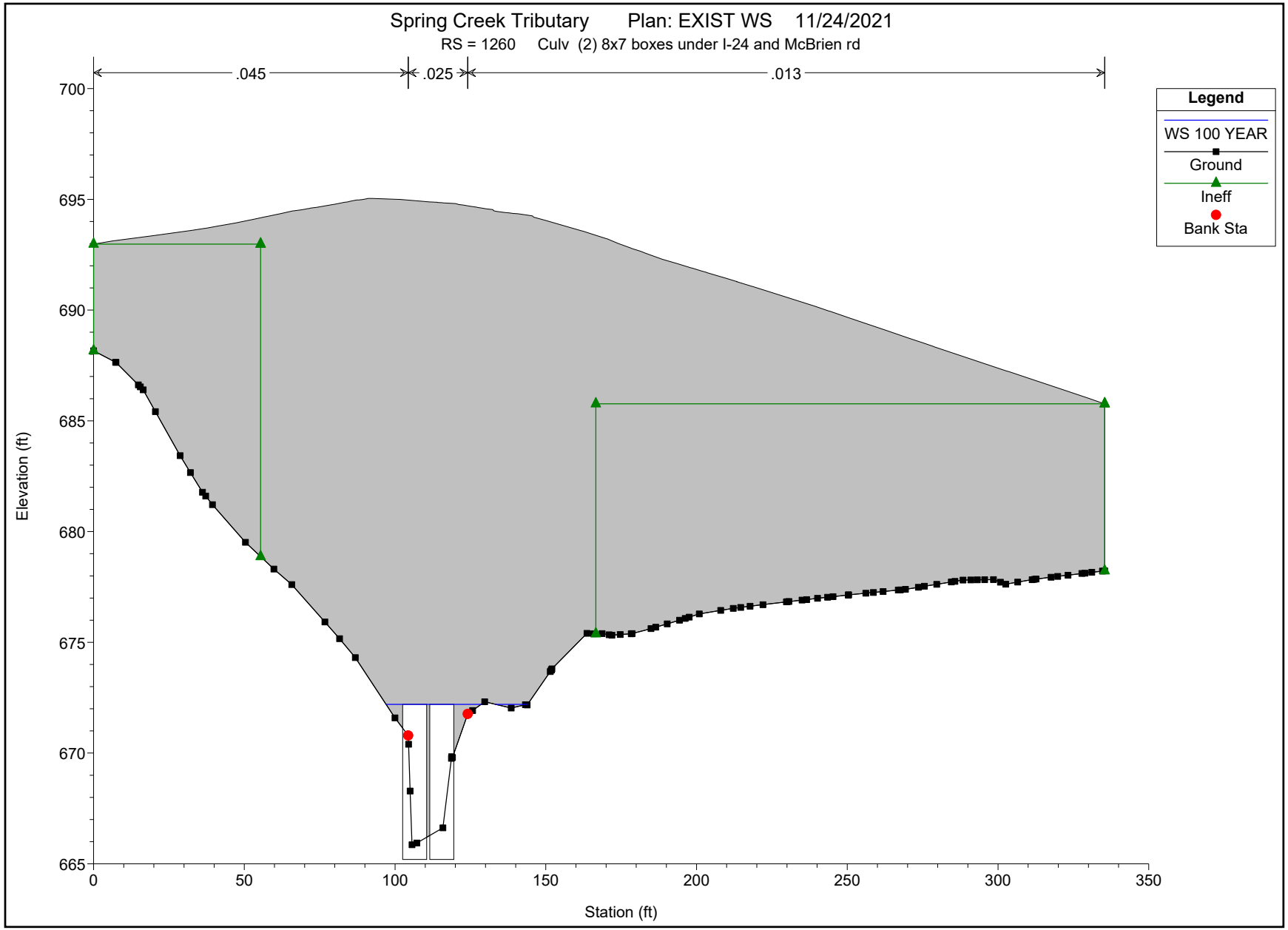
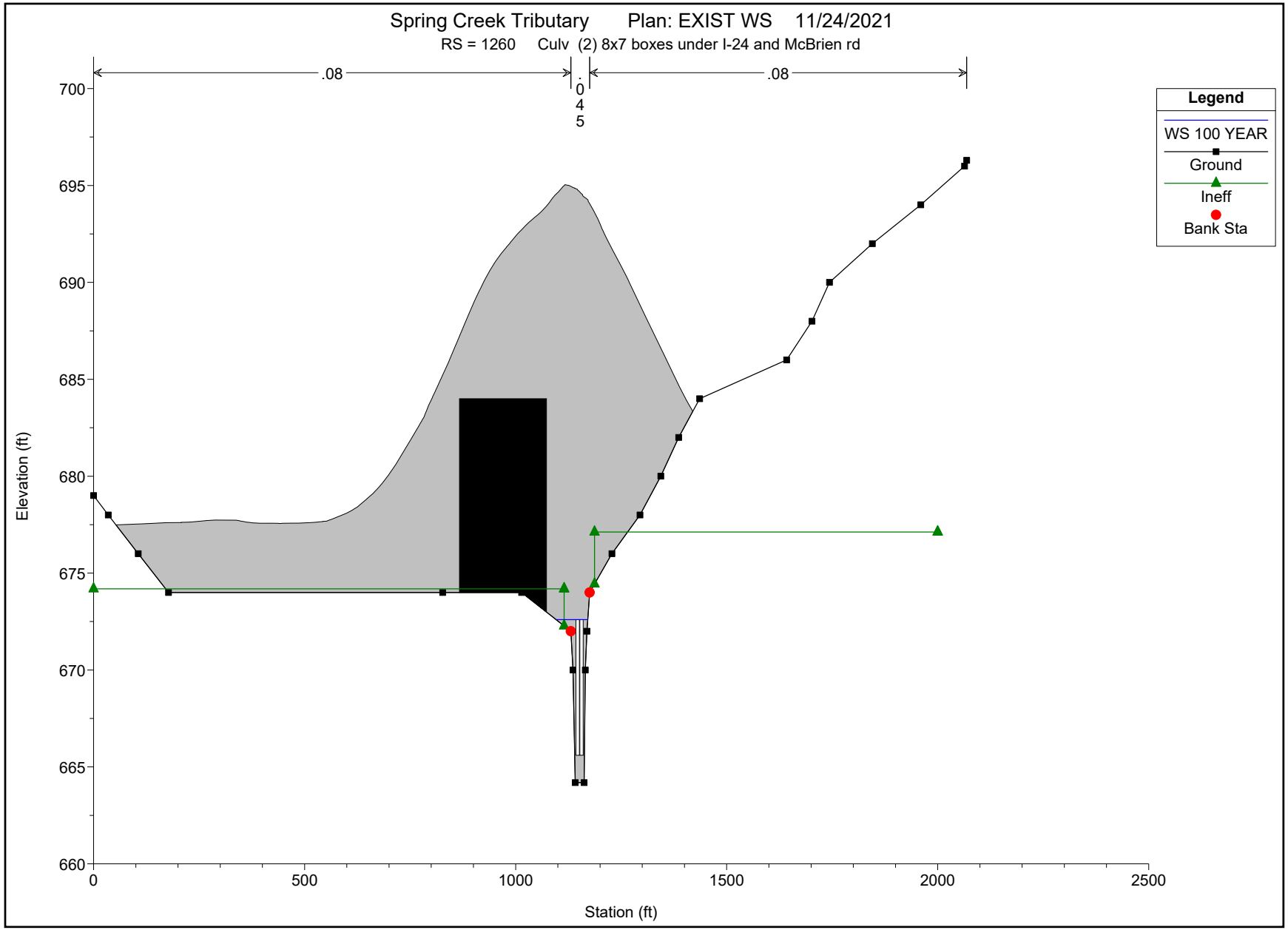
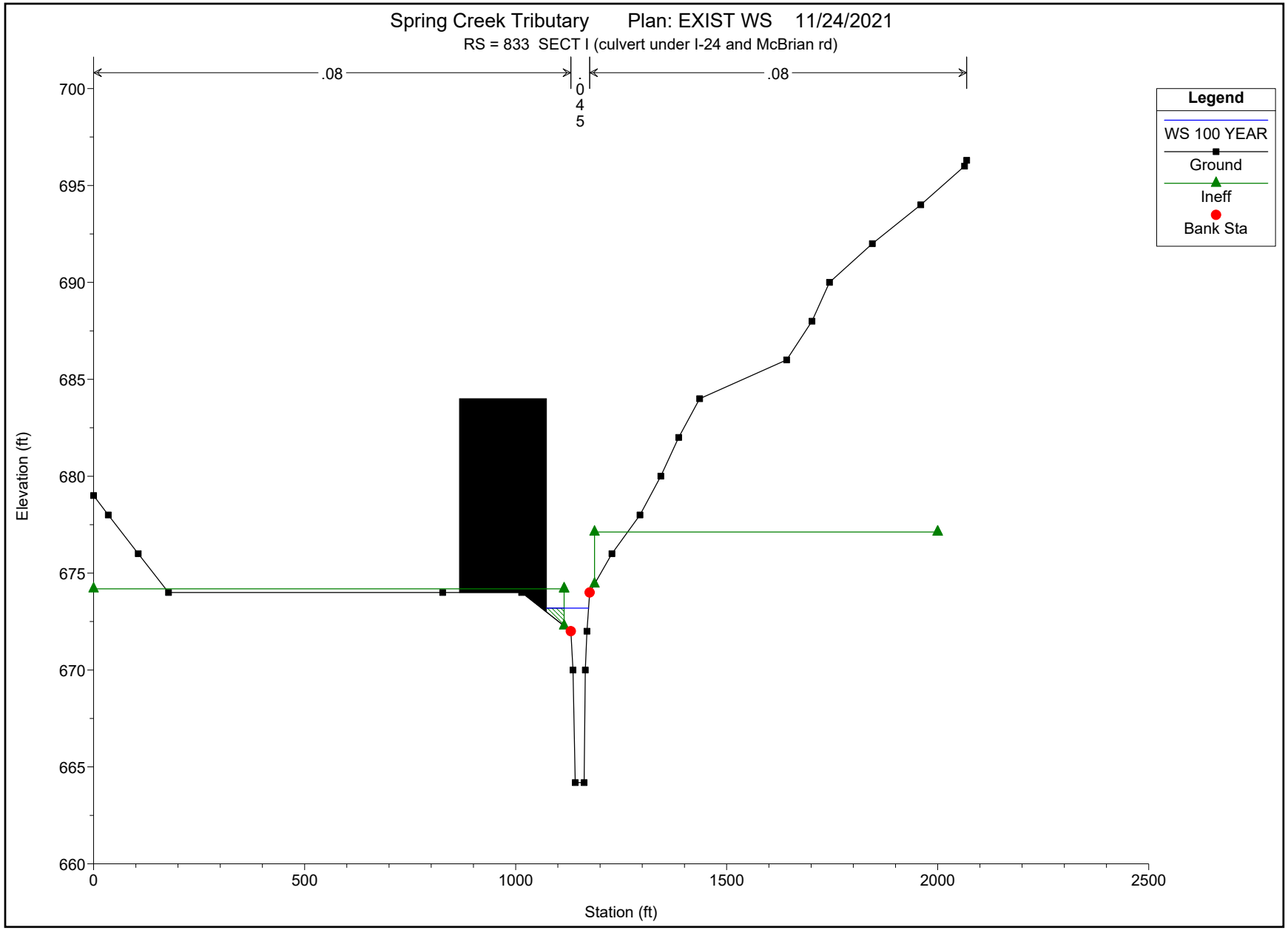
350
Station (ft)

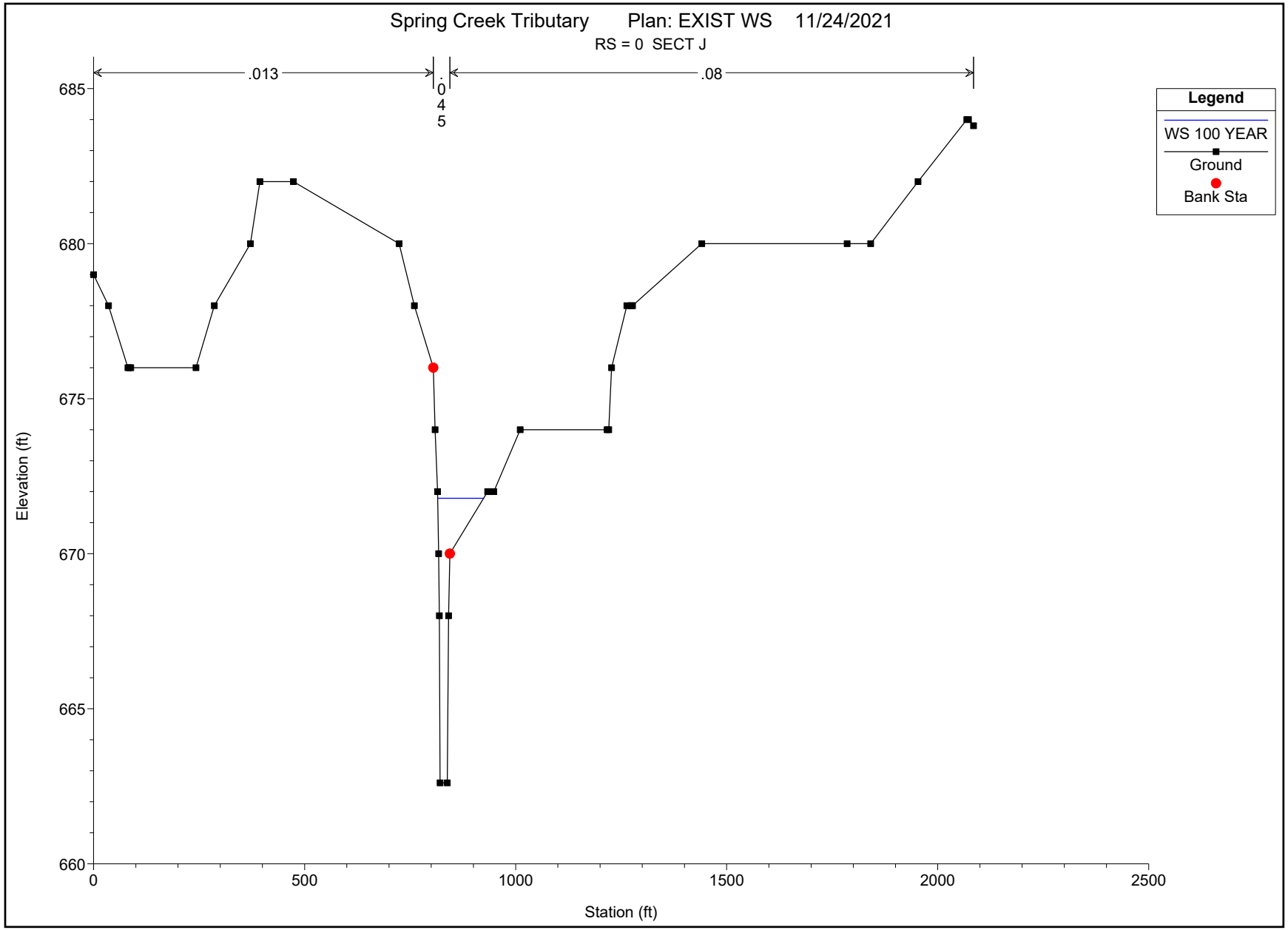

Spring Creek Tributary Plan: EXIST WS 11/24/2021
RS = 1919 SECT G
.04
.025
.015
Legend
WS 100 YEAR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
680
678
676
674
672
670
668
666
0
50
100
150
200
250
300
350


Spring Creek Tributary Plan: EXIST WS 11/24/2021
RS = 1676 SECT H (upstream end of culvert under I-24 and McBrien rd)
.045
.025
.013
Legend
WS 100 YEAR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
695
690
685
680
675
670
665
0
50
100
150
200
250
300
350


Spring Creek Tributary Plan: EXIST WS 11/24/2021
RS = 1260 Culv (2) 8x7 boxes under I-24 and McBrien rd
.045
.025
.013
Legend
WS 100 YEAR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
700
695
690
685
680
675
670
665
0
50
100
150
200
250
300
350


Spring Creek Tributary Plan: EXIST WS 11/24/2021
RS = 1260 Culv (2) 8x7 boxes under I-24 and McBrien rd
.08
.045
.08
Legend
WS 100 YEAR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
700
695
690
685
680
675
670
665
660
0
500
1000
1500
2000
2500


Spring Creek Tributary Plan: EXIST WS 11/24/2021
RS = 833 SECT I (culvert under I-24 and McBrian rd)
.08
.045
.08
Legend
WS 100 YEAR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
700
695
690
685
680
675
670
665
660
0
500
1000
1500
2000
2500


Spring Creek Tributary Plan: EXIST WS 11/24/2021
RS = 0 SECT J
.013
.045
.08
Legend
WS 100 YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
660
665
670
675
680
685
0
500
1000
1500
2000
2500

Existing Conditions HEC-RAS Output

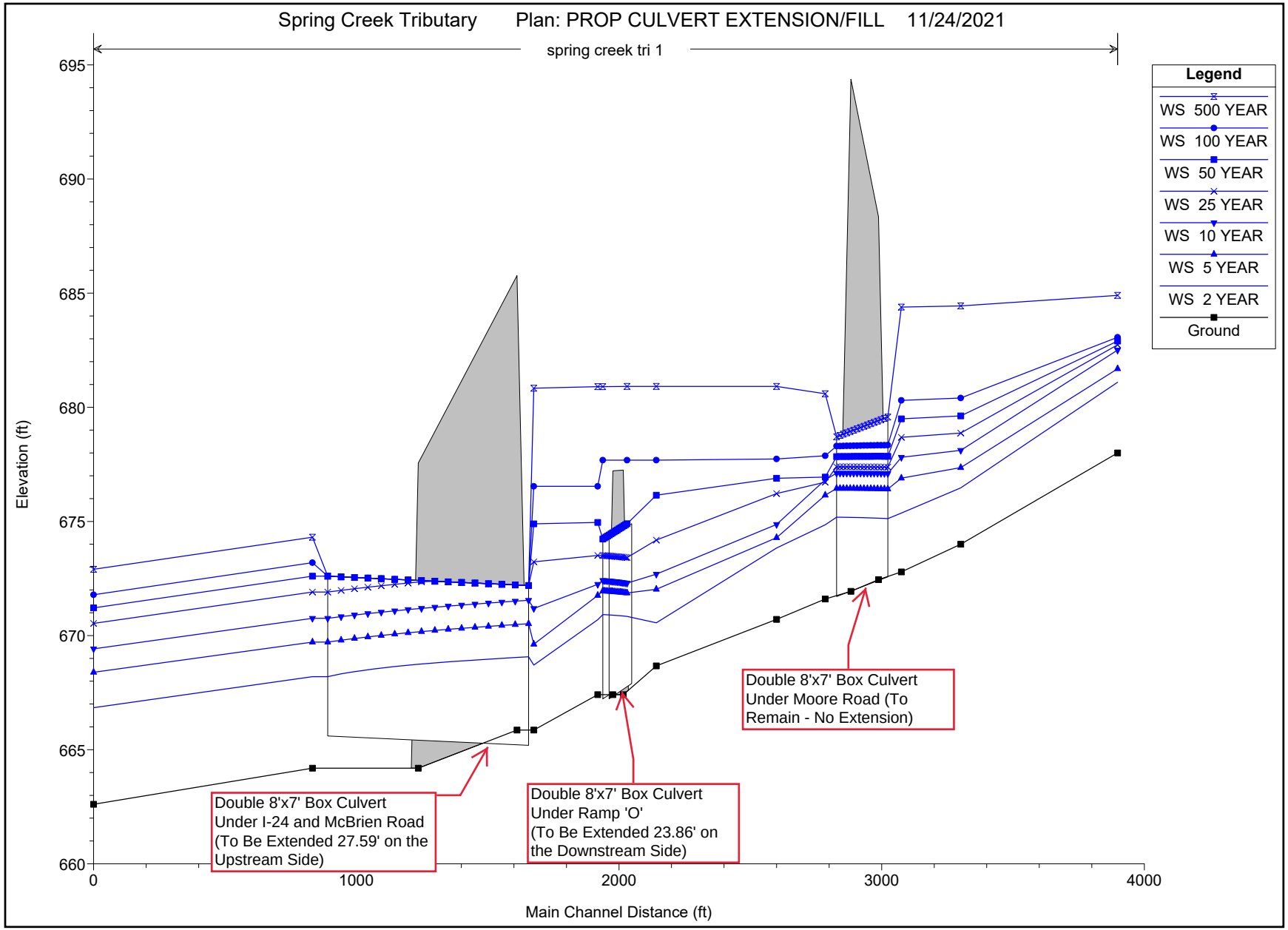
HEC-RAS Plan: EXIST WS River: spring creek tri Reach: 1

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)	
1	0	2 YEAR	243.00	662.61	666.84	664.41	666.98	0.001900	3.02	80.46	20.87	0.27
1	0	5 YEAR	397.00	662.61	668.39	665.10	668.58	0.001900	3.48	113.92	22.81	0.27
1	0	10 YEAR	515.00	662.61	669.42	665.56	669.63	0.001901	3.71	138.69	25.29	0.28
1	0	25 YEAR	677.00	662.61	670.53	666.13	670.78	0.001900	4.01	174.64	51.28	0.29
1	0	50 YEAR	809.00	662.61	671.21	666.56	671.48	0.001903	4.22	219.86	82.41	0.29
1	0	100 YEAR	948.00	662.61	671.79	666.98	672.07	0.001902	4.39	274.97	108.92	0.29
1	0	500 YEAR	1302.00	662.61	672.90	667.98	673.18	0.001902	4.62	433.58	164.18	0.30
1	833	2 YEAR	243.00	664.19	668.20		668.30	0.001310	2.54	95.80	26.54	0.24
1	833	5 YEAR	397.00	664.19	669.72		669.84	0.001214	2.89	137.59	28.54	0.23
1	833	10 YEAR	515.00	664.19	670.76		670.90	0.001211	3.05	168.97	32.36	0.24
1	833	25 YEAR	677.00	664.19	671.91		672.07	0.001232	3.24	209.17	37.59	0.24
1	833	50 YEAR	809.00	664.19	672.60		672.78	0.001255	3.41	243.58	75.04	0.25
1	833	100 YEAR	948.00	664.19	673.19		673.39	0.001294	3.60	277.12	99.76	0.25
1	833	500 YEAR	1302.00	664.19	674.31	668.82	674.56	0.001433	4.09	434.72	811.22	0.27
1	1260		Culvert									
1	1676	2 YEAR	243.00	665.86	668.71	668.71	669.84	0.009507	8.51	28.55	12.89	1.01
1	1676	5 YEAR	397.00	665.86	669.62	669.62	671.10	0.009162	9.74	40.76	13.93	1.00
1	1676	10 YEAR	515.00	665.86	671.18	670.28	672.13	0.004466	7.83	66.17	20.35	0.73
1	1676	25 YEAR	677.00	665.86	673.31	671.04	673.68	0.001087	5.13	150.96	58.00	0.39
1	1676	50 YEAR	809.00	665.86	674.91	671.63	675.10	0.000371	3.56	257.78	76.94	0.24
1	1676	100 YEAR	948.00	665.86	676.50	672.75	676.62	0.000152	2.61	396.06	137.66	0.16
1	1676	500 YEAR	1302.00	665.86	680.72	673.35	680.78	0.000030	1.51	843.29	292.76	0.07
1	1919	2 YEAR	243.00	667.41	670.70	669.78	671.17	0.002792	5.54	44.06	17.42	0.58
1	1919	5 YEAR	397.00	667.41	671.76	670.65	672.37	0.002382	6.35	65.82	23.52	0.57
1	1919	10 YEAR	515.00	667.41	672.23	671.25	673.00	0.002588	7.15	77.60	26.25	0.61
1	1919	25 YEAR	677.00	667.41	673.50	671.95	674.13	0.001598	6.66	115.25	33.09	0.50
1	1919	50 YEAR	809.00	667.41	674.91	672.44	675.37	0.000883	5.76	170.09	47.46	0.38
1	1919	100 YEAR	948.00	667.41	676.47	672.91	676.77	0.000488	4.89	256.23	92.83	0.29
1	1919	500 YEAR	1302.00	667.41	680.78	673.86	680.80	0.000025	1.46	1268.15	280.72	0.07
1	1996		Culvert									
1	2142	2 YEAR	243.00	668.67	670.56	670.56	671.47	0.009136	7.67	31.68	17.39	1.00
1	2142	5 YEAR	397.00	668.67	672.01	671.27	672.75	0.004020	6.90	57.54	18.27	0.69
1	2142	10 YEAR	515.00	668.67	672.66	671.75	673.51	0.003868	7.40	69.62	18.66	0.68
1	2142	25 YEAR	677.00	668.67	674.15	672.35	674.79	0.001952	6.52	115.43	43.86	0.51
1	2142	50 YEAR	809.00	668.67	675.97	672.81	676.25	0.000661	4.64	245.19	110.30	0.31
1	2142	100 YEAR	948.00	668.67	677.86	673.63	677.95	0.000160	2.68	541.17	229.40	0.16
1	2142	500 YEAR	1302.00	668.67	680.79	674.88	680.81	0.000027	1.33	1485.99	383.73	0.07
1	2600	2 YEAR	243.00	670.71	673.84	673.38	674.59	0.005241	6.99	34.76	13.67	0.77
1	2600	5 YEAR	397.00	670.71	674.29	674.29	675.74	0.008709	9.65	41.12	14.32	1.00
1	2600	10 YEAR	515.00	670.71	674.87	674.87	676.54	0.008648	10.37	49.65	15.60	1.01
1	2600	25 YEAR	677.00	670.71	676.15	676.15	677.24	0.004001	8.74	86.07	42.06	0.72
1	2600	50 YEAR	809.00	670.71	676.99	676.99	677.58	0.002046	7.00	149.58	104.02	0.53
1	2600	100 YEAR	948.00	670.71	677.88		678.13	0.000723	4.61	253.74	124.70	0.32
1	2600	500 YEAR	1302.00	670.71	680.79		680.84	0.000087	2.06	791.75	280.81	0.12
1	2785	2 YEAR	243.00	671.60	674.85		675.48	0.004043	6.36	38.21	14.23	0.68
1	2785	5 YEAR	397.00	671.60	676.15		676.87	0.003193	6.82	58.73	18.37	0.63
1	2785	10 YEAR	515.00	671.60	676.82	675.69	677.67	0.002985	7.39	72.15	21.50	0.63
1	2785	25 YEAR	677.00	671.60	676.80	676.39	678.27	0.005246	9.77	71.71	21.40	0.84
1	2785	50 YEAR	809.00	671.60	676.94	676.94	678.90	0.006705	11.28	74.69	22.04	0.95
1	2785	100 YEAR	948.00	671.60	677.87	677.87	679.55	0.004577	10.60	102.39	55.16	0.81
1	2785	500 YEAR	1302.00	671.60	680.46		681.24	0.001486	7.87	219.76	86.36	0.49
1	2926		Culvert									
1	3075	2 YEAR	243.00	672.79	675.36	674.87	675.94	0.004215	6.09	39.90	17.85	0.72
1	3075	5 YEAR	397.00	672.79	676.90	675.63	677.39	0.002439	5.62	70.59	23.40	0.57
1	3075	10 YEAR	515.00	672.79	677.81	676.15	678.28	0.001974	5.48	94.06	27.88	0.53
1	3075	25 YEAR	677.00	672.79	678.69	676.82	679.19	0.001604	5.67	121.59	35.14	0.49
1	3075	50 YEAR	809.00	672.79	679.49	677.27	679.99	0.001263	5.66	152.60	42.45	0.45
1	3075	100 YEAR	948.00	672.79	680.30	677.71	680.80	0.001034	5.66	191.86	61.51	0.42
1	3075	500 YEAR	1302.00	672.79	684.25	678.54	684.49	0.000277	4.15	558.57	221.19	0.24
1	3301	2 YEAR	243.00	674.00	676.47	676.47	677.40	0.008324	7.75	31.35	17.02	1.01
1	3301	5 YEAR	397.00	674.00	677.36	677.25	678.43	0.006906	8.32	47.73	19.99	0.95
1	3301	10 YEAR	515.00	674.00	678.12	677.75	679.12	0.005218	8.06	63.94	23.28	0.85
1	3301	25 YEAR	677.00	674.00	678.88	678.36	679.92	0.004493	8.20	84.65	30.51	0.81
1	3301	50 YEAR	809.00	674.00	679.62		680.57	0.003513	7.84	108.32	33.36	0.73

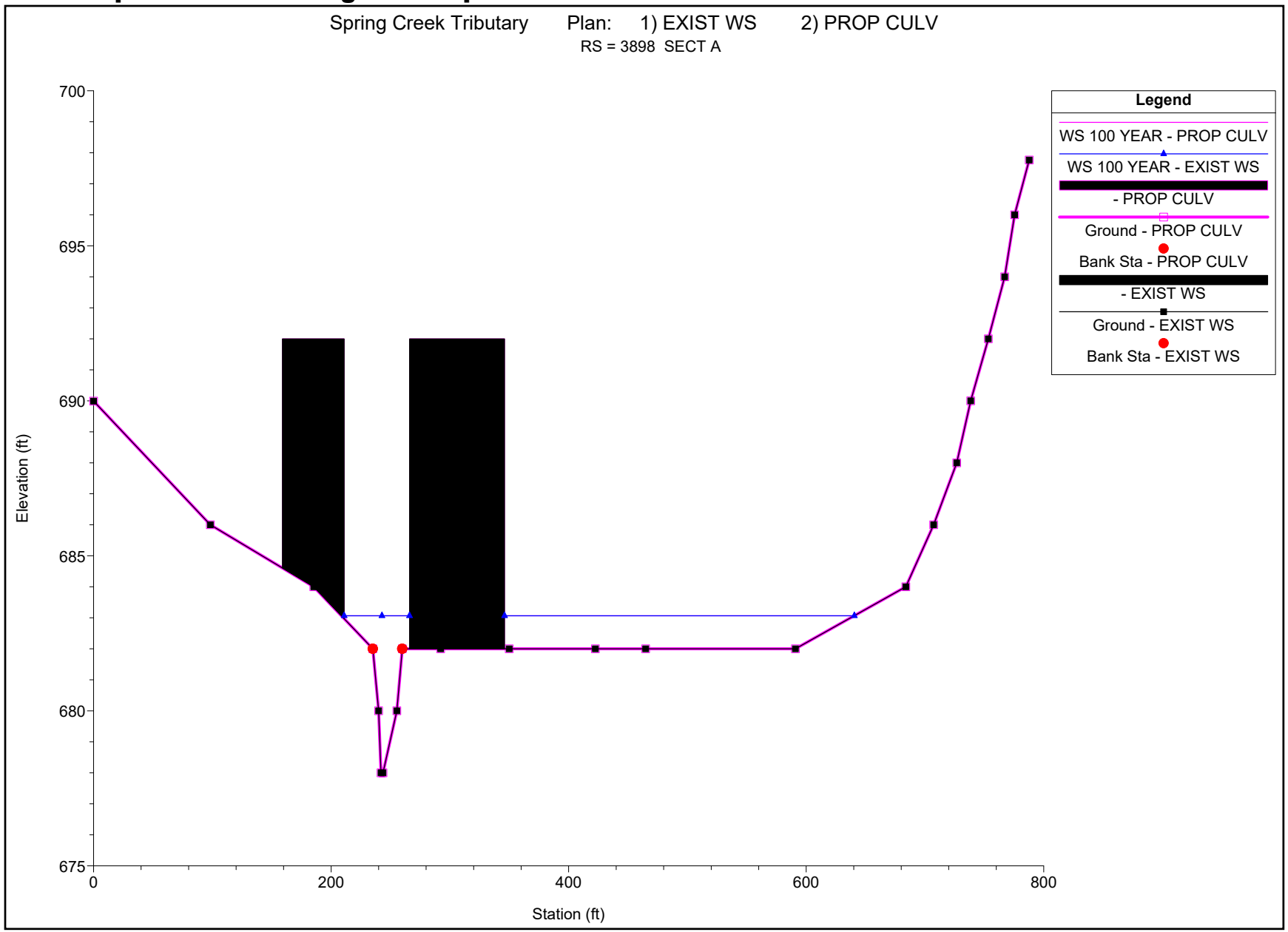
HEC-RAS Plan: EXIST WS River: spring creek tri Reach: 1 (Continued)

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)	
1	3301	100 YEAR	948.00	674.00	680.40		681.26	0.002582	7.46	139.74	57.07	0.64
1	3301	500 YEAR	1302.00	674.00	684.31		684.57	0.000393	4.51	659.85	172.00	0.28
1	3898	2 YEAR	243.00	678.00	681.09	680.90	681.78	0.006276	6.63	36.66	20.51	0.87
1	3898	5 YEAR	397.00	678.00	681.69	681.62	682.68	0.007257	8.00	49.62	23.29	0.97
1	3898	10 YEAR	515.00	678.00	682.51	682.51	683.00	0.002992	6.18	205.65	311.84	0.65
1	3898	25 YEAR	677.00	678.00	682.73	682.73	683.28	0.003254	6.79	278.53	328.10	0.69
1	3898	50 YEAR	809.00	678.00	682.90	682.90	683.47	0.003379	7.17	334.01	339.96	0.71
1	3898	100 YEAR	948.00	678.00	683.07	683.07	683.64	0.003415	7.46	392.21	349.54	0.72
1	3898	500 YEAR	1302.00	678.00	684.79		684.91	0.000625	4.20	1052.13	410.06	0.33

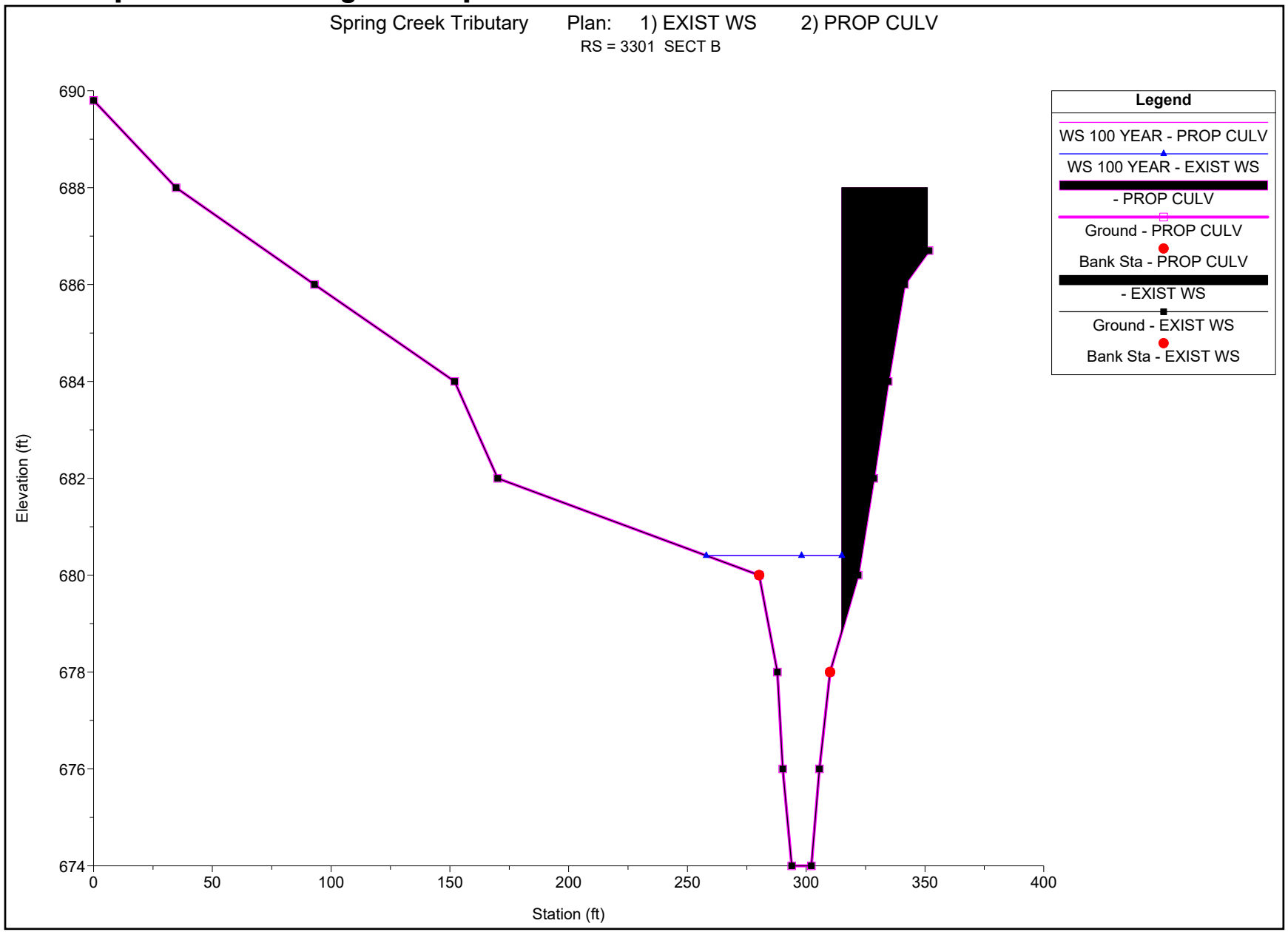
Appendix 3 – Proposed Conditions HEC-RAS


Spring Creek Tributary
Plan: PROP CULVERT EXTENSION/FILL
11/24/2021
spring creek tri 1
Legend
WS 500 YEAR
WS 100 YEAR
WS 50 YEAR
WS 25 YEAR
WS 10 YEAR
WS 5 YEAR
WS 2 YEAR
Ground
Elevation (ft)
695
690
685
680
675
670
665
660
0
1000
2000
3000
4000
Main Channel Distance (ft)
Double 8'x7' Box Culvert
Under I-24 and McBrien Road
(To Be Extended 27.59' on the
Upstream Side)
Double 8'x7' Box Culvert
Under Ramp 'O'
(To Be Extended 23.86' on
the Downstream Side)
Double 8'x7' Box Culvert
Under Moore Road (To
Remain - No Extension)

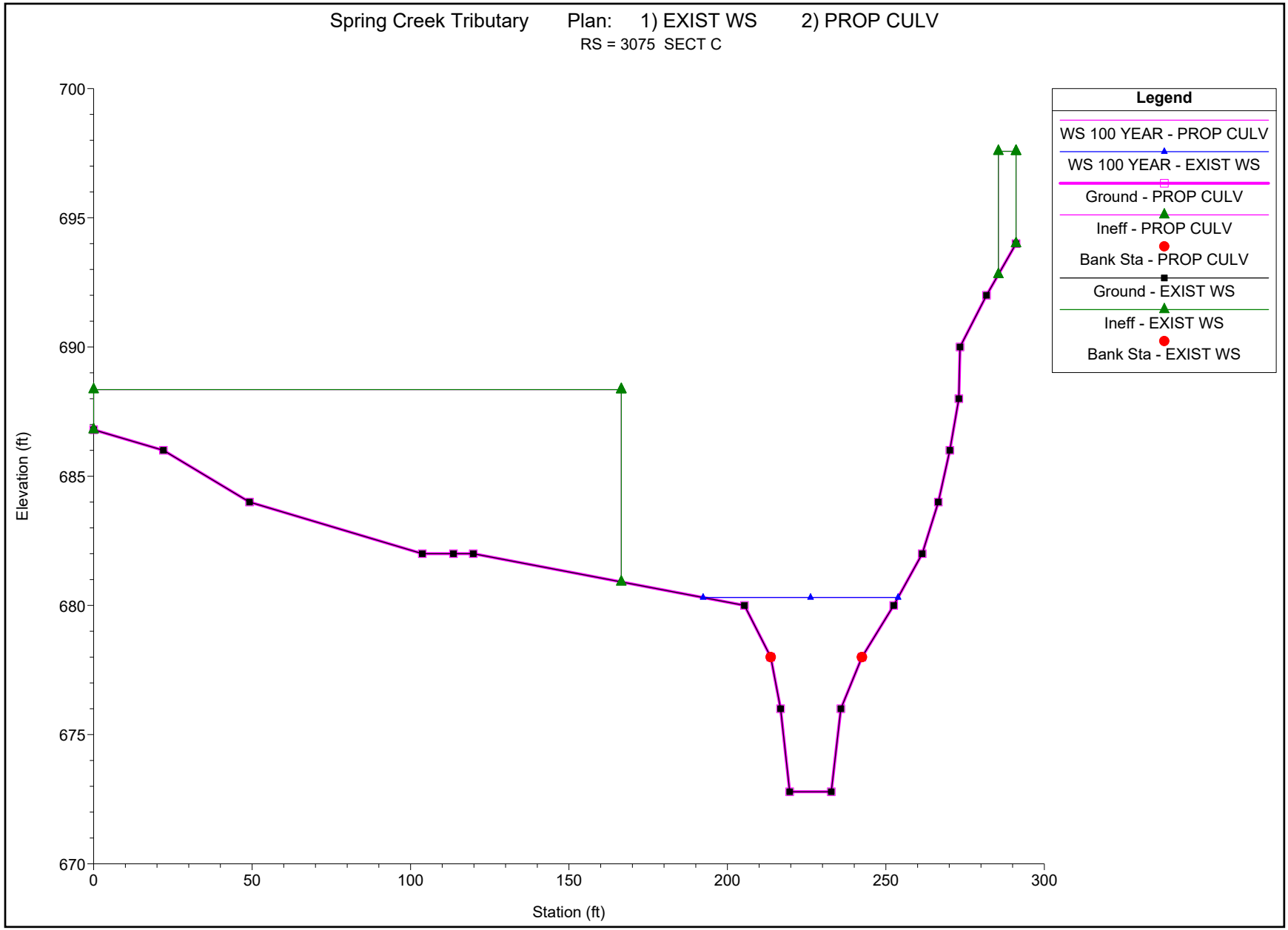
Comparison of Existing and Proposed HEC-RAS Cross-Sections



Comparison of Existing and Proposed HEC-RAS Cross-Sections



Comparison of Existing and Proposed HEC-RAS Cross-Sections



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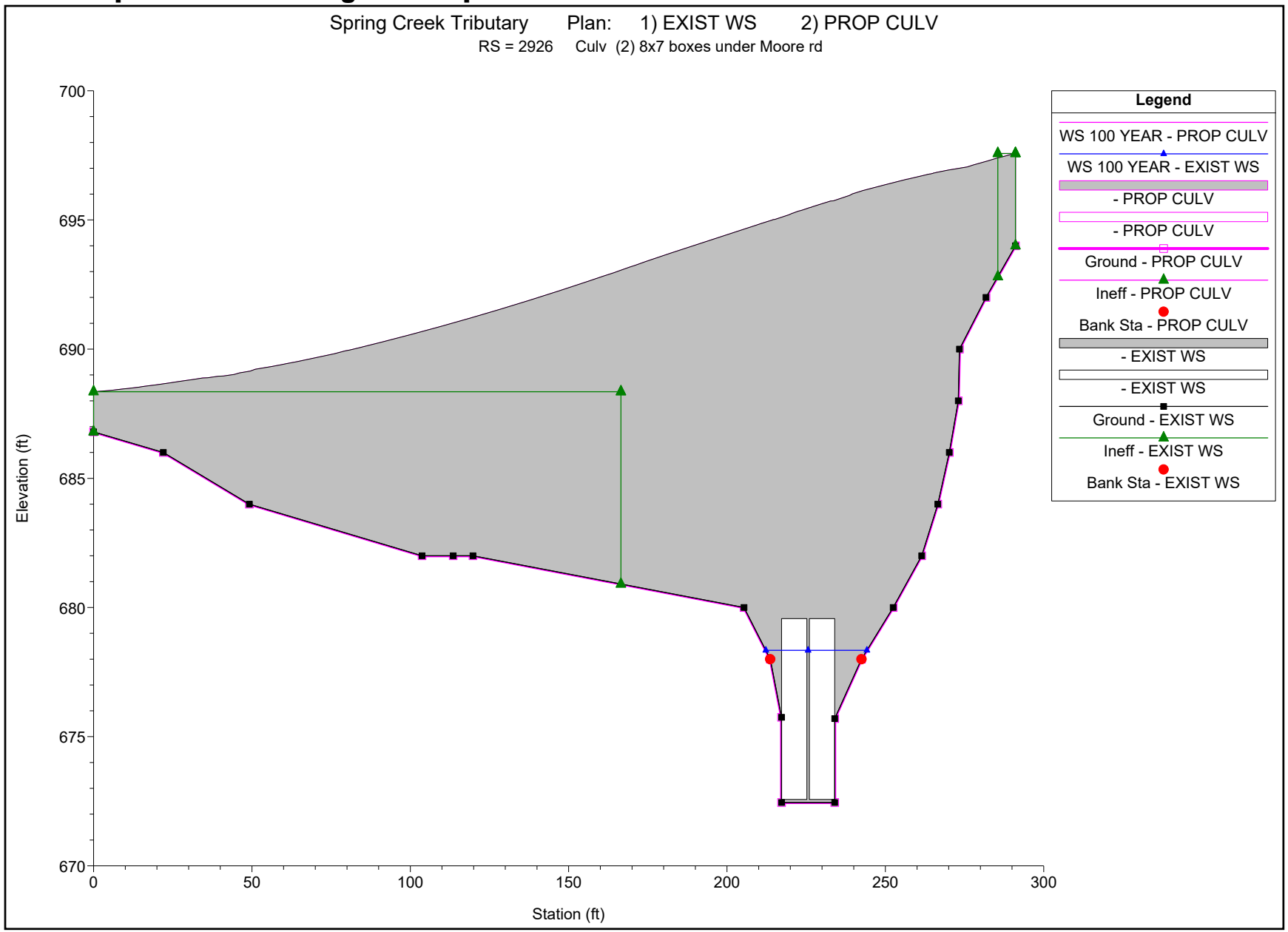

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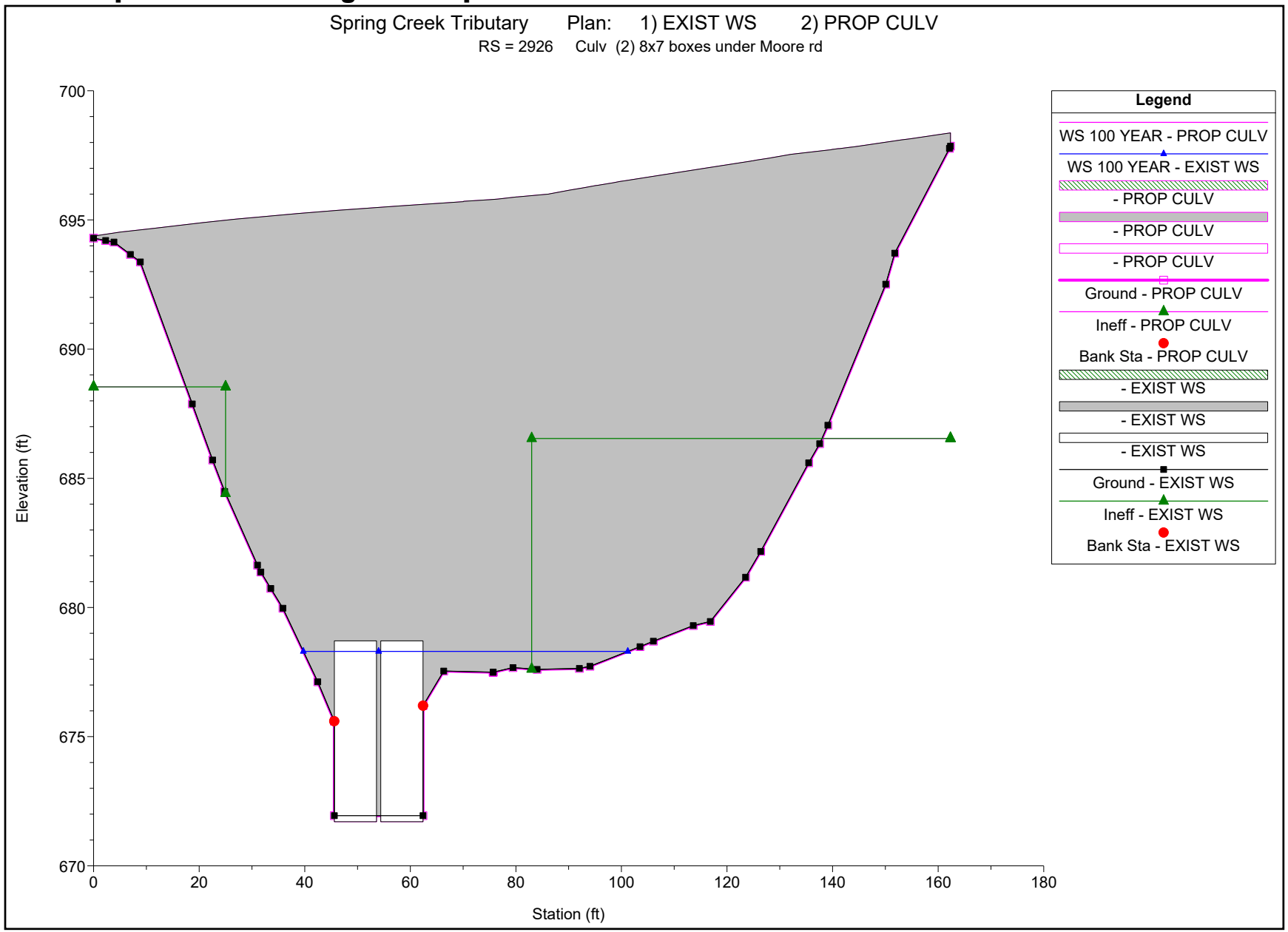
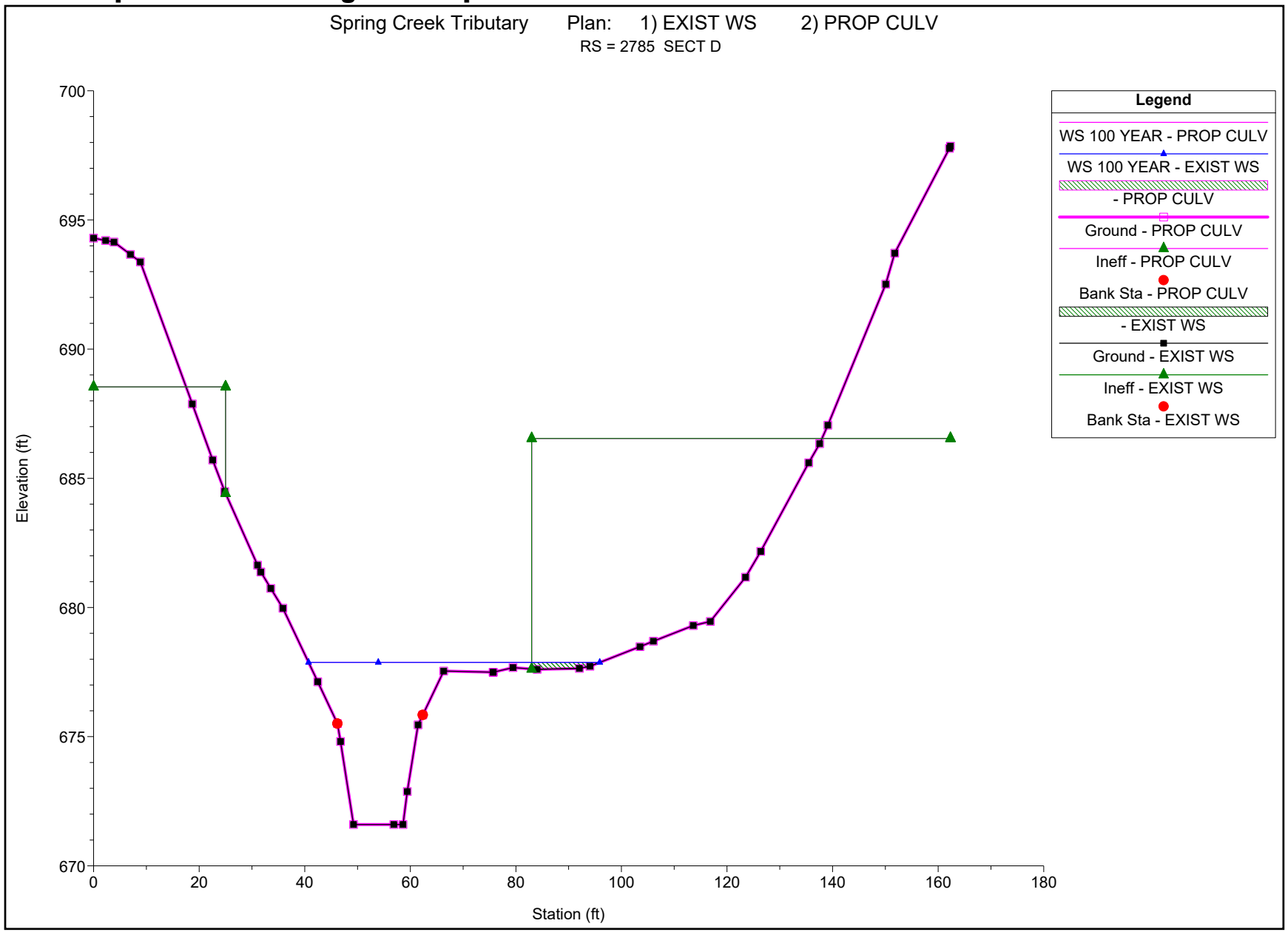


Comparison of Existing and Proposed HEC-RAS Cross-Sections



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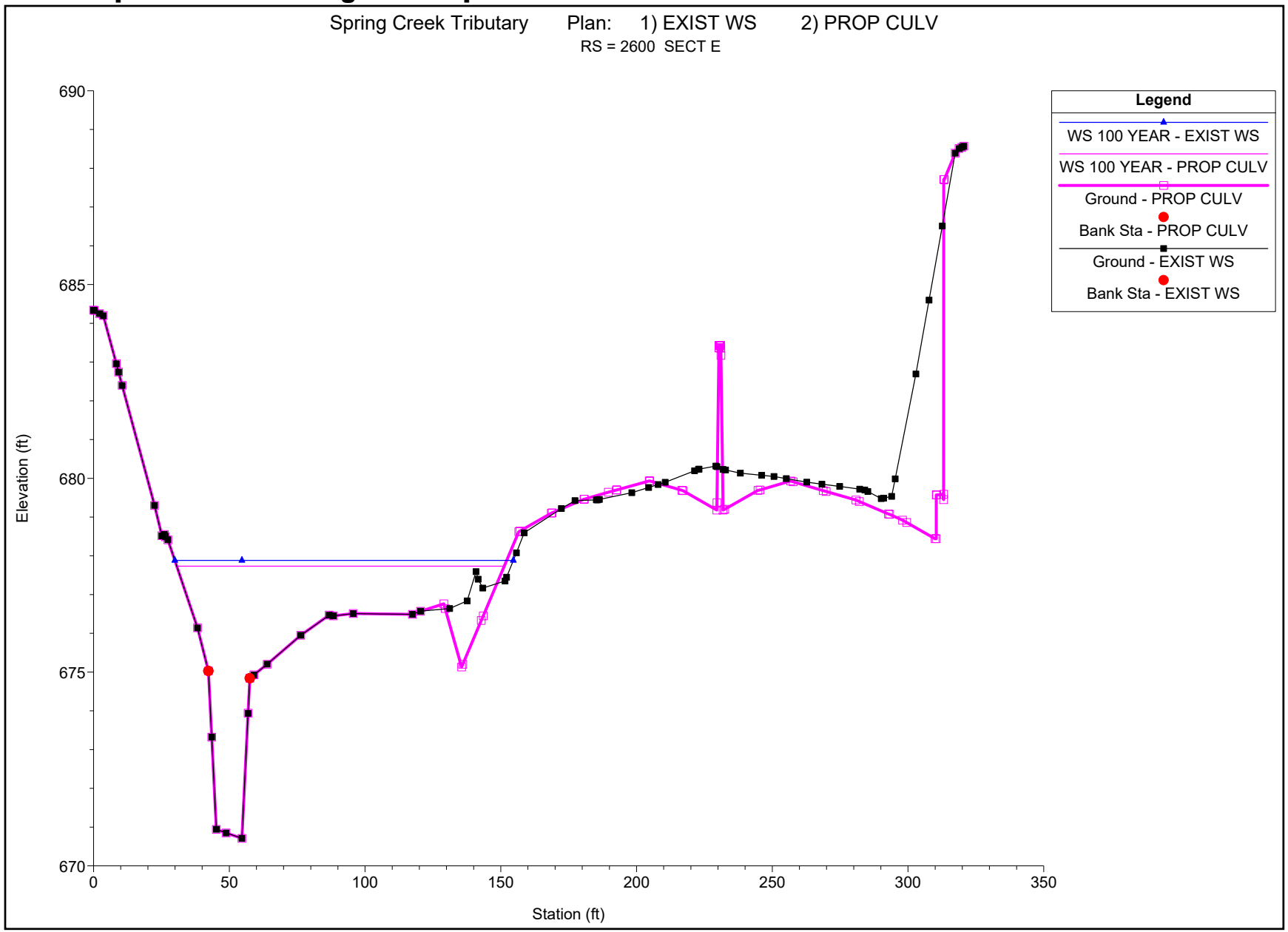
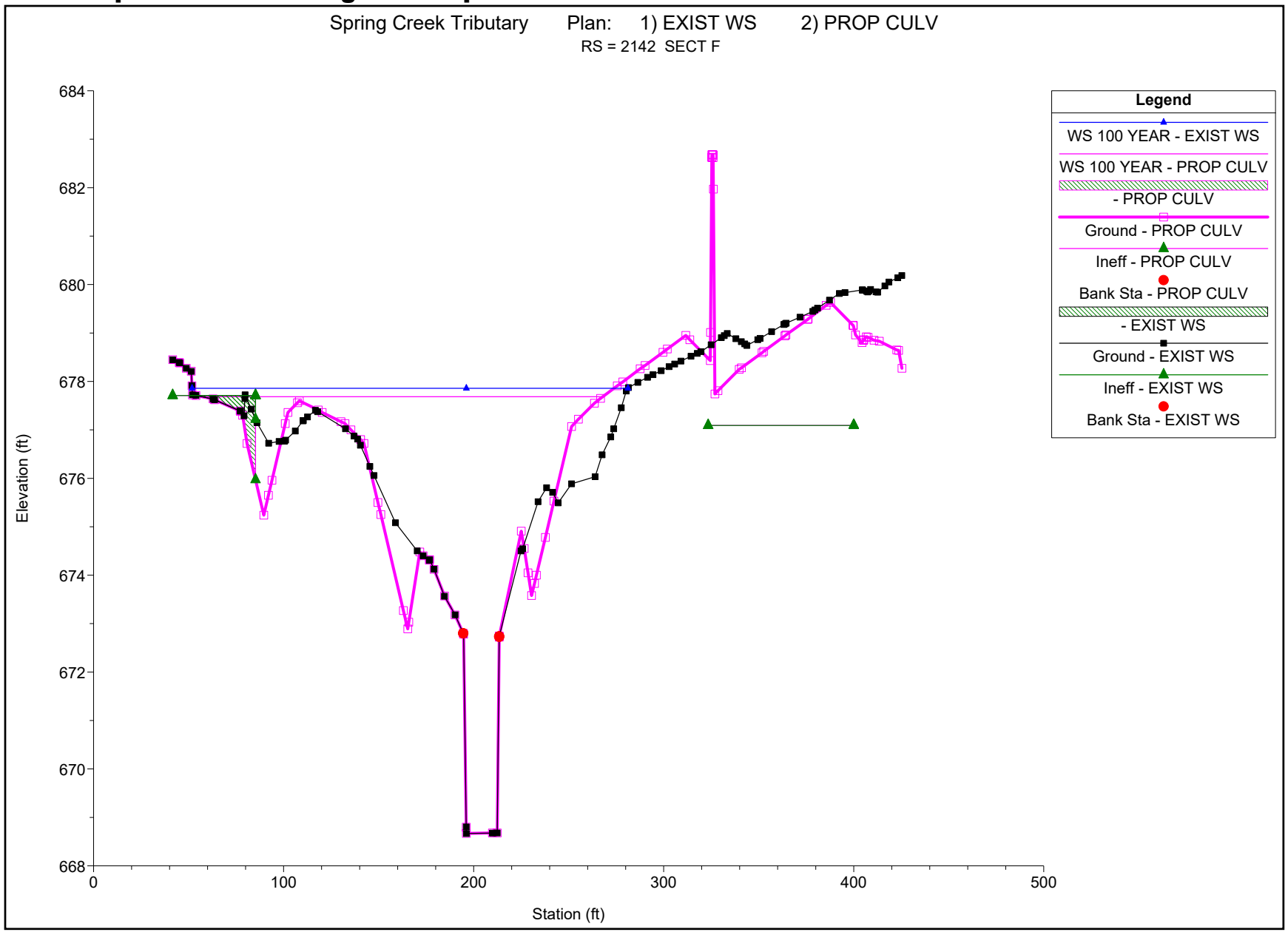
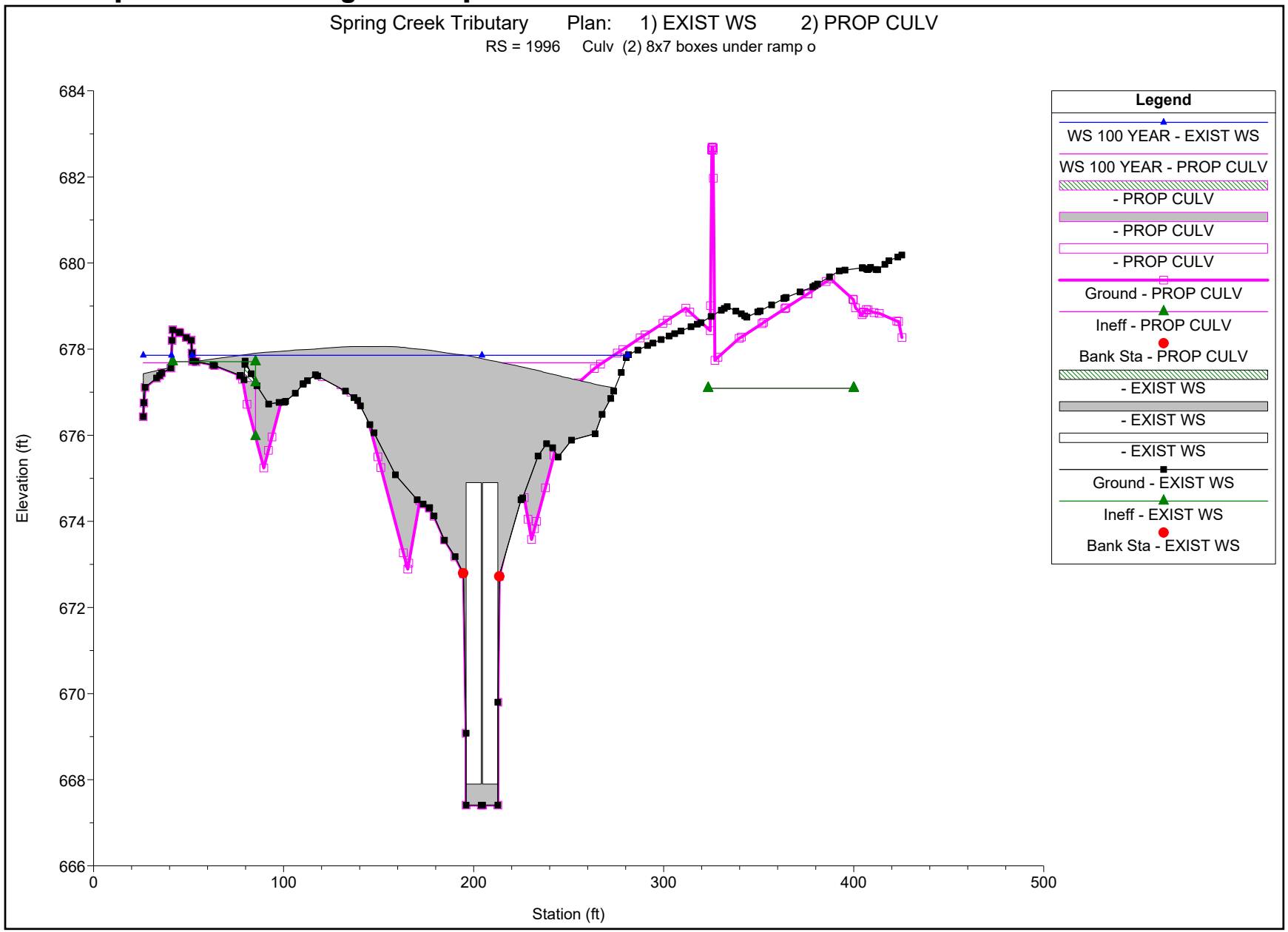


Comparison of Existing and Proposed HEC-RAS Cross-Sections



Comparison of Existing and Proposed HEC-RAS Cross-Sections



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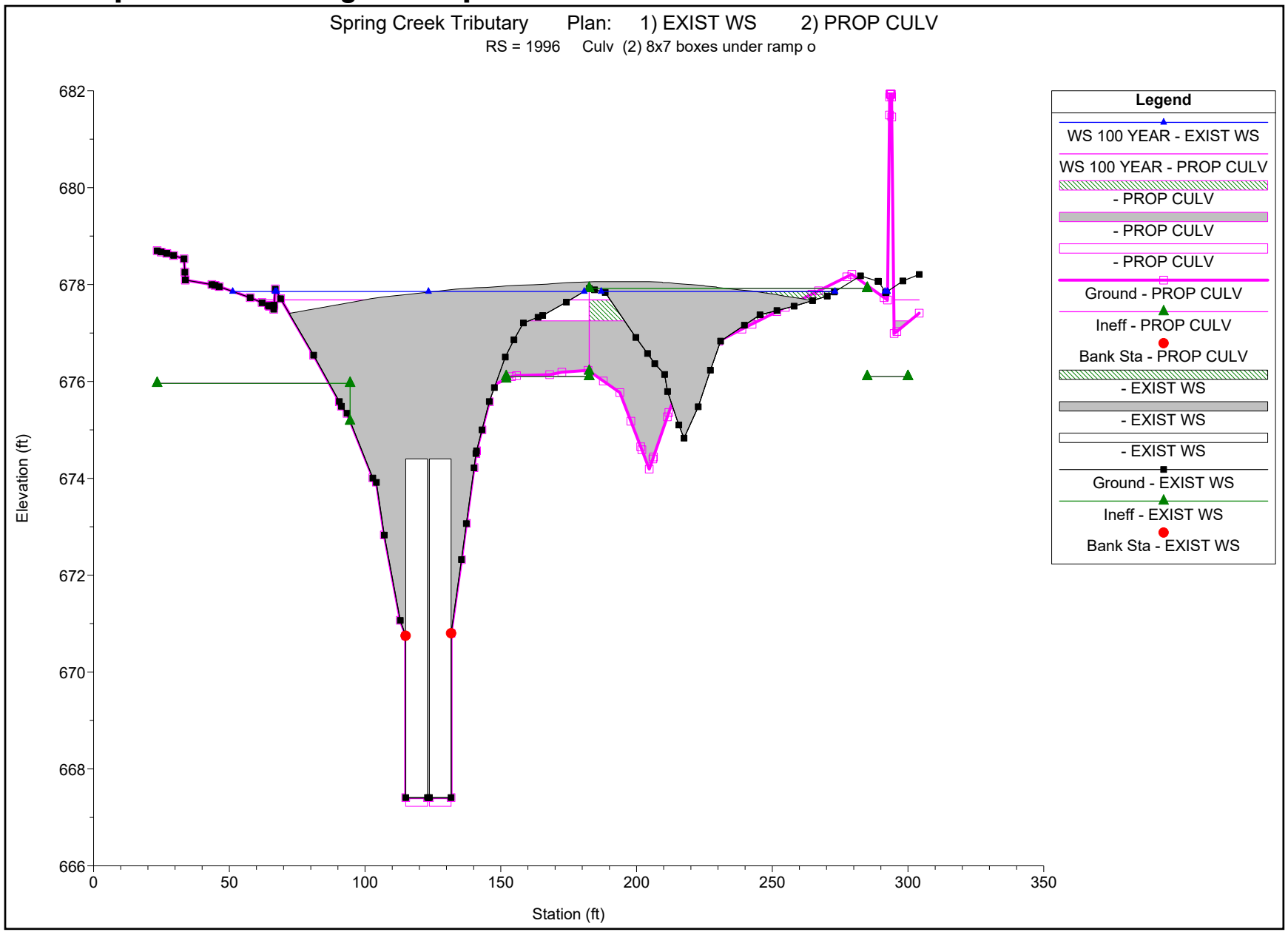
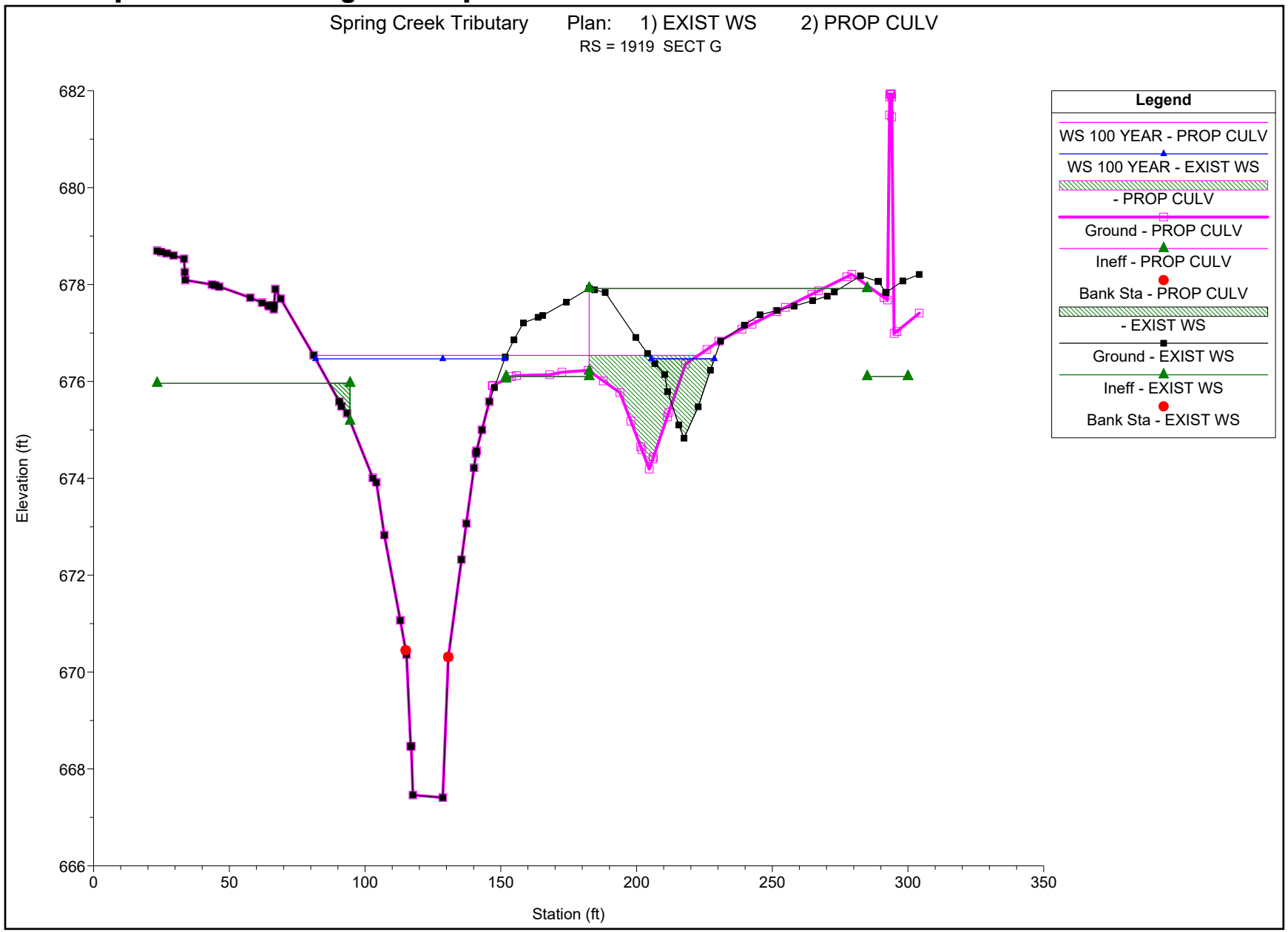
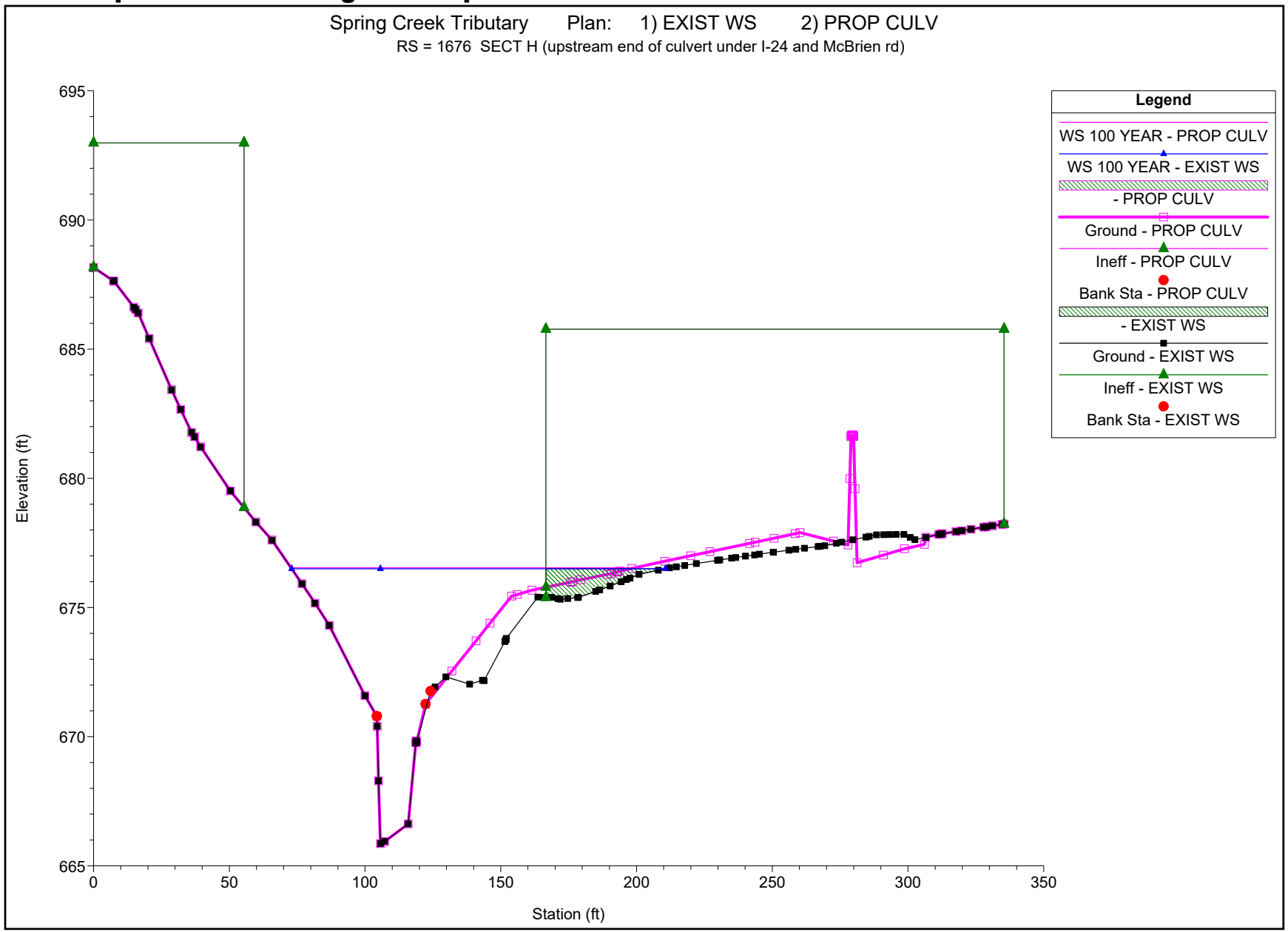


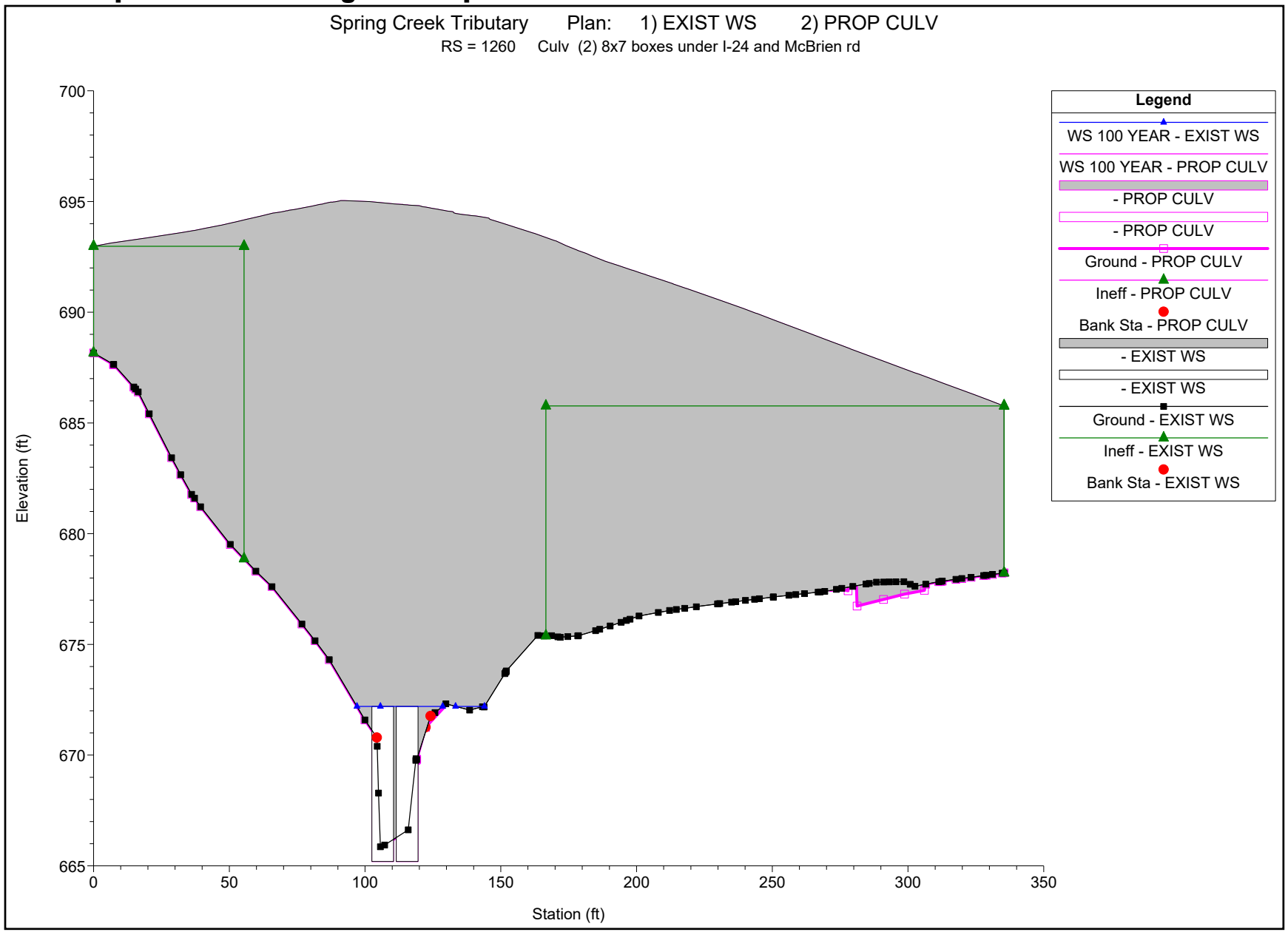
Comparison of Existing and Proposed HEC-RAS Cross-Sections



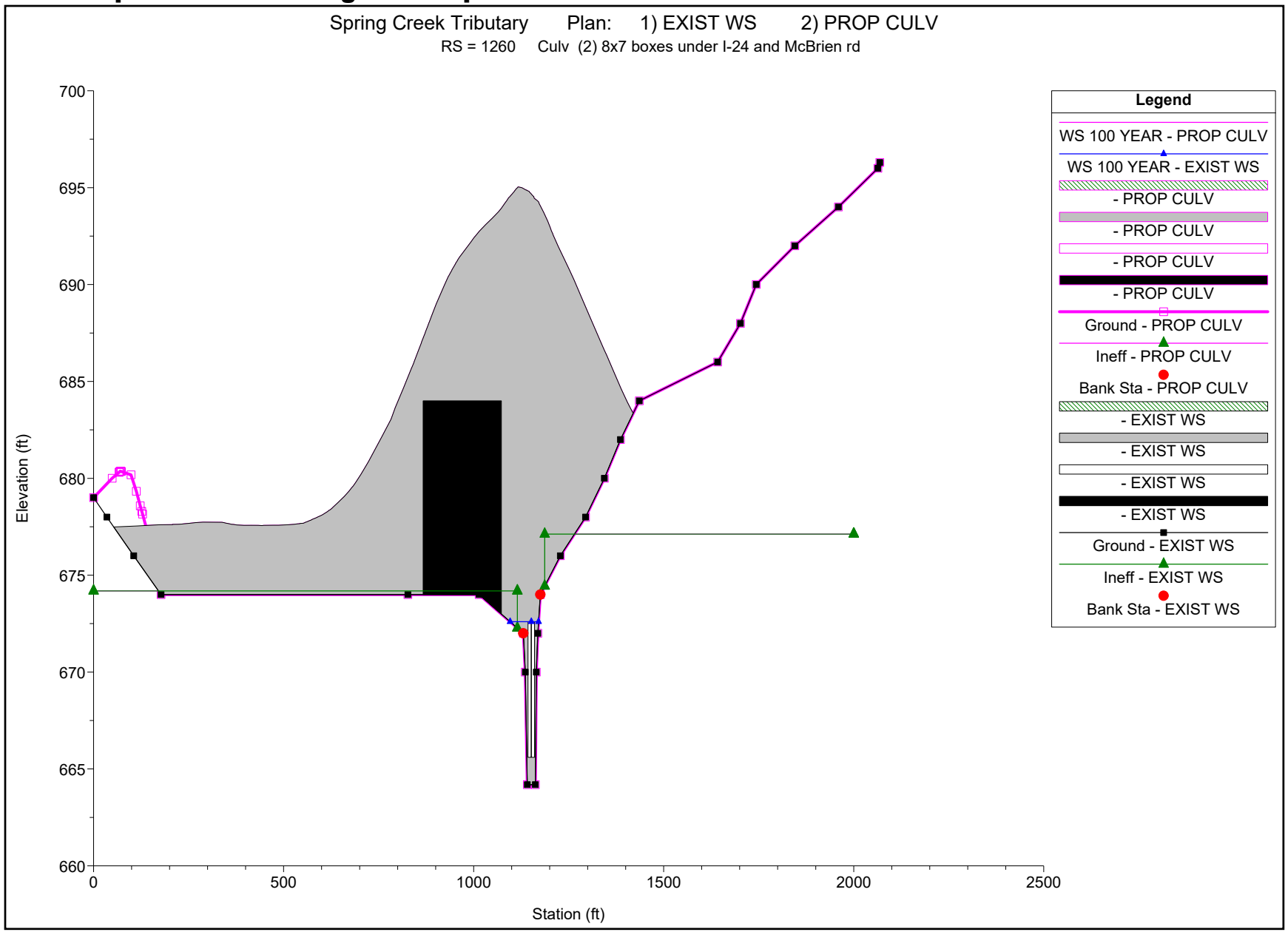
Comparison of Existing and Proposed HEC-RAS Cross-Sections



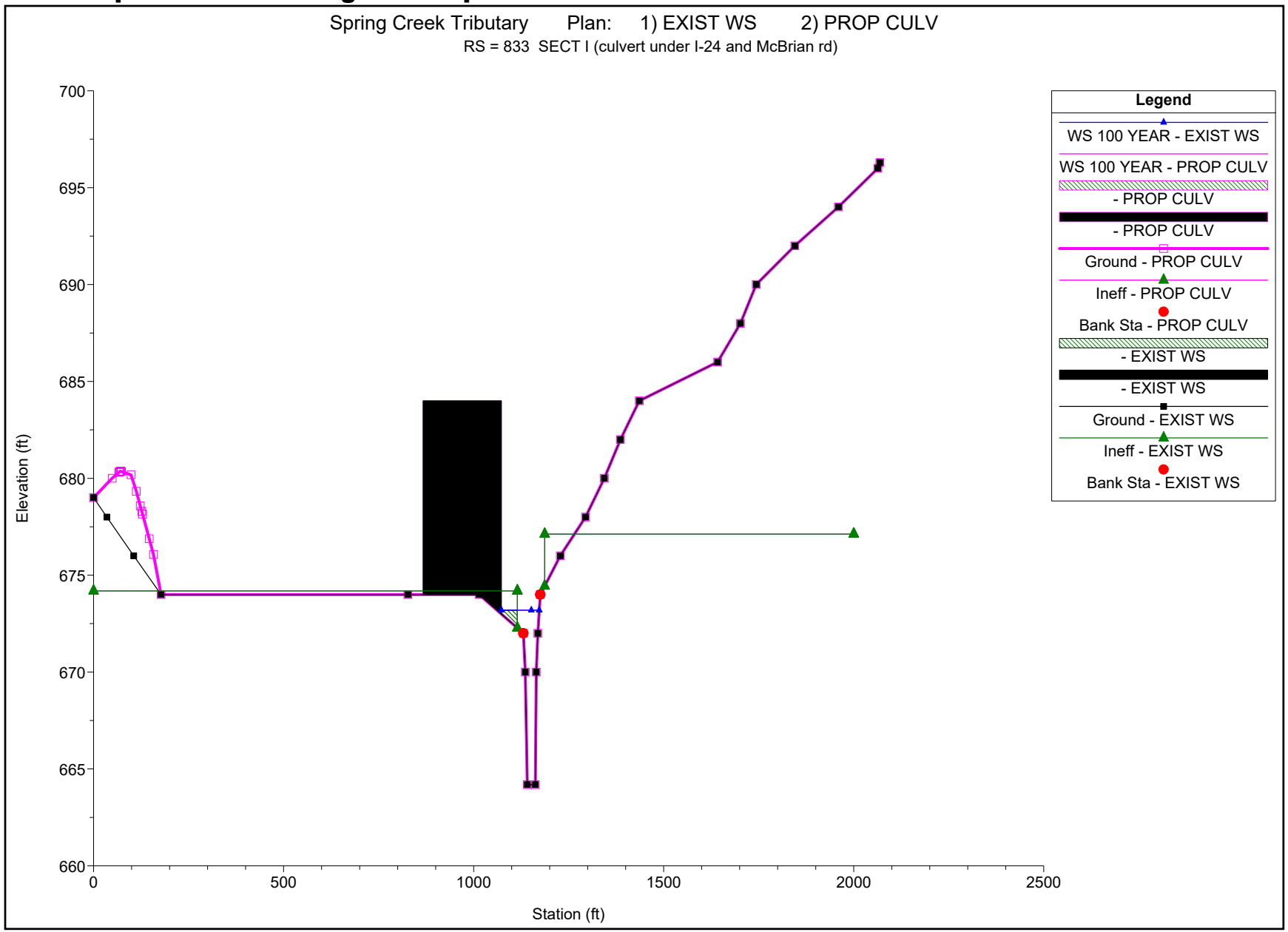
Comparison of Existing and Proposed HEC-RAS Cross-Sections



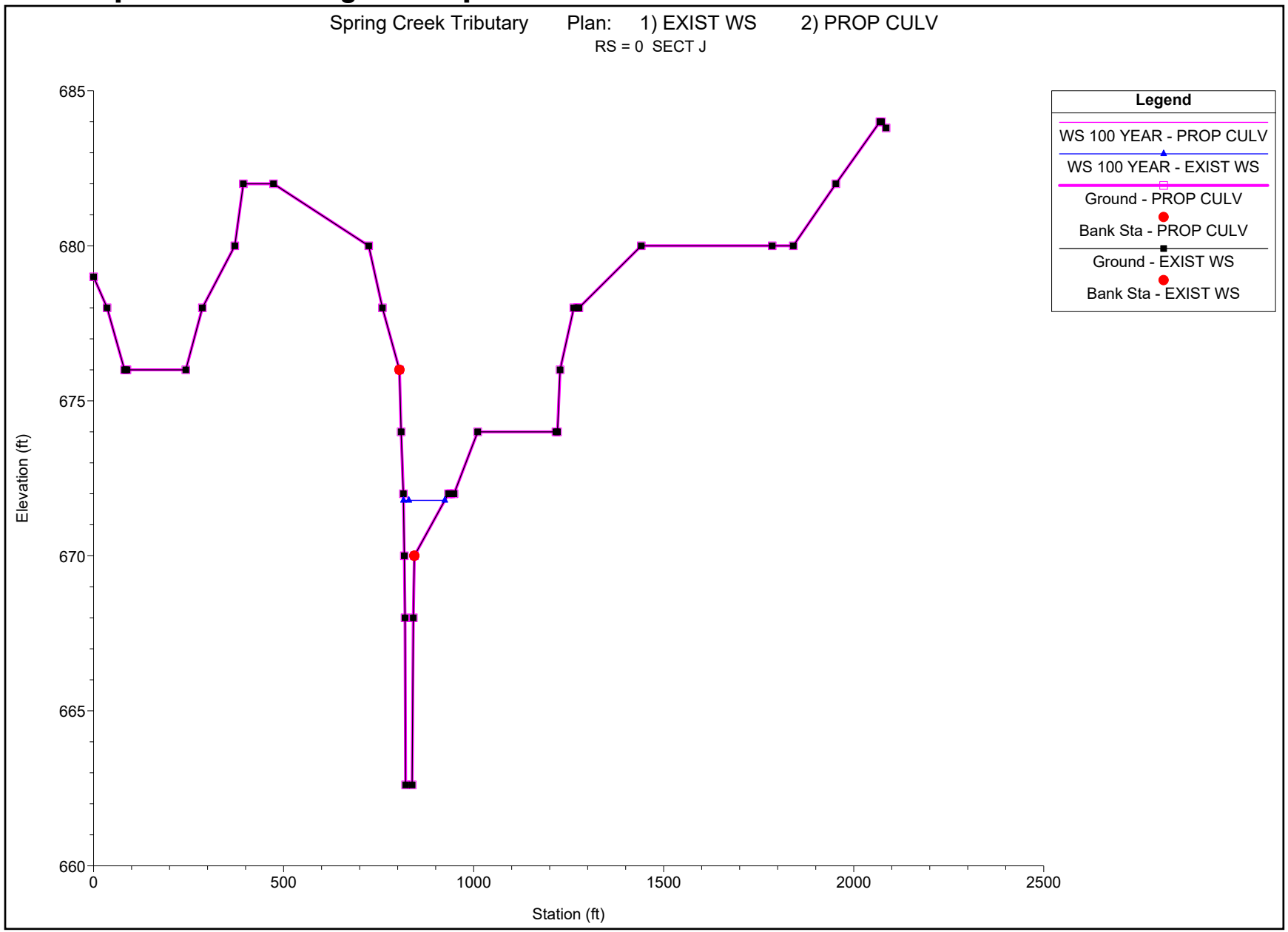
Comparison of Existing and Proposed HEC-RAS Cross-Sections



Comparison of Existing and Proposed HEC-RAS Cross-Sections



Comparison of Existing and Proposed HEC-RAS Cross-Sections



Proposed Conditions HEC-RAS Output

HEC-RAS Plan: PROP CULV River: spring creek tri Reach: 1

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)	
1	0	2 YEAR	243.00	662.61	666.84	664.41	666.98	0.001900	3.02	80.46	20.87	0.27
1	0	5 YEAR	397.00	662.61	668.39	665.10	668.58	0.001900	3.48	113.92	22.81	0.27
1	0	10 YEAR	515.00	662.61	669.42	665.56	669.63	0.001901	3.71	138.69	25.29	0.28
1	0	25 YEAR	677.00	662.61	670.53	666.13	670.78	0.001900	4.01	174.64	51.28	0.29
1	0	50 YEAR	809.00	662.61	671.21	666.56	671.48	0.001903	4.22	219.86	82.41	0.29
1	0	100 YEAR	948.00	662.61	671.79	666.98	672.07	0.001902	4.39	274.97	108.92	0.29
1	0	500 YEAR	1302.00	662.61	672.90	667.98	673.18	0.001902	4.62	433.58	164.18	0.30
1	833	2 YEAR	243.00	664.19	668.20		668.30	0.001310	2.54	95.80	26.54	0.24
1	833	5 YEAR	397.00	664.19	669.72		669.84	0.001214	2.89	137.59	28.54	0.23
1	833	10 YEAR	515.00	664.19	670.76		670.90	0.001211	3.05	168.97	32.36	0.24
1	833	25 YEAR	677.00	664.19	671.91		672.07	0.001232	3.24	209.17	37.59	0.24
1	833	50 YEAR	809.00	664.19	672.60		672.78	0.001255	3.41	243.58	75.04	0.25
1	833	100 YEAR	948.00	664.19	673.19		673.39	0.001294	3.60	277.12	99.76	0.25
1	833	500 YEAR	1302.00	664.19	674.31	668.82	674.56	0.001434	4.09	433.48	803.05	0.27
1	1260		Culvert									
1	1676	2 YEAR	243.00	665.86	668.71	668.71	669.83	0.009506	8.51	28.54	12.89	1.01
1	1676	5 YEAR	397.00	665.86	669.62	669.62	671.09	0.009155	9.74	40.77	13.93	1.00
1	1676	10 YEAR	515.00	665.86	671.19	670.26	672.14	0.004374	7.83	66.14	19.97	0.72
1	1676	25 YEAR	677.00	665.86	673.23	671.03	673.72	0.001347	5.81	132.54	45.21	0.43
1	1676	50 YEAR	809.00	665.86	674.89	671.70	675.15	0.000519	4.28	225.00	66.54	0.28
1	1676	100 YEAR	948.00	665.86	676.54	672.38	676.68	0.000219	3.18	360.52	126.88	0.19
1	1676	500 YEAR	1302.00	665.86	680.84	673.42	680.90	0.000035	1.65	817.45	292.18	0.08
1	1919	2 YEAR	243.00	667.41	670.69	669.79	671.17	0.002799	5.55	44.02	17.41	0.59
1	1919	5 YEAR	397.00	667.41	671.76	670.63	672.37	0.002388	6.36	65.74	23.50	0.57
1	1919	10 YEAR	515.00	667.41	672.24	671.24	673.00	0.002564	7.13	77.86	26.31	0.60
1	1919	25 YEAR	677.00	667.41	673.51	671.95	674.14	0.001580	6.64	115.70	33.15	0.49
1	1919	50 YEAR	809.00	667.41	674.96	672.45	675.40	0.000858	5.70	172.19	56.76	0.38
1	1919	100 YEAR	948.00	667.41	676.54	672.91	676.84	0.000510	5.03	273.65	141.64	0.30
1	1919	500 YEAR	1302.00	667.41	680.91	673.86	680.93	0.000018	1.25	1383.24	279.64	0.06
1	1996		Culvert									
1	2142	2 YEAR	243.00	668.67	670.56	670.56	671.47	0.009137	7.67	31.68	17.39	1.00
1	2142	5 YEAR	397.00	668.67	672.03	671.27	672.76	0.003955	6.86	57.86	18.28	0.68
1	2142	10 YEAR	515.00	668.67	672.69	671.75	673.53	0.003789	7.34	70.12	18.68	0.67
1	2142	25 YEAR	677.00	668.67	674.18	672.35	674.78	0.001864	6.40	125.69	61.78	0.49
1	2142	50 YEAR	809.00	668.67	676.15	672.82	676.33	0.000410	3.71	300.73	111.16	0.24
1	2142	100 YEAR	948.00	668.67	677.68	673.76	677.78	0.000190	2.88	507.59	210.68	0.17
1	2142	500 YEAR	1302.00	668.67	680.91	674.99	680.93	0.000021	1.19	1579.80	382.39	0.06
1	2600	2 YEAR	243.00	670.71	673.84	673.38	674.59	0.005232	6.99	34.79	13.68	0.77
1	2600	5 YEAR	397.00	670.71	674.29	674.29	675.74	0.008711	9.65	41.12	14.32	1.00
1	2600	10 YEAR	515.00	670.71	674.87	674.87	676.54	0.008640	10.37	49.66	15.58	1.01
1	2600	25 YEAR	677.00	670.71	676.22	676.22	677.15	0.003442	8.20	95.25	54.85	0.67
1	2600	50 YEAR	809.00	670.71	676.89	676.89	677.46	0.002045	6.91	152.90	111.48	0.53
1	2600	100 YEAR	948.00	670.71	677.73		677.98	0.000726	4.55	251.03	120.64	0.32
1	2600	500 YEAR	1302.00	670.71	680.92		680.95	0.000055	1.66	904.86	295.28	0.10
1	2785	2 YEAR	243.00	671.60	674.85		675.48	0.004048	6.36	38.19	14.23	0.68
1	2785	5 YEAR	397.00	671.60	676.15		676.87	0.003194	6.82	58.72	18.37	0.63
1	2785	10 YEAR	515.00	671.60	676.82	675.69	677.66	0.002988	7.40	72.12	21.49	0.63
1	2785	25 YEAR	677.00	671.60	676.72	676.39	678.26	0.005615	9.97	69.96	21.02	0.86
1	2785	50 YEAR	809.00	671.60	676.94	676.94	678.90	0.006705	11.28	74.69	22.04	0.95
1	2785	100 YEAR	948.00	671.60	677.87	677.87	679.55	0.004577	10.60	102.39	55.16	0.81
1	2785	500 YEAR	1302.00	671.60	680.59		681.33	0.001380	7.66	226.15	87.25	0.48
1	2926		Culvert									
1	3075	2 YEAR	243.00	672.79	675.36	674.87	675.94	0.004219	6.09	39.88	17.85	0.72
1	3075	5 YEAR	397.00	672.79	676.90	675.63	677.39	0.002439	5.62	70.59	23.39	0.57
1	3075	10 YEAR	515.00	672.79	677.81	676.15	678.28	0.001975	5.48	94.04	27.87	0.53
1	3075	25 YEAR	677.00	672.79	678.68	676.82	679.18	0.001617	5.68	121.23	35.05	0.49
1	3075	50 YEAR	809.00	672.79	679.49	677.27	679.99	0.001263	5.66	152.60	42.45	0.45
1	3075	100 YEAR	948.00	672.79	680.30	677.71	680.80	0.001034	5.66	191.86	61.51	0.42
1	3075	500 YEAR	1302.00	672.79	684.39	678.54	684.62	0.000263	4.08	572.73	223.36	0.23
1	3301	2 YEAR	243.00	674.00	676.47	676.47	677.40	0.008327	7.75	31.34	17.02	1.01
1	3301	5 YEAR	397.00	674.00	677.36	677.25	678.43	0.006907	8.32	47.73	19.99	0.95
1	3301	10 YEAR	515.00	674.00	678.11	677.75	679.12	0.005221	8.06	63.93	23.28	0.85
1	3301	25 YEAR	677.00	674.00	678.87	678.36	679.92	0.004523	8.22	84.42	30.48	0.81
1	3301	50 YEAR	809.00	674.00	679.62		680.57	0.003513	7.84	108.32	33.36	0.73

Proposed Conditions HEC-RAS Output

HEC-RAS Plan: PROP CULV River: spring creek tri Reach: 1 (Continued)

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)	
1	3301	100 YEAR	948.00	674.00	680.40		681.26	0.002582	7.46	139.74	57.07	0.64
1	3301	500 YEAR	1302.00	674.00	684.44		684.70	0.000368	4.41	684.00	176.09	0.27
1	3898	2 YEAR	243.00	678.00	681.09	680.90	681.78	0.006273	6.63	36.67	20.51	0.87
1	3898	5 YEAR	397.00	678.00	681.69	681.62	682.68	0.007256	8.00	49.62	23.29	0.97
1	3898	10 YEAR	515.00	678.00	682.51	682.51	683.00	0.002992	6.18	205.65	311.84	0.65
1	3898	25 YEAR	677.00	678.00	682.73	682.73	683.28	0.003254	6.79	278.53	328.10	0.69
1	3898	50 YEAR	809.00	678.00	682.90	682.90	683.47	0.003379	7.17	334.01	339.96	0.71
1	3898	100 YEAR	948.00	678.00	683.07	683.07	683.64	0.003415	7.46	392.21	349.54	0.72
1	3898	500 YEAR	1302.00	678.00	684.90		685.01	0.000557	4.02	1098.83	416.31	0.31

Comparison of Existing and Proposed 100-Year HEC-RAS Output

HEC-RAS River: spring creek tri Reach: 1 Profile: 100 YEAR

Reach	River Sta	Profile	Plan	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)	
1	0	100 YEAR	EXIST WS	948.00	662.61	671.79	666.98	672.07	0.001902	4.39	274.97	108.92	0.29
1	0	100 YEAR	PROP CULV	948.00	662.61	671.79	666.98	672.07	0.001902	4.39	274.97	108.92	0.29
1	833	100 YEAR	EXIST WS	948.00	664.19	673.19		673.39	0.001294	3.60	277.12	99.76	0.25
1	833	100 YEAR	PROP CULV	948.00	664.19	673.19		673.39	0.001294	3.60	277.12	99.76	0.25
1	1260			Culvert									
1	1676	100 YEAR	EXIST WS	948.00	665.86	676.50	672.75	676.62	0.000152	2.61	396.06	137.66	0.16
1	1676	100 YEAR	PROP CULV	948.00	665.86	676.54	672.38	676.68	0.000219	3.18	360.52	126.88	0.19
1	1919	100 YEAR	EXIST WS	948.00	667.41	676.47	672.91	676.77	0.000488	4.89	256.23	92.83	0.29
1	1919	100 YEAR	PROP CULV	948.00	667.41	676.54	672.91	676.84	0.000510	5.03	273.65	141.64	0.30
1	1996			Culvert									
1	2142	100 YEAR	EXIST WS	948.00	668.67	677.86	673.63	677.95	0.000160	2.68	541.17	229.40	0.16
1	2142	100 YEAR	PROP CULV	948.00	668.67	677.68	673.76	677.78	0.000190	2.88	507.59	210.68	0.17
1	2600	100 YEAR	EXIST WS	948.00	670.71	677.88		678.13	0.000723	4.61	253.74	124.70	0.32
1	2600	100 YEAR	PROP CULV	948.00	670.71	677.73		677.98	0.000726	4.55	251.03	120.64	0.32
1	2785	100 YEAR	EXIST WS	948.00	671.60	677.87	677.87	679.55	0.004577	10.60	102.39	55.16	0.81
1	2785	100 YEAR	PROP CULV	948.00	671.60	677.87	677.87	679.55	0.004577	10.60	102.39	55.16	0.81
1	2926			Culvert									
1	3075	100 YEAR	EXIST WS	948.00	672.79	680.30	677.71	680.80	0.001034	5.66	191.86	61.51	0.42
1	3075	100 YEAR	PROP CULV	948.00	672.79	680.30	677.71	680.80	0.001034	5.66	191.86	61.51	0.42
1	3301	100 YEAR	EXIST WS	948.00	674.00	680.40		681.26	0.002582	7.46	139.74	57.07	0.64
1	3301	100 YEAR	PROP CULV	948.00	674.00	680.40		681.26	0.002582	7.46	139.74	57.07	0.64
1	3898	100 YEAR	EXIST WS	948.00	678.00	683.07	683.07	683.64	0.003415	7.46	392.21	349.54	0.72
1	3898	100 YEAR	PROP CULV	948.00	678.00	683.07	683.07	683.64	0.003415	7.46	392.21	349.54	0.72