PIONEER TECHNICAL SERVICES, INC.

RESTORING OUR ENVIRONMENT ▸ DESIGNING OUR FUTURE

Physical Map Revision
Silver Bow Creek
Silver Bow County, Montana
Hydraulic Analysis Report

Montana Department of Environmental Quality (DEQ)
May 17, 2019

Pioneer Technical Services, Inc. 106 Pronghorn Trail, Bozeman Montana 59718
www.pioneer-technical.com

Physical Map Revision
Silver Bow Creek
Silver Bow County, Montana
Hydraulic Analysis Report

Prepared for:
State of Montana, Department of Environmental Quality
P.O. Box 200901
Helena, Montana 59620-0901

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Pioneer Technical Services, Inc.
106 Pronghorn Trail
Bozeman, Montana 59718

Physical Map Revision

Silver Bow Creek

Silver Bow County, Montana

Hydraulic Analysis Report

May 17, 2019

I hereby certify that all work products (maps, reports, etc.) prepared for this project were done so under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Montana.

Jonathan Jupka, P.E., CFM

MONTANA
JONATHAN JW JUPKA
No. 51146PE
LICENSED PROFESSIONAL ENGINEER

Date: 05/17/19 Montana Registration No. 51146

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1 INTRODUCTION

Portions of Silver Bow Creek (SBC) and its floodplain located in Silver Bow County were reconstructed under the Superfund Streamside Tailings Operable Unit (SST OU) Remedial Action (RA). Following the RA completion, the Montana Department of Environmental Quality (DEQ) contracted Pioneer Technical Services, Inc. (Pioneer) to update the Flood Insurance Rate Maps (FIRMs) on SBC within the SST OU RA area through the Federal Emergency Management Agency (FEMA). As part of the FIRM updates, Pioneer completed a comprehensive peak flow hydrologic analysis for a 17-mile, main stem, SBC study reach located within the SST OU boundary (Pioneer, 2018a). The SBC study reach extends from the Deer Lodge/Silver Bow County boundary upstream to the FIRM panel 30093C0302E boundary located approximately 250 feet upstream of the westbound Interstate 90 (I-90) bridge west of Butte, Montana. The SST OU upstream boundary is 200 feet upstream of the FIRM panel 30093C0302E boundary. This study area watershed encompasses approximately 335 square miles. Information gathered from this analysis will be used for both enhanced level and base level hydraulic analyses and floodplain mapping. Figure 1- Figure 4 show the project study reach.

Additional information referenced throughout this report is included in the appendices below.

Appendix A Hydraulic Work Maps
Appendix B Flood Insurance Study (FIS) Profiles
Appendix C Floodway Data Tables
Appendix D Study Area Photographs
Appendix E Modeled Cross Sections
Appendix F cHECk-RAS Reports
Appendix G Bridge Sketches

1.1 Basin Description

Silver Bow Creek combines with Warm Springs Creek to form the Clark Fork River, which is a major tributary to the Pend Oreille River and Columbia River upper headwaters located west of the continental divide in western Montana. The creek originates in the Deerlodge National Forest near the continental divide. The watershed is formed by the Pioneer and Highland Mountains. Beginning in Butte, Montana, at the Upper SBC and Blacktail Creek confluence, SBC flows northwest for approximately 34 miles before it combines with Warm Spring Creek to form the Clark Fork River near Warm Springs, Montana. The entire SBC watershed area encompasses approximately 473 square miles (Figure 5). The study watershed basin area upstream of the Deer Lodge/Silver Bow County boundary is approximately 335 square miles. The SBC basin elevations within the study area range from approximately 8,900 feet in the mountains to approximately 5,070 feet at the county border. The terrain varies from a high alpine environment in its headwaters to a heavily cultivated landscape in the Deer Lodge valley, with expansive irrigated pasture lands bracketed by rolling foothills. The basin hydrology is primarily snowmelt driven.

Land use in SBC basin is primarily agricultural with irrigated farming and ranching operations. The intensely farmed land is predominately located in the Deer Lodge Valley within the SBC floodplain.

1.2 Background Information

The FEMA administers the National Flood Insurance Program (NFIP). As part of this program, FEMA supports flood hazard studies and prepares flood hazard maps and related documents. The Silver Bow County study reach is located downstream of Butte; therefore, the SBC in Silver Bow County is sparsely populated in a predominantly rural environment. The existing floodplain mapping for SBC in the study area includes 13.2 miles of Approximate Zone A and 3.2 miles of Detailed Zone AE near Rocker, Montana, and near Fairmont Hot Springs Resort (towards Anaconda, Montana). The existing mapping study was completed in 1977.

Approximate Zone A flood maps are developed using approximate methodologies and are not based on detailed hydraulic analysis. This level of flood mapping is often used in rural areas with low populations. Base Flood Elevations (BFEs) or flood depths are not identified in Approximate Zone A mapping (a BFE is the computed elevation to which floodwater is estimated to rise during the base flood). As a result, areas designated as Zone A are difficult for local communities to manage and administer.

Enhanced and base level mapping are similar in that both use standard hydrologic and hydraulic modeling methods to estimate BFEs and flood inundation areas. Both require the same topographic accuracy. However, base level mapping does not include floodway delineation, may not include a 500-year floodplain delineation, and may allow some flexibility in the acquisition and modeling of bathymetric and structure survey data. This study will replace all the Effective Zone A and Effective Zone AE mapping with Zone AE mapping. Both enhanced and base level methods will be used to develop the Zone AE mapping.

A summary of the eight FIRM panels covering the new study reach is listed below:

Community:	Community No:	Panels:	Effective Date:
Butte-Silver Bow County, MT	300077	0302E	1/06/2012
Butte-Silver Bow County, MT	300077	0165E	1/06/2012
Butte-Silver Bow County, MT	300077	0163E	1/06/2012
Butte-Silver Bow County, MT	300077	0145E	1/06/2012
Butte-Silver Bow County, MT	300077	0285E	1/06/2012
Butte-Silver Bow County, MT	300077	0280E	1/06/2012
Butte-Silver Bow County, MT	300077	0140E	1/06/2012
Butte-Silver Bow County, MT	300077	0120E	1/06/2012

LEGEND

- RIVER MILES (STARTING DOWNSTREAM END AT COUNTY BOUNDARY)
- PROPOSED ENHANCED REACH
- PROFILE BASELINE
- COUNTY BOUNDARIES
- NHS INTERSTATE
- SECONDARY
- CITY-COUNTY
- RAMP
- EFFECTIVE ZONE A (1977, 2012)
- EFFECTIVE ZONE AE (1977, 2012)

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 750 1,500 3,000
Feet

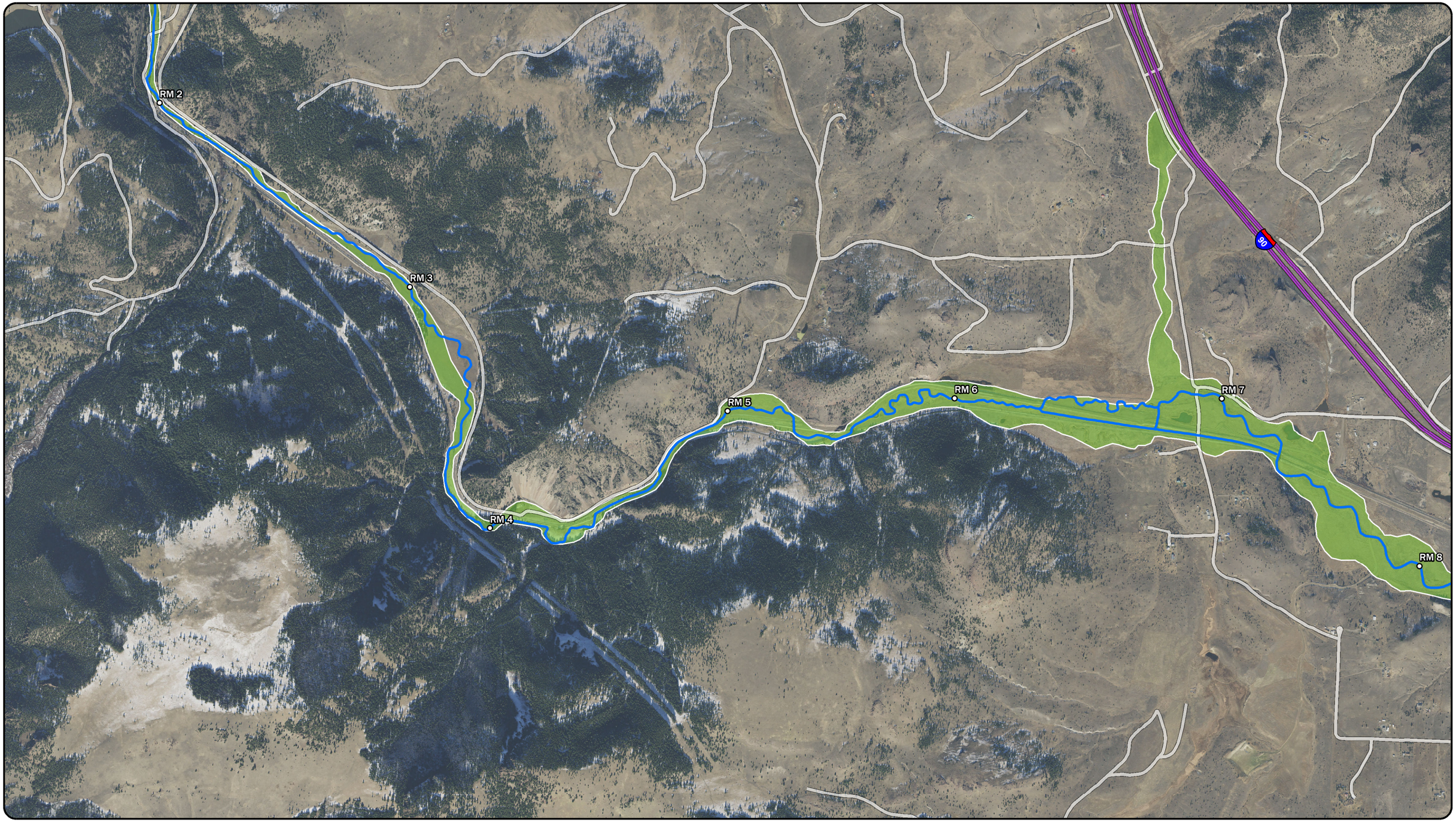
FIGURE 1

SILVER BOW CREEK
STUDY AREA

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/17/2019

Path: H:\DEQ\SSTOU new\2018\FEMA_PMR\Hydraulic Analysis\Drawings\GIS\SilverBowCreek_F1-4_SiteLocation.mxd



LEGEND

- RIVER MILES (STARTING DOWNSTREAM END AT COUNTY BOUNDARY)
- PROFILE BASELINE
- COUNTY BOUNDARIES
- NHS INTERSTATE
- CITY-COUNTY
- EFFECTIVE ZONE A (1977, 2012)

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 750 1,500 3,000
Feet

FIGURE 2

SILVER BOW CREEK STUDY AREA

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/17/2019

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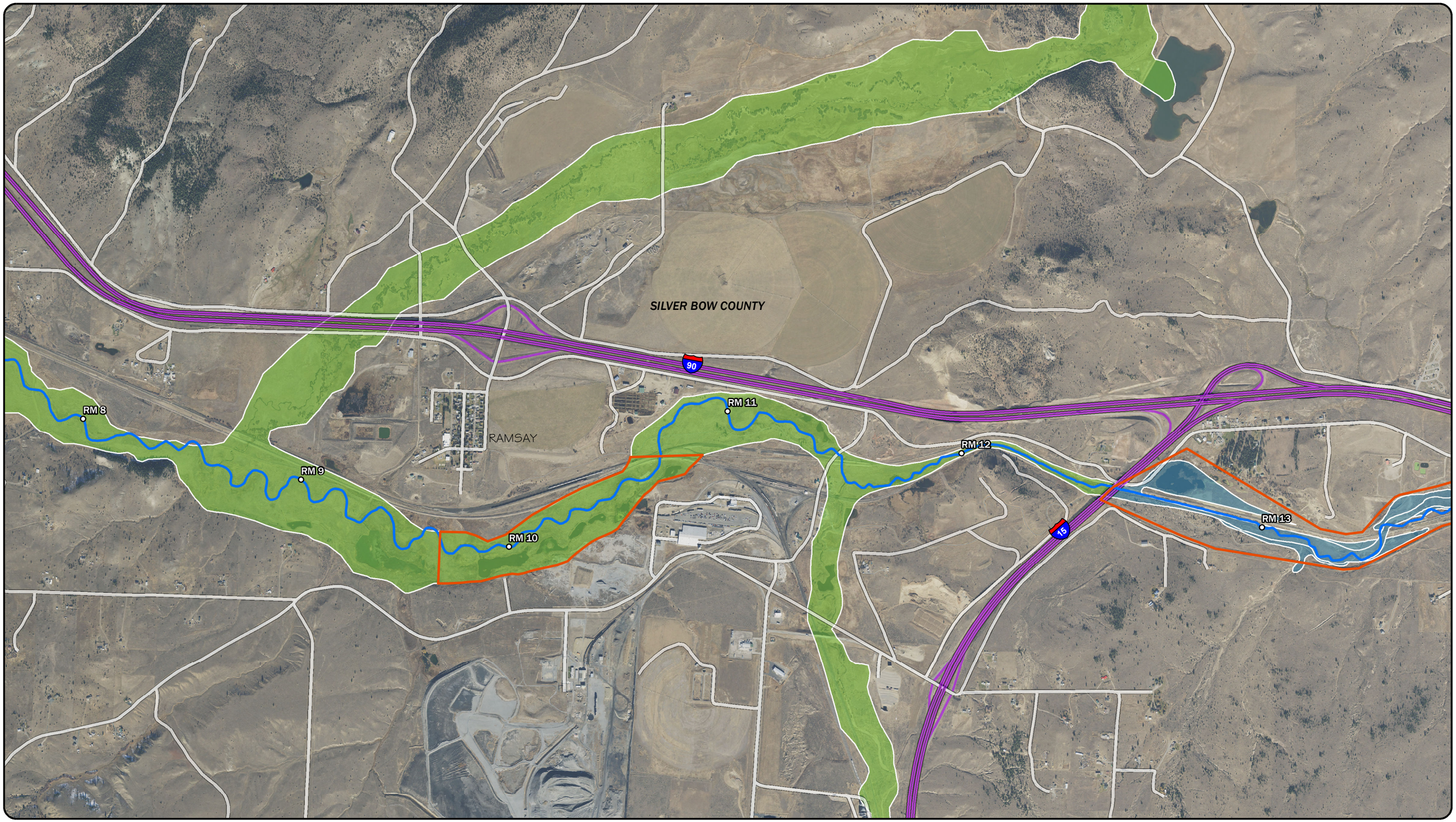


LEGEND

- RIVER MILES (STARTING DOWNSTREAM END AT COUNTY BOUNDARY)
- PROPOSED ENHANCED REACH
- PROFILE BASELINE
- COUNTY BOUNDARIES
- NHS INTERSTATE
- CITY-COUNTY
- RAMP
- EFFECTIVE ZONE A (1977, 2012)
- EFFECTIVE ZONE AE (1977, 2012)

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 750 1,500 3,000
Feet

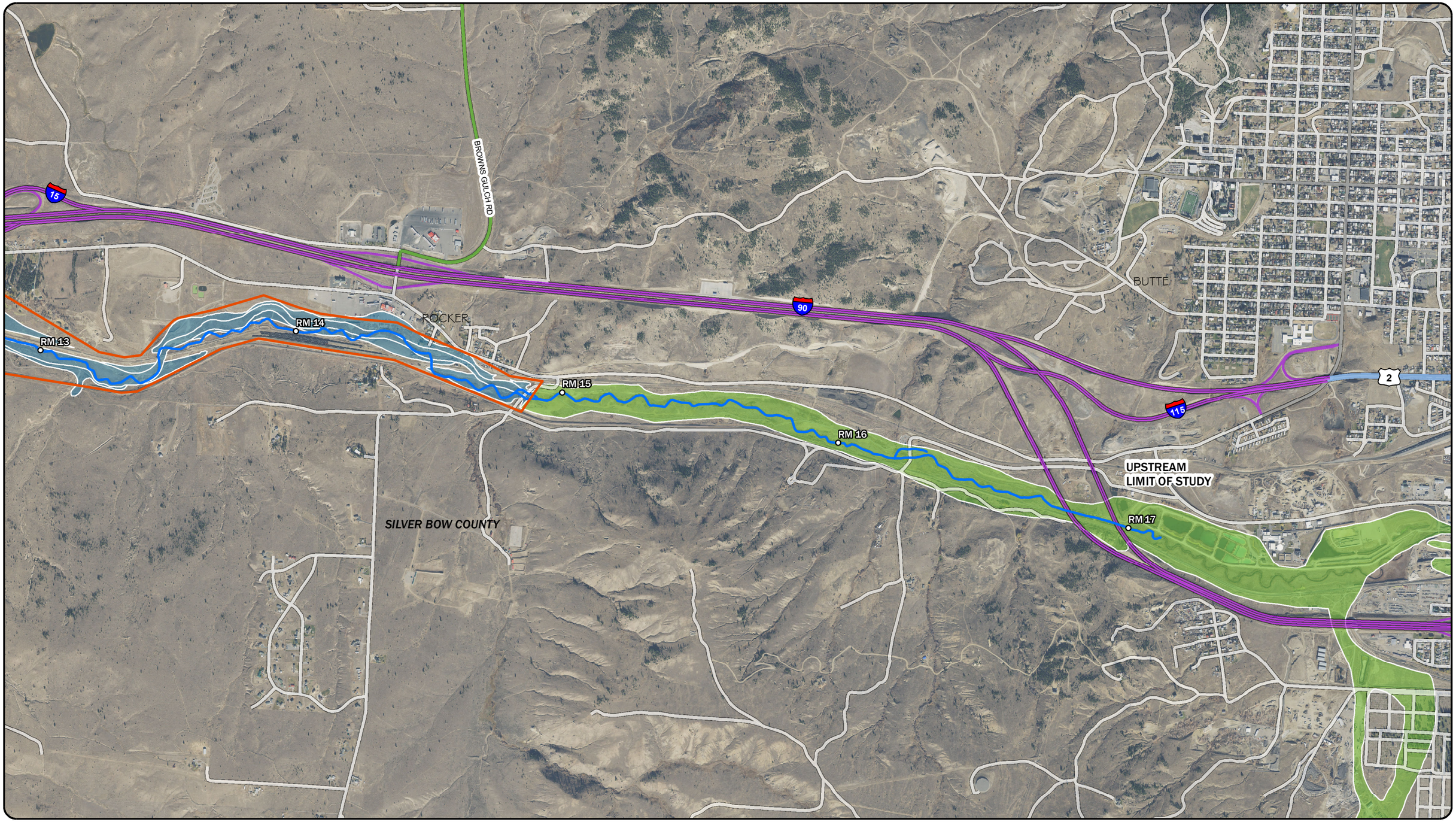
FIGURE 3

SILVER BOW CREEK STUDY AREA

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/17/2019

Path: H:\DEQ\SSTOU new\2018\FEMA_PMR\Hydraulic Analysis\Drawings\GIS\SilverBowCreek_F1-4_SiteLocation.mxd



LEGEND

- RIVER MILES (STARTING DOWNSTREAM END AT COUNTY BOUNDARY)
- PROPOSED ENHANCED REACH
- PROFILE BASELINE
- COUNTY BOUNDARIES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- SECONDARY
- URBAN
- CITY-COUNTY
- RAMP
- EFFECTIVE ZONE A (1977, 2012)
- EFFECTIVE ZONE AE (1977, 2012)

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 750 1,500 3,000
Feet

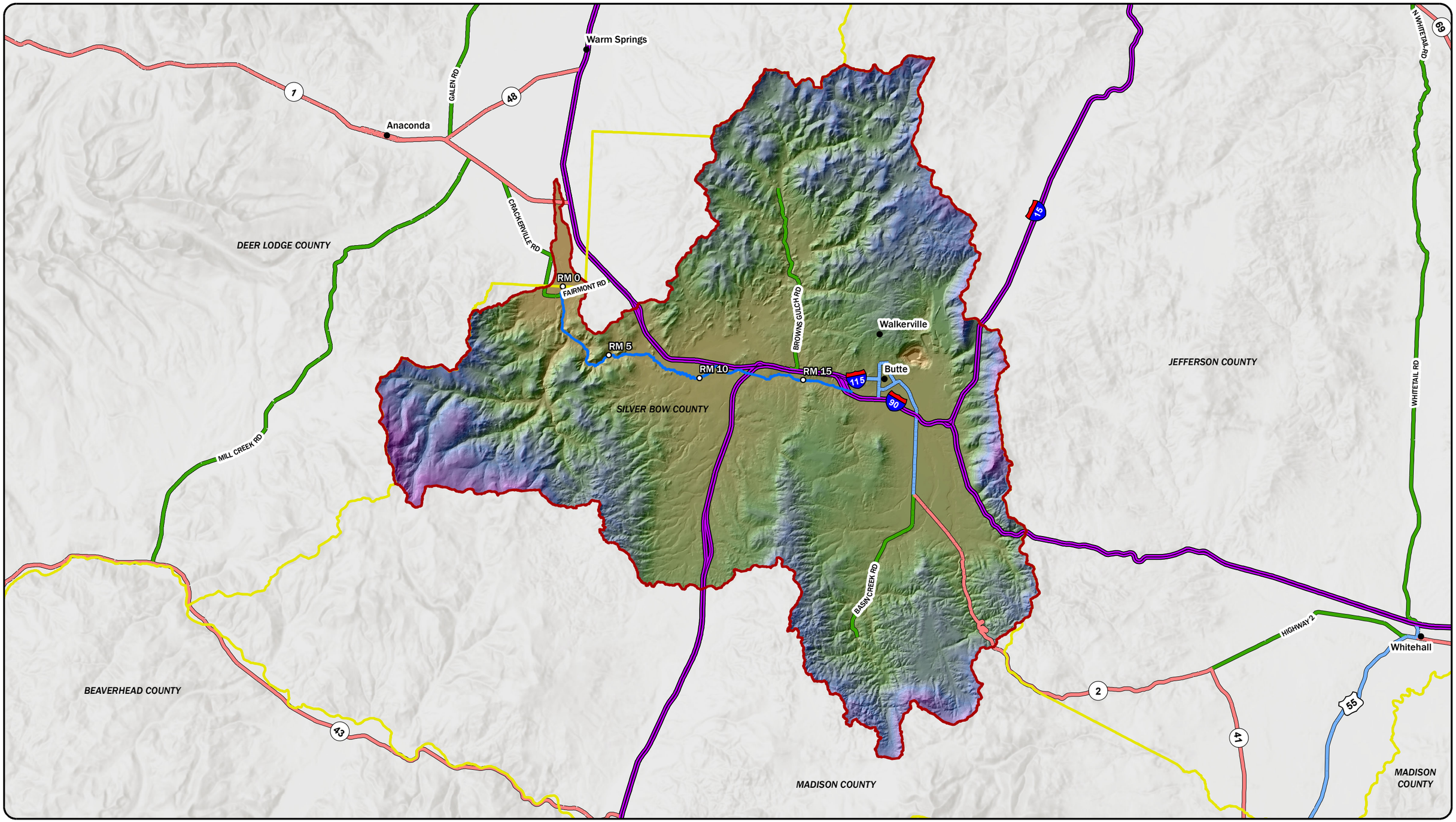
FIGURE 4

SILVER BOW CREEK
STUDY AREA

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/17/2019

Path: H:\DEQ\SSTOU new\2018\FEMA_PMR\Hydraulic Analysis\Drawings\GIS\SilverBowCreek_F1-4_SiteLocation.mxd



LEGEND

- RIVER MILE
- CITIES
- STUDY REACH
- SILVER BOW CREEK WATERSHED AREA
- COUNTY BOUNDARIES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- PRIMARY
- SECONDARY

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 1.75 3.5 7
Miles

FIGURE 5

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/17/2019

SILVER BOW CREEK STUDY AREA WATERSHED

Path: H:\DEQ\SSTOU new\2018\FEMA_PMR\Hydraulic Analysis\Drawings\GIS\SilverBowCreek_F5_Watershed.mxd

1.3 Silver Bow Creek Enhanced Level Study

The current effective mapping contains 2-Zone AE reaches within the study area that were developed using enhanced level study methods (the Fairmont Reach and the Rocker Reach). In this study, the SBC enhanced level study reaches includes three reaches: Fairmont, Ramsay, and Rocker reaches. The Fairmont Reach extends from river mile 0.0 to 1.3 based on the profile baseline, the Ramsay reach extends from river mile 9.7 to 10.6, and the Rocker reach extends from river mile 12.5 to 14.9. All other reaches will be mapped as Zone AE using base level study methods. The project area and study level extents are shown on Figure 1 - Figure 4. This report summarizes the hydraulic analysis developed for the enhanced and base level studies along SBC and includes the 10%, 4%, 2%, 1%, 0.2%, and 1%+ Annual Exceedance Probability (AEP) flood events and 1% AEP floodway (enhanced level only).

2 HYDROLOGIC ANALYSIS

Pioneer previously completed a detailed hydrologic analysis of the 17-mile SBC study reach and summarized the results in the *Physical Map Revision, Silver Bow Creek, Silver Bow County, Montana, Hydrologic Analysis* report, dated October 19, 2018 (Pioneer, 2018a). The hydrologic analysis started approximately 250 feet upstream of the westbound I-90 bridge east of Butte, Montana, and ended at the Silver Bow/Deer Lodge County boundary. The analysis was reviewed and approved by the FEMA Production and Technical Services contractor on October 26, 2018. Table 2-1 following provides a summary of the discharges estimated in the hydrologic analysis and chosen for the SBC study reach. Figure 6 - Figure 9 show the flow node locations.

Table 2-1: Hydrologic Analysis - Summary of Discharges for Silver Bow Creek

Node/USGS Station ID	Location Description	AEP Peak Discharge (cfs)						
		50% AEP	10% AEP	4% AEP	2% AEP	1% AEP	0.2AEP	1%+
		2-year	10-year	25-year	50-year	100-year	500-year	
12323250	**SBC below Blacktail Creek at Butte, MT**	**169**	**313**	**400**	**473**	**554**	**774**	**729**
600	Rocker, MT	176	333	429	511	601	847	797
500	Sand Creek	179	341	440	526	620	876	824
400	Browns Gulch	209	432	578	704	847	1,237	1,164
300	McCleery Gulch	254	580	809	1,013	1,249	1,902	1,787
200	German Gulch	261	604	848	1,066	1,318	2,018	1,896
100	Silver Bow County Boundary	281	679	969	1,231	1,537	2,392	2,247
12323600	**SBC at Opportunity, MT**	**285**	**691**	**988**	**1,257**	**1,572**	**2,452**	**2,304**

AEP: Annual Exceedance Probability. USGS: U.S. Geological Survey. SBC: Silver Bow Creek. cfs: cubic feet per second.

3 HYDRAULIC ANALYSIS OVERVIEW AND PROCEDURES

This section contains details of the hydraulic analysis methods and techniques used to complete the SBC enhanced and base level study reaches. Version 5.0.6 of the Hydraulic Engineering Center River Analysis System (HEC-RAS) was used in association with GeoHECRAS to develop a 1-dimensional (1D) hydraulic model for the study reach. This section includes the procedures performed to complete the hydraulic analysis. The hydraulic analysis references various FEMA risk analysis and mapping guidance documents for general hydraulic considerations (FEMA, 2016a), Letter of Map Revisions (LOMRs) (FEMA, 2016b), Elevation Guidance (FEMA, 2016c), and Data Capture-Workflow Details (FEMA, 2017).

3.1 Topographic Data Acquisition

Survey methods and procedures were conducted in accordance with FEMA Guidance for Flood Risk Analysis and Mapping: Elevation Guidance (FEMA, 2016c) and Data Capture – Workflow Details (FEMA, 2017).

3.1.1 LiDAR Survey

Montana DEQ contracted Quantum Spatial Inc. (QSI) to complete a light Detection and Ranging (LiDAR) survey for the entire SBC study reach. The survey was completed in November 2017. The LiDAR deliverables included 3-foot grid bare earth digital elevation models (DEMs) for the entire length of the SBC study reach corridor (QSI, 2017). The LiDAR data were collected with the following specifications:

Projection:	Montana State Plane	Units
Datum:	Horizontal – NAD83	International Feet
	Vertical – NAVD88	US Feet

NAD: North American Datum. NAVD: North American Vertical Datum.

3.1.2 Field Survey

Brown and Associates Inc. (Brown) performed a field survey for DEQ between July 1, 2018, and October 31, 2018 (Pioneer, 2018b). The field survey was delayed due to high flows in SBC. The field survey included bathymetric cross sections and structure survey. The survey information was collected as listed below:

Projection:	Montana State Plane	Units
Datum:	Horizontal – NAD83	International Feet
	Vertical – NAVD88	US Feet

3.1.2.1 Structure Survey

Structure survey activities included surveying 1 concrete fish barrier structure, 40 bridge structures, and 20 secondary floodplain culverts. Secondary culverts are located adjacent to the active floodplain and are not on the main channel. Secondary bridge openings (bridge openings adjacent to the active floodplain) that may allow backwatering, were not surveyed. The LiDAR survey was used for secondary bridge openings. Bridges and culverts outside of and not adjacent to the active floodplain were not surveyed.

The survey included collecting information on both the upstream and downstream faces of the bridge. In addition to surveying the structure, Brown surveyed four river channel bathymetric cross sections to facilitate hydraulic modeling of the bridge structures. Appendix G contains the bridge sketches showing surveyed cross sections and surveyed bridge data for each structure. Two I-90 bridges were under construction during the time of the survey and were not surveyed. Design drawings were obtained from Montana Department of Transportation (MDT) for the two bridges under construction. The two I-90 bridges under construction were dimensioned from the MDT-provided design drawings.

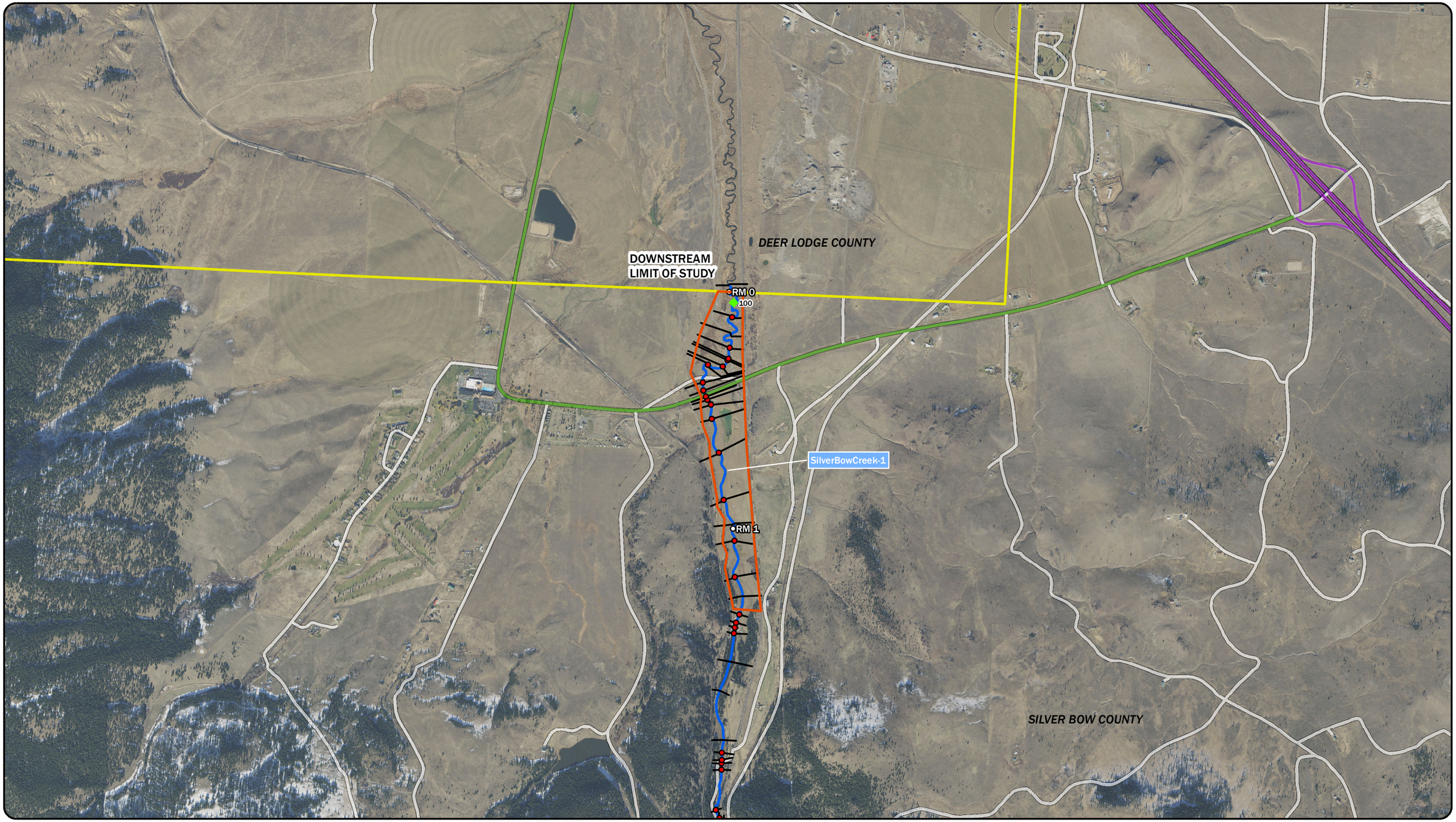
3.1.2.2 Bathymetric Survey

Prior to conducting the fieldwork, proposed locations for the bathymetric survey cross sections were developed using Bing 2011 aerial imagery in AutoCAD Civil 3d 2016 and Google Earth 2014 aerial imagery. During the survey fieldwork, cross-section locations were adjusted based on the observed channel riffle locations.

Bathymetric survey data were collected in a manner compliant with FEMA data capture standards (FEMA, 2017). Figure 6 - Figure 9 show the locations of the bathymetric surveyed sections.

3.1.3 Merged DEM

The LiDAR and bathymetric datasets were used to develop a merged DEM. Merged DEMs were created for the enhanced level detail study reaches. For base level study reaches, the bare earth DEM (no bathymetric detail) provided by QSI was used. The bathymetric data surveyed at bridge structures were used to create a merged bathymetric DEM spanning the four surveyed cross sections. Merged DEMs (enhanced level and base level at structures) and bare earth DEMs (base level outside of structures) were combined to create one sitewide DEM. This DEM became the geometry file to sample cross sections using GeoHECRAS software.



LEGEND

- FLOW CHANGE NODE
- PROPOSED ENHANCED REACH
- RIVER MILES (STARTING DOWNSTREAM END AT COUNTY BOUNDARY)
- BATHYMETRIC SURVEY LOCATIONS
- CROSS SECTIONS
- STUDY PROFILE BASELINE (COLOR VARIES BY REACH)
- COUNTY BOUNDARIES
- NHS INTERSTATE
- SECONDARY
- CITY-COUNTY
- RAMP

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 750 1,500 3,000
Feet

FIGURE 6

PIONEER TECHNICAL SERVICES, INC.

SILVER BOW CREEK
BATHYMETRIC SURVEY
LOCATIONS

DATE: 5/17/2019

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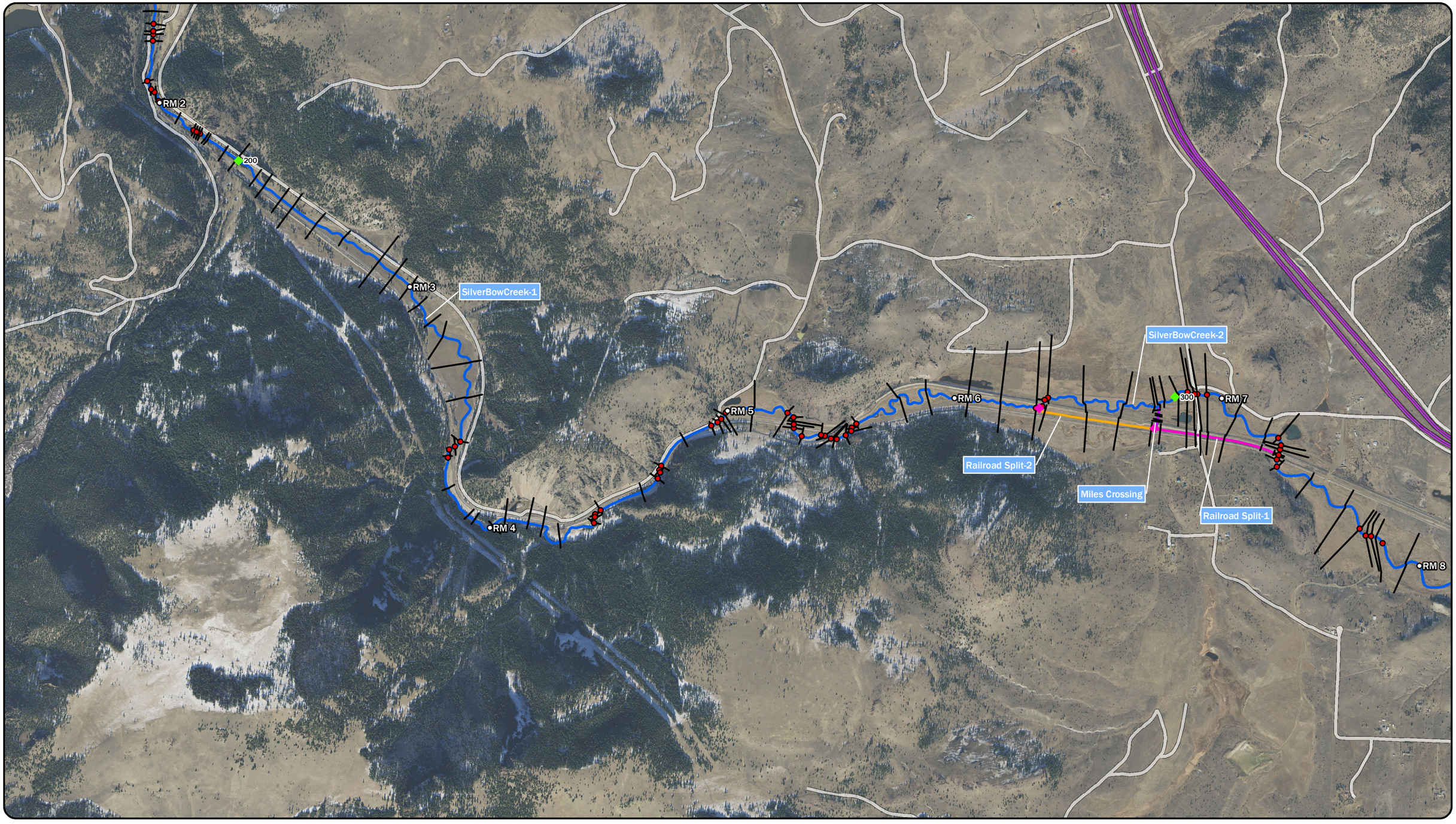

LEGEND

- FLOW JUNCTION
- FLOW CHANGE NODE
- RIVER MILES (STARTING DOWNSTREAM END AT COUNTY BOUNDARY)
- BATHYMETRIC SURVEY LOCATIONS
- CROSS SECTIONS
- STUDY PROFILE BASELINE (COLOR VARIES BY REACH)
- COUNTY BOUNDARIES
- NHS INTERSTATE
- CITY-COUNTY

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 750 1,500 3,000
Feet

FIGURE 7

PIONEER TECHNICAL SERVICES, INC.

SILVER BOW CREEK
BATHYMETRIC SURVEY
LOCATIONS

DATE: 5/17/2019

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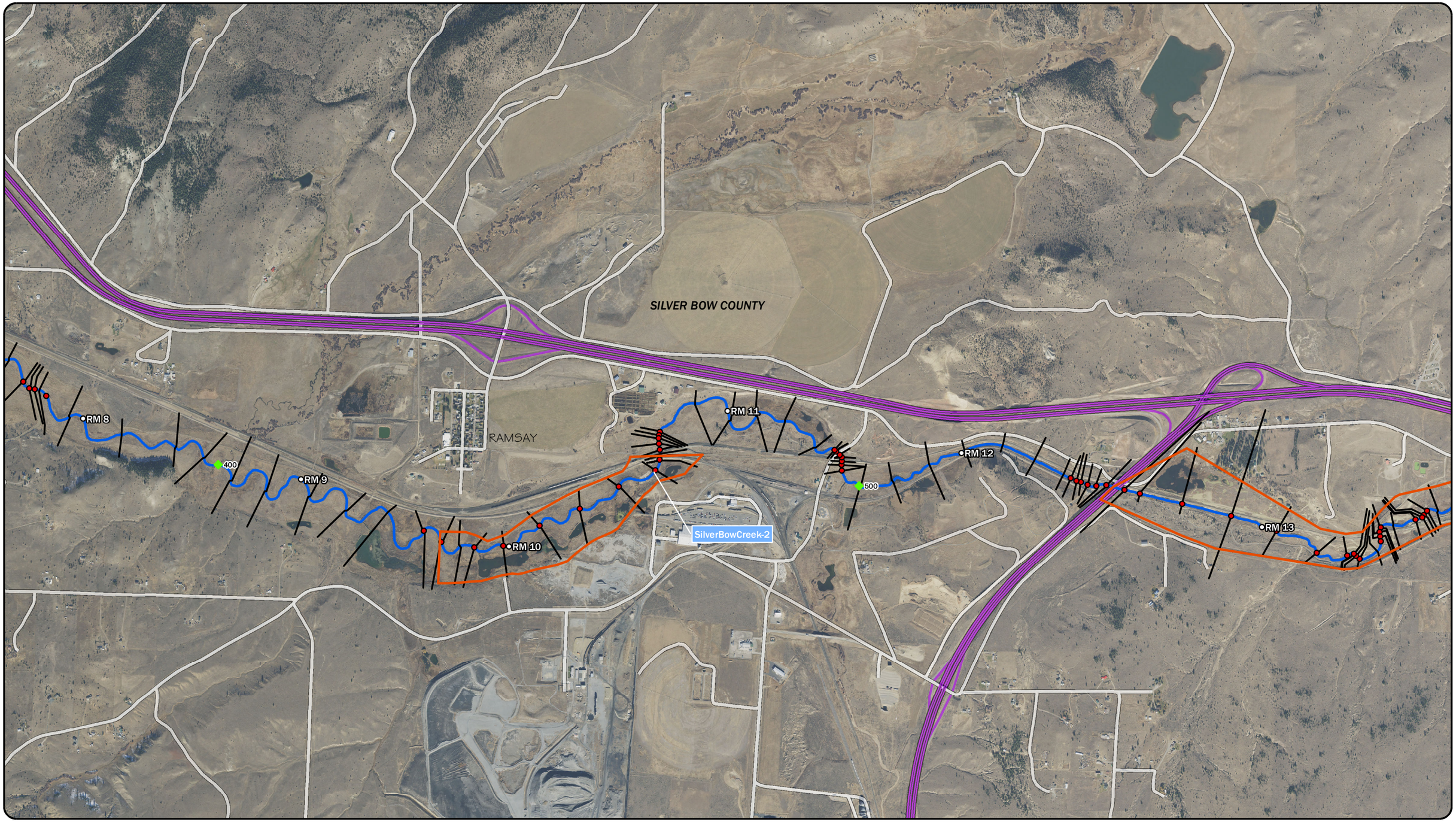


LEGEND

- FLOW CHANGE NODE
- PROPOSED ENHANCED REACH
- RIVER MILES (STARTING DOWNSTREAM END AT COUNTY BOUNDARY)
- BATHYMETRIC SURVEY LOCATIONS
- CROSS SECTIONS
- STUDY PROFILE BASELINE (COLOR VARIES BY REACH)
- COUNTY BOUNDARIES
- NHS INTERSTATE
- CITY-COUNTY
- RAMP

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 750 1,500 3,000
Feet

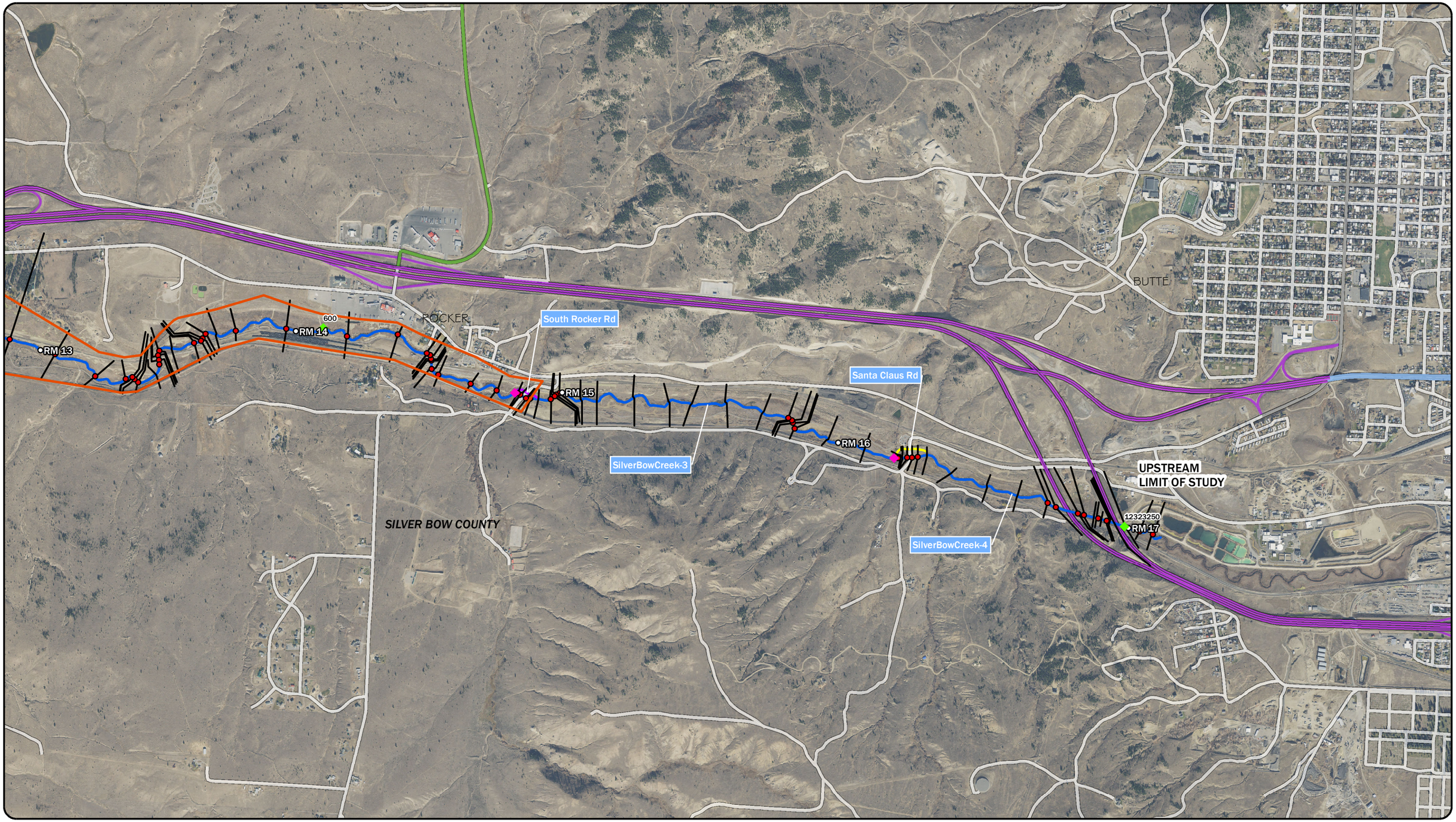
FIGURE 8

PIONEER TECHNICAL SERVICES, INC.

SILVER BOW CREEK BATHYMETRIC SURVEY LOCATIONS

DATE: 5/17/2019

Path: H:\DEQ\SSTOU new\2018\FEMA_PMR\Hydraulic Analysis\Drawings\GIS\SilverBowCreek_F6-9_SurveyLocations.mxd



LEGEND

- FLOW JUNCTION
- FLOW CHANGE NODE
- PROPOSED ENHANCED REACH
- RIVER MILES (STARTING DOWNSTREAM END AT COUNTY BOUNDARY)
- BATHYMETRIC SURVEY LOCATIONS
- CROSS SECTIONS
- STUDY PROFILE BASELINE (COLOR VARIES BY REACH)
- COUNTY BOUNDARIES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- SECONDARY
- URBAN
- CITY-COUNTY
- RAMP

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 750 1,500 3,000
Feet

FIGURE 9

PIONEER TECHNICAL SERVICES, INC.

SILVER BOW CREEK BATHYMETRIC SURVEY LOCATIONS

DATE: 5/17/2019

Path: H:\DEQ\SSTOU new\2018\FEMA_PMR\Hydraulic Analysis\Drawings\GIS\SilverBowCreek_F6-9_SurveyLocations.mxd

3.2 Split Flows

To support the the 1D hydraulic model, Pioneer developed a 2-dimensional (2D) HEC-RAS hydraulic model for the SBC study reach, to aid in identifying split flow paths, flow directions and expansion\contraction limits. Split flow is where measurable flow leaves the mainstem flow mass and becomes a flooding source separate from the mainstem SBC flow mass. It was determined substantial flow left the mainstem flow mass in four locations. To better represent these split flows, four additional reaches were added as split flow reaches in the 1D hydraulic model. Table 3-1 summarizes the four split flow reaches:

Table 3-1: Split Flow Summary

Split Flow Reach	Description	Reach Length (mi)	Work Map No.
Miles Crossing Split	Split flow downstream of Miles Crossing (Bridge 17). Secondary channel goes through culverts under haul road and two railroad bridges. Split flow connects with Railroad Split.	0.1	8
Railroad Split	Channel between BNSF and RARUS railroads (Bridge 20 and Bridge 19). Flow leaves SBC and flows downstream between railroads. Re-connects with SBC downstream of Bridge 16.	0.8	9
South Rocker Rd Split	Split flow at South Rocker Rd (Bridge 36) where water leaves SBC to go through secondary bridge. Multiple opening function did not accurately define split. Re-connects with SBC downstream of South Rocker Rd.	0.1	18
Santa Claus Rd Split	Split flow at Santa Claus Rd (Bridge 39) where water leaves SBC to go through secondary culvert below road. Multiple opening function did not accurately define split. Re-connects with SBC downstream of Santa Claus Rd.	0.1	19

Lateral weirs were used with HEC-RAS's 1D flow optimization tool to determine flows in split flow reaches. Lateral weir coefficients were selected according to Table 3-1 in the 2D Modeling User's Manual (U.S. Army Corps of Engineers, 2016b). All lateral weirs were modeled as "overland flow escaping the main river" (U.S. Army Corps of Engineers, 2016b) weir coefficients were selected in the prescribed range of 0.20-0.50.

Junctions are not typically used in floodplain mapping (FEMA, 2013) unless coincident peaks are present. All split flow conditions in the model are splits that leave the main SBC profile baseline and rejoin the SBC profile baseline downstream. Since the entire flow in a split flow reaches is dependent on the SBC flood event and not from an outside tributary, the use of a junction with a coincident peak is acceptable.

3.3 Profile Baseline

The approximate SBC mainstem channel centerline was used to define the mainstem profile baseline and river stationing for the entire study reach. Profile baselines were also developed for each split flow reach (described in Table 3-1). The mainstem stream centerline was created during the previous hydrologic effort as the S_Hydro_Reach (Pioneer, 2018a). Minor alterations were made to the stream centerline to create a profile baseline that better represented the 1% AEP flow path. The profile baselines are shown on the Work Maps included in Appendix A. Modeled river stationing for SBC corresponds to the stationing used for the flood profile and Floodway Data Table (FWDT) included in Appendix B and Appendix C, respectively. A summary of key features along the mainstem SBC profile and split flow reaches are provided in Table 3-2.

Table 3-2: Mainstem Profile Baseline and Split Flow Reach Profile Baseline Key Feature Summary

Silver Bow Creek Mainstem Reach		
River Station	Feature	Description/Notes (Photo # (P-#) – see Appendix D)
0	Downstream Limit of Study	Butte-Silver Bow/Deer Lodge County Boundary
1839	Greenway Trail - B1	Greenway Trail Pedestrian Bridge - total span of 67.9 feet (P-01)
2846	Fairmont Rd - B2	Highway Bridge – 2-lane, dual-span bridge with total span of 103.4 feet (P-02)
6992	Fish Barrier - B3	Concrete Fish Barrier spanning the channel with a span of 55 feet (P-03)
9304	Unnamed Rd - B4	Pedestrian Bridge - total span of 78.2 feet (P-04)
10314	Railroad - B5	Railroad Bridge - total span of 77.4 feet (P-05)
11374	Pipeline - B6	2-foot Diameter Pipeline Crossing - total span of 92.9 feet (P-06)
19346	Railroad - B7A	Railroad Bridge - total span of 56.6 feet (P-07)
19346	Railroad - B7B	Railroad Bridge - total span of 52.0 feet (P-08)
23461	Railroad - B8	Railroad Bridge - total span of 106.9 feet (P-09)
24829	Railroad - B9	Railroad Bridge - total span of 61.3 feet (P-10)
26193	Unnamed Rd - B10	Four 4-foot CMP Culverts and Greenway Trail Crossing (P-11)
27685	Unnamed Rd - B11	Four 4- foot CMP Culverts and Greenway Trail Crossing (P-12)
27739	Unnamed Rd - B12	Vehicle Bridge - total span of 70.0 feet (P-13)
27801	Railroad - B13	Railroad Bridge - total span of 328.3 feet (P-14)
28513	Railroad - B14	Railroad Bridge - total span of 328.3 feet (P-15)
28975	Railroad - B15	Railroad Bridge - total span of 88.4 feet (P-16)
33151	Railroad Confluence	Confluence of Railroad Split with SBC
33270	Railroad/Unnamed Rd - B16	3 Concrete Culverts - all 12 feet wide by 8 feet tall (P-17)

Silver Bow Creek Mainstem Reach		
River Station	Feature	Description/Notes (Photo # (P-#) – see Appendix D)
35725	Miles Crossing Split	Silver Bow Creek splits and flow accesses Miles Crossing Split
36486	Miles Crossing - B17	Greenway Trail Vehicle Bridge - total span of 36.7 feet (P-18)
38482	Unnamed Rd- B18	Four 4-foot CMP Culverts and Greenway Trail Crossing (P-19)
38567	Unnamed Rd - B19	Railroad Bridge - total span of 57.4 feet (P-20)
38620	Railroad Split	Silver Bow Creek splits and flow accesses Railroad Split
38669	Railroad - B20	Railroad Bridge - total span of 71.1 feet (P-21)
41051	Unnamed Rd - B21	Four 4-foot CMP Culverts and Greenway Trail Crossing (P-22)
56127	Railroad - B22	Railroad Bridge - total span of 86.6 feet (P-23)
56183	Unnamed Rd - B23	Vehicle Bridge - total span of 94.8 feet (P-24)
56220	Railroad - B24	Railroad Bridge - total span of 72.1 feet (P-25)
56489	Greenway Trail - B25	Greenway Trail Pedestrian Bridge - total span of 56.9 feet (P-26)
60622	Silver Bow Rd - B26	Greenway Trail Pedestrian Bridge - total span of 74.3 feet (P-27)
60763	Railroad - B27	Railroad Bridge - total span of 57.2 feet (P-28)
60822	Unnamed Rd - B28	Vehicle Bridge - total span of 82.0 feet (P-29)
65478	Unnamed Rd - B29	Vehicle Bridge - total span of 46.8 feet (P-30)
66103	Interstate 15 - B30	East and Westbound Interstate 15 Bridges - total span of 608.3 feet (P-31)
70494	Greenway Trail - B31	Greenway Trail Pedestrian Bridge - total span of 51.7 feet (P-32)
71231	Railroad – B32	Railroad Bridge - total span of 59.6 feet (P-33)
72118	Greenway Trail – B33	Greenway Trail Pedestrian Bridge - total span of 51.9 feet (P-34)
76500	Greenway Trail -B34	Greenway Trail Pedestrian Bridge - total span of 46.8 feet (P-35)
76606	Railroad – B35	Railroad Bridge - total span of 68.1 feet (P-36)
78344	South Rocker Rd Confluence	Confluence of South Rocker Rd Split with SBC
78491	S. Rocker Rd - B36	CMP Arch Culvert – 11.8-foot-wide culvert (P-37)
78749	South Rocker Rd Split	Silver Bow Creek splits and flow accesses South Rocker Rd Split
79072	Greenway Trail - B37	Greenway Trail Pedestrian Bridge - total span of 46.9 feet (P-38)
83513	Greenway Trail - B38	Greenway Trail Pedestrian Bridge - total span of 46.9 feet (P-39)
85481	Santa Claus Rd Confluence	Confluence of Santa Claus Rd Split with SBC

Silver Bow Creek Mainstem Reach		
River Station	Feature	Description/Notes (Photo # (P-#) – see Appendix D)
85733	Santa Claus Rd - B39	2 CMP Arch Culverts - 11.8-foot-wide culvert (P-40)
86027	Santa Claus Rd Split	Silver Bow Creek splits and flow accesses Santa Claus Rd Split
88739	Interstate 90 - B40	Interstate 90 Bridge - total span of 598 feet (Not yet constructed/No Photo)
89182	Flume - B41	Flume Crossing - total span of 59.8 feet (P-41)
89419	Flume - B42	Flume Crossing - total span of 60.3 feet (P-42)
89563	Interstate 90 - B43	Interstate 90 Bridge - total span of 598 feet (Not yet constructed/No Photo)

Split Flow Reaches		
Split Flow Profile River Station	Feature	Description/Notes (Photo # (P-#) – see Appendix D)
Railroad Split		
2674	Haul Road Culvert	CMP Arch Culverts - 8.4 feet wide culvert – No Photo
1954	Miles Crossing Confluence	Confluence of Miles Crossing Split and Railroad Split
Miles Crossing		
191	Unnamed Rd - C4	Four 4-foot CMP Culverts under haul road (P-43)
104	Railroad Bridge	2 - Railroad bridges (not surveyed) Span ~30 feet
South Rocker Rd		
223	S. Rocker Rd - B36b	South Rocker Rd Bridge - Total Span of 48.2 feet (P-44)
Santa Claus Rd		
308	Santa Claus Rd - B39b	CMP Arch Culverts - 11.8-foot wide culverts (P-45)

CMP: corrugated metal pipe.

3.4 Flood Discharges for Hydraulic Modeling

Flood discharge values used in the hydraulic model are based on the values published in the SBC Hydrology Report (Pioneer, 2018a). Flood values were applied upstream of their corresponding flow change node location to assure discharges were not underestimated. At split flow locations, flow was removed from the SBC channel flow. Split flow channel flow was returned to the SBC channel at the corresponding split flow channel confluence with SBC. Table 3-3 shows a summary of the flows used in the hydraulic model:

Table 3-3: Hydraulic Modeling Flood Discharge Summary

Model Reach	Reach Station (ft)	AEP Peak Discharge (cfs)						
		50% AEP	10% AEP	4% AEP	2% AEP	1% AEP	0.2% AEP	1%+
		2-year	10-year	25-year	50-year	100-year	500-year	
Mainstem								
SilverBowCreek-4	90215	169	313	400	473	554	774	729
SilverBowCreek-4	89707	176	333	429	511	601	847	797
SilverBowCreek-4	85873	176	328	402	457	511	642	616
SilverBowCreek-3	84962	176	333	429	511	601	847	797
SilverBowCreek-3	78630	176	323	384	429	475	586	564
SilverBowCreek-2	78257	176	333	429	511	601	847	797
SilverBowCreek-2	73754	179	341	440	526	620	876	824
SilverBowCreek-2	60953	209	432	578	704	847	1,237	1,164
SilverBowCreek-2	44896	254	580	809	1,013	1,249	1,902	1,787
SilverBowCreek-2	38608	249	541	756	951	1,177	1,803	1,694
SilverBowCreek-2	35886	239	497	685	856	1,054	1,612	1,512
SilverBowCreek-1	33083	261	604	848	1,066	1,318	2,018	1,896
SilverBowCreek-1	12184	281	679	969	1,231	1,537	2,392	2,247
Split Flow								
Santa Claus Rd	453	0	5	27	54	90	205	181
South Rocker Rd	321	0	10	45	82	126	261	233
Railroad Split-1	3975	5	39	53	62	72	99	94
Railroad Split-2	1903	22	107	163	210	264	406	384
Miles Crossing	325	17	68	110	148	192	307	290

AEP: Annual Exceedance Probability. cfs: cubic feet per second. ft: feet.

3.5 Boundary Conditions

Pioneer ran the HEC-RAS models using the subcritical flow condition. The subcritical model requires a downstream boundary condition to perform a subcritical flow simulation. The hydraulic model downstream boundary extends downstream from the study reach boundary to minimize the boundary condition affects to the model solution. A normal depth boundary condition was used for the downstream boundary condition, the normal slope was estimated from the downstream channel slope. Both enhanced and base level detail reaches were included in one HEC-RAS model to reduce coordinating additional boundary conditions. Split flow locations were identified using the 2D model and boundary conditions were set by using a

junction in HEC-RAS. Boundary conditions for the SBC model and its associated split flows are listed in Table 3-4.

Table 3-4: HEC-RAS Model Boundary Conditions

Downstream Conditions	
Reach	Boundary Condition
Silver Bow Creek	Normal Depth S = 0.0045
Miles Crossing	Junction with Silver Bow Creek (Junction: Miles Crossing)
Railroad Split	Junction with Silver Bow Creek (Junction: Railroad)
South Rocker Rd	Junction with Silver Bow Creek (Junction: South Rocker Rd)
Santa Claus Rd	Junction with Silver Bow Creek (Junction: Santa Claus Rd)

3.6 Cross-Section Development

As previously mentioned, the LiDAR and field survey data were combined into a merged DEM. The merged DEM was used as the three-dimensional (3D) data source to create the cross sections. For enhanced level study reaches, bathymetric cross sections were placed at surveyed riffle locations. Where this was not possible, cross sections were sampled from the merged DEM that incorporated an interpolated bathymetric surface based on surveyed cross sections. Base level study reach cross sections were sampled based on the bare earth DEM (no bathymetric data were used).

GeoHECRAS was used to place cross sections perpendicular to channel and floodplain flow at the bathymetric-surveyed locations. The cross sections were extended beyond the expected 0.2% AEP event flooding or 1%+ AEP event, whichever was greater. Cross sections were placed to capture gradual changes in geometry and roughness generally spaced less than 1,000 feet between cross sections with an average spacing of 600-700 feet. Cross sections were placed at key locations including channel riffles, structures, and abrupt changes in channel or floodplain geometry. Cross sections are shown on the hydraulic work maps in Appendix A. Model sections are provided in Appendix E. Figure 6 - Figure 9 compare the surveyed cross-section locations with the modeled sections. No cross sections were interpolated in the hydraulic models.

Cross section contraction and expansion values were assigned per HEC-RAS guidance documents (U.S. Army Corps of Engineers, 2016a): 0.1 and 0.3 for gradual transitions and 0.3 and 0.5 for typical bridge cross sections. Contraction and expansion values outside of the recommended values were assigned per the engineer's judgement to account for abrupt changes and to produce representative hydraulic results. HEC-RAS's skew tool was used on several bridges to accurately represent the conveyance area through bridges that are skewed at an angle greater than 15 degrees in relation to the flow direction of SBC. The skew tool was used in accordance with the HEC-RAS Reference Manual (U.S. Army Corps of Engineers, 2016a).

Bank stations were assigned based on a combination of surveyed top of banks, topographic breaks, and the approximate 50% AEP flow extents.

Split flow cross sections were sampled using the bare earth DEM created from the LiDAR data. All split flow locations were primarily dry during the LiDAR flight. It was determined the bare earth DEM provided adequate detail for the dry split flow reaches and additional survey efforts were not required.

3.7 Hydraulic Structures

A total of 43 structures were modeled on the SBC reach and 5 structures were modeled on split flow reaches. All structures were modeled based on surveyed data unless specified otherwise:

- There are three pipeline/flume structures within the SBC study reach (B6, B41, & B42). All three pipeline/flume crossings are above the highest modeled flow and contain no embankments that constrict floodplain flow. The pipeline/flume cross sections were modeled as cross sections with a 'Cross Section Lid' to capture the pipeline/flume geometry.
- The railroad crossing at the Miles Crossing Split is adjacent to the active floodplain and therefore was not surveyed per Section 3.1.2.1. The crossing produces minor contraction and does not pose a risk of overtopping at design flows. Due to these conditions, this bridge was modeled as a cross section with a ‘Cross Section Lid’ to approximate the opening.
- The culvert road crossing on Railroad Split -1 was outside of and not adjacent to the active floodplain and therefore was not surveyed per Section 3.1.2.1. As-built drawings provide the culvert dimensions, inlet, and outlet elevations. This information was used to model the structure and is provided in Appendix G.
- B41 and B43 are I-90 bridges located east of Butte. These two structures were under construction during the SBC study. The MDT provided design drawings that were used to model these two structures.

Table 3-5 summarizes the modeled hydraulic structures. Structure photos are shown in Appendix D and structure sketches are shown in Appendix G.

Table 3-5: Summary of Hydraulic Structures

Reach: Silver Bow Creek – 1 Bridges						
Location	River Station (ft)	Type of Structure	Total Span (ft)	Bridge/Weir Width (ft)	Number of Piers	Pier Width (ft)
B1	1839	Bridge	67.9	11.9	0	n/a
B2	2846	Bridge	103.4	37.5	1	2.5
B3	6992	Fish Barrier	55	24.3	n/a	n/a
B4	9304	Bridge	78.2	8.7	2	0.67
B5	10314	Bridge	77.4	14.9	0	n/a
B6[1]	11374	Bridge	92.9	2	2	0.5
B7A	19346	Bridge	56.6	14.4	0	n/a
B7B	19346	Bridge	52	16.2	0	n/a
B8	23461	Bridge	106.9	11	5	1,3.6,4.8
B9	24829	Bridge	61.3	12.5	4	1
B12	27739	Bridge	70	21	0	n/a
B13	27801	Bridge	75	14.6	2	2.7
B14	28513	Bridge	328.3	11	4	1,33,1,8.4
B15	28975	Bridge	88.4	10	5	1

Reach: Silver Bow Creek - 1 Culverts						
Location	River Station (ft)	Type of Structure	Culvert Span (ft)	Culvert Height/Dia (ft)	Number of Barrels	Length (ft)
B10	26193	Culvert	NA	4	4	59
B11	27685	Culvert	NA	4	4	39.5

Reach: Silver Bow Creek - 2 Bridges						
Location	River Station (ft)	Type of Structure	Total Span (ft)	Bridge/Weir Width (ft)	Number of Piers	Pier Width (ft)
B17	36486	Bridge	36.7	14.5	0	n/a
B19	38567	Bridge	57.4	10	3	1
B20	38669	Bridge	71.1	10	4	1
B22	56127	Bridge	86.62	13	5	1
B23	56183	Bridge	94.8	14.3	6	1
B24	56220	Bridge	72.1	21.5	4	1
B25	56489	Bridge	56.9	13.2	0	n/a
B26	60622	Bridge	74.3	24	0	n/a
B27	60763	Bridge	57.2	9.2	3	1
B28	60822	Bridge	82	16.5	5	1
B29	65478	Bridge	46.8	18.5	0	n/a
B30	66103	Bridge	608.3	89.6	20	3
B31	71231	Bridge	51.7	13	0	n/a
B32	72118	Bridge	59.6	35.2	7	1
B33	76500	Bridge	51.9	12	0	n/a
B34	76606	Bridge	46.8	13	0	n/a
B35	78491	Bridge	68.1	35	2	1

Reach: Silver Bow Creek - 2 Culverts						
Location	River Station (ft)	Type of Structure	Culvert Span (ft)	Culvert Height/Dia (ft)	Number of Barrels	Length (ft)
B16	33270	Culvert	12	8	3	66.2, 66.2, 48.6
B18	38482	Culvert	NA	4	4	39.7 (all 4)
B21	41051	Culvert	NA	4	4	40, 40, 37.3,38

Reach: Silver Bow Creek - 3 Bridges						
Location	River Station (ft)	Type of Structure	Total Span (ft)	Bridge/Weir Width (ft)	Number of Piers	Pier Width (ft)
B37	79072	Bridge	46.9	12	0	n/a
B38	83513	Bridge	46.9	12	0	n/a

Reach: Silver Bow Creek - 3 Culverts						
Location	River Station (ft)	Type of Structure	Culvert Span (ft)	Culvert Height/Dia (ft)	Number of Barrels	Length (ft)
B36	78491	Culvert	11.8	7.6	1	86.7

Reach: Silver Bow Creek - 4 Bridges						
Location	River Station (ft)	Type of Structure	Total Span (ft)	Bridge/Weir Width (ft)	Number of Piers	Pier Width (ft)
B40[2]	88739	Bridge	598	40	3	7
B41[1]	89182	Bridge	59.8	5.2	0	n/a
B42[1]	89419	Bridge	60.3	5.4	0	n/a
B43[2]	89563	Bridge	598	40	3	7

Reach: Silver Bow Creek - 4 Culverts						
Location	River Station (ft)	Type of Structure	Culvert Span (ft)	Culvert Height/Dia (ft)	Number of Barrels	Length (ft)
B39	85733	Culvert	11.8	7.6	2	49.9

Reach: Miles Crossing Bridges						
Location	River Station (ft)	Type of Structure	Total Span (ft)	Bridge/Weir Width (ft)	Number of Piers	Pier Width (ft)
Railroad [3]	104	Bridge	30	25	2	1

Reach: Miles Crossing Culverts						
Location	River Station (ft)	Type of Structure	Culvert Span (ft)	Culvert Height/Dia (ft)	Number of Barrels	Length (ft)
C4	191	Culvert	NA	4	4	40

Reach: Railroad Split - 1 Culverts						
Location	River Station (ft)	Type of Structure	Culvert Span (ft)	Culvert Height/Dia (ft)	Number of Barrels	Length (ft)
Culvert[4]	2674	Culvert	8.4	6	1	40

Reach: South Rocker Rd Bridges						
Location	River Station (ft)	Type of Structure	Total Span (ft)	Bridge/Weir Width (ft)	Number of Piers	Pier Width (ft)
B36b	223	Bridge	48.2	33	1	1

Reach: Santa Claus Rd Culverts						
Location	River Station (ft)	Type of Structure	Culvert Span (ft)	Culvert Height/Dia (ft)	Number of Barrels	Length (ft)
B39b	308	Culvert	11.8	7.6	1	49.6

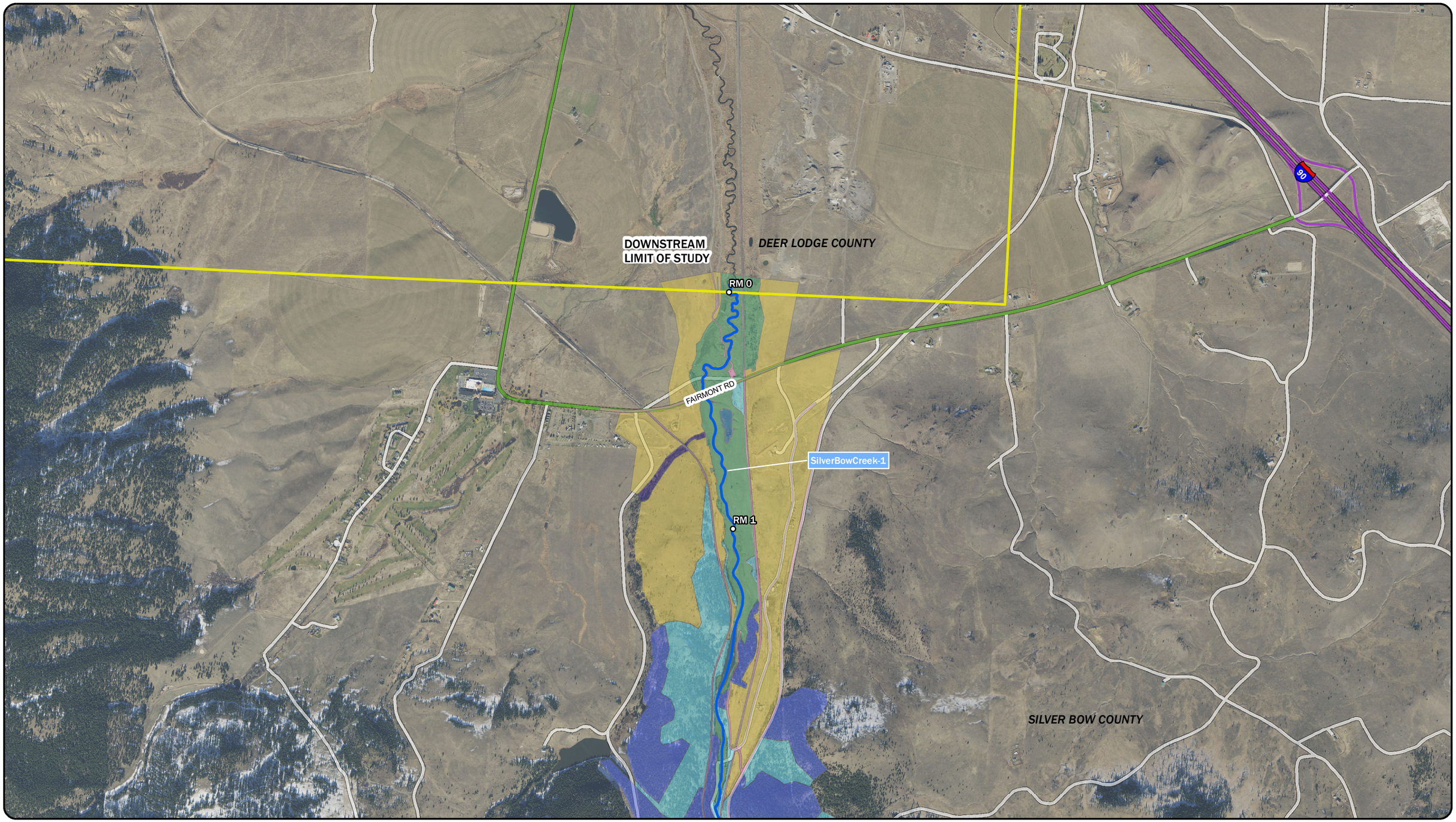
1: Pipeline modeled as lid.
2: I-90 bridge, under construction modeled from design drawings.
3: Railroad bridge not surveyed, modeled as lid.
4: Haul road culvert not surveyed, modeled from as-builts.
ft: feet

Hydraulic structures were modeled using accepted engineering practices and per HEC-RAS guidance documents. For the bridge approach sections, a contraction ratio of approximately 1:1 was initially used to set the ineffective flow areas. For sections downstream of the bridge, an expansion ratio of approximately 2:1 was initially used to set the ineffective flow areas. The 2D hydraulic model was used to verify that contraction/expansion ratios were set to represent the site-specific hydraulic conditions. Section 3.9 provides additional information of other areas of non-conveyance. Due to the floodplain topography and the channels incised nature at some locations, the HEC-RAS standard bridge cross section 1 and cross section 4 were not always placed based on contraction/expansion extents. In instances where structures are overtopped and/or flanked, standard cross-section layouts were not applicable. Bridge cross sections were placed in a manner to best represent active flow based on the results of the 2D HEC-RAS model Pioneer created for the SBC study reach and engineering experience.

3.8 Roughness Coefficients

Using the 2011 Bing and 2014 Google aerial imagery of the study reach, areas of consistent land use or roughness were delineated into polygons. Figure 10 - Figure 13 shows the delineated polygons. The polygons were assigned a Manning's roughness *n* value attribute. Manning's *n* values were determined based on aerial imagery evaluation, field reconnaissance, photographs, experience, and professional judgement.

The Manning's *n* roughness values as presented by Chow (Chow, 1959) and U.S. Geological Survey (USGS) (Phillips & Tadayon, 2006) were the primary references for selecting values for each land use type. Throughout the SBC study reach the SBC channel varies in bed material size, channel vegetation, and overbank vegetation. To account for this variation, four channel Manning's *n* values were developed using the USGS composite Manning's *n* method. The values selected for each roughness area/land use type are listed in Table 3-6. Table 3-7 lists the location where each channel Manning's *n* value was applied.



LEGEND

- RIVER MILES (STARTING DOWNSTREAM END AT COUNTY BOUNDARY)
- STUDY PROFILE BASELINE (COLOR VARIES BY REACH)
- COUNTY BOUNDARIES
- CHANNEL-1, 0.037
- FP GRASS, 0.06
- HEAVILY FORESTED, 0.1
- MODERATE FORESTED, 0.08
- PAVEMENT, 0.02
- UPLAND, 0.05
- WATER, 0.028
- WILLOWS MODERATE, 0.11
- NHS INTERSTATE
- SECONDARY
- CITY-COUNTY
- RAMP

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 750 1,500 3,000
Feet

FIGURE 10

PIONEER TECHNICAL SERVICES, INC.

SILVER BOW CREEK
MANNING'S ROUGHNESS
POLYGONS

DATE: 5/17/2019

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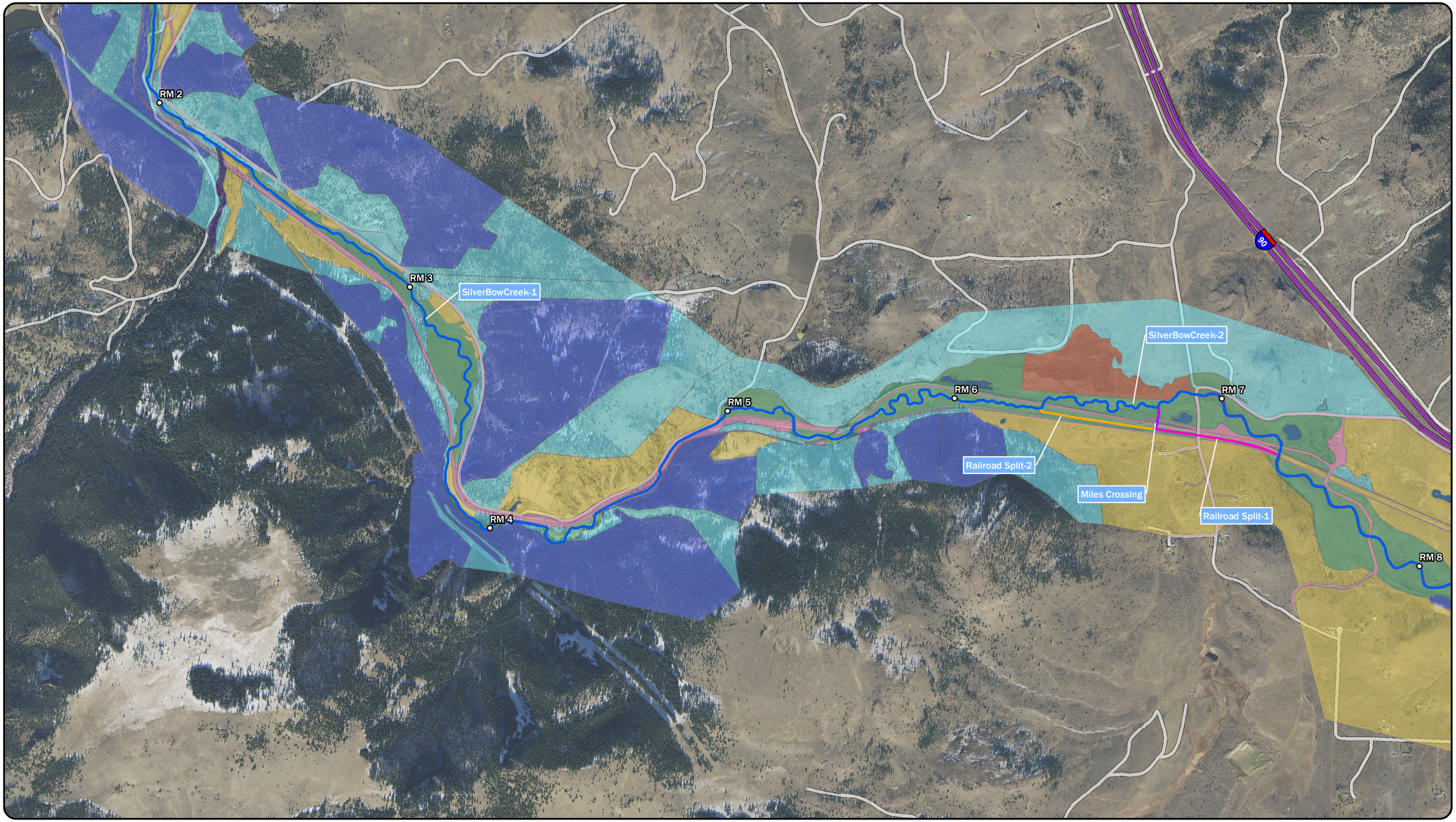

LEGEND

- RIVER MILES (STARTING DOWNSTREAM END AT COUNTY BOUNDARY)
- STUDY PROFILE BASELINE (COLOR VARIES BY REACH)
- COUNTY BOUNDARIES
- CHANNEL-1, 0.037
- CHANNEL-2, 0.042
- CHANNEL-3, 0.046
- AGRICULTURE, 0.04
- FP GRASS, 0.06
- HEAVILY FORESTED, 0.1
- MODERATE FORESTED, 0.08
- PAVEMENT, 0.02
- UPLAND, 0.05
- WATER, 0.028
- WILLOWS MODERATE, 0.11
- NHS INTERSTATE
- CITY-COUNTY

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 750 1,500 3,000
Feet

FIGURE 11

PIONEER TECHNICAL SERVICES, INC.

SILVER BOW CREEK
MANNING'S ROUGHNESS
POLYGONS

DATE: 5/17/2019

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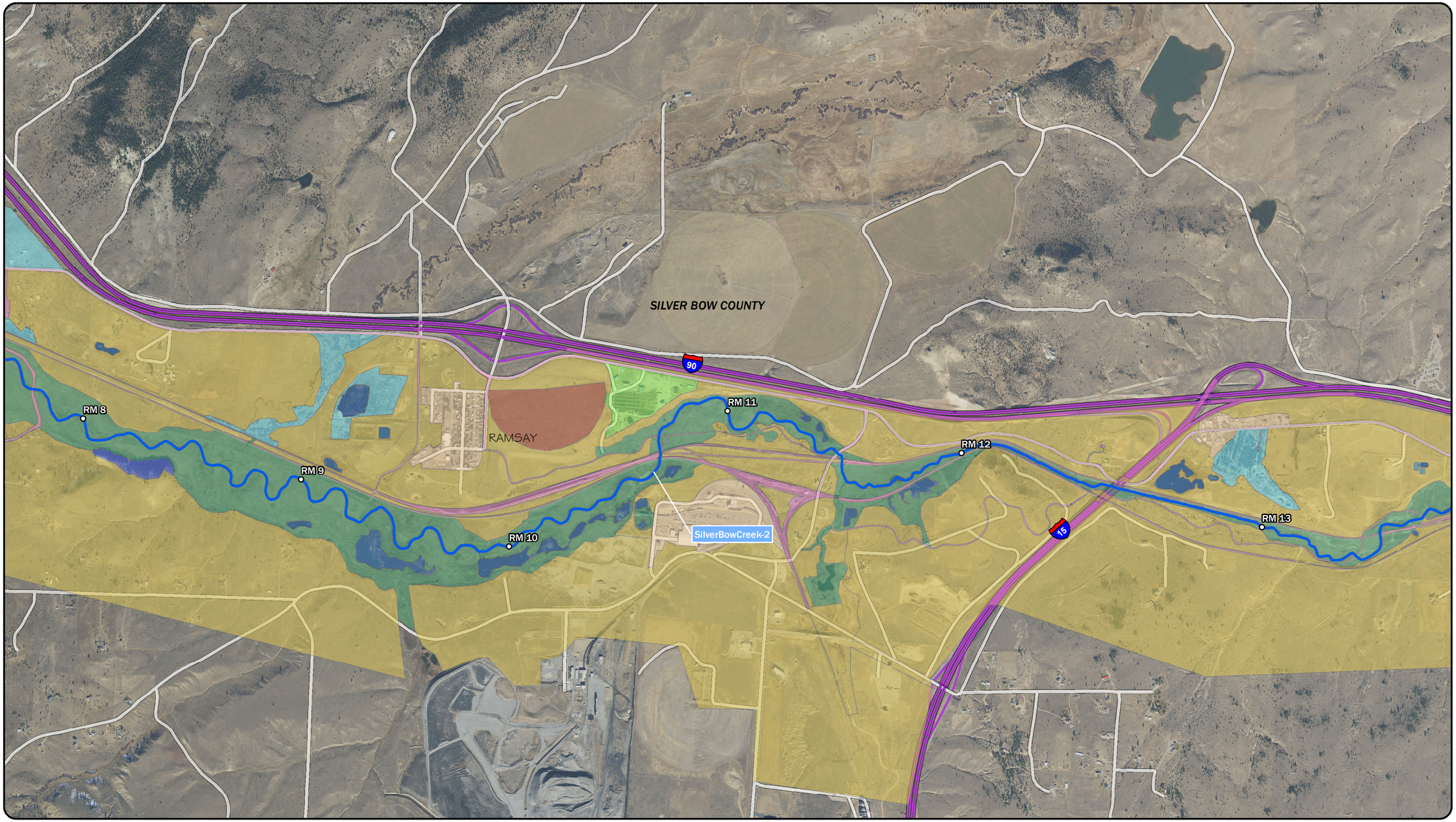

LEGEND

- RIVER MILES (STARTING DOWNSTREAM END AT COUNTY BOUNDARY)
- STUDY PROFILE BASELINE (COLOR VARIES BY REACH)
- COUNTY BOUNDARIES
- CHANNEL-2, 0.042
- CHANNEL-3, 0.046
- CHANNEL-4, 0.053
- AGRICULTURE, 0.04
- DIRT, 0.02
- FP GRASS, 0.06
- HEAVILY FORESTED, 0.1
- MODERATE FORESTED, 0.08
- PAVEMENT, 0.02
- UPLAND, 0.05
- URBAN, 0.045
- WATER, 0.028
- WILLOWS DENSE, 0.15
- WILLOWS MODERATE, 0.11
- NHS INTERSTATE
- CITY-COUNTY
- RAMP

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 750 1,500 3,000
Feet

FIGURE 12

PIONEER TECHNICAL SERVICES, INC.

SILVER BOW CREEK
MANNING'S ROUGHNESS
POLYGONS

DATE: 5/17/2019

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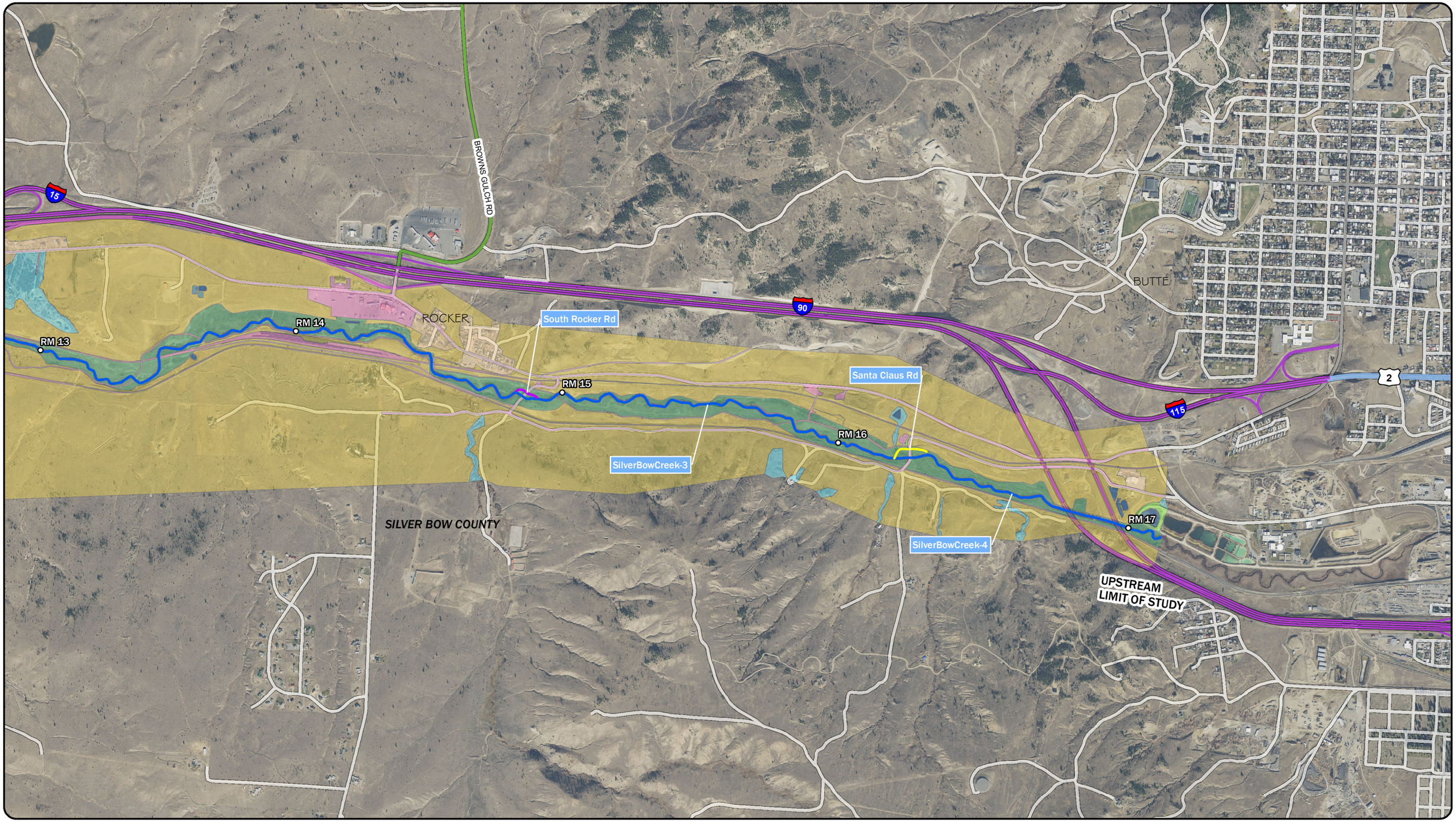

LEGEND

- RIVER MILES (STARTING DOWNSTREAM END AT COUNTY BOUNDARY)
- STUDY PROFILE BASELINE (COLOR VARIES BY REACH)
- COUNTY BOUNDARIES
- CHANNEL-2, 0.042
- CHANNEL-3, 0.046
- CHANNEL-4, 0.053
- DIRT, 0.02
- FP GRASS, 0.06
- MODERATE FORESTED, 0.08
- PAVEMENT, 0.02
- UPLAND, 0.05
- URBAN, 0.045
- WATER, 0.028
- WILLOWS DENSE, 0.15
- WILLOWS MODERATE, 0.11
- NHS INTERSTATE
- NHS NON-INTERSTATE
- SECONDARY
- URBAN
- CITY-COUNTY
- RAMP

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD1983/NAVD88
UNITS: INT'L FEET
SOURCE: MSL/PIONEER

0 750 1,500 3,000
Feet

FIGURE 13

PIONEER TECHNICAL SERVICES, INC.

SILVER BOW CREEK
MANNING'S ROUGHNESS
POLYGONS

DATE: 5/17/2019

Path: H:\DEQ\SSTOU new\2018\FEMA_PMR\Hydraulic Analysis\Drawings\GIS\SilverBowCreek_F10-13_Mannings.mxd

Table 3-6: Manning's n Roughness Coefficient Values

Roughness Area/Land Use Type	Manning's *n* Value	Description
Open Water	0.028	Coarse Gravel Channel[1]
Dirt/Pavement	0.020	Firm Earth[1]
Agriculture Fields	0.040	Mature Field Crops, (normal)[2]
Upland Grass	0.050	Scattered Shrubs, Heavy weeds[2]
Floodplain Grass	0.060	Light shrubs and trees in Summer (normal)[2]
Moderate Forest	0.080	Heavy stand of timber, few down trees (minimum)[2]
Heavily Forested	0.100	Heavy stand of timber, few down trees(normal)[2]
Moderate Willows	0.110	Dense Willows, summer straight (minimum)[2]
Dense Willows	0.150	Dense Willows, summer straight (normal)[2]
Urban	0.045	Finished concrete (0.015)+ 15-50% obstructions (0.02)+small amount vegetation (0.01) = 0.045[2]
Channel 1	0.037	Cobble (0.030)+minor surface irregularity (0.002)+ gradual XS variation (0.002)+ <5% Obstructions (0.002) = 0.037[2]
Channel 2	0.042	Cobble (0.030)+minor surface irregularity (0.002)+ mostly gradual XS variation (0.003)+ <5% Obstructions (0.002)+ mid-value of channel vegetation (0.005) = 0.042[2]
Channel 3	0.046	Gravel (0.028)+Minor Surface irregularity (0.002)+ mostly gradual XS variation (0.003)+ mid-value <15% Obstruct, (0.008)+ mid-value of channel veg. (0.005) = 0.046[2]
Channel 4	0.053	Gravel (0.028)+Minor Surface irreg. (0.002)+ mostly gradual XS variation (0.003)+ high-value <15% Obstruct. (0.015)+ mid-value channel veg. (0.005) = 0.053[2]

1: Value determined from Chow
2: Value determined from USGS

Table 3-7: Channel Manning's n Summary

River Station	Roughness Area	Channel Manning's n
0	Channel 1	0.037
18,480	Channel 2	0.042
35,904	Channel 3	0.046
50,160	Channel 4	0.053
60,720	Channel 2	0.042
62,832	Channel 3	0.046
63,360	Channel 4	0.053
66,528	Channel 3	0.046
67,584	Channel 4	0.053
68,640	Channel 2	0.042
71,122	Channel 3	0.046
73,762	Channel 4	0.053
77,986	Channel 3	0.046
89,285	Channel 4	0.053

3.9 Areas of Non-Conveyance

Pioneer applied the HEC-RAS *Ineffective Flow Area* tool in the model to remove portions of sections determined to be non-conveyance areas. Areas inundated by flood waters but identified as not transporting effective flow were given an ineffective flow area designation. The areas included the following:

- Backwater and ponded areas.
- Flow constriction or expansion.
- Areas isolated by non-accredited levees, railroad embankments, or elevated roads.
- High topography either upstream or downstream that limits flow to a lower area.

Ineffective flow area limits and elevations were determined from an analysis of the site topography, impacts due to hydraulic structures, and areas isolated from active flood waters. The 2D Hydraulic model was also used as a reference to identify areas of non-conveyance. Topographic depressions determined not to be accessible by flowing water were removed using the *Blocked Obstruction* tool in HEC-RAS and marked as permanent ineffective flow areas. Modeling results for the 100-year and 500-year inundation maps were checked and edits made to accurately model these areas. This process was iterative until a final inundation map was developed. The ineffective flows and blocked obstruction areas are provided in Appendix E (Modeled Cross Sections). The cHECk-RAS reports (Appendix F) also provides information on the non-conveyance areas. Section 3.7 provides additional detail for the hydraulic structure bounding sections.

3.10 Model Calibration

The FEMA Guidelines (FEMA, 2016a) require calibrating the hydraulic model parameters using measured elevation data from major historic floods. The last significant flood event (AEP of 10% or larger) occurred in the spring of 2003. The majority of SST OU construction was not completed until fall of 2003. Due to the lack of significant flood events post SST OU reclamation, calibration to past flood events based on current topography was not possible. FEMA guidance (FEMA, 2016a) states if calibration data "*is lacking or are out of date the Mapping Partner should determine the roughness coefficients using Cowan's method*." These values are to be compared to published values and observations from site visits. Cowan's method of determining Manning's *n* is described in the USGS literature (Phillips & Tadayon, 2006) and was used to determine the channel Manning's *n* values. Floodplain Manning's *n* were based on published values, site observations, and engineering experience.

3.11 Letter of Map Change and Previous Studies

FEMA requires the determination of the applicability of all effective map revisions including Letter of Map Amendments (LOMAs) and LOMRs (FEMA, 2016b). If map revisions are deemed

applicable, map revisions will be incorporated into the floodplain study. At the time of the SBC hydraulic analysis, no effective map revisions were filed within the SBC study reach.

3.12 Floodway Analysis

The floodway encroachment analysis was completed using Method 4 and the allowable State of Montana maximum surcharge of 0.5 feet. Equal conveyance reduction from each side of the floodplain was used. Ineffective flow areas were not included within the floodway. Floodway delineation began at the downstream section and proceeded upstream while maximizing the surcharge. Transitions were slightly adjusted using Method 1 and editing tools in ArcGIS to retain smooth transition between sections and incorporate the main channel profile baseline. All sections maintained a surcharge of 0.0 feet to 0.5 feet. The results of the floodway computations are tabulated at the lettered cross sections in the FWDTs in Appendix C.

3.13 cHECk-RAS

The FEMA cHECk-RAS, Version 2.01 (FEMA, 2013), validation tool for HEC-RAS was used to check the validity of the hydraulic analysis discussed above. The program checks five categories:

- NT (Manning's roughness coefficients and transition loss coefficients)
- XS (cross sections)
- Floodways
- Structures
- Profiles

The program routine developed report tables for each of the five areas. The generated reports including any clarifying comments are provided in Appendix F.

4 FLOODPLAIN MAPPING

Pioneer used the flood map tools in GeoHECRAS software to generate the floodplain mapping spatial files for the SBC study reach. The tool was set to remove high areas of less than 1 acre in size and develop the inundation extents and floodway boundary. The GeoHECRAS data were imported into ArcGIS for final compilation and minor editing of the floodway. Shape file products developed included the profile baseline/stream centerline, HEC-RAS model cross sections (lettered and unlettered), BFEs, structures, floodway boundaries, and the 1% and 0.2% annual-chance floodplain boundaries. Pioneer will create a water surface elevation grid, depth grid, and manually smooth out the inundation boundaries to remove small jagged edges on the extent boundary as part of the Floodplain Mapping task. The preliminary floodplain work maps developed are included in Appendix A.

4.1 Tie-Into Effective Mapping

Both the upstream and downstream study extent for the SBC study reach tie into existing approximate Zone A floodplain boundaries (Appendix A). The effective floodplain boundary for Butte-Silver Bow county was obtained from the existing National Flood Hazard Layer (NFHL). The effective boundary for Deer Lodge County was digitized from the existing FIRM map. Proposed tie-in transitions to the effective floodplain mapping are shown on the hydraulic work maps (Appendix A).

5 FLOOD INSURANCE STUDY PRODUCTS

5.1 Flood Profile

Digital profiles of the 10%-, 4%-, 2%-, 1%-, 0.2%, and 1%+ AEP flood water surface elevations were developed for the SBC study reach using FEMA's RASPLOT software. The resulting profiles for the study are included in Appendix B.

5.2 Floodway Data Table

Previously described in Section 3.12, a floodway encroachment analysis was completed for the study reach. The results of the floodway analysis are summarized in the FWDTs in Appendix C. Water surface elevations conforming to the 1% AEP, including the floodway resultant water surface, were tabulated for the lettered cross sections and rounded to the nearest tenth of a foot. The water surface difference between the normal profile and floodway were subtracted and reported as the increase in the FWDTs.

6 REFERENCES

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U.S. Army Corps of Engineers. (2016b). *HEC-RAS River Analysis System, 2D Modeling User's Manual, Version 5.0.* U.S. Army Corps of Engineers, Hydrologic Engineering Center, February 2016.

Appendix A Hydraulic Work Maps

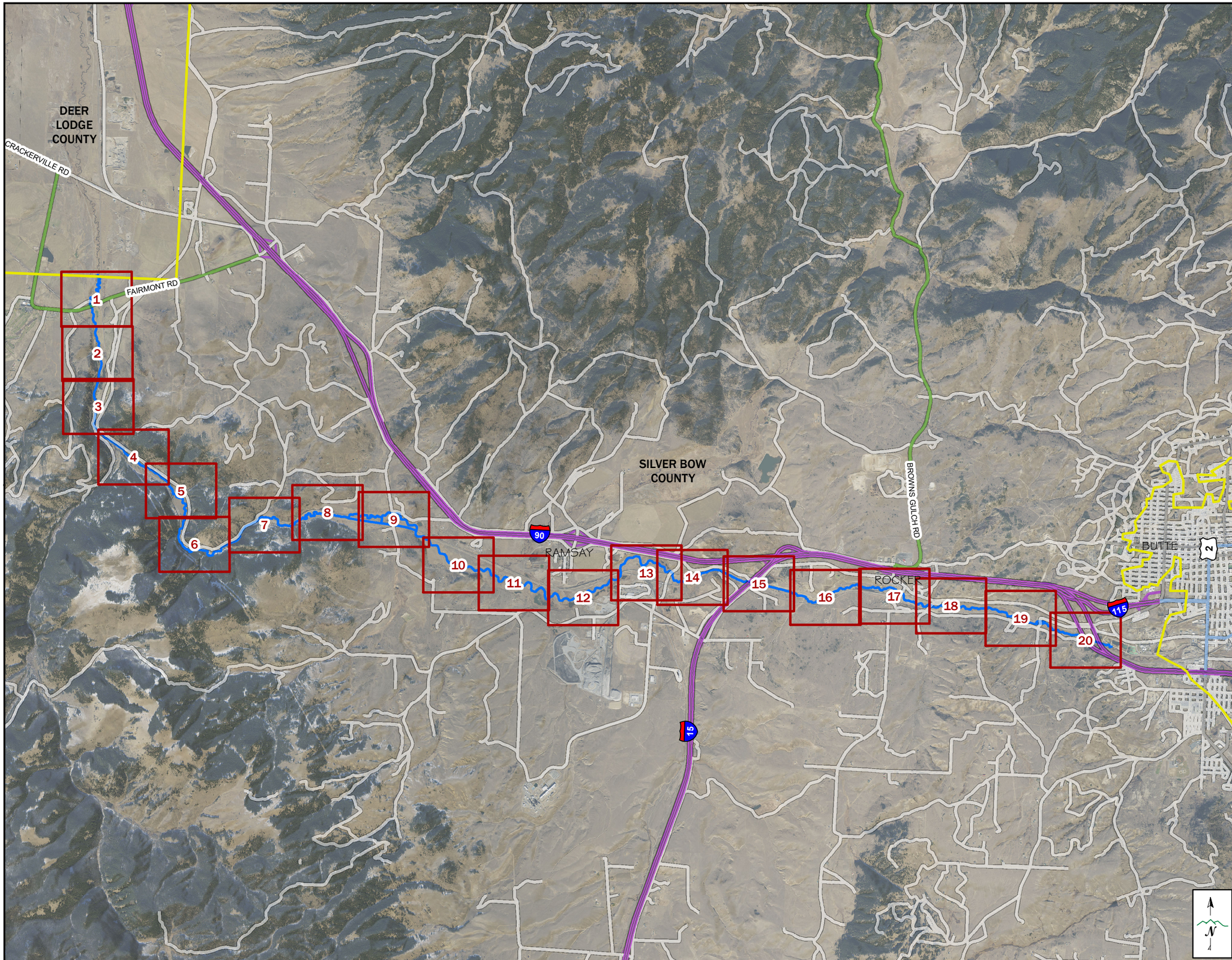
I hereby certify that the hydraulic work maps prepared for this project were done so under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Montana.

Jonathan Jupka P.E., CFM

MONTANA
JONATHAN JW JUPKA
No. 51146PE
LICENSED
PROFESSIONAL ENGINEER

Date: 05/17/19 Montana Registration No. 51146

SILVER BOW CREEK FLOODPLAIN STUDY



LEGEND

- STUDY PROFILE BASELINE
- WORK MAP SHEET INDEX
- POLITICAL BOUNDARIES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- SECONDARY
- URBAN
- CITY-COUNTY
- RAMP

0 0.5 1 2 Miles

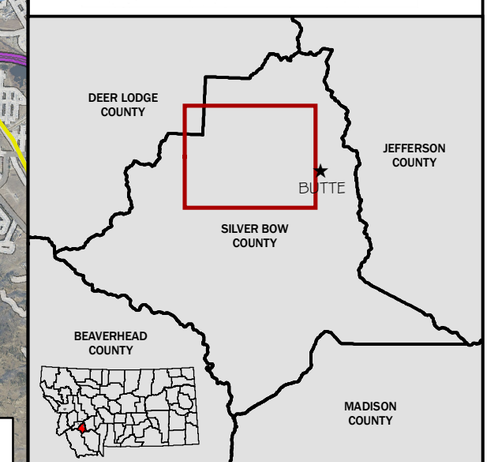
1 INCH = 5,280 FEET

SILVER BOW CREEK WORK MAP
SILVER BOW CREEK FLOODPLAIN STUDY
SILVER BOW COUNTY, MT
DATE: 5/17/2019
IMAGERY: NAIP 2017
TOPOGRAPHIC DATA: LIDAR 2017, BATHYMETRY 2017
PROJECTION: MONTANA STATE PLANE
HORIZONTAL DATUM: NAD83, INT'L FT
VERTICAL DATUM: NAVD88, FT

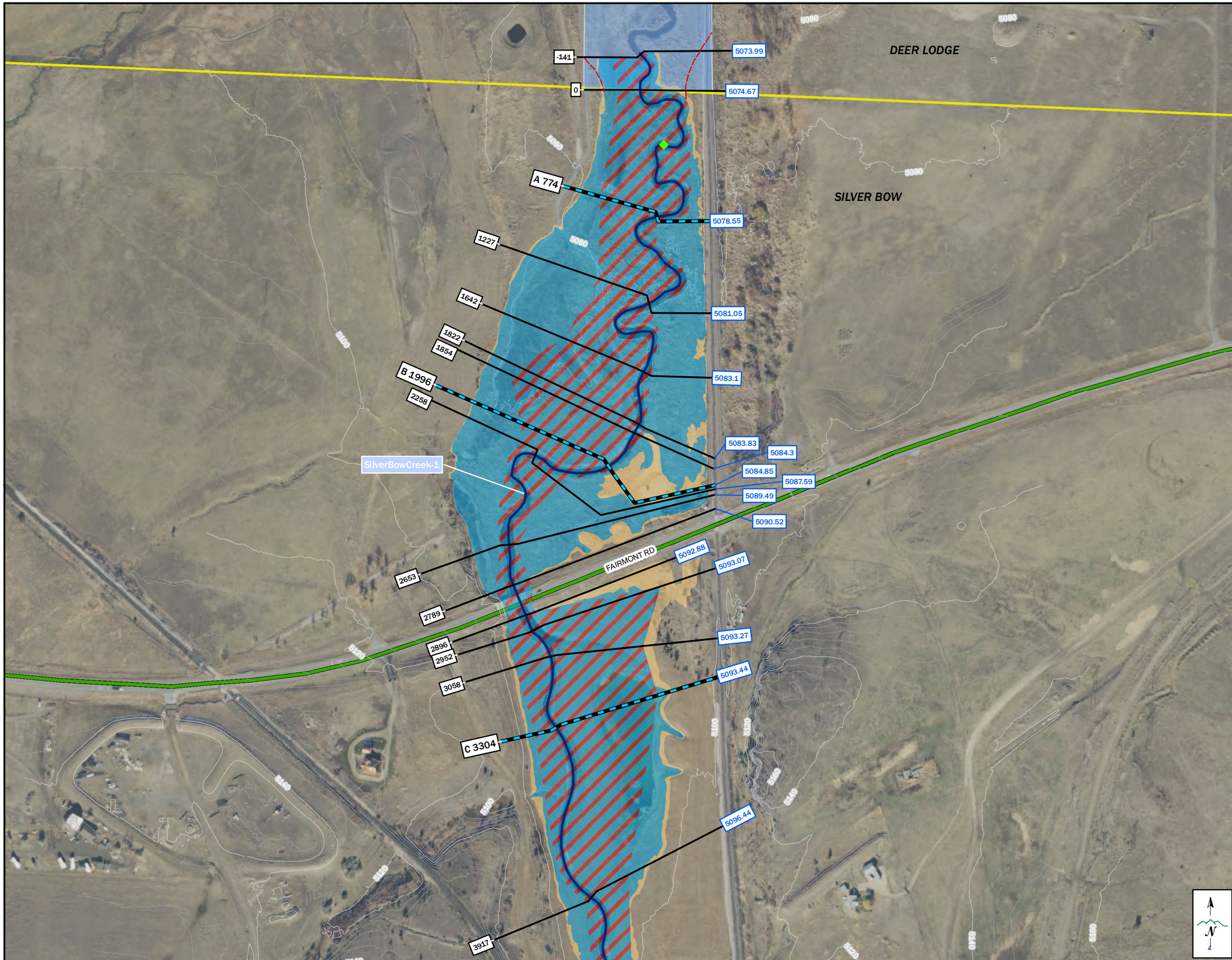
The City-County of BUTTE SILVER BOW

DEQ Montana Department of Environmental Quality

PIONEER TECHNICAL SERVICES, INC.



WORK MAP INDEX



SILVER BOW CREEK FLOODPLAIN STUDY

LEGEND

- FLOW JUNCTION
- FLOW CHANGE NODE
- PROPOSED EFFECTIVE TIE-IN
- PROPOSED LETTERED CROSS SECTION
- PROPOSED CROSS SECTION
- STUDY PROFILE BASELINE (COLOR VARIES BY REACH)
- POLITICAL BOUNDARIES

PROPOSED FLOOD HAZARD ZONES

- PROPOSED FLOODWAY
- PROPOSED ZONE AE
- PROPOSED ZONE X
- EFFECTIVE ZONE A
- 20 FOOT CONTOURS
- 4 FOOT CONTOURS
- 3160.7 BASE FLOOD ELEVATION

0 150 300 600 FEET

1 INCH = 300 FEET

SILVER BOW CREEK WORK MAP
SILVER BOW CREEK FLOODPLAIN STUDY
SILVER BOW COUNTY, MT
DATE: 5/20/2019
IMAGERY: NAIP 2017
TOPOGRAPHIC DATA: LIDAR 2017, BATHYMETRY 2017
PROJECTION: MONTANA STATE PLANE
HORIZONTAL DATUM: NAD83, INT'L FT
VERTICAL DATUM: NAVD88, FT

The City-County of BUTTE SILVER BOW

DEQ Montana Department of Environmental Quality

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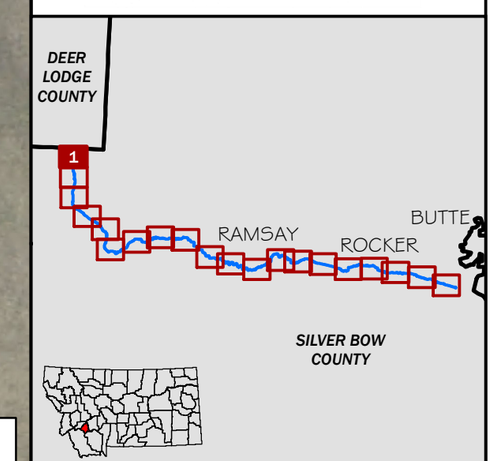

WORK MAP 1 OF 20

SILVER BOW CREEK FLOODPLAIN STUDY

LEGEND

- FLOW JUNCTION
- FLOW CHANGE NODE
- PROPOSED EFFECTIVE TIE-IN
- PROPOSED LETTERED CROSS SECTION
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DATE: 5/20/2019
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VERTICAL DATUM: NAVD88, FT

The City-County of BUTTE SILVER BOW

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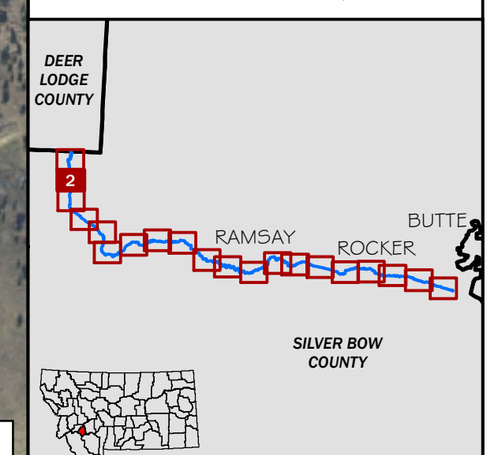

WORK MAP 2 OF 20

SILVER BOW CREEK FLOODPLAIN STUDY

LEGEND

- FLOW JUNCTION
- FLOW CHANGE NODE
- PROPOSED EFFECTIVE TIE-IN
- PROPOSED LETTERED CROSS SECTION
- PROPOSED CROSS SECTION
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SILVER BOW CREEK WORK MAP
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SILVER BOW COUNTY, MT
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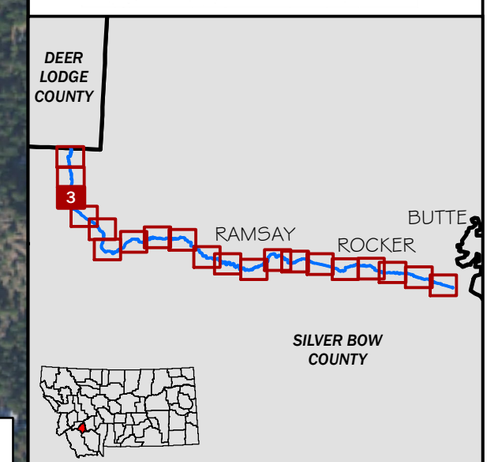
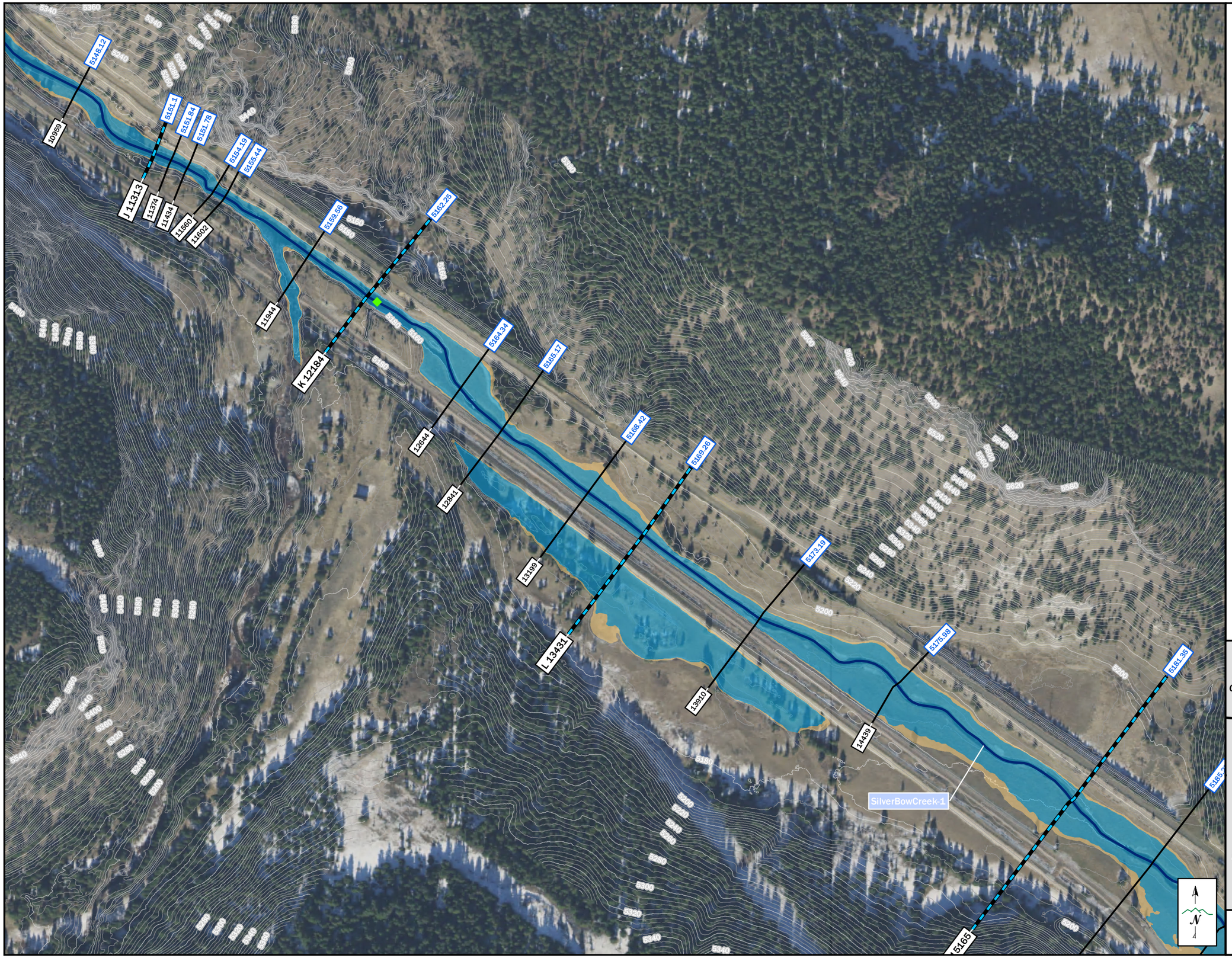


WORK MAP 3 OF 20



SILVER BOW CREEK FLOODPLAIN STUDY

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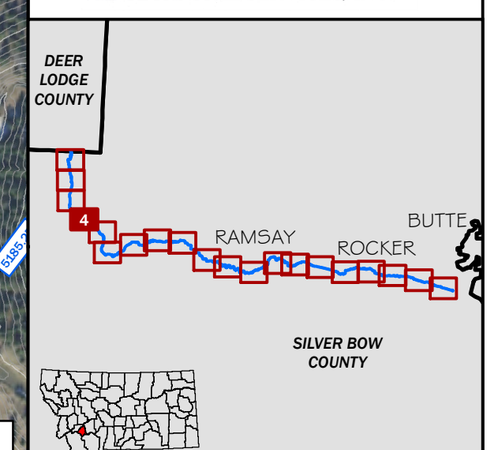

WORK MAP 4 OF 20

SILVER BOW CREEK FLOODPLAIN STUDY

LEGEND

- FLOW JUNCTION
- FLOW CHANGE NODE
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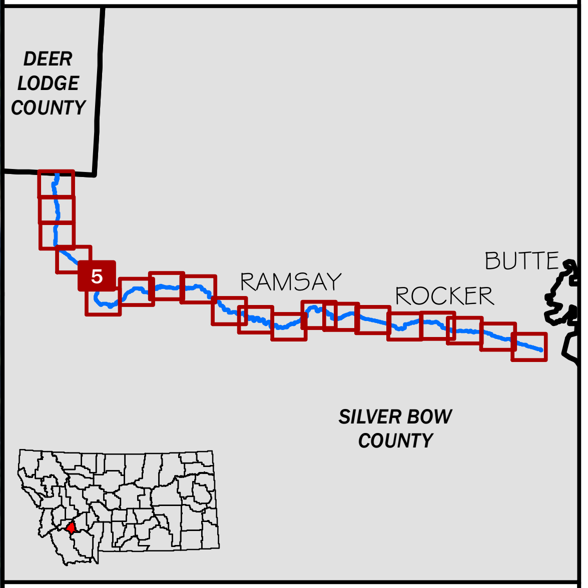

WORK MAP 5 OF 20

SILVER BOW CREEK FLOODPLAIN STUDY

LEGEND

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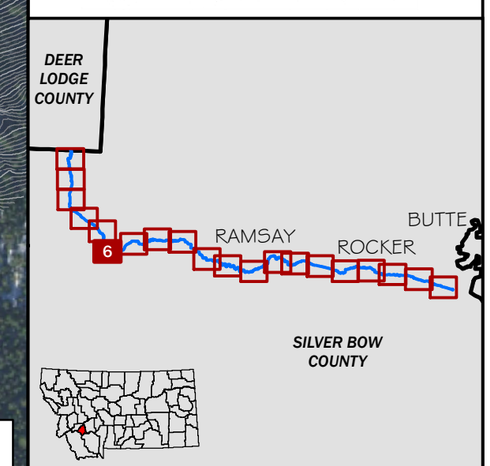
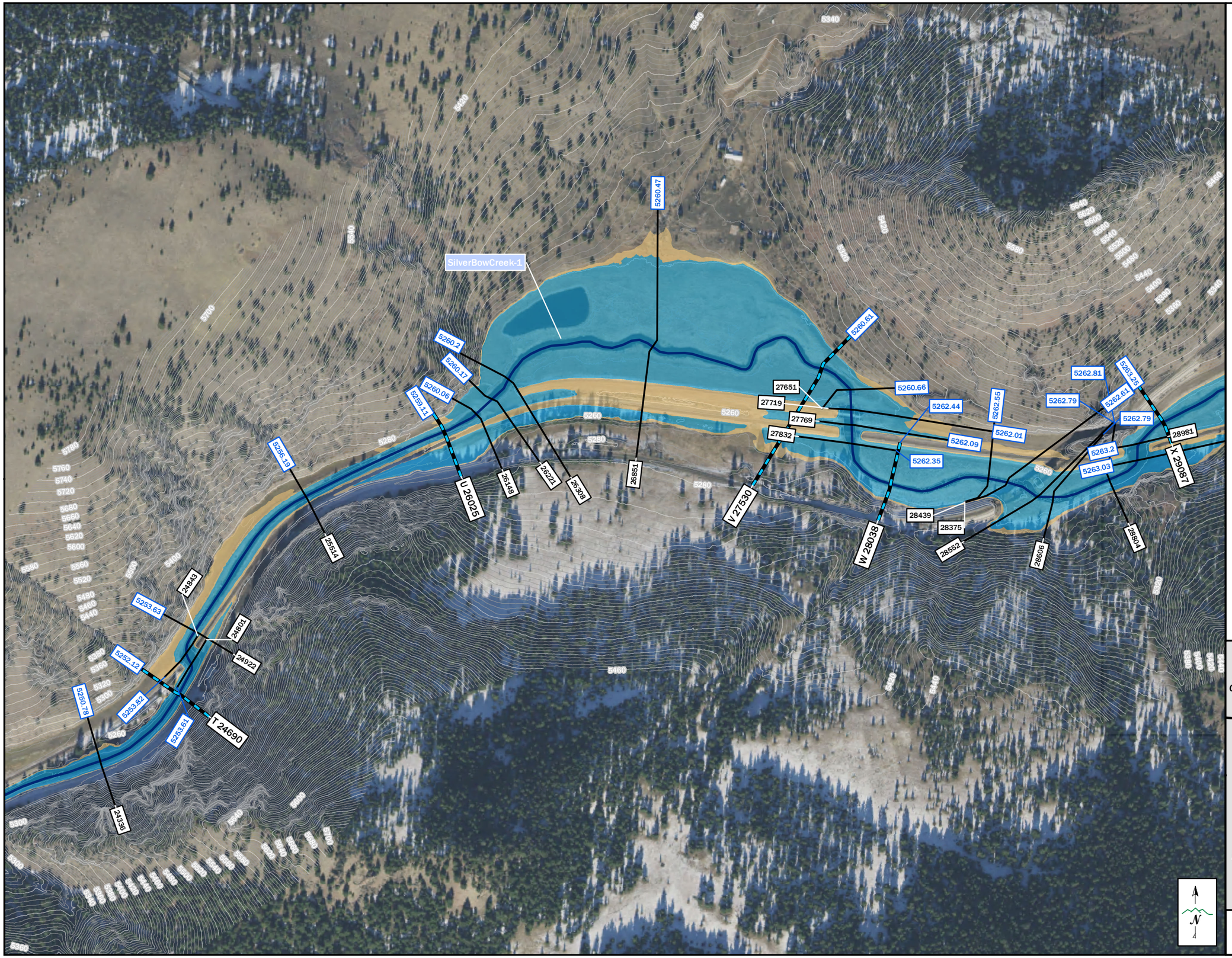


WORK MAP 6 OF 20

SILVER BOW CREEK FLOODPLAIN STUDY



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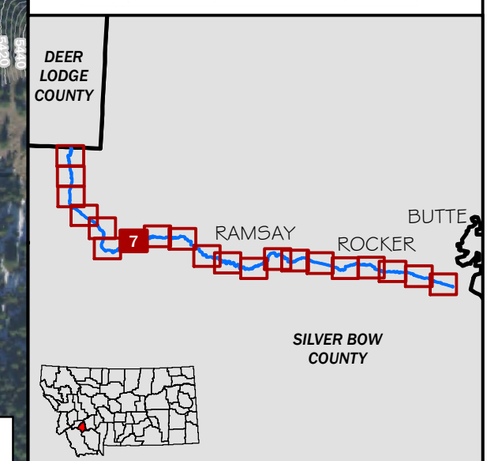
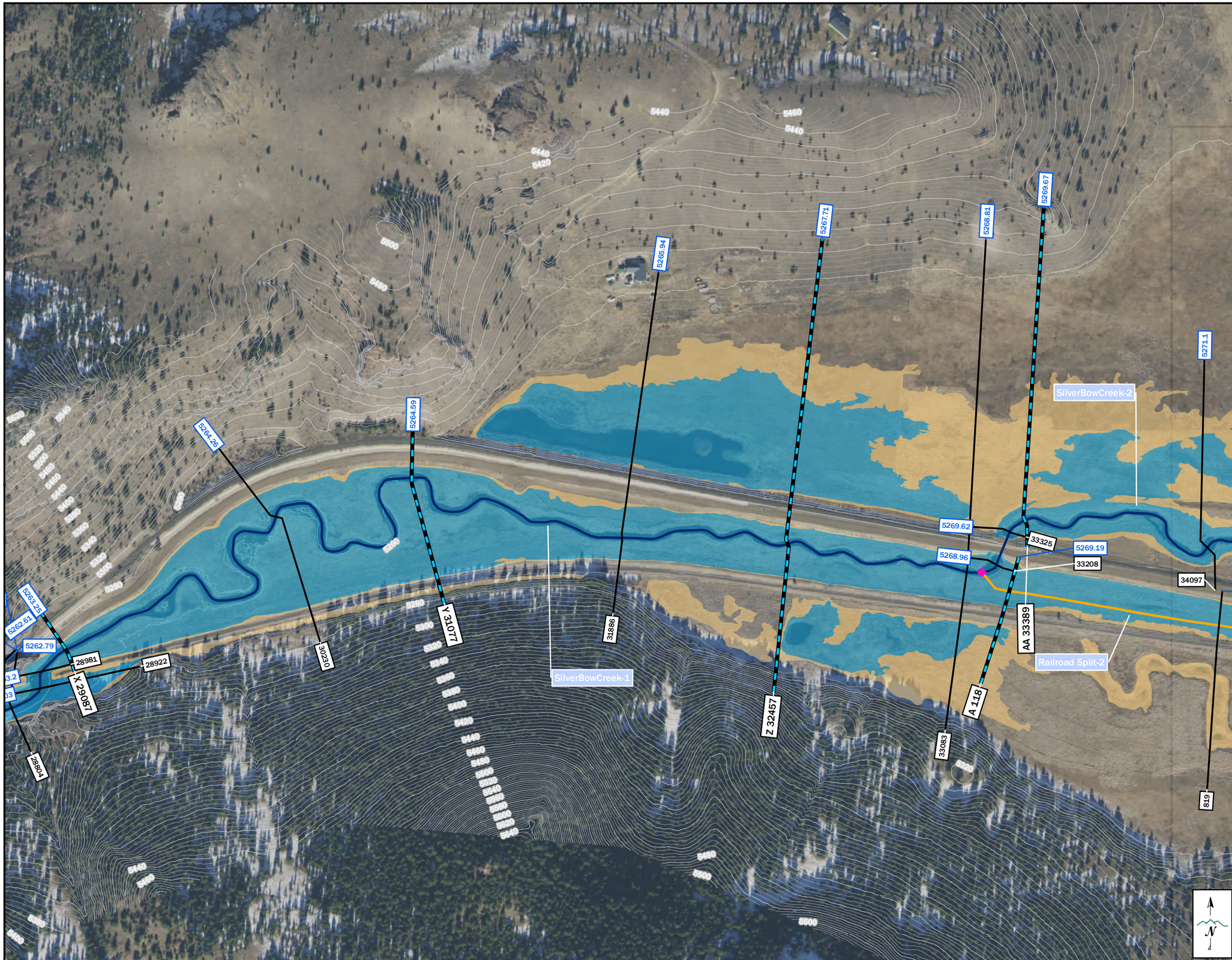


WORK MAP 7 OF 20

SILVER BOW CREEK FLOODPLAIN STUDY



LEGEND

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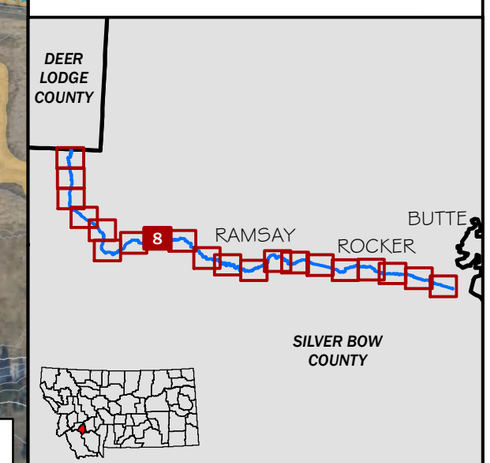
VERTICAL DATUM: NAVD88, FT

The City-County of BUTTE SILVER BOW

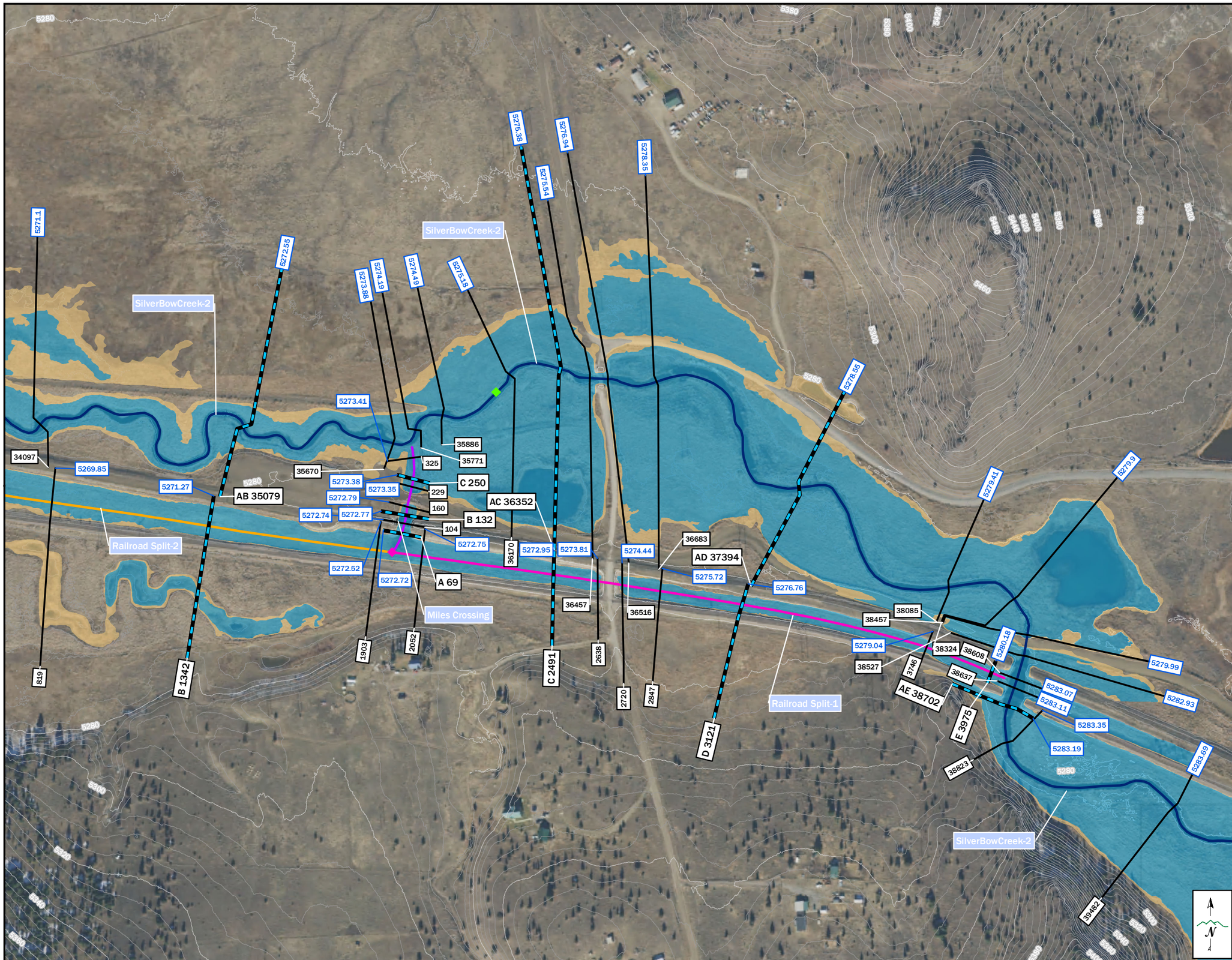
DEQ Montana Department of Environmental Quality

PIONEER TECHNICAL SERVICES, INC.



WORK MAP 8 OF 20

SILVER BOW CREEK FLOODPLAIN STUDY



LEGEND

- FLOW JUNCTION
- FLOW CHANGE NODE
- PROPOSED EFFECTIVE TIE-IN
- PROPOSED LETTERED CROSS SECTION
- PROPOSED CROSS SECTION
- STUDY PROFILE BASELINE (COLOR VARIES BY REACH)
- POLITICAL BOUNDARIES

PROPOSED FLOOD HAZARD ZONES

- PROPOSED FLOODWAY
- PROPOSED ZONE AE
- PROPOSED ZONE X
- EFFECTIVE ZONE A
- 20 FOOT CONTOURS
- 4 FOOT CONTOURS
- 3160.7 BASE FLOOD ELEVATION

0 150 300 600 FEET

1 INCH = 300 FEET

SILVER BOW CREEK WORK MAP
SILVER BOW CREEK FLOODPLAIN STUDY
SILVER BOW COUNTY, MT
DATE: 5/20/2019
IMAGERY: NAIP 2017
TOPOGRAPHIC DATA: LIDAR 2017, BATHYMETRY 2017
PROJECTION: MONTANA STATE PLANE
HORIZONTAL DATUM: NAD83, INT'L FT
VERTICAL DATUM: NAVD88, FT

The City-County of BUTTE SILVER BOW

DEQ Montana Department of Environmental Quality

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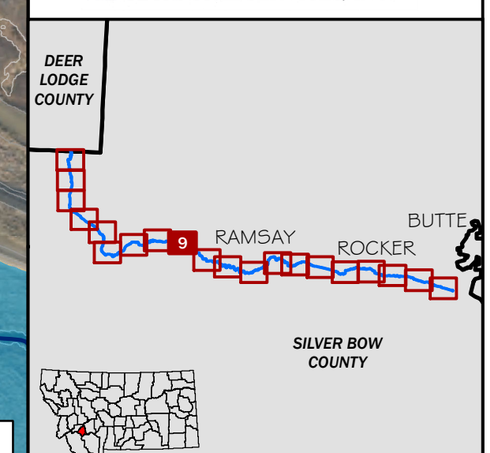
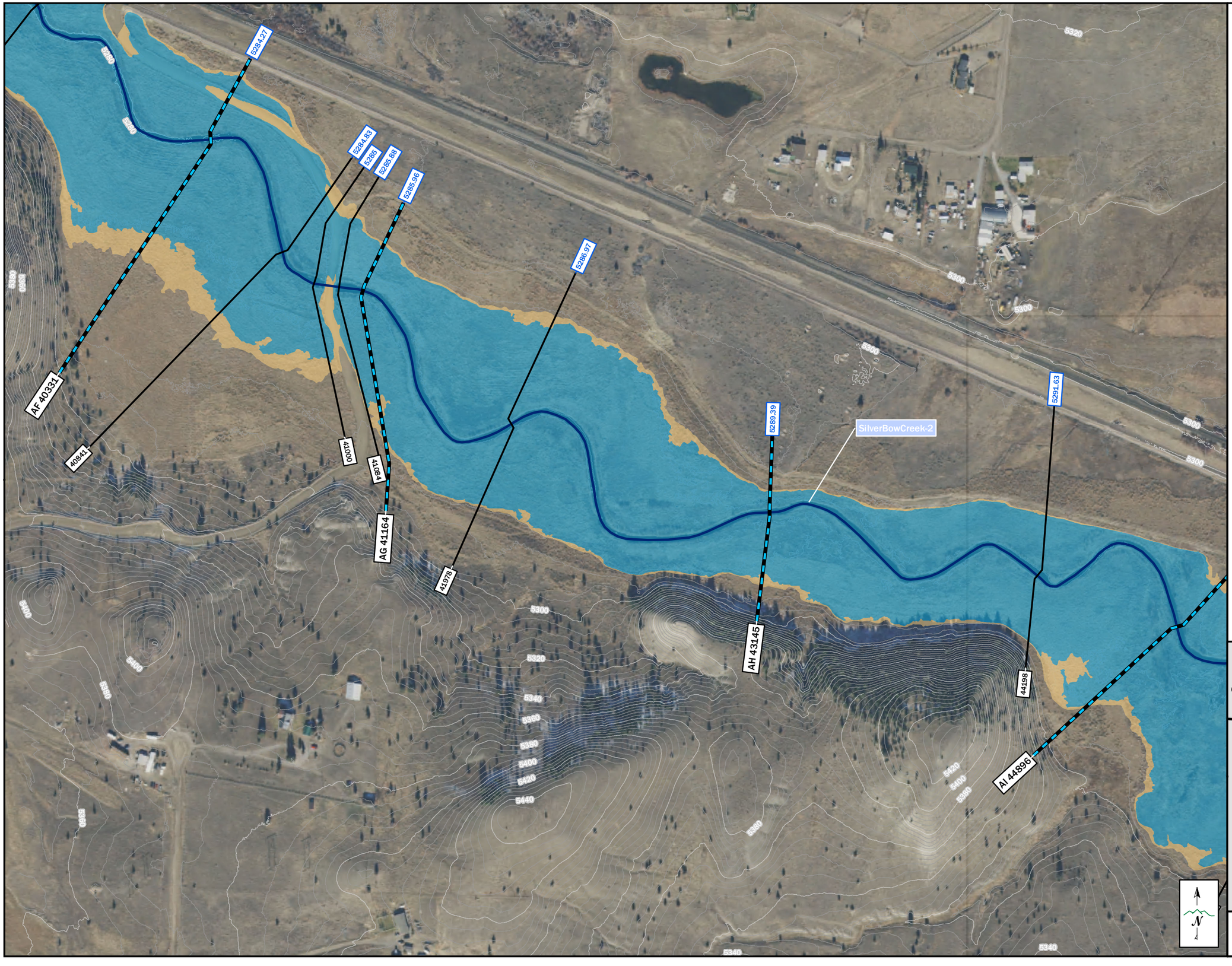


WORK MAP 9 OF 20

SILVER BOW CREEK FLOODPLAIN STUDY



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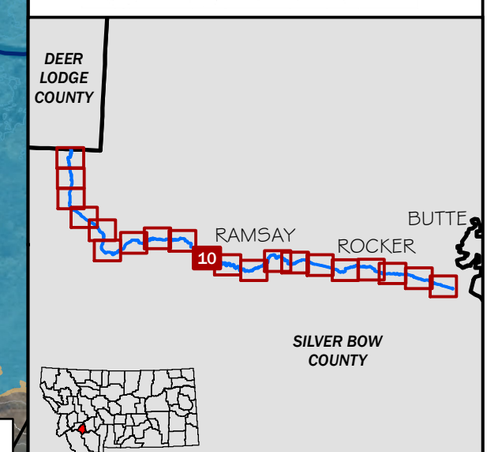
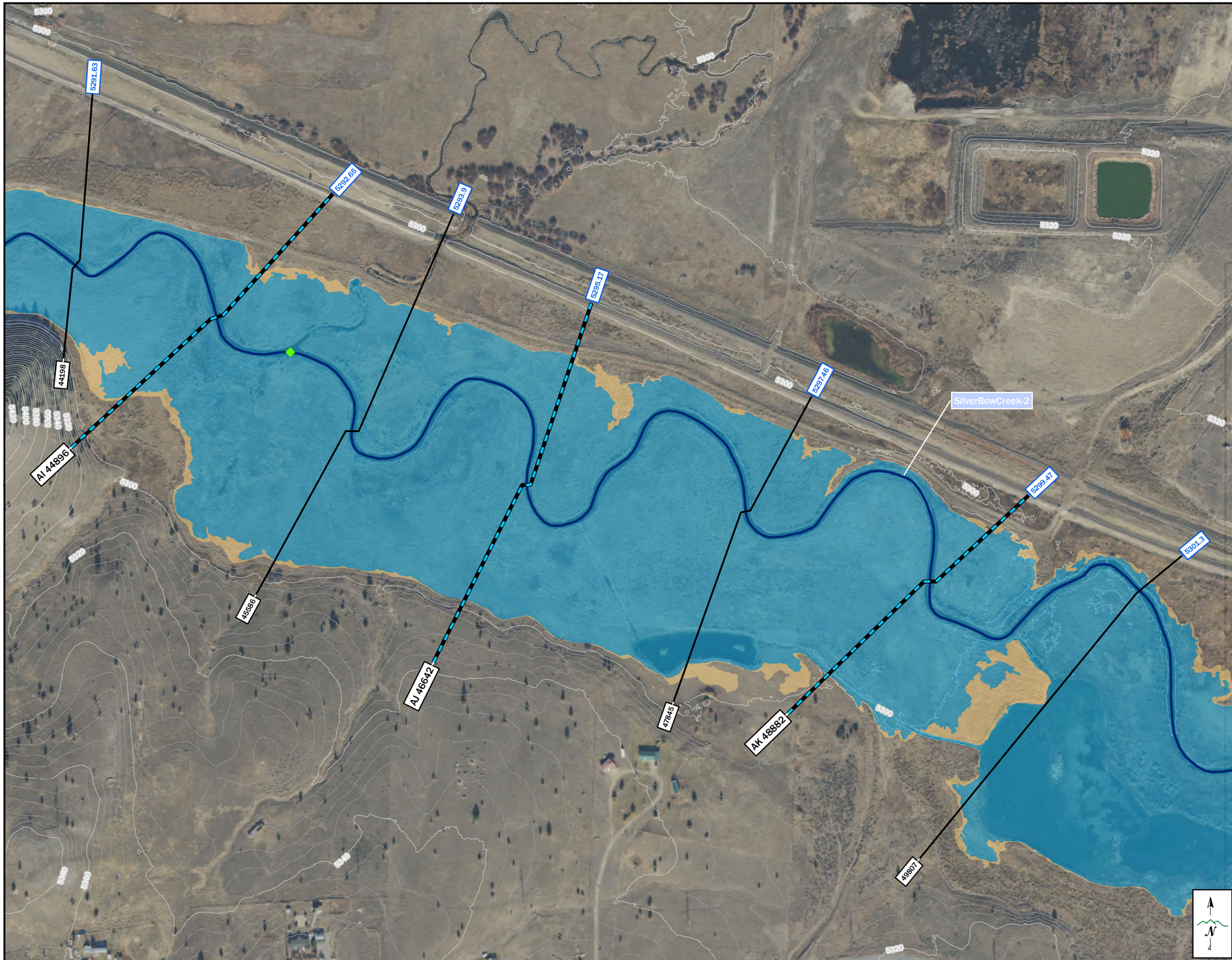


WORK MAP 10 OF 20



SILVER BOW CREEK FLOODPLAIN STUDY

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The City-County of BUTTE SILVER BOW

DEQ Montana Department of Environmental Quality

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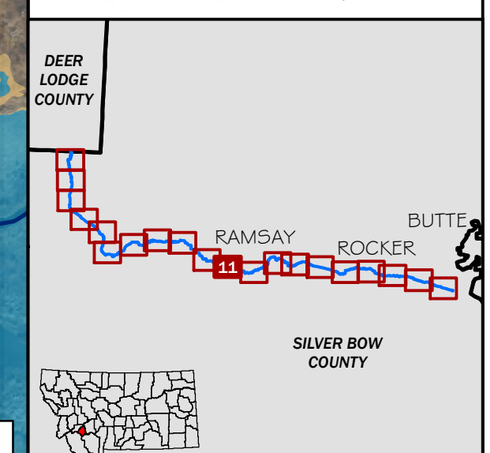

WORK MAP 11 OF 20

SILVER BOW CREEK FLOODPLAIN STUDY

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The City-County of BUTTE SILVER BOW

DEQ Montana Department of Environmental Quality

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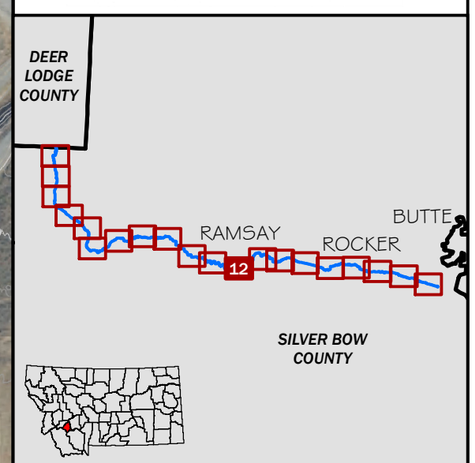
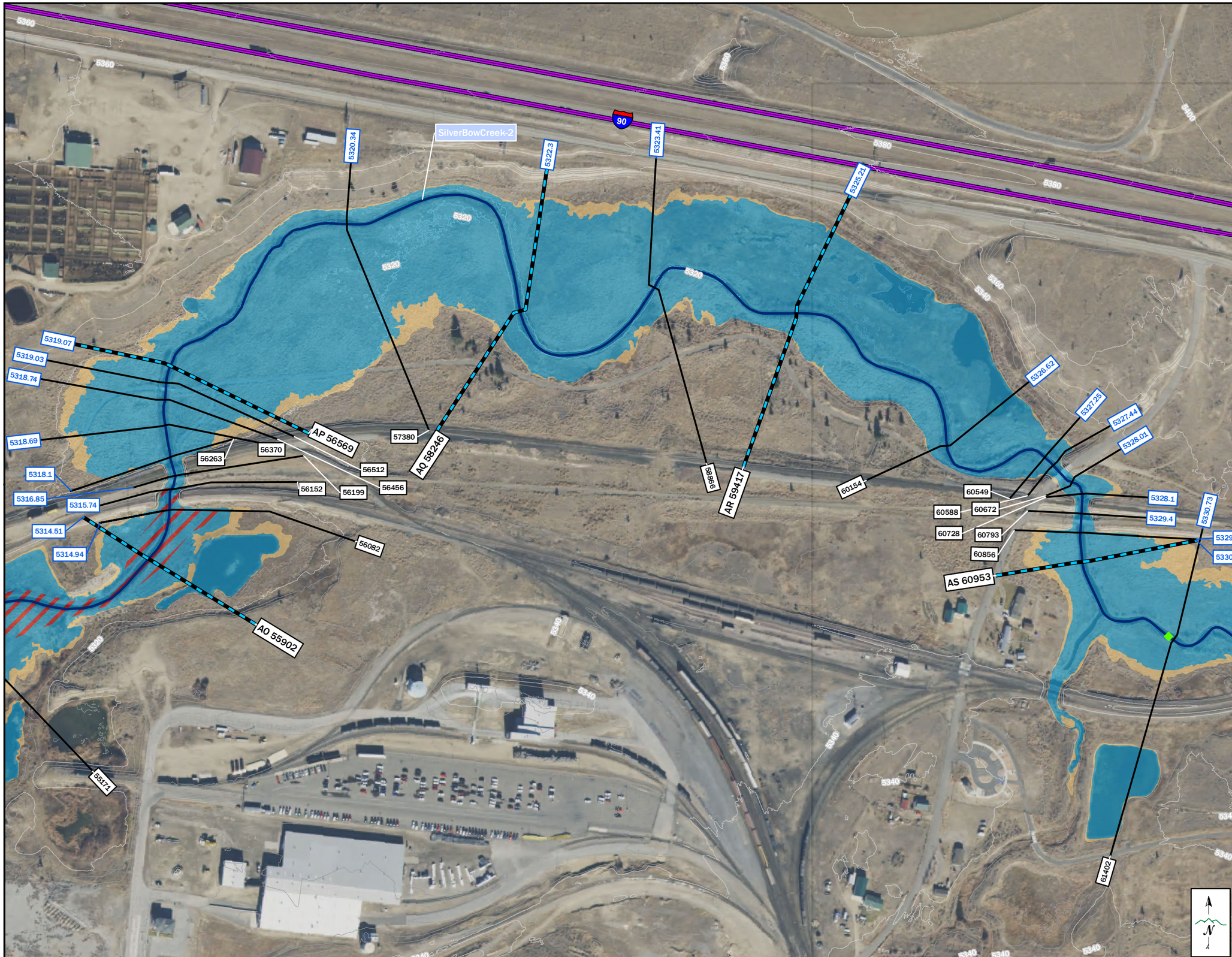


WORK MAP 12 OF 20

SILVER BOW CREEK FLOODPLAIN STUDY



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The City-County of BUTTE SILVER BOW

DEQ Montana Department of Environmental Quality

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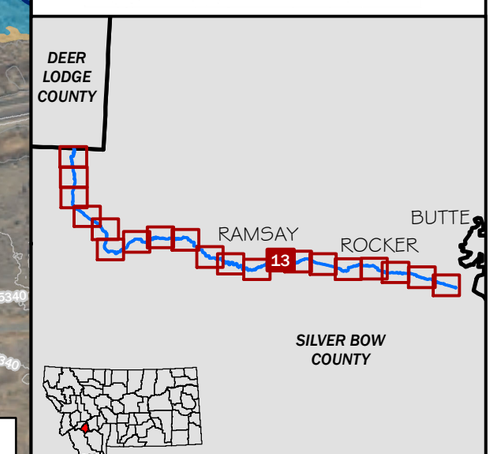
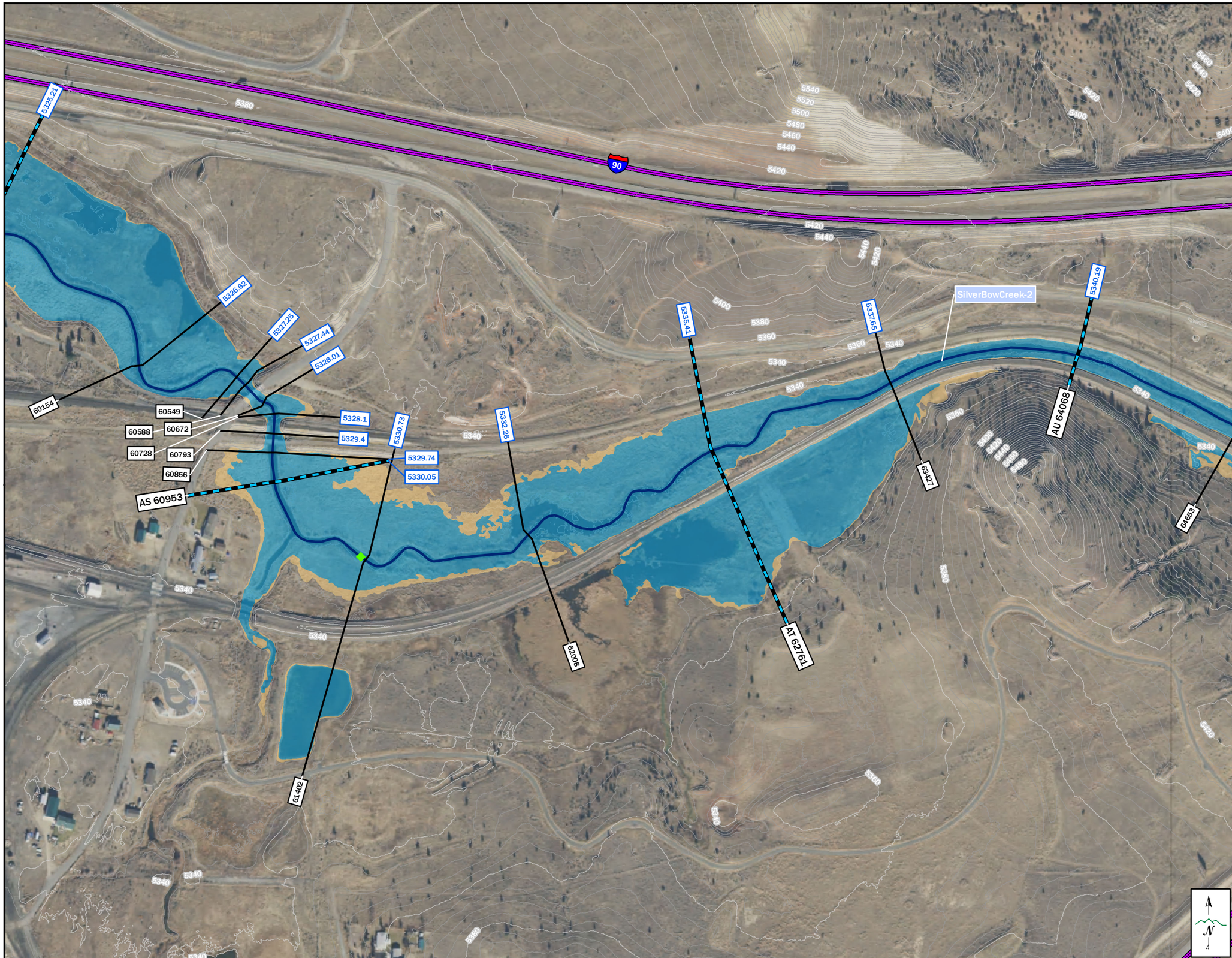


WORK MAP 13 OF 20



SILVER BOW CREEK FLOODPLAIN STUDY

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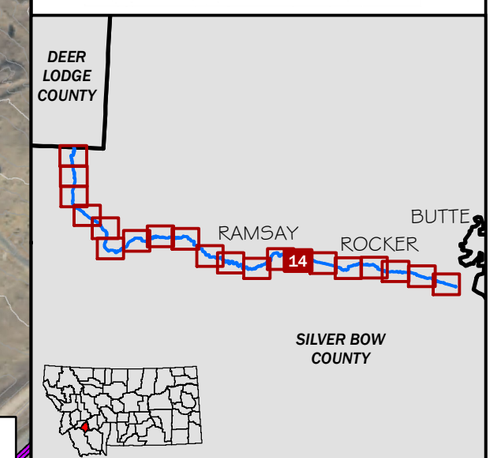
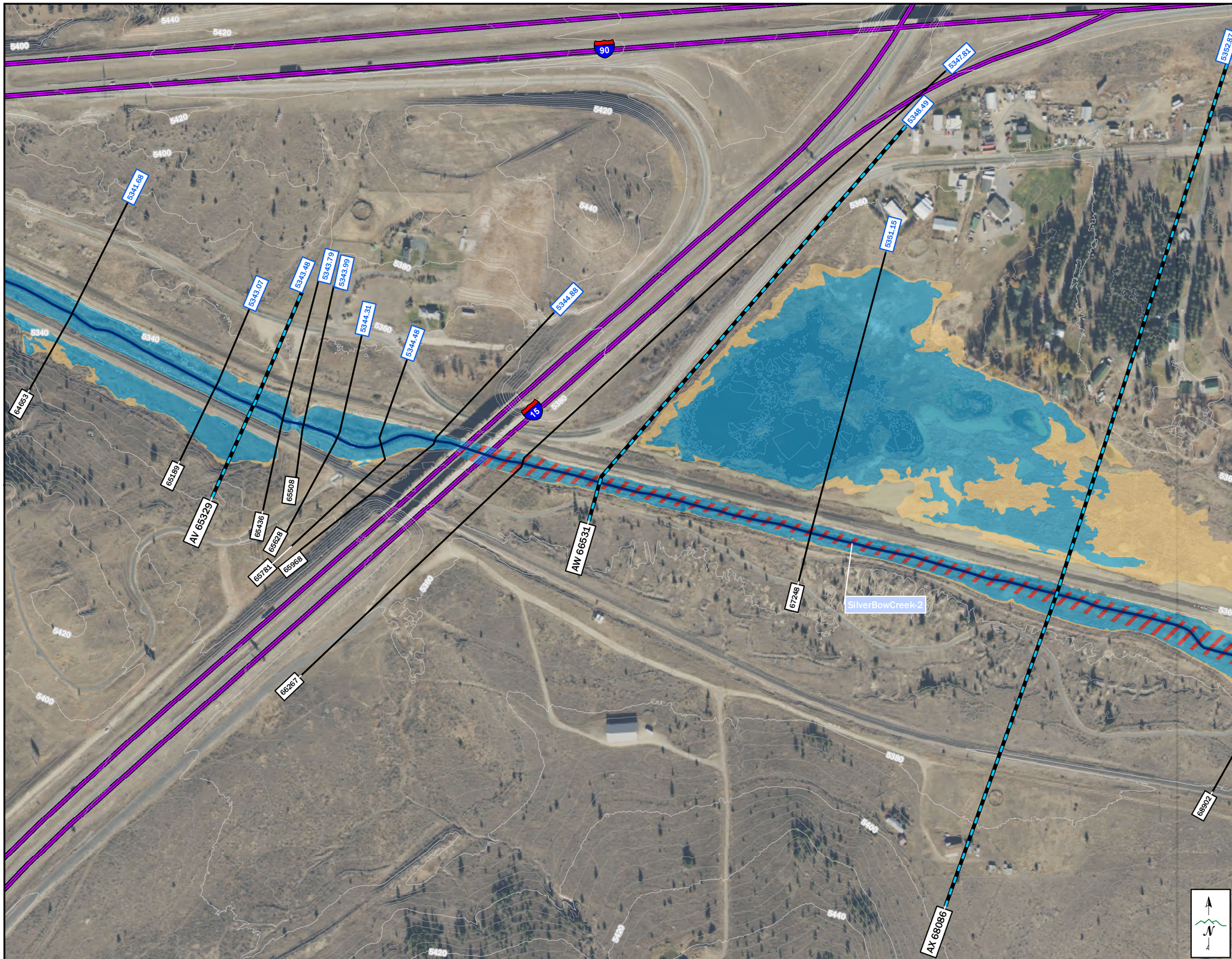


WORK MAP 14 OF 20



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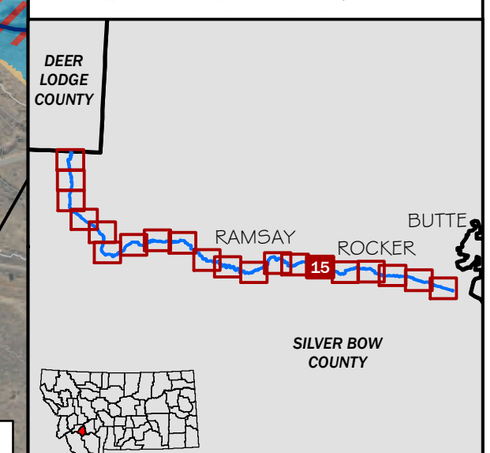
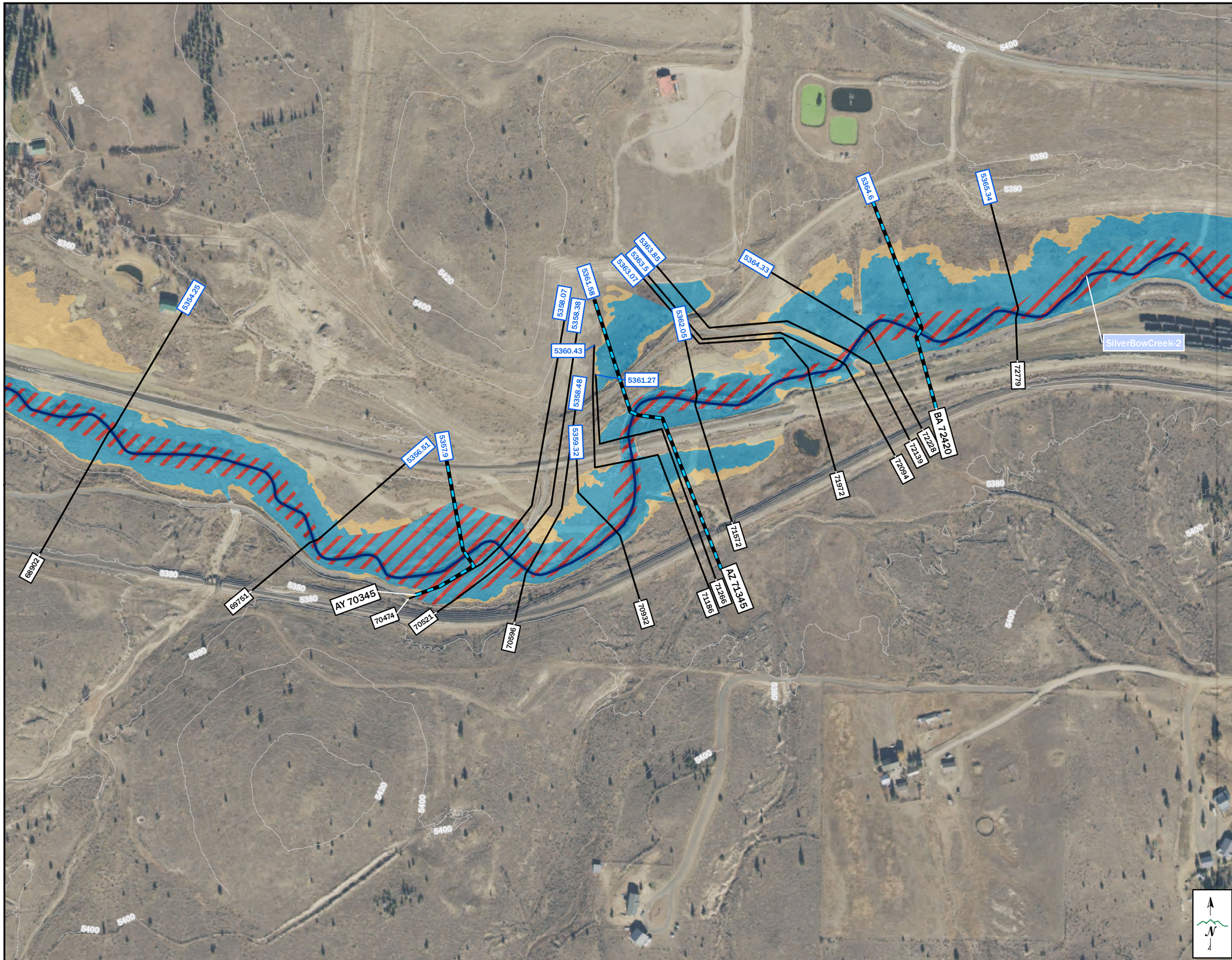


WORK MAP 15 OF 20



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DEQ Montana Department of Environmental Quality

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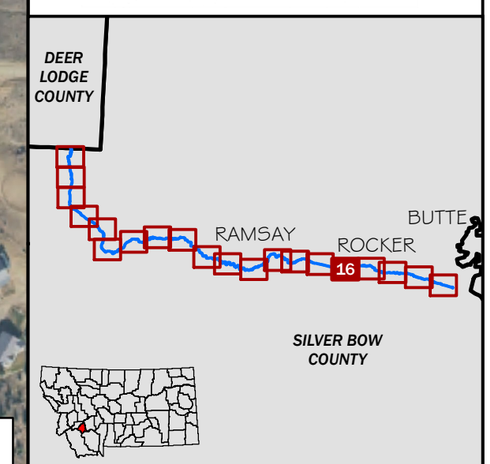

WORK MAP 16 OF 20

SILVER BOW CREEK FLOODPLAIN STUDY

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The City-County of BUTTE SILVER BOW

DEQ Montana Department of Environmental Quality

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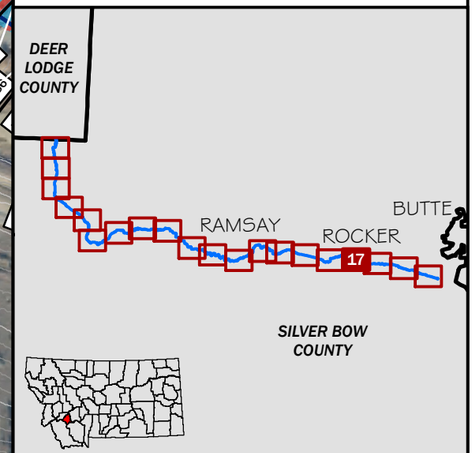
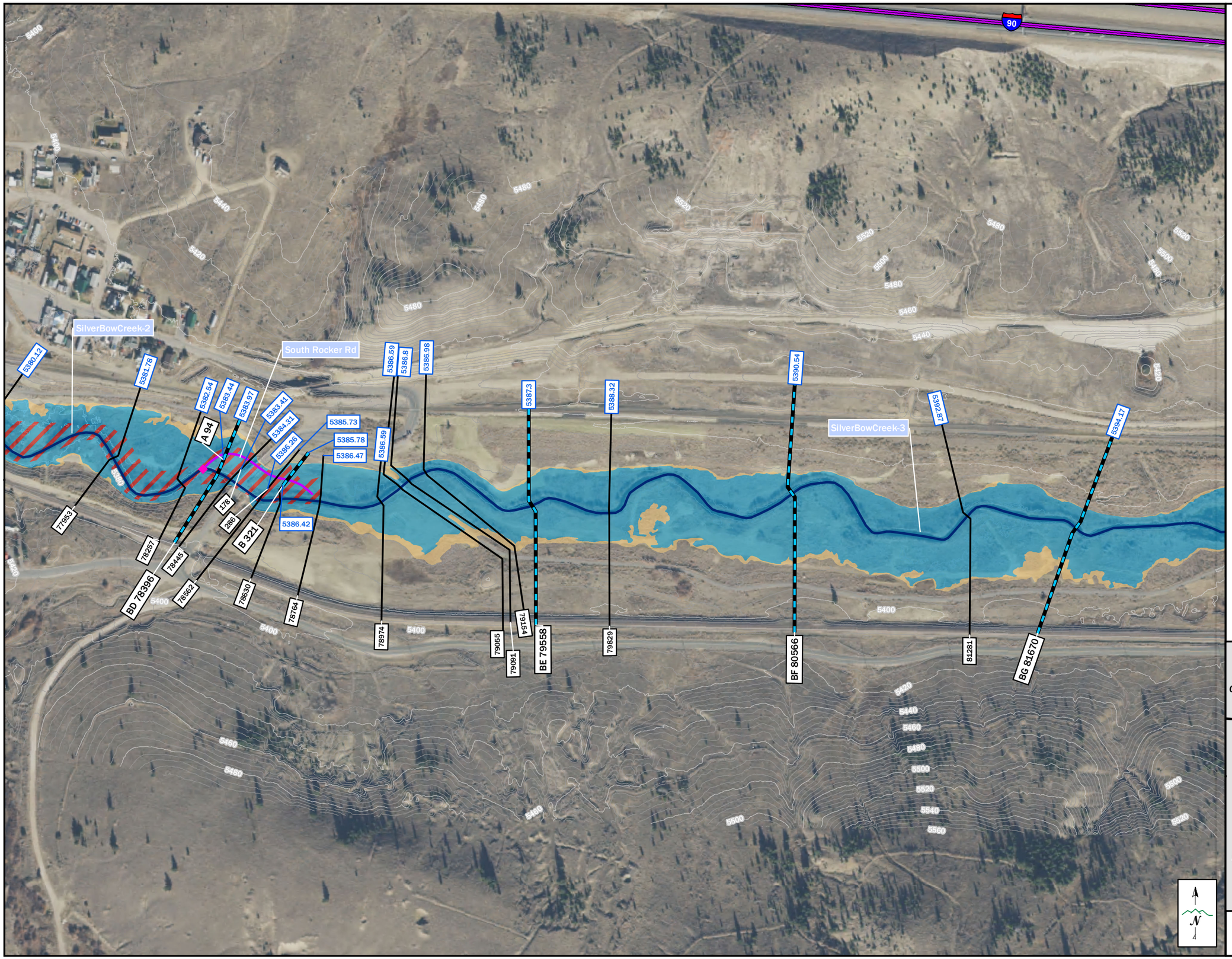


WORK MAP 17 OF 20

SILVER BOW CREEK FLOODPLAIN STUDY



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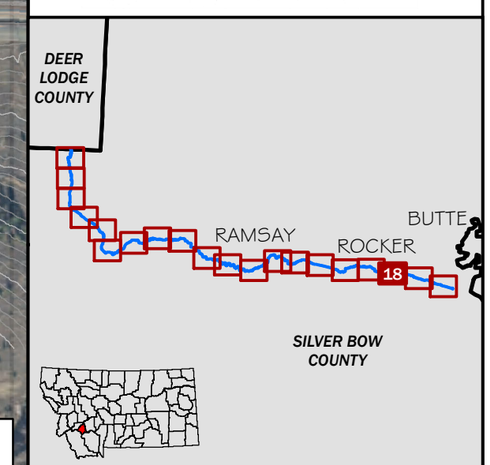
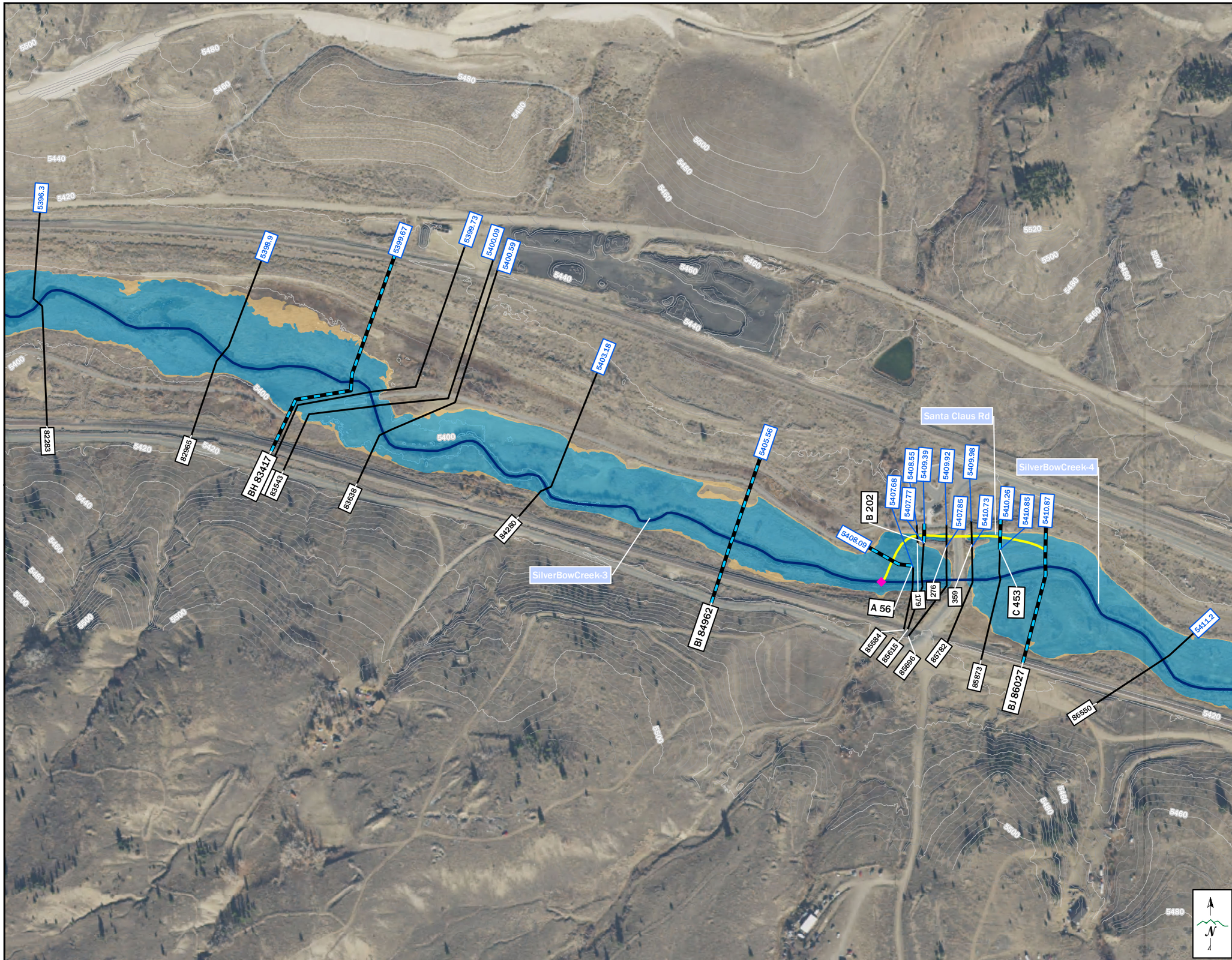


WORK MAP 18 OF 20



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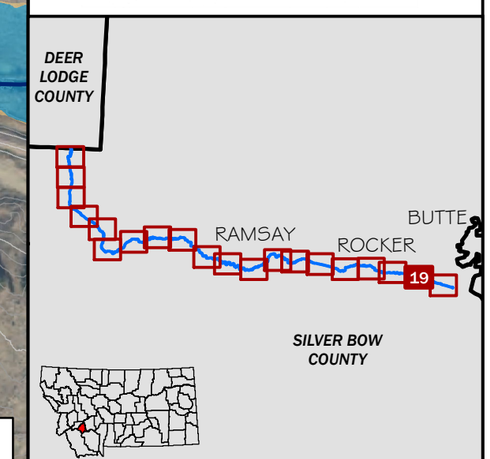
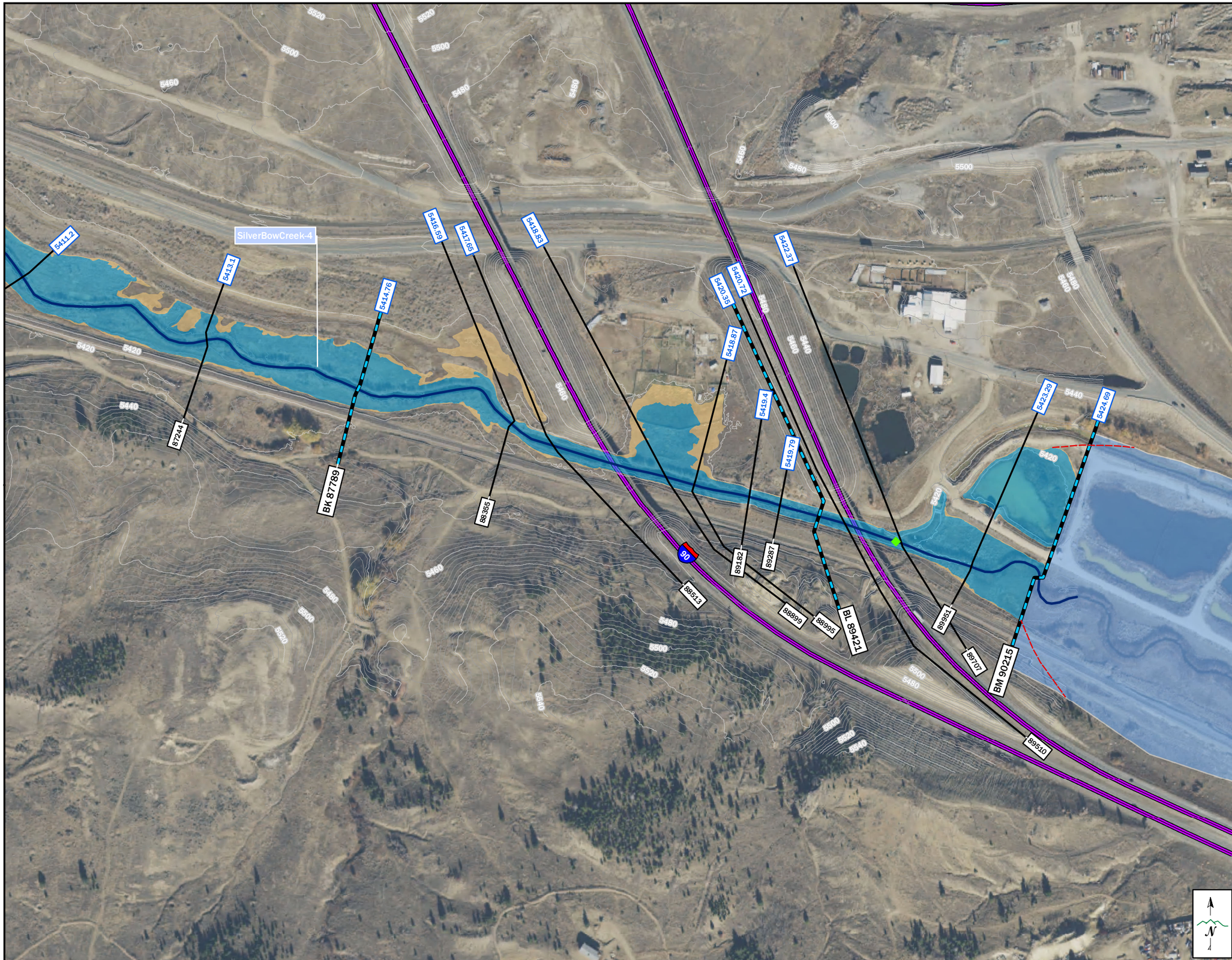


WORK MAP 19 OF 20



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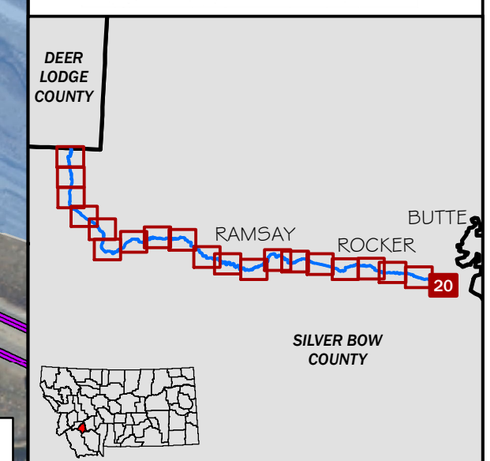
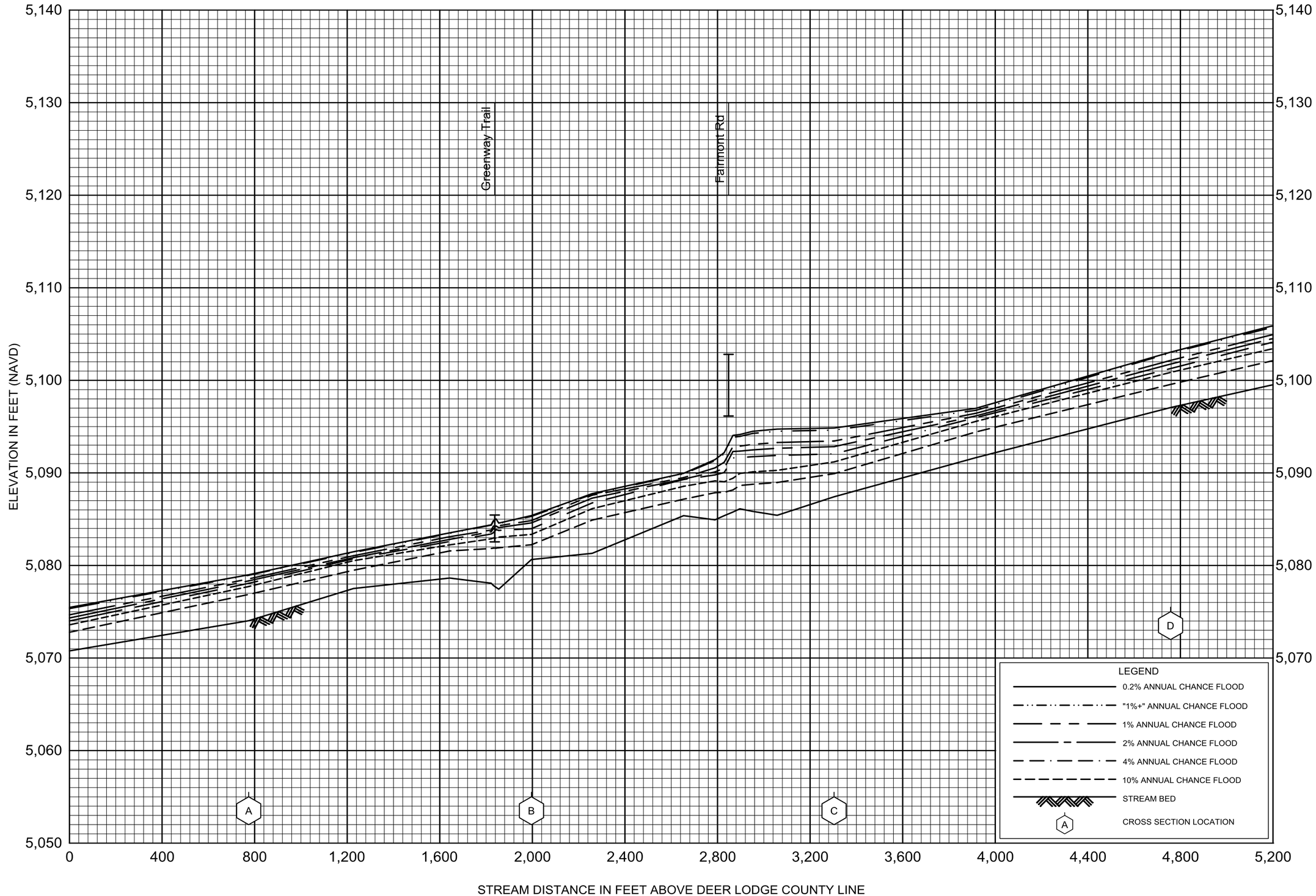


WORK MAP 20 OF 20

Appendix B FIS Profiles



FLOOD PROFILES

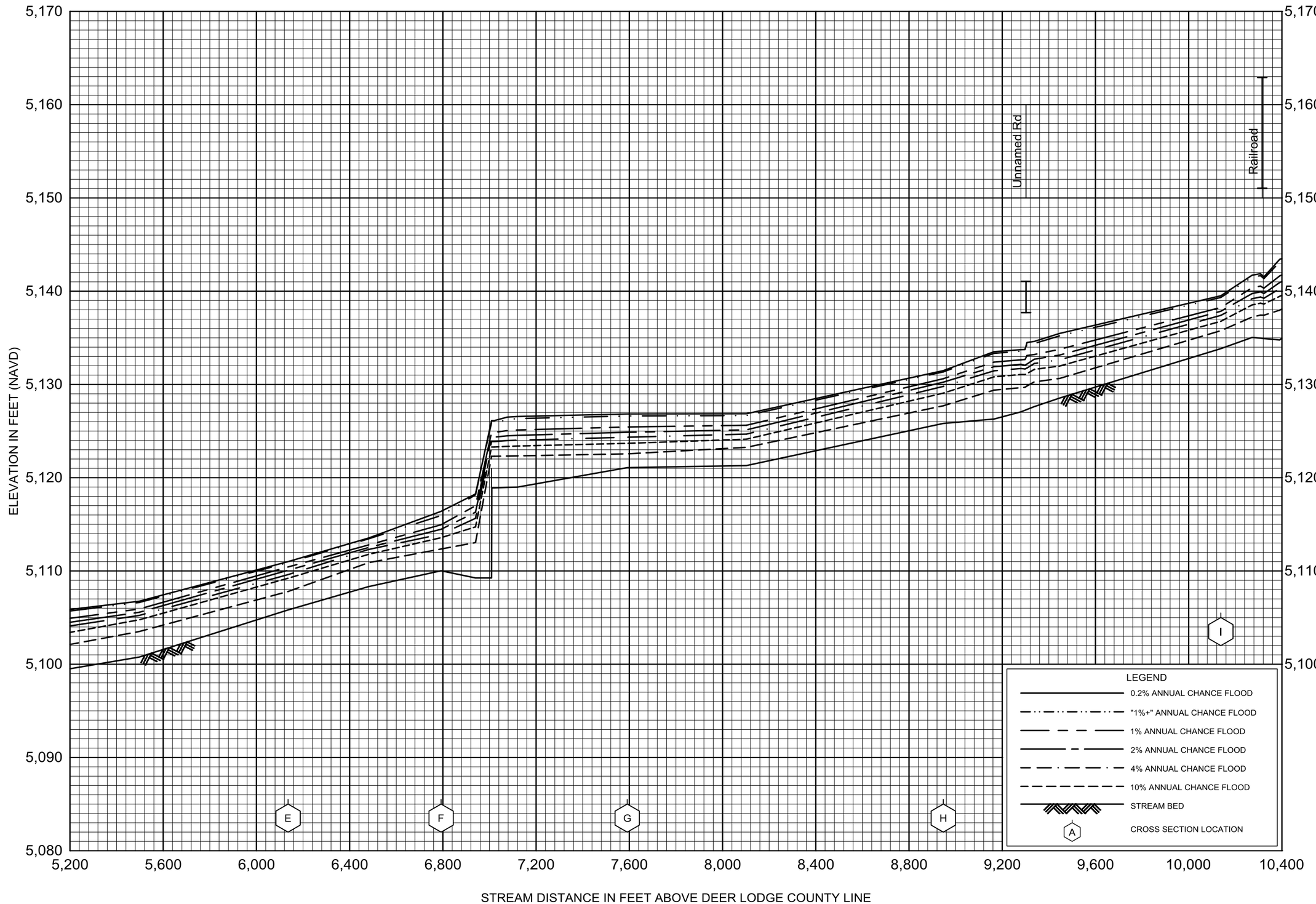
SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

01P



FLOOD PROFILES

SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

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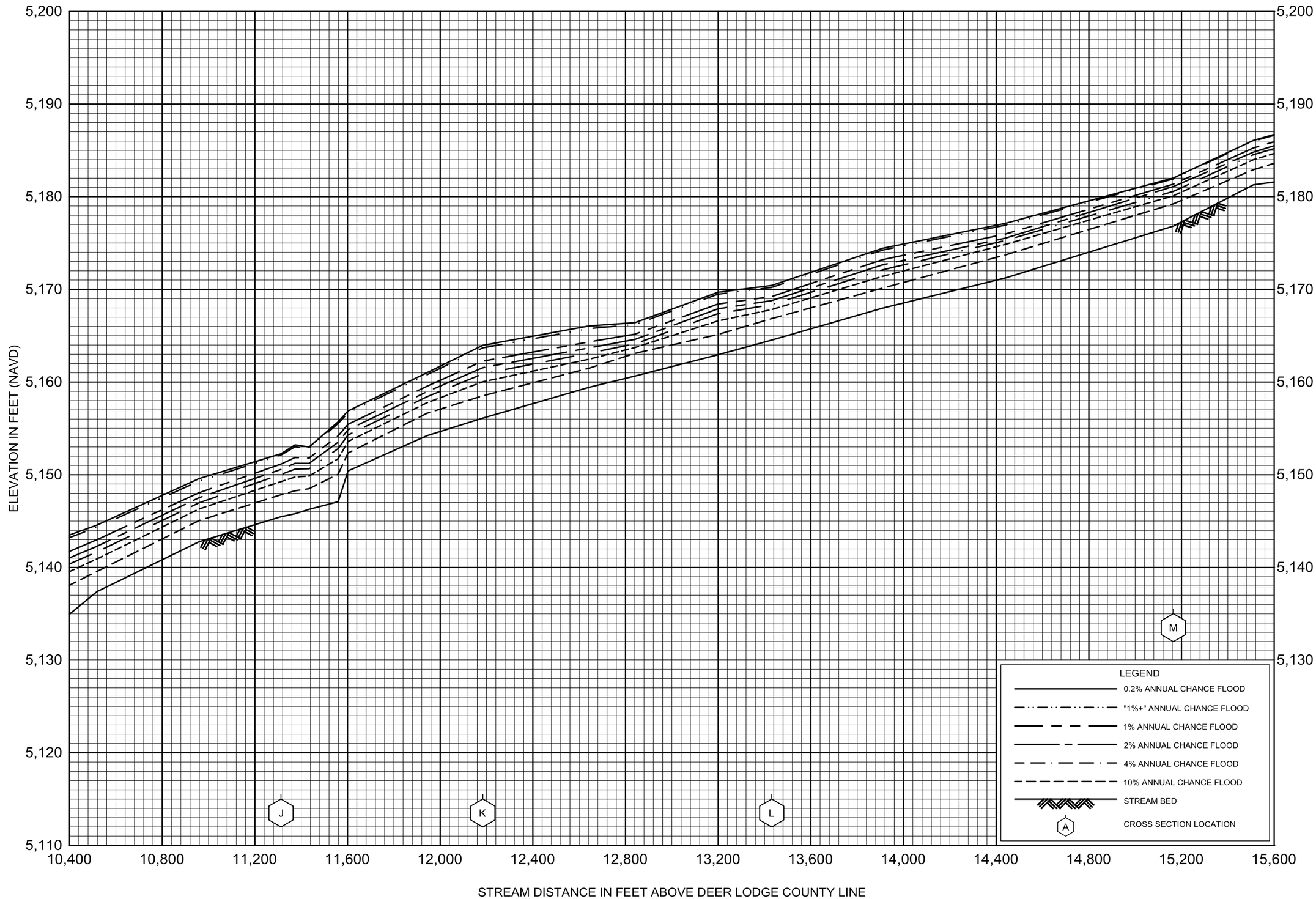
(ALL JURISDICTIONS)

02P



FLOOD PROFILES

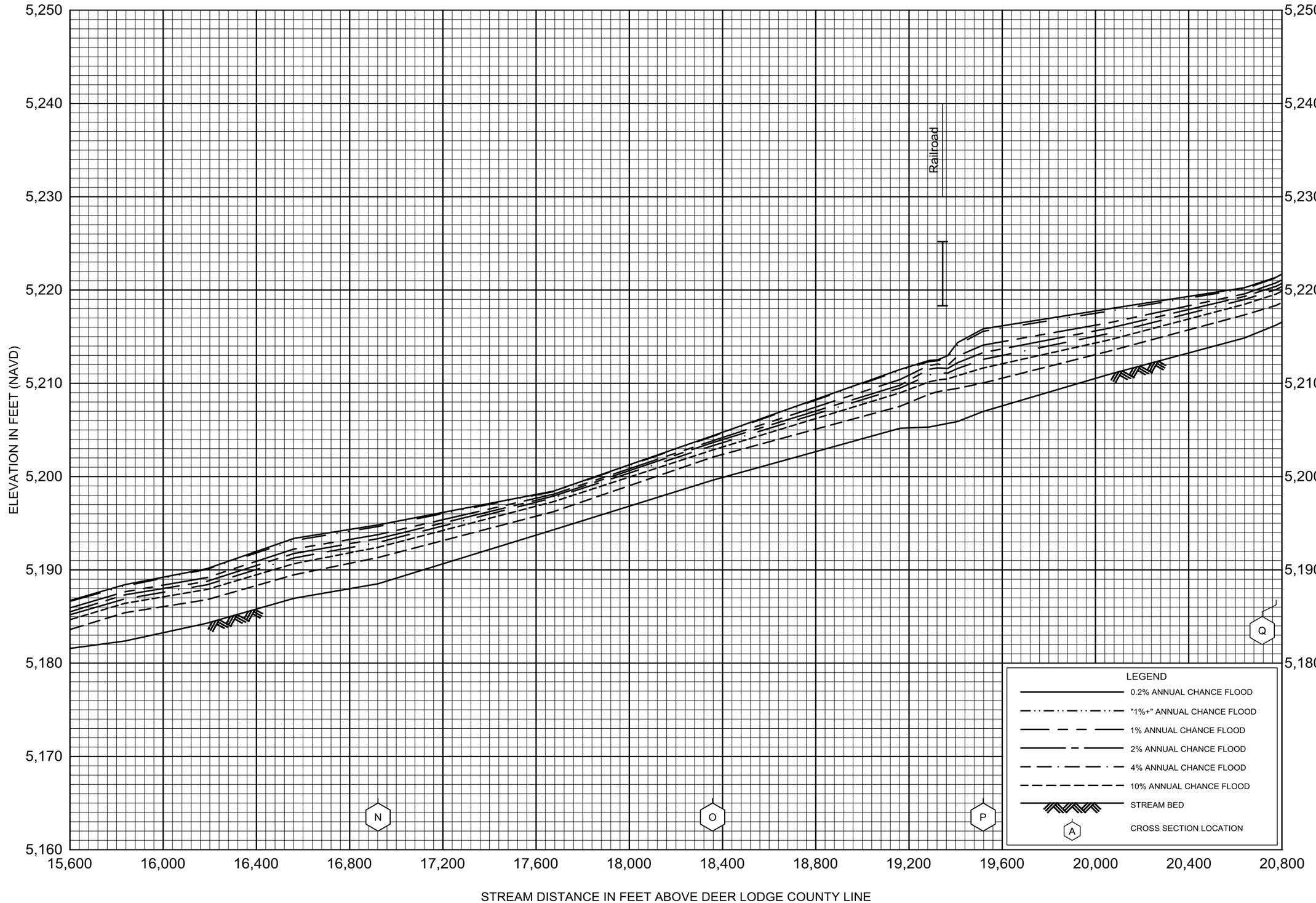
SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

03P



FLOOD PROFILES

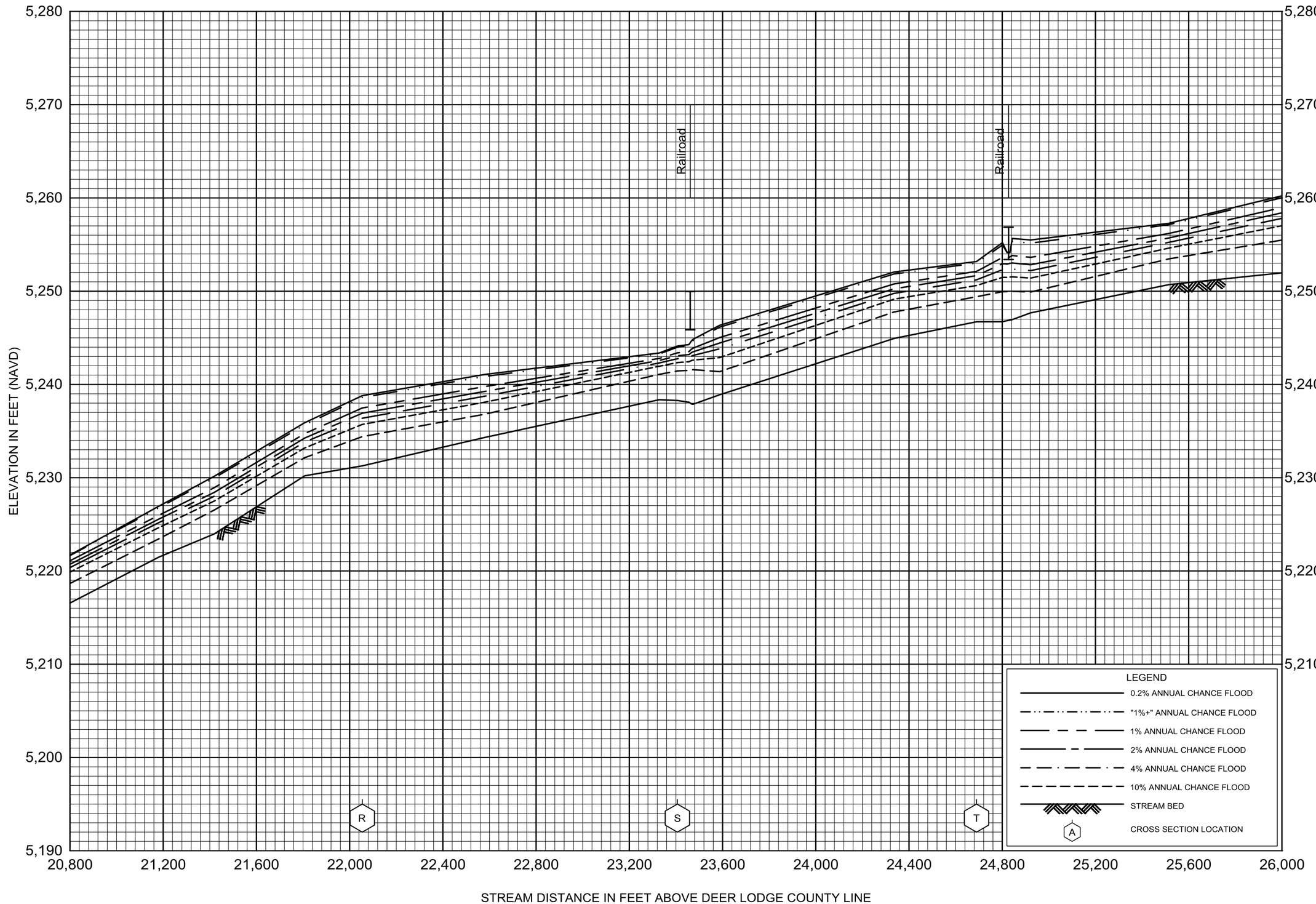
SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

04P



FLOOD PROFILES

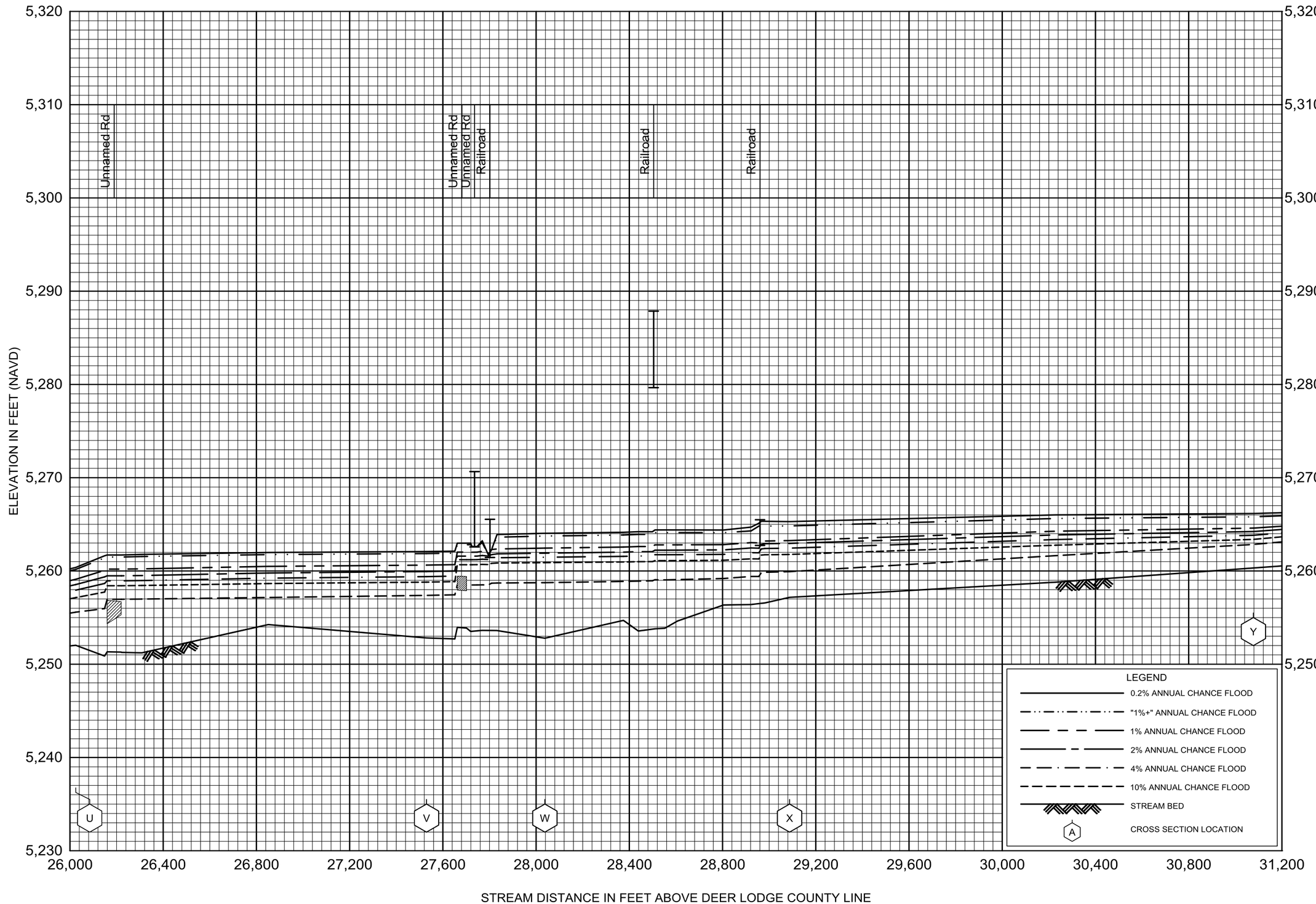
SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

05P



FLOOD PROFILES

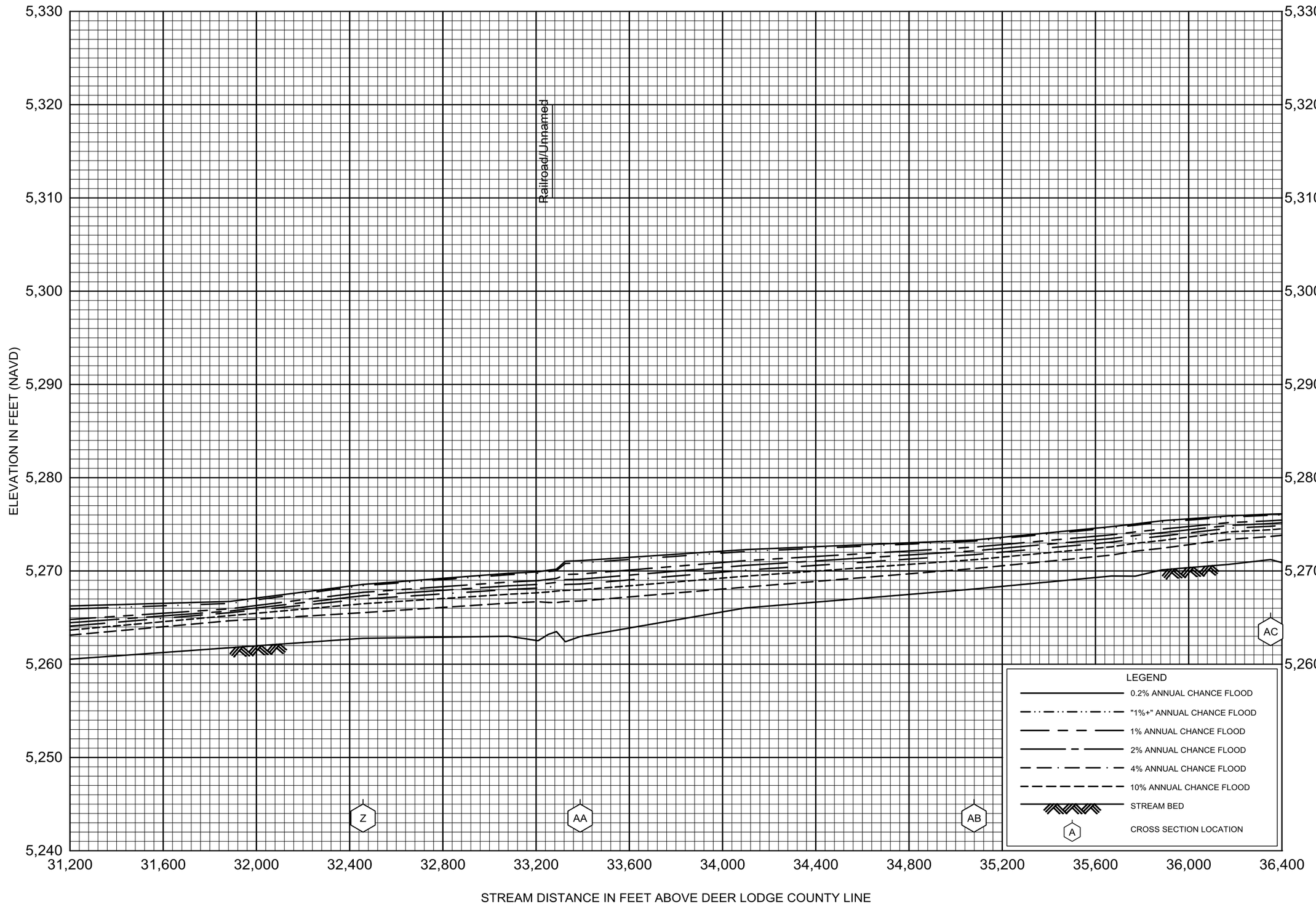
SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

06P



FLOOD PROFILES

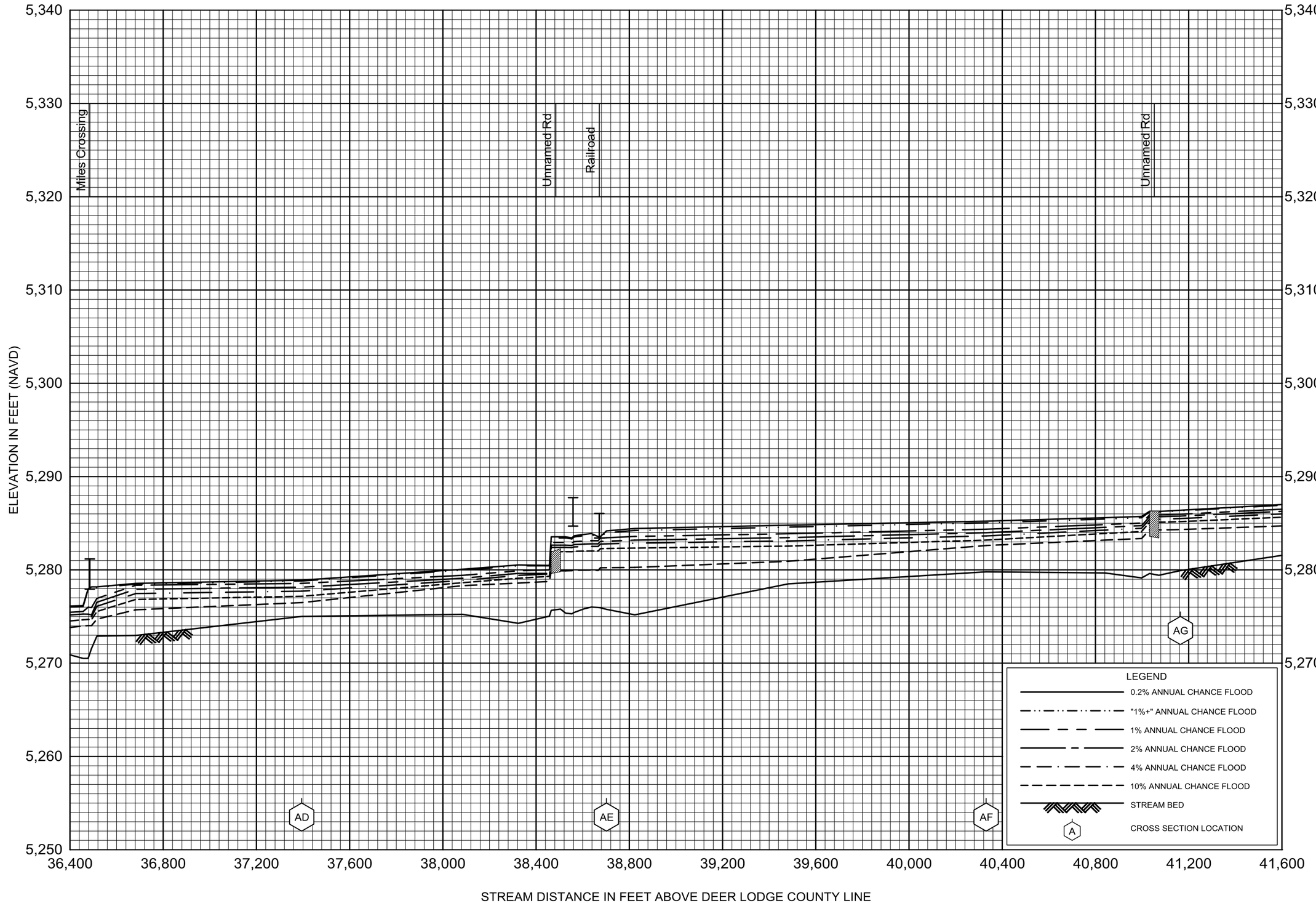
SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

07P



FLOOD PROFILES

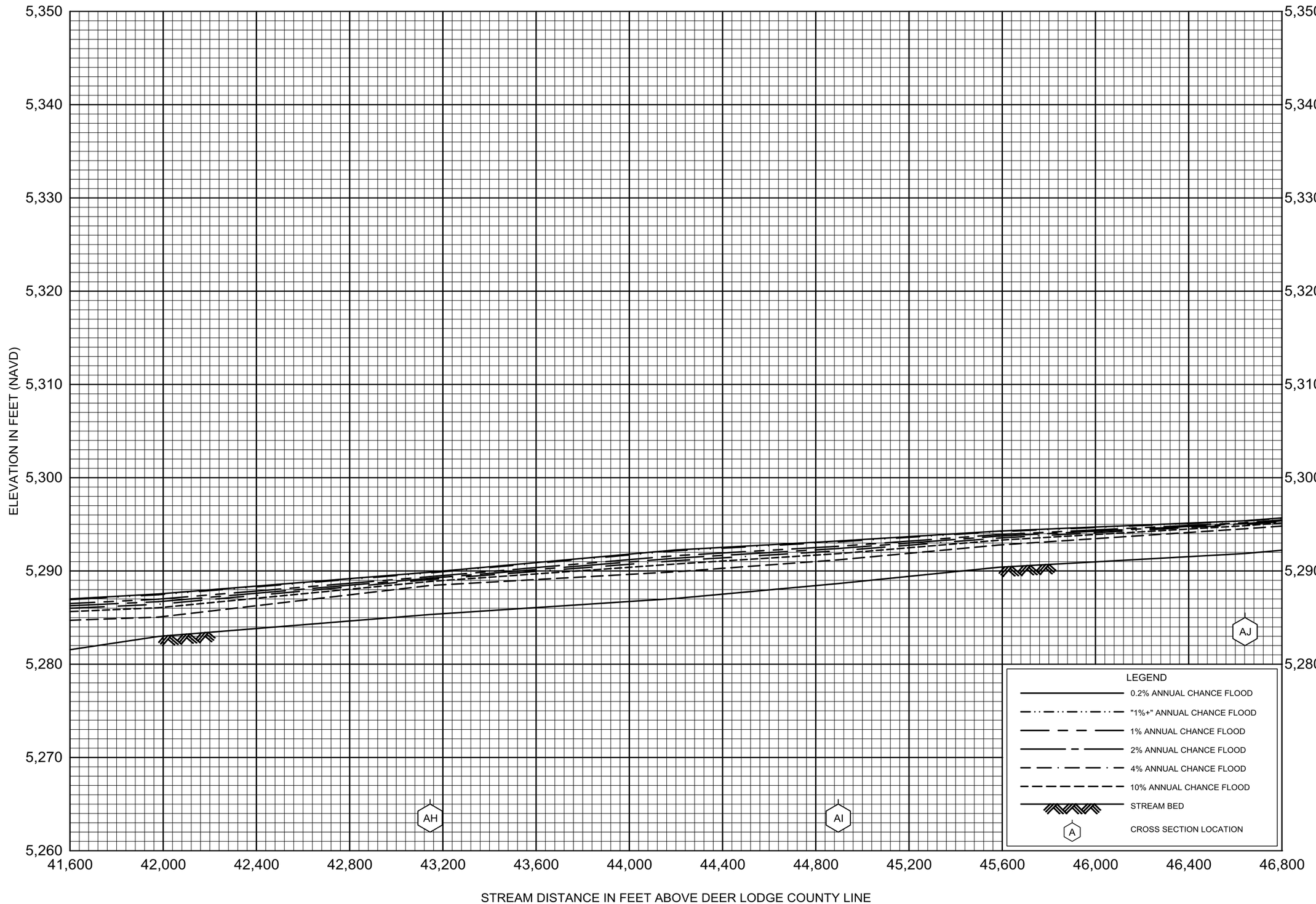
SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

08P



FLOOD PROFILES

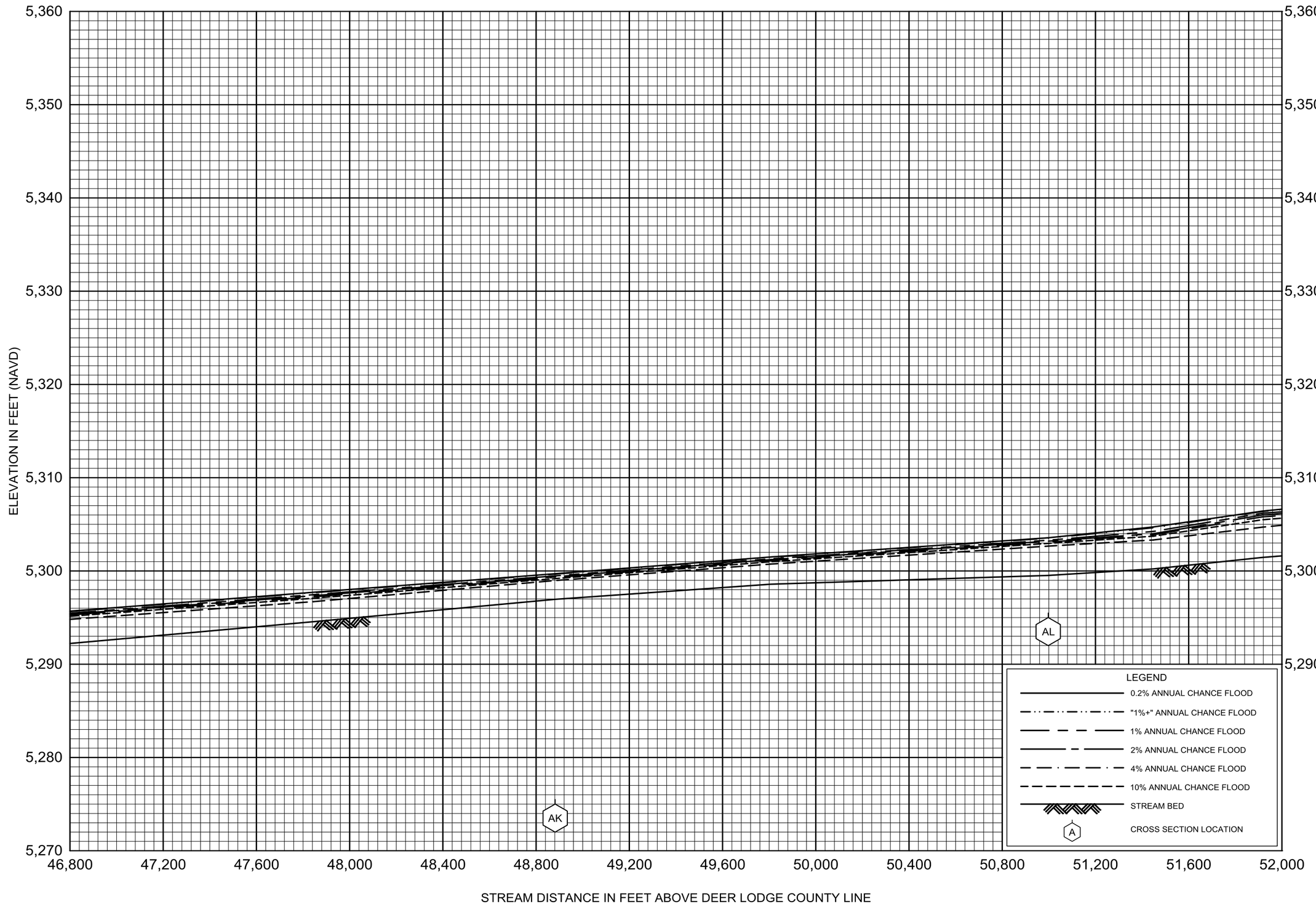
SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

09P



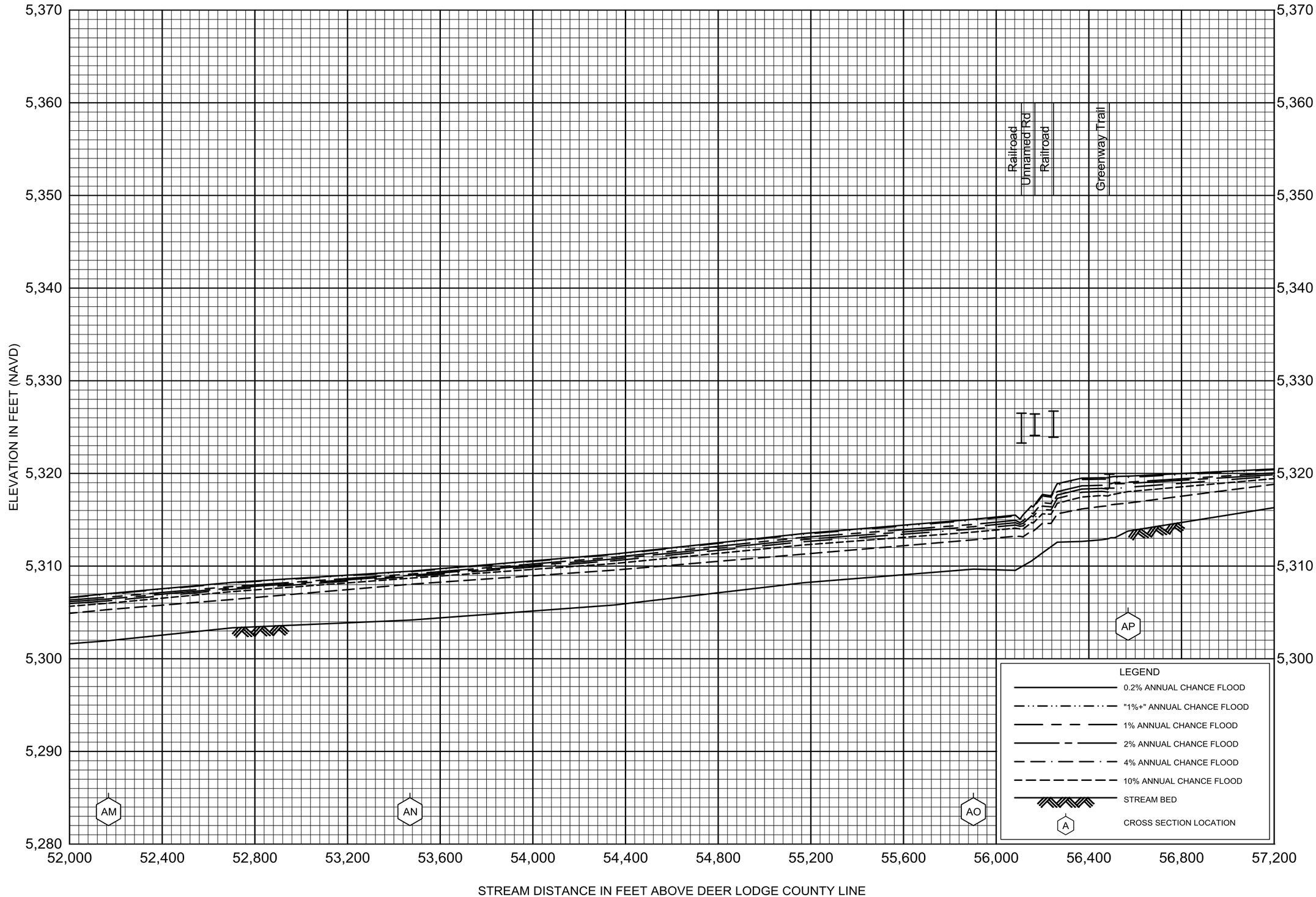
FLOOD PROFILES

SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)



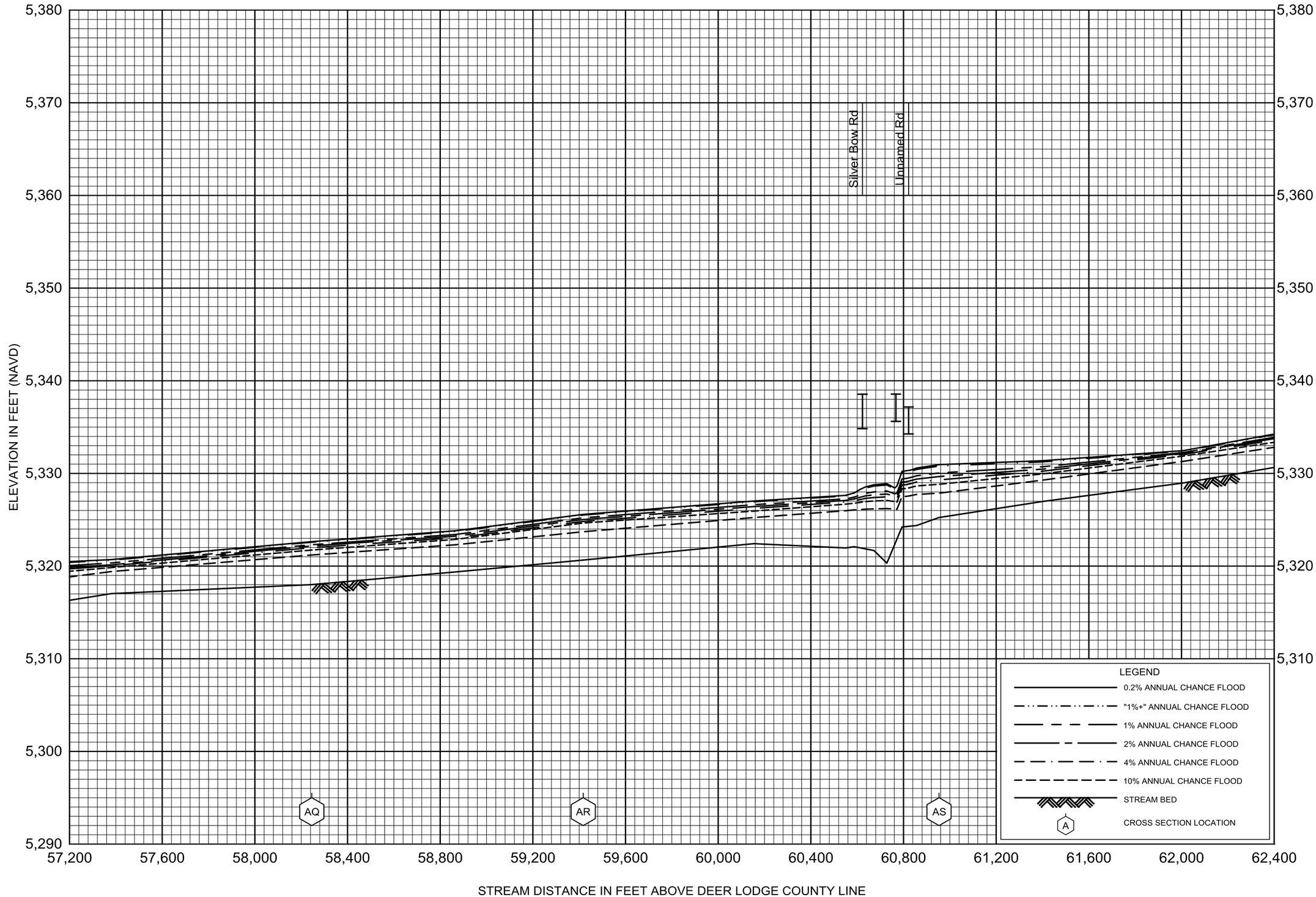
FLOOD PROFILES

SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)



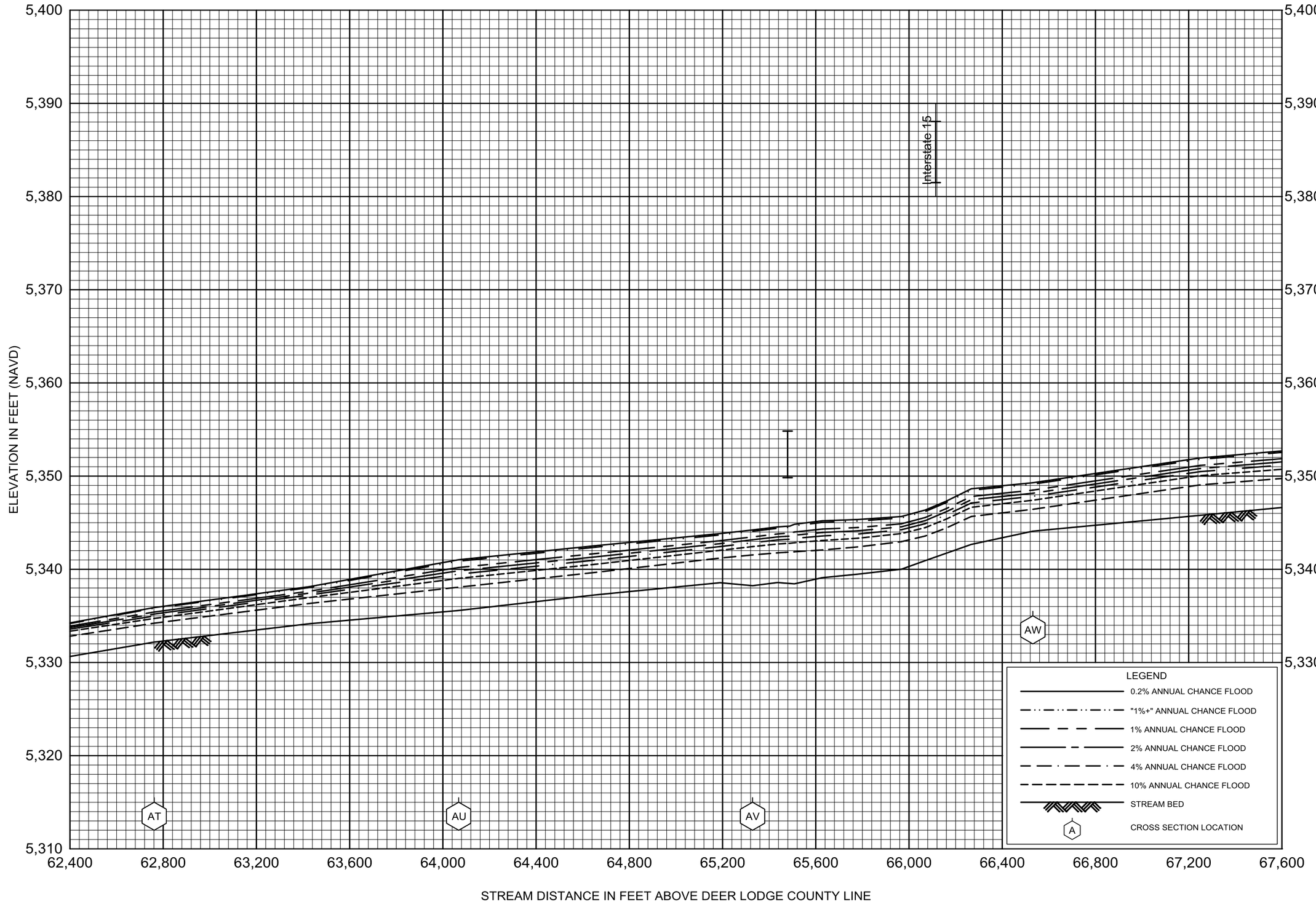
FLOOD PROFILES

SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)



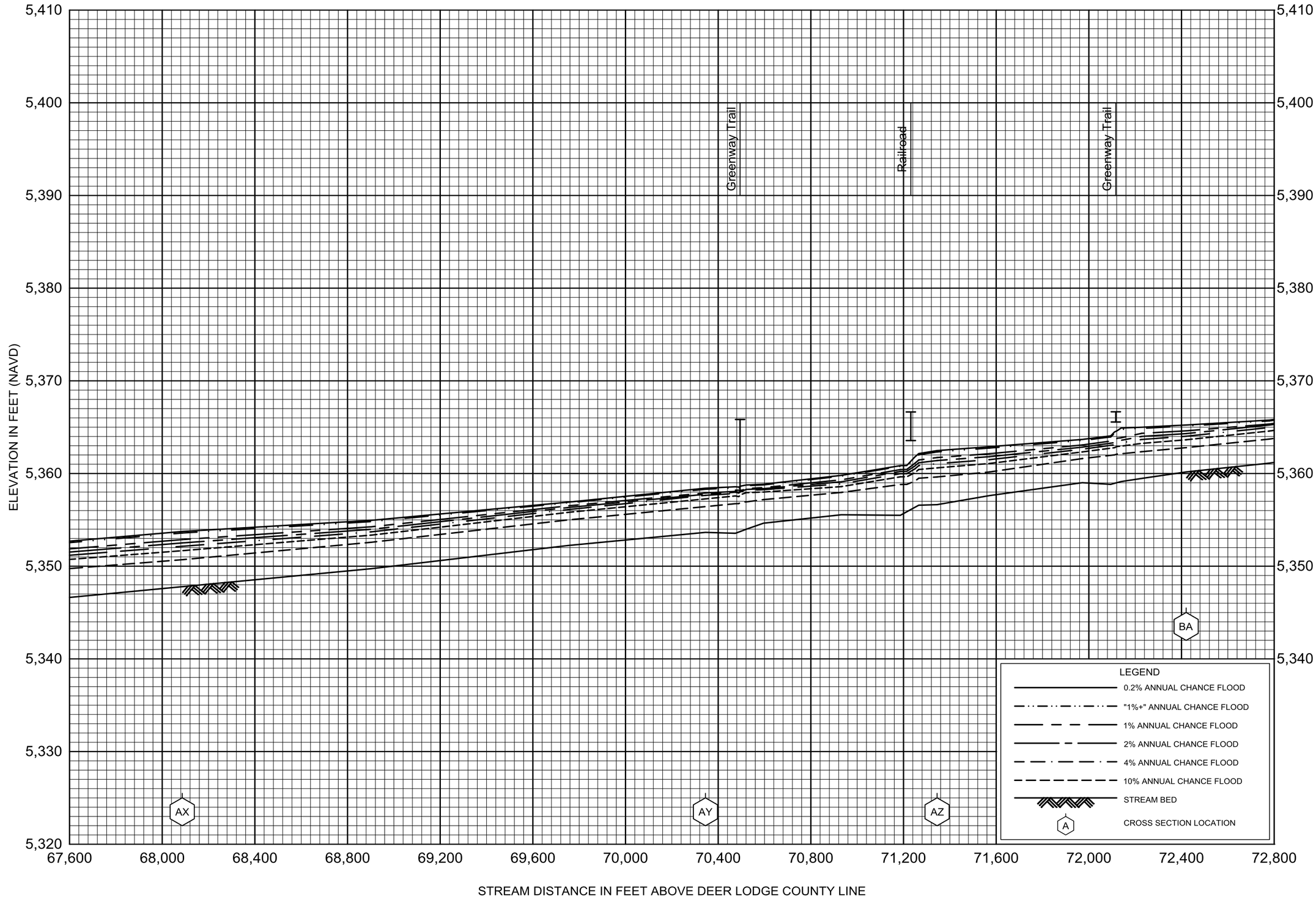
FLOOD PROFILES

SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)



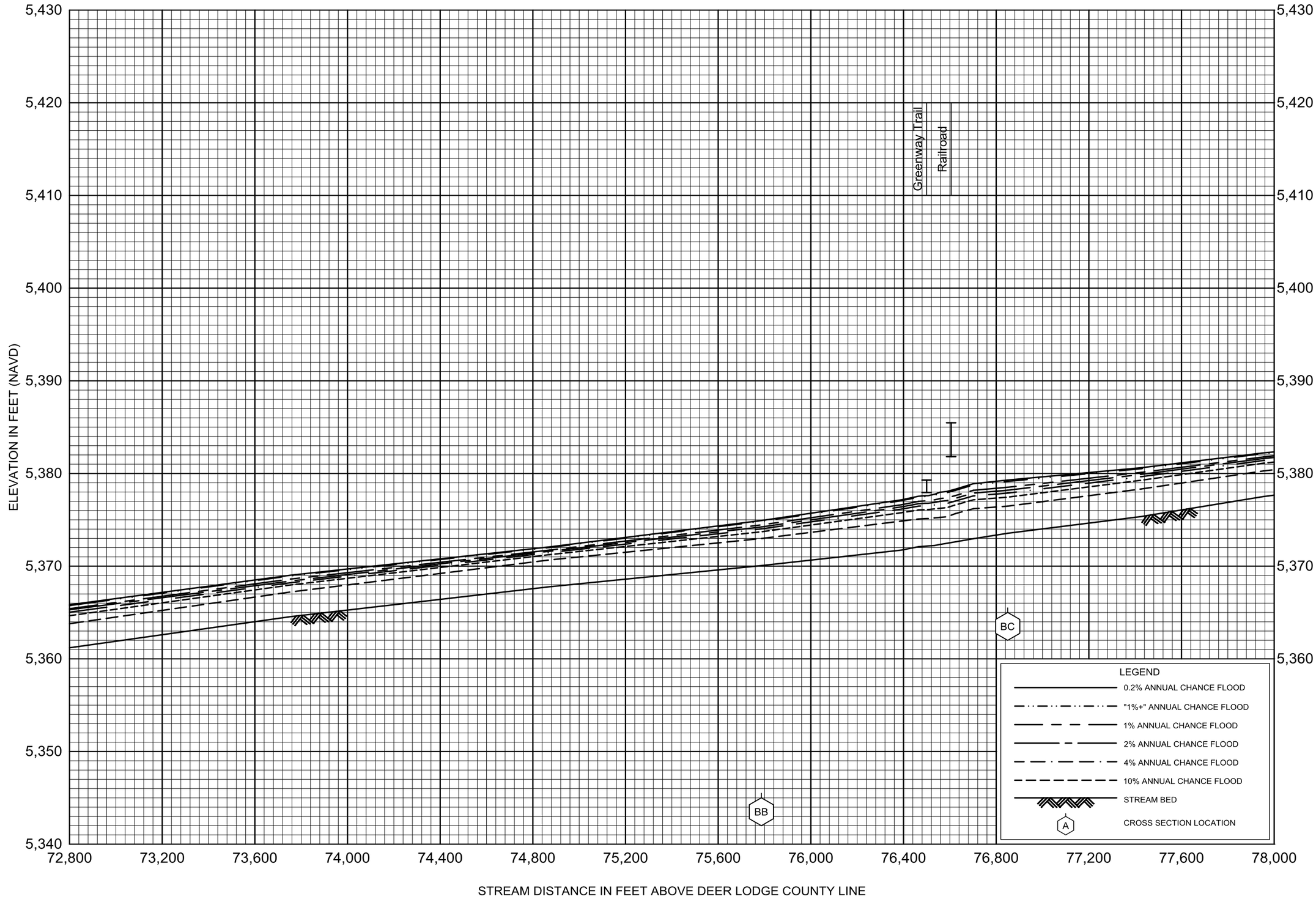
FLOOD PROFILES

SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)



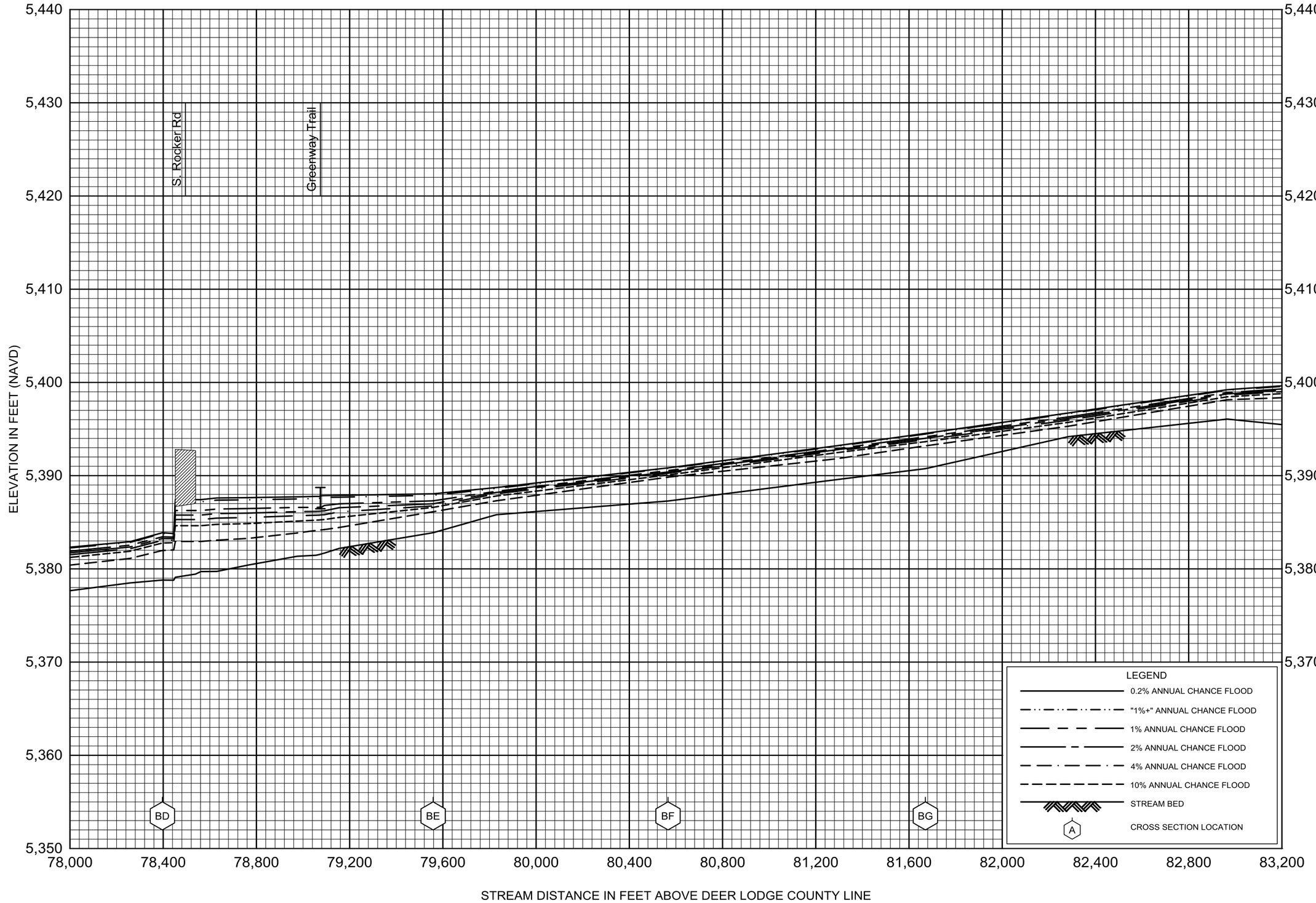
FLOOD PROFILES

SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)



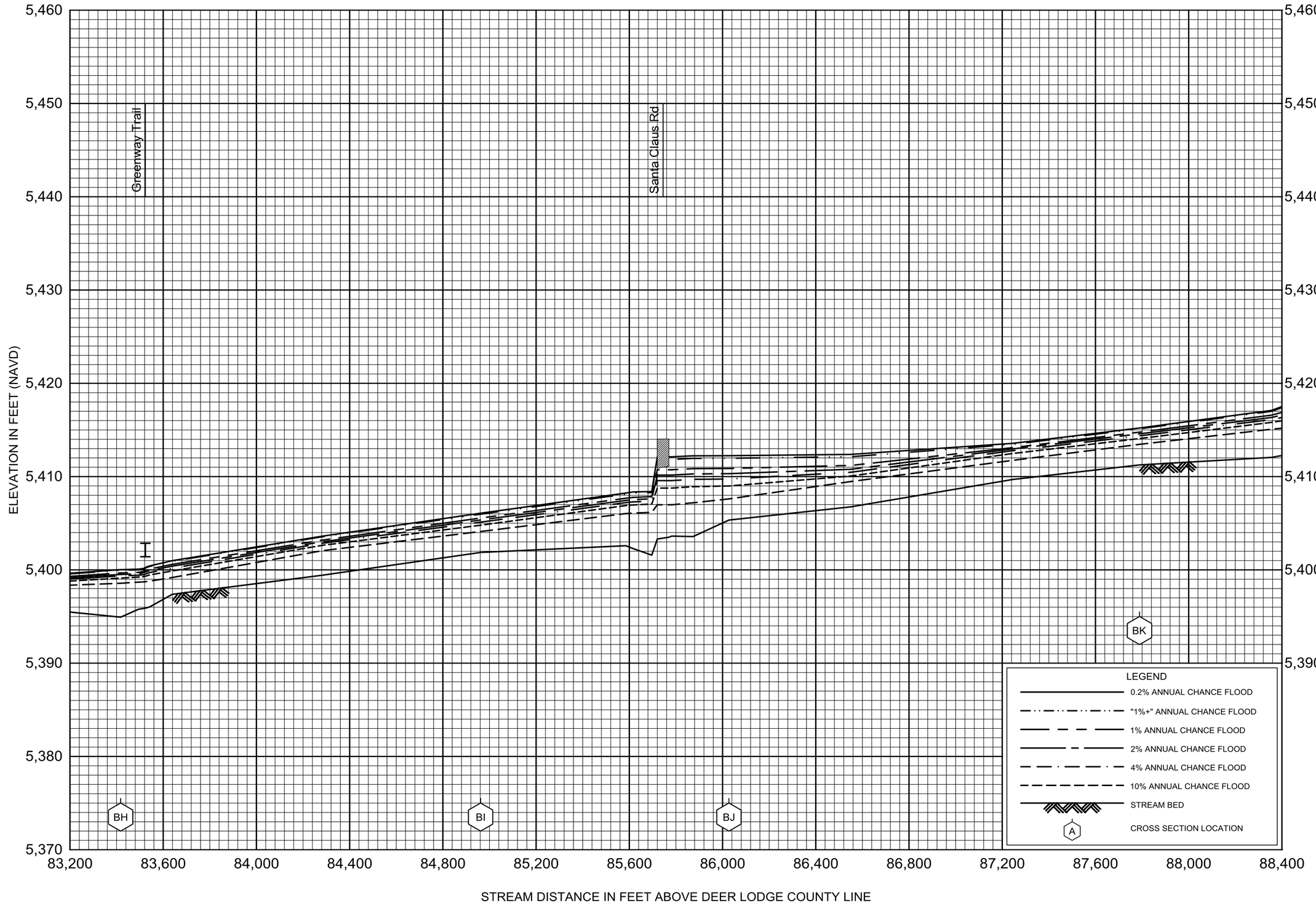
FLOOD PROFILES

SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)



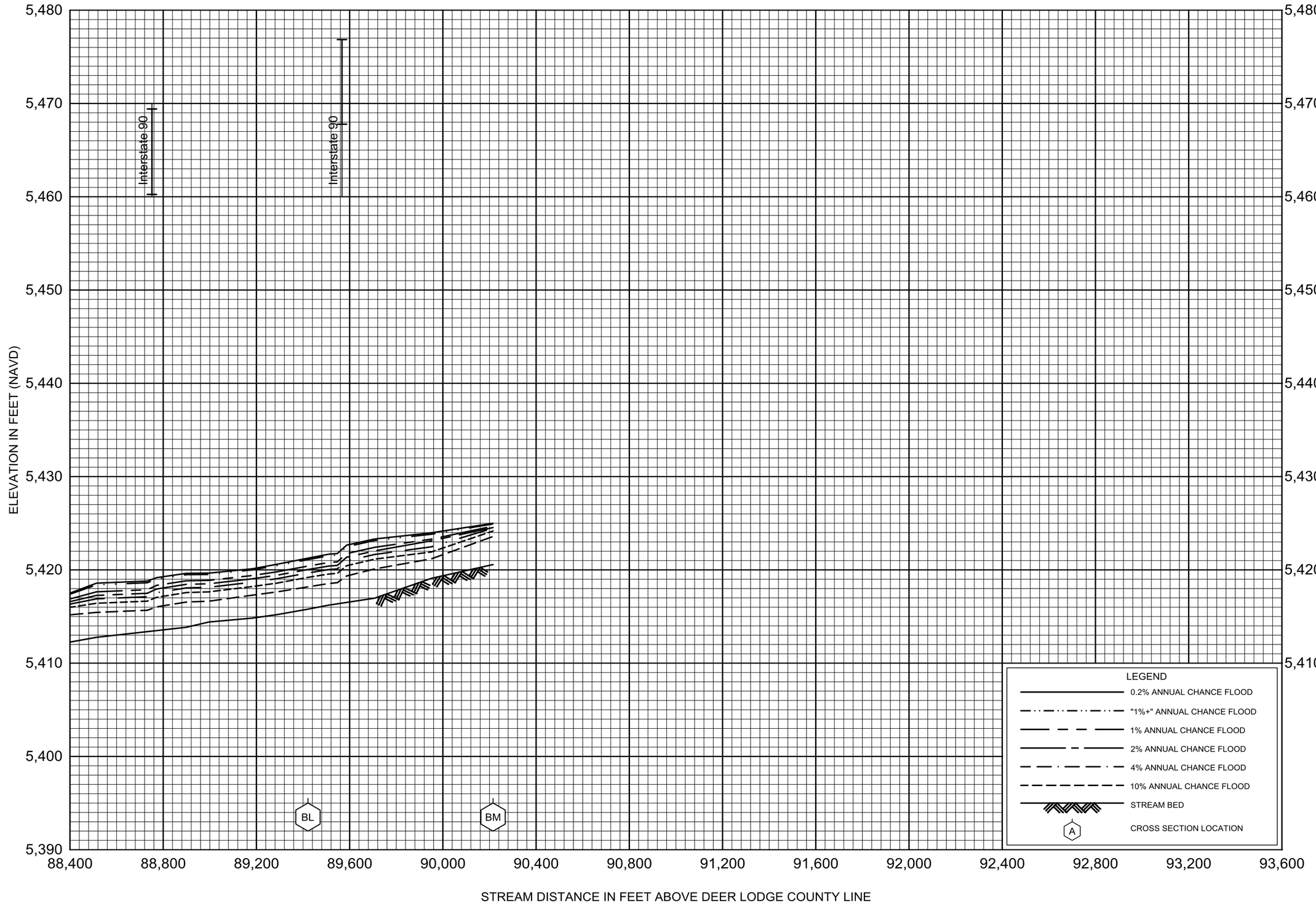
FLOOD PROFILES

SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)



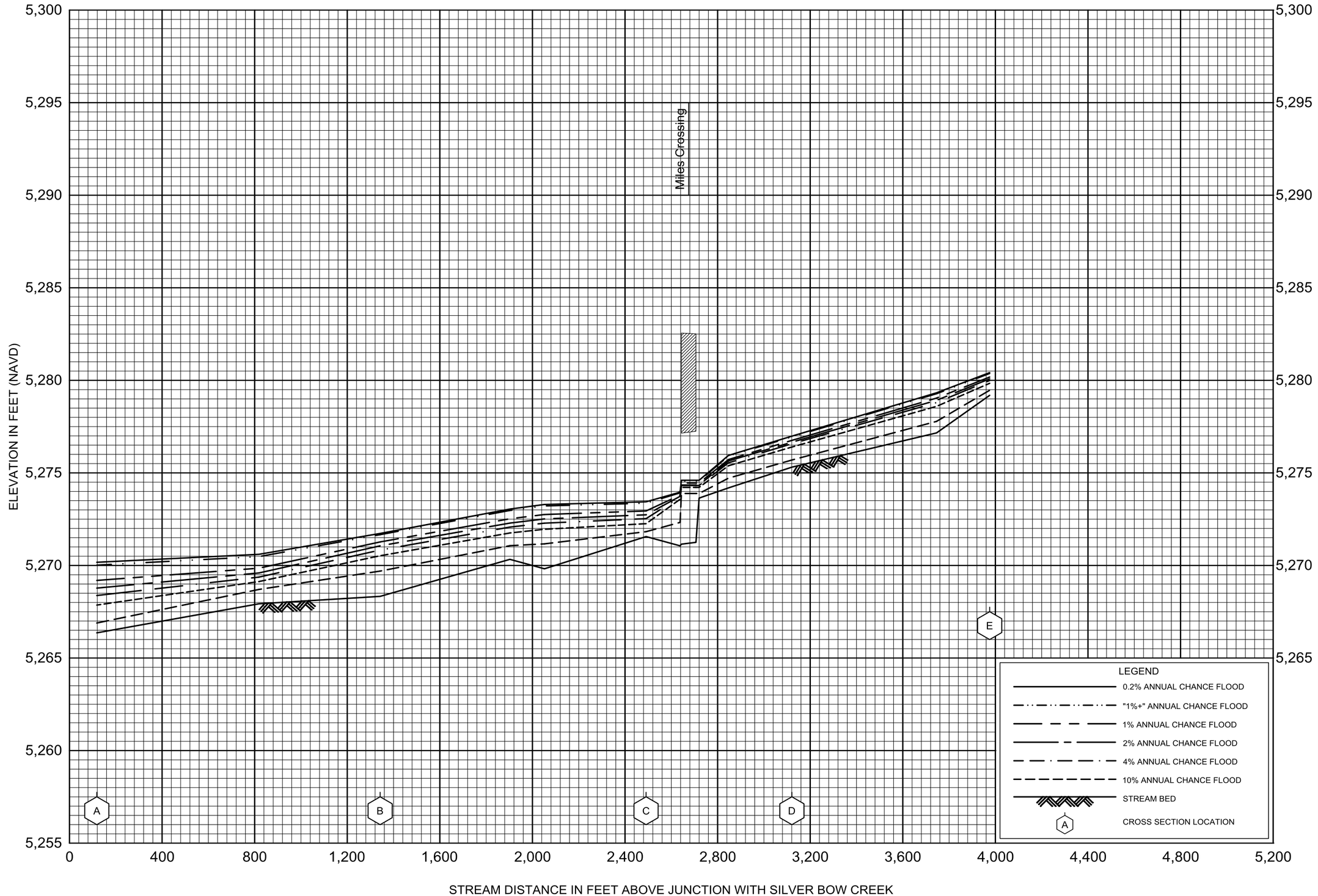
FLOOD PROFILES

SILVER BOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)



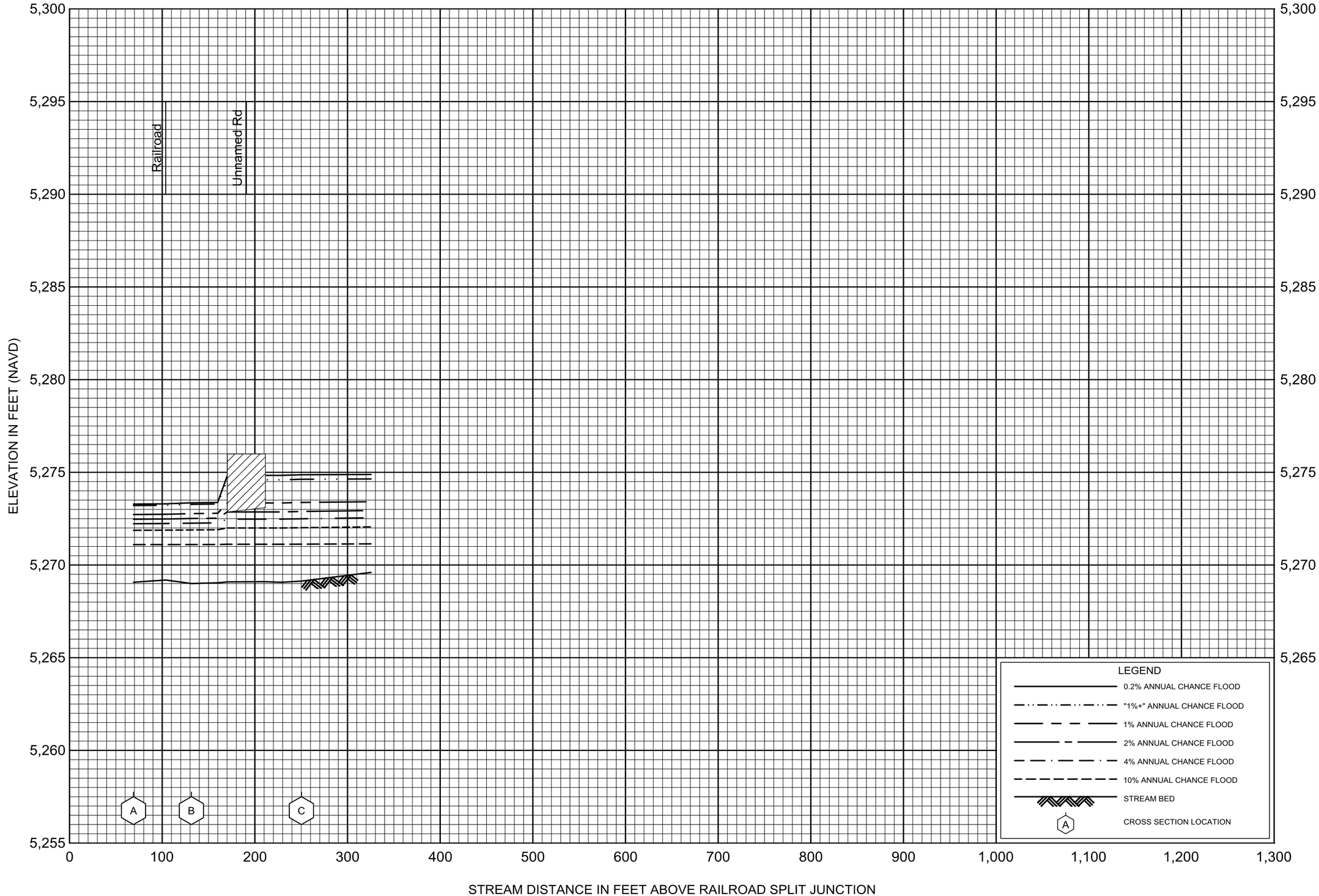
FLOOD PROFILES

RAILROAD SPLIT

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)



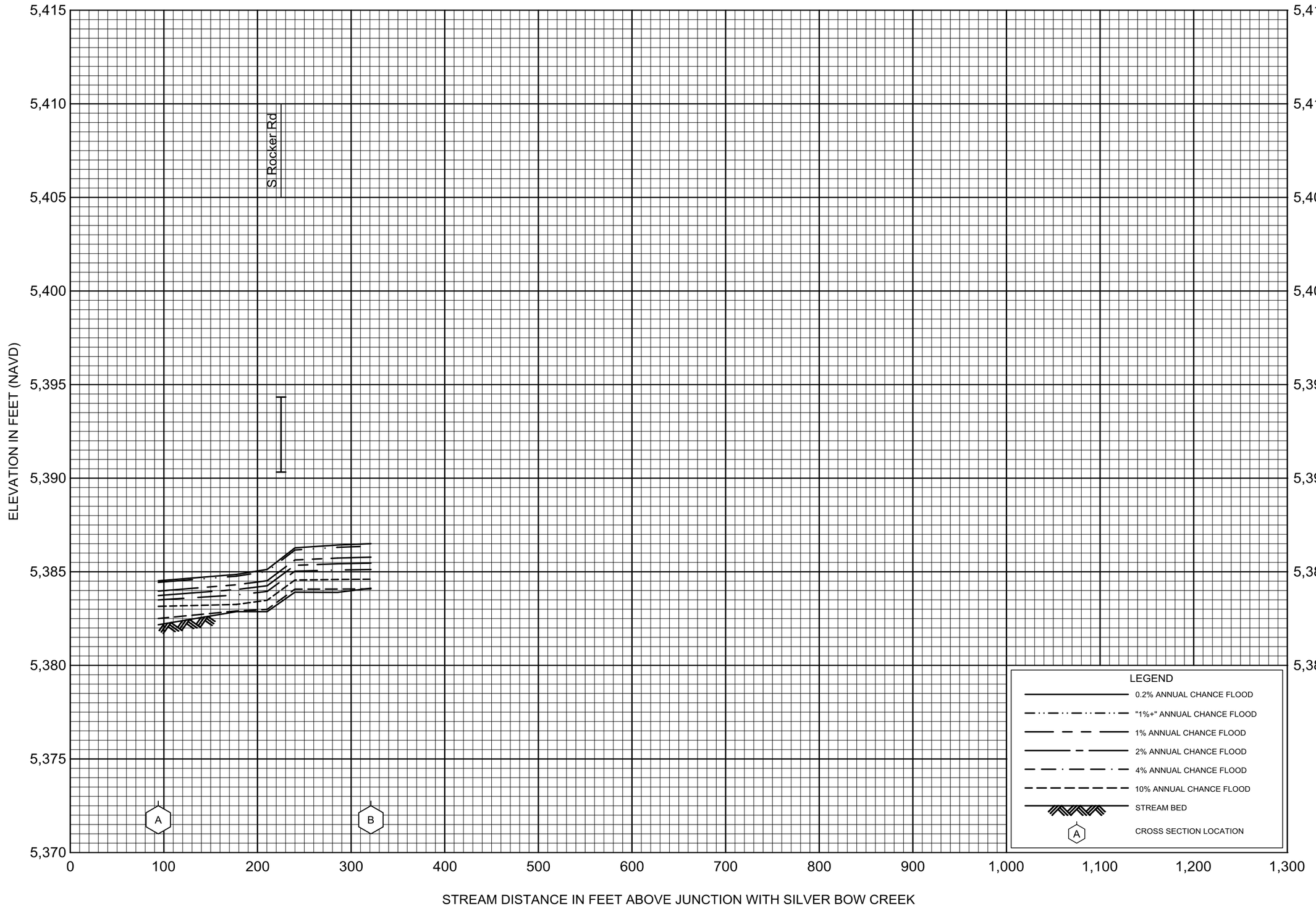
FLOOD PROFILES

MILES CROSSING SPLIT

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)



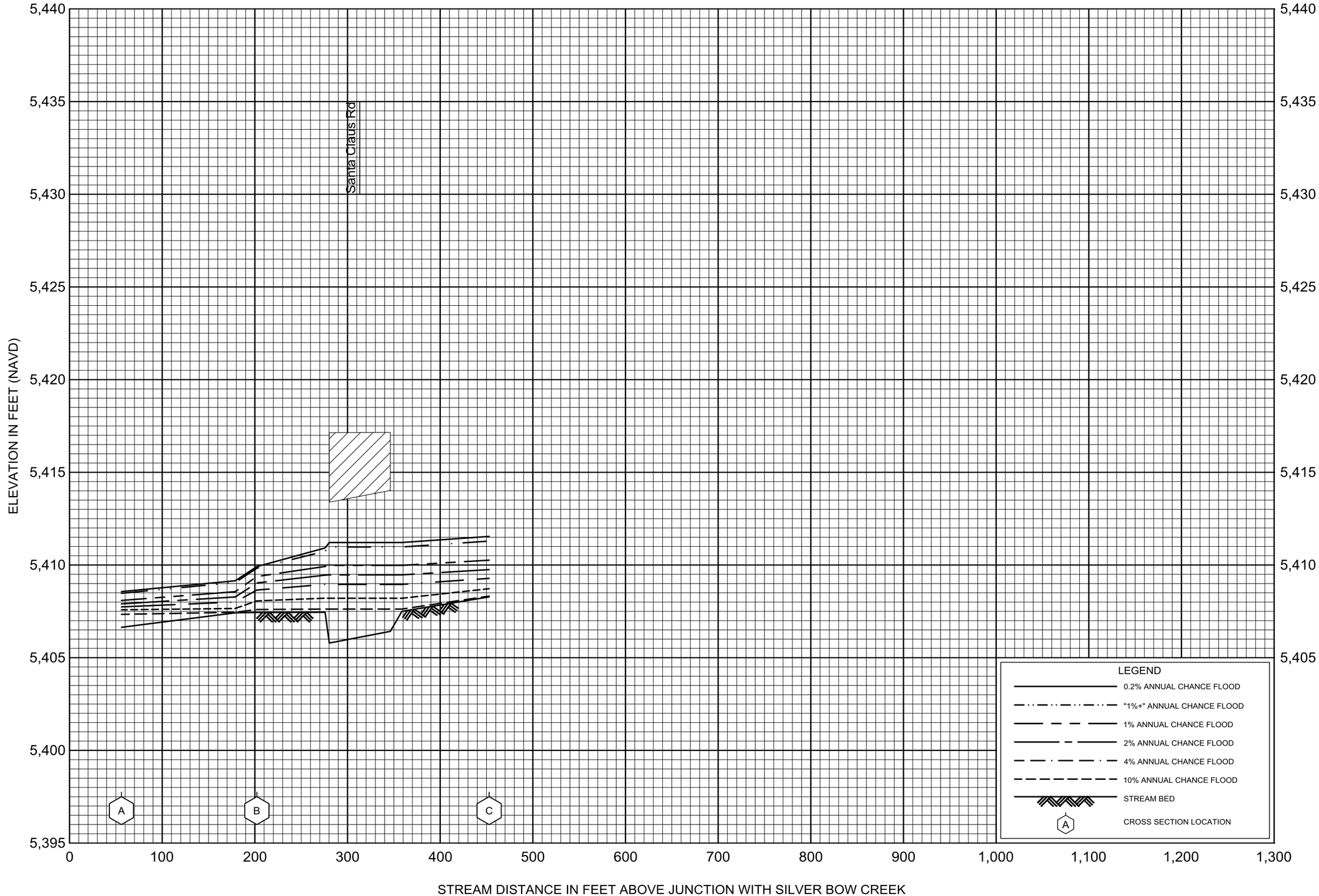
FLOOD PROFILES

SOUTH ROCKER RD SPLIT

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)



FLOOD PROFILES

SANTA CLAUS RD SPLIT

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

Appendix C Floodway Data Tables

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	774	222	433	3.5	5,078.5	5,078.5	5,079.0	0.5
B	1,996	236	301	5.1	5,084.8	5,084.8	5,085.3	0.5
C	3,304	393	710	2.2	5,093.4	5,093.4	5,093.4	0.0
D	4,758	57	198	7.8	5,102.1	5,102.1	5,102.4	0.3
E	6,136	110	243	6.3	5,110.4	5,110.4	5,110.5	0.1
F	6,792	70	188	8.2	5,115.0	5,115.0	5,115.0	0.0

[1] Feet above Deer Lodge County Border.

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

FLOODWAY DATA

FLOODING SOURCE: SILVER BOW CREEK

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AL	50,997	551	549	1.5	5,303.3	5,303.3	5,303.5	0.2
AM	52,168	147	355	2.4	5,306.7	5,306.7	5,307.1	0.4
AN	53,469	225	493	1.7	5,309.1	5,309.1	5,309.6	0.5
AO	55,902	123	344	2.5	5,314.5	5,314.5	5,314.9	0.4

[1] Feet above Deer Lodge County Border

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

FLOODWAY DATA

FLOODING SOURCE: SILVER BOW CREEK

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AW	66,531	43	132	4.7	5,348.5	5,348.5	5,348.5	0.0
AX	68,086	53	227	2.7	5,352.9	5,352.9	5,353.3	0.4
AY	70,345	319	493	1.3	5,357.9	5,357.9	5,358.2	0.3
AZ	71,345	42	177	3.5	5,361.7	5,361.7	5,361.9	0.2
BA	72,420	89	217	2.9	5,364.6	5,364.6	5,364.9	0.3
BB	75,786	66	203	3.0	5,374.5	5,374.5	5,374.9	0.4
BC	76,850	52	184	3.3	5,378.5	5,378.5	5,378.8	0.3
BD	78,396	56	193	2.5	5,383.4	5,383.4	5,383.9	0.5
BE	79,558	203	283	2.1	5,387.3	5,387.3	5,387.4	0.1

[1] Feet above Deer Lodge County Border.

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

FLOODWAY DATA

FLOODING SOURCE: SILVER BOW CREEK

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	94	52	93	1.3	5,384.0	5,384.0	5,384.5	0.5
B	321	40	67	1.8	5,385.7	5,385.7	5,385.9	0.2

[1] Feet above Junction with Silver Bow Creek.

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

SILVER BOW COUNTY, MT

(ALL JURISDICTIONS)

FLOODWAY DATA

FLOODING SOURCE: SOUTH ROCKER RD SPLIT

Appendix D Study Area Photographs

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 1
	Date: 8/20/2018
	Description: Bridge 1 - Greenway Trail Pedestrian Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 2
	Date: 8/20/2018
	Description: Bridge 2 - Highway Bridge – Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 3
	Date: 8/20/2018
	Description: Bridge 3 - Concrete Fish Barrier - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 4
	Date: 10/10/2018
	Description: Bridge 4 - Pedestrian Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 5
	Date: 10/10/2018
	Description: Bridge 5 - Railroad Bridge - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 6
	Date: 10/25/2018
	Description: Bridge 6 - Pipeline Crossing - Facing Southwest
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 7
	Date: 10/10/2018
	Description: Bridge 7A - Railroad Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 8
	Date: 10/10/2018
	Description: Bridge 7B - Railroad Bridge - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 9
	Date: 10/10/2018
	Description: Bridge 8 - Railroad Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 10
	Date: 10/10/2018
	Description: Bridge 9 - Railroad Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 11
	Date: 10/10/2018
	Description: Bridge 10 - CMP Culverts - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 12
	Date: 10/10/2018
	Description: Bridge 11 - CMP Culverts - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 13
	Date: 9/24/2018
	Description: Bridge 12 - Vehicle Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 14
	Date: 9/24/2018
	Description: Bridge 13 - Railroad Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 15
	Date: 10/25/2018
	Description: Bridge 14 - Railroad Bridge - Facing Northeast
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 16
	Date: 9/24/2018
	Description: Bridge 15 - Railroad Bridge - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 17
	Date: 9/24/2018
	Description: Bridge 16 - Concrete Culverts - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 18
	Date: 9/24/2018
	Description: Bridge 17 - Greenway Trail Vehicle Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 19
	Date: 9/24/2018
	Description: Bridge 18 -CMP Culverts - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 20
	Date: 9/24/2018
	Description: Bridge 19 - Railroad Bridge - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 21
	Date: 9/24/2018
	Description: Bridge 20 - Railroad Bridge - Facing East
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 22
	Date: 9/24/2018
	Description: Bridge 21 - CMP Culverts - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 23
	Date: 9/24/2018
	Description: Bridge 22 - Railroad Bridge - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 24
	Date: 9/26/2018
	Description: Bridge 23 - Vehicle Bridge - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 25
	Date: 9/26/2018
	Description: Bridge 24 - Railroad Bridge - Facing Southwest
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 26
	Date: 9/26/2018
	Description: Bridge 25 - Greenway Trail Pedestrian Bridge - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 27
	Date: 9/26/2018
	Description: Bridge 26 - Greenway Trail Pedestrian Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 28
	Date: 9/26/2018
	Description: Bridge 27 - Railroad Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 29
	Date: 9/26/2018
	Description: Bridge 28 - Vehicle Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 30
	Date: 9/28/2018
	Description: Bridge 29 - Vehicle Bridge - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 31
	Date: 9/28/2018
	Description: Bridge 30 - East and Westbound Interstate 15 Bridges - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 32
	Date: 9/26/2018
	Description: Bridge 31 - Greenway Trail Pedestrian Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 33
	Date: 9/26/2018
	Description: Bridge 32 - Railroad Bridge - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 34
	Date: 9/26/2018
	Description: Bridge 33 - Greenway Trail Pedestrian Bridge - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 35
	Date: 9/26/2018
	Description: Bridge 34 - Greenway Trail Pedestrian Bridge - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 36
	Date: 9/26/2018
	Description: Bridge 35 - Railroad Bridge - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 37
	Date: 9/26/2018
	Description: Bridge 36 - CMP Arch Culvert - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 38
	Date: 9/26/2018
	Description: Bridge 37 - Greenway Trail Pedestrian Bridge - Facing South
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 39
	Date: 9/26/2018
	Description: Bridge 38 - Greenway Trail Pedestrian Bridge - Facing East
	Project: Silver Bow Creek Hydraulic Analysis

	Photo Number: 40
	Date: 9/26/2018
	Description: Bridge 39 - CMP Arch Culvert - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 41
	Date: 9/28/2018
	Description: Bridge 41 - Flume Crossing - Facing West
	Project: Silver Bow Creek Hydraulic Analysis

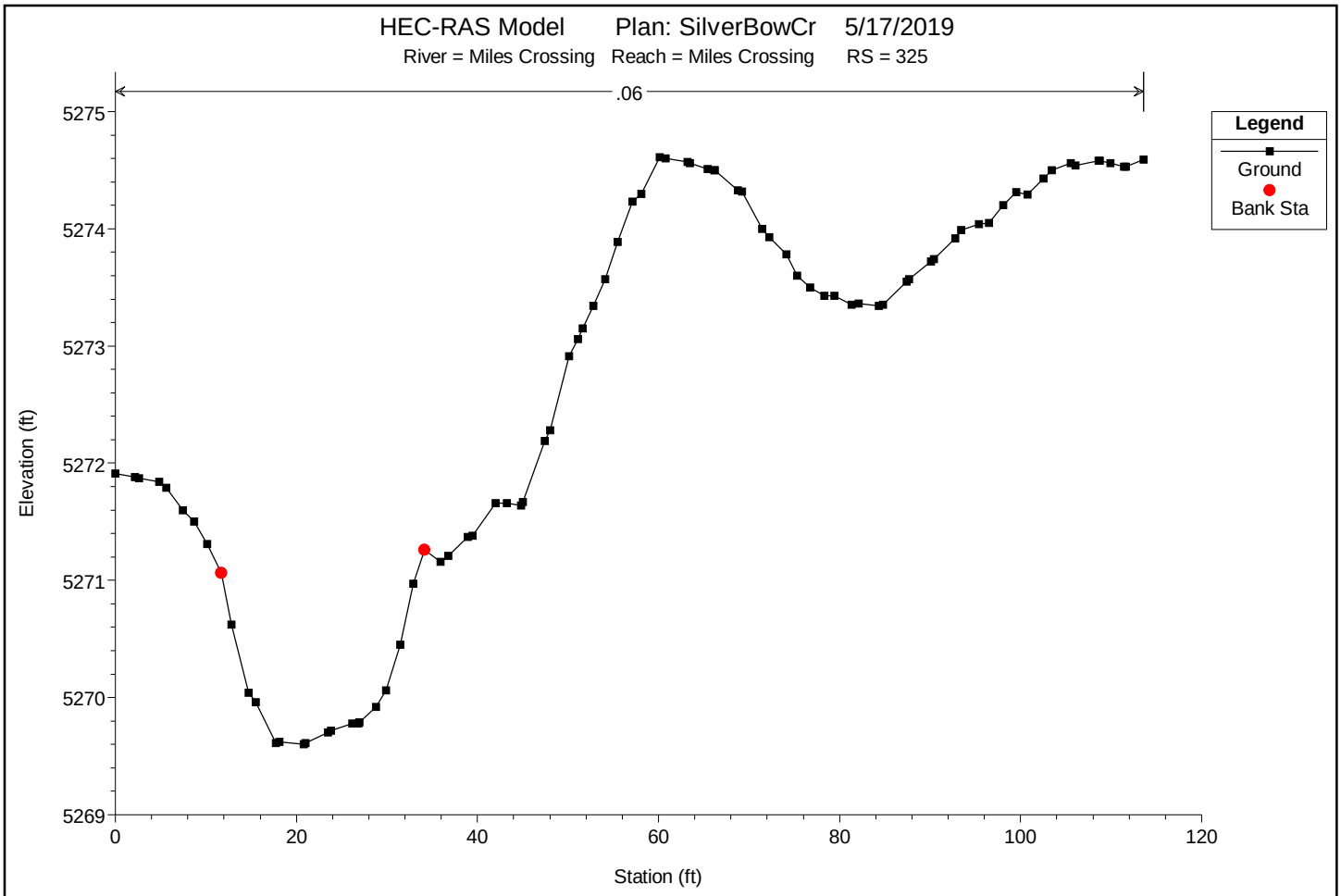
	Photo Number: 42
	Date: 9/28/2018
	Description: Bridge 42 - Flume Crossing - Facing Downstream
	Project: Silver Bow Creek Hydraulic Analysis

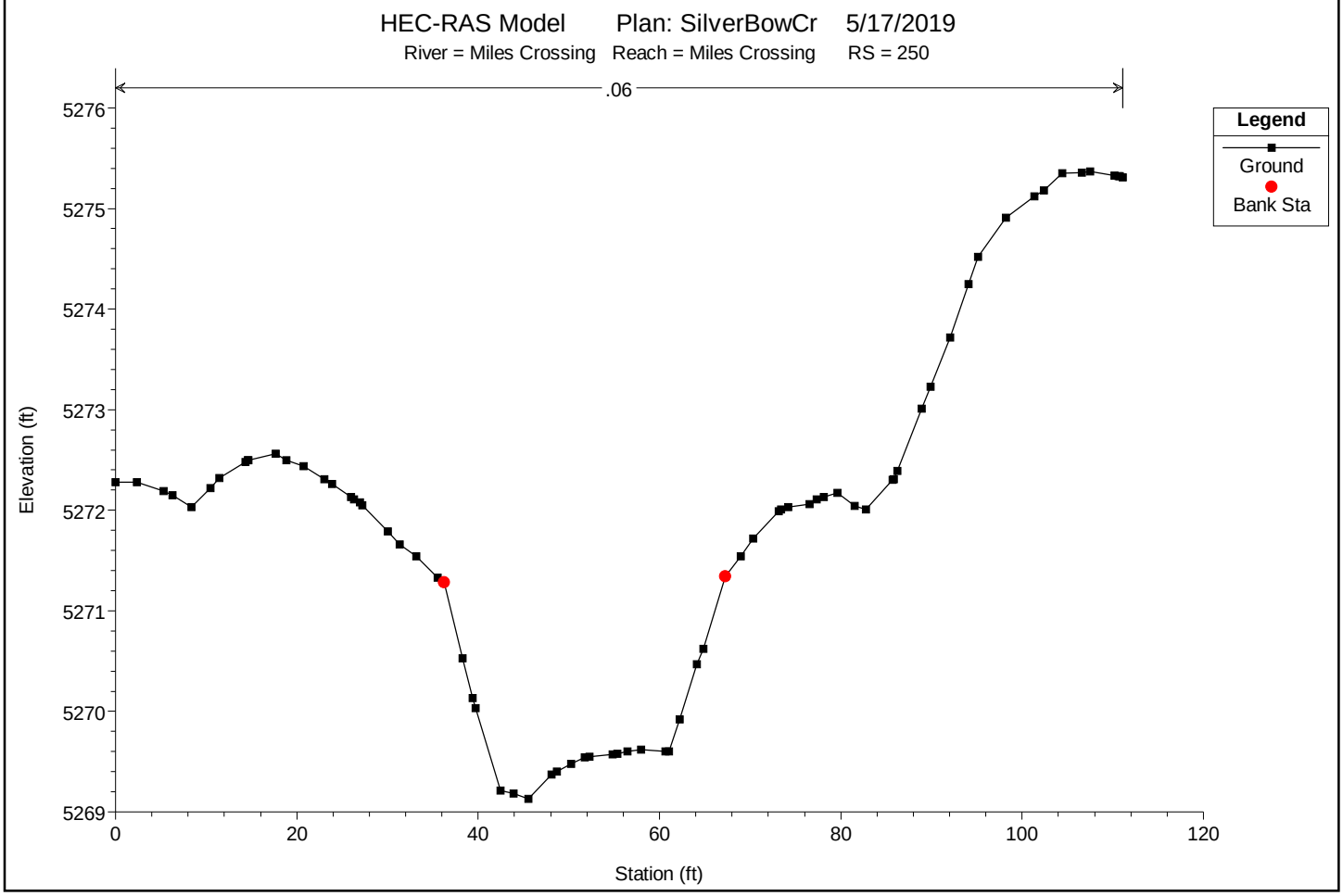
PIONEER TECHNICAL SERVICES, INC.	Photo Number: 43
	Date: 9/26/2018
	Description: C4 - Secondary Culvert - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 44
	Date: 10/4/2018
	Description: Bridge 36b - Secondary Opening - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

PIONEER TECHNICAL SERVICES, INC.	Photo Number: 45
	Date: 10/4/2018
	Description: Bridge 39b - Secondary Culvert - Facing Upstream
	Project: Silver Bow Creek Hydraulic Analysis

Appendix E Modeled Cross Sections





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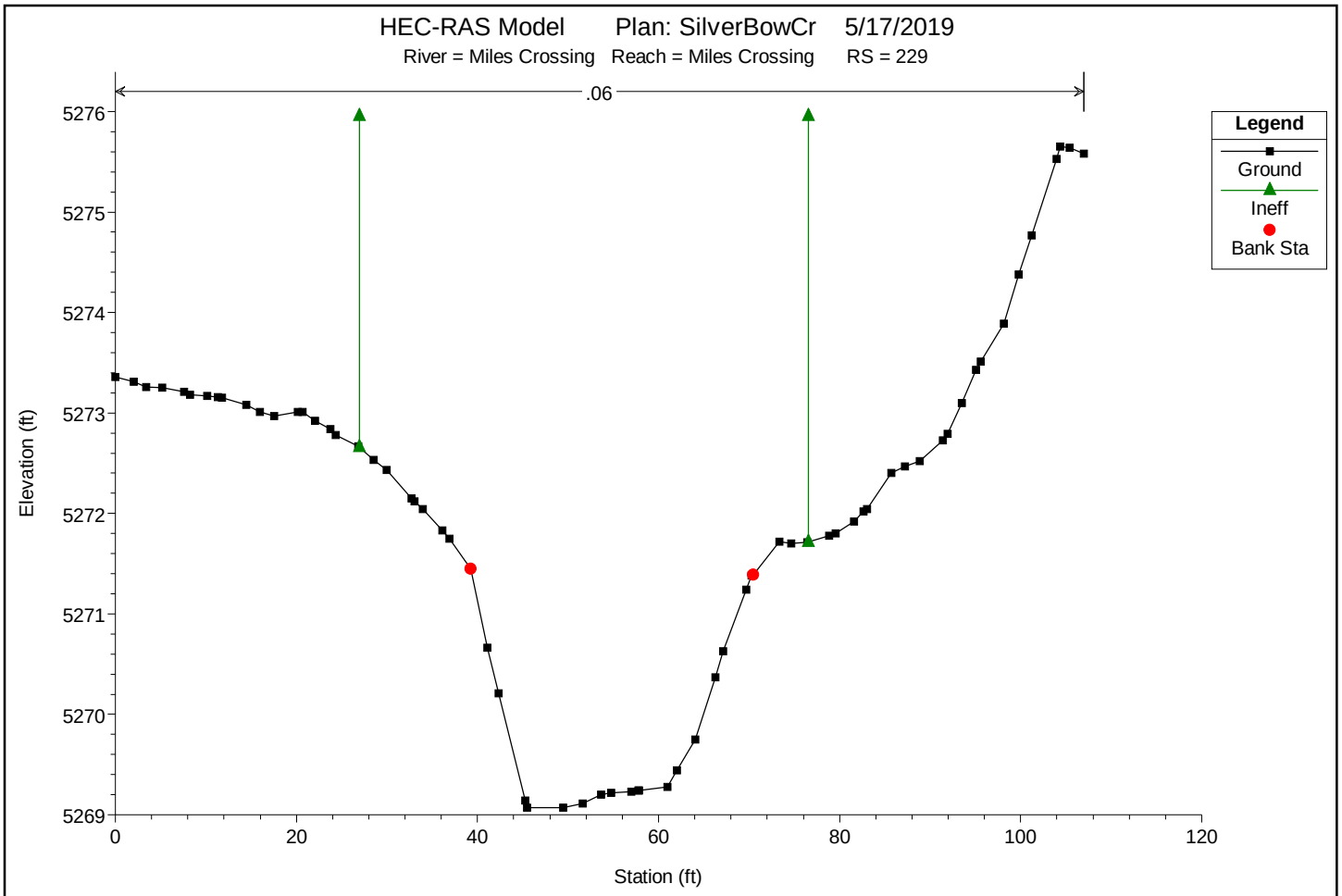

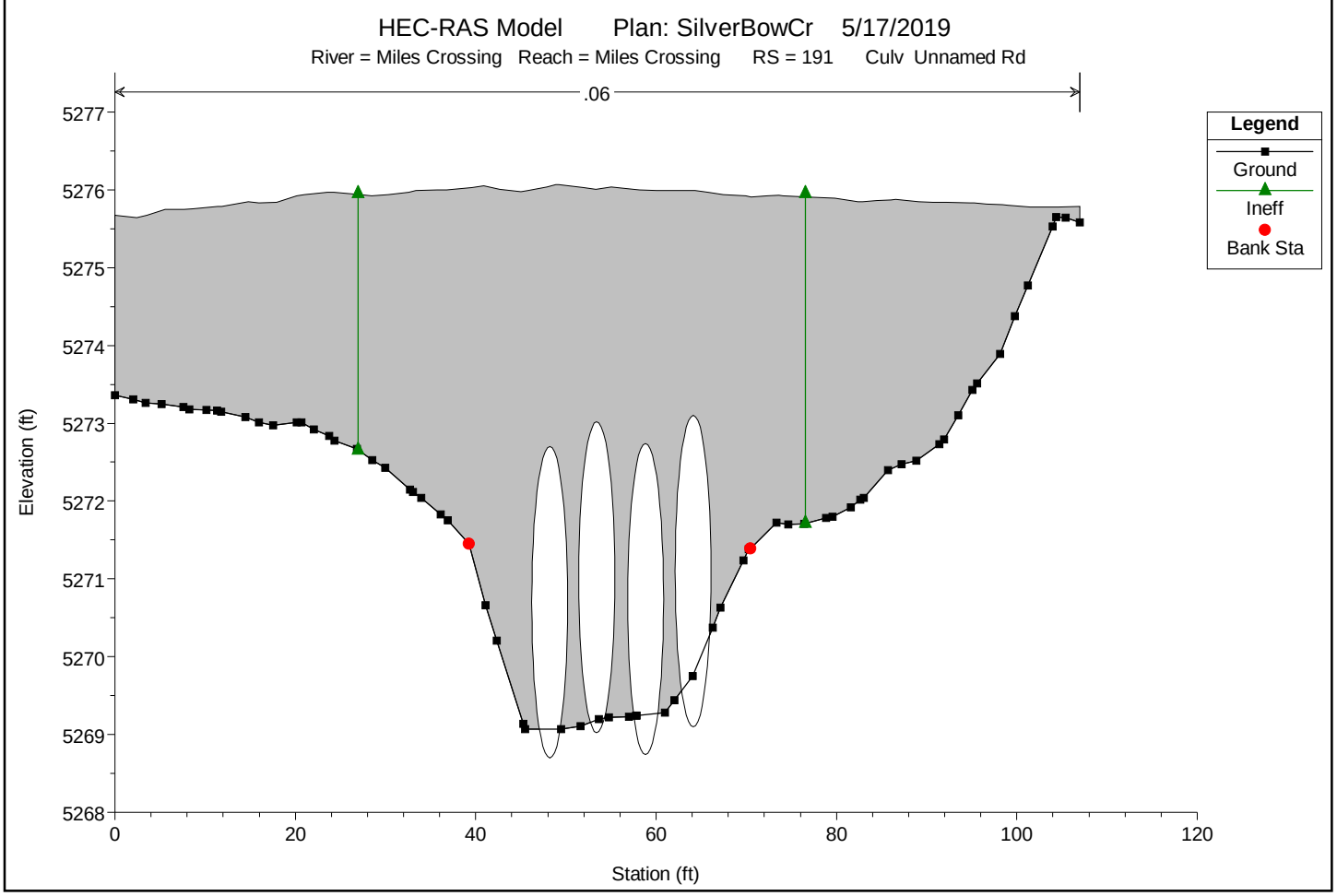

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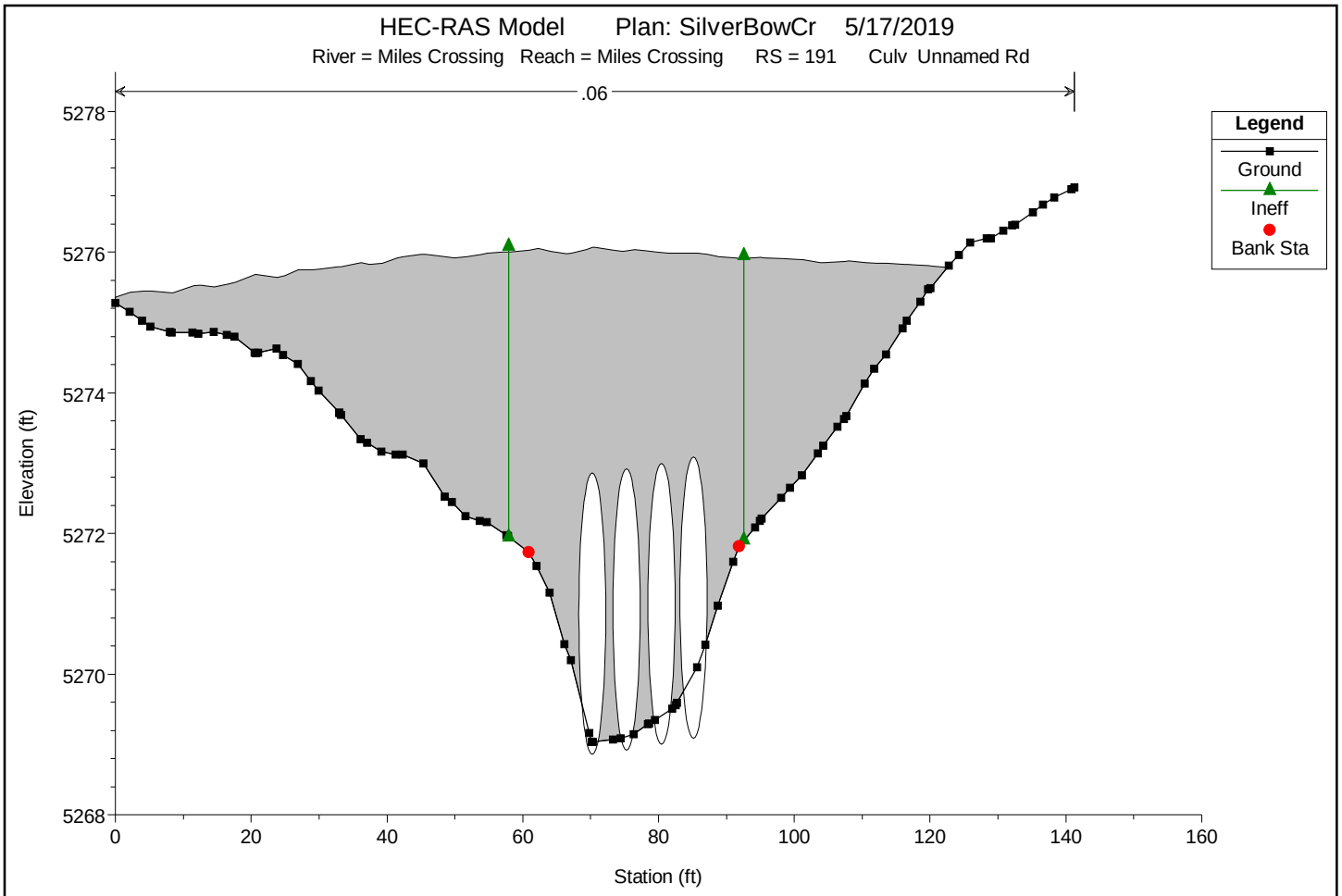

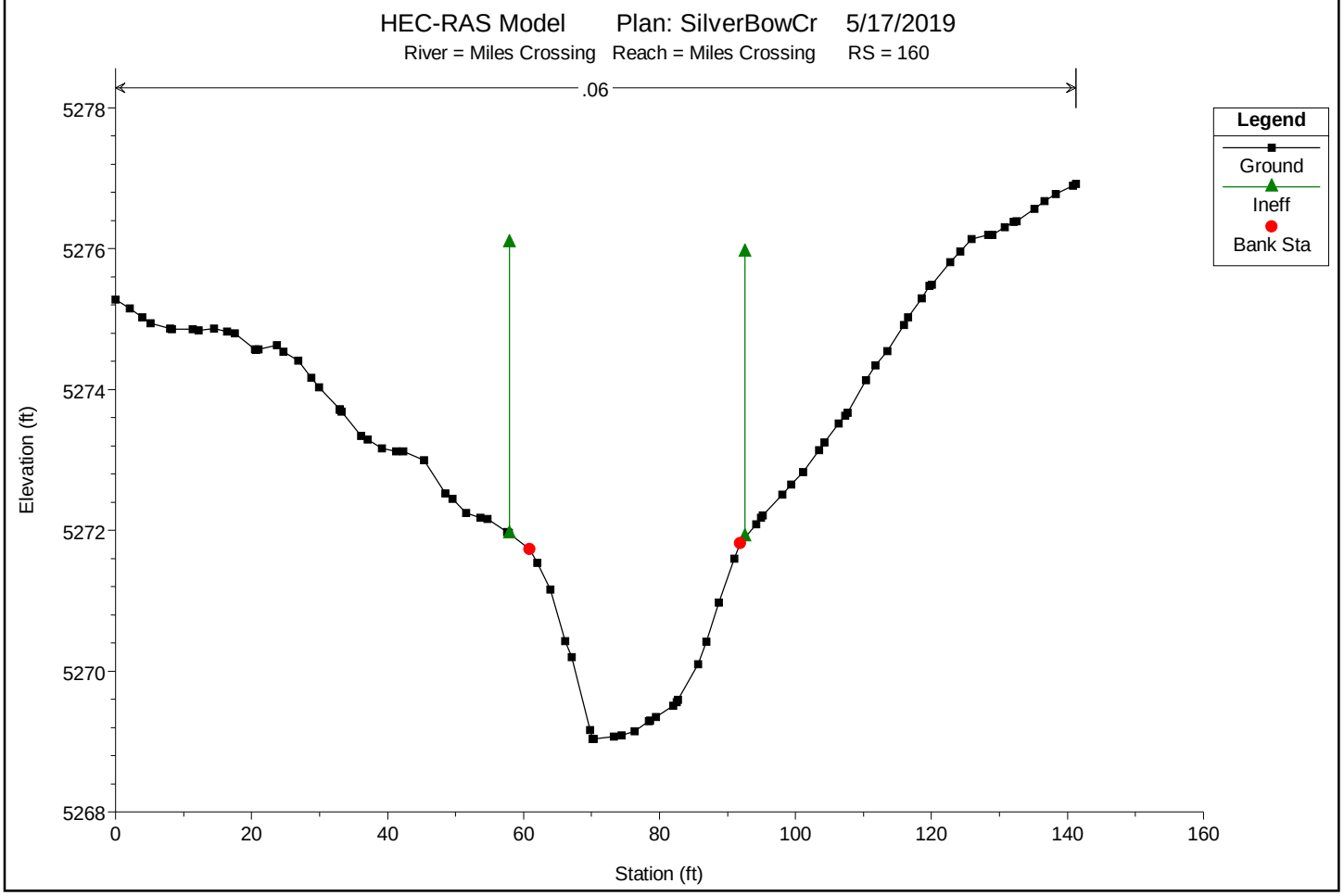

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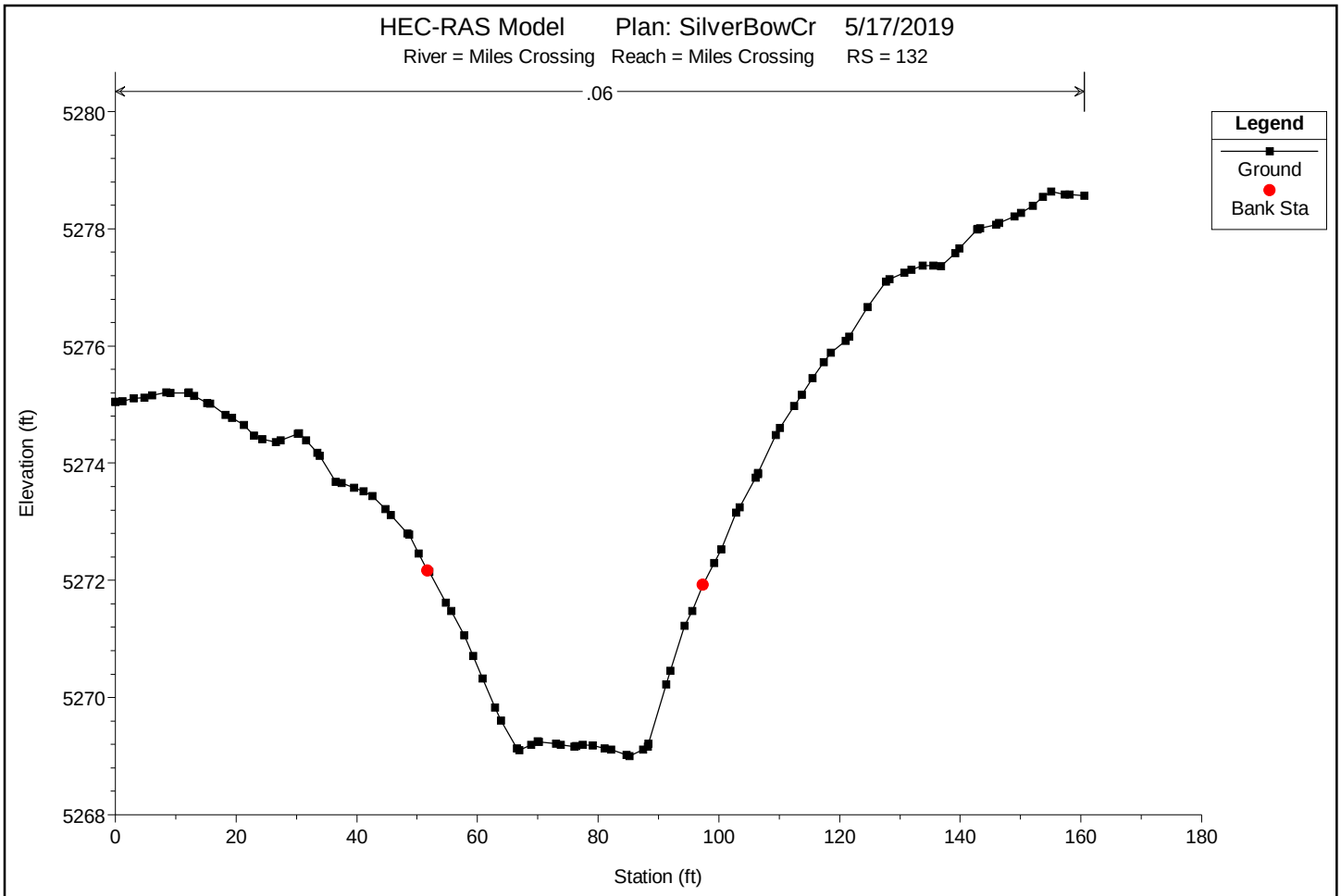

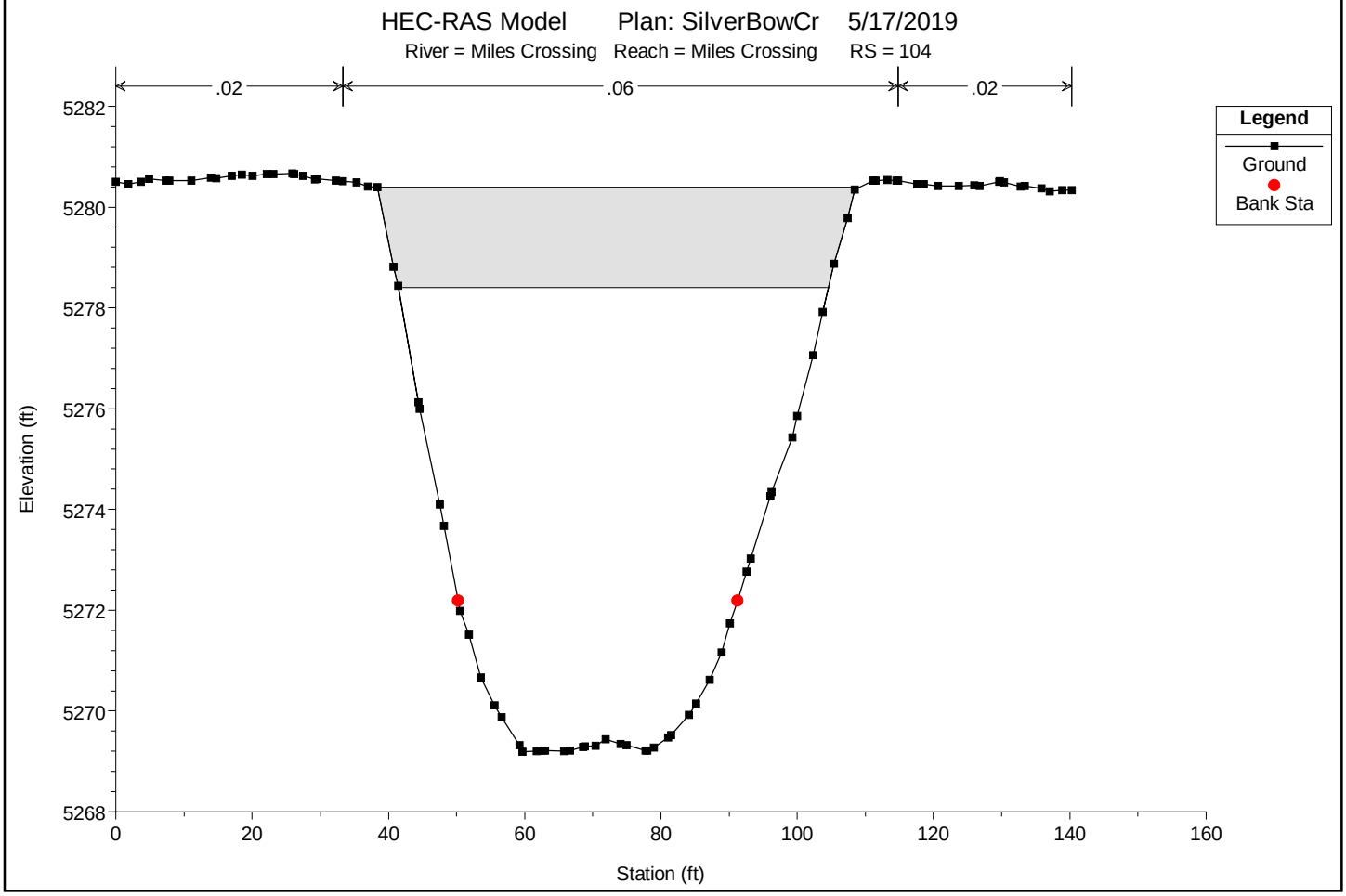

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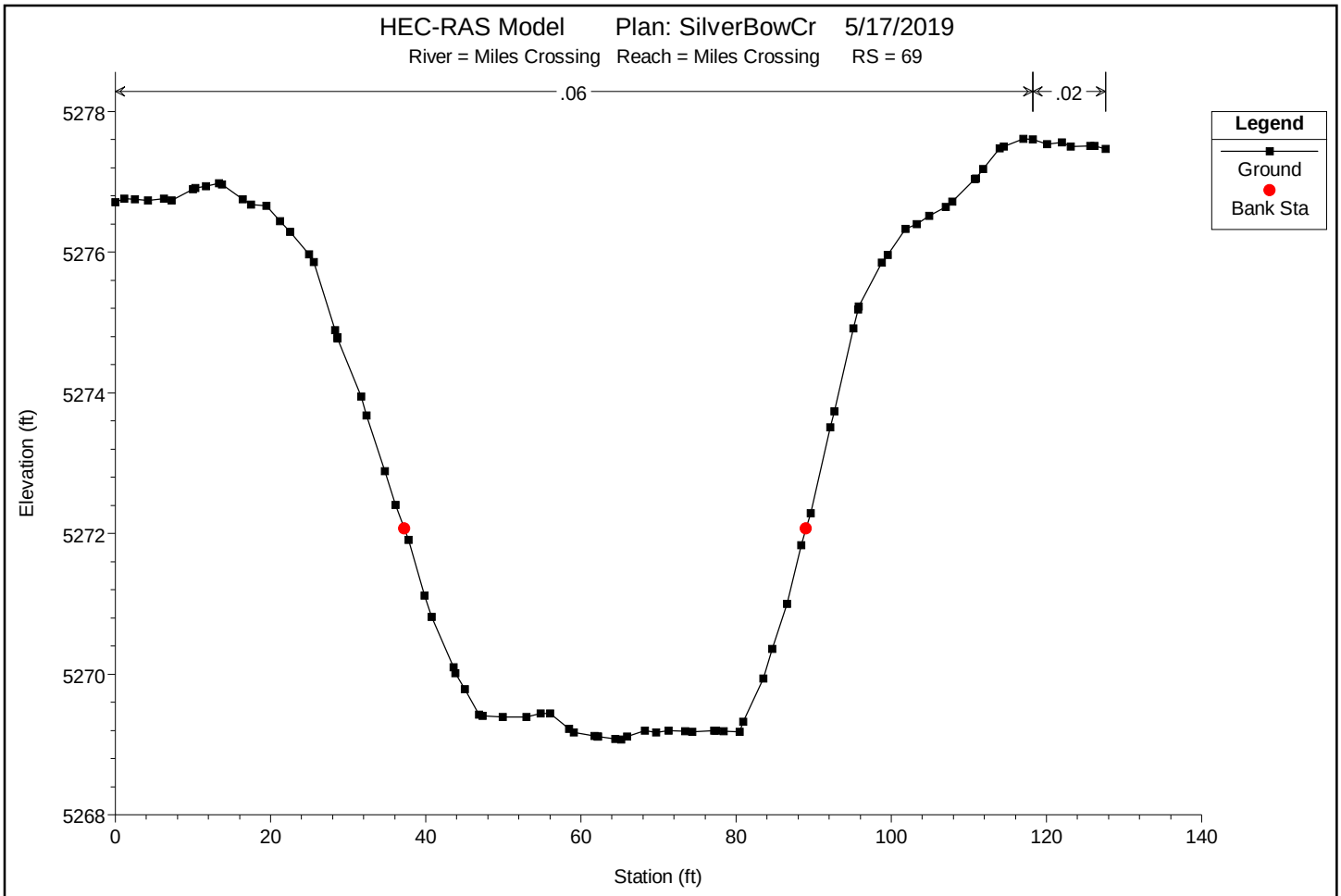

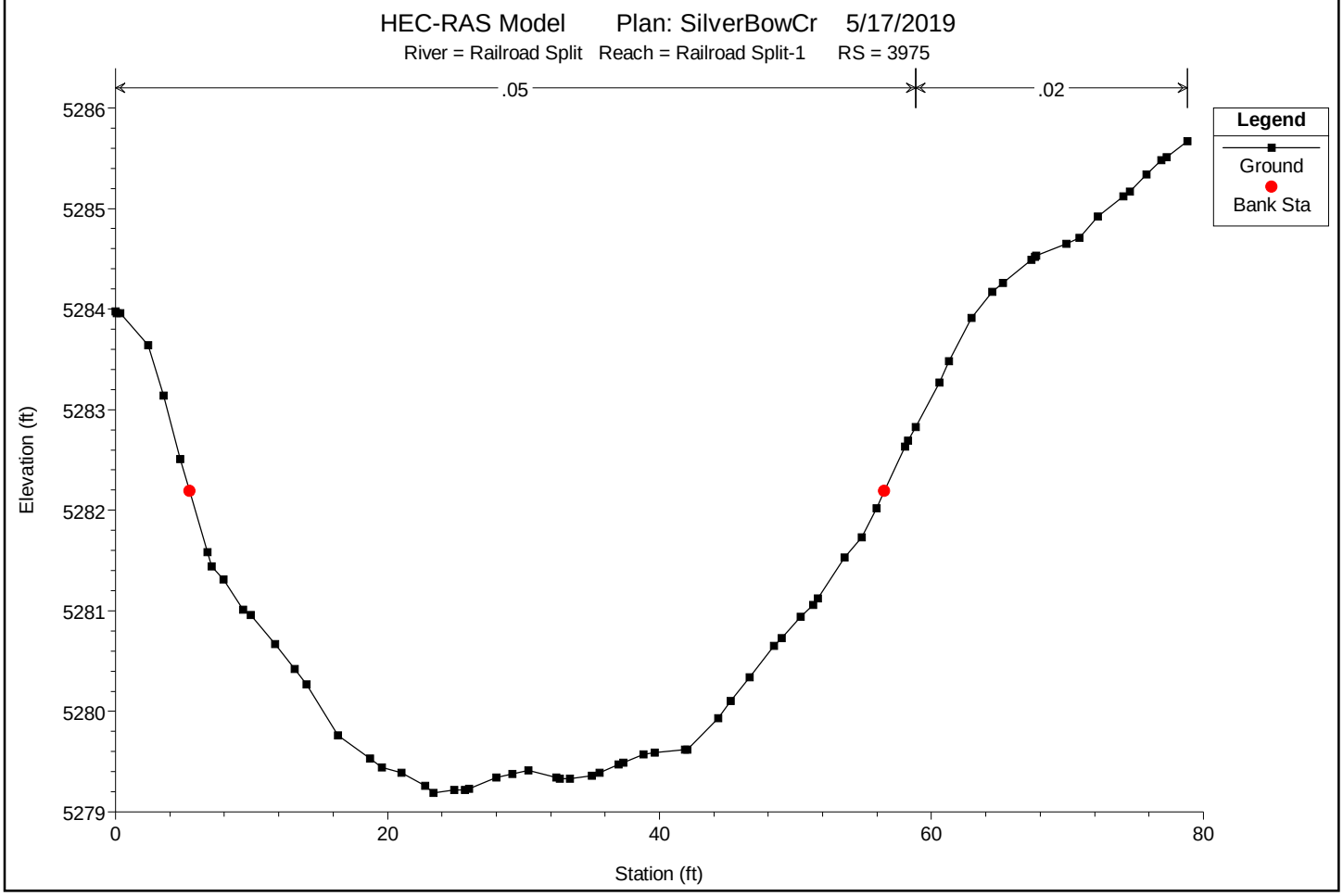

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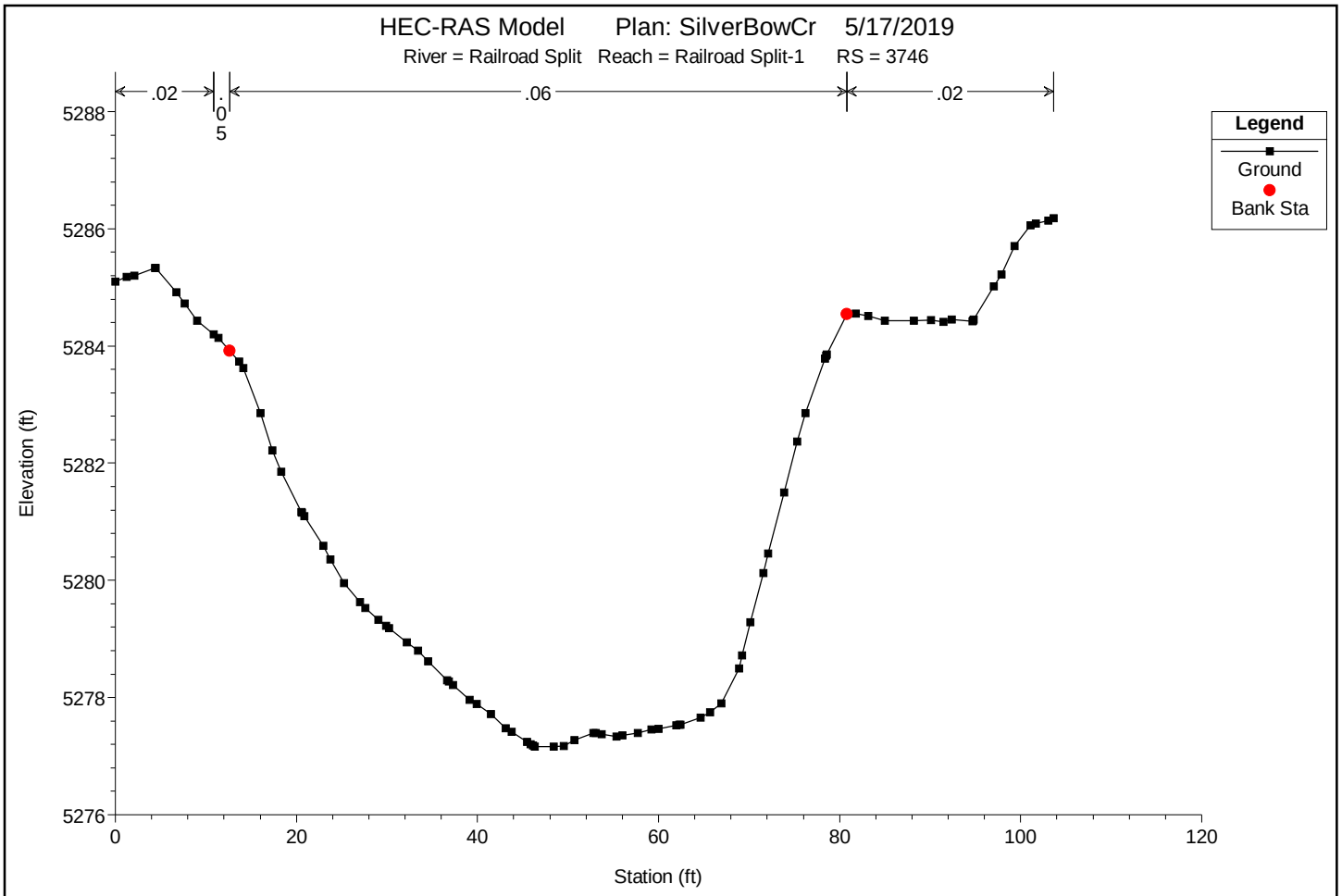

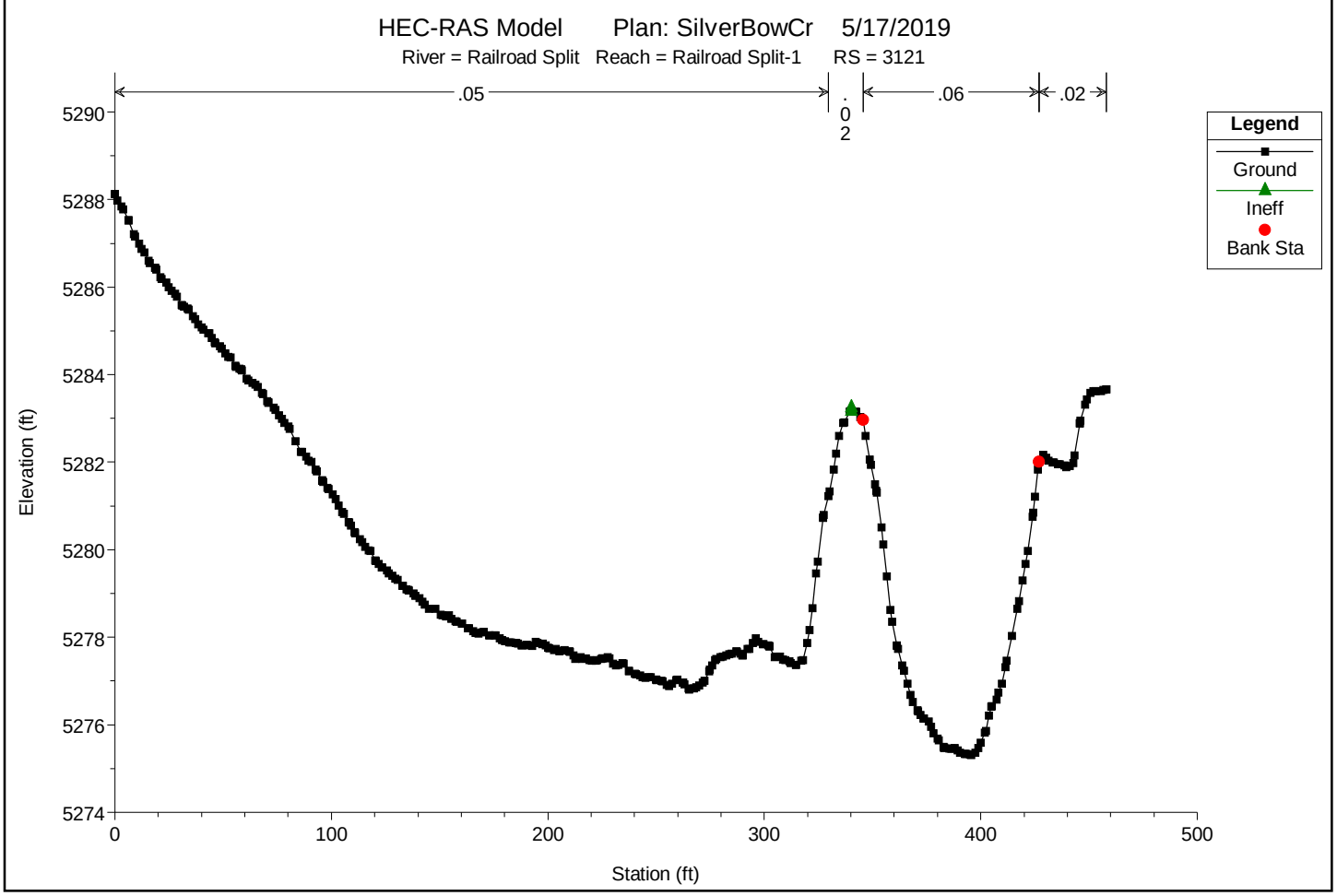

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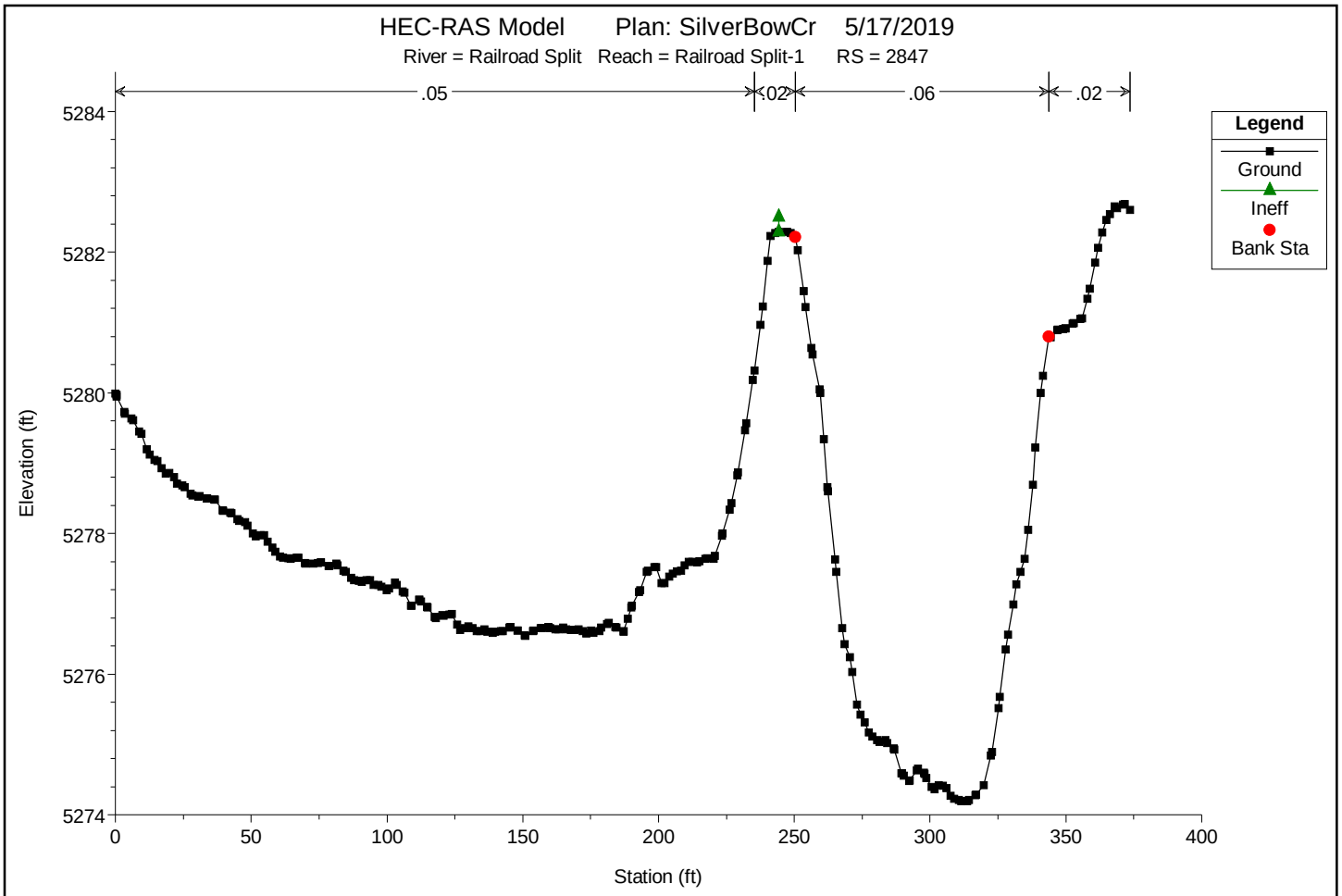

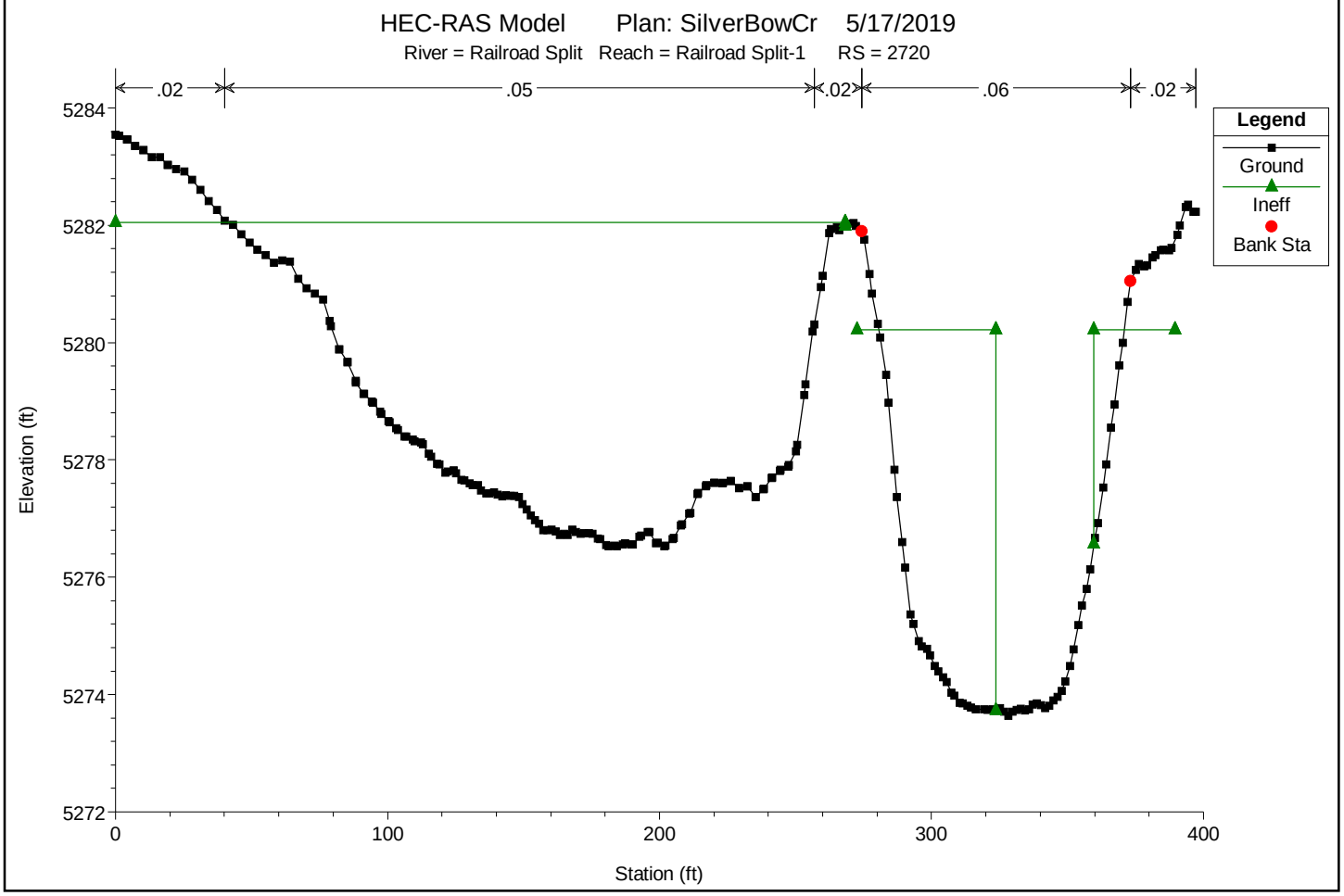

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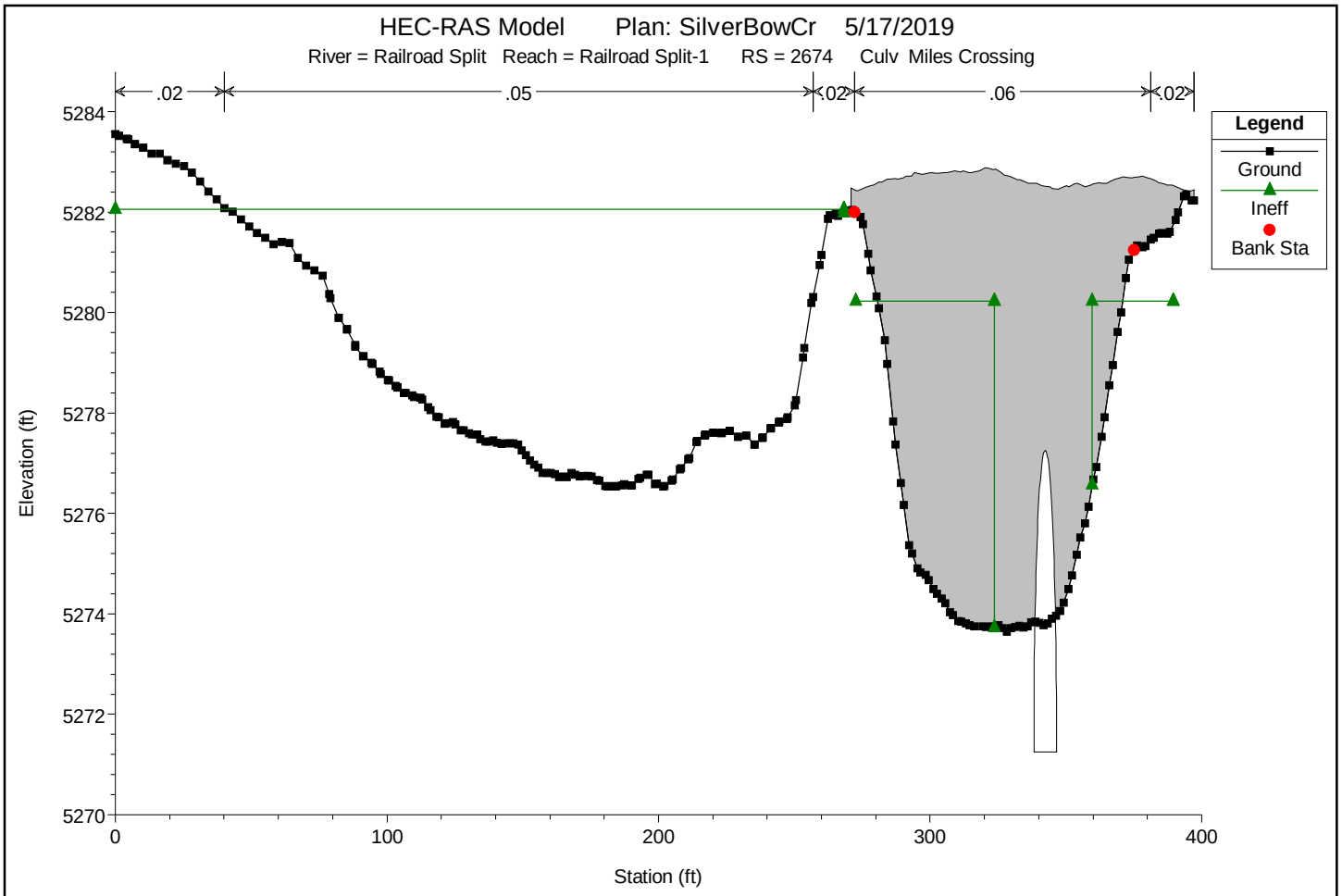

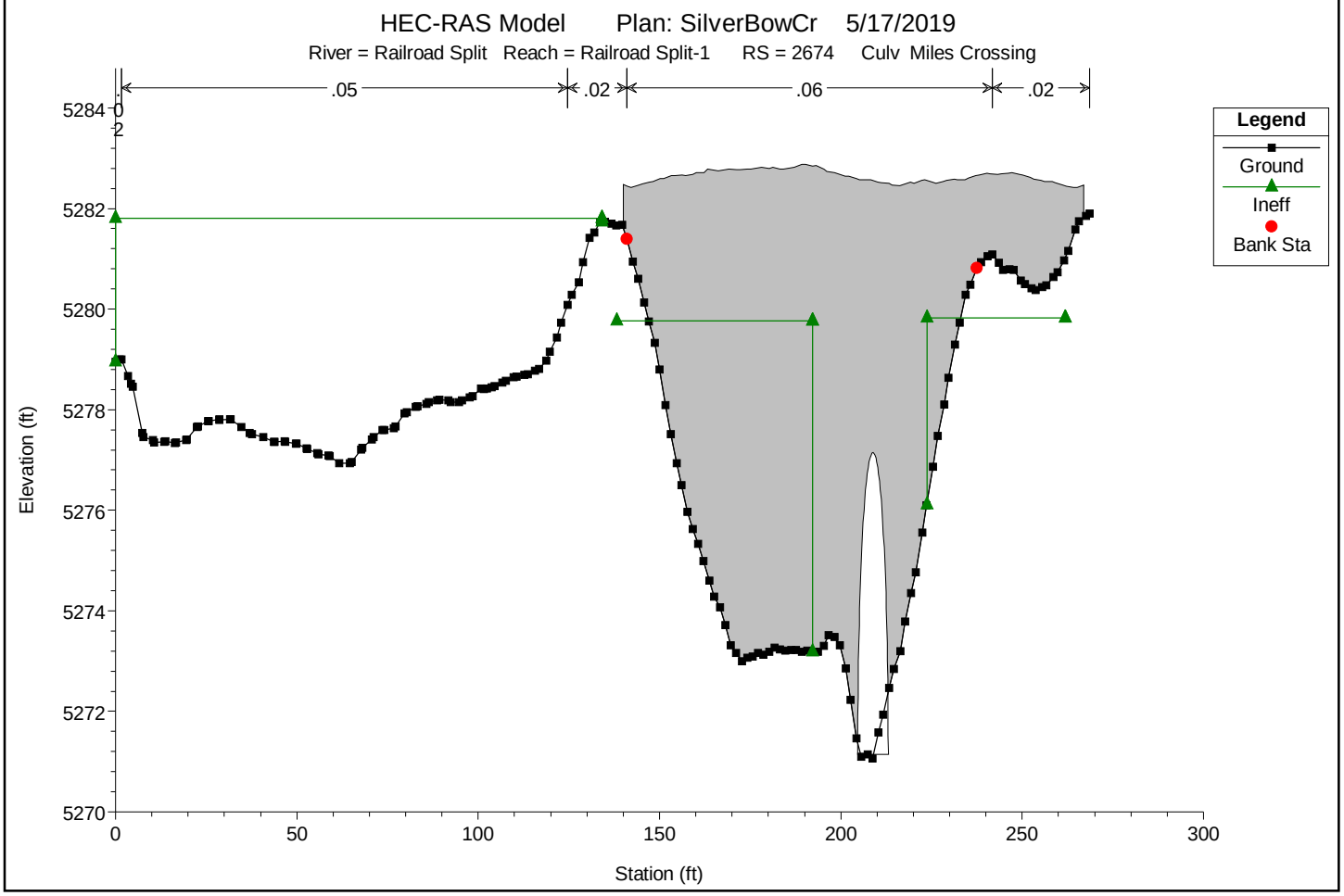

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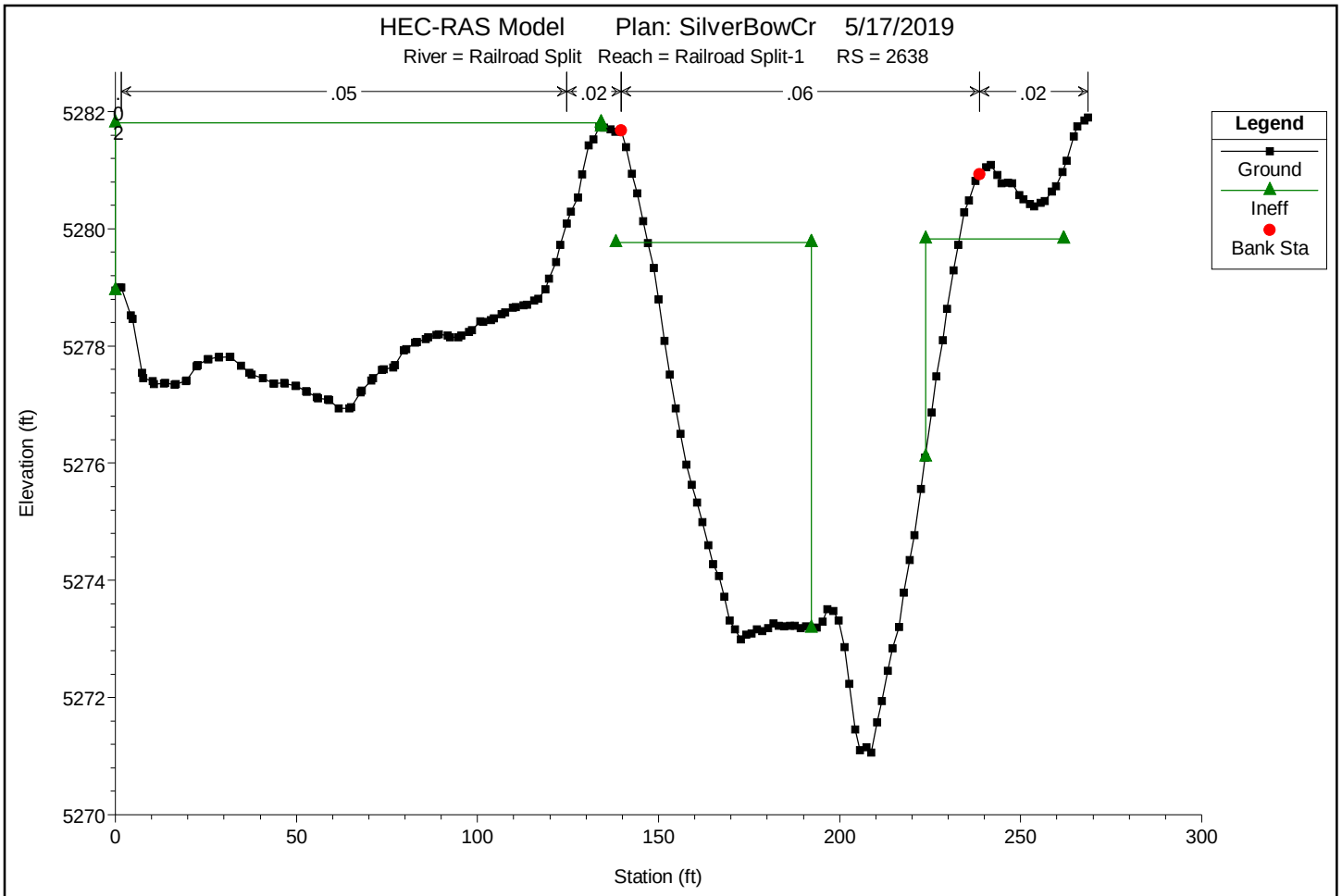

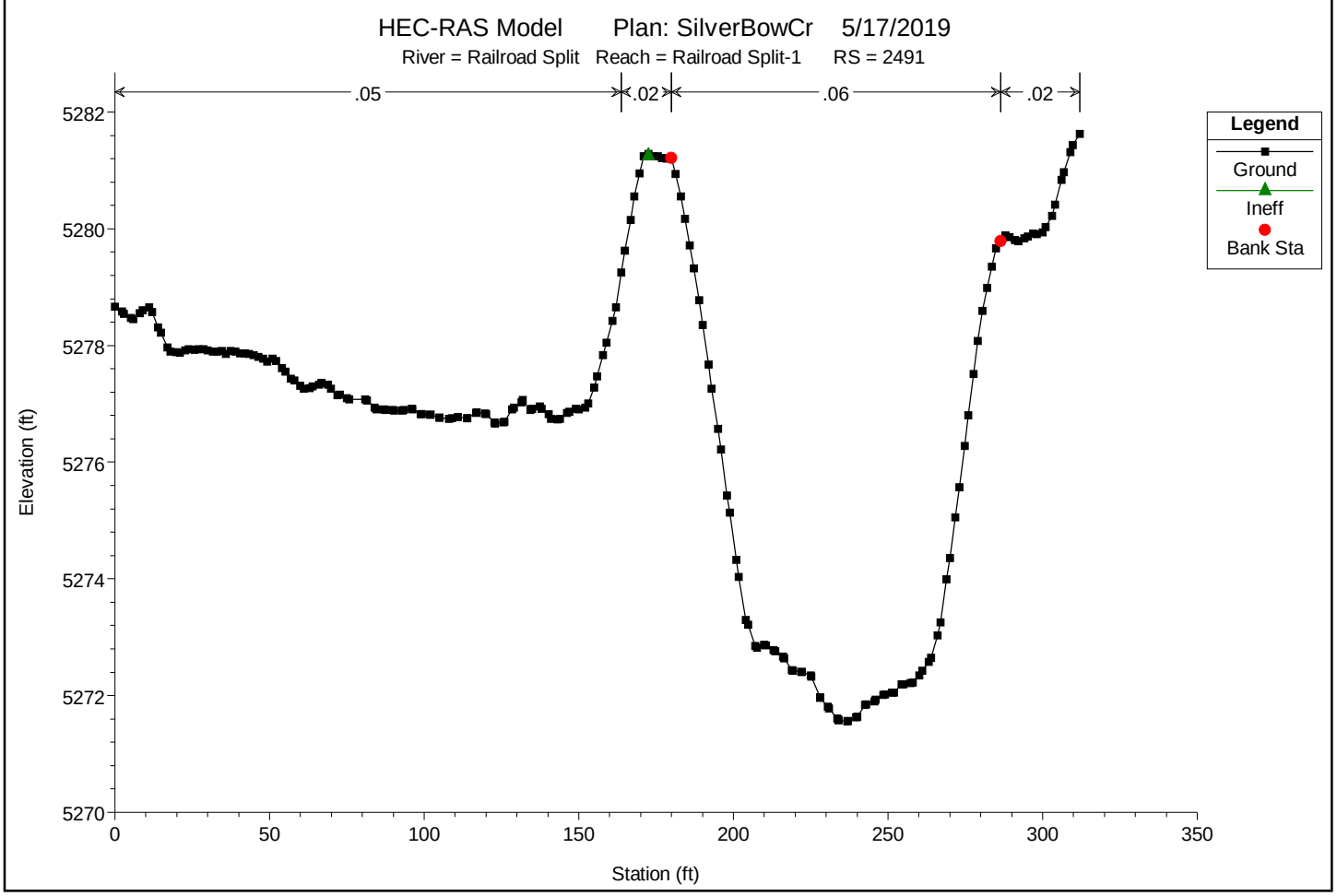

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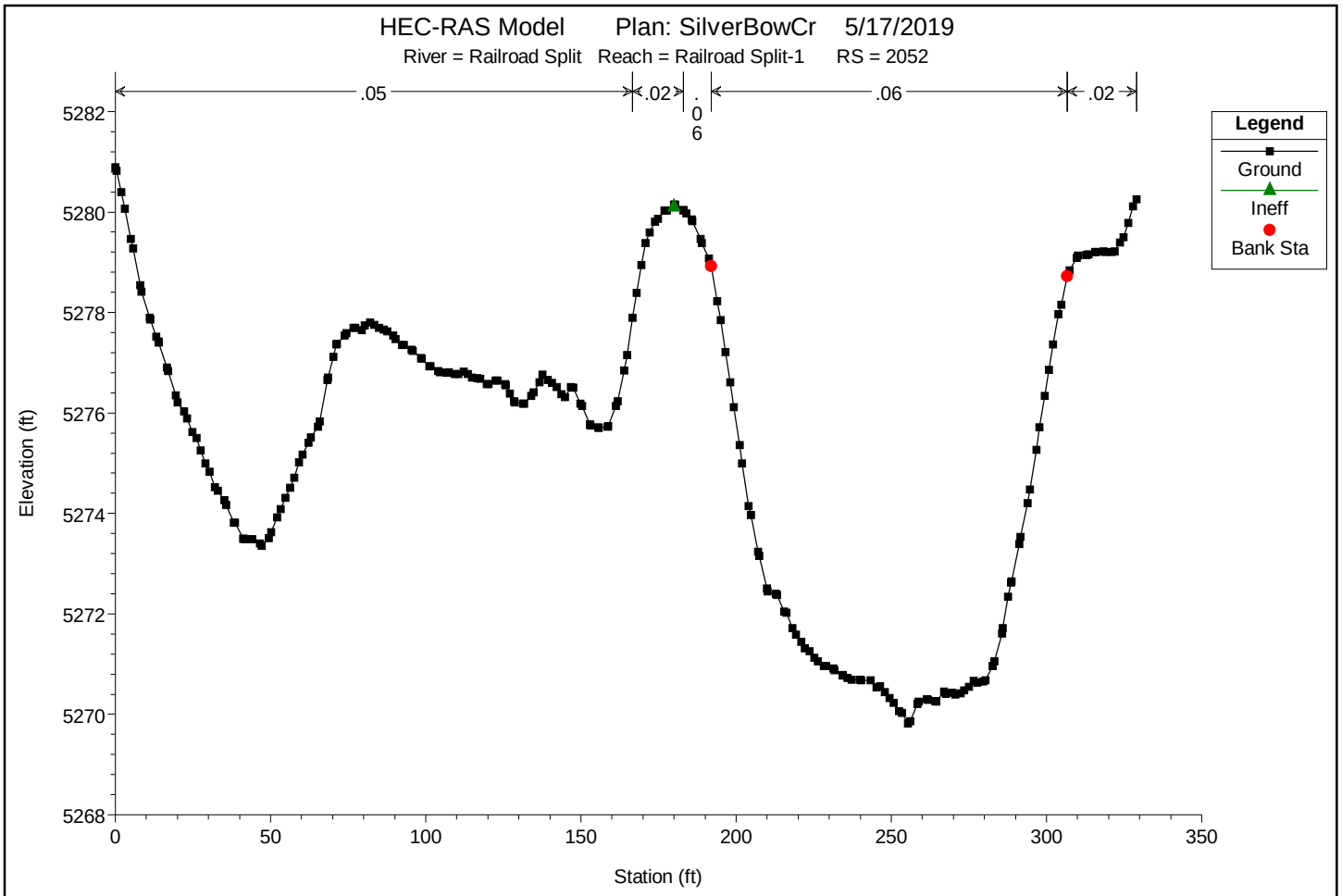

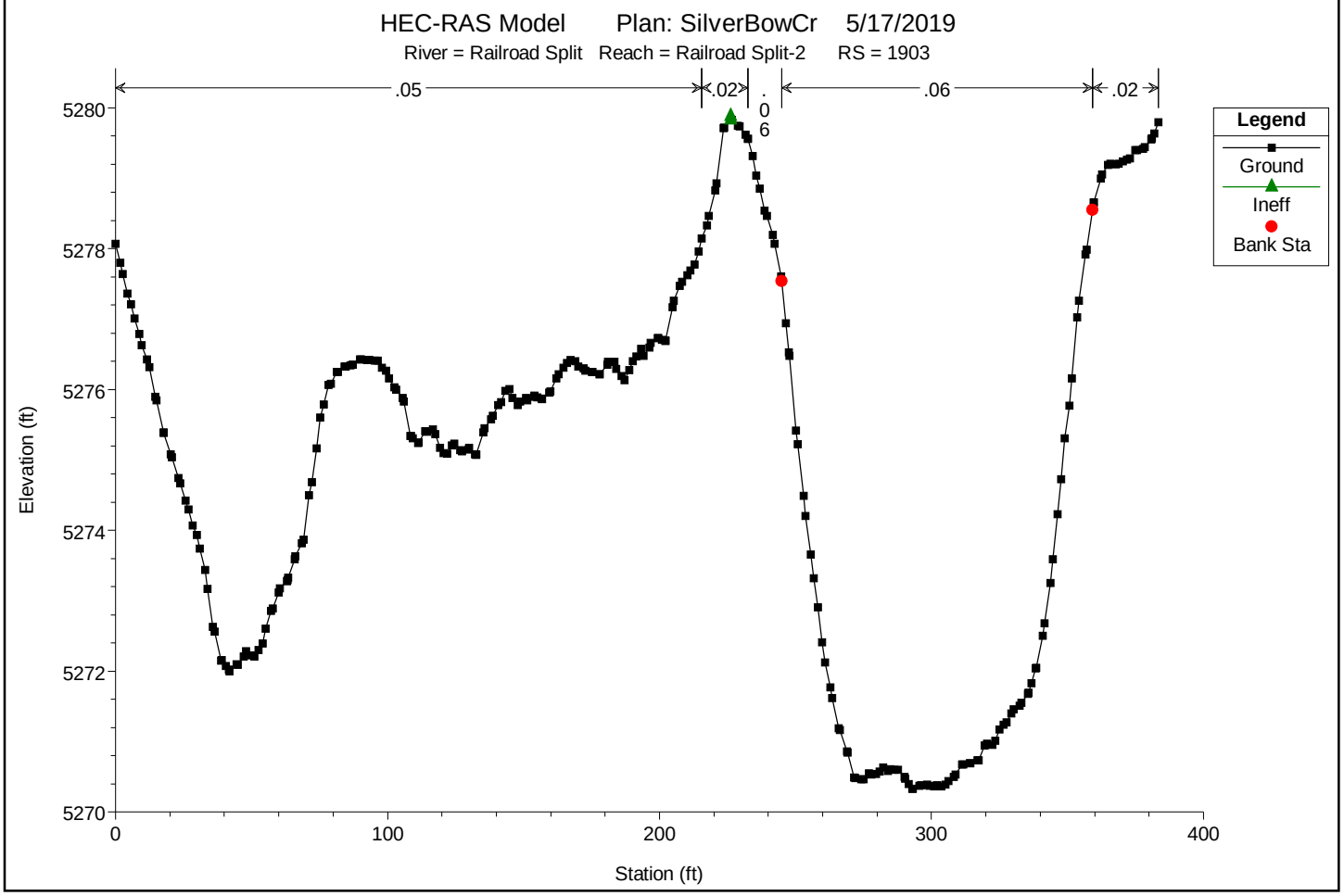

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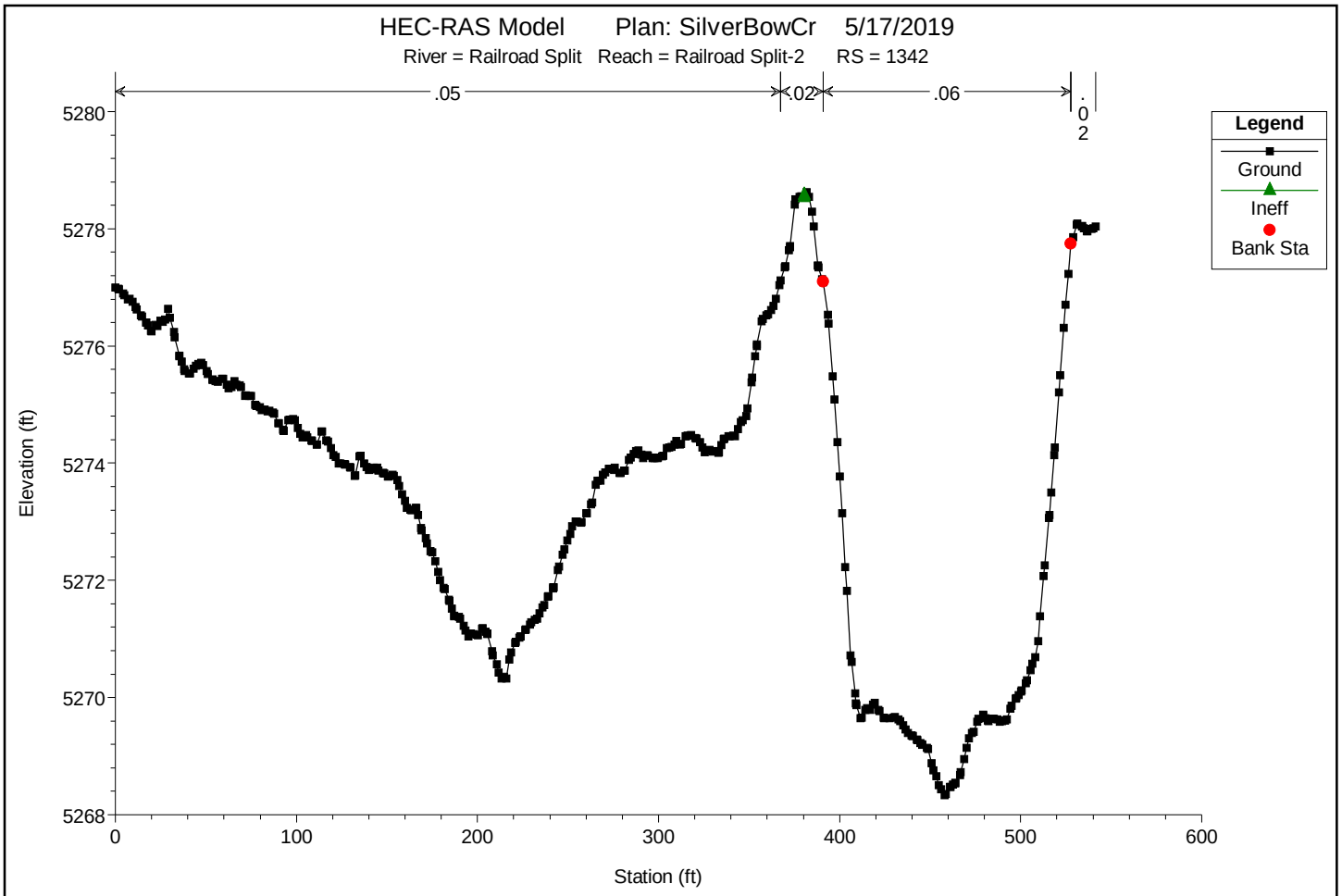

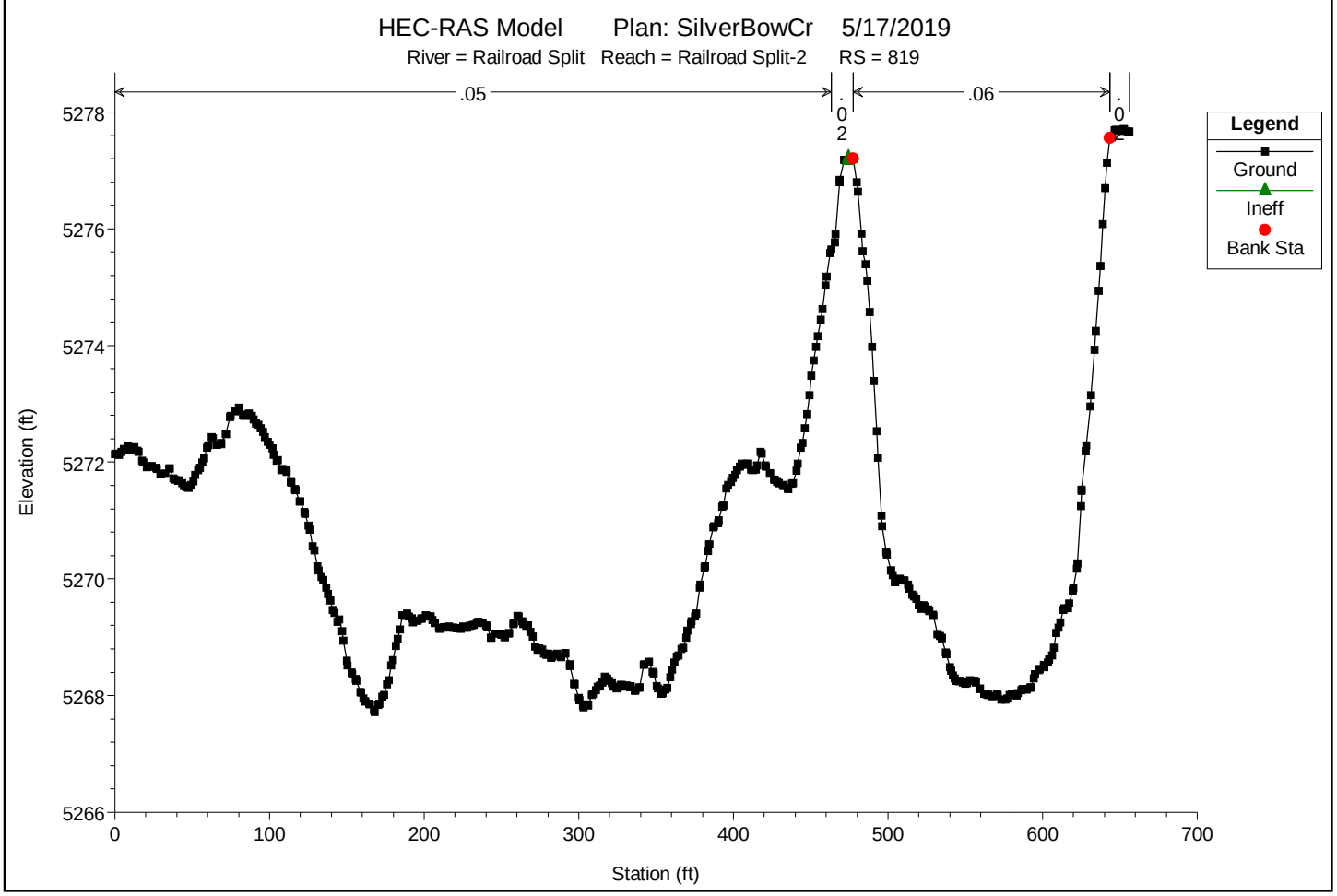

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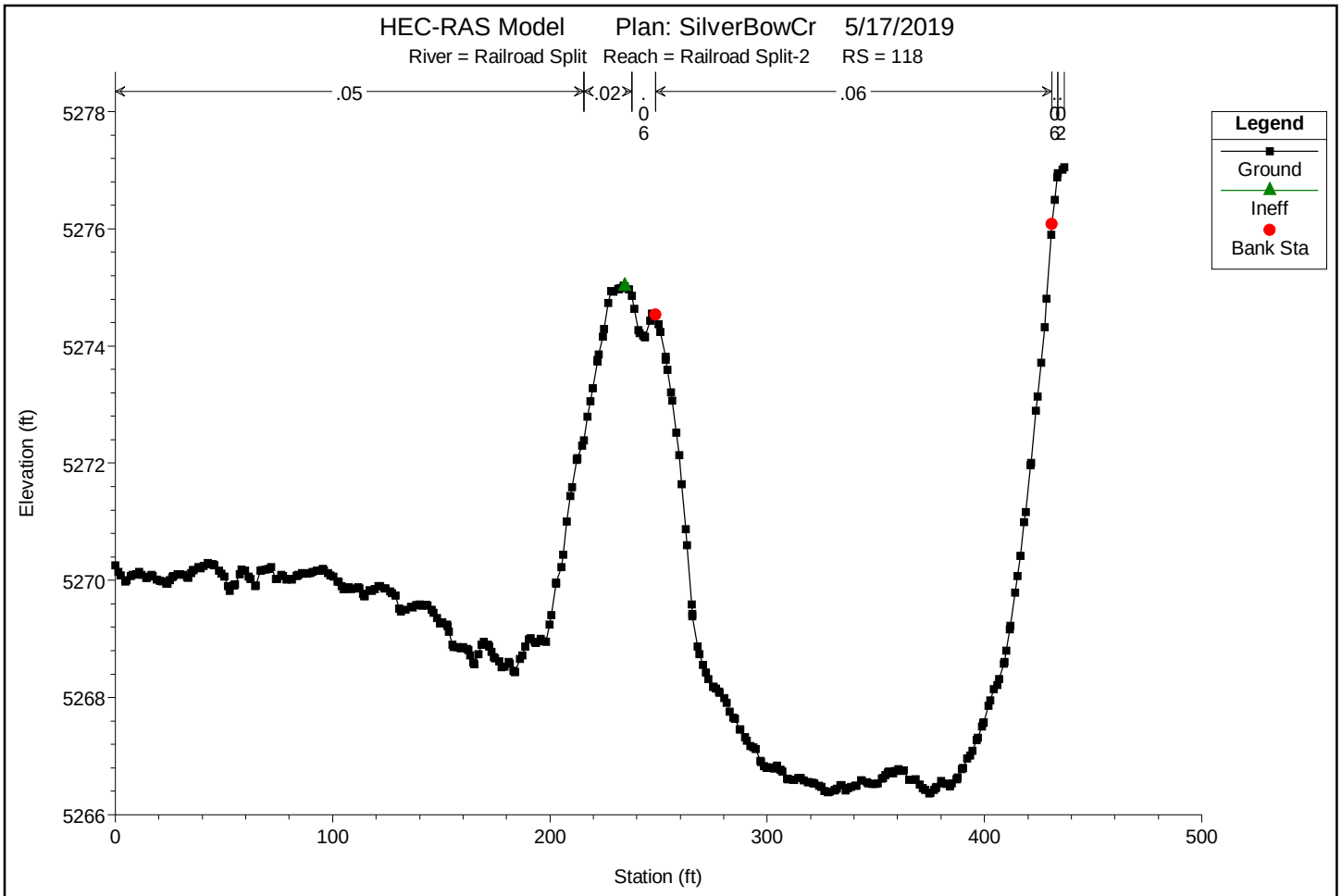

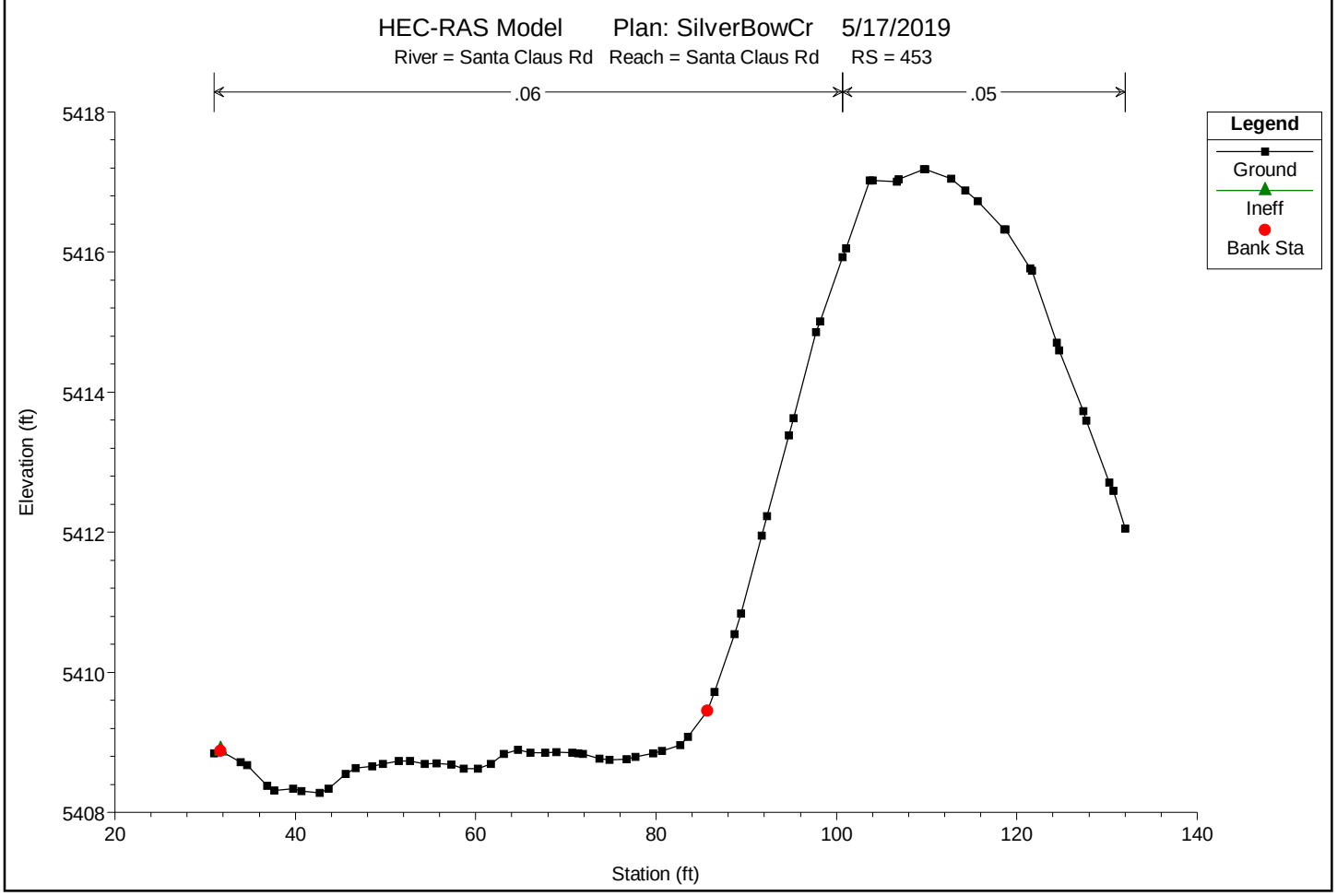

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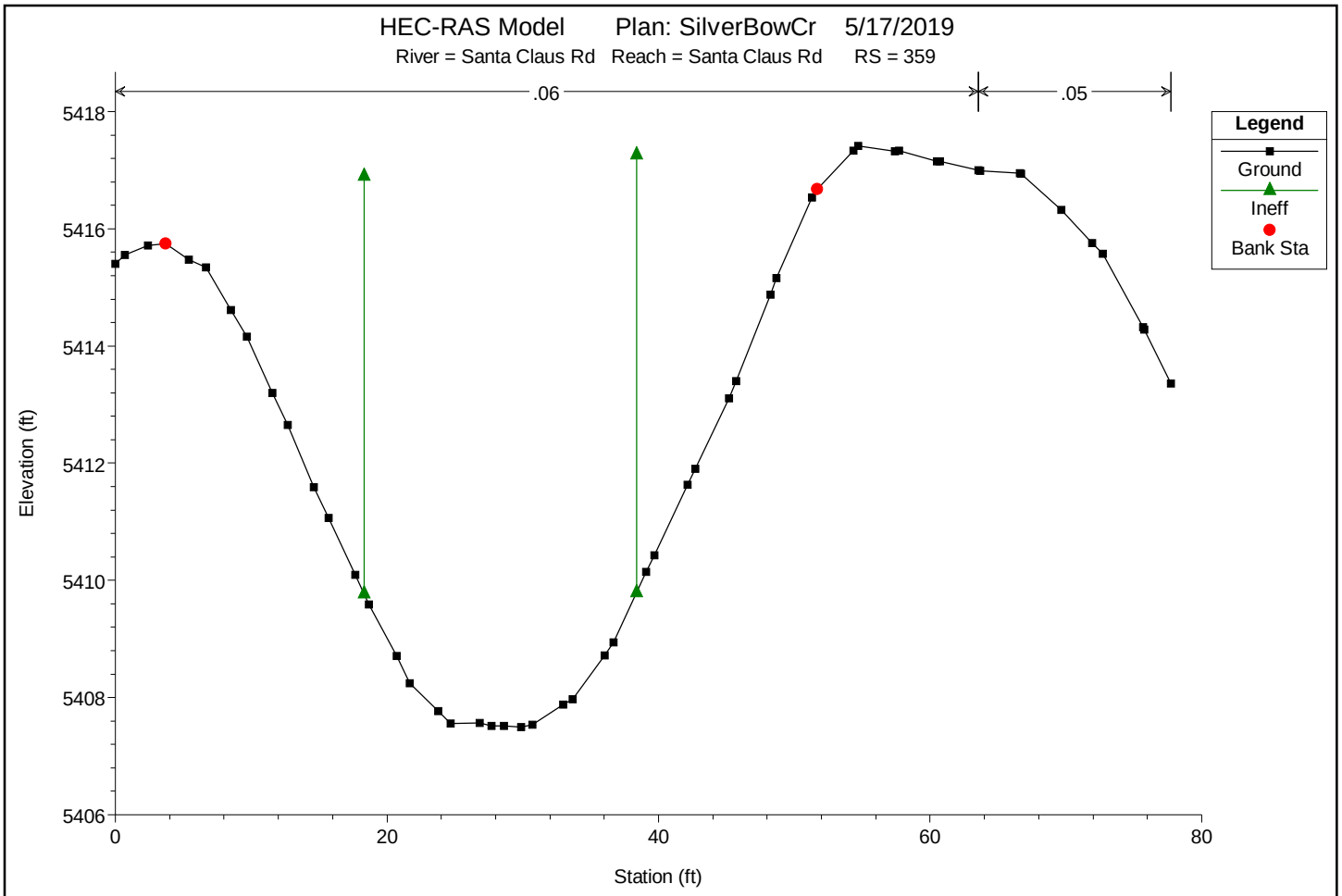

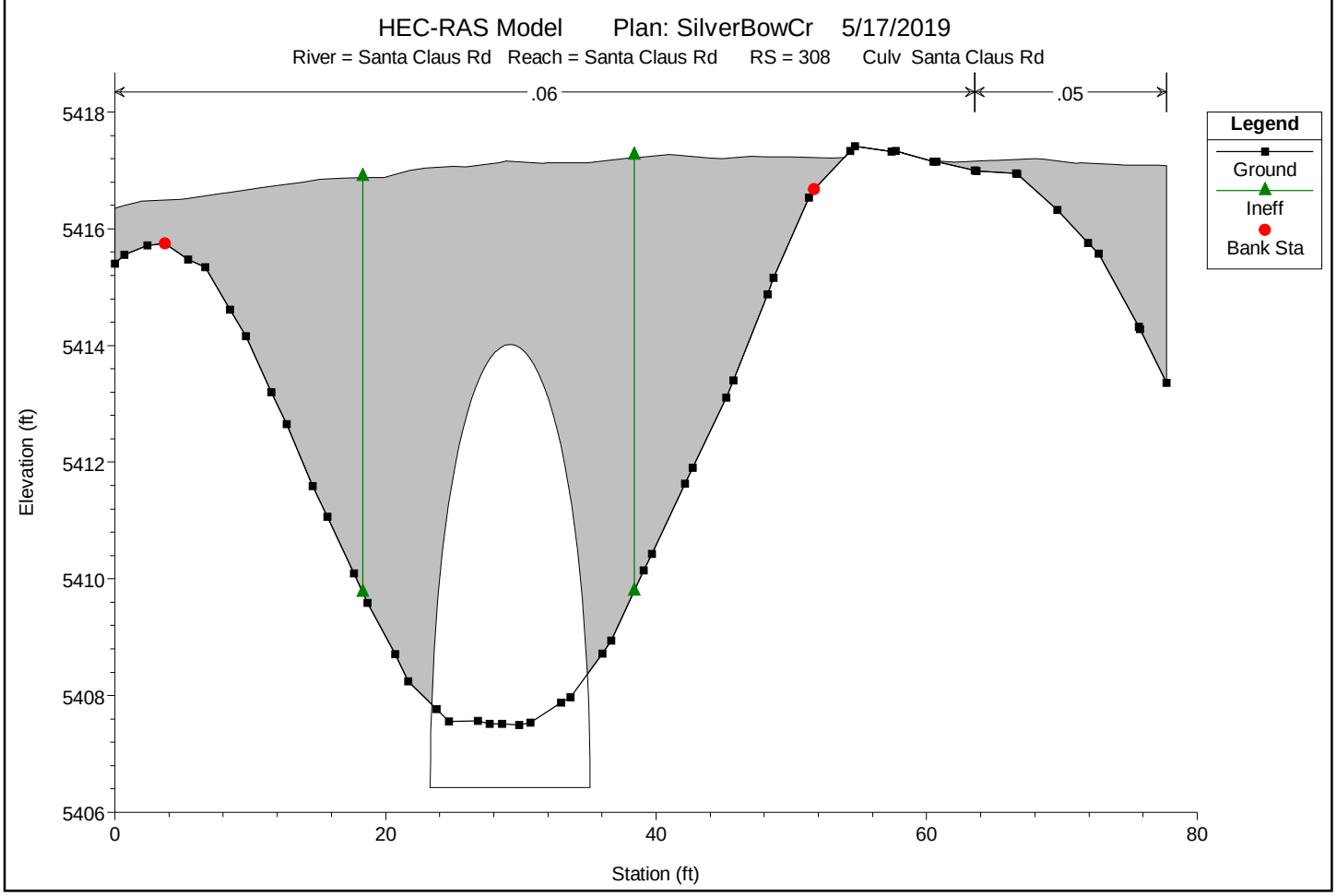

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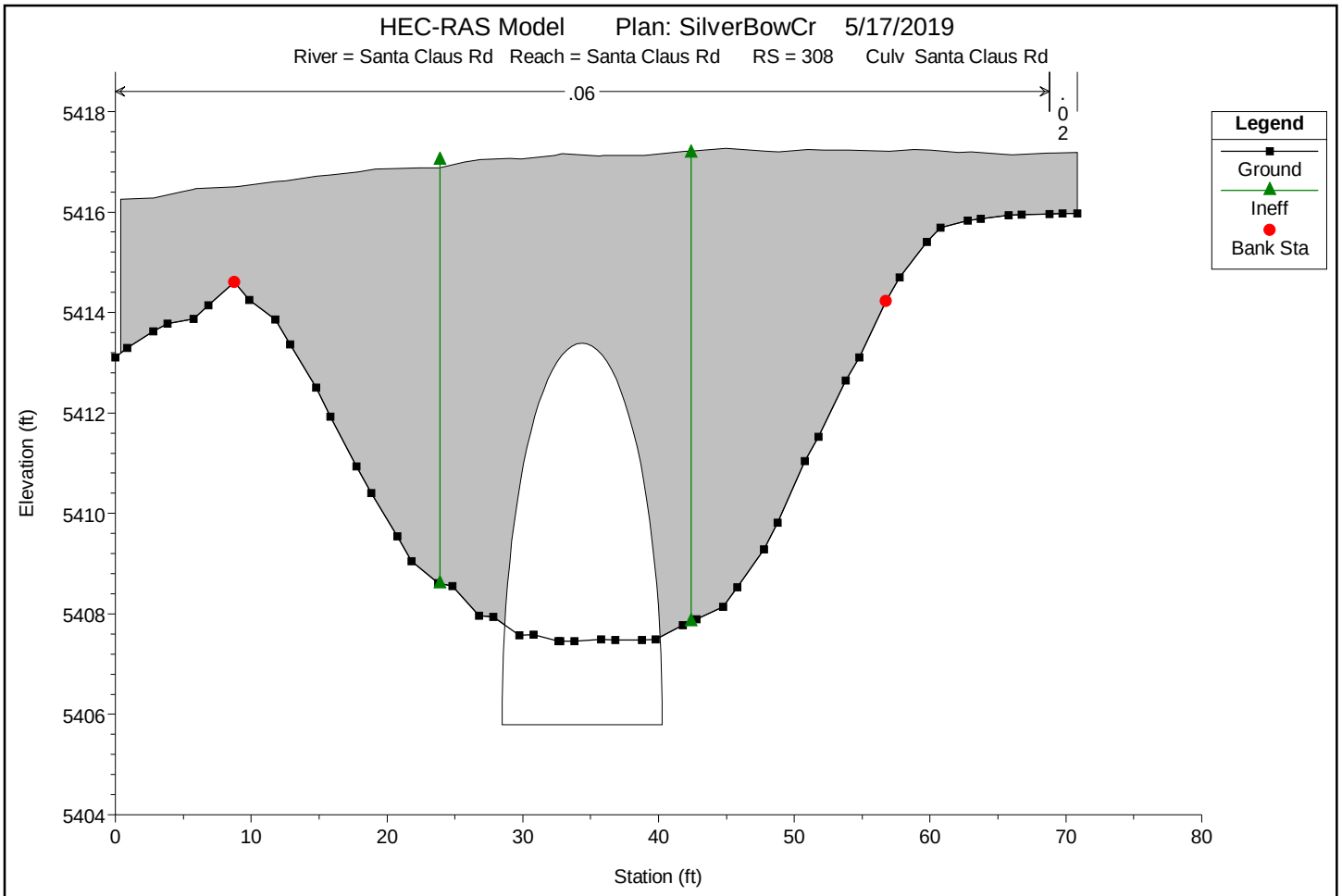

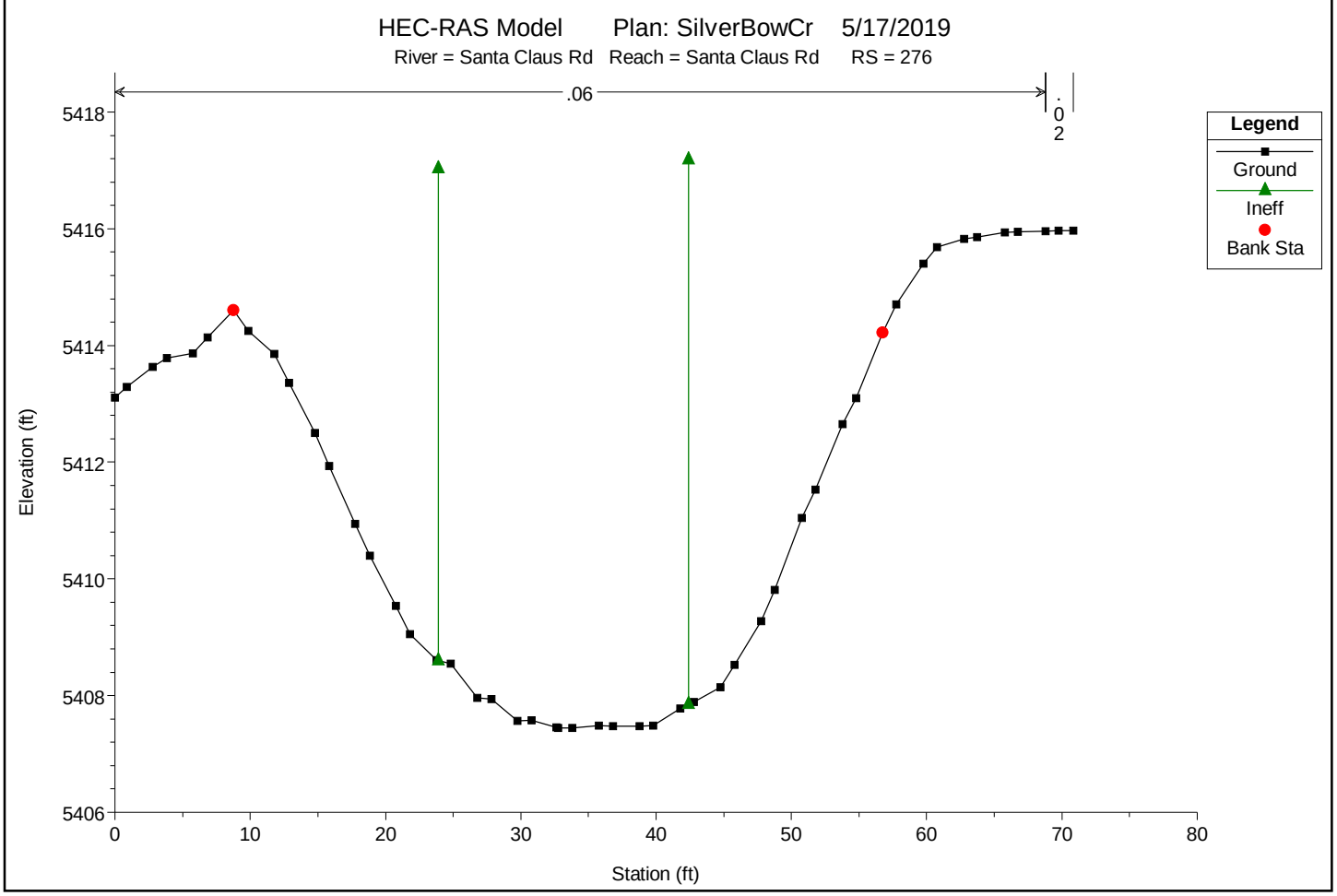

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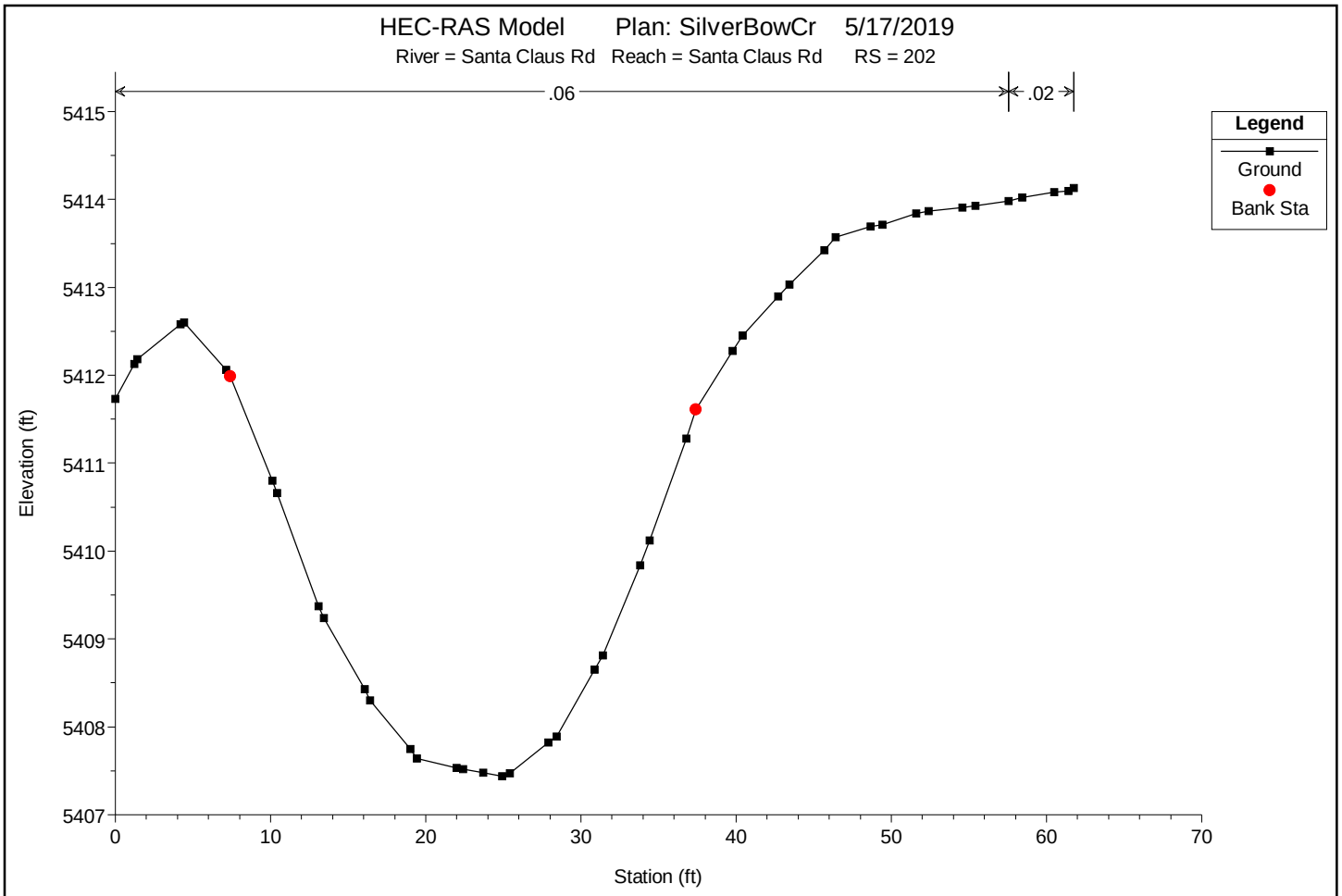

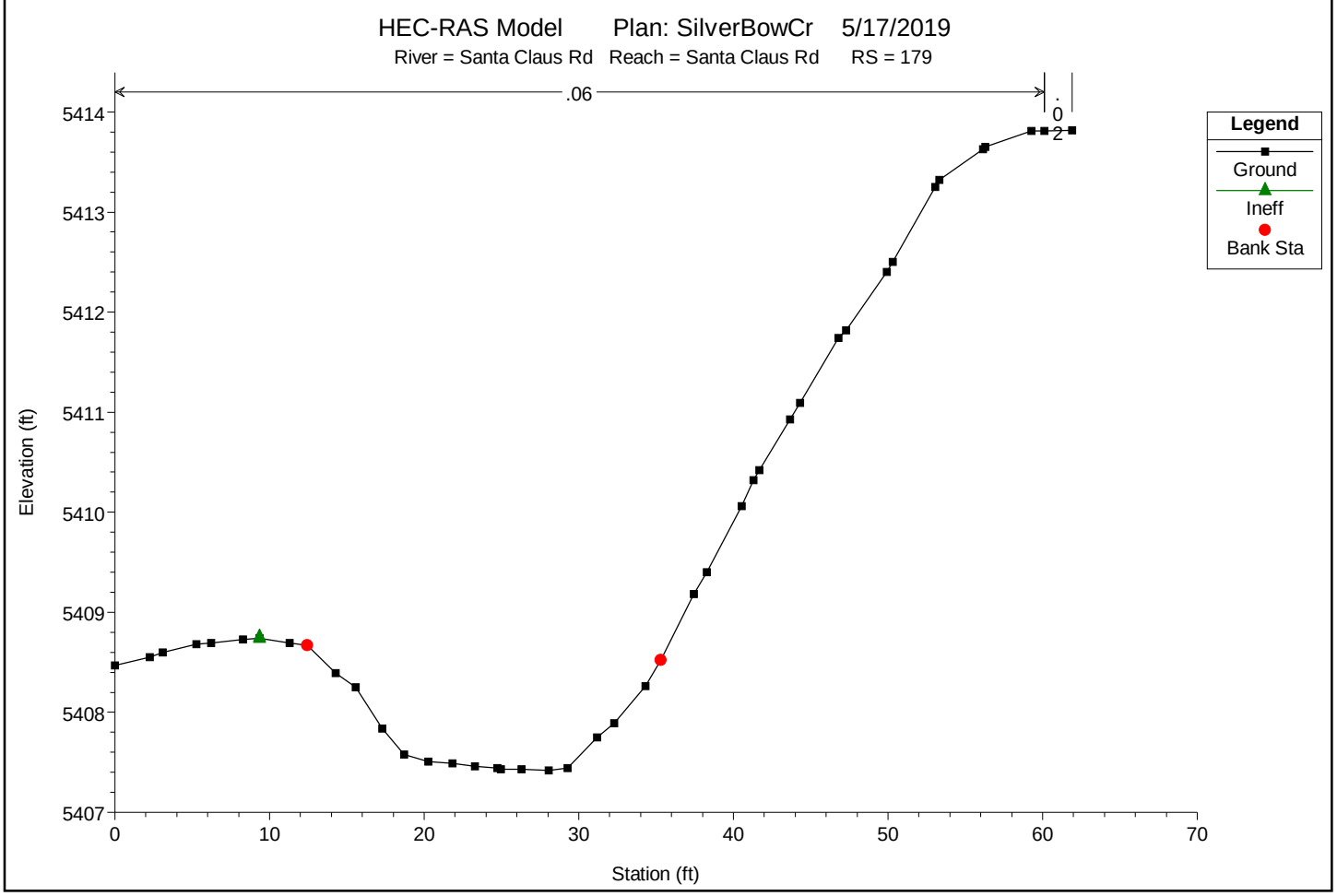

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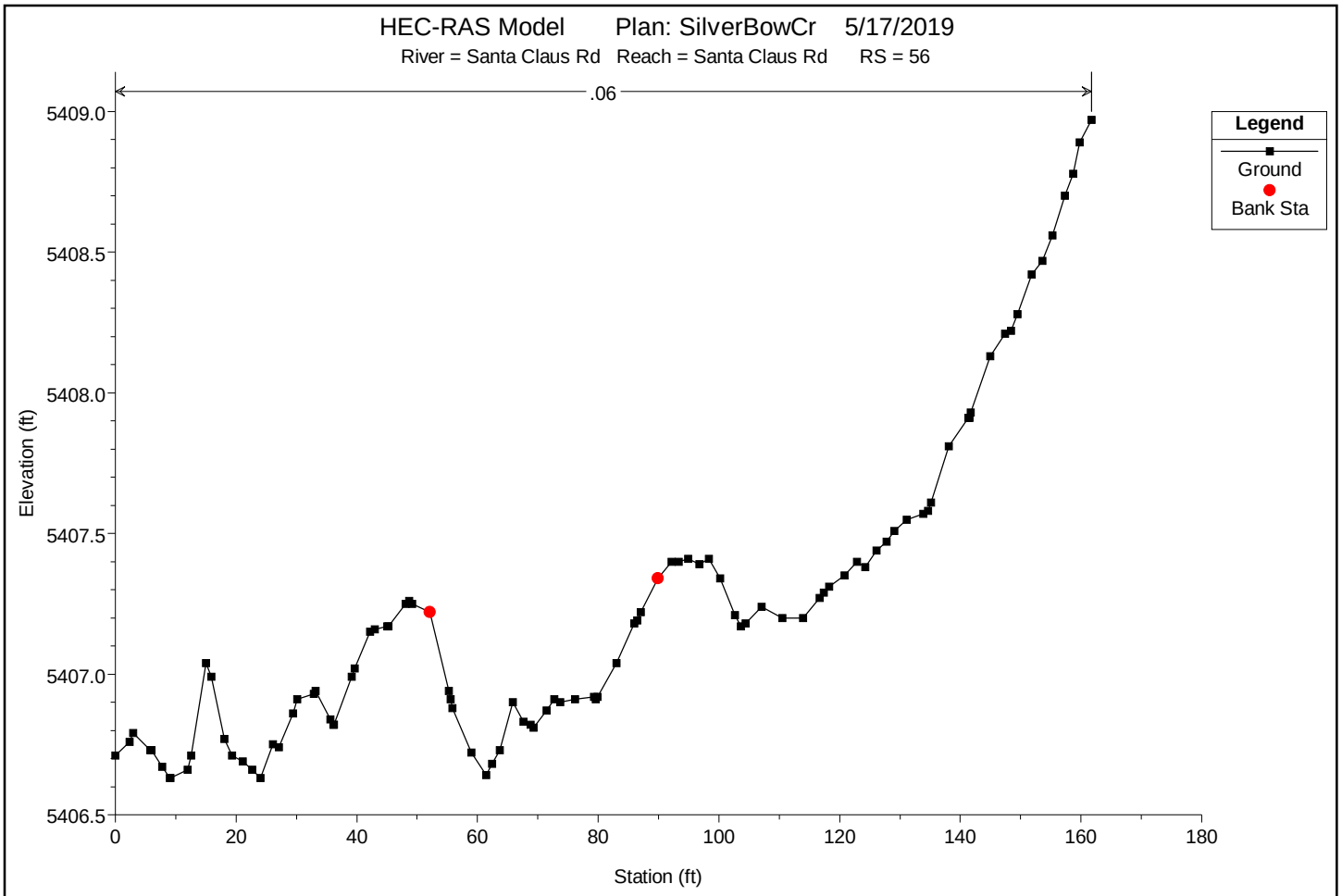

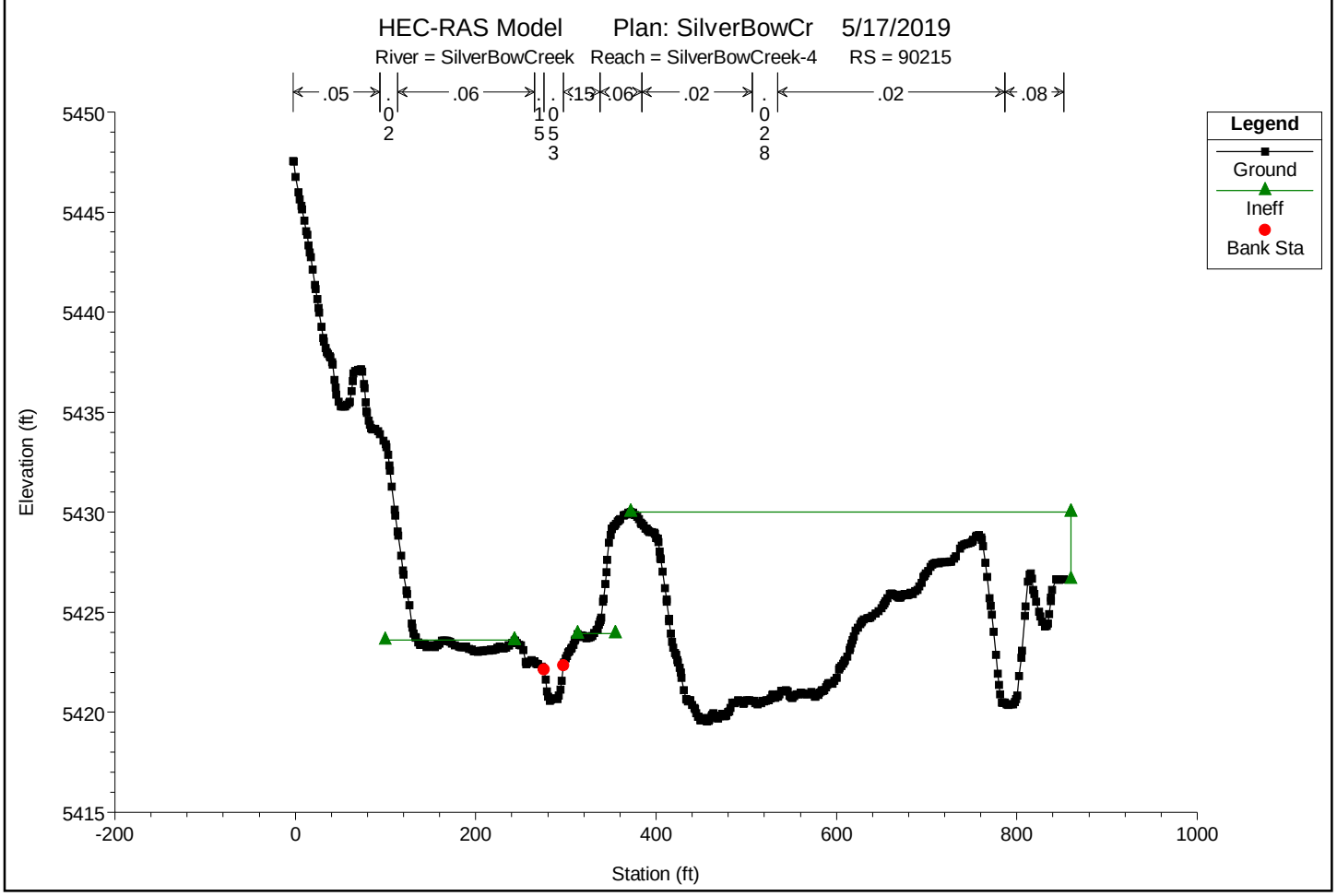

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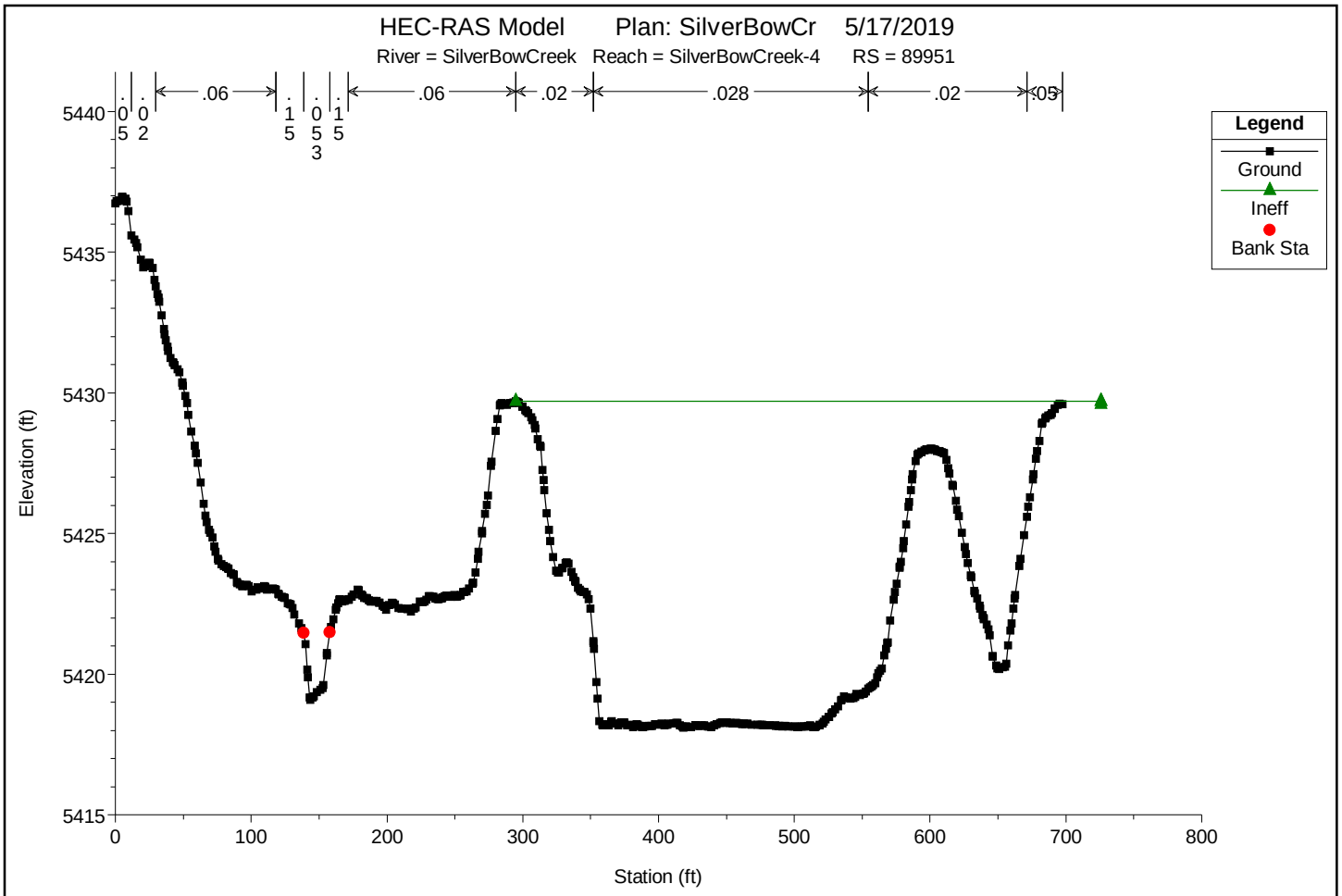

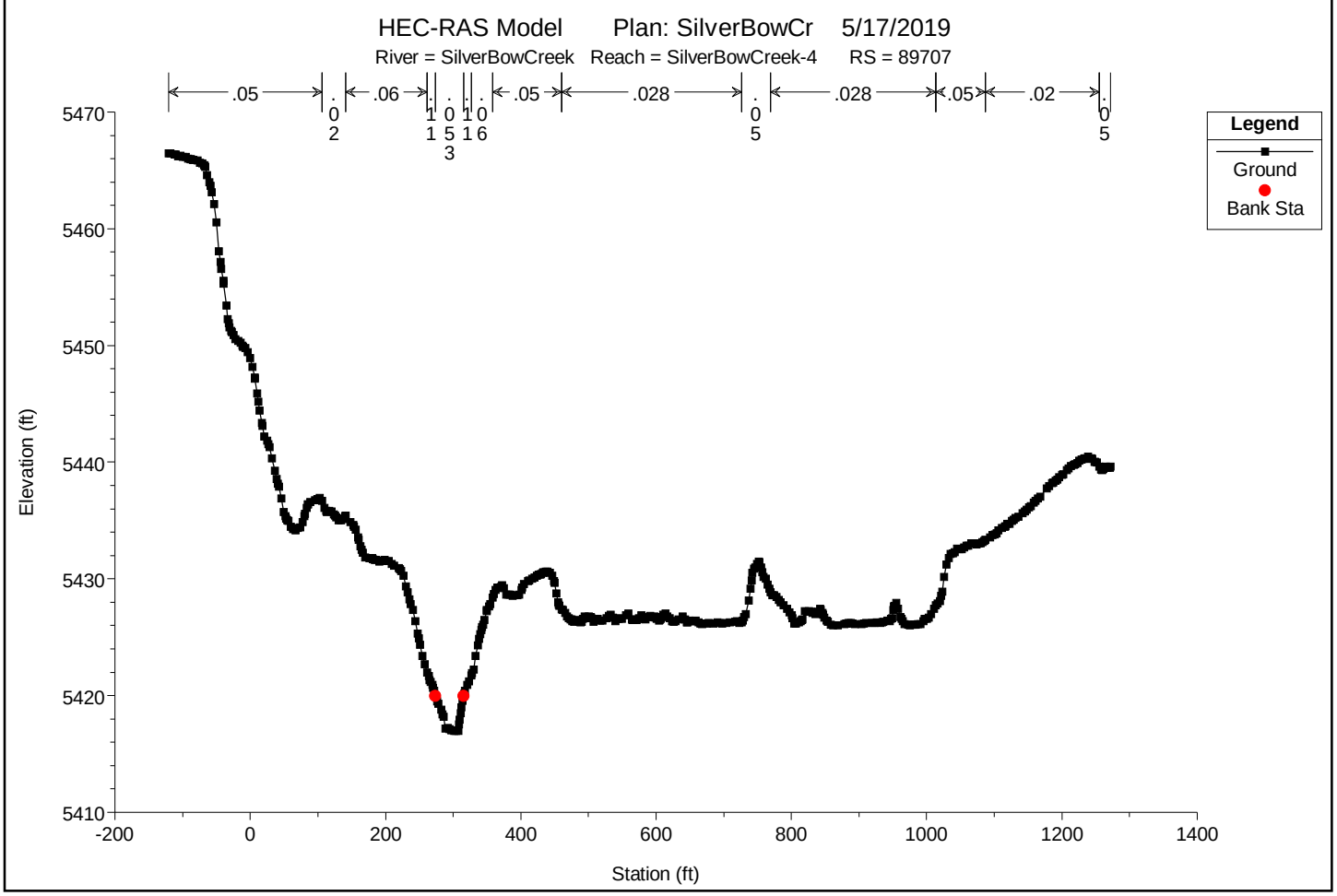

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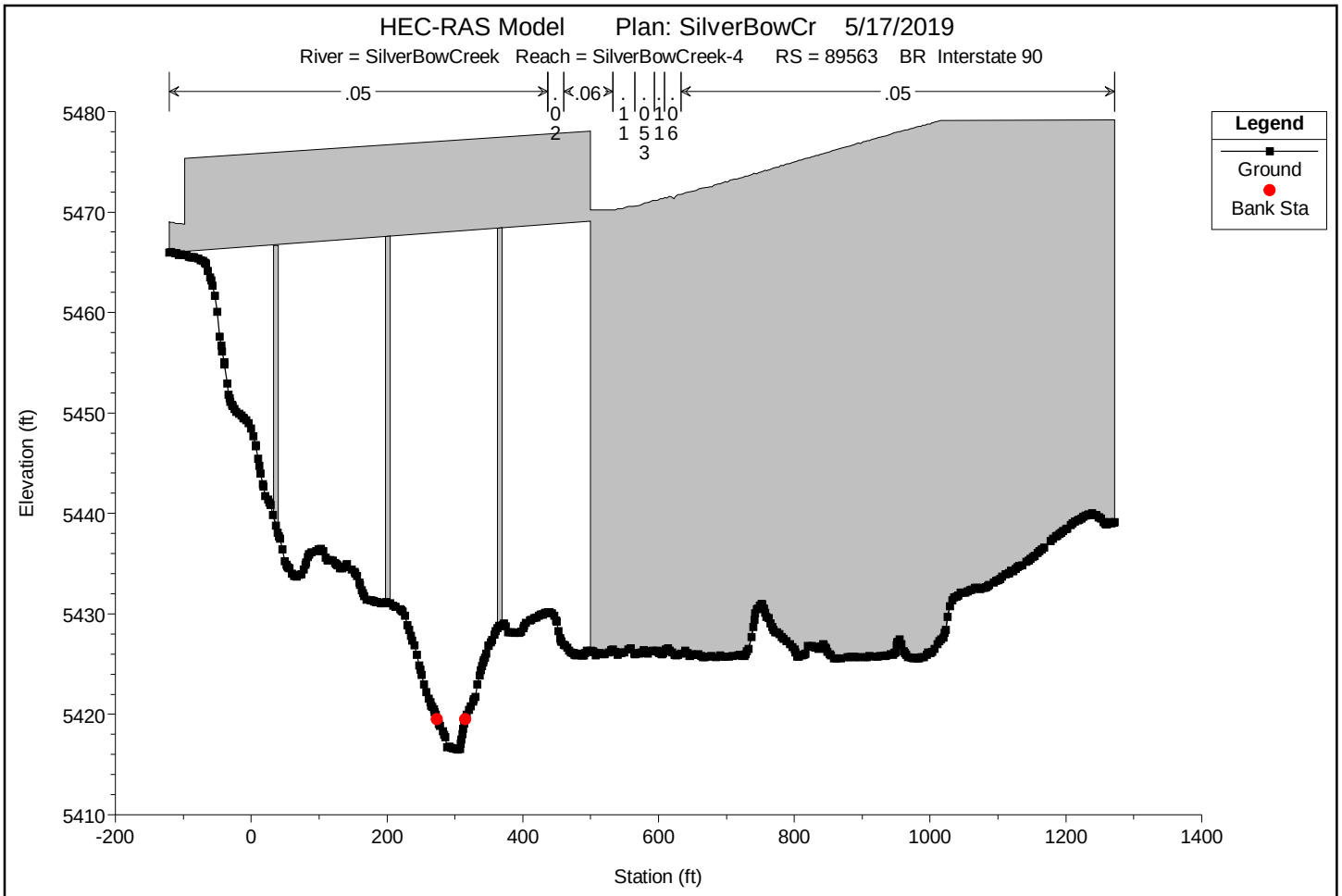

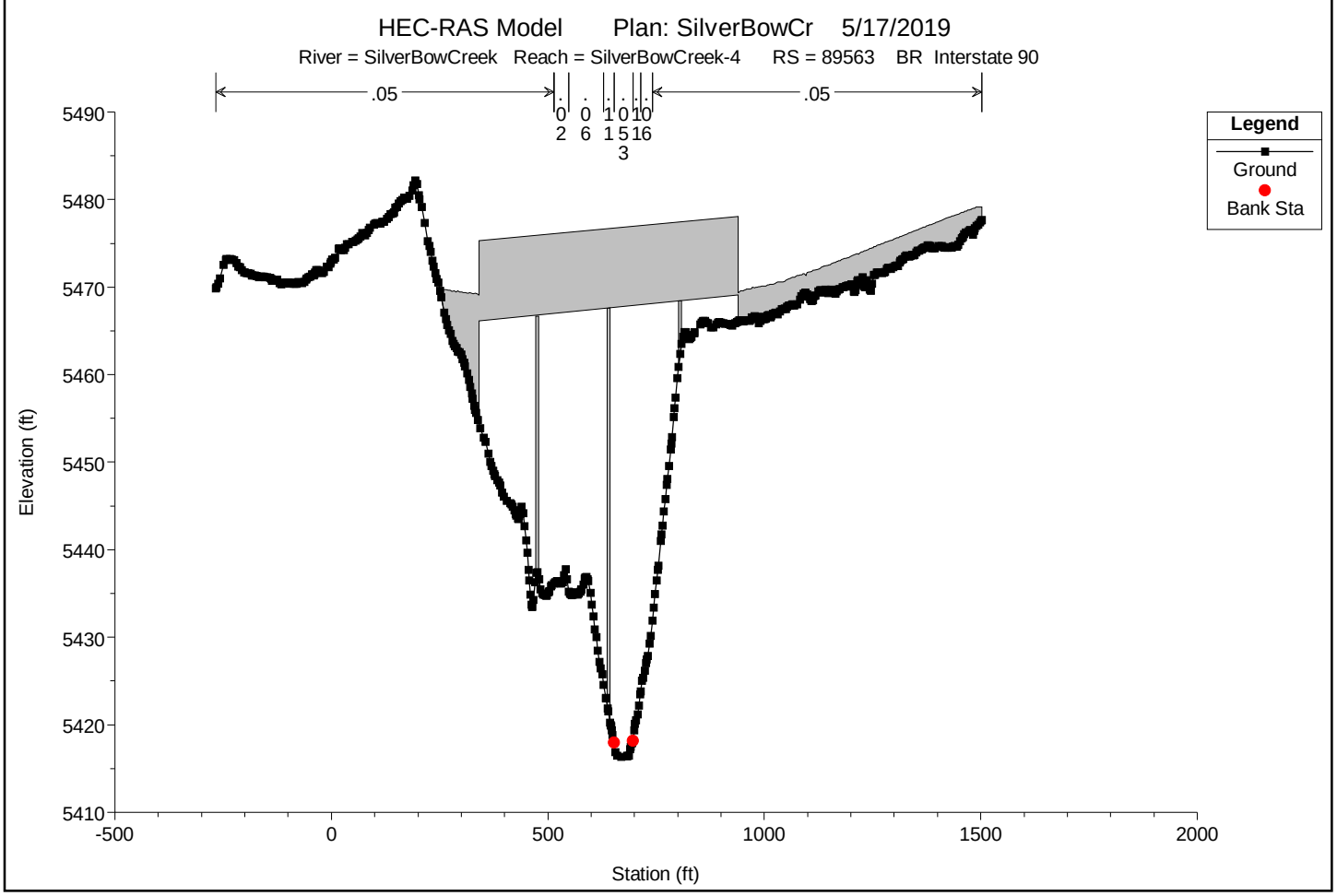

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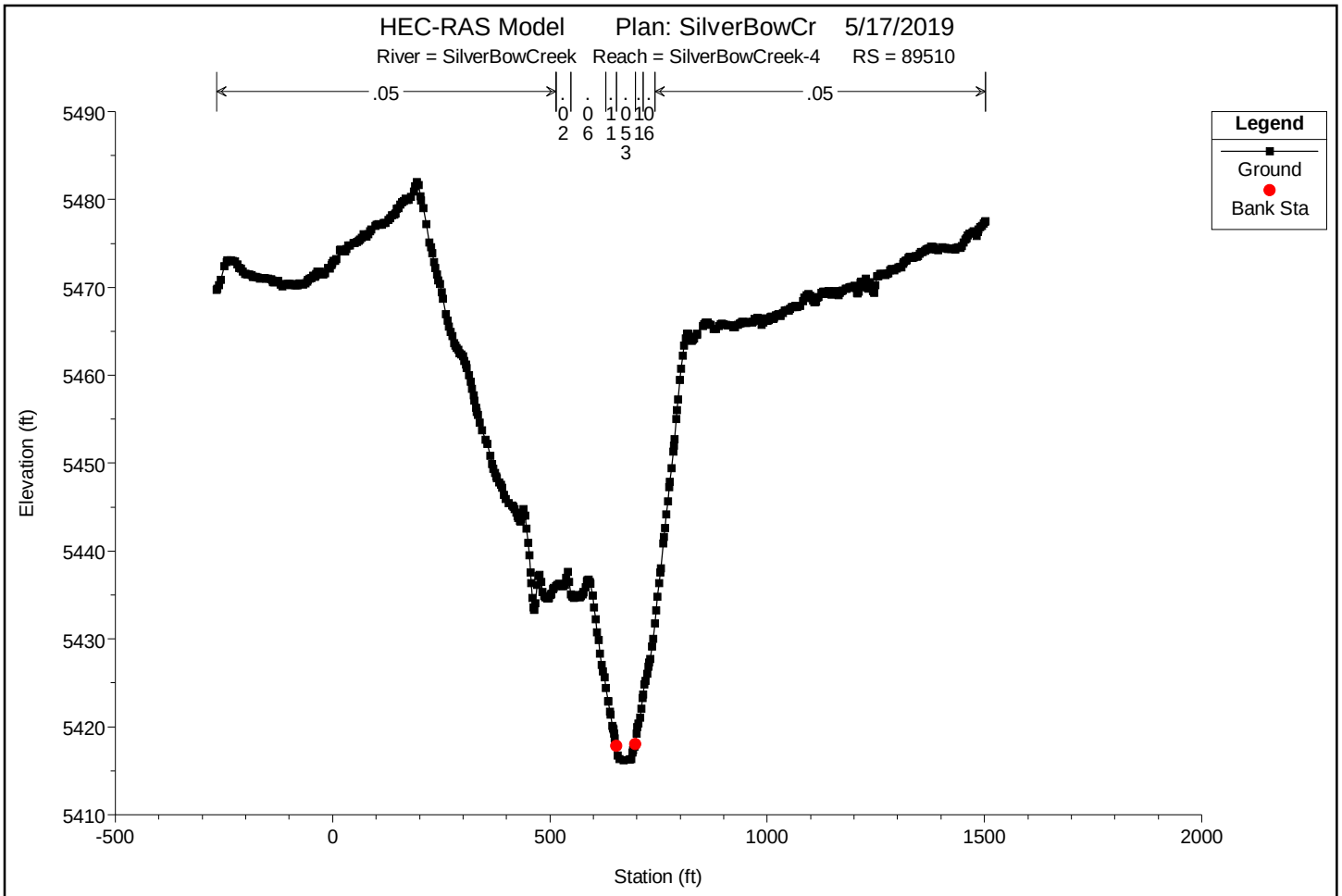

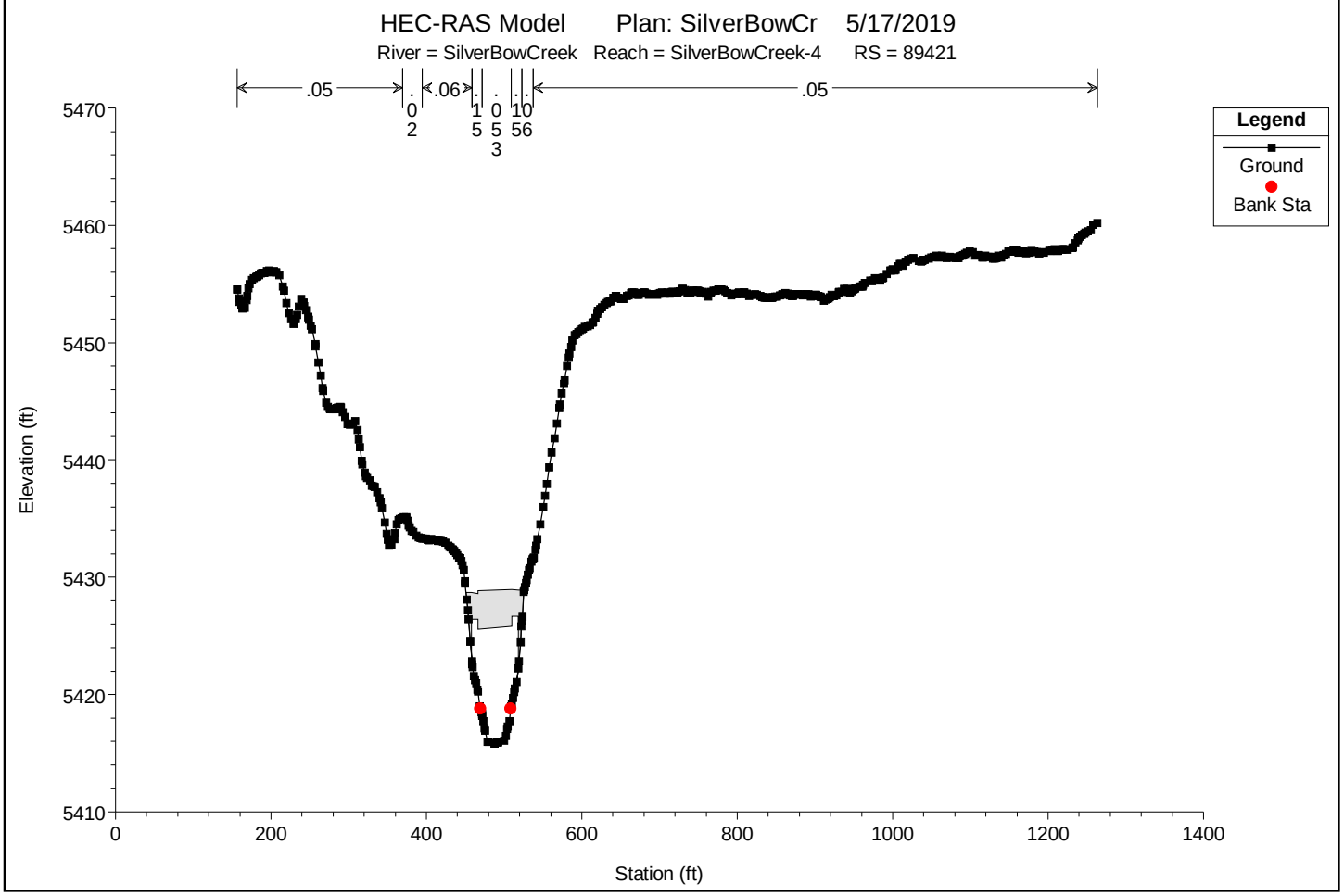

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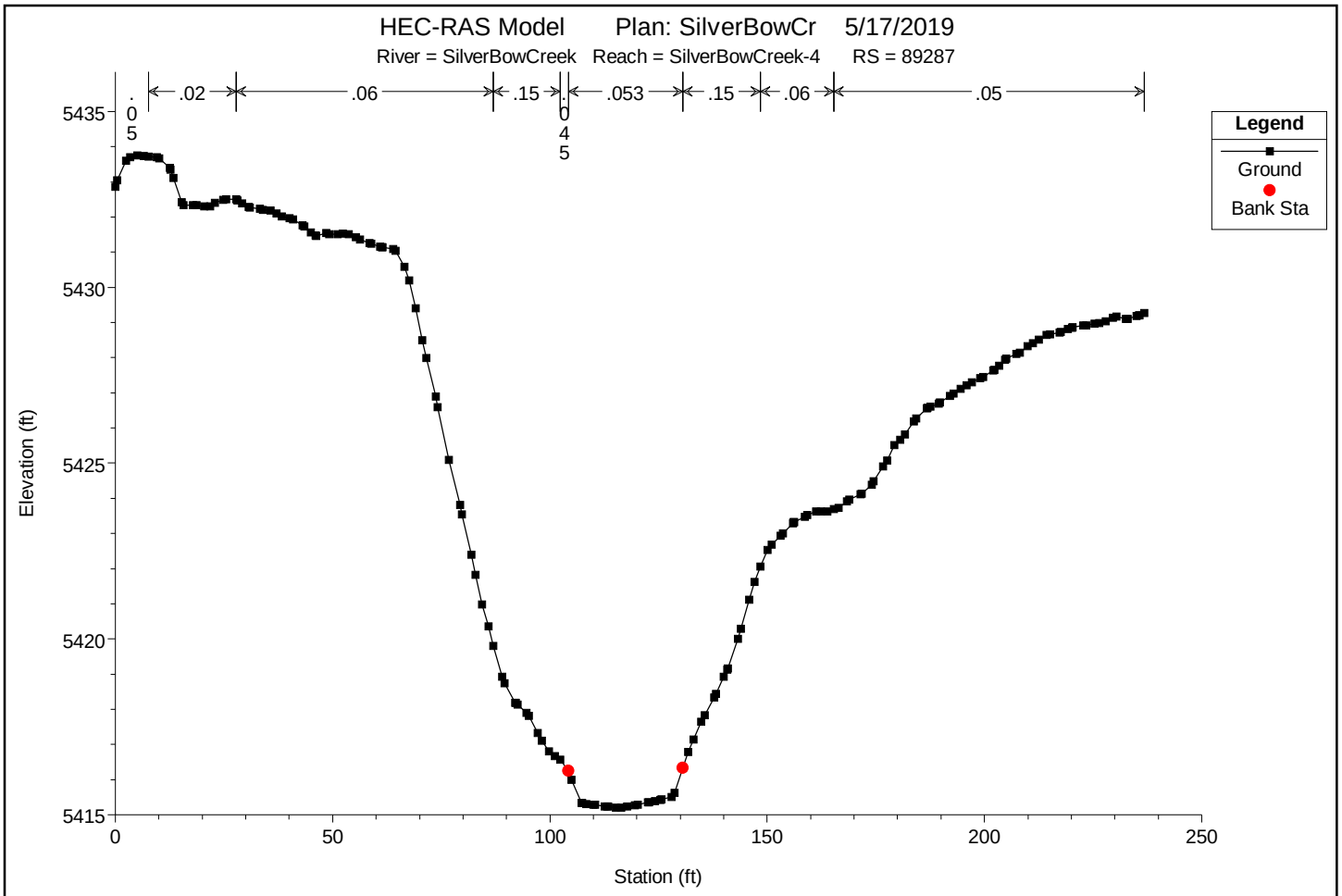

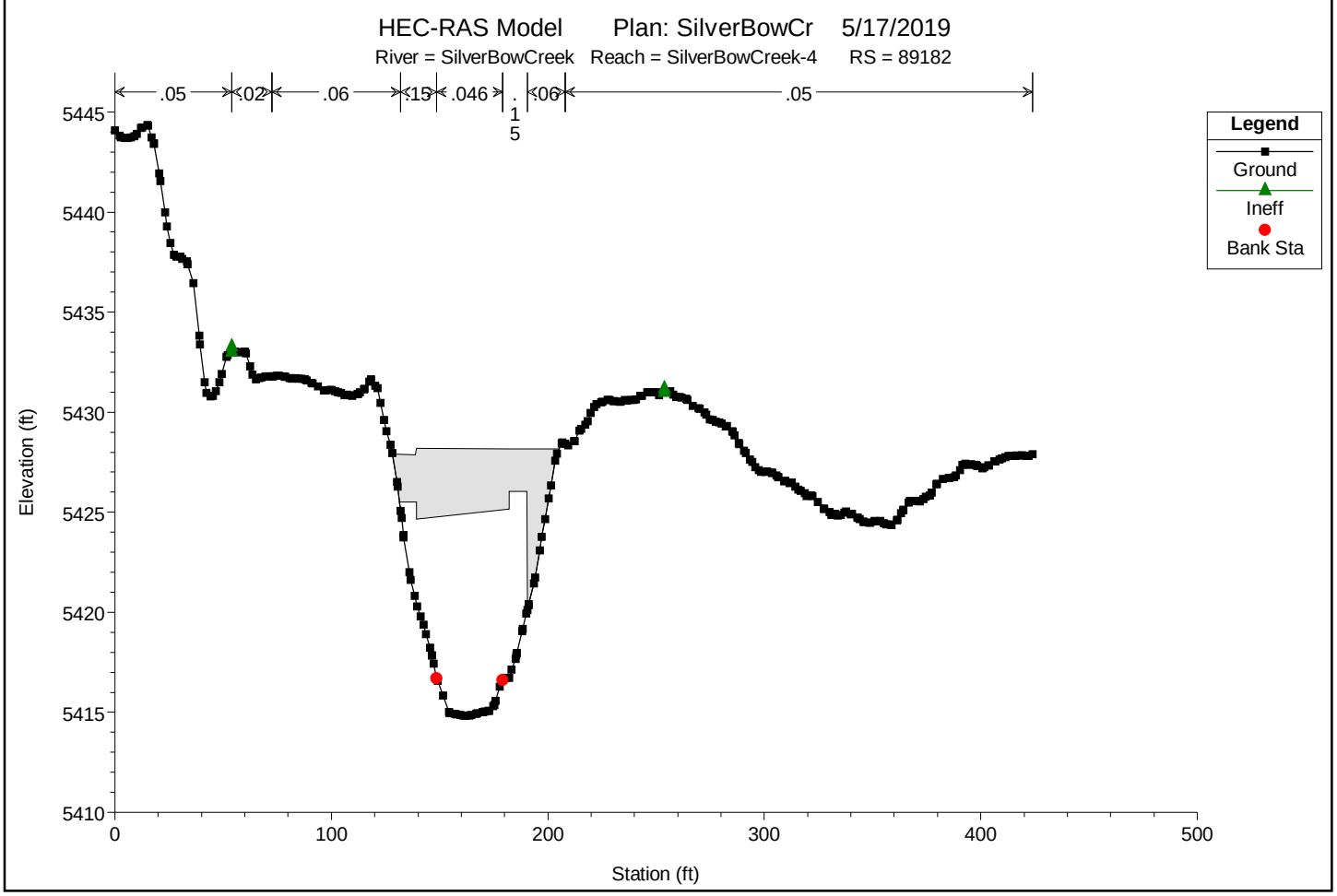

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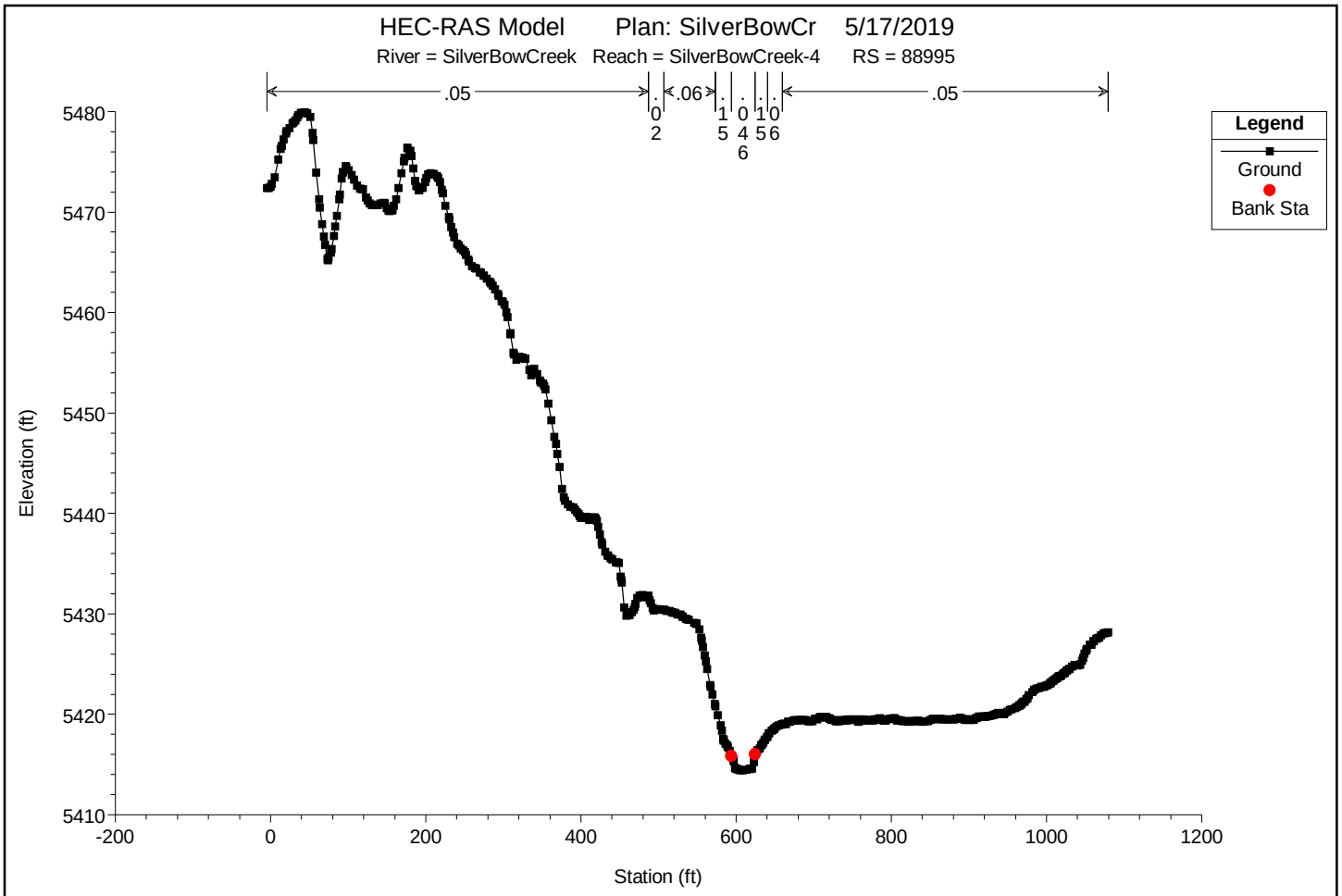

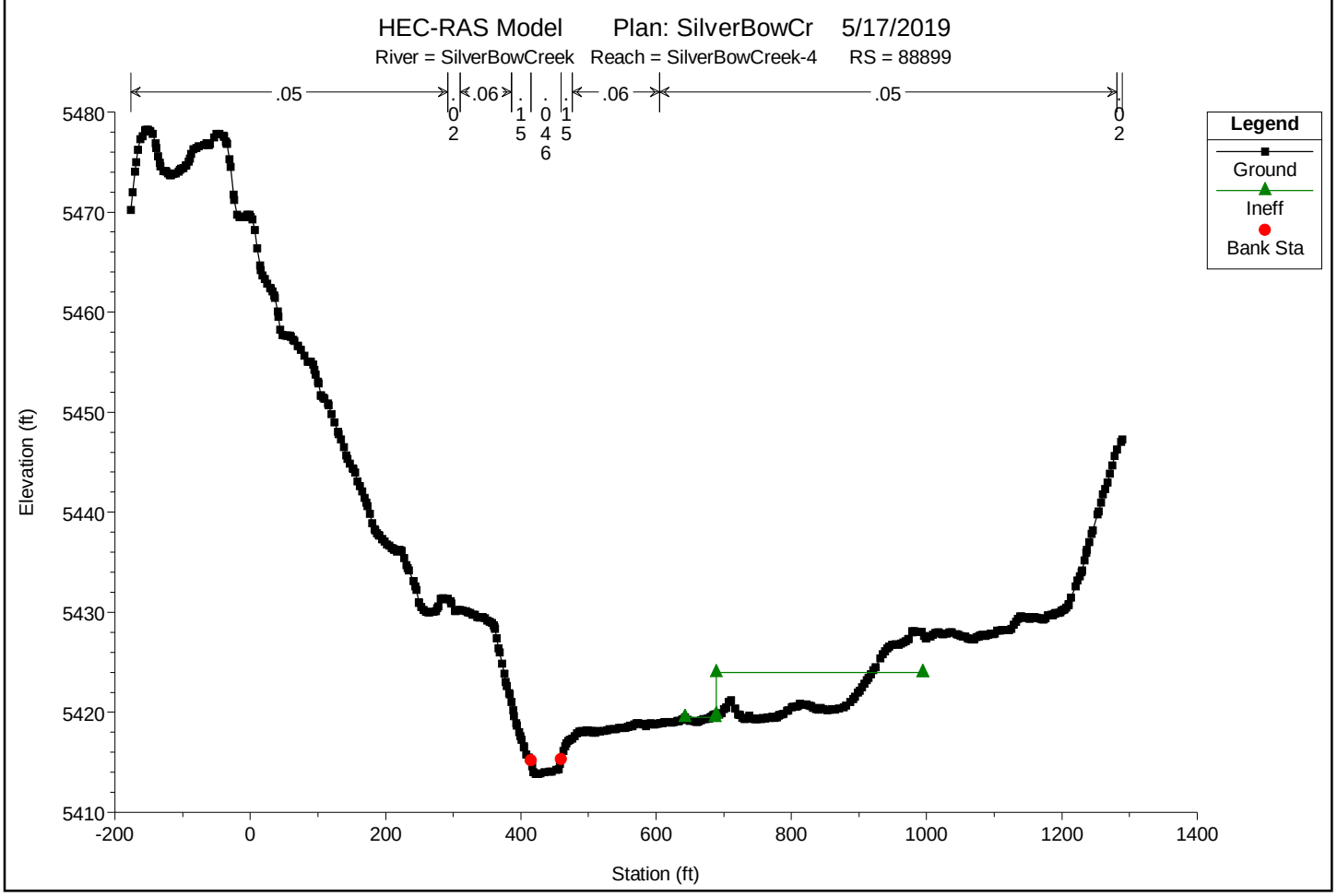

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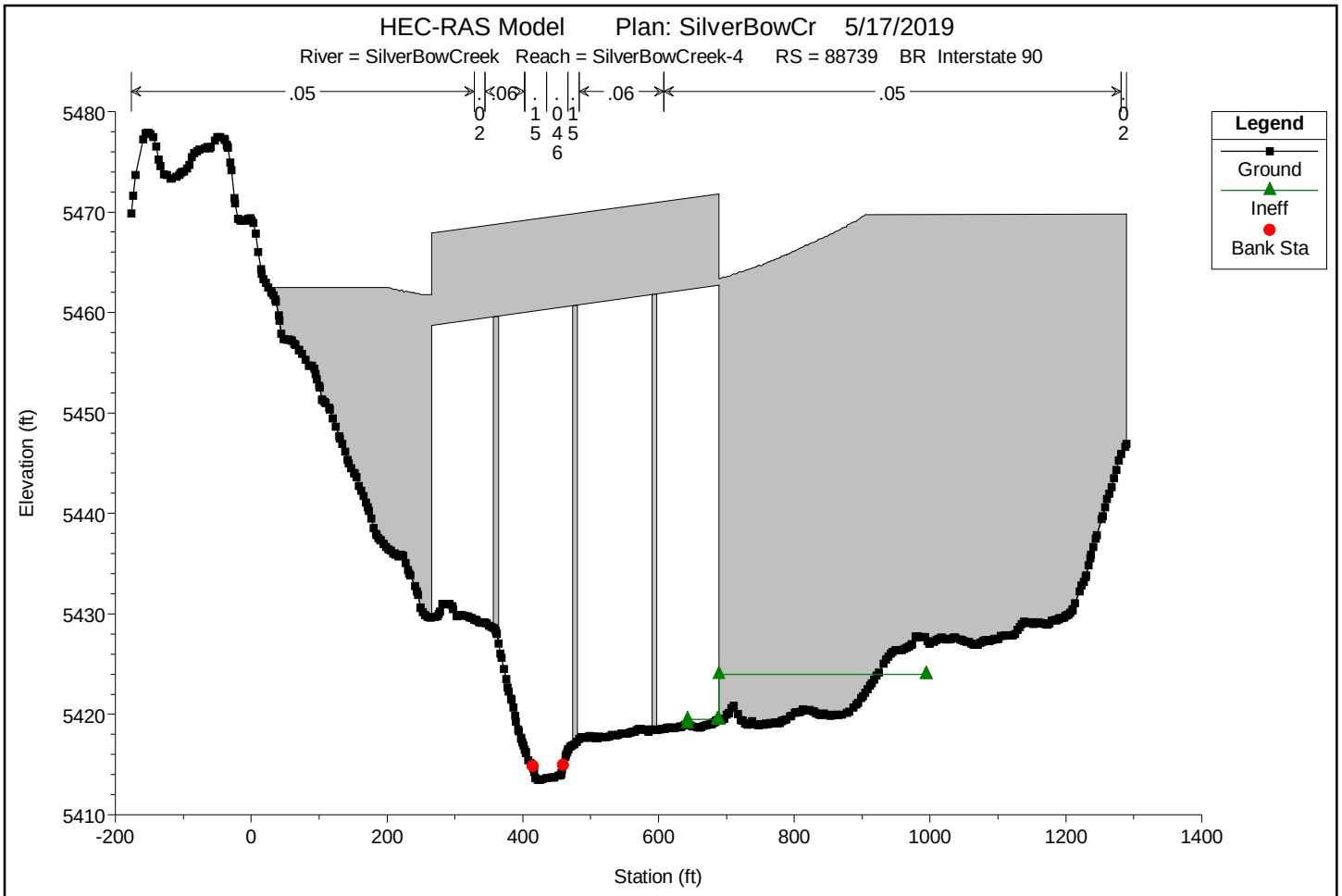

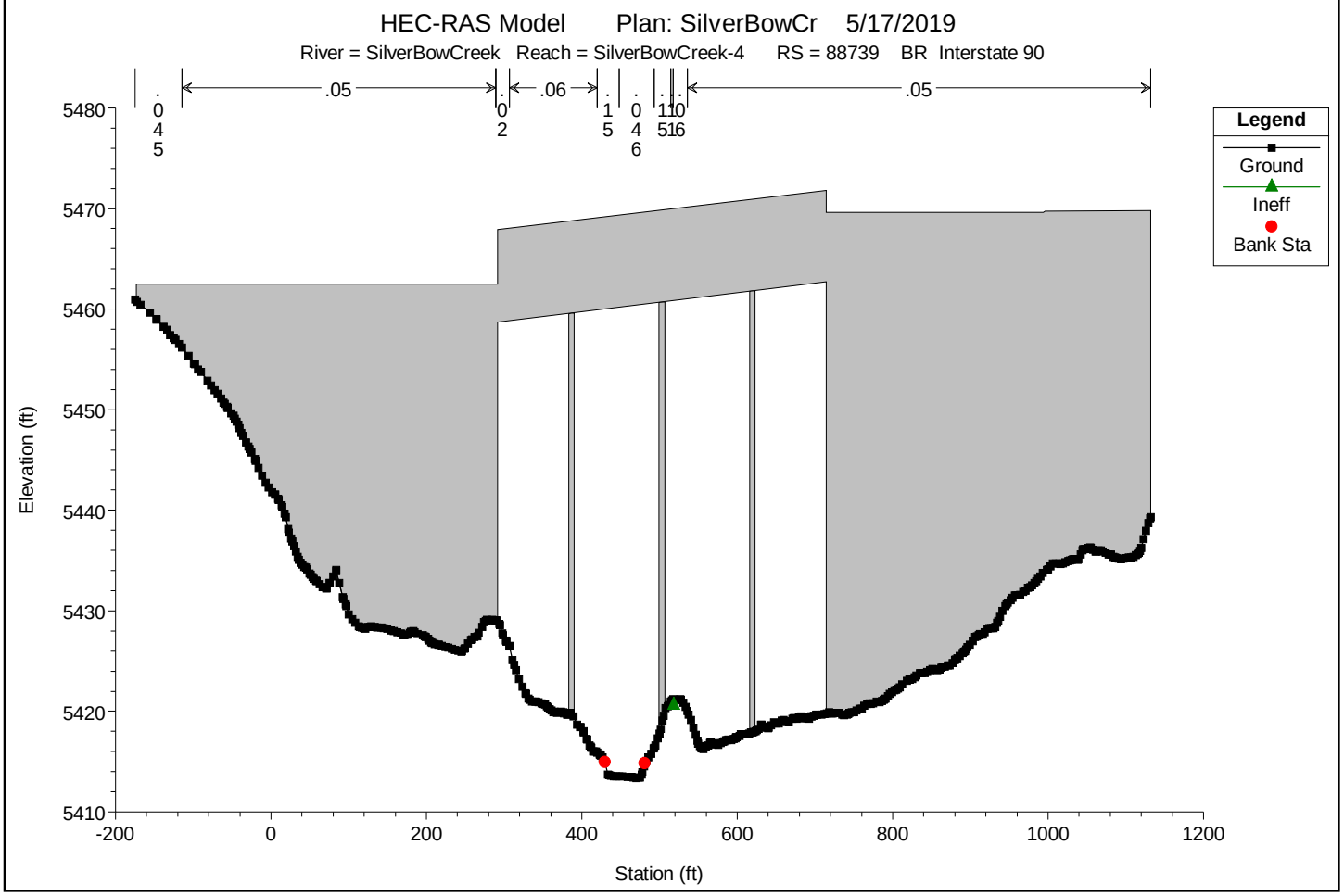

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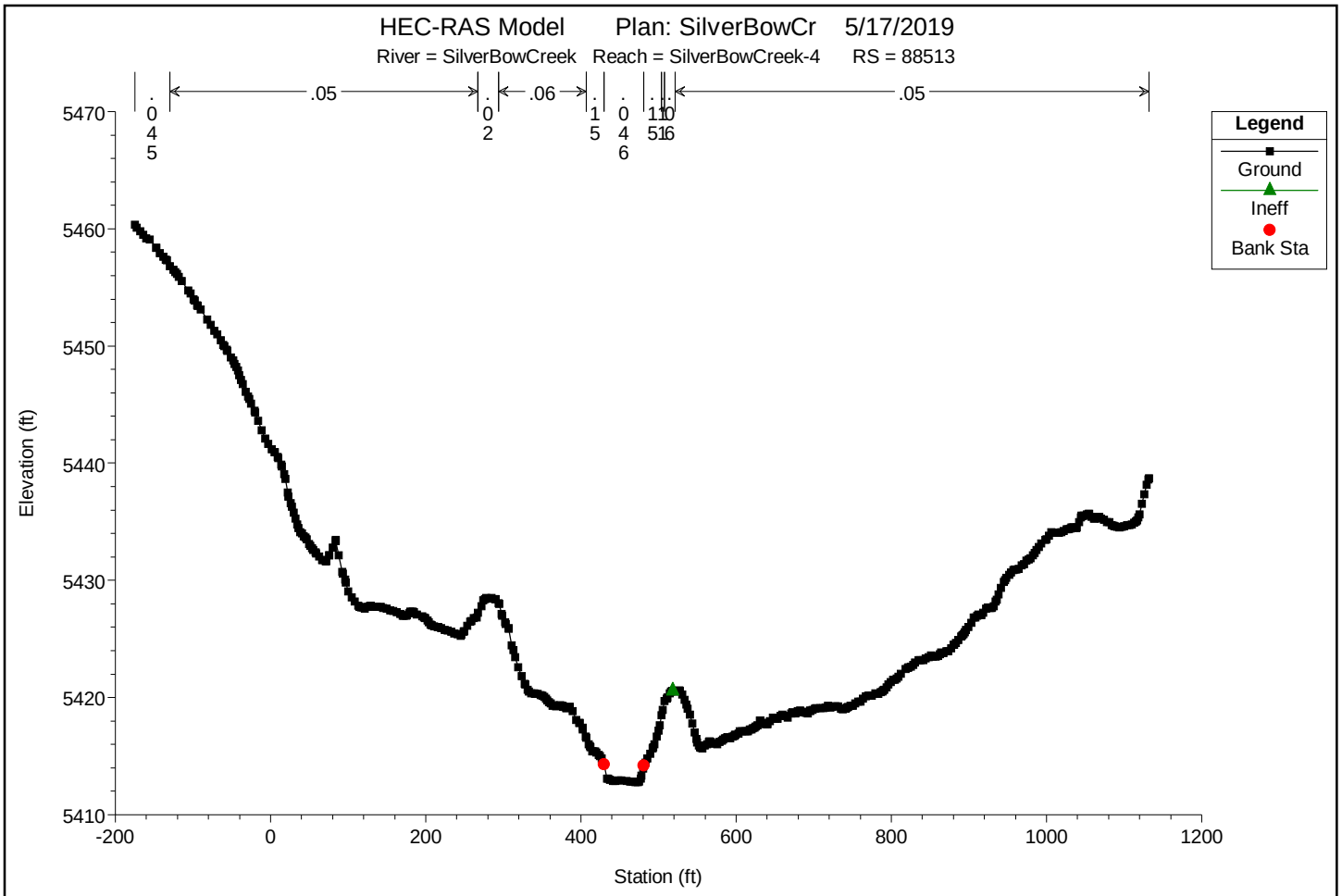

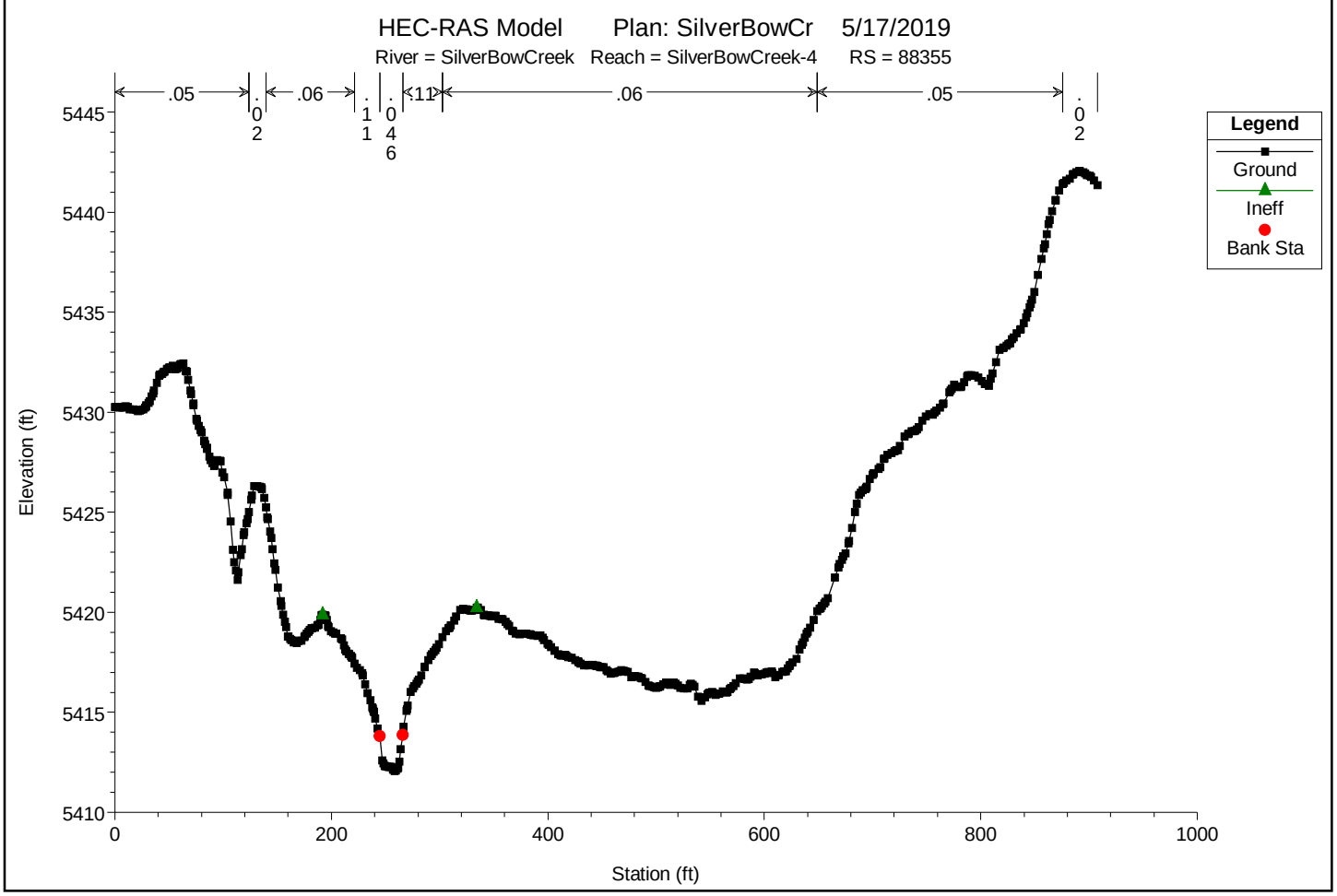

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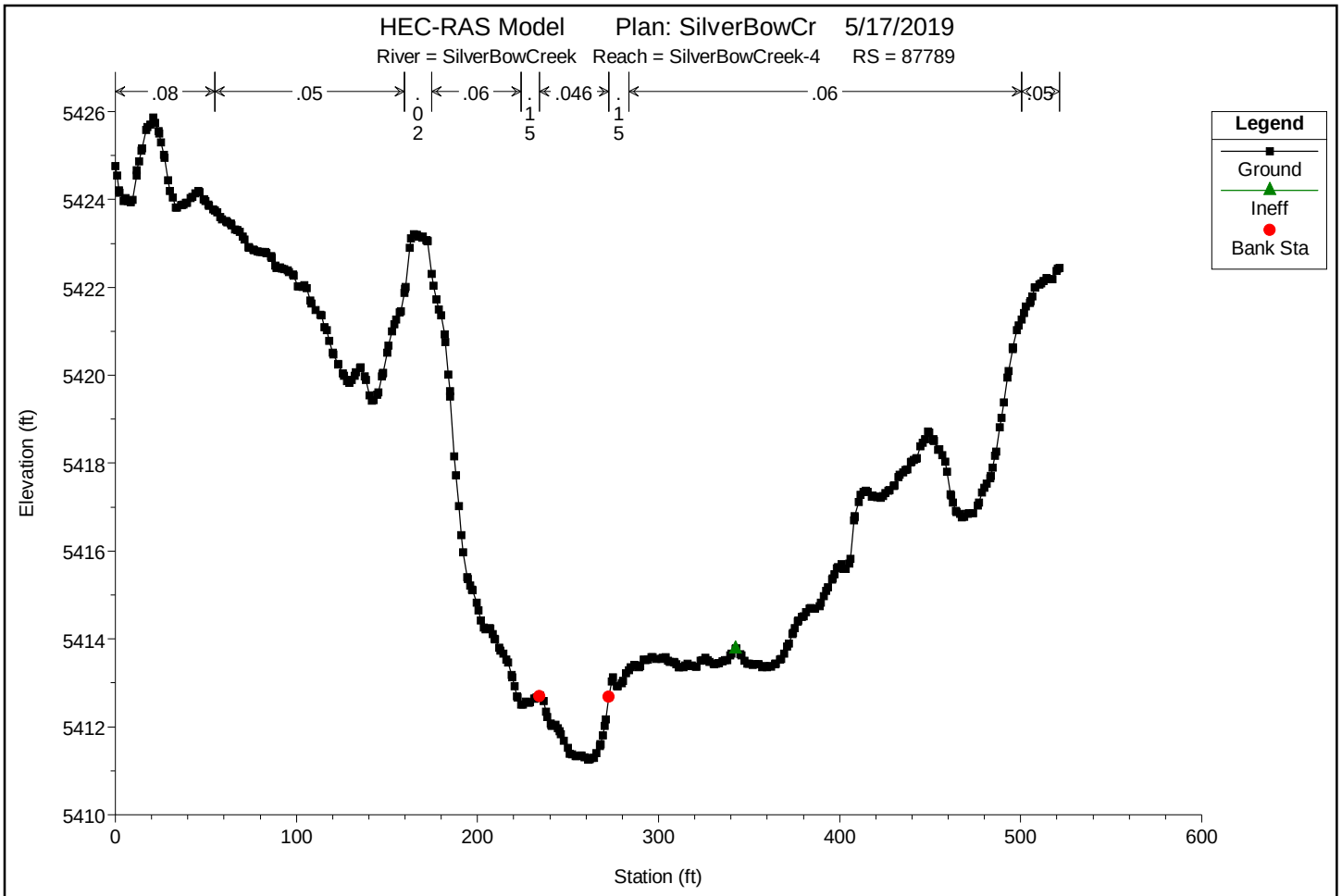

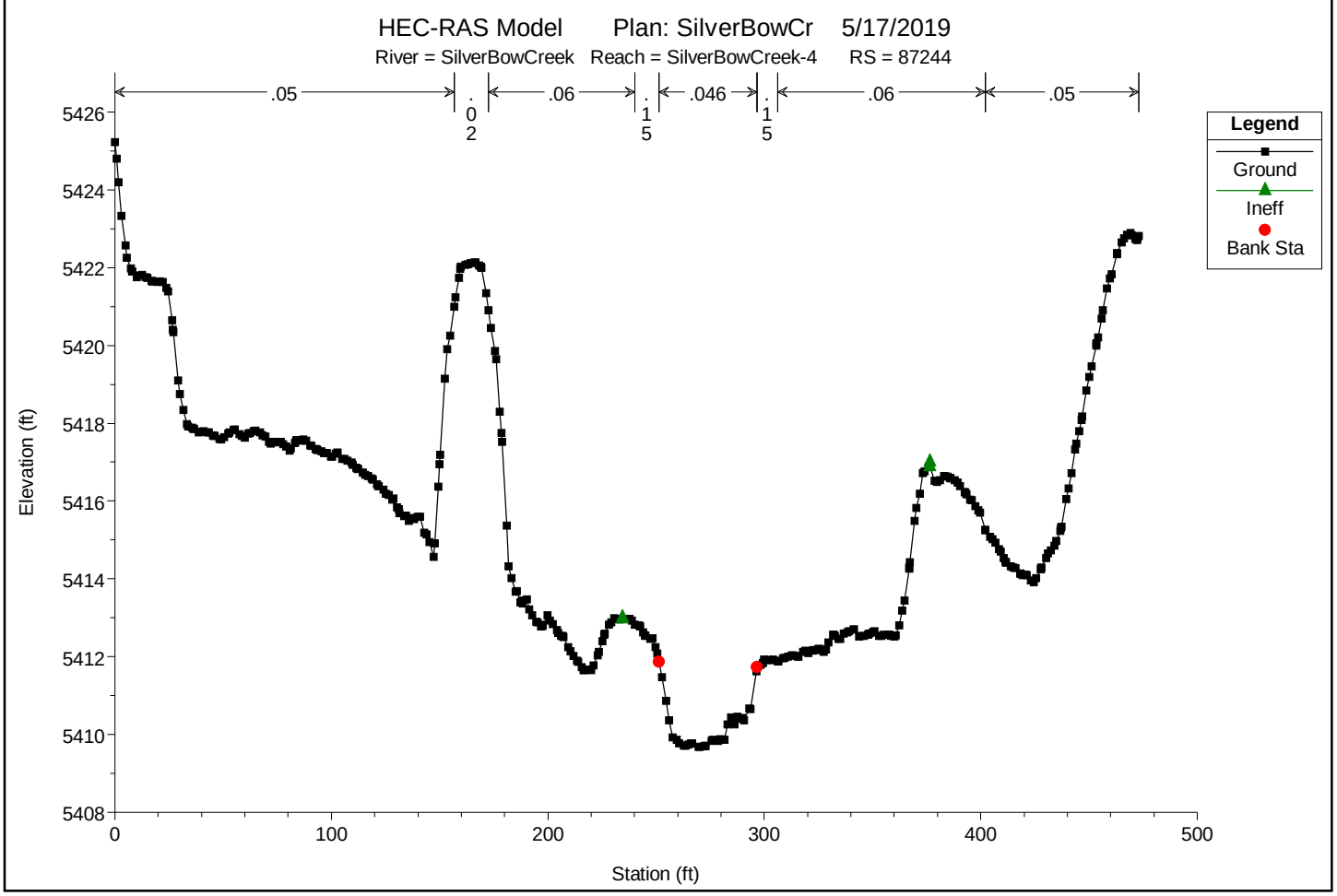

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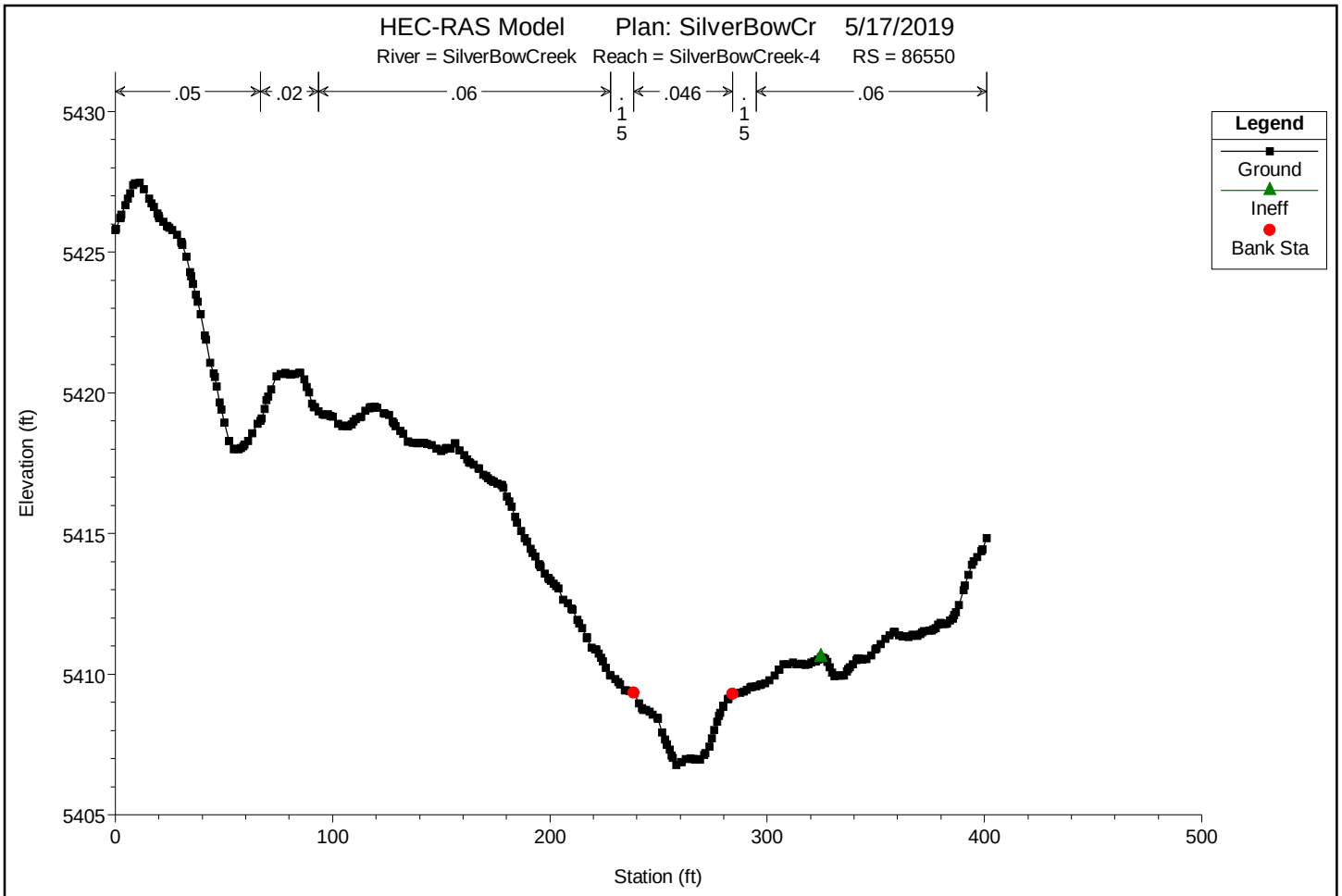

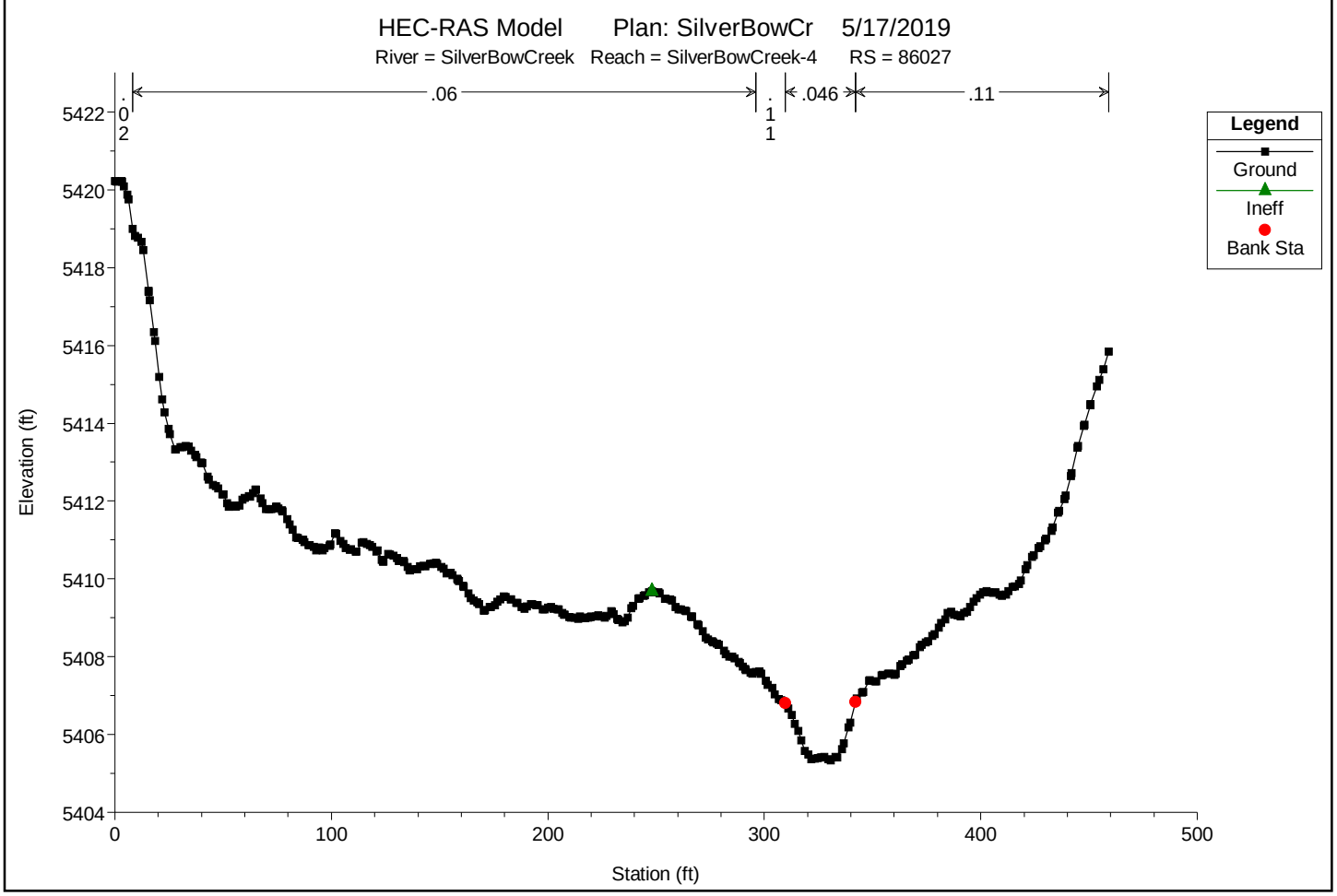

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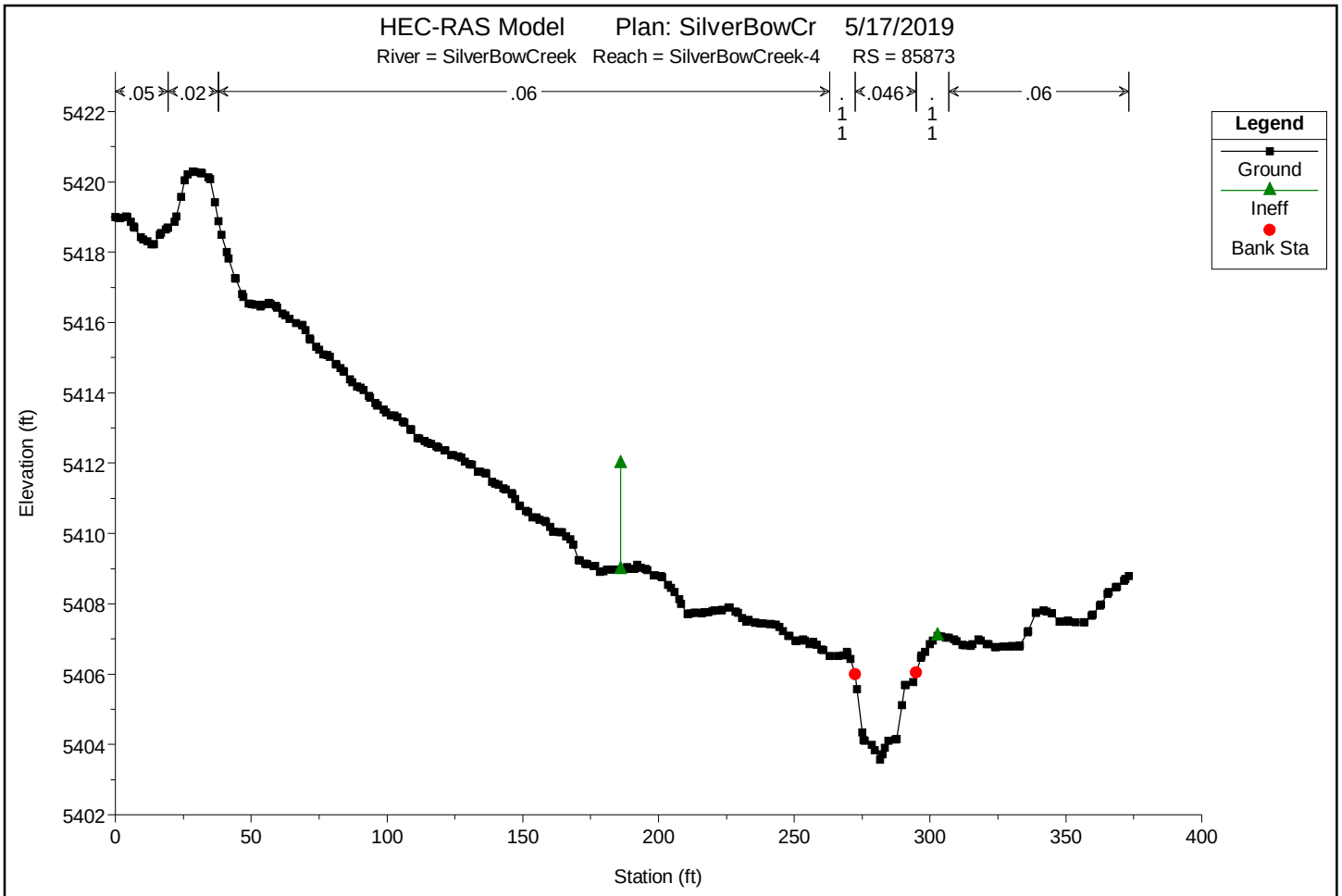

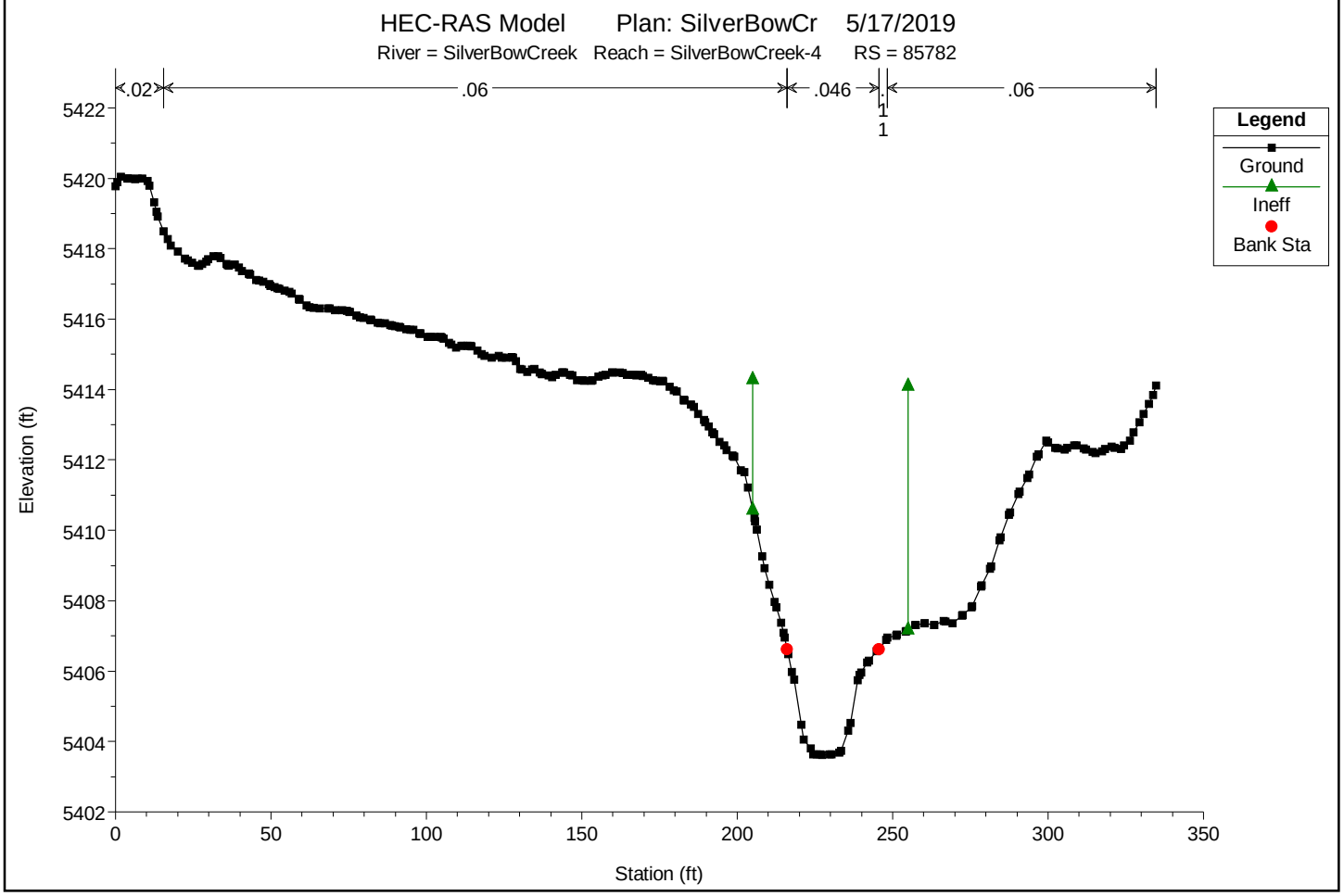

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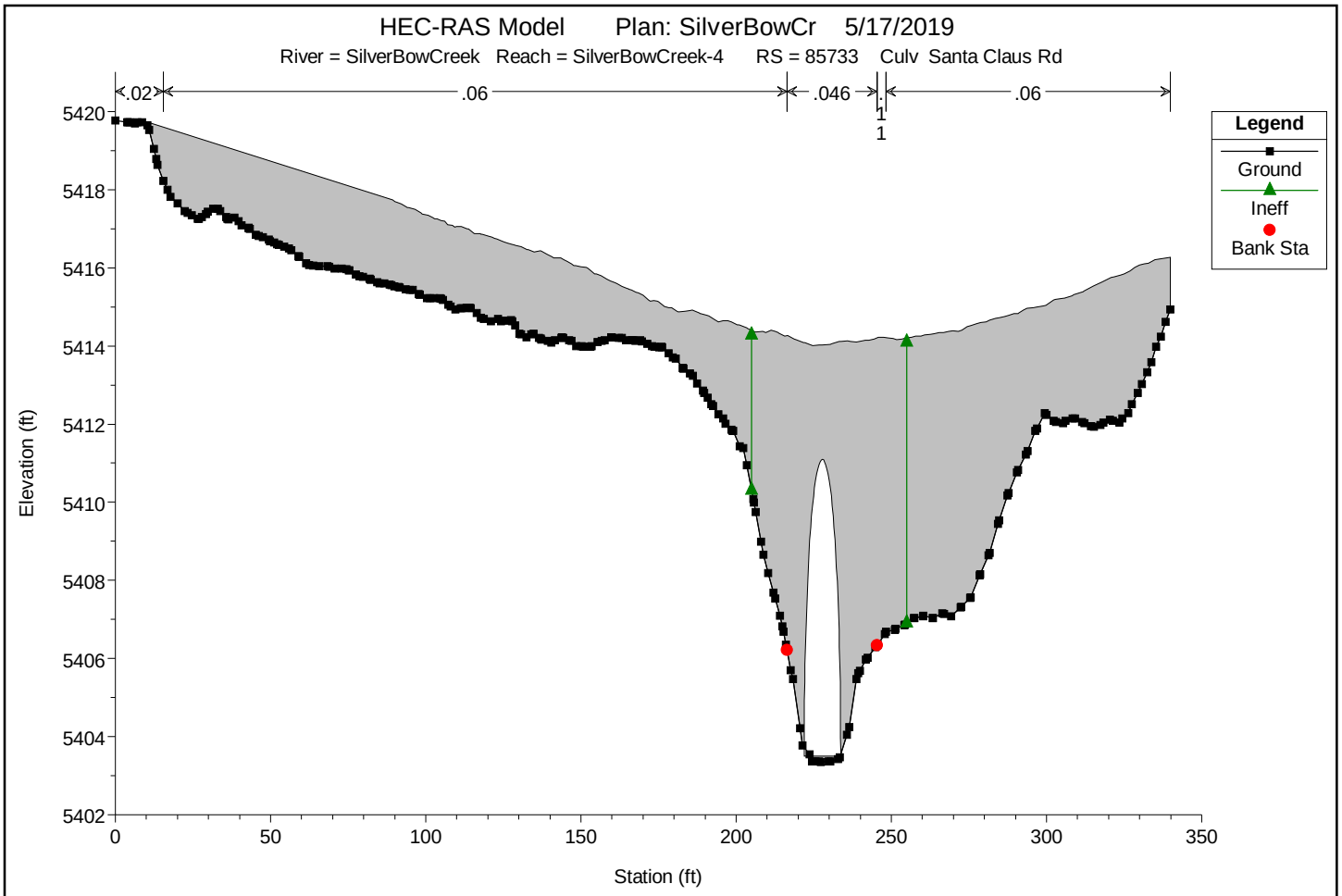

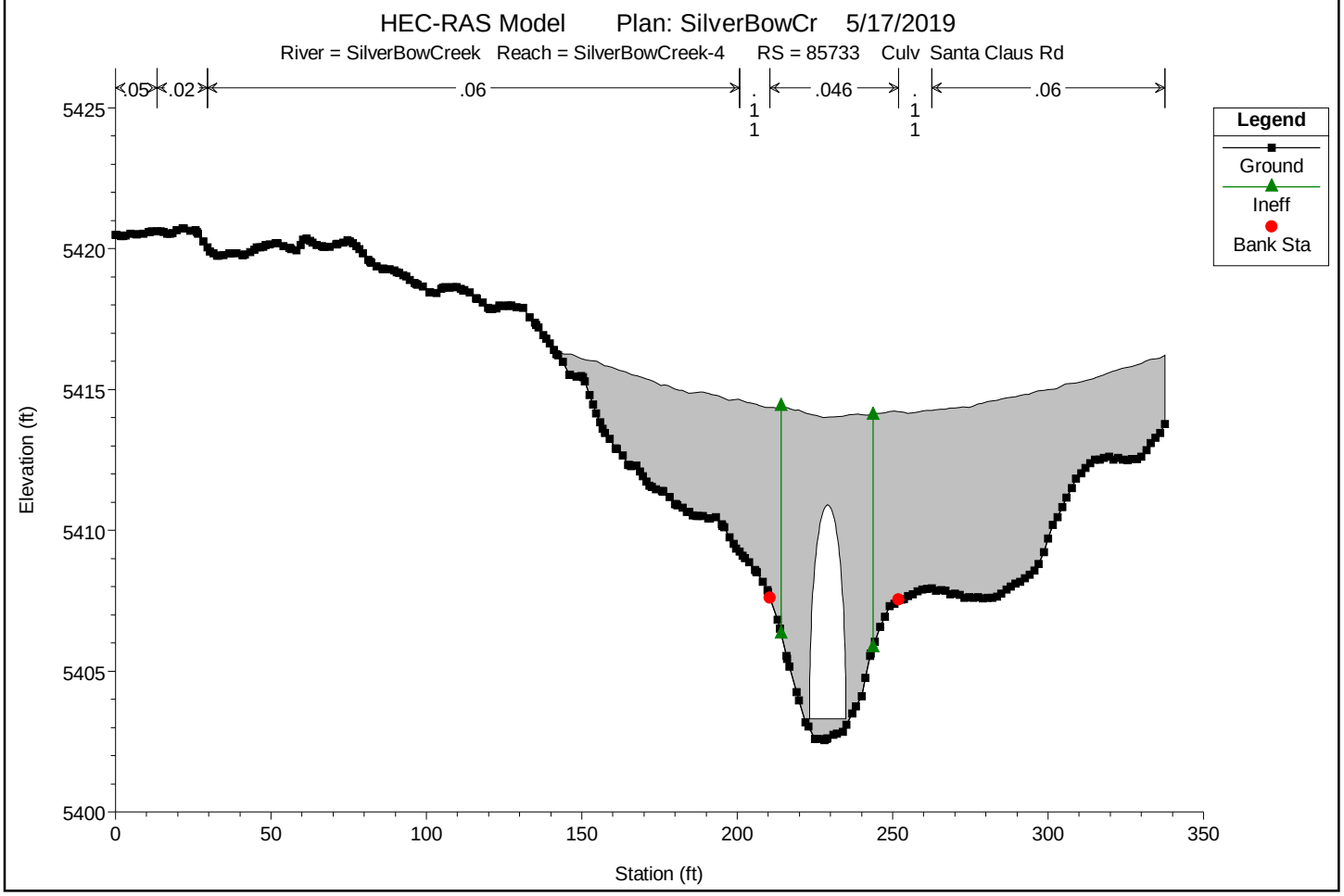

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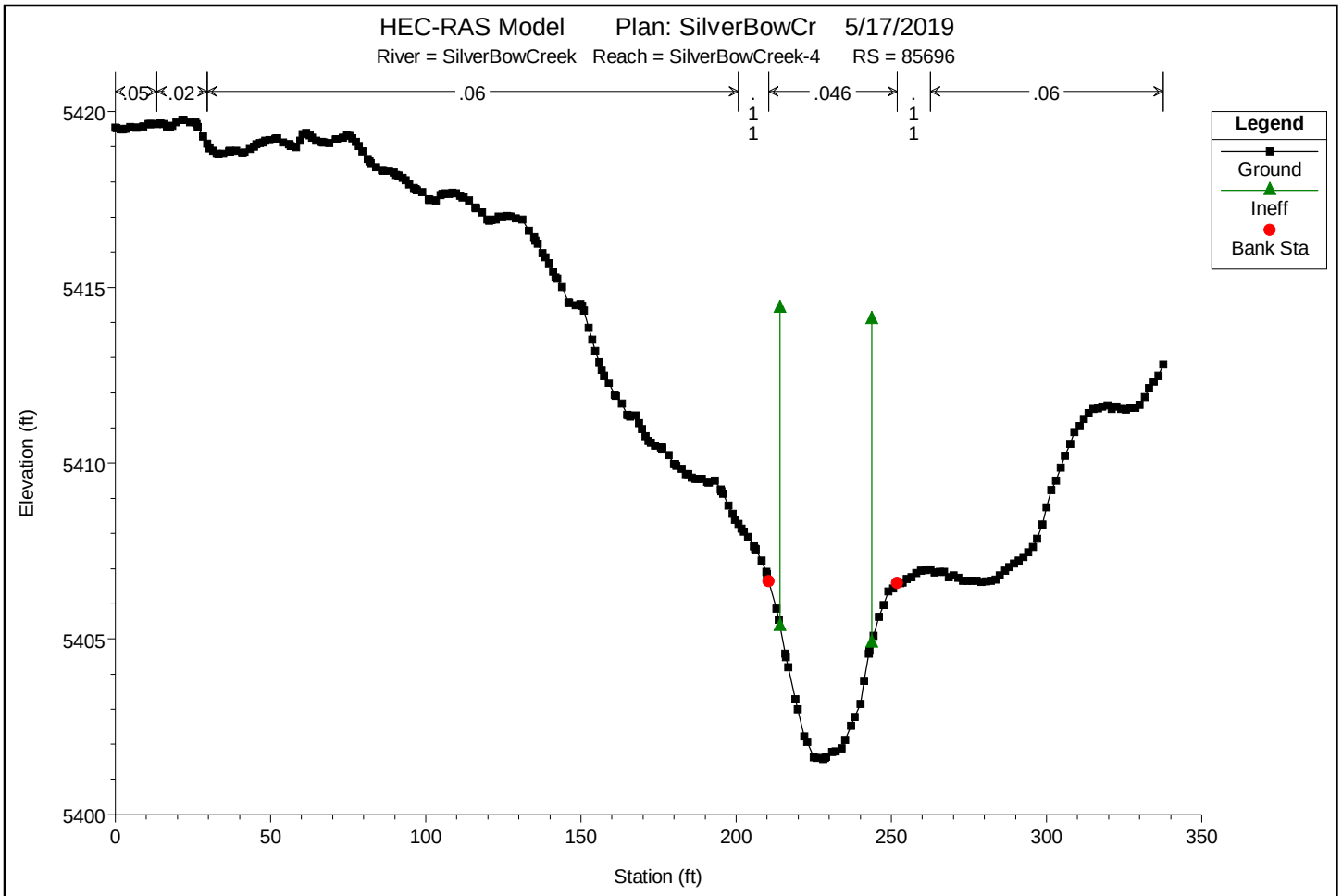

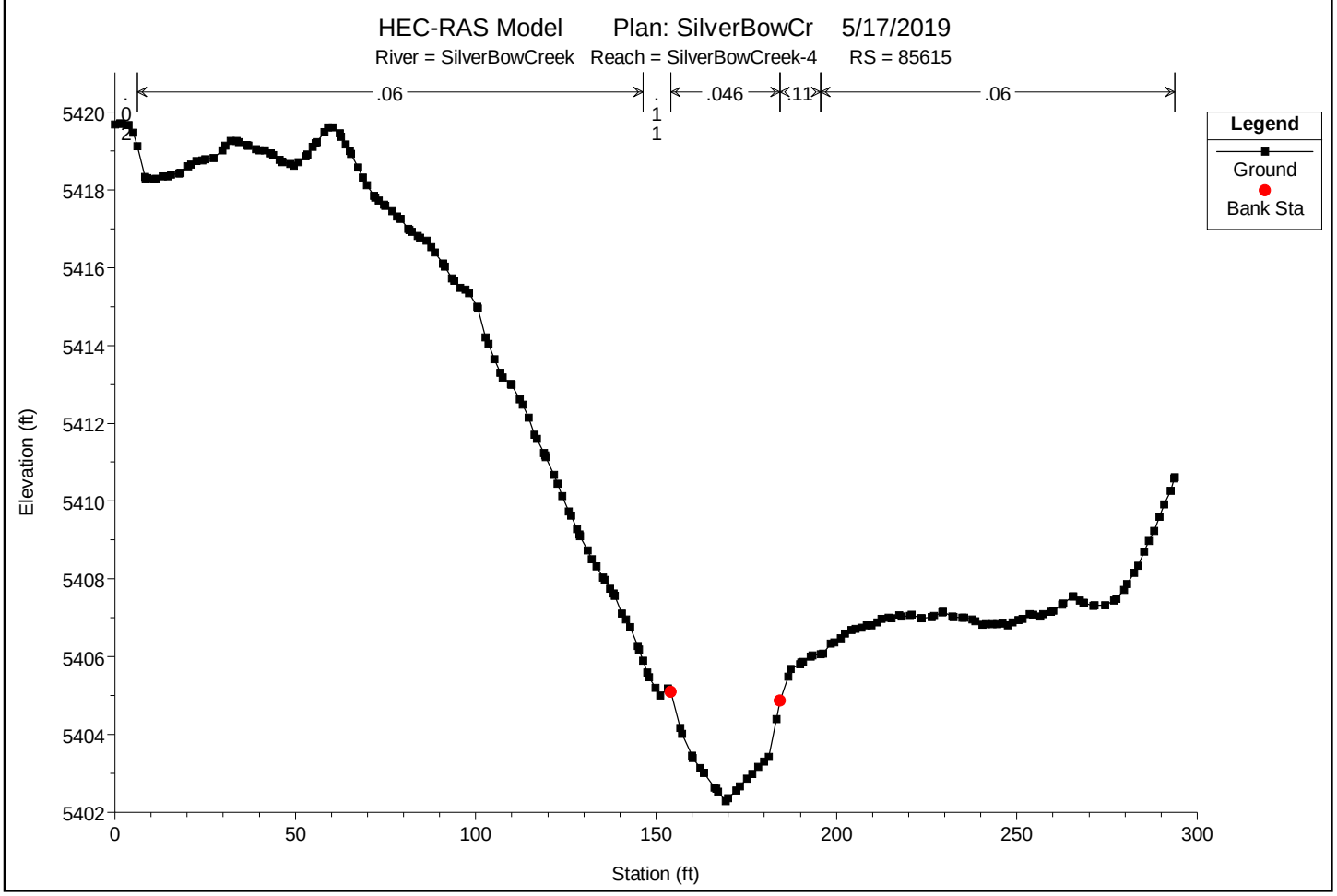

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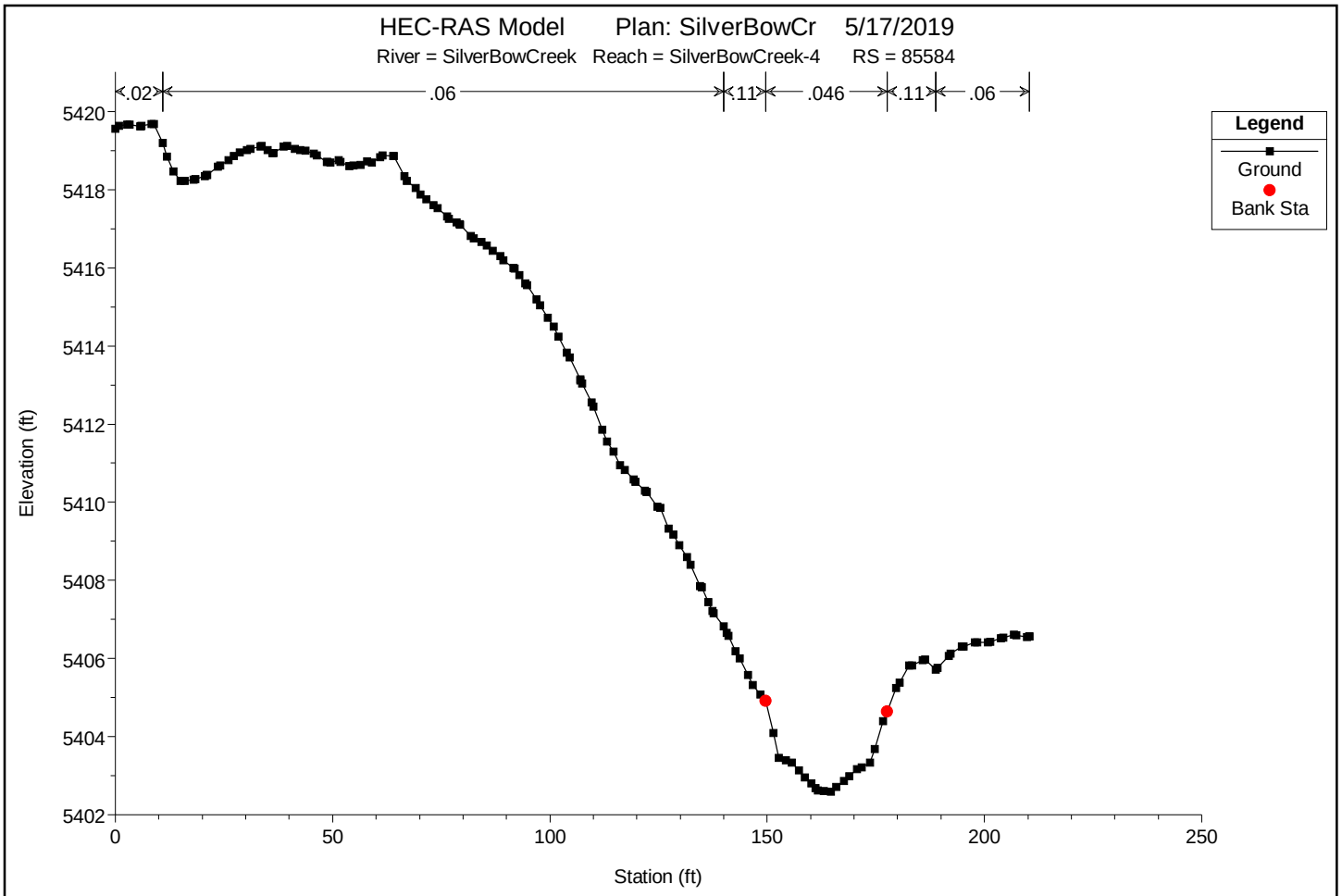

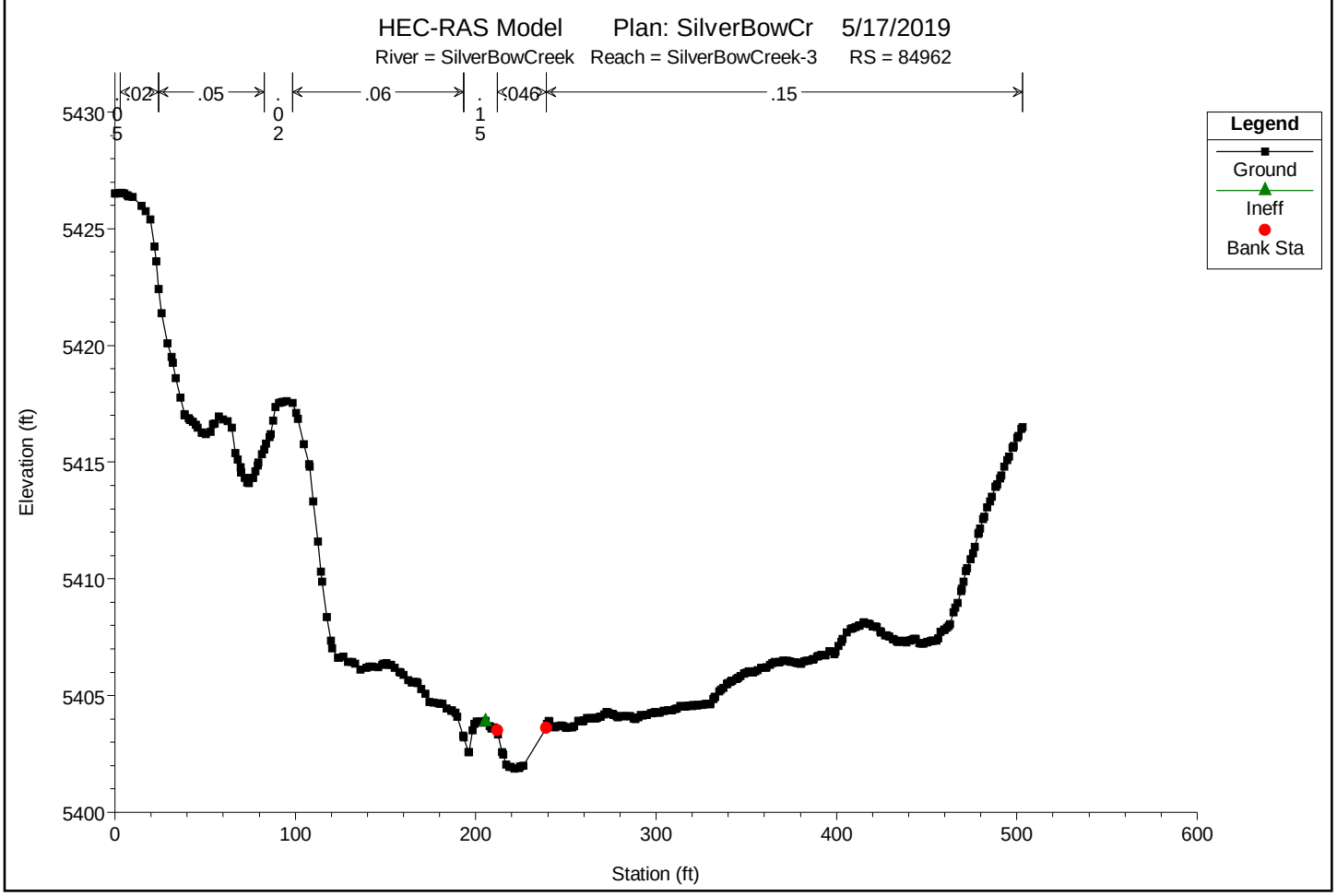

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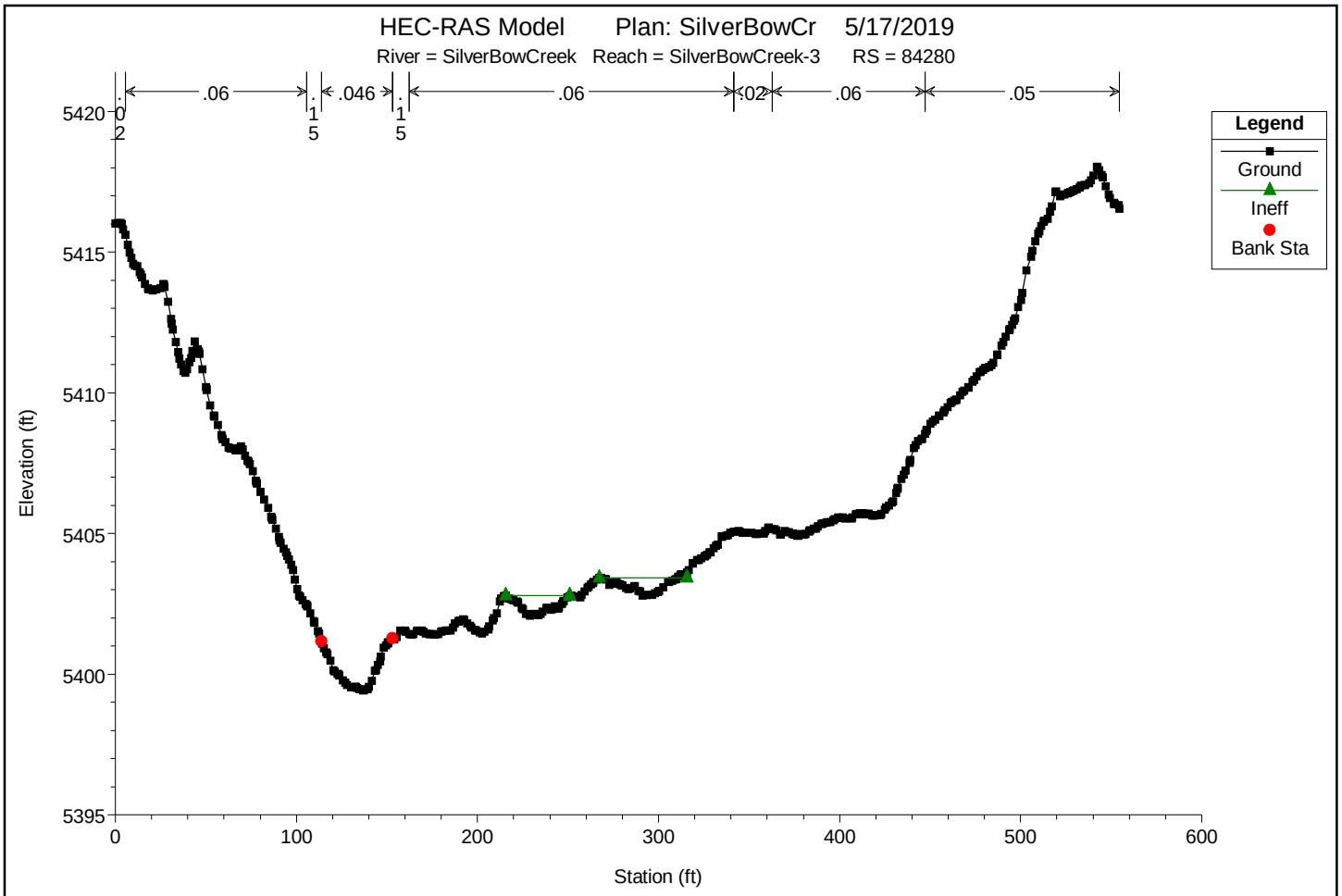

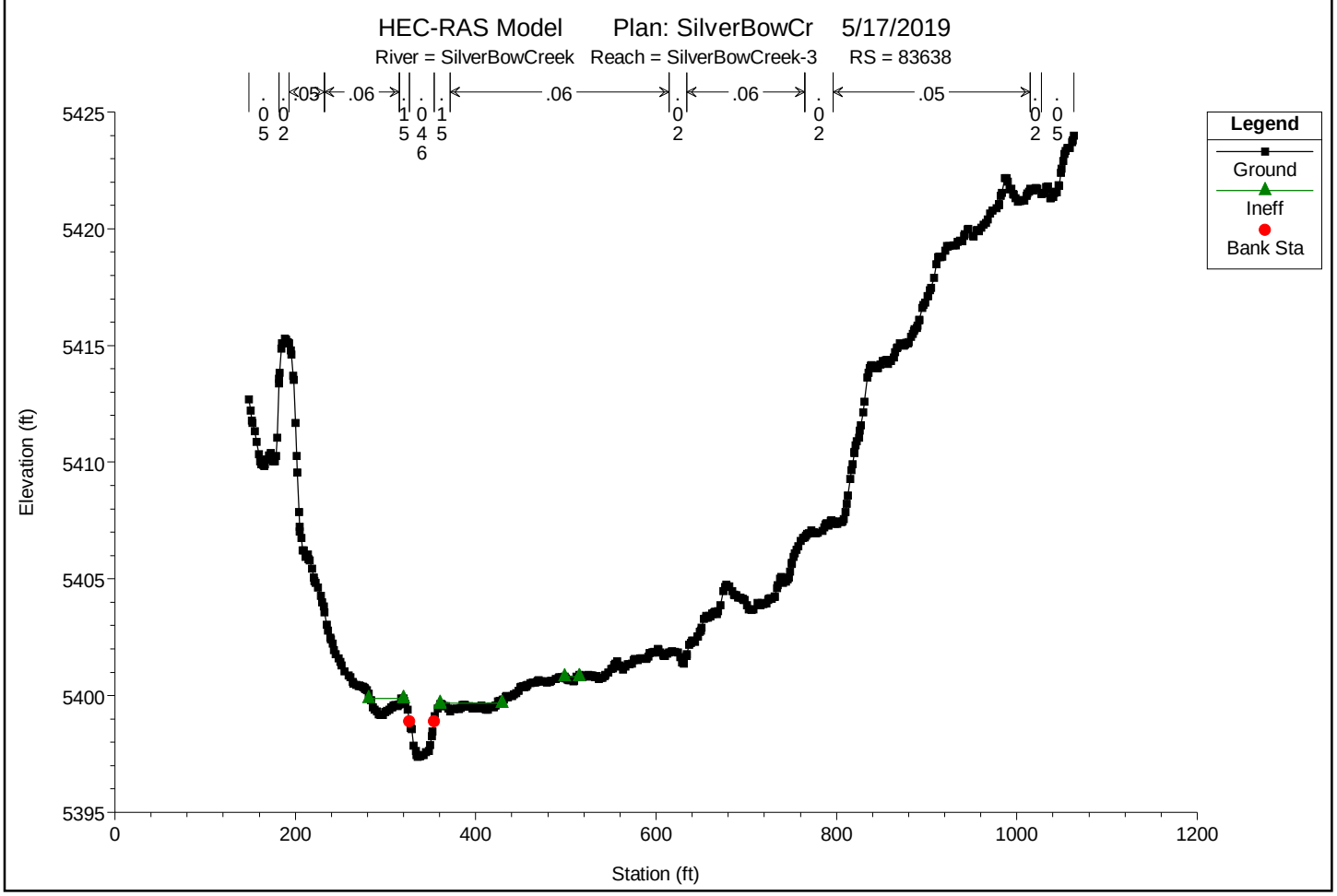

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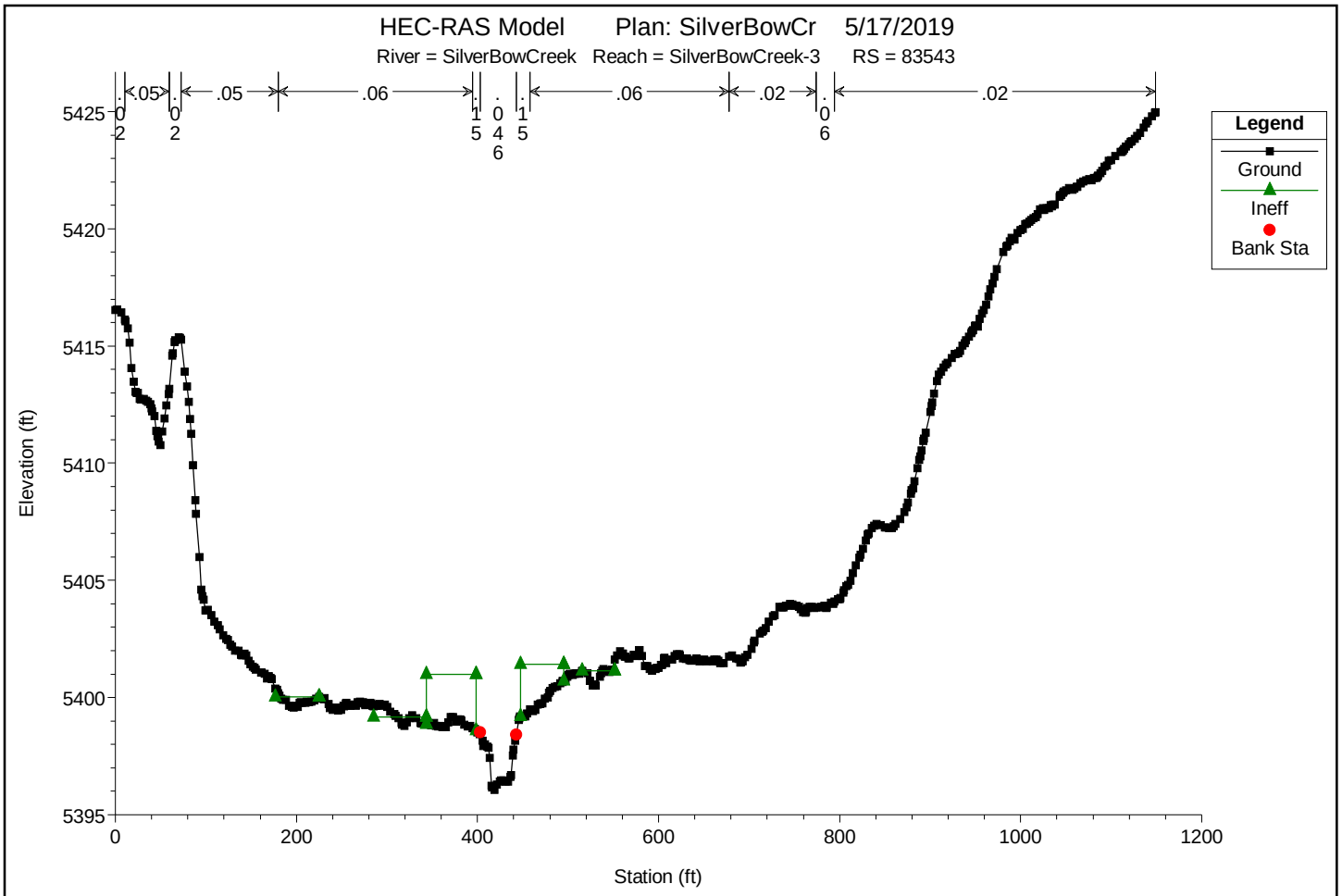

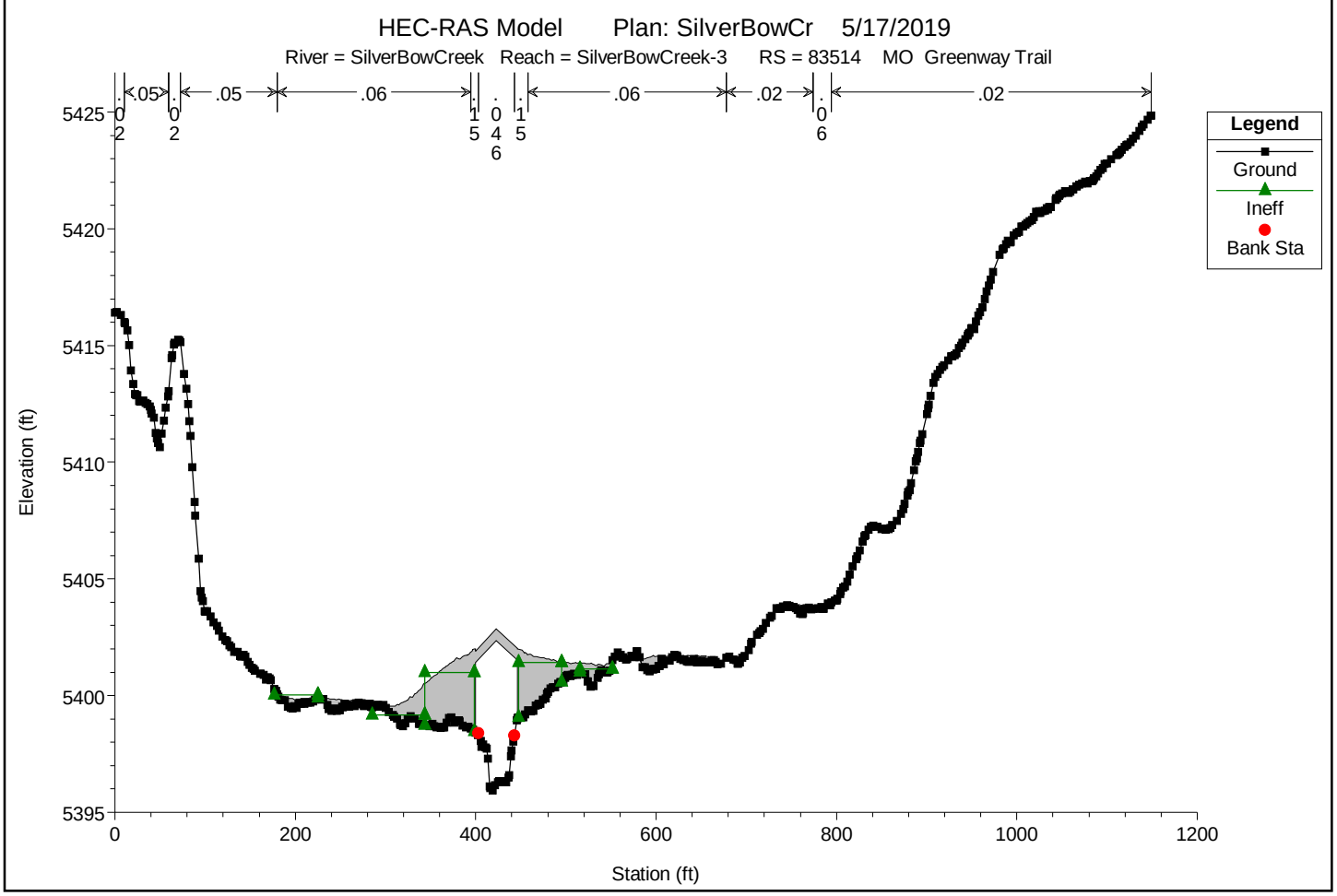

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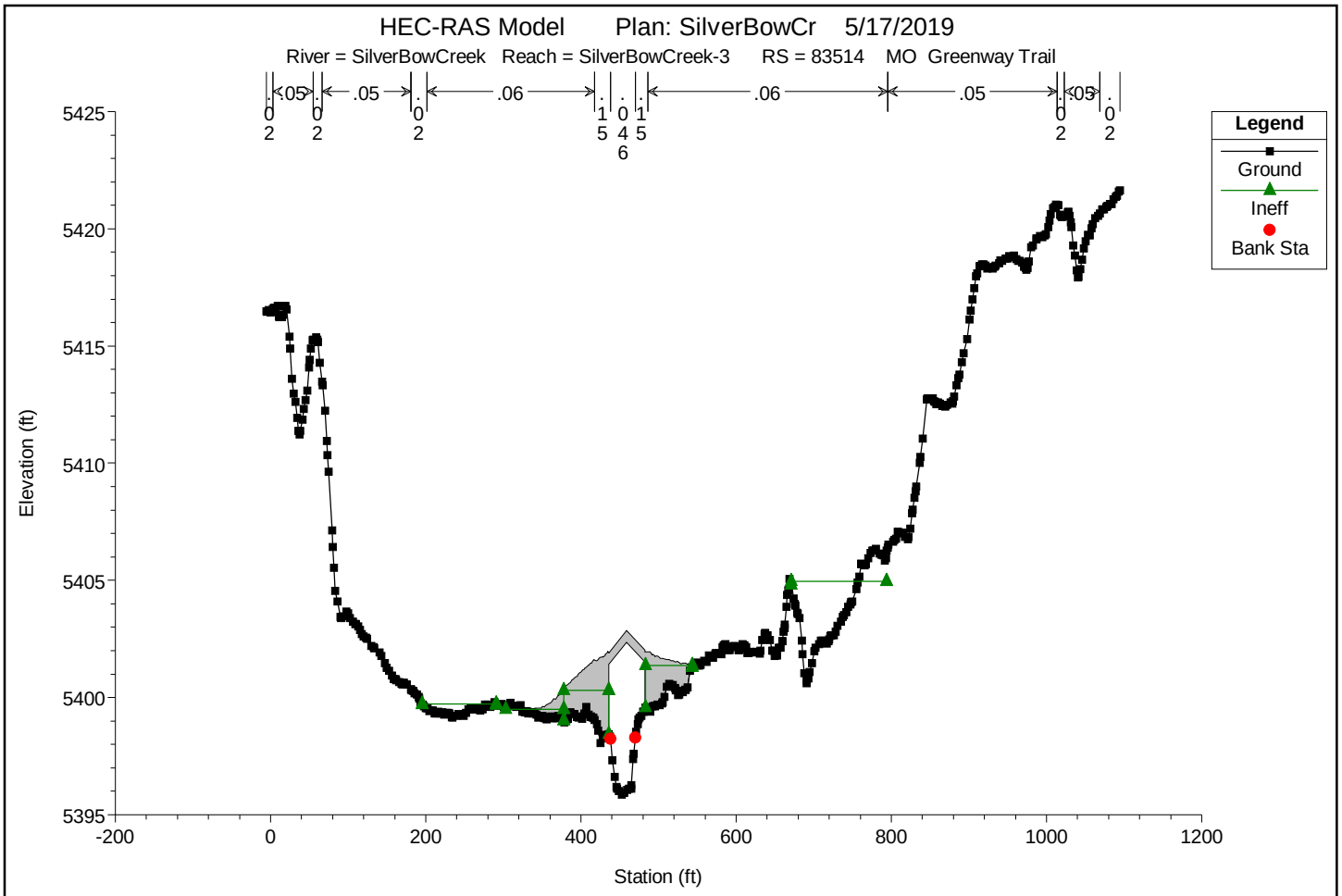

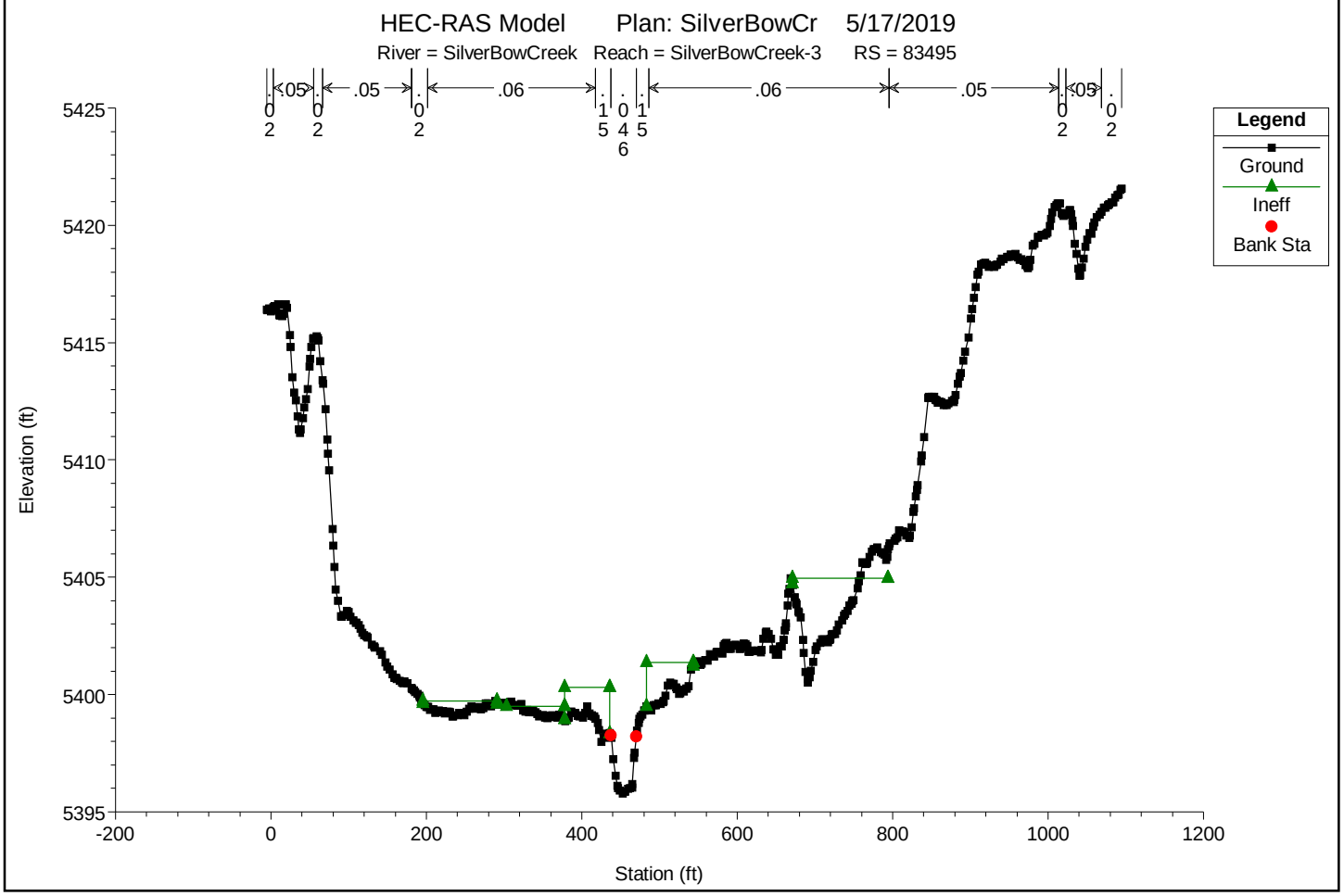

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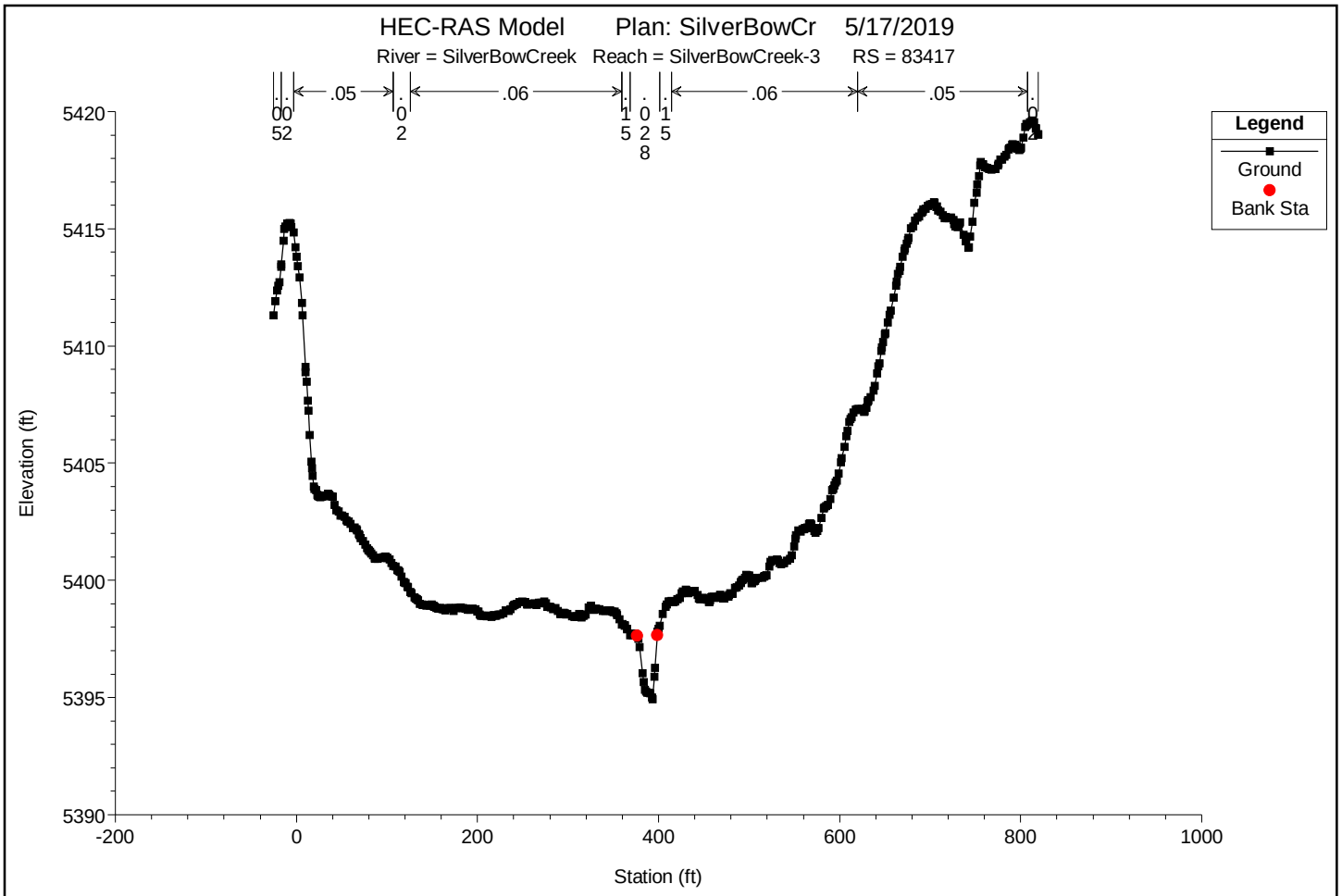

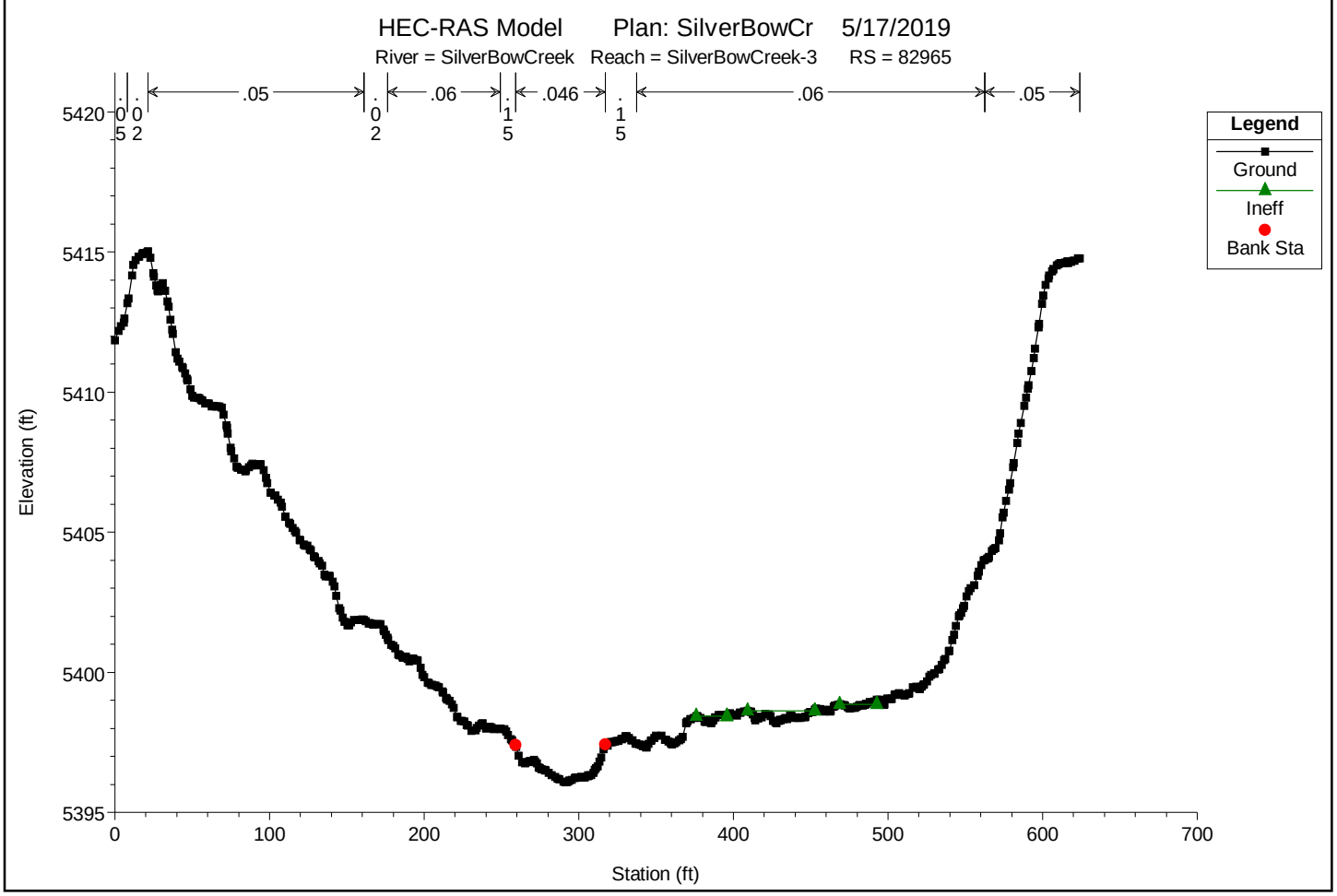

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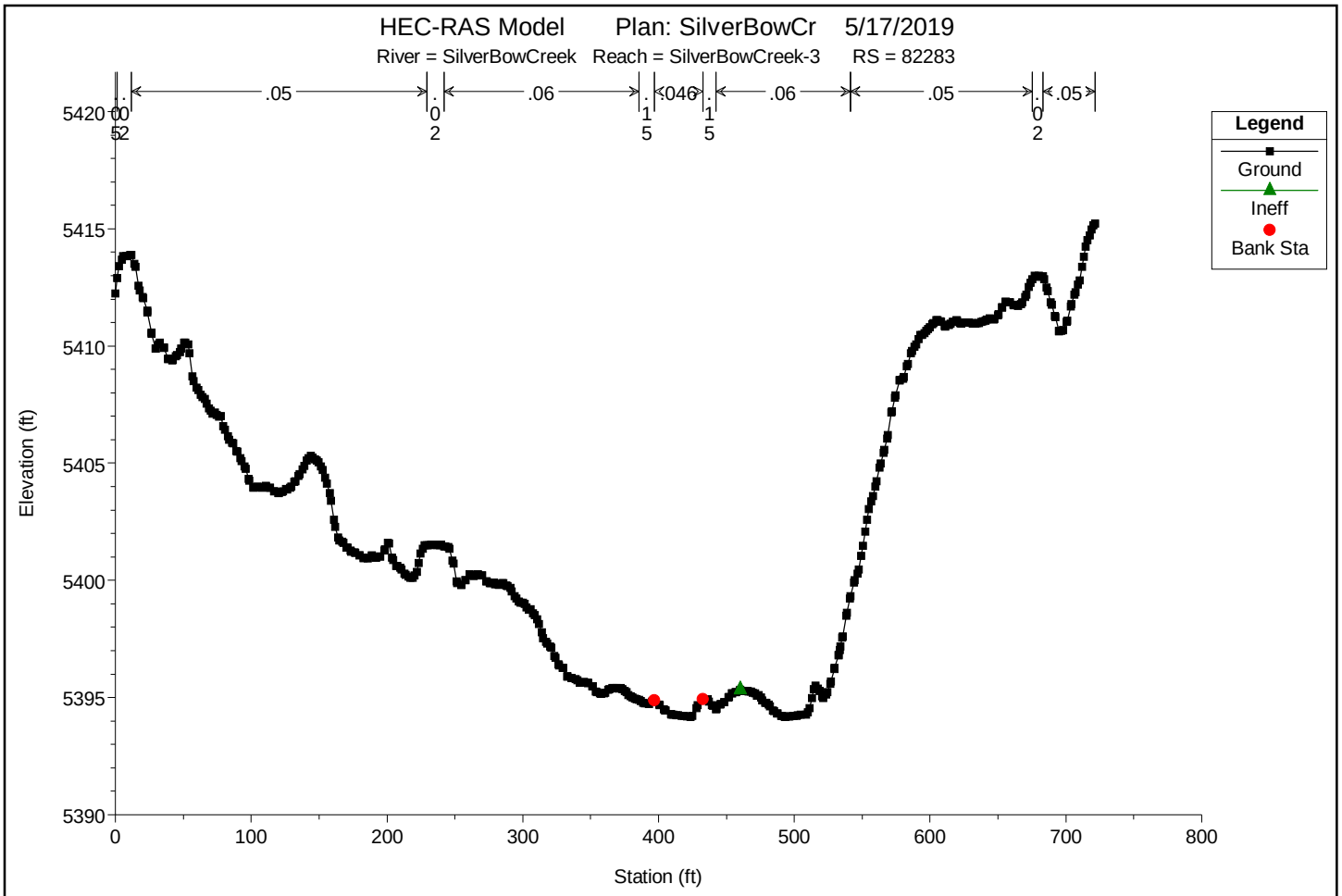

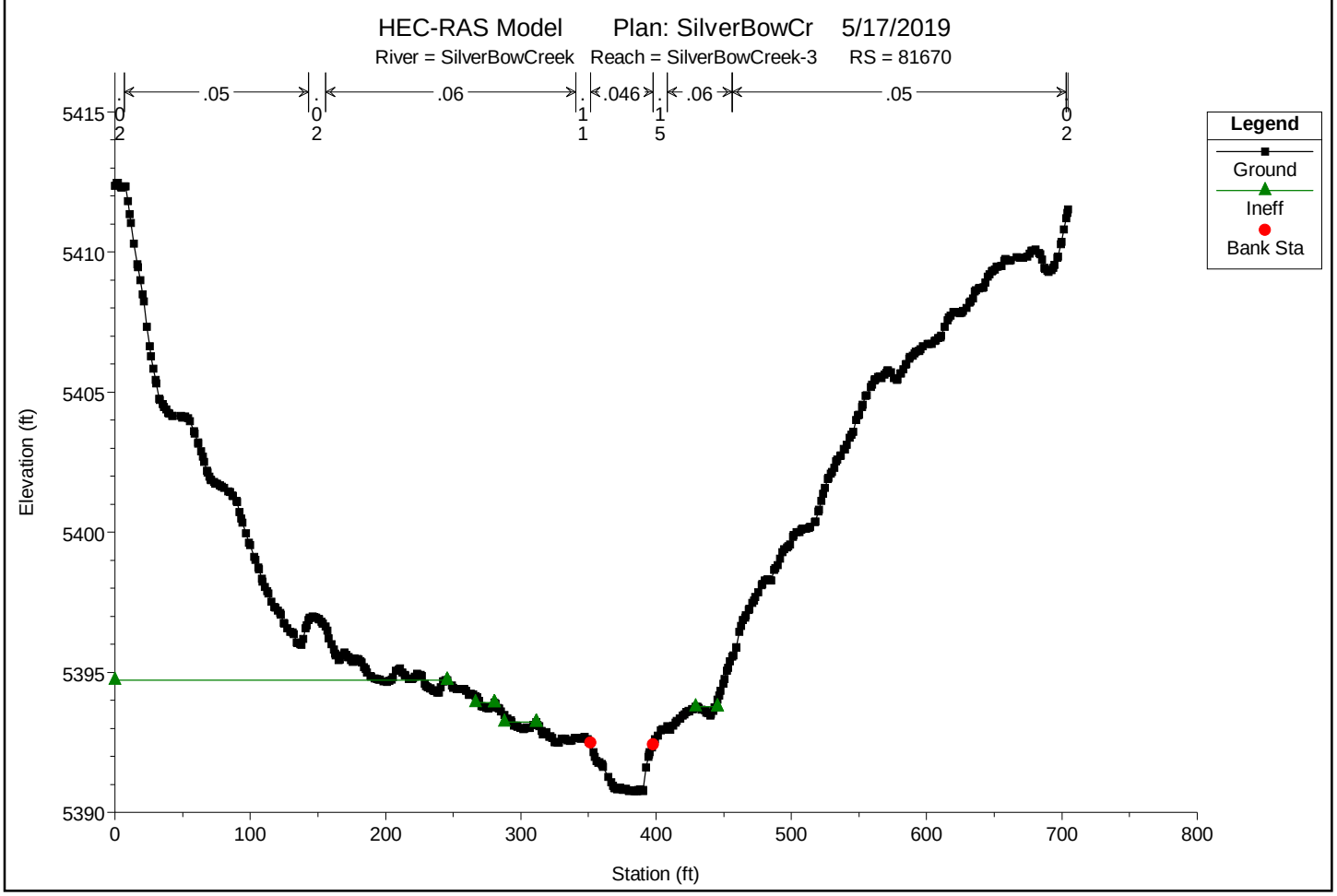

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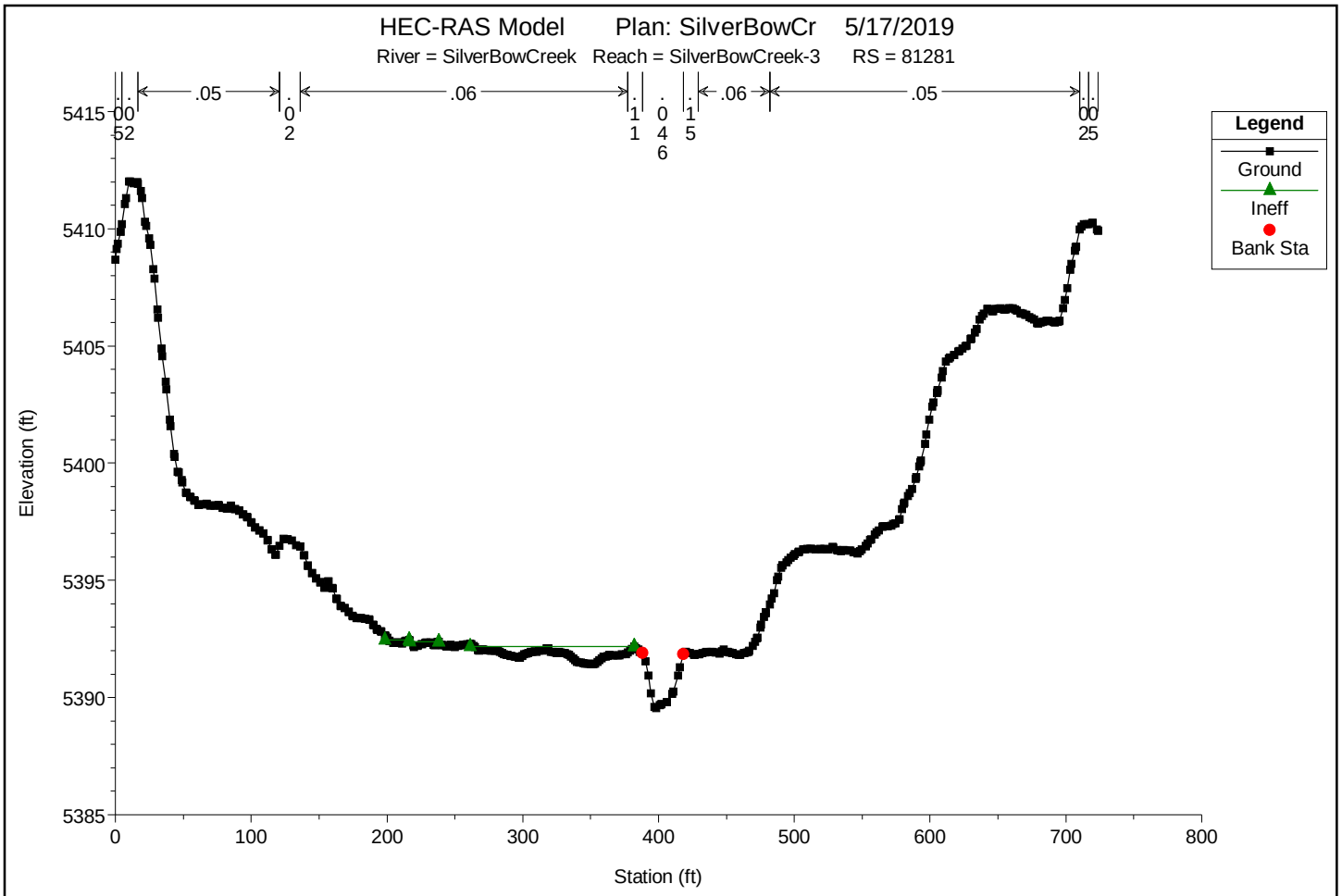

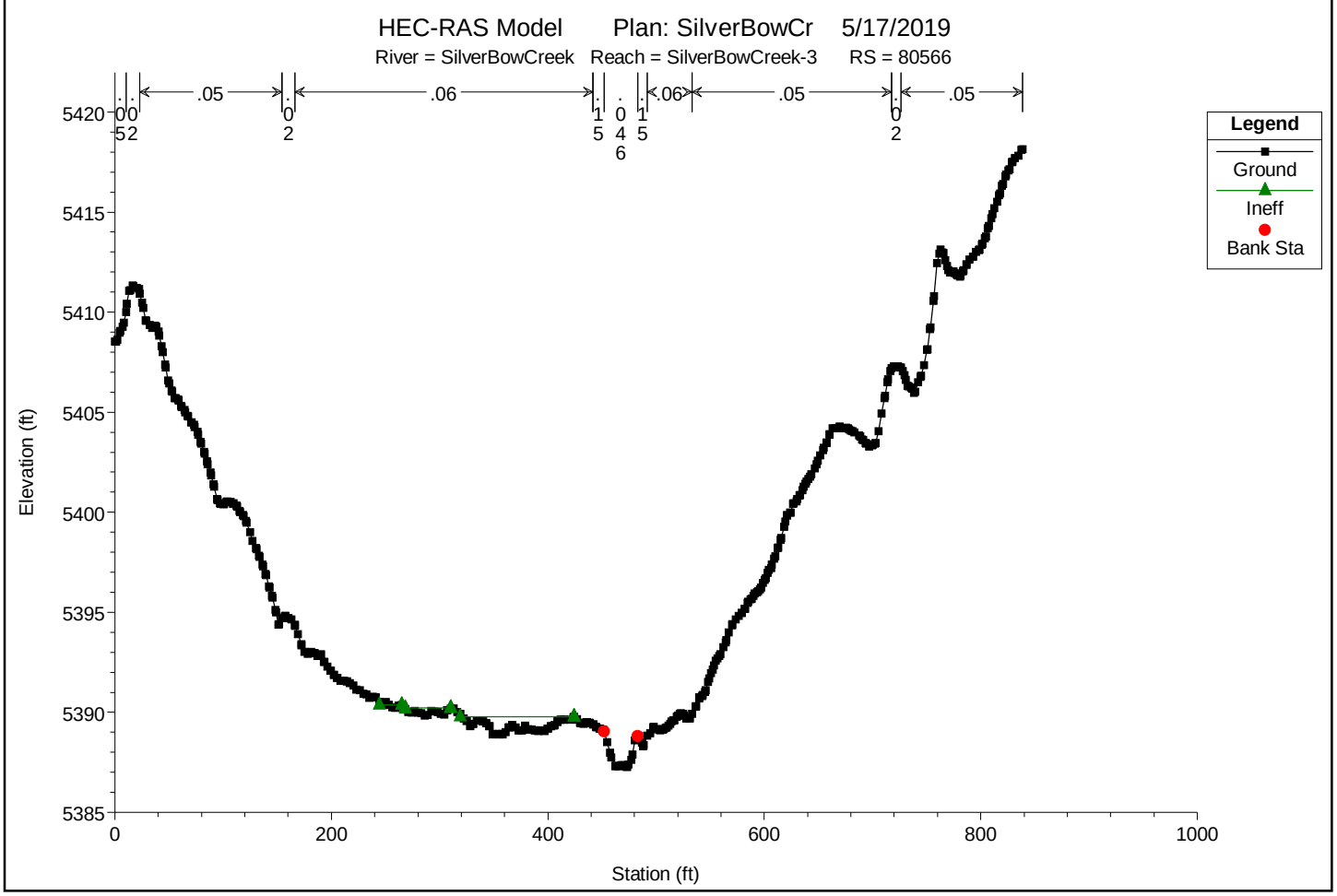

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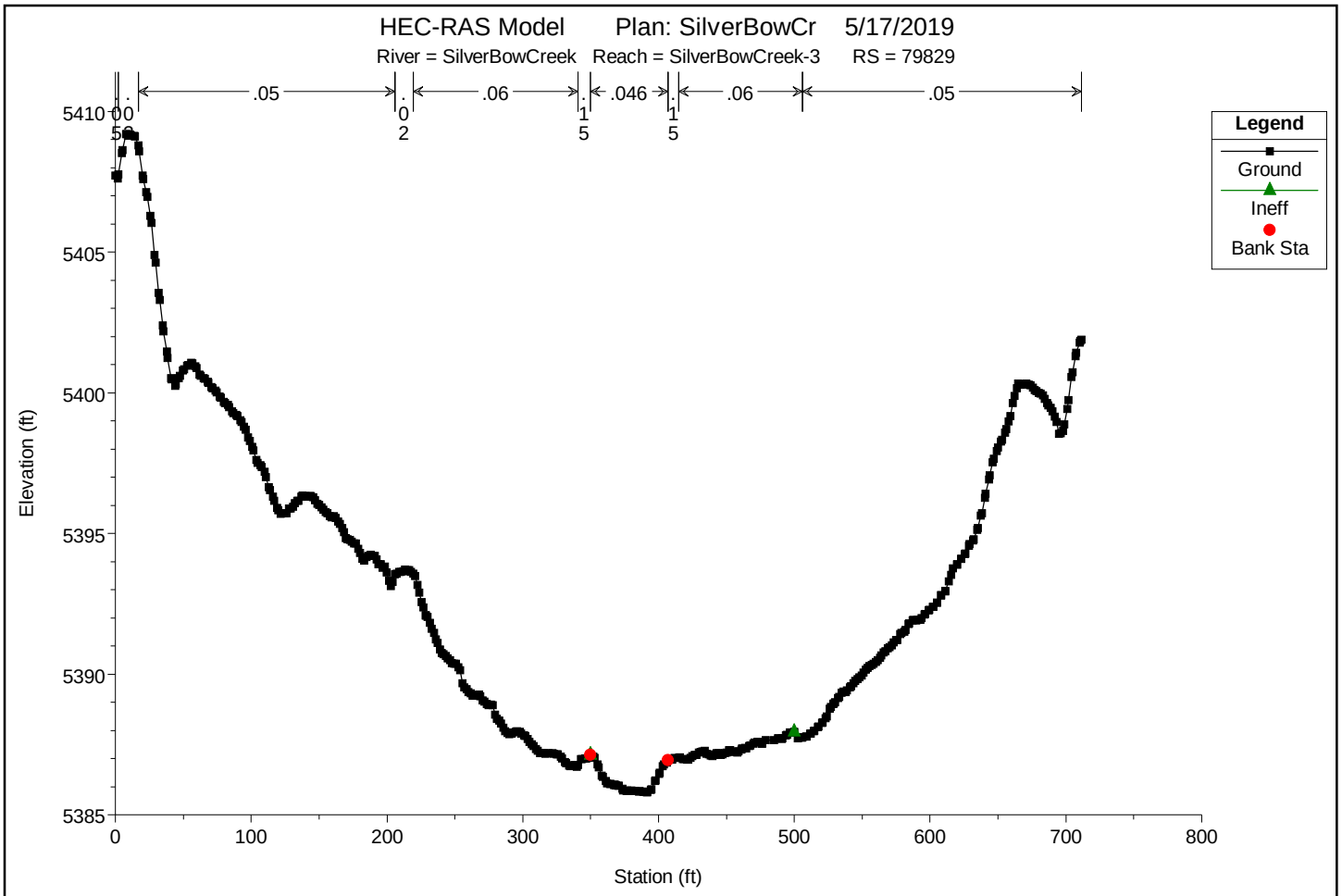

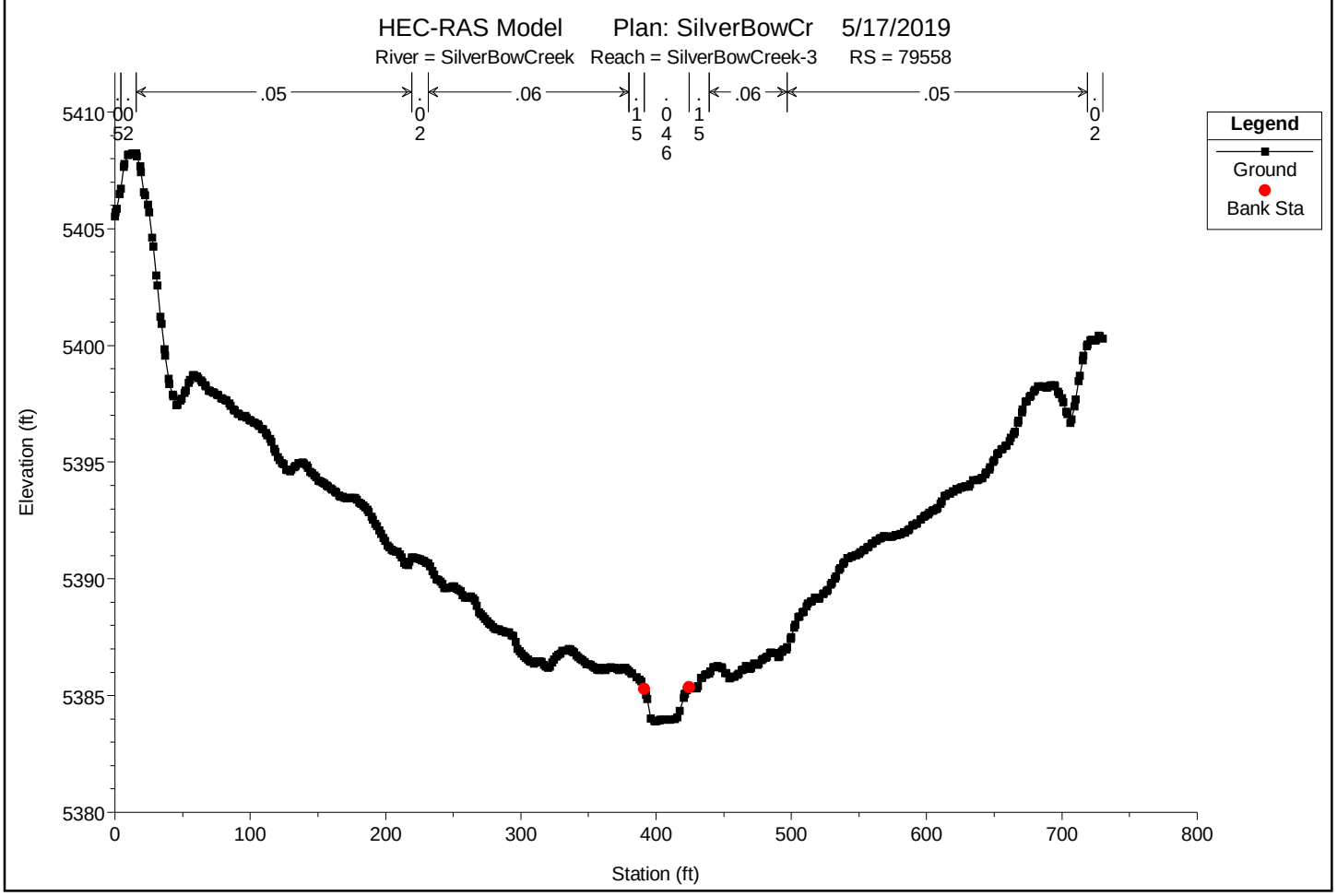

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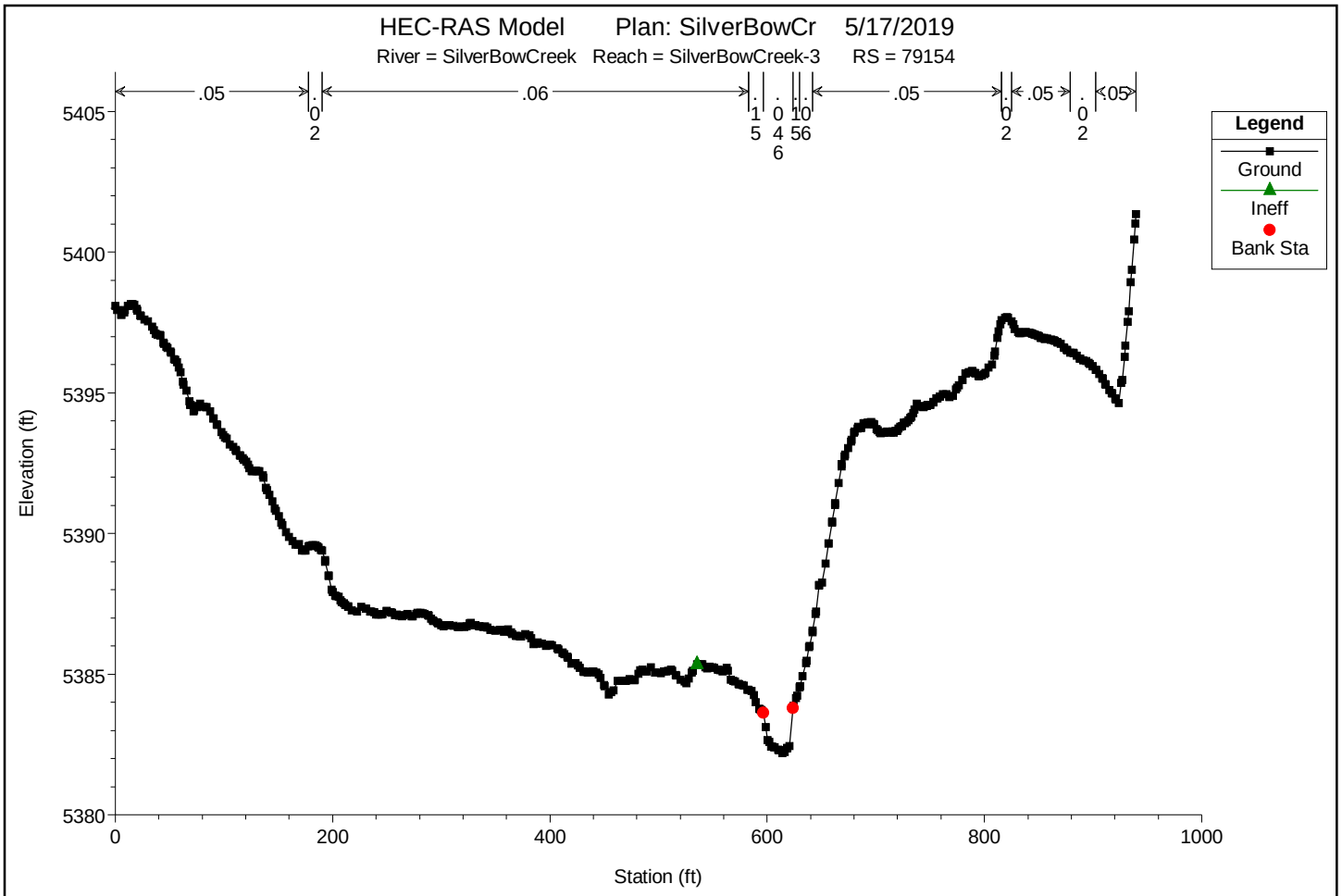

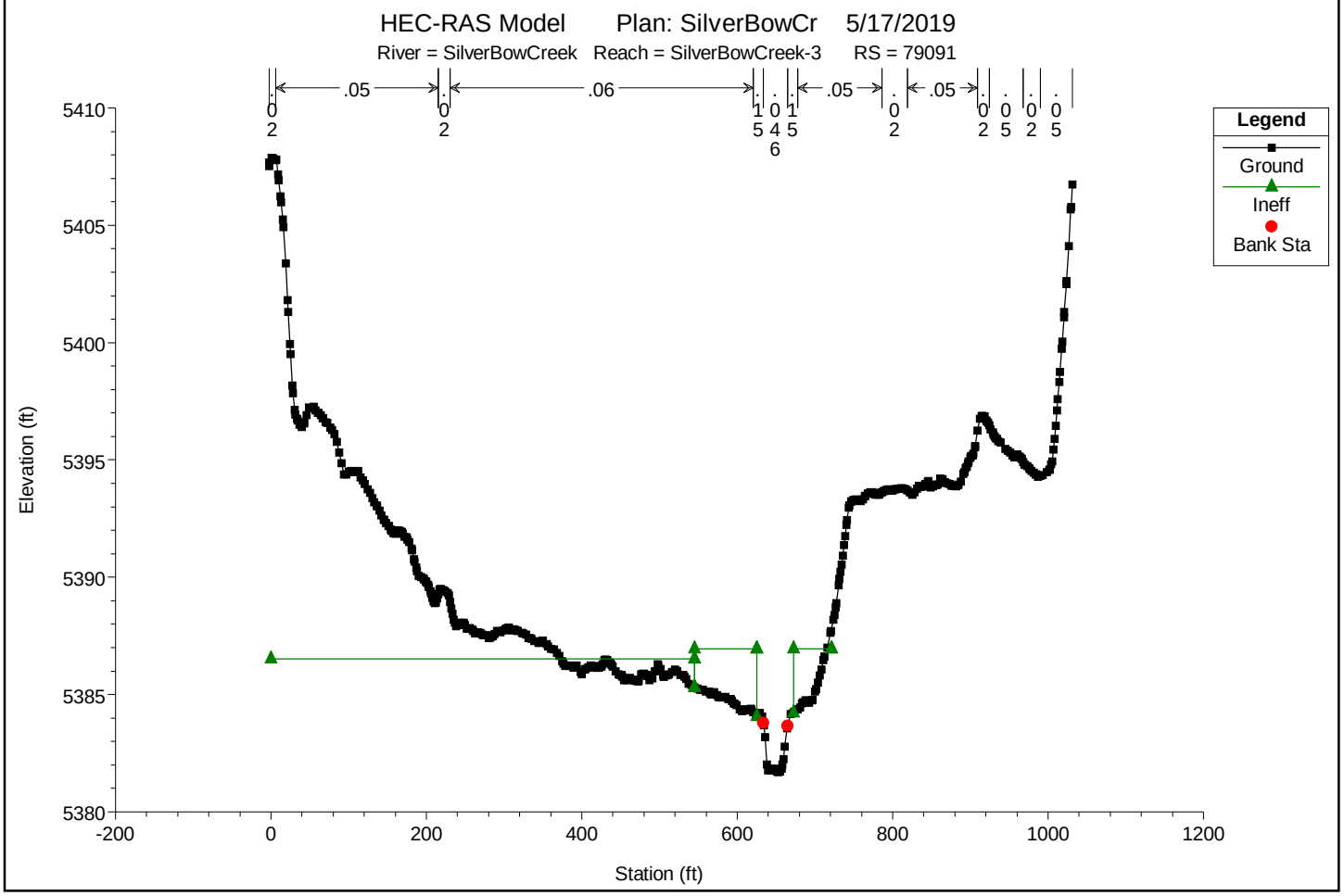

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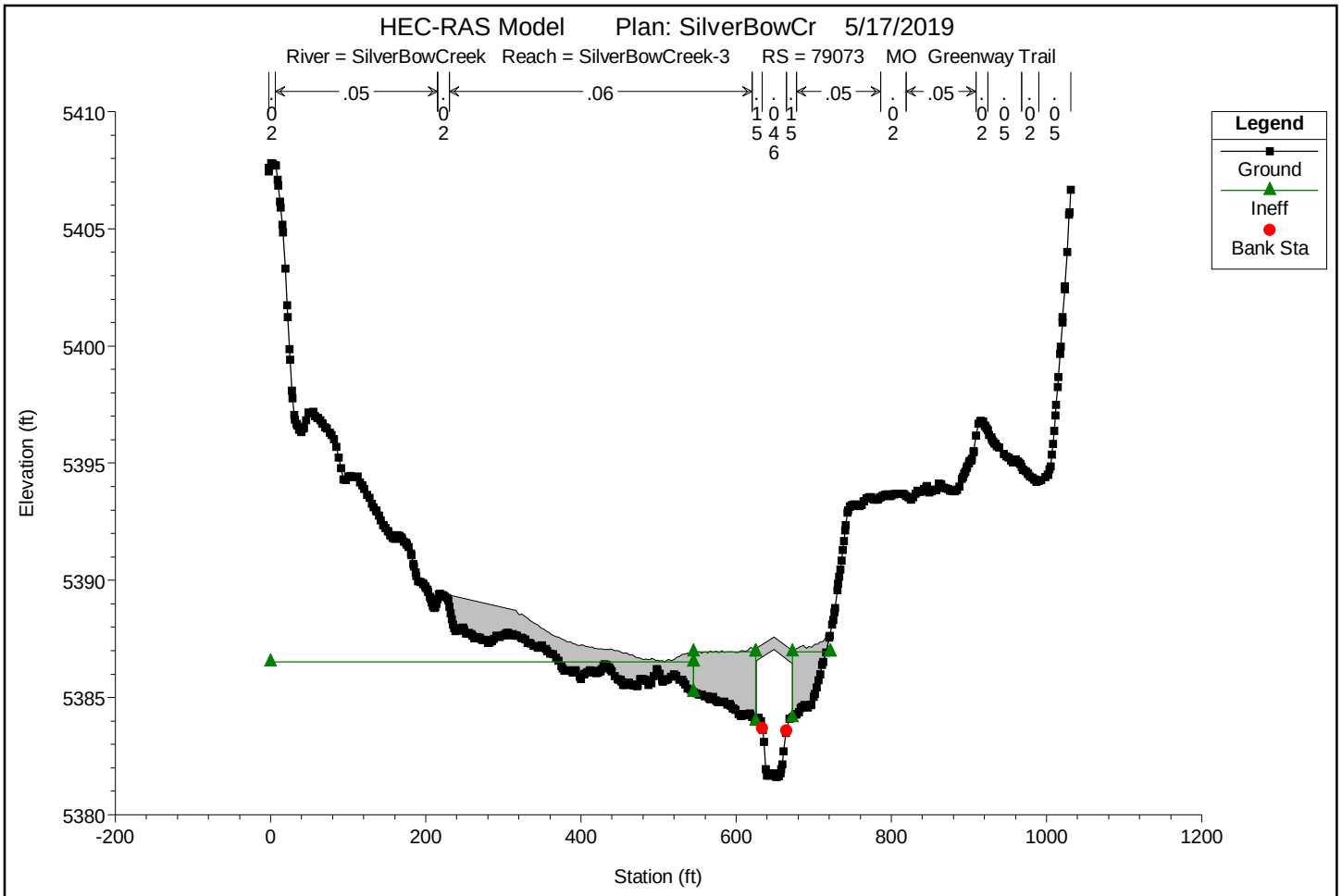

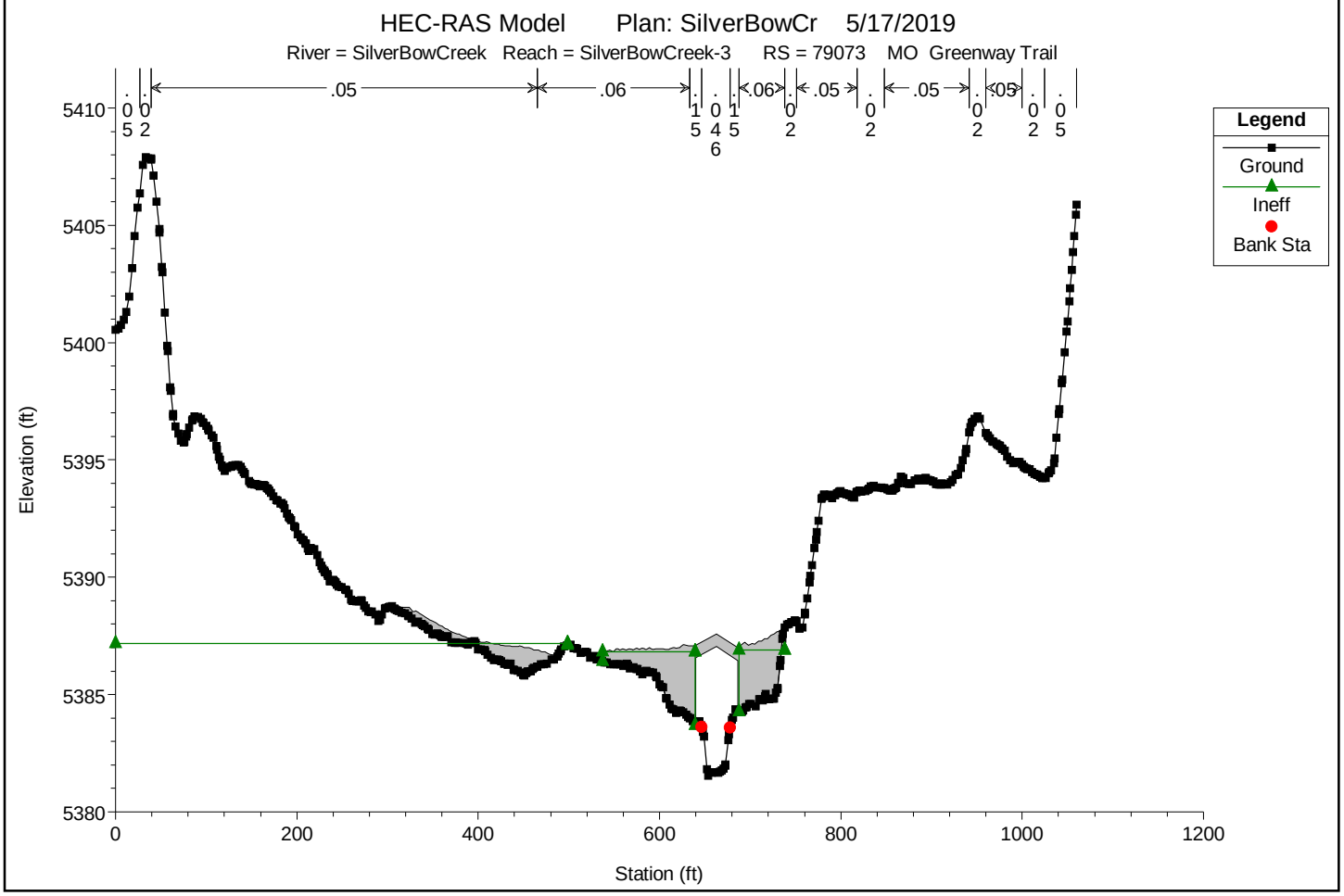

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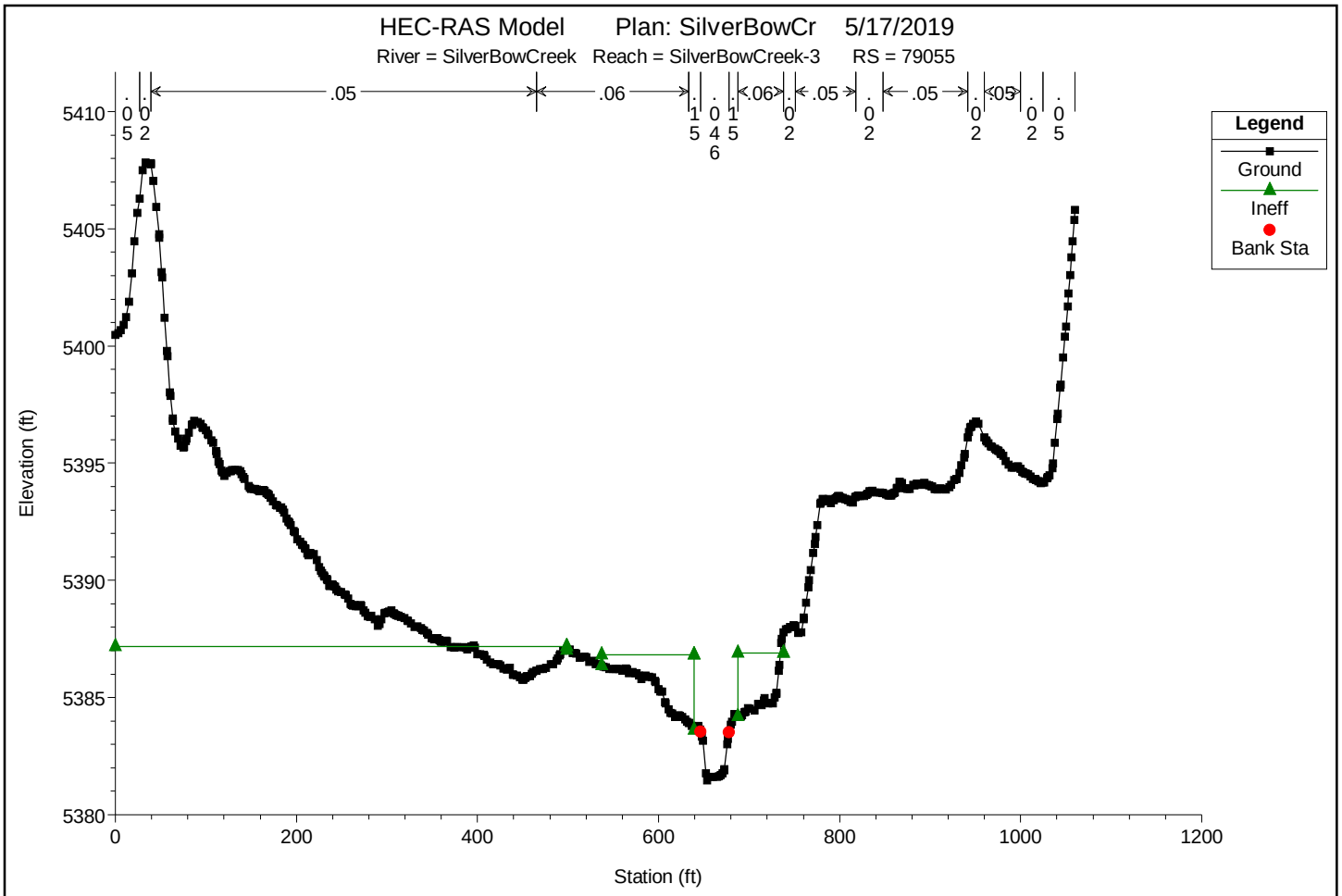

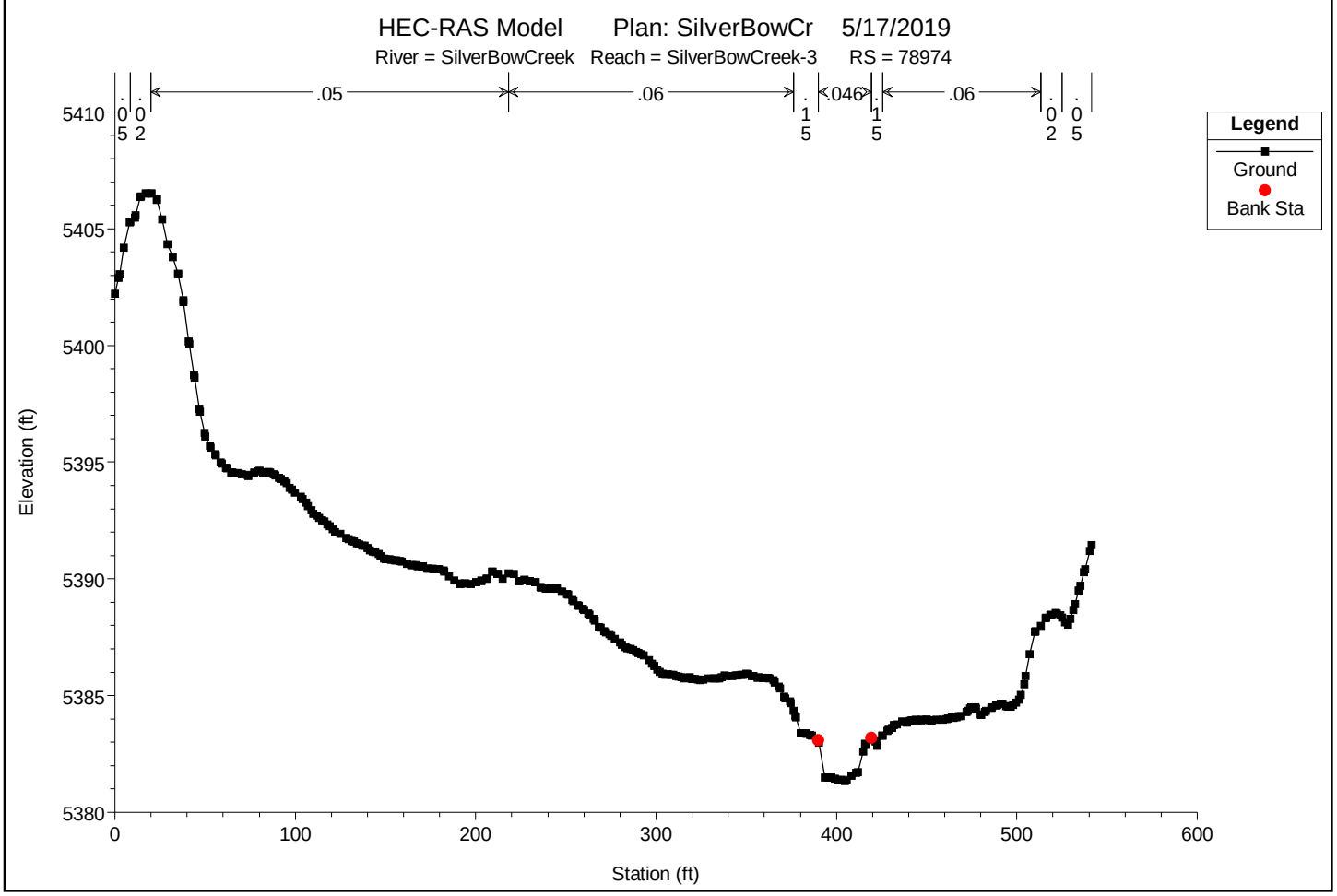

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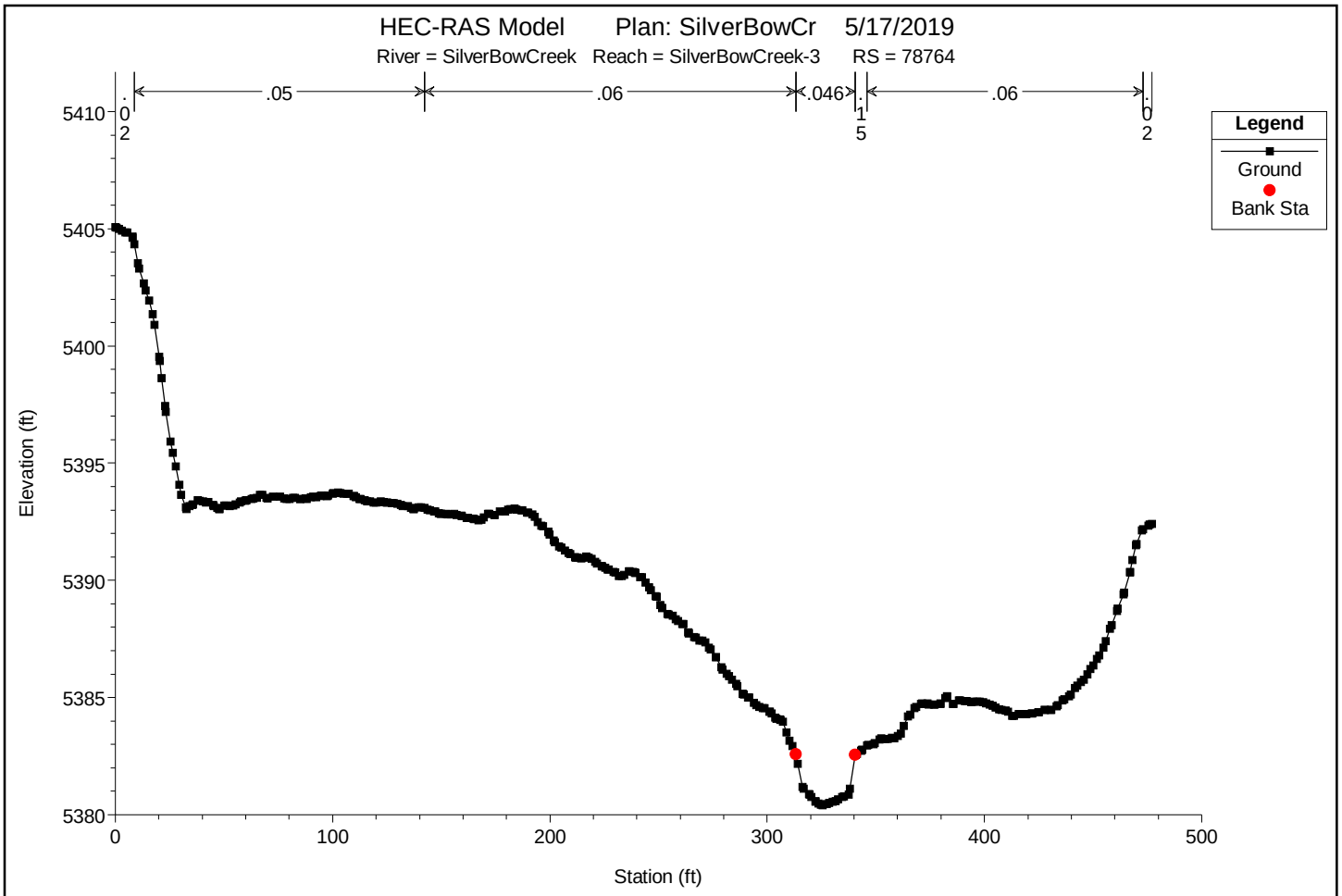

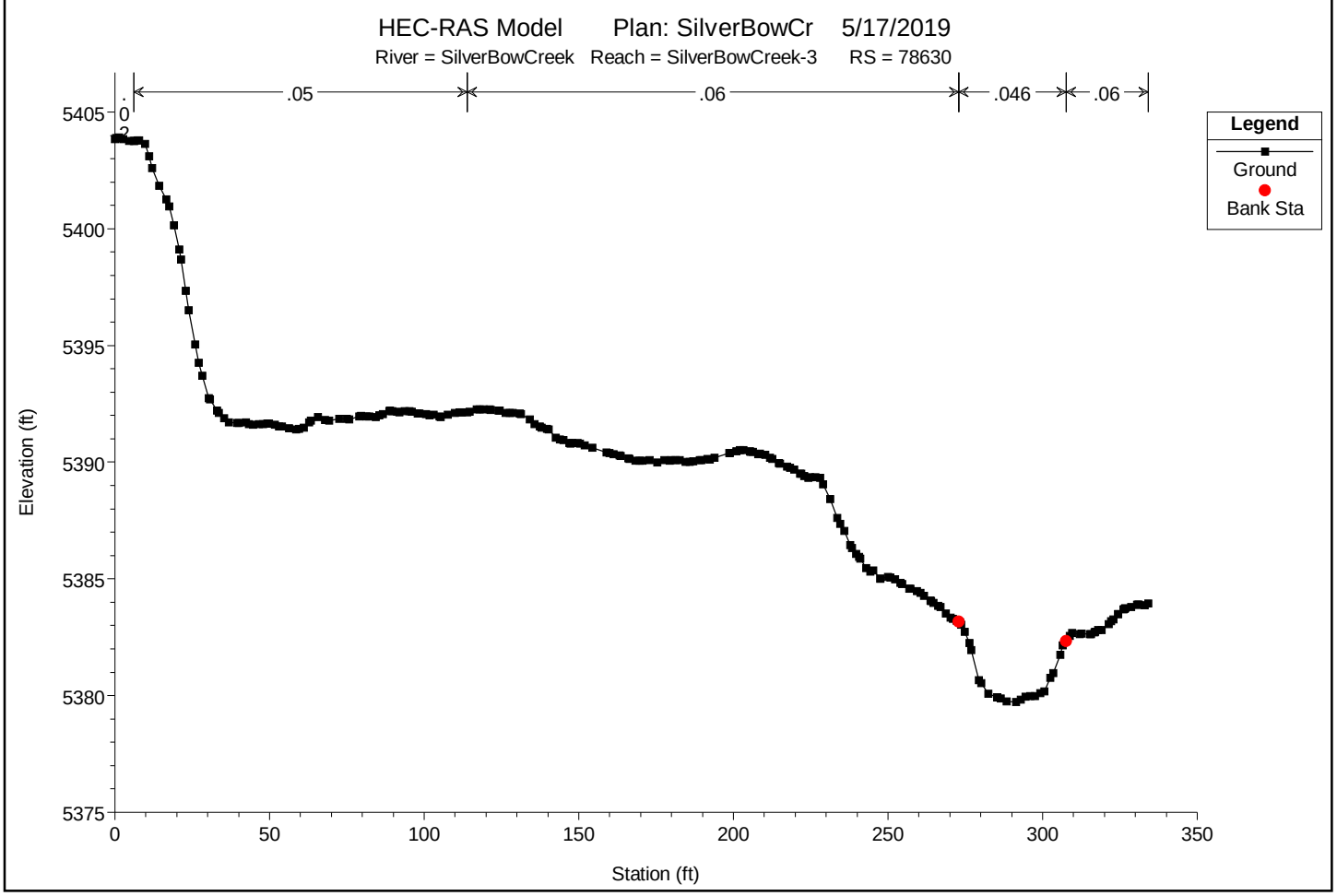

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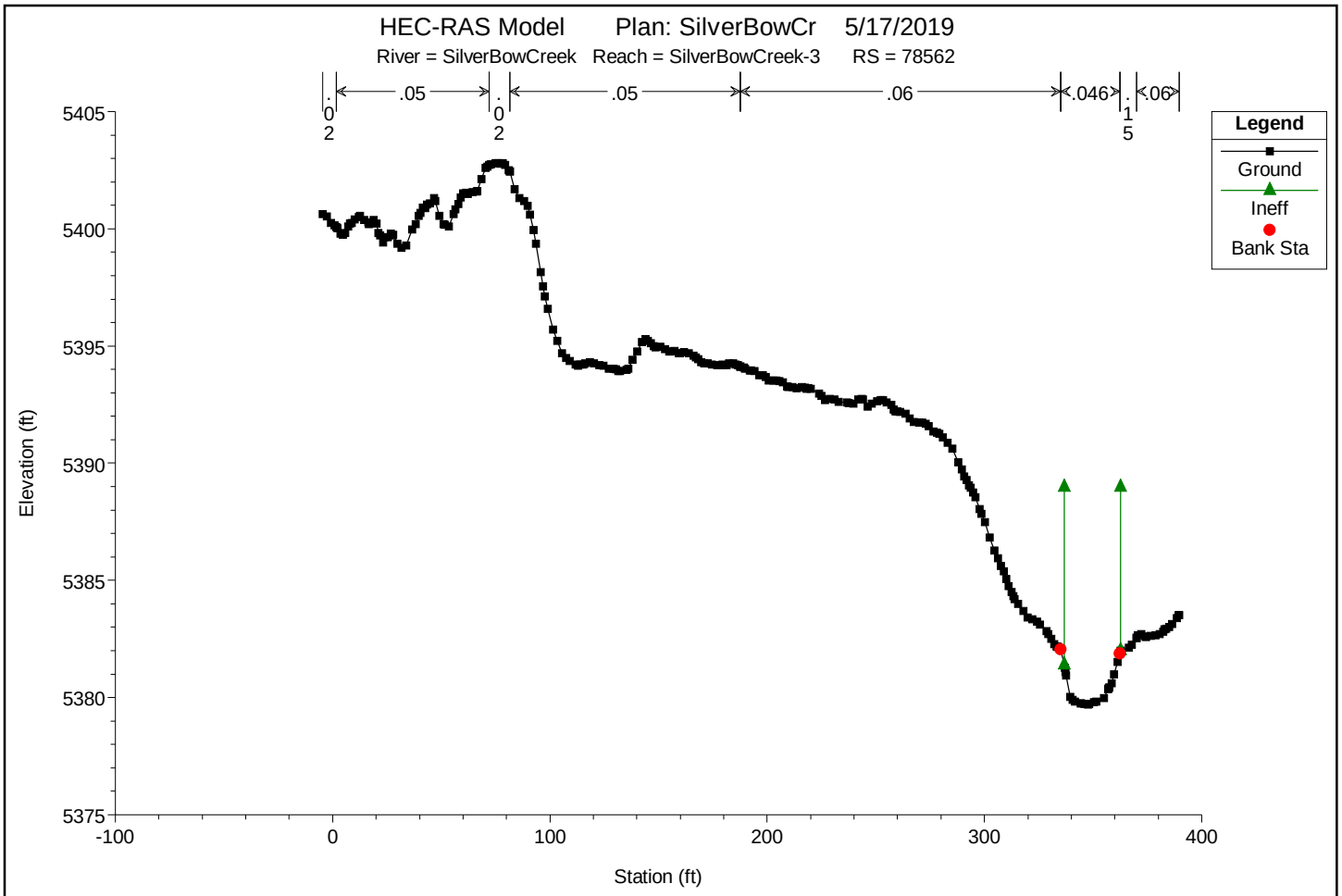

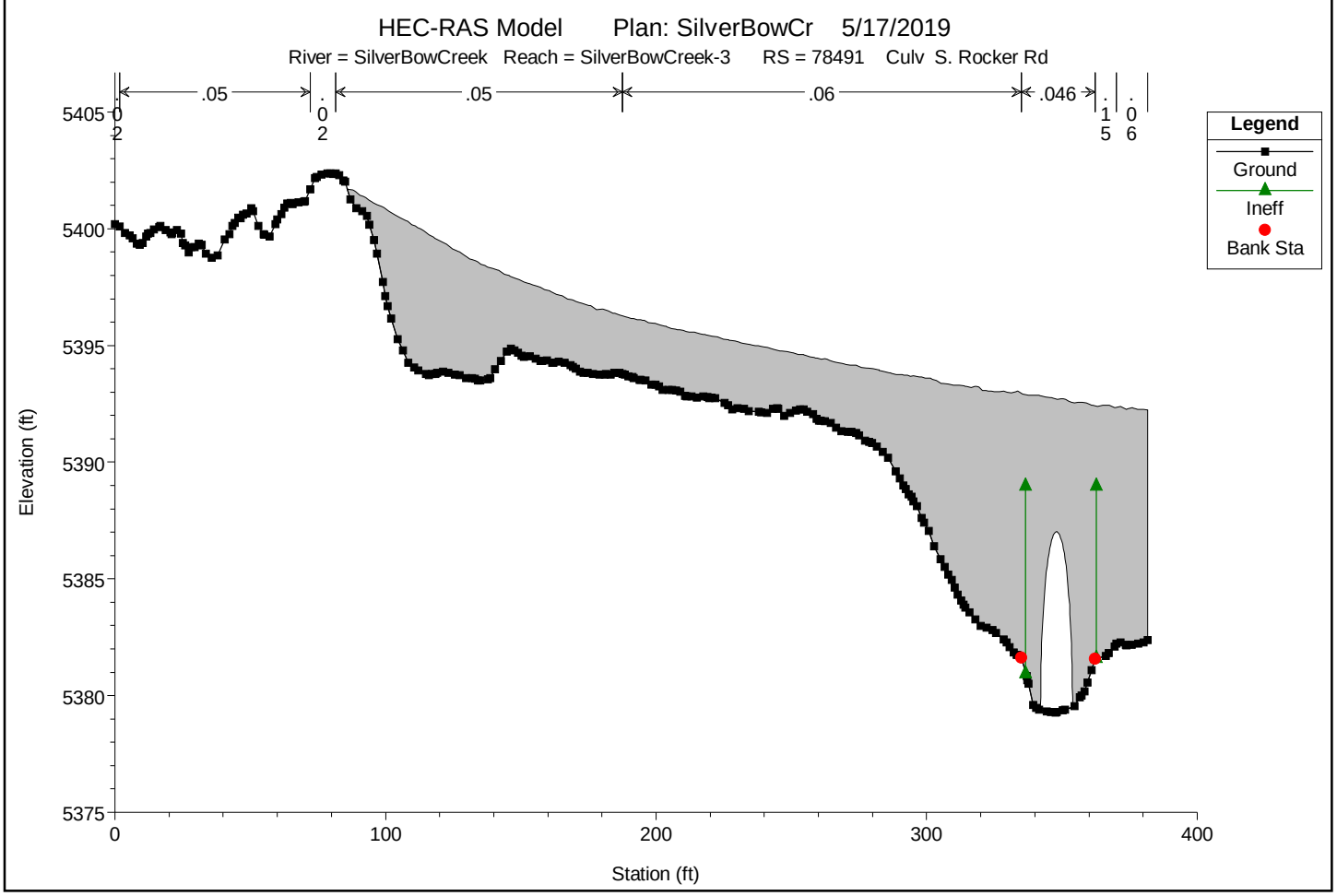

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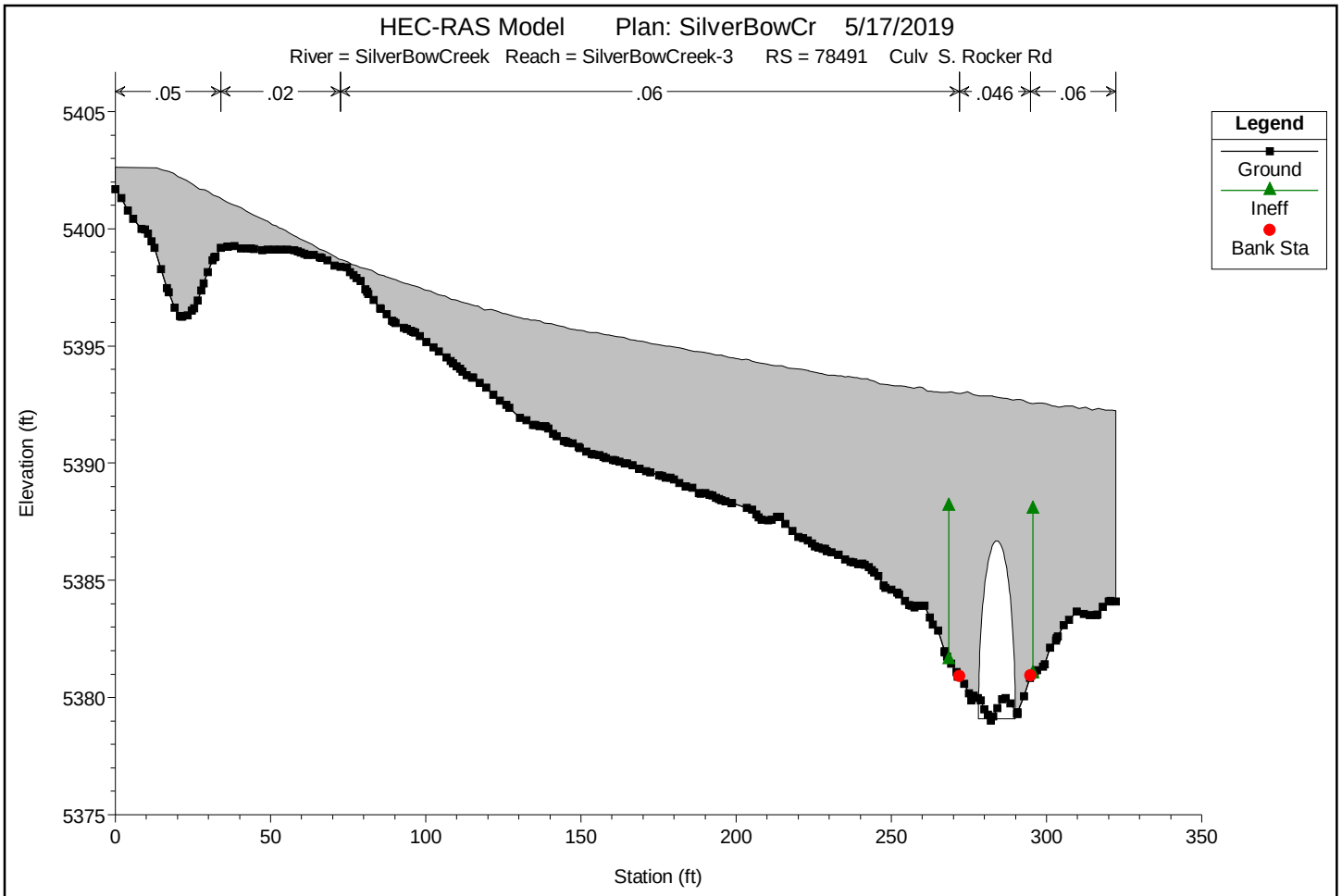

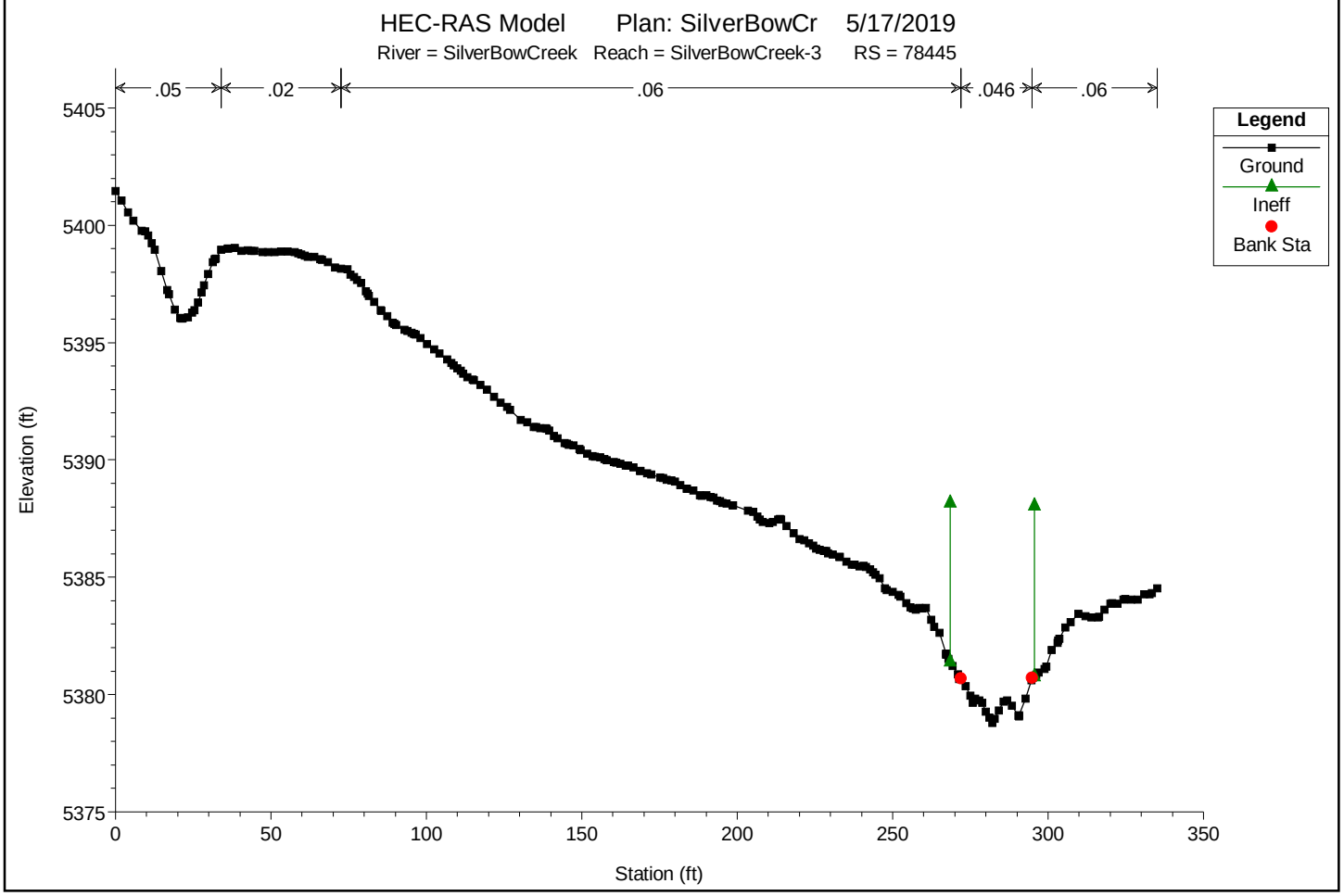

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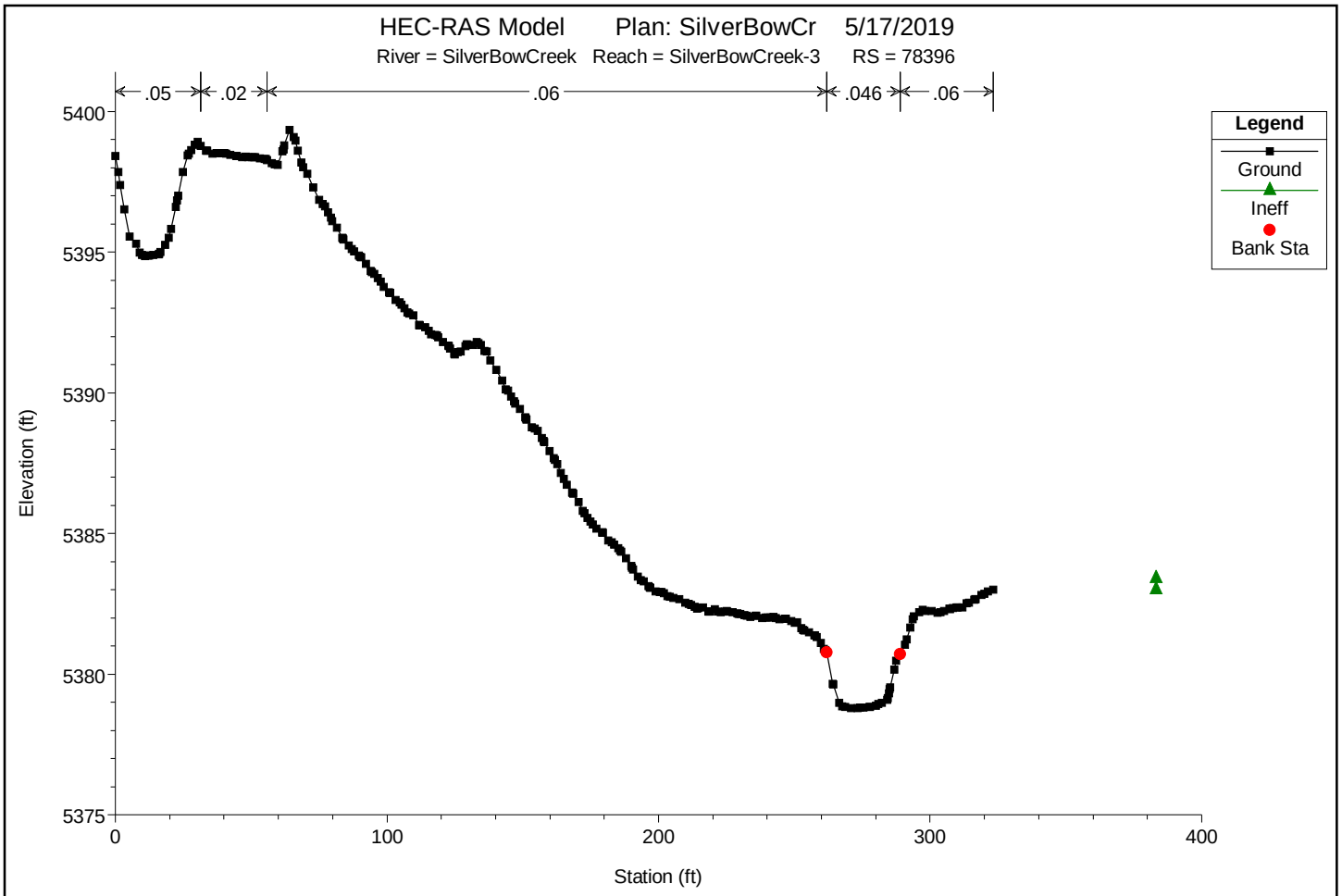

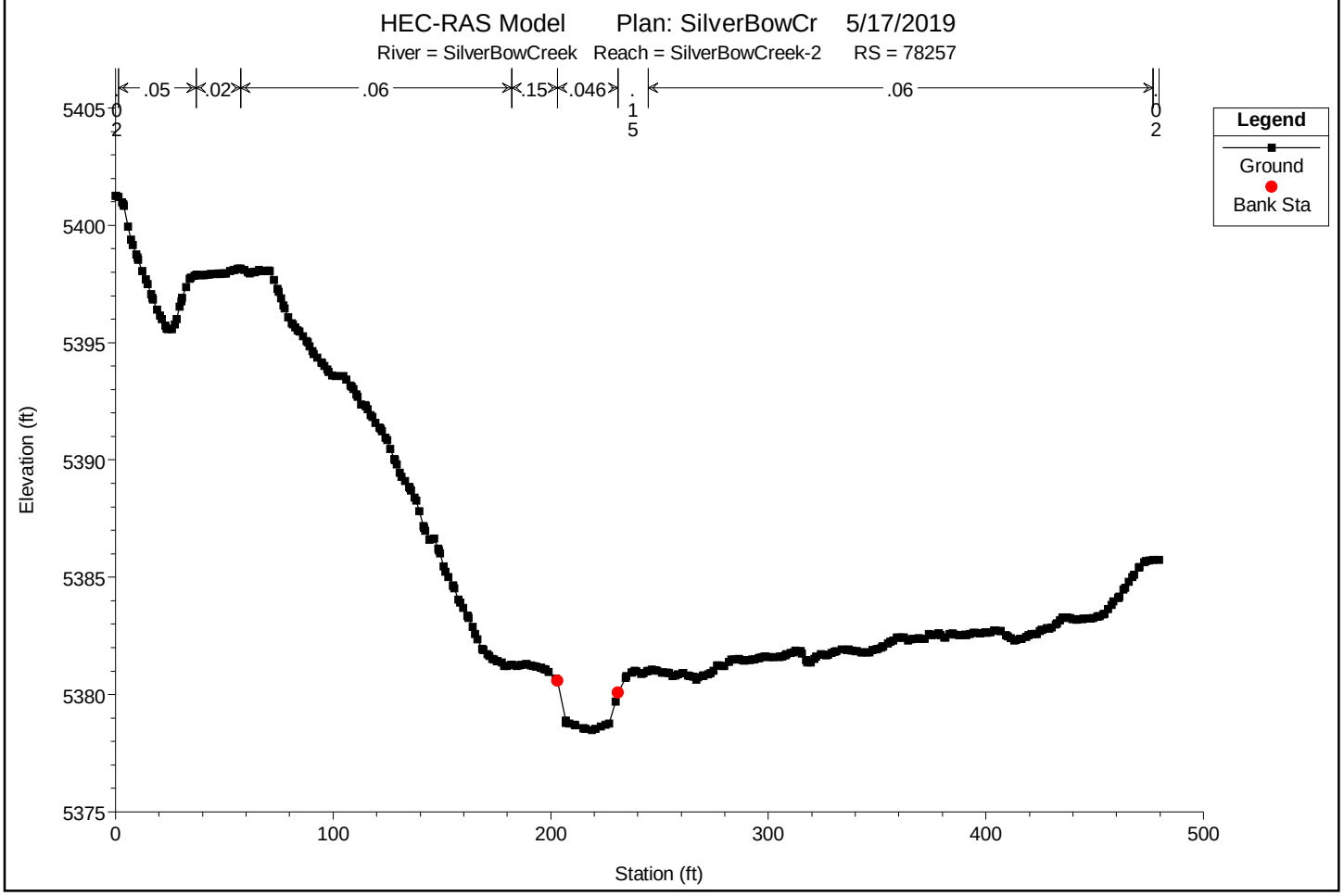

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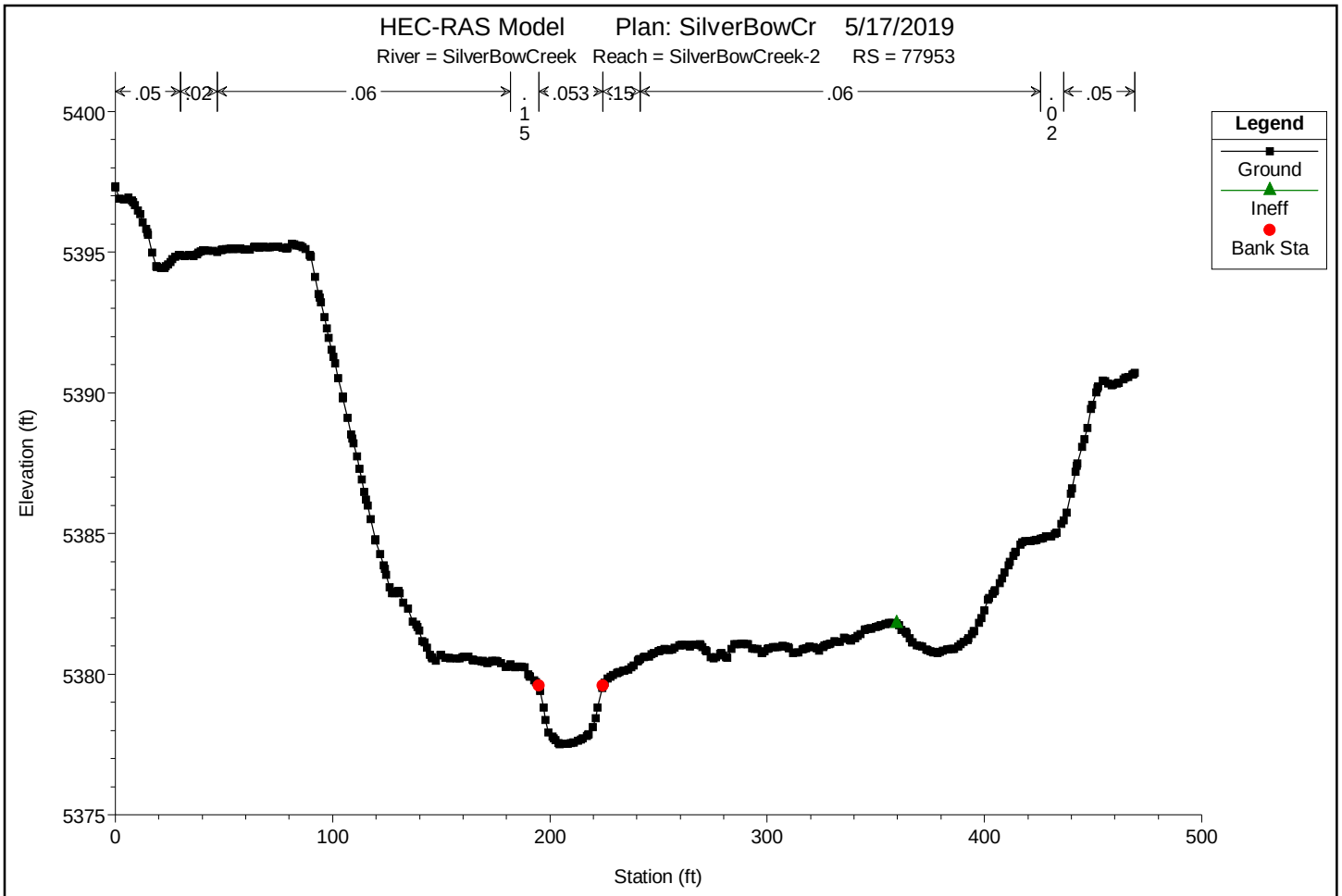

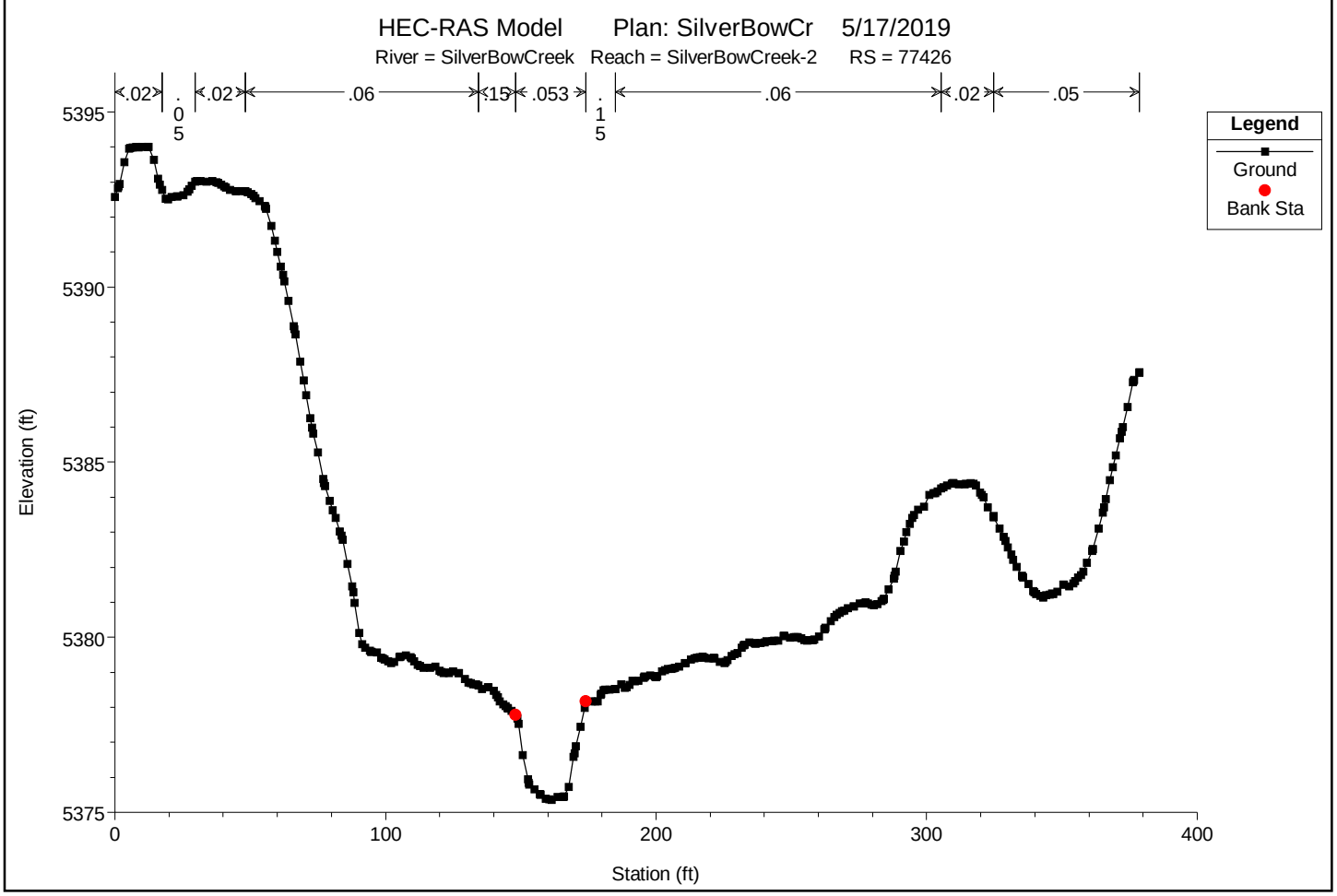

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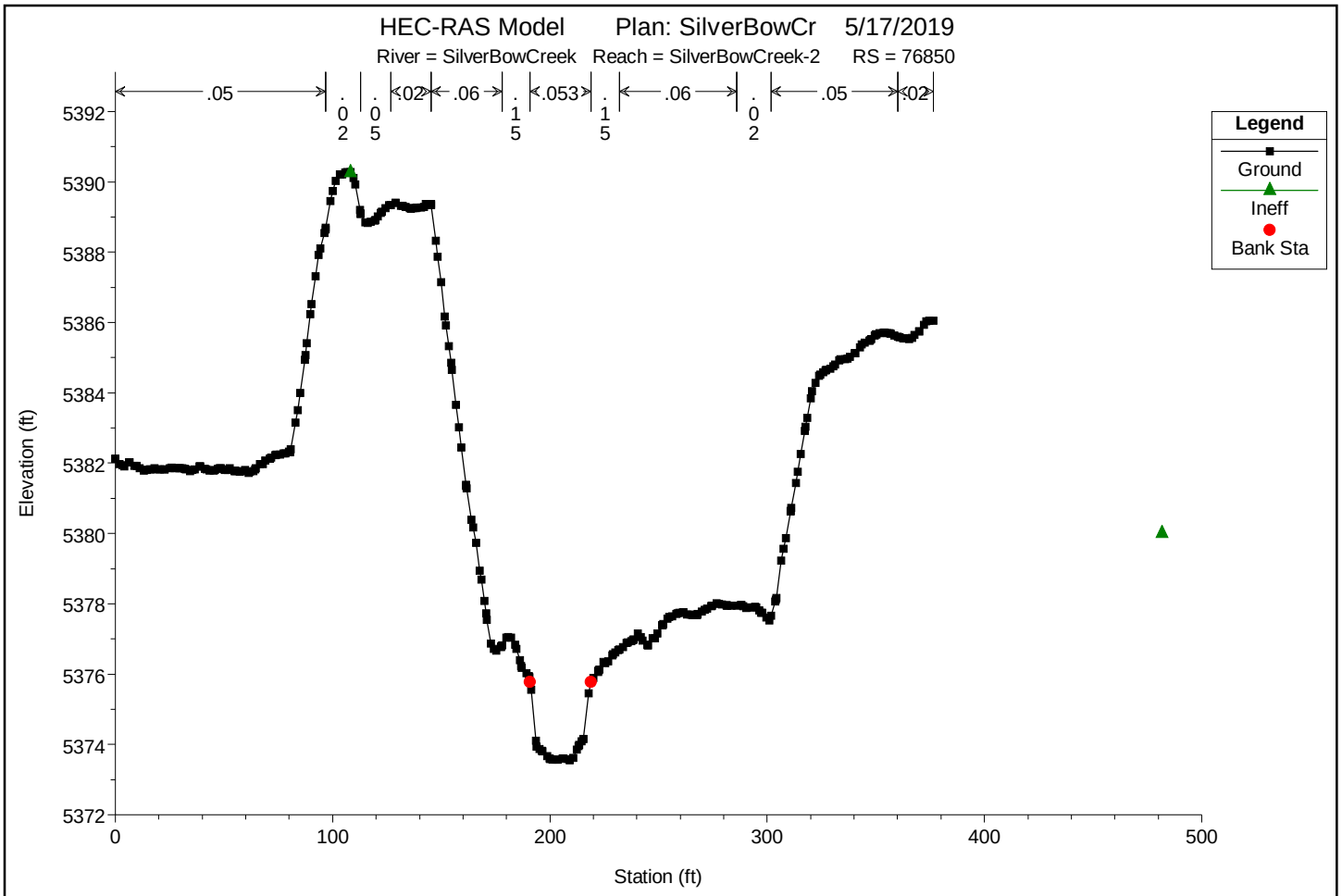

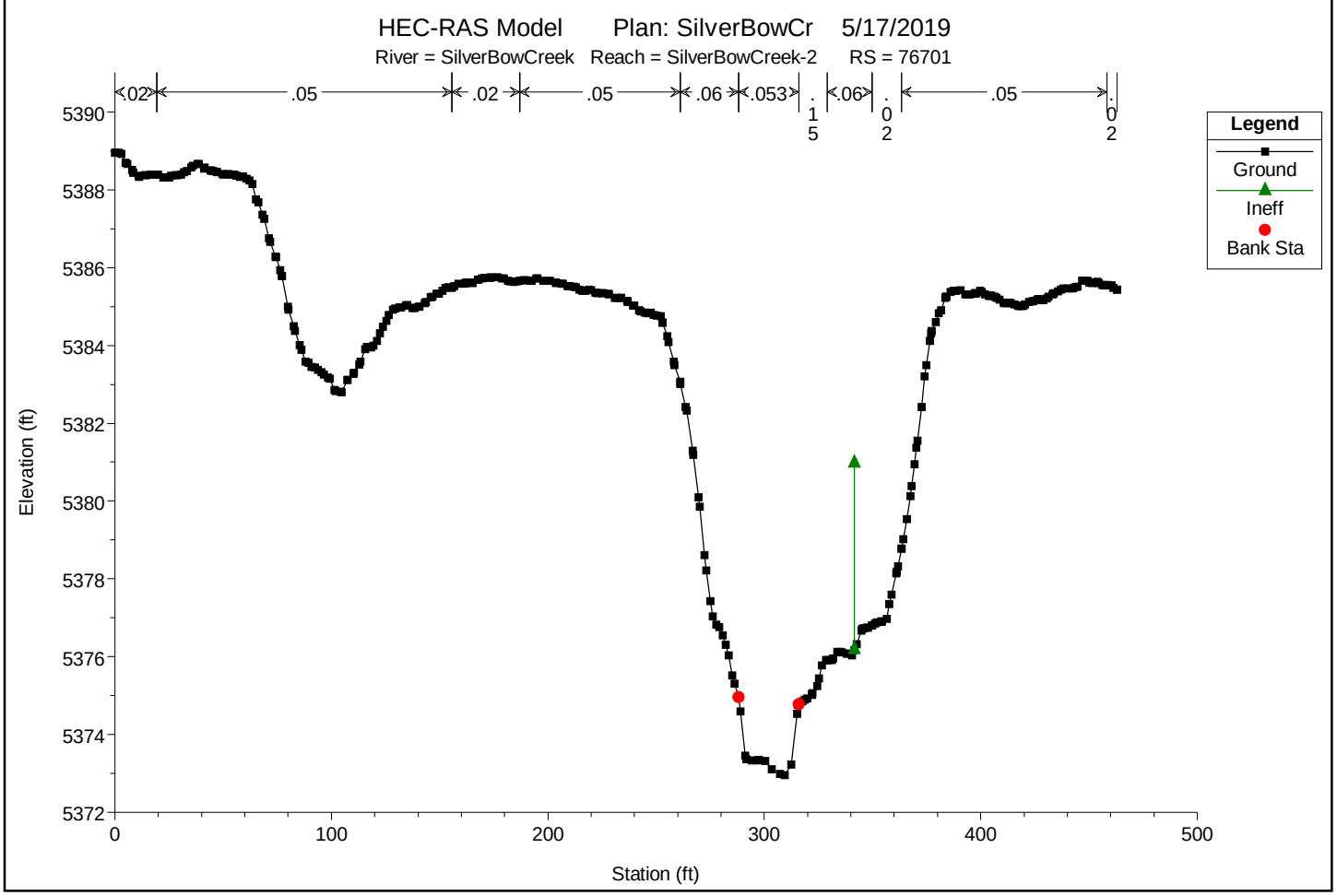

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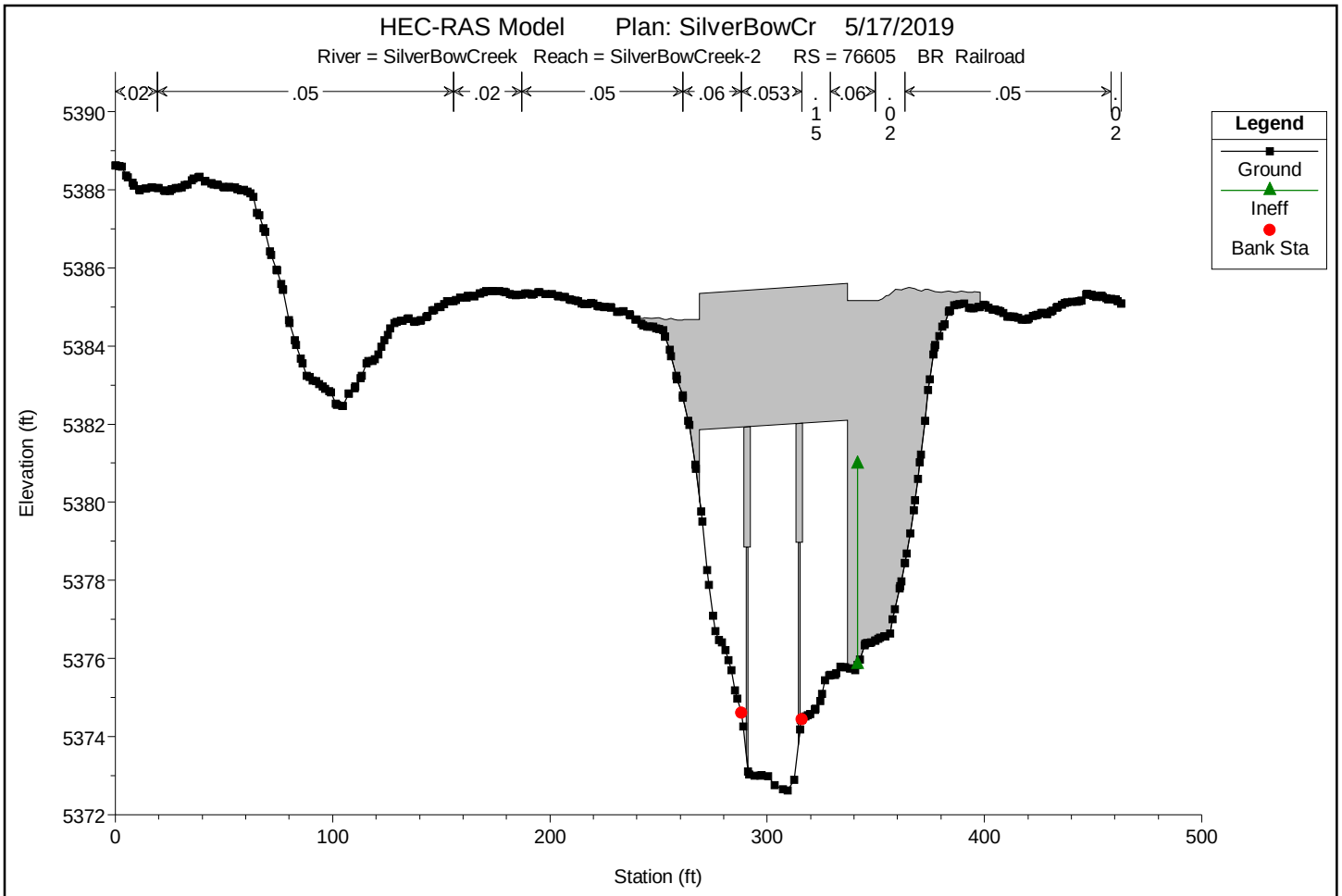

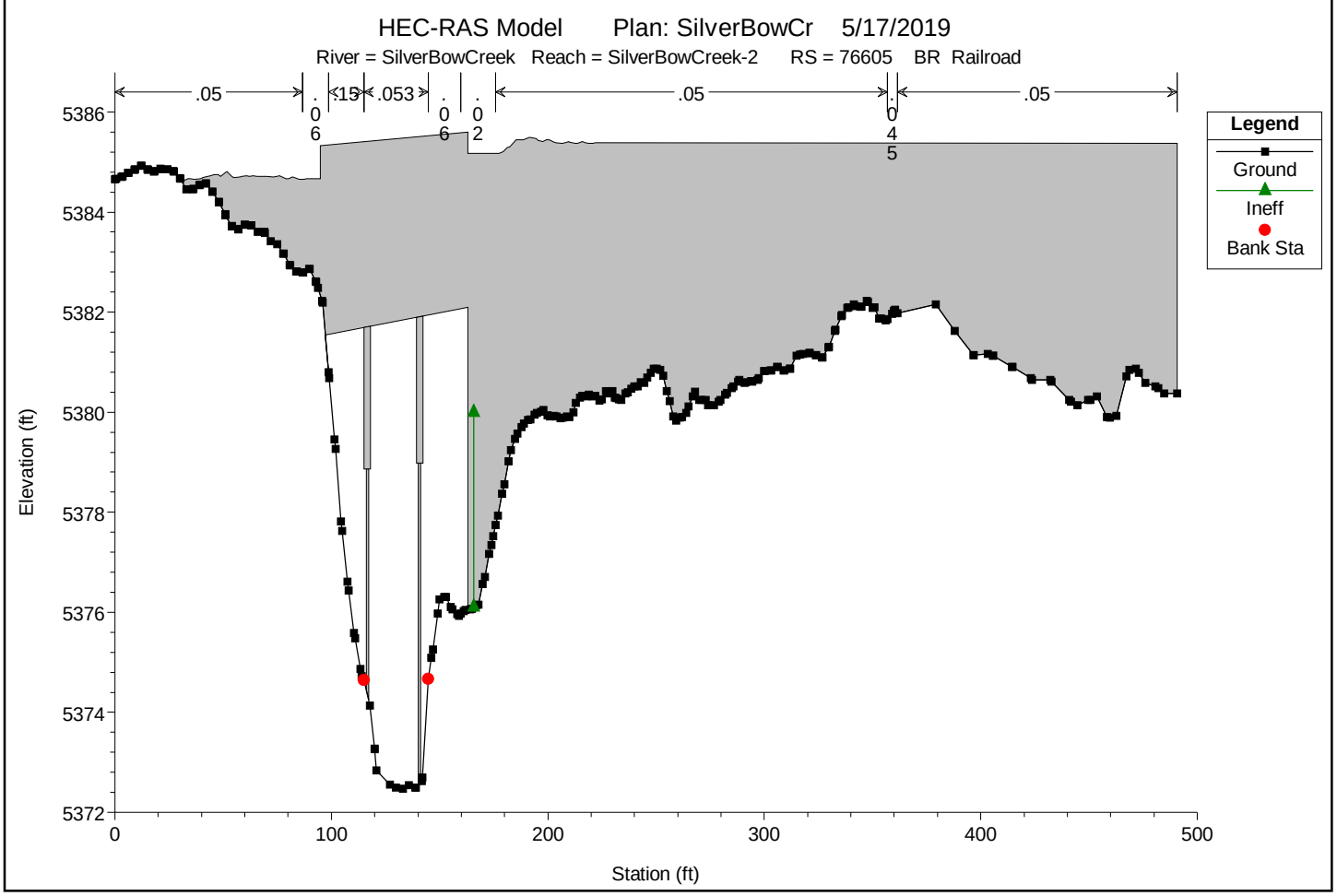

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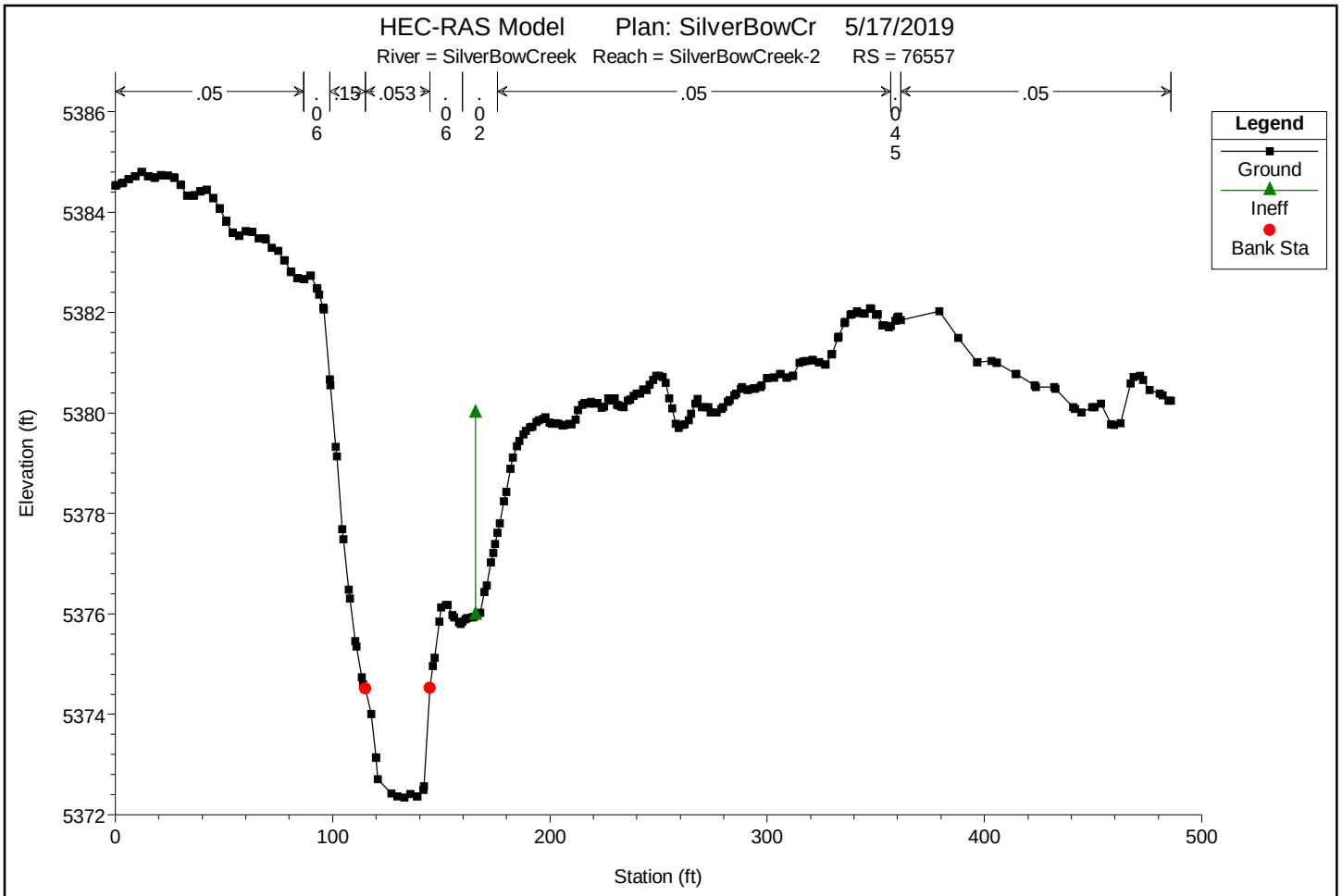

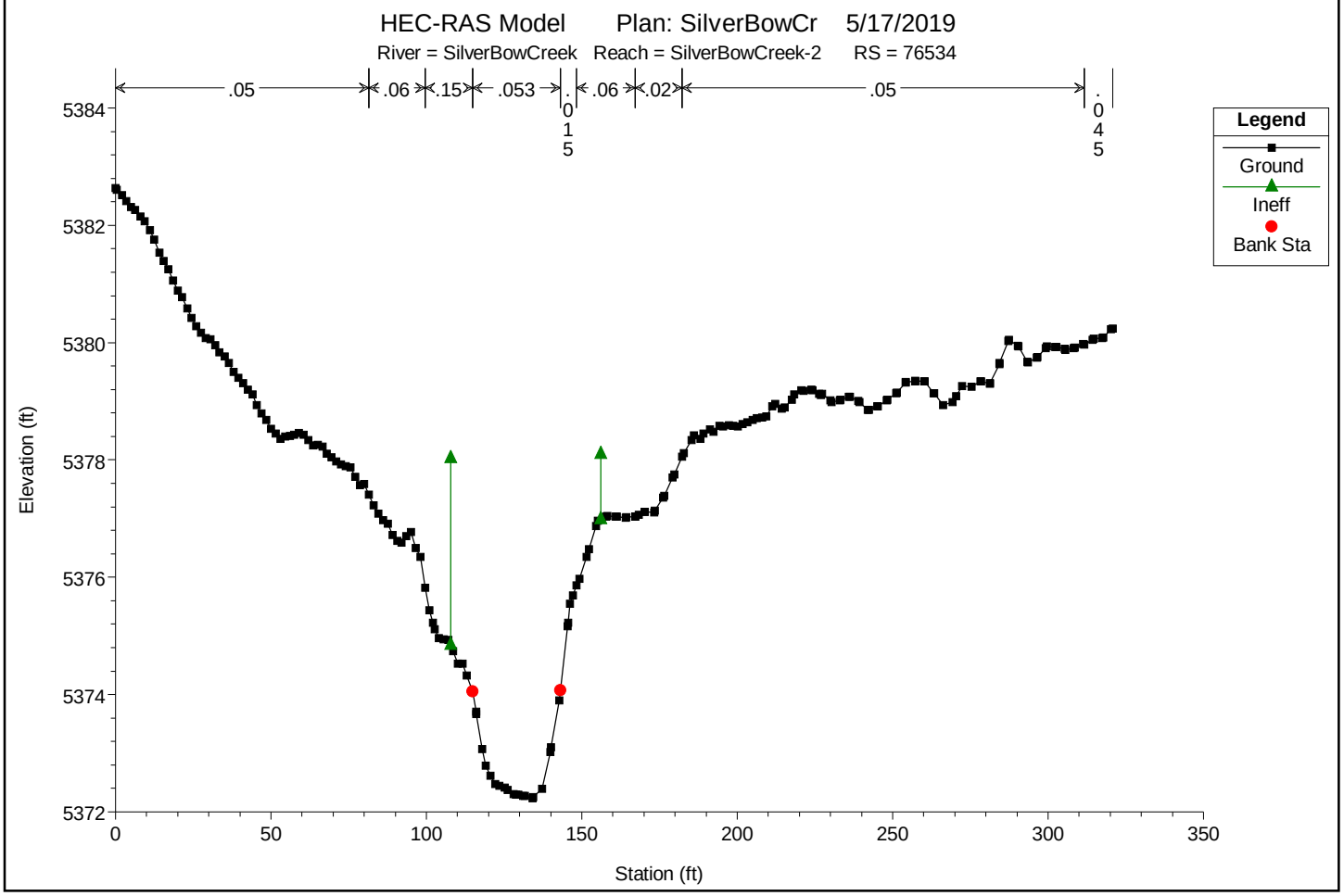

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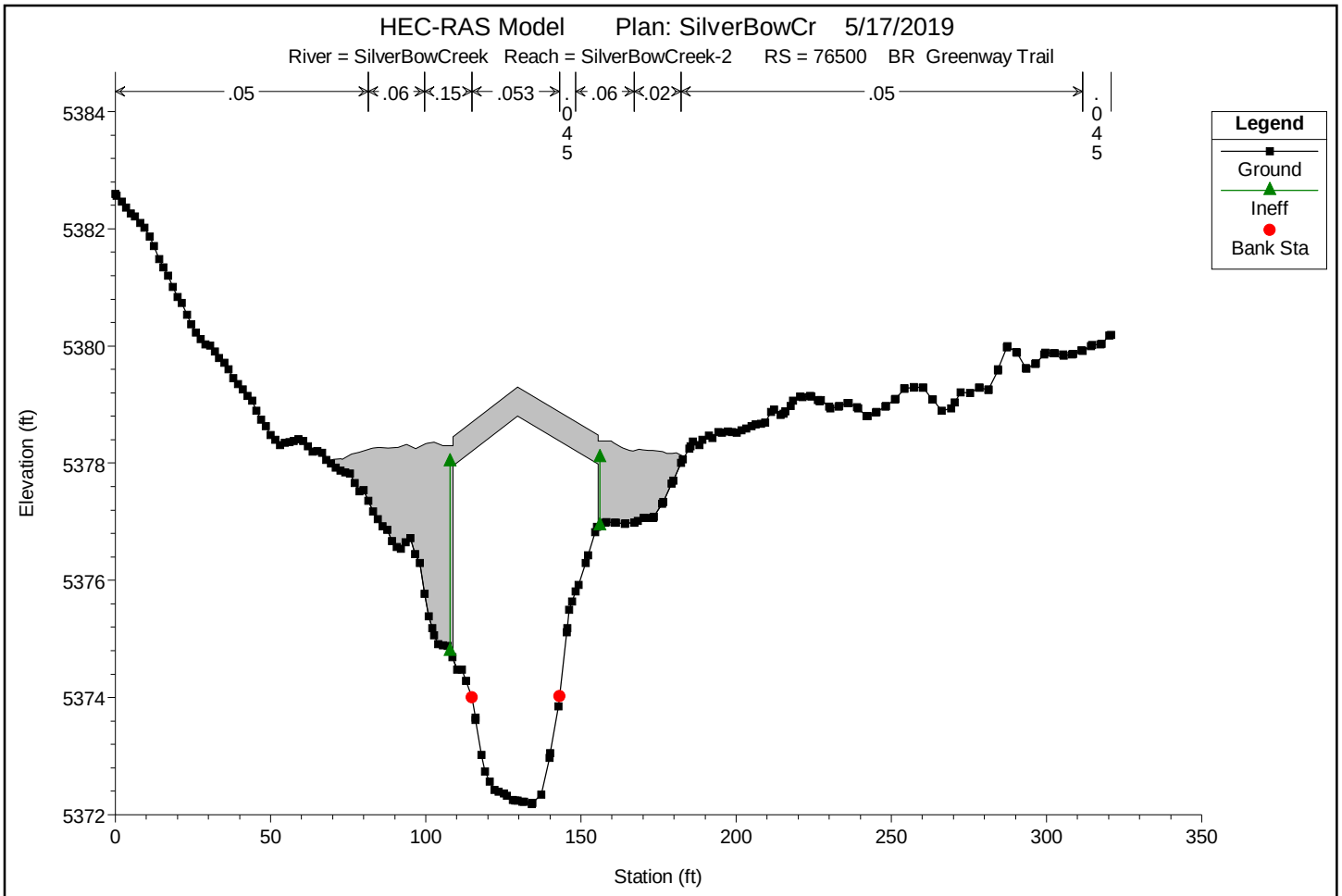

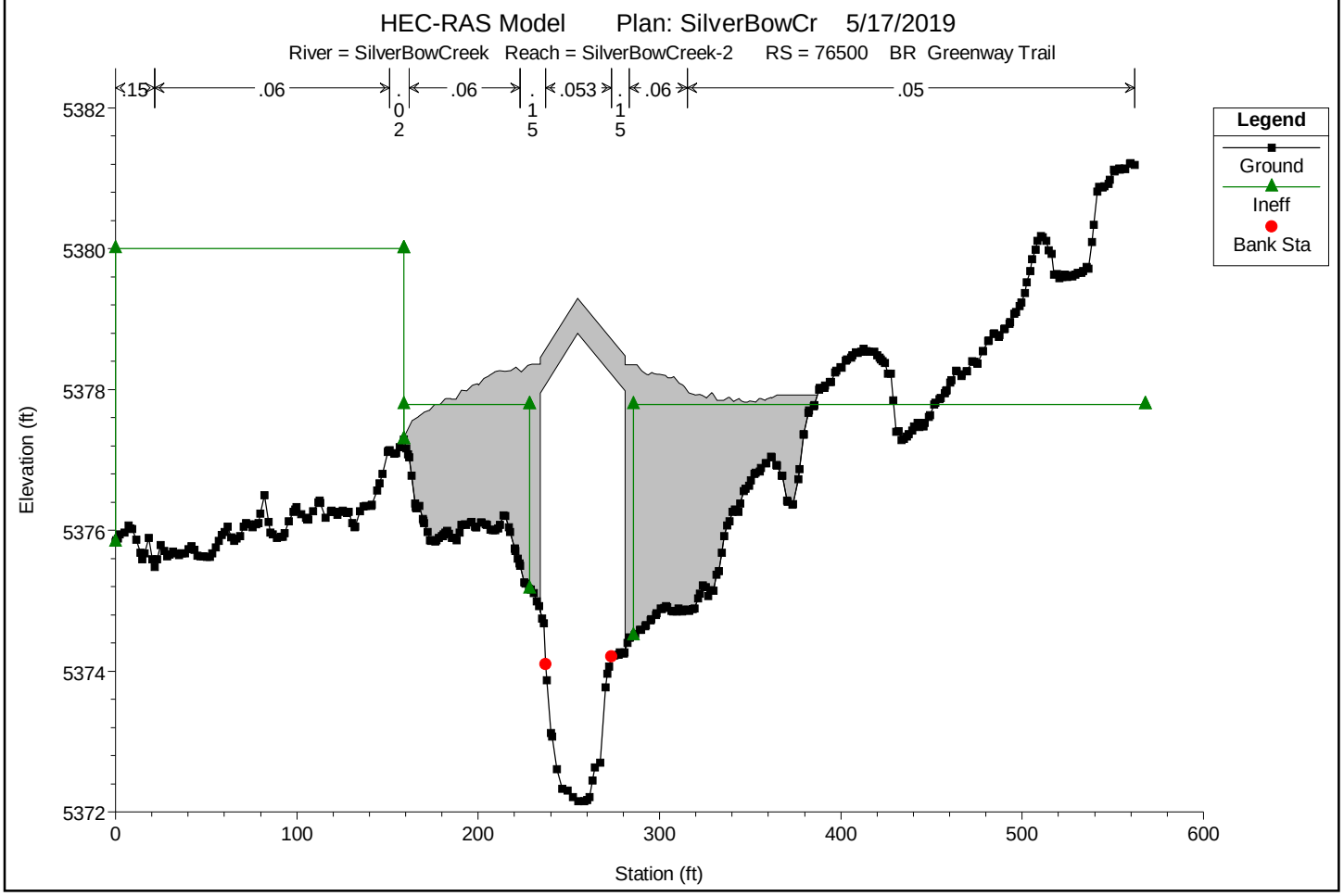

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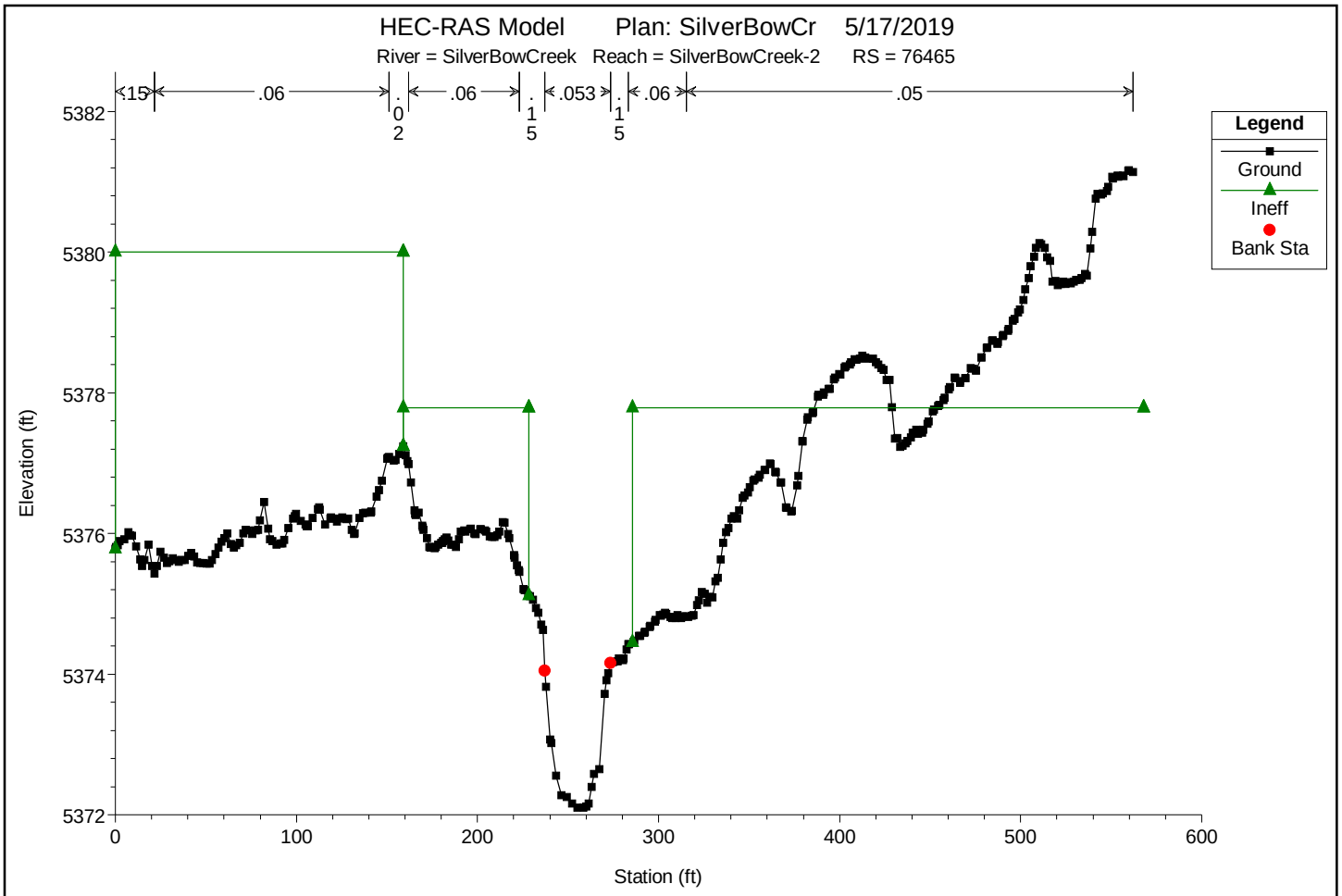

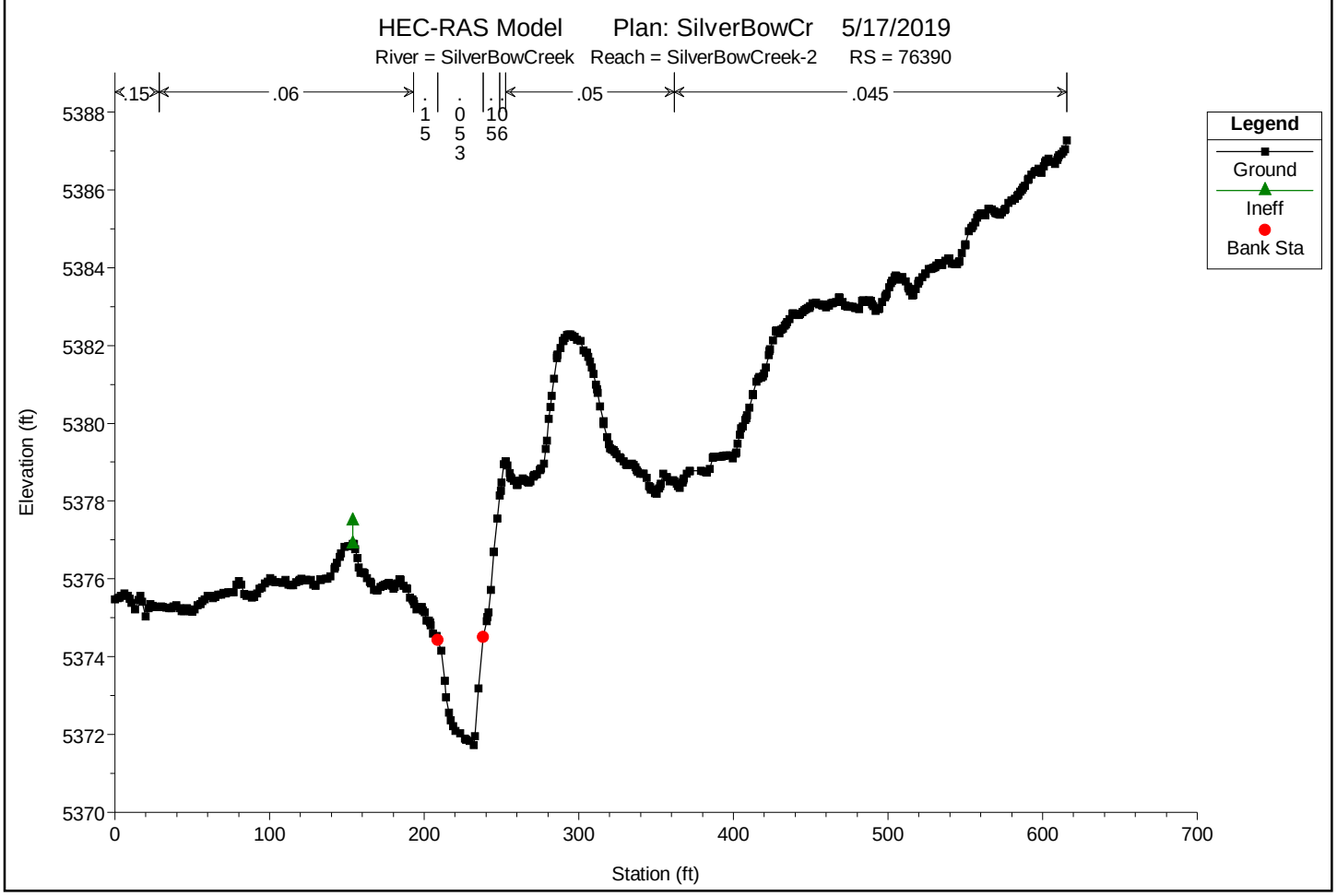

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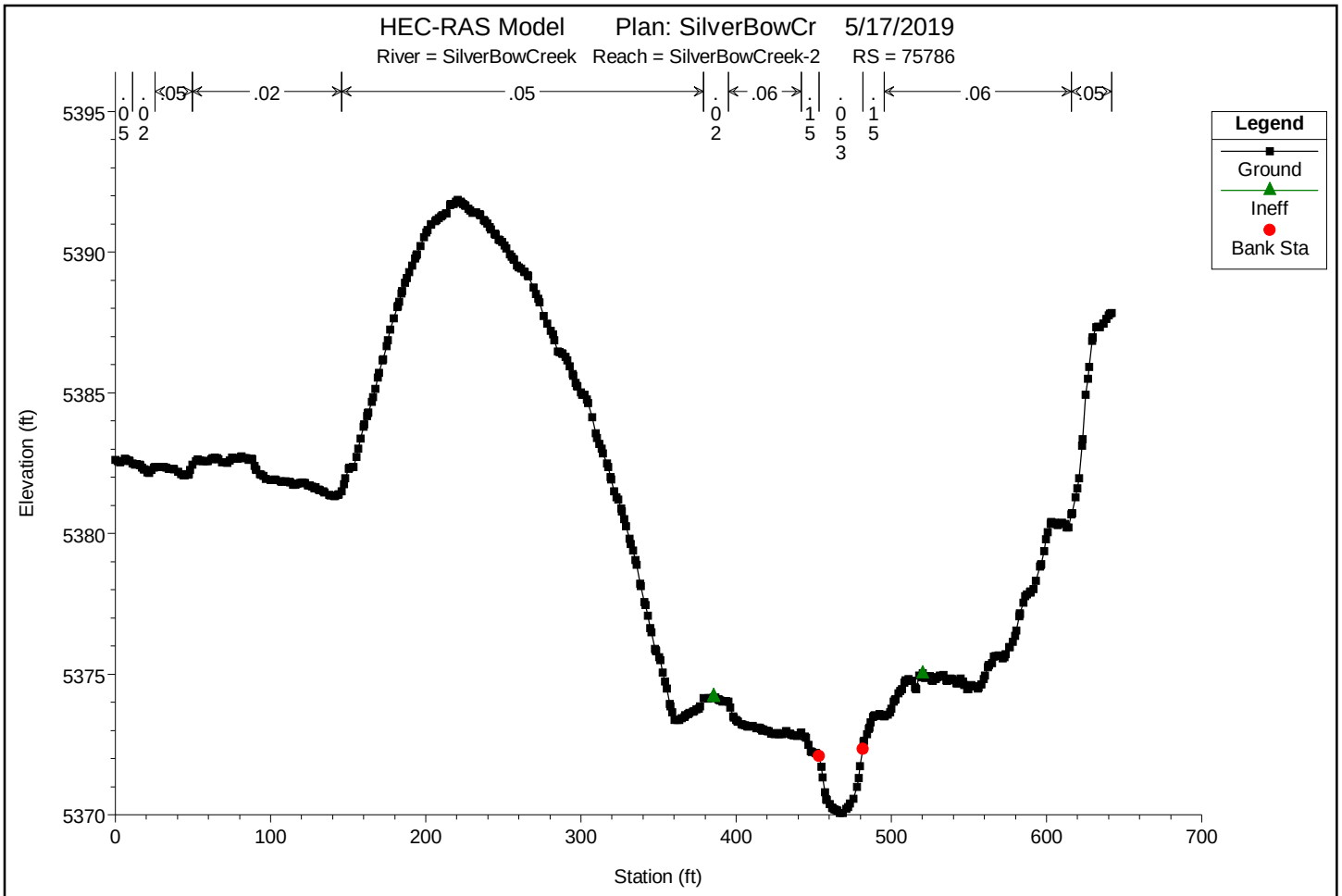

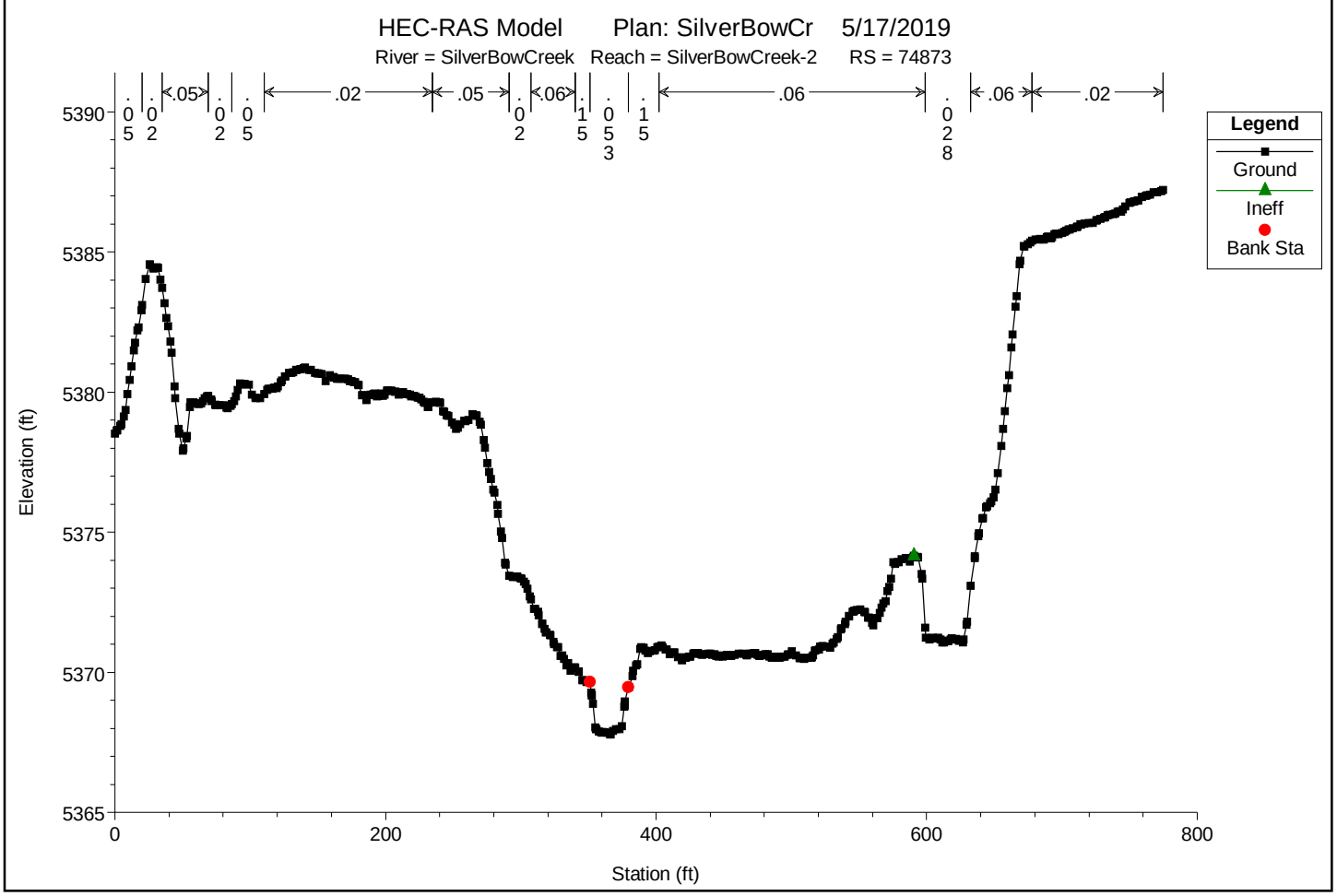

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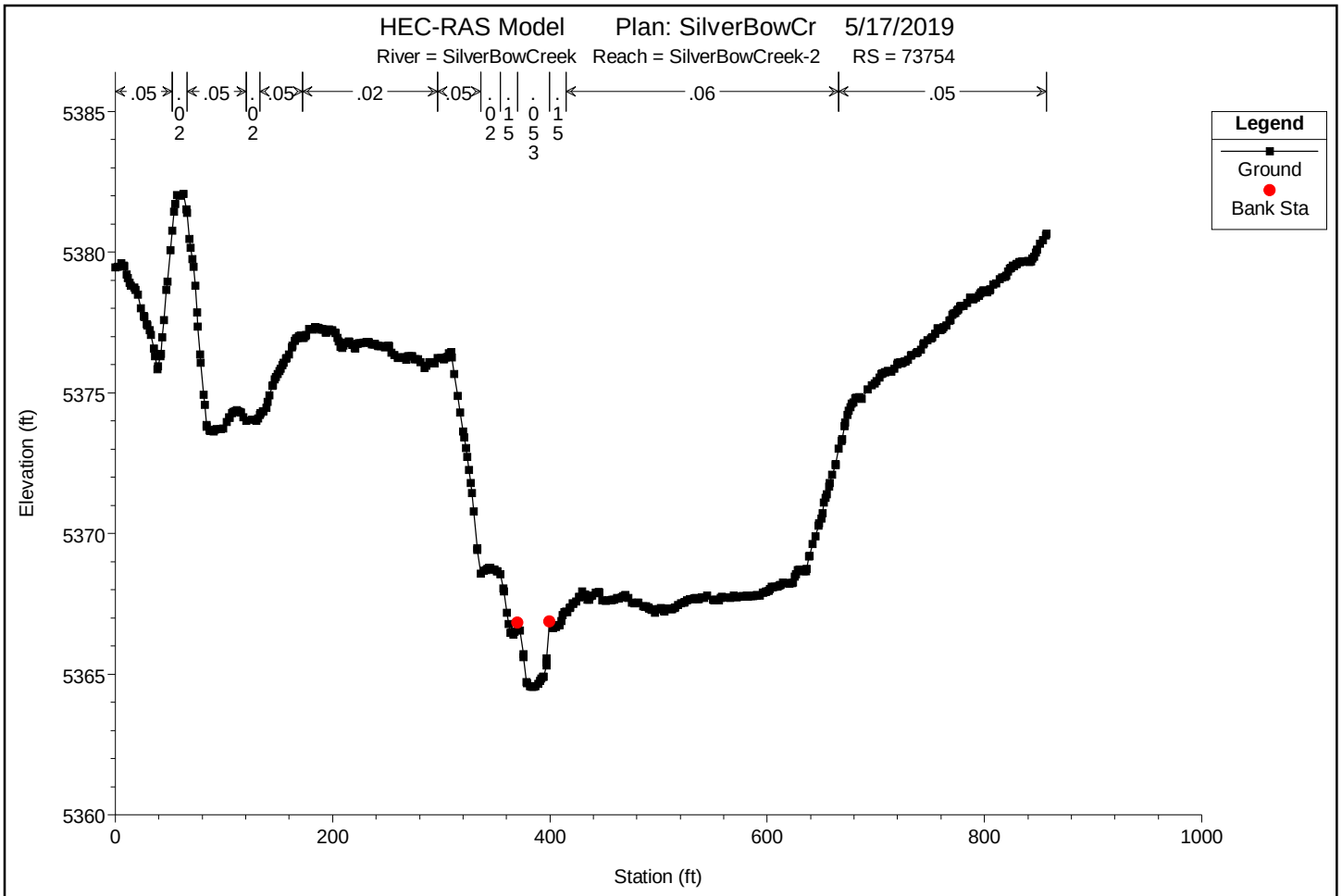

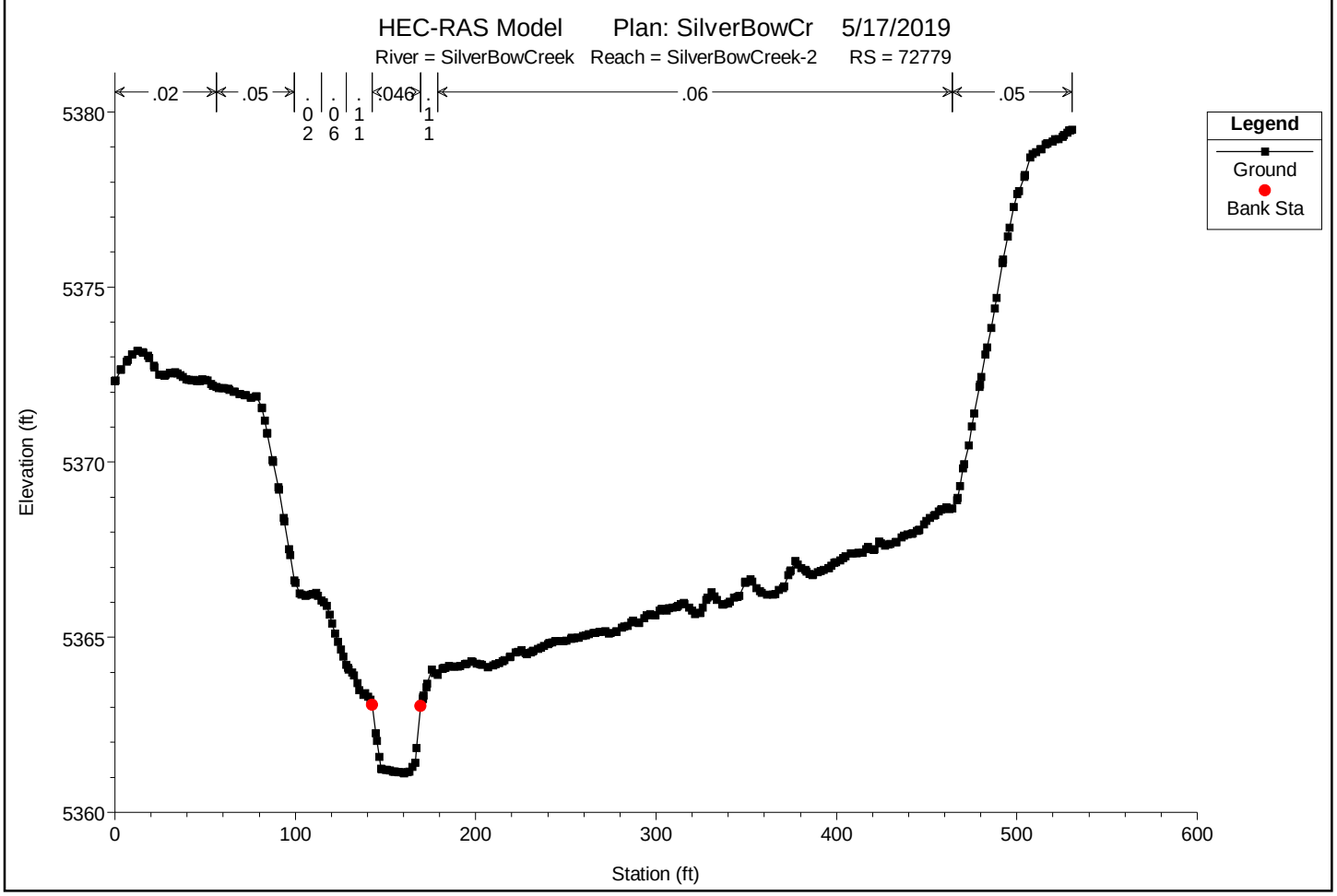

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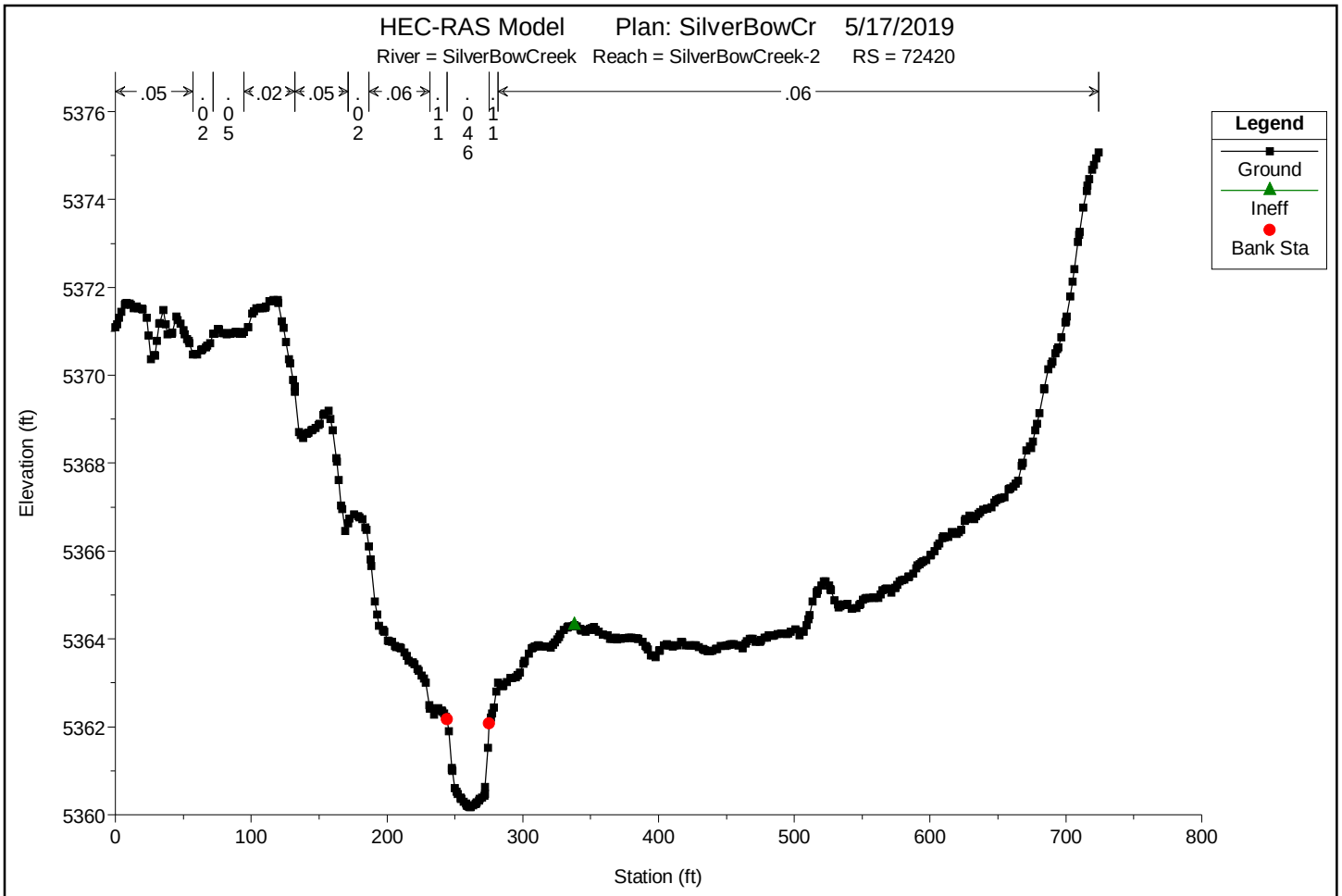

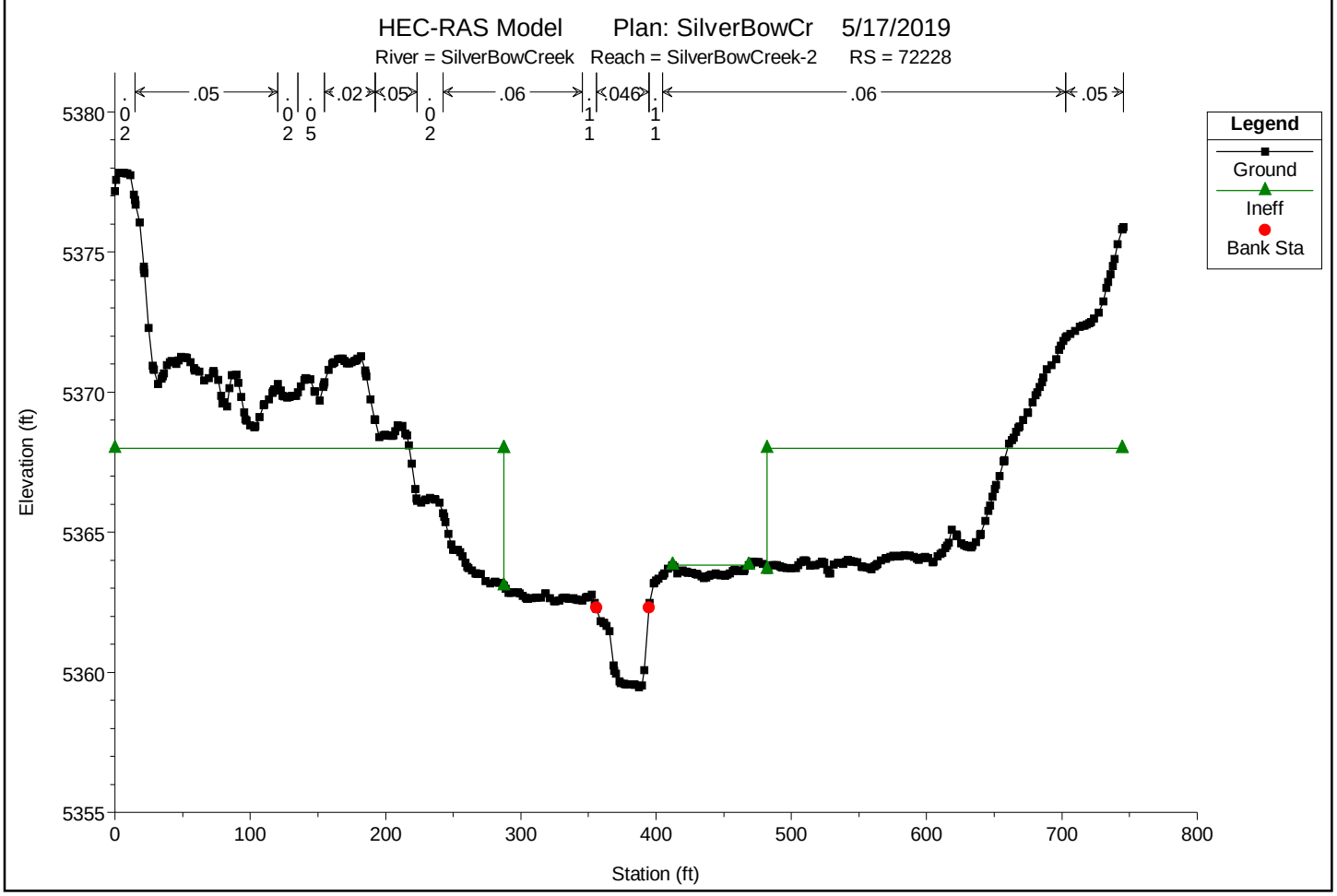

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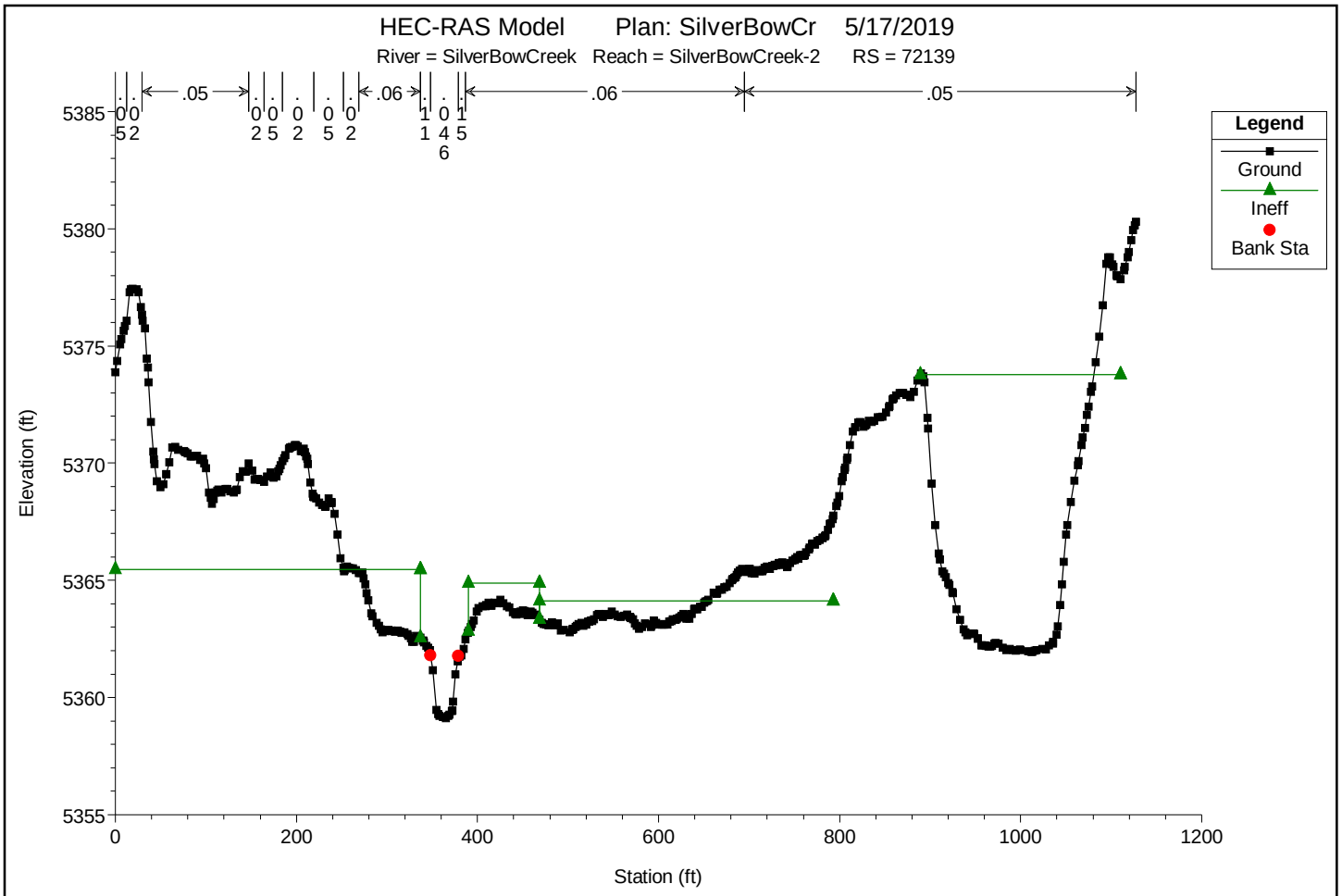

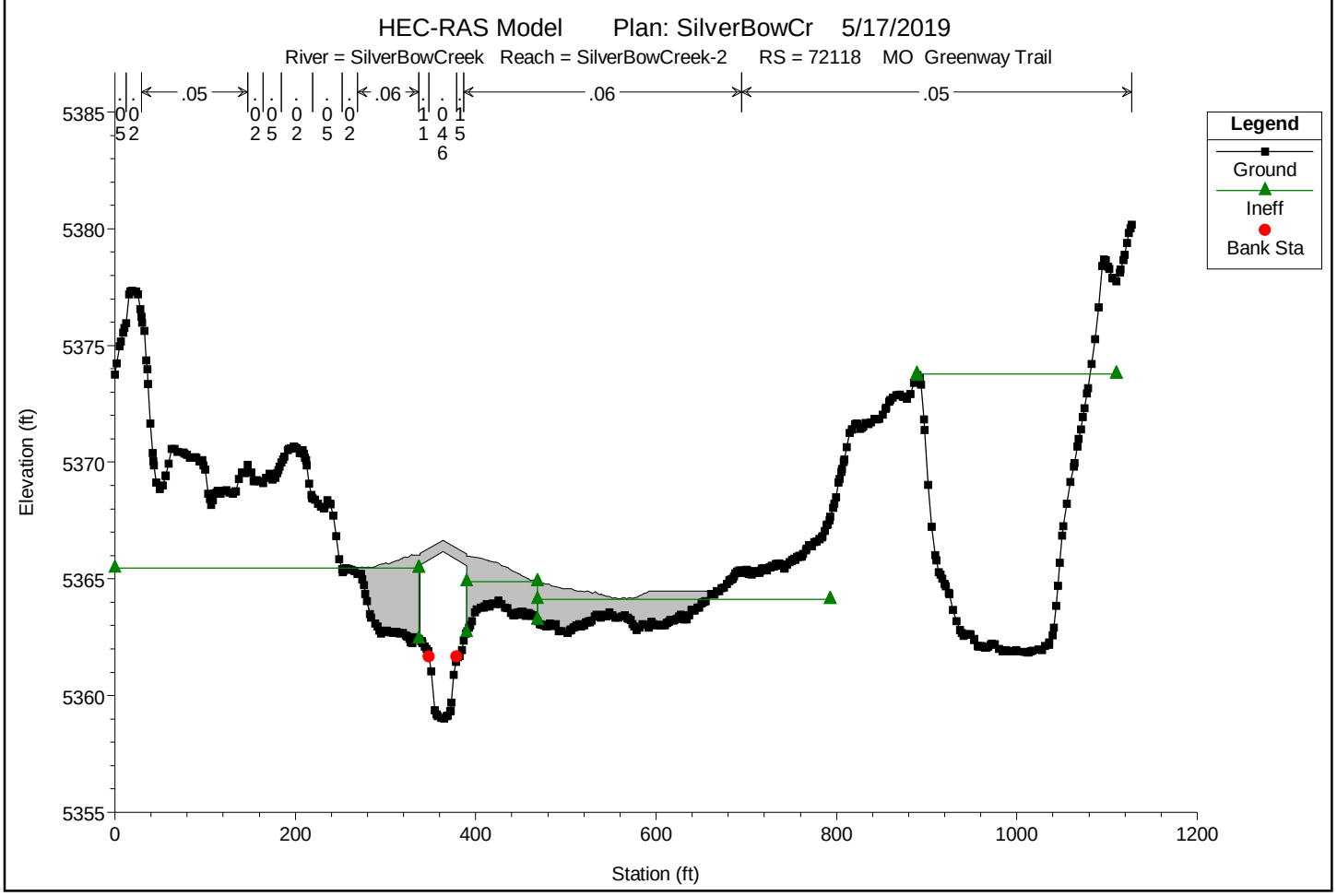

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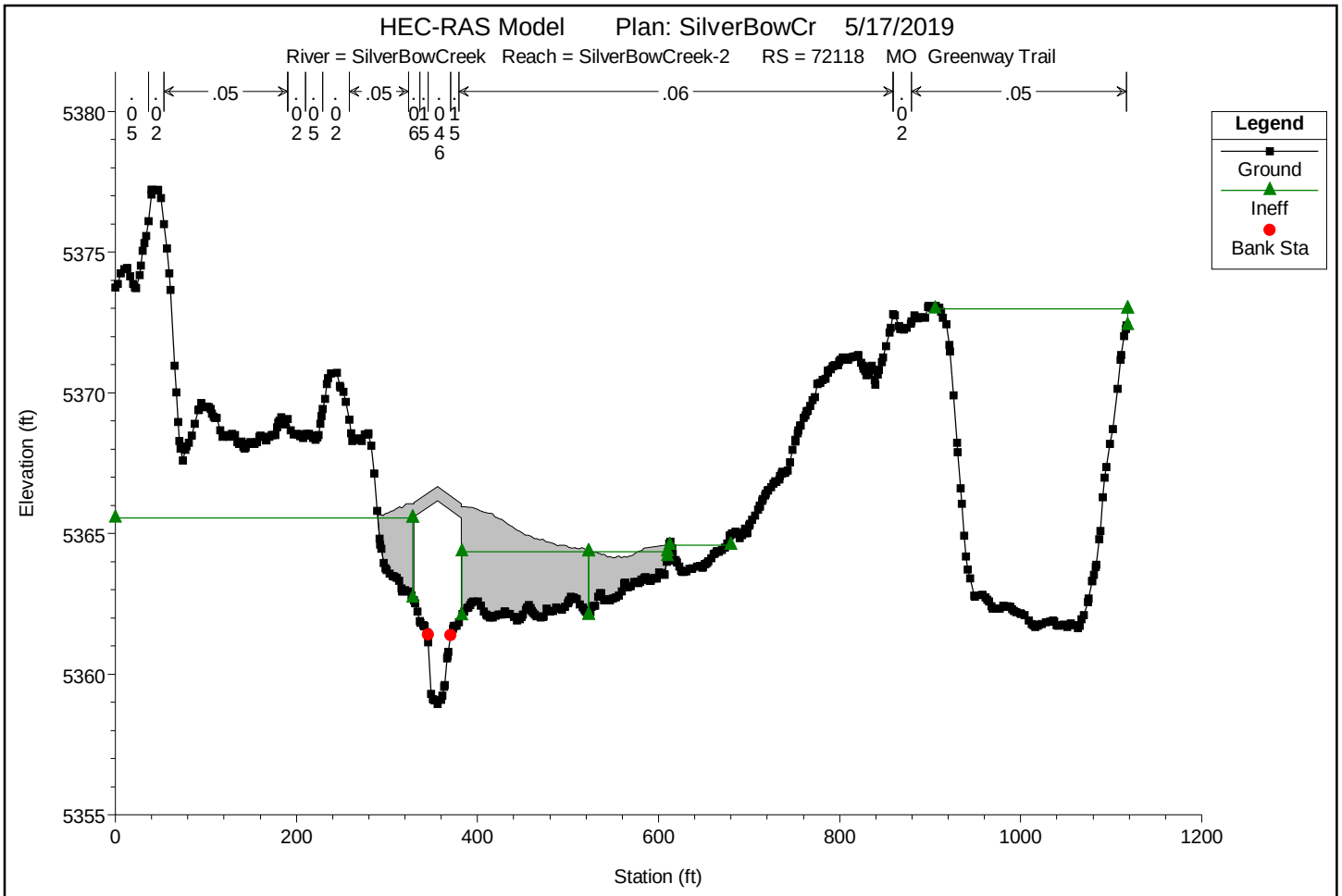

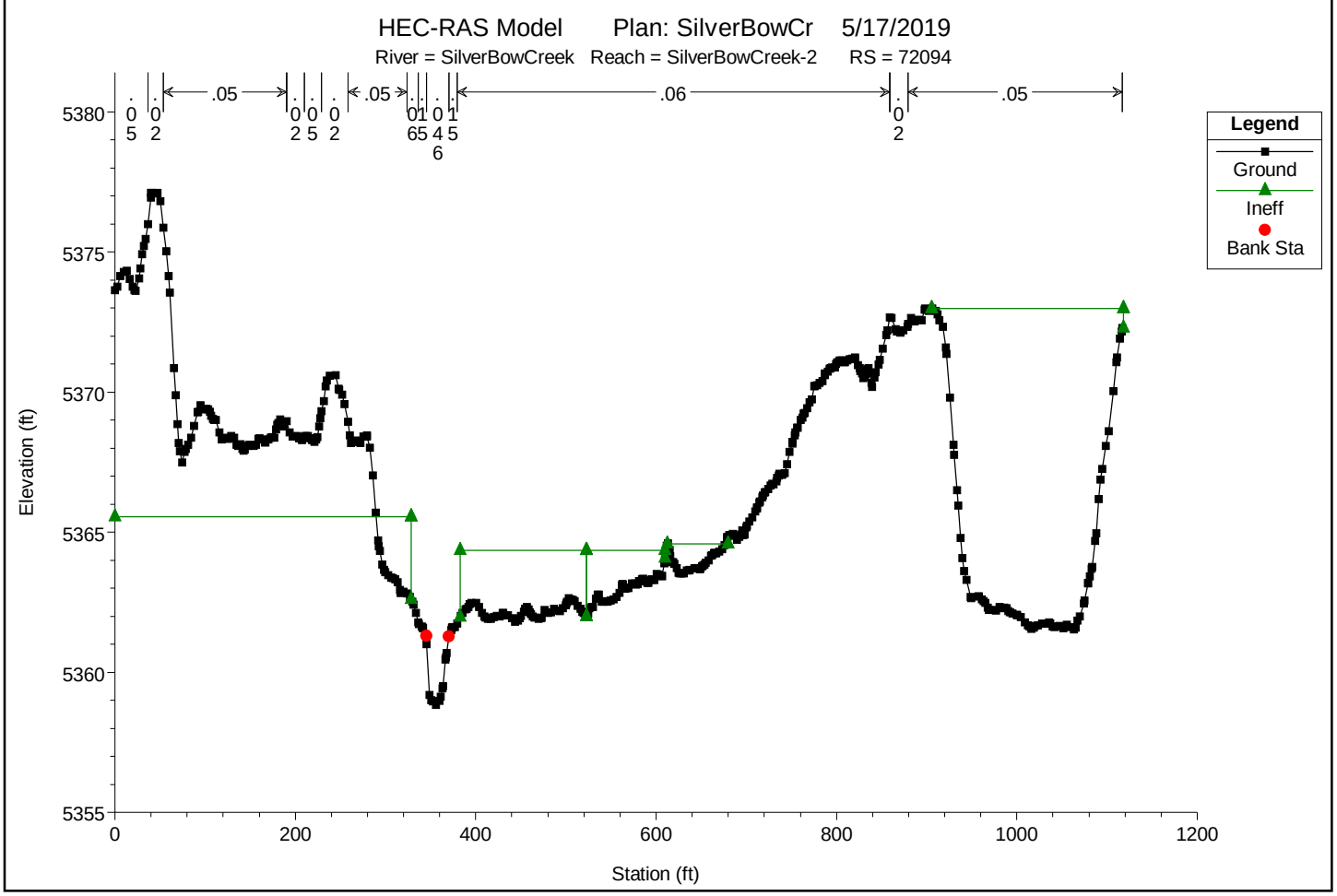

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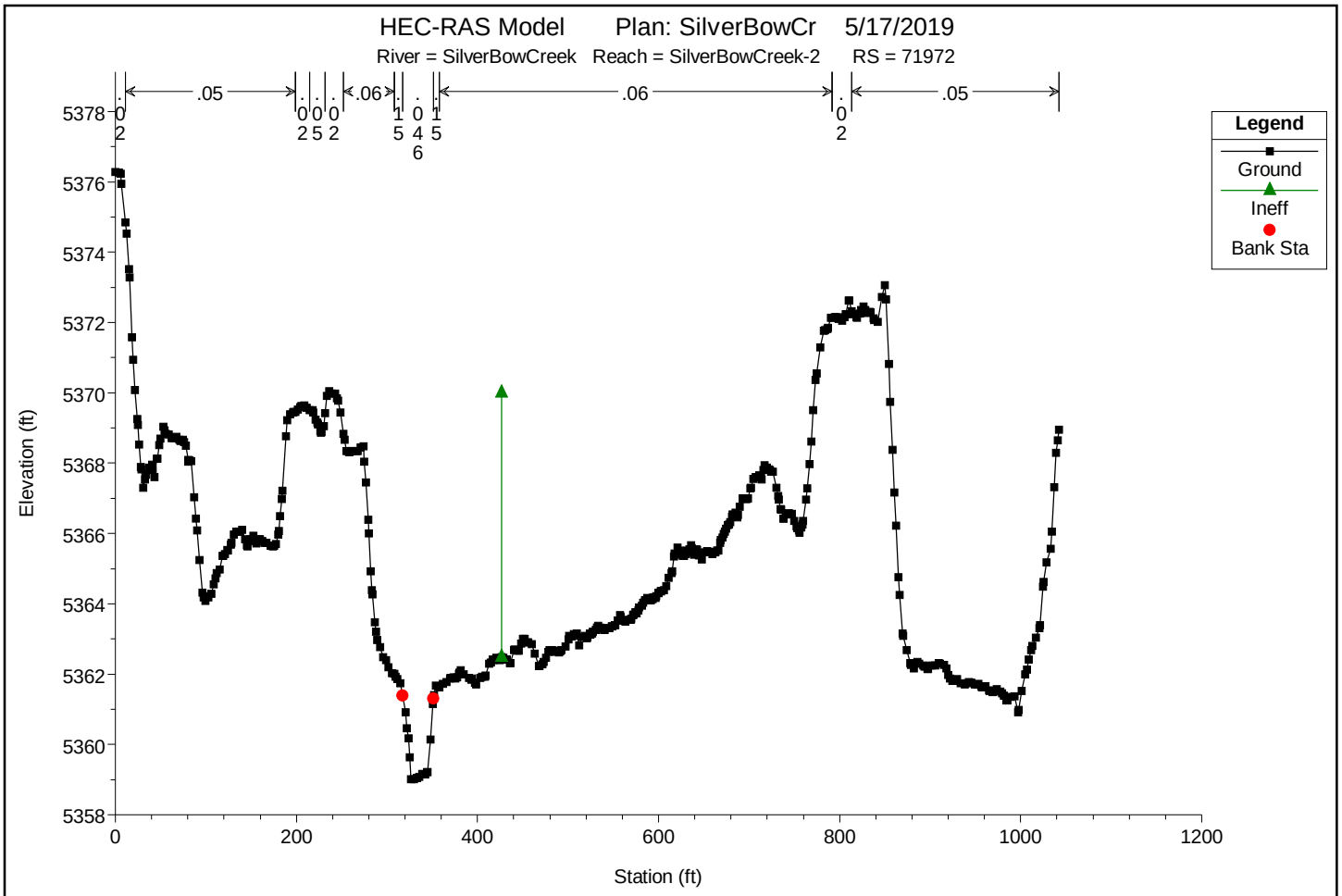

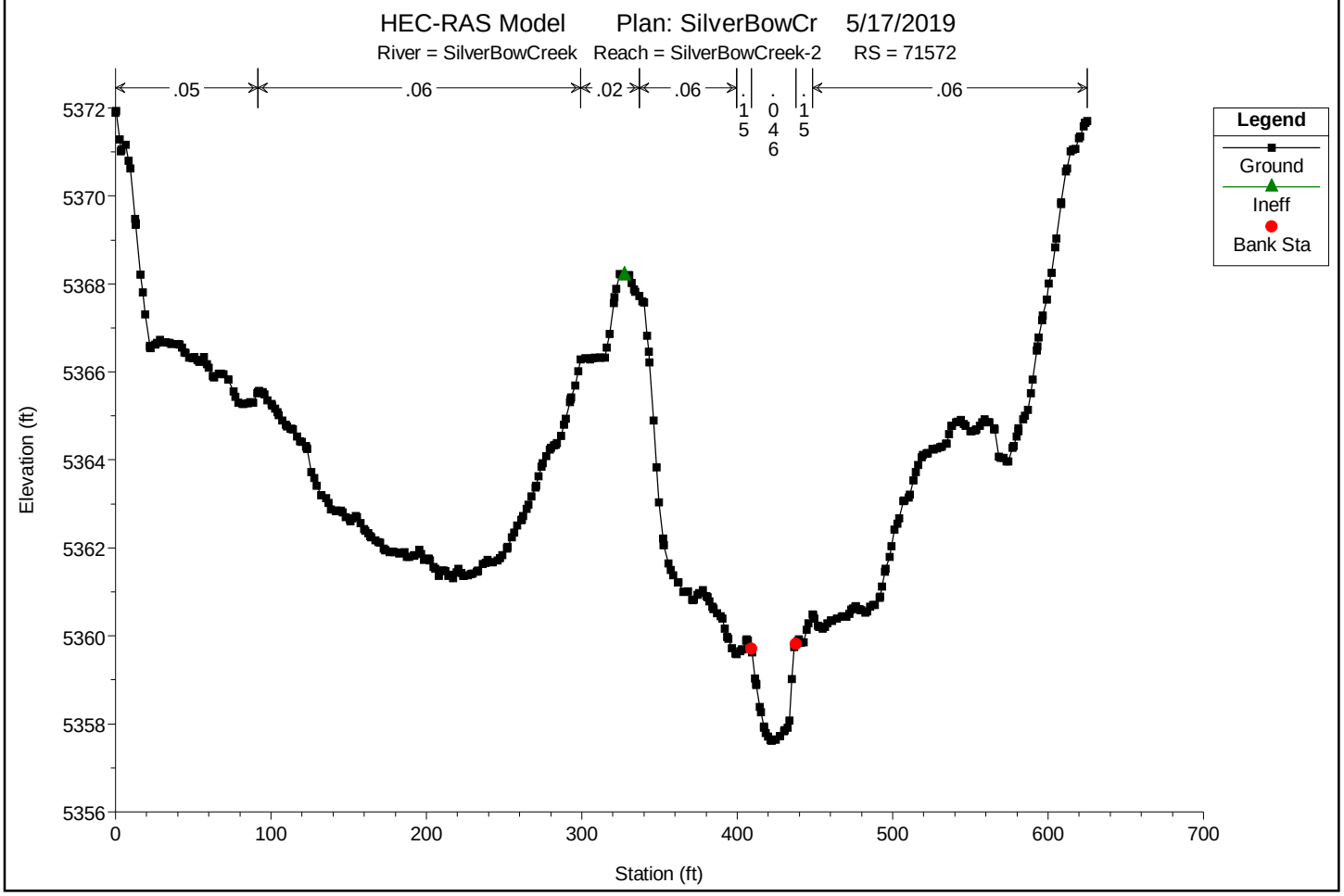

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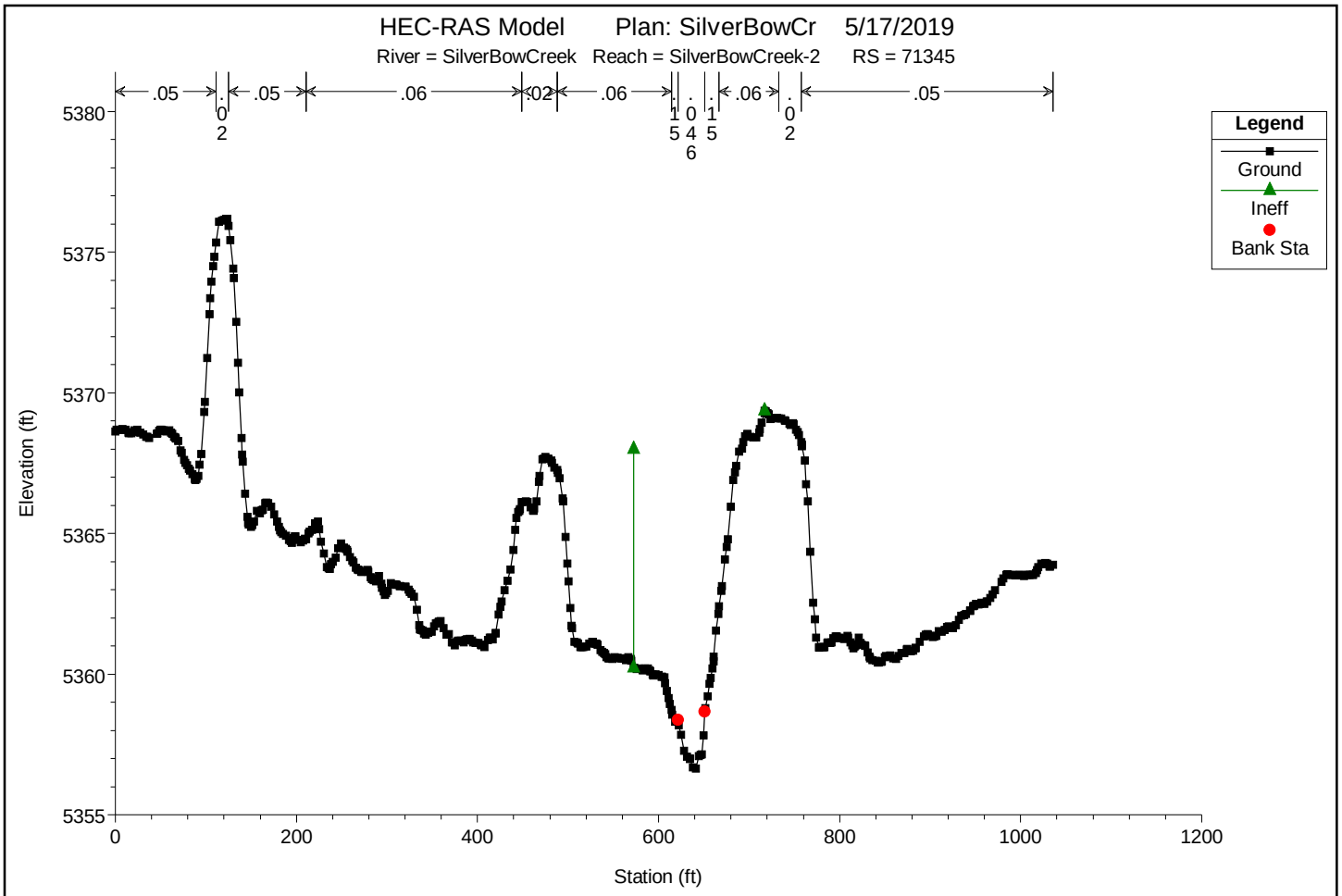

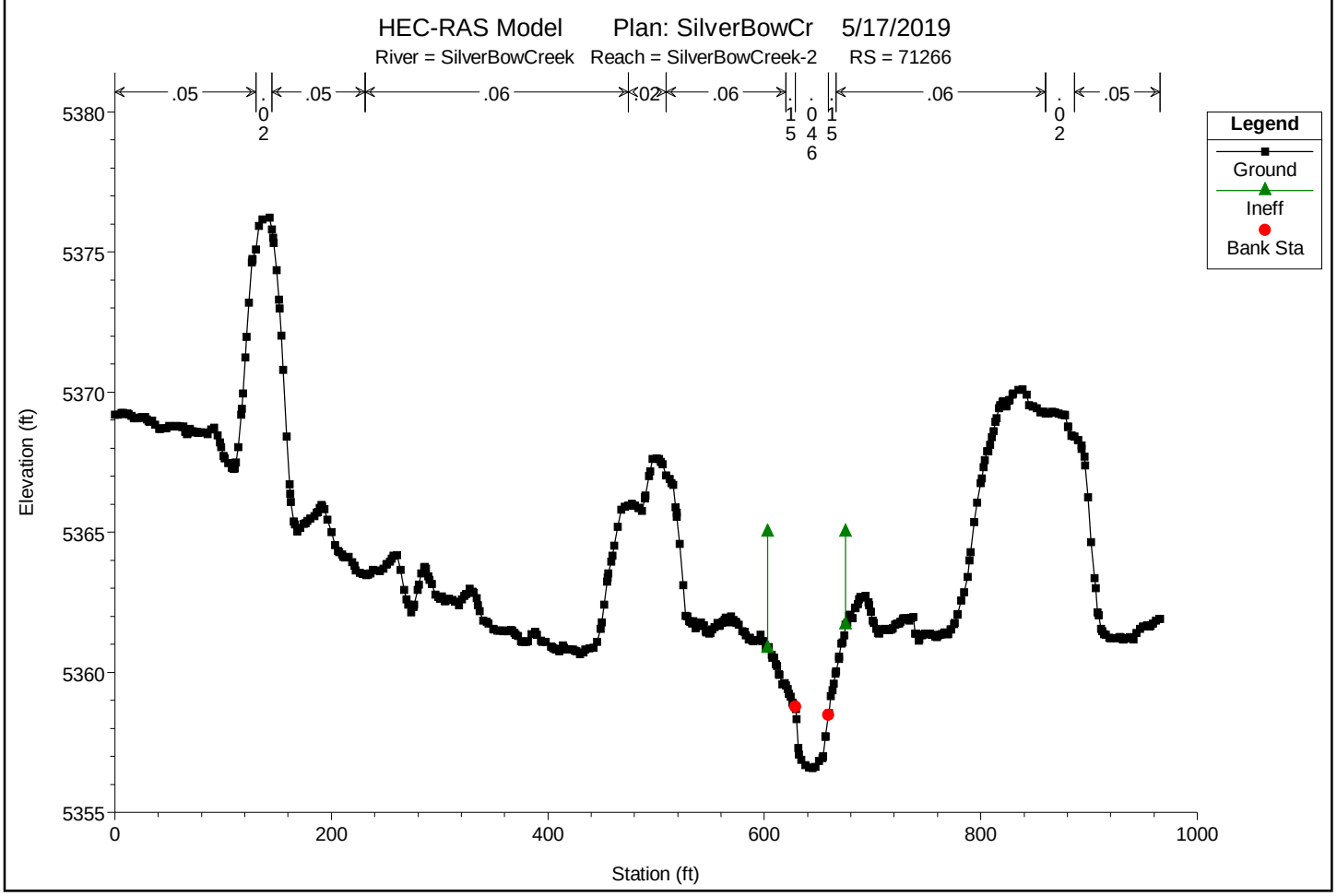

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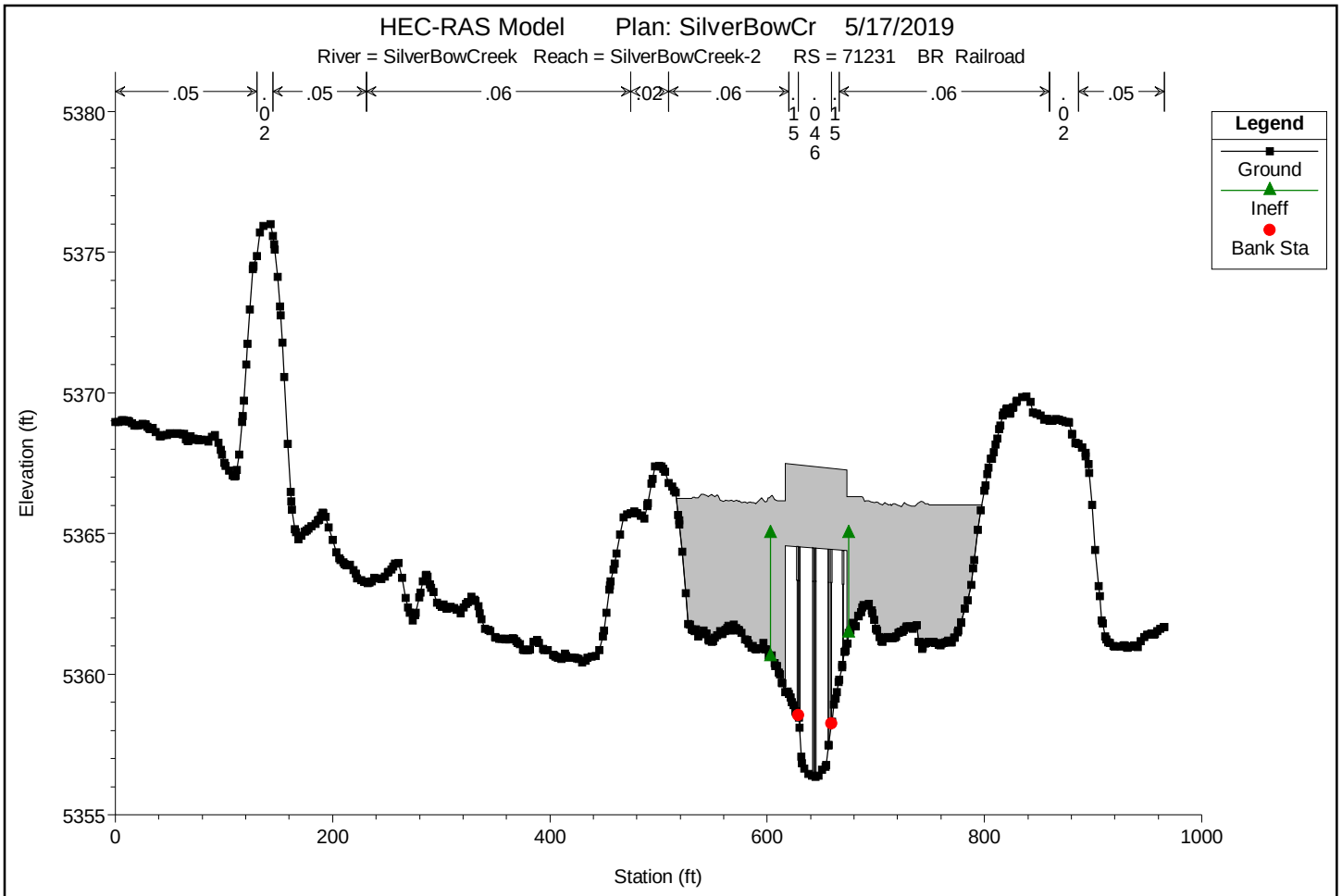

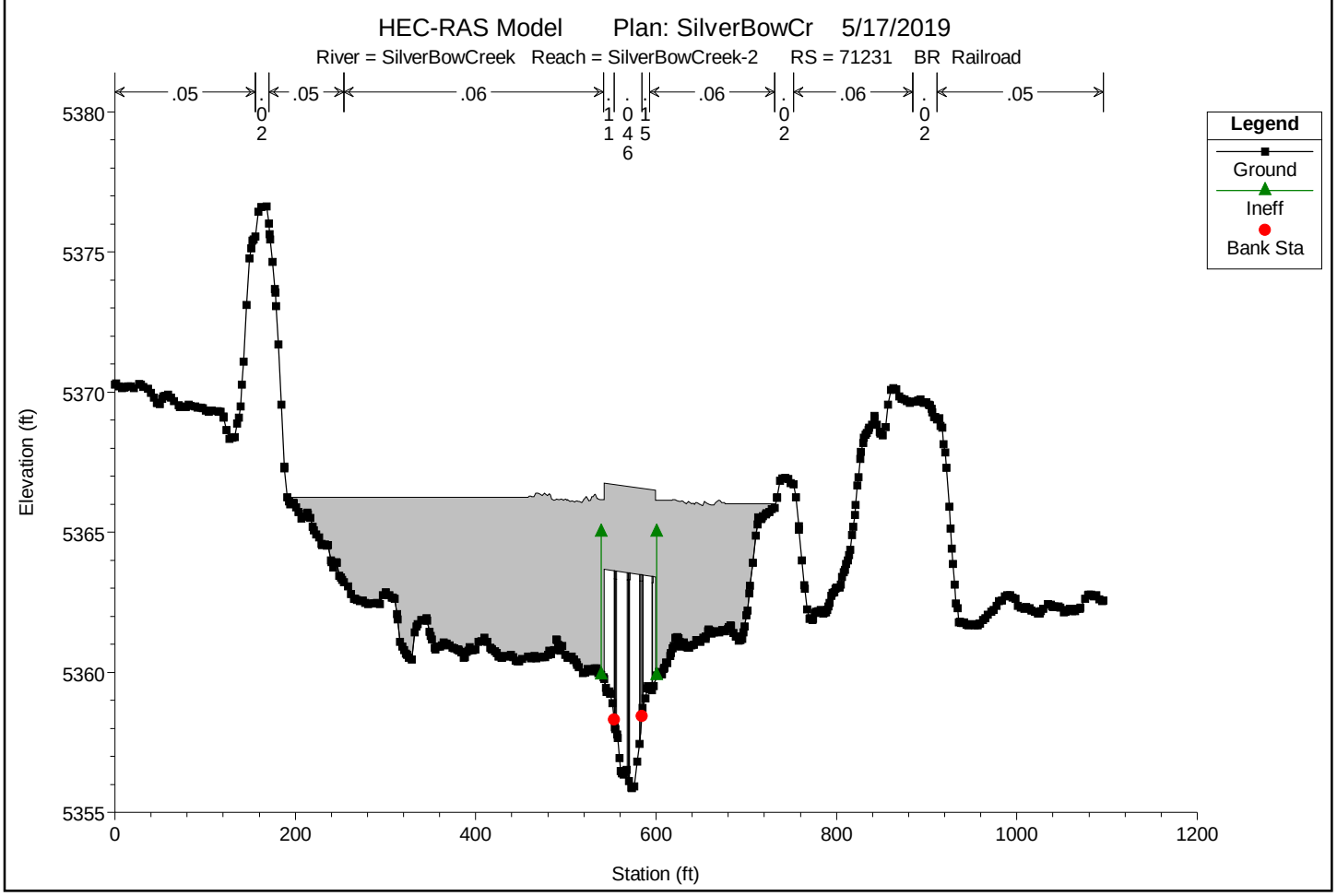

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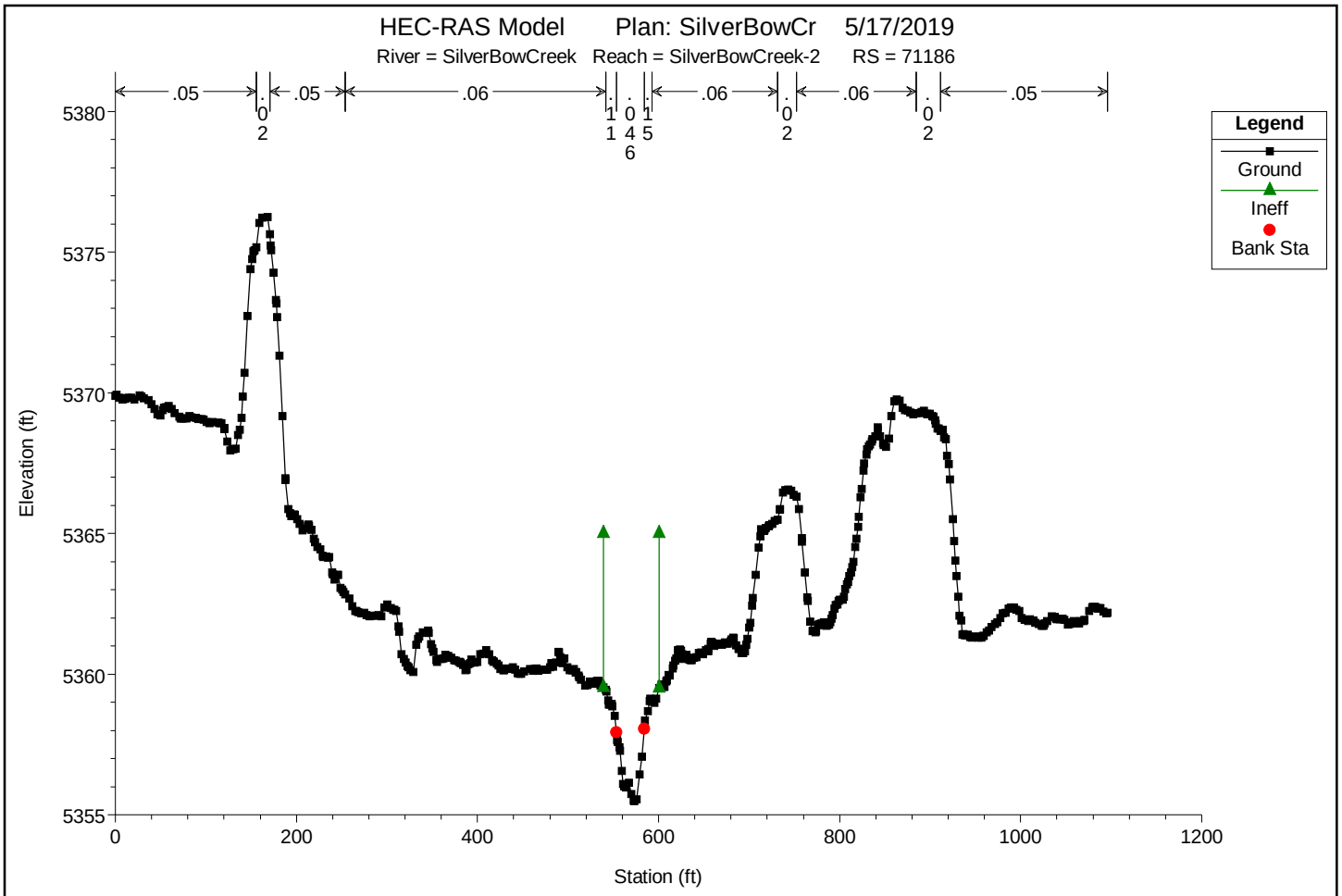

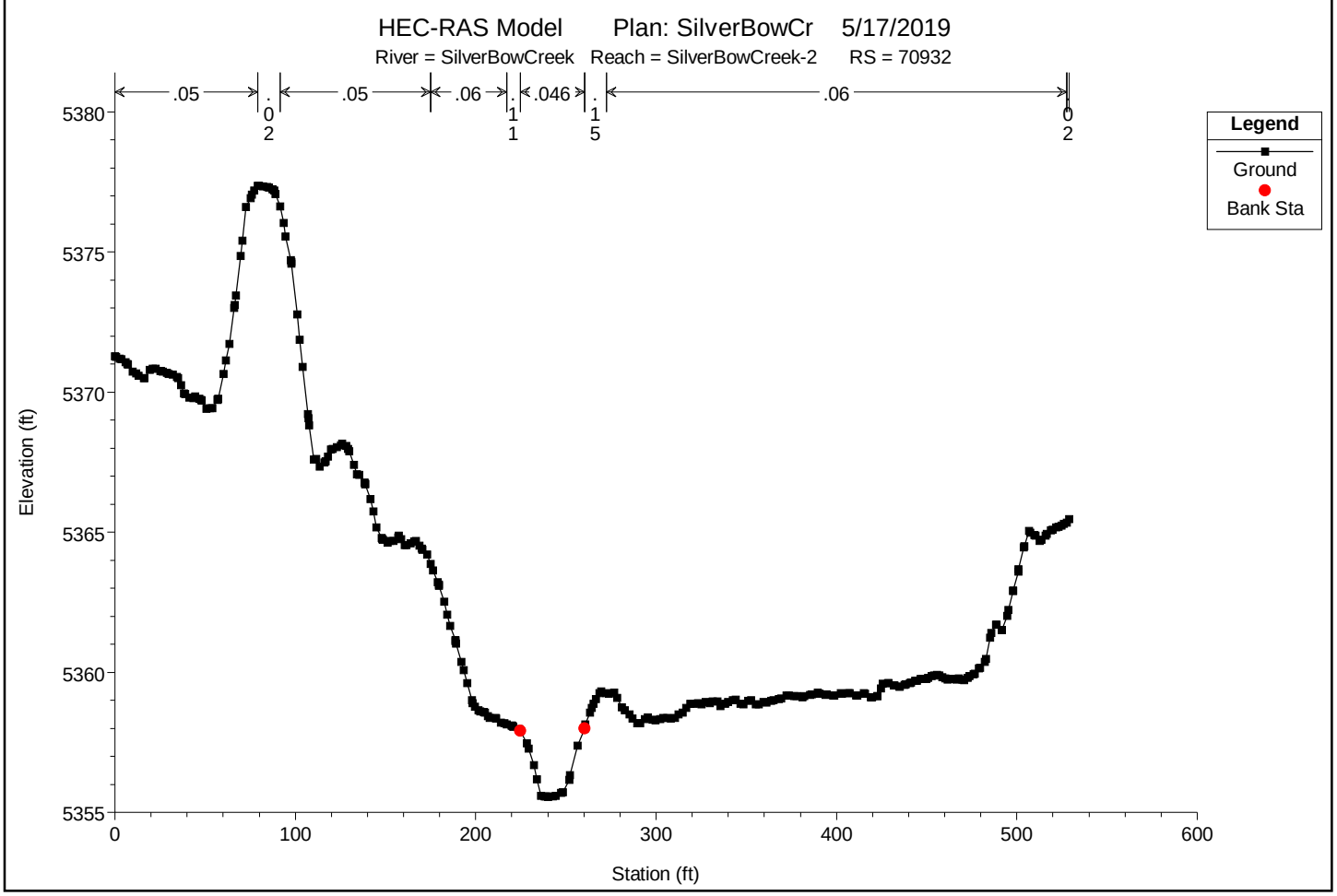

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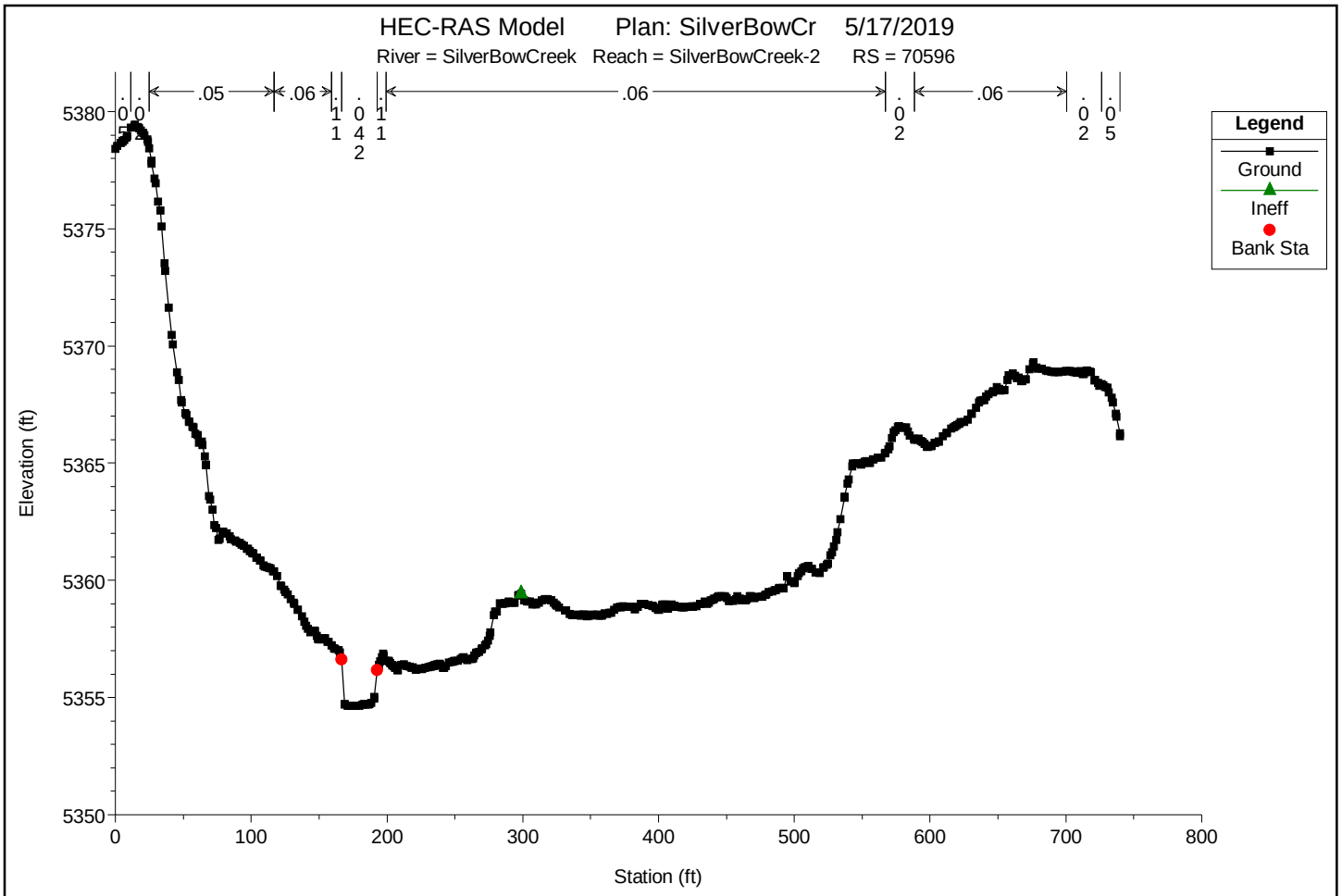

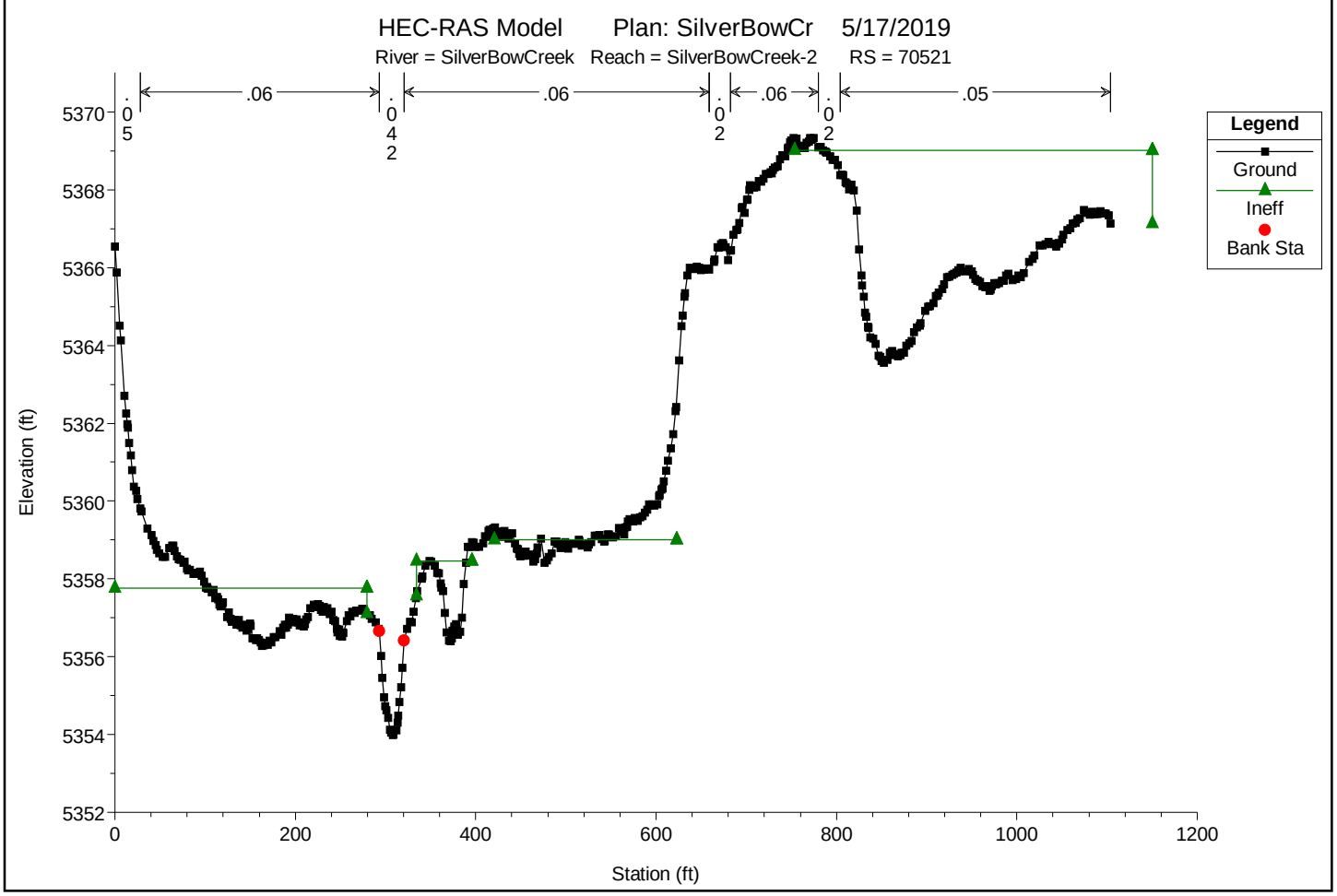

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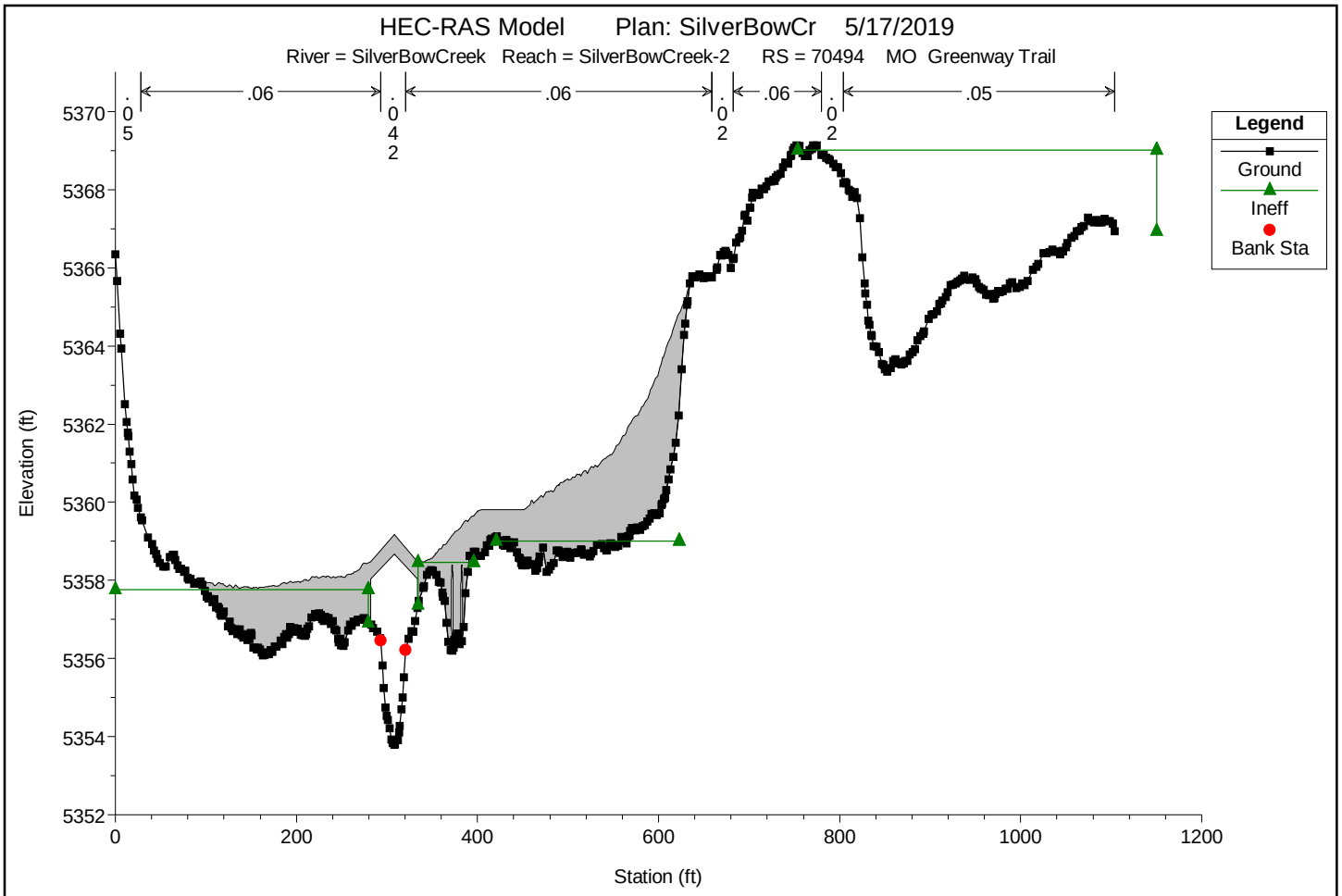

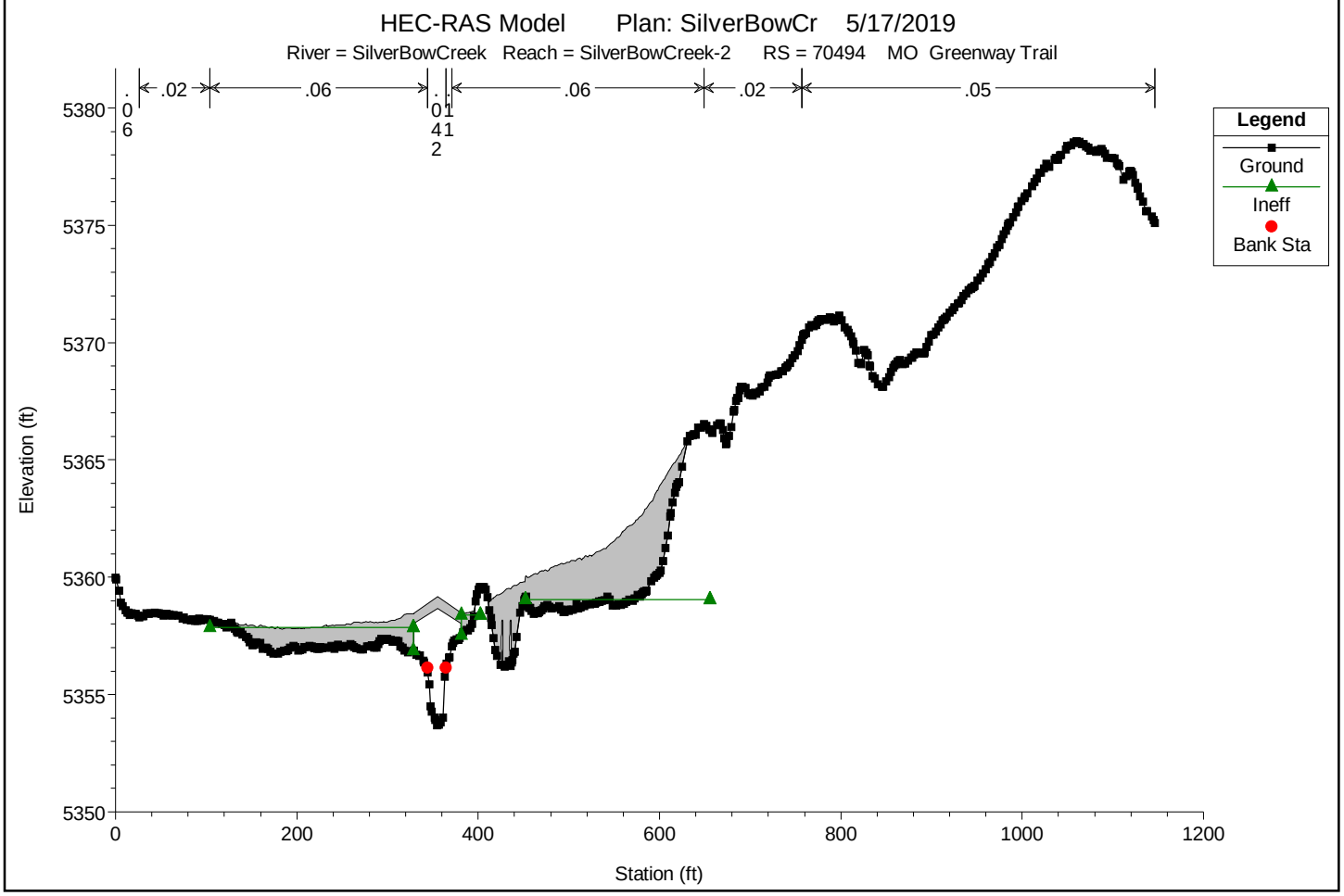

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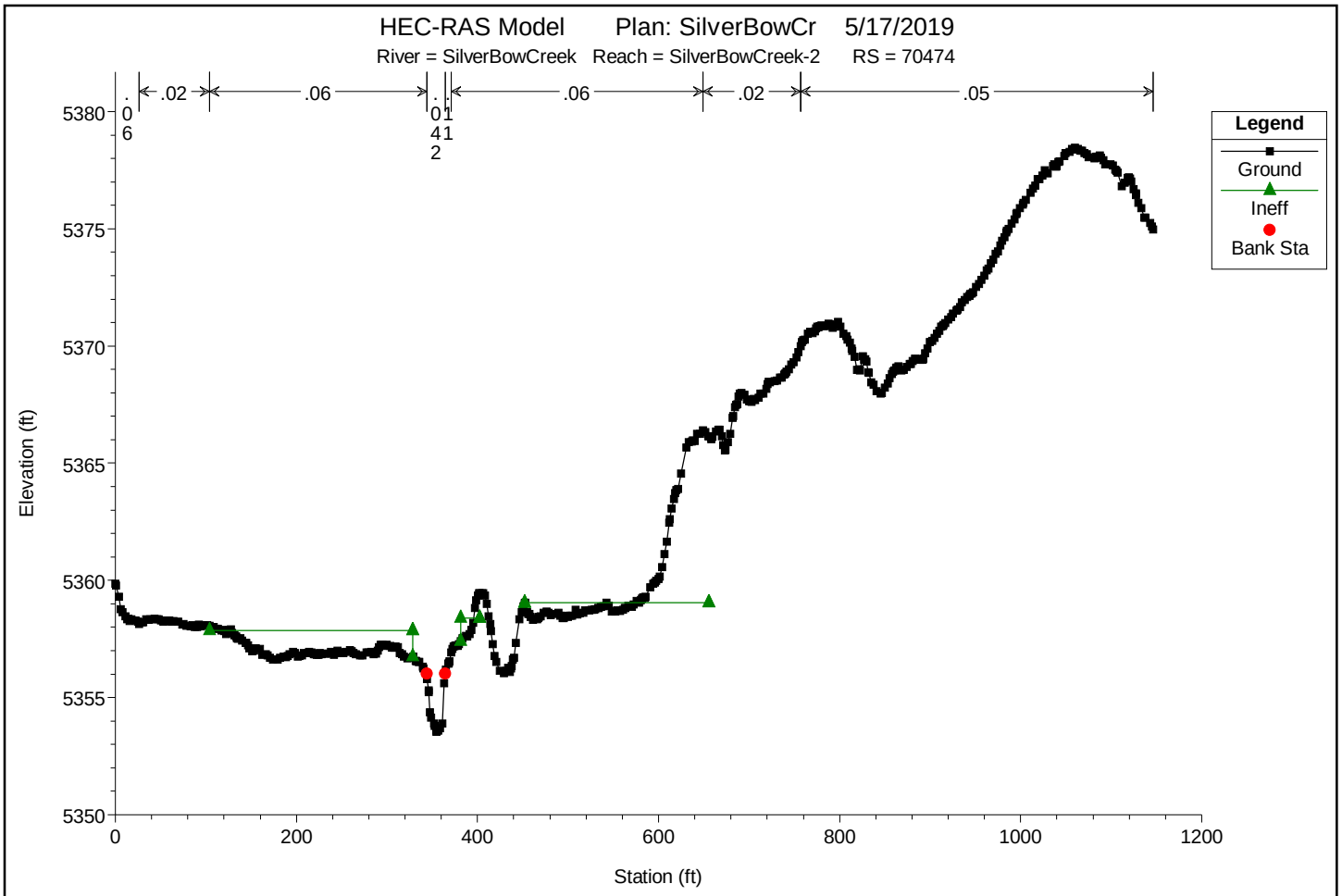

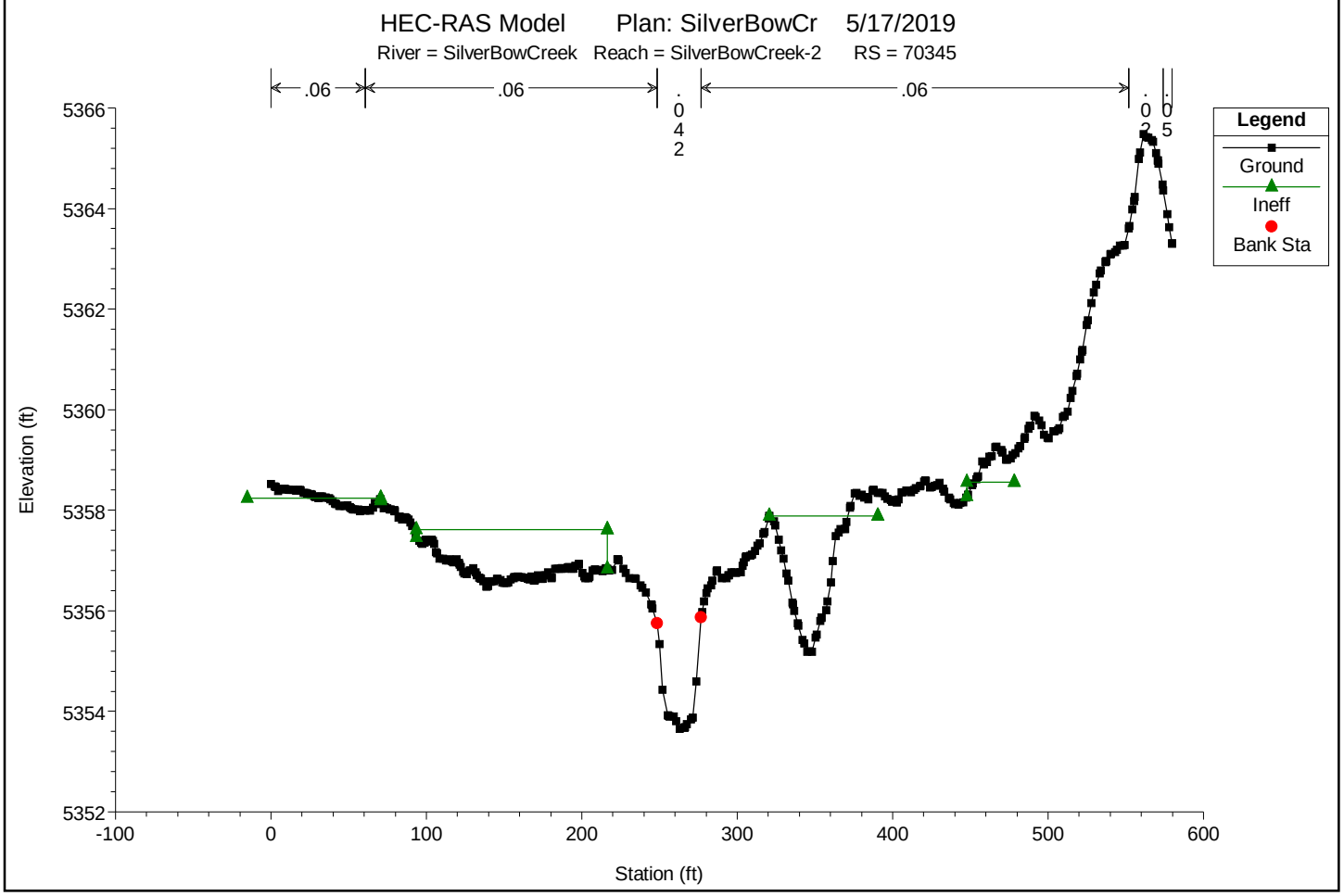

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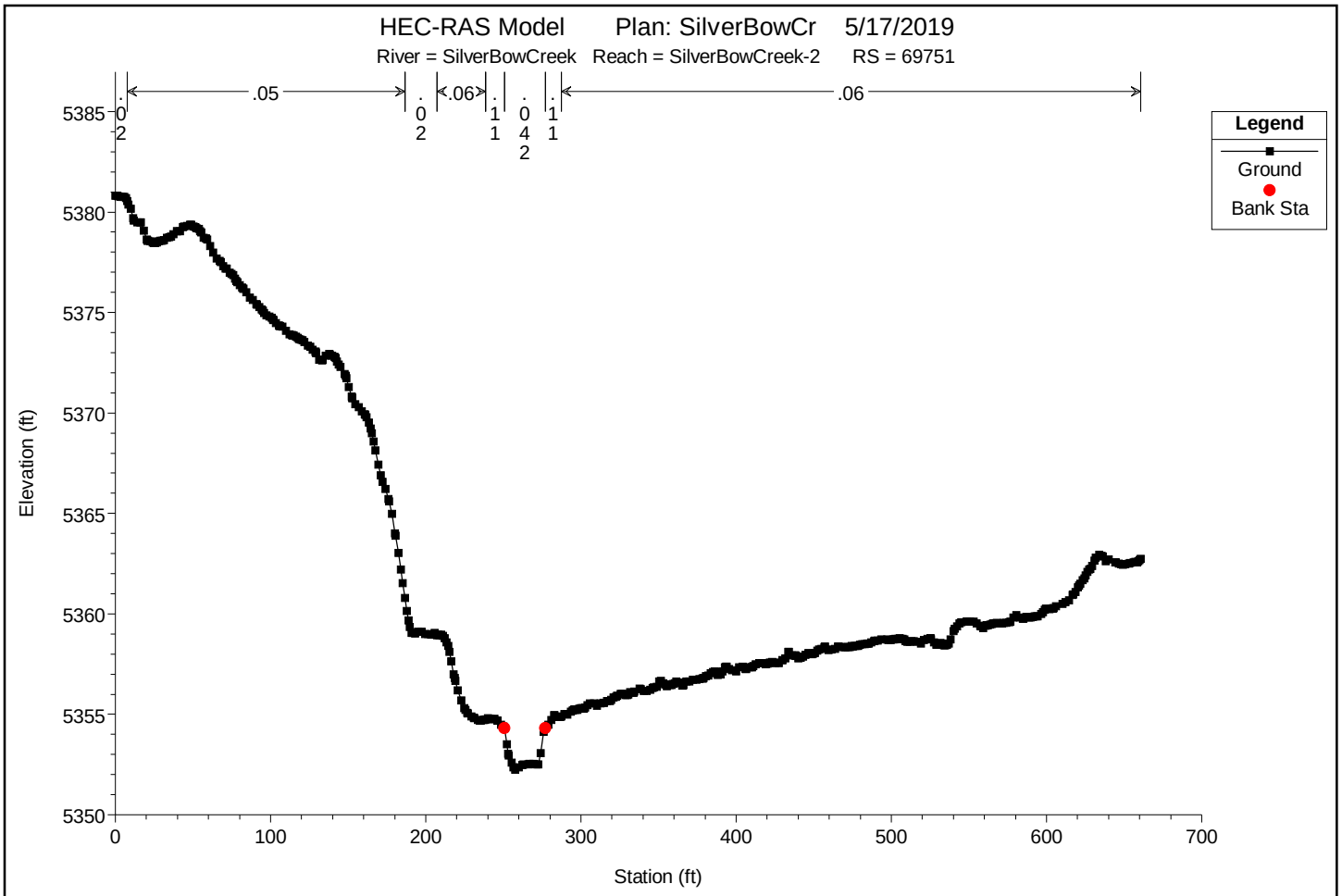

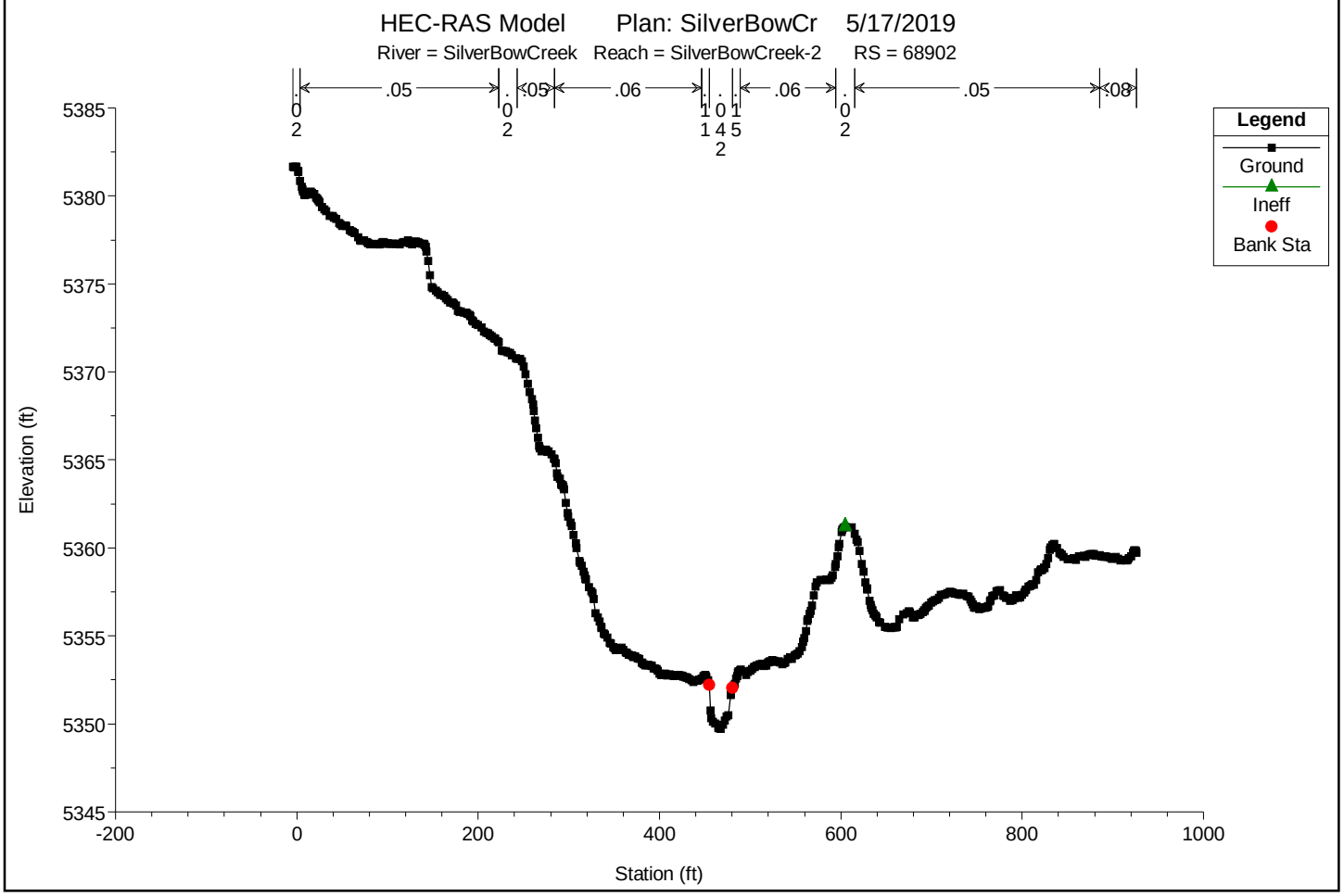

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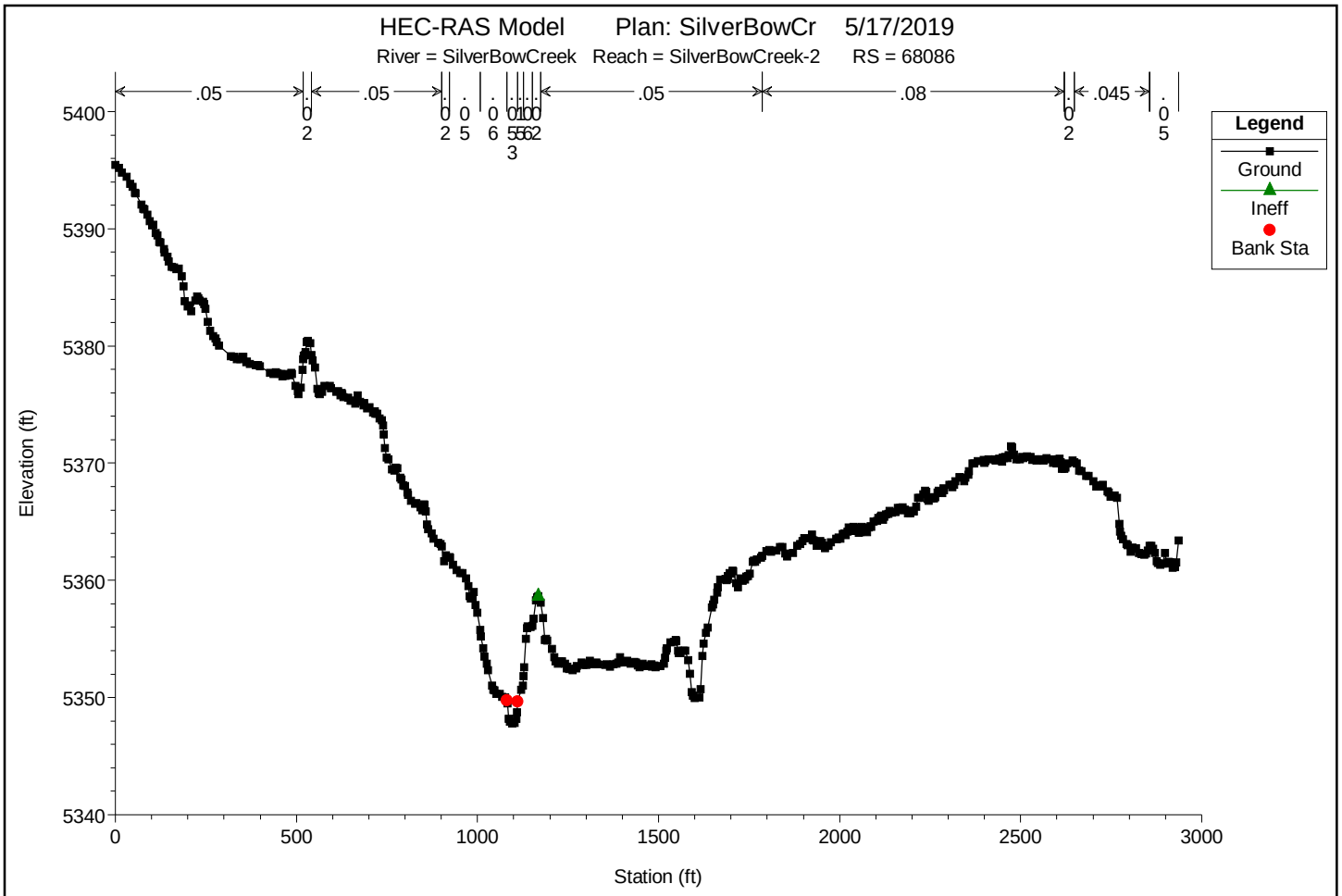

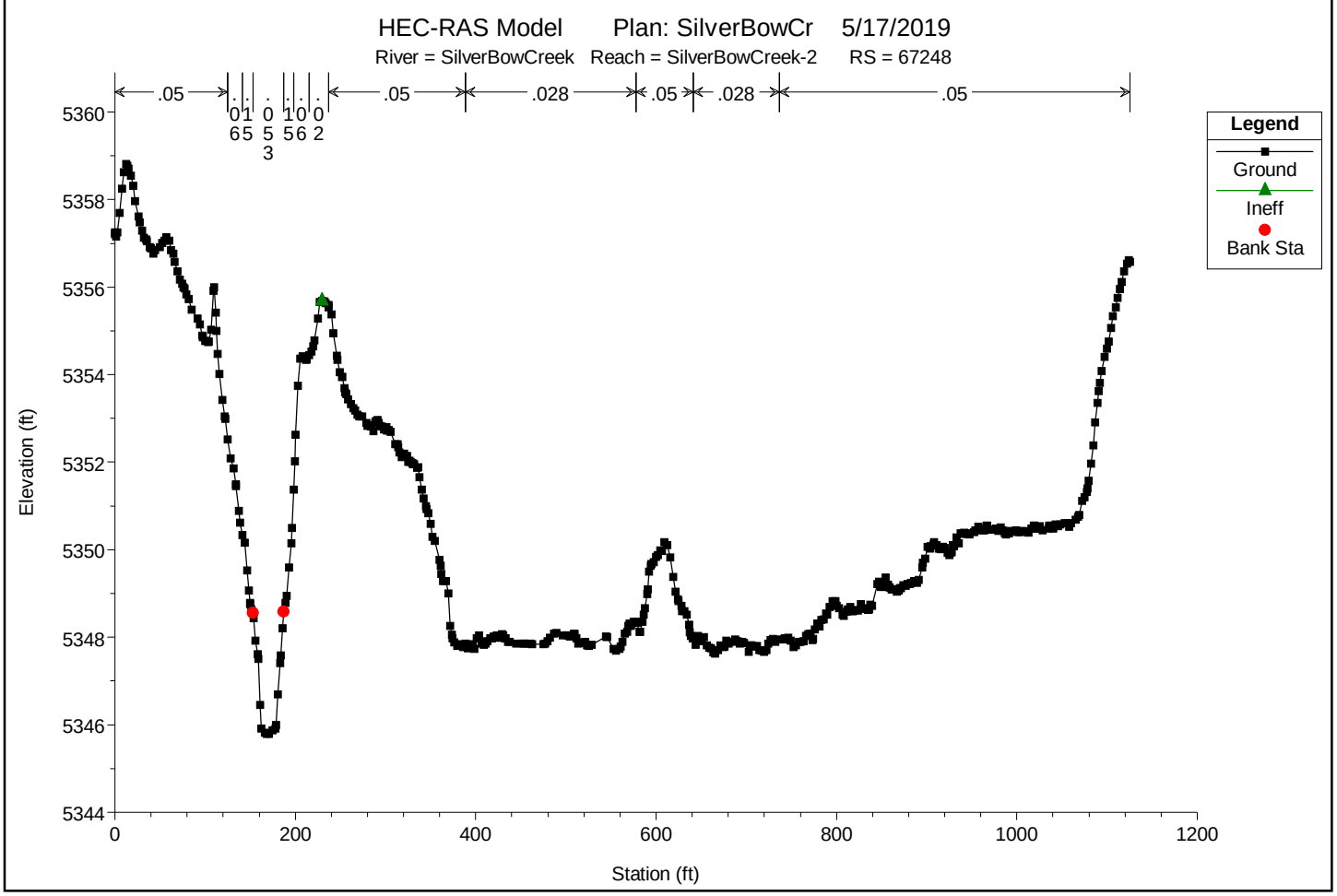

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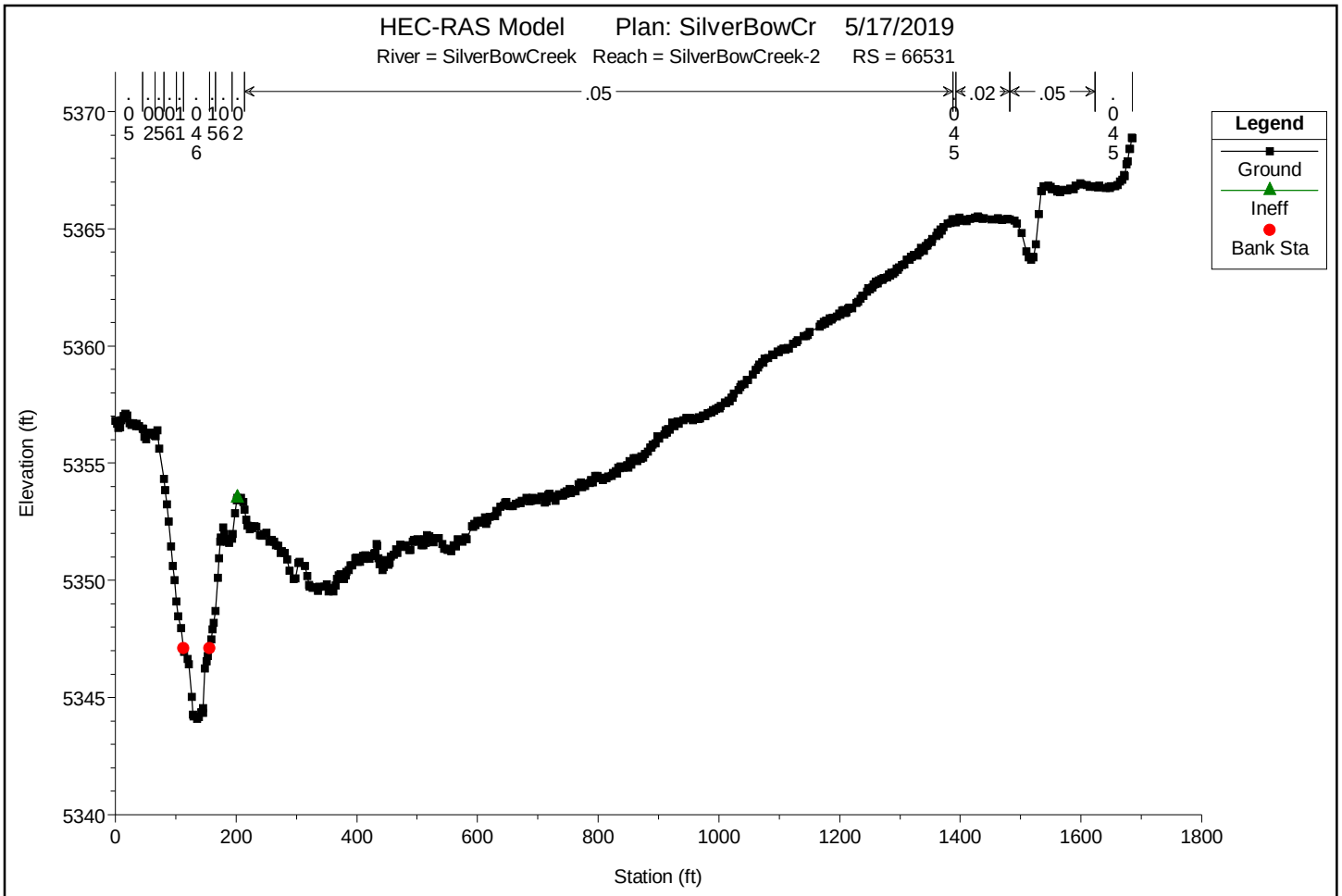

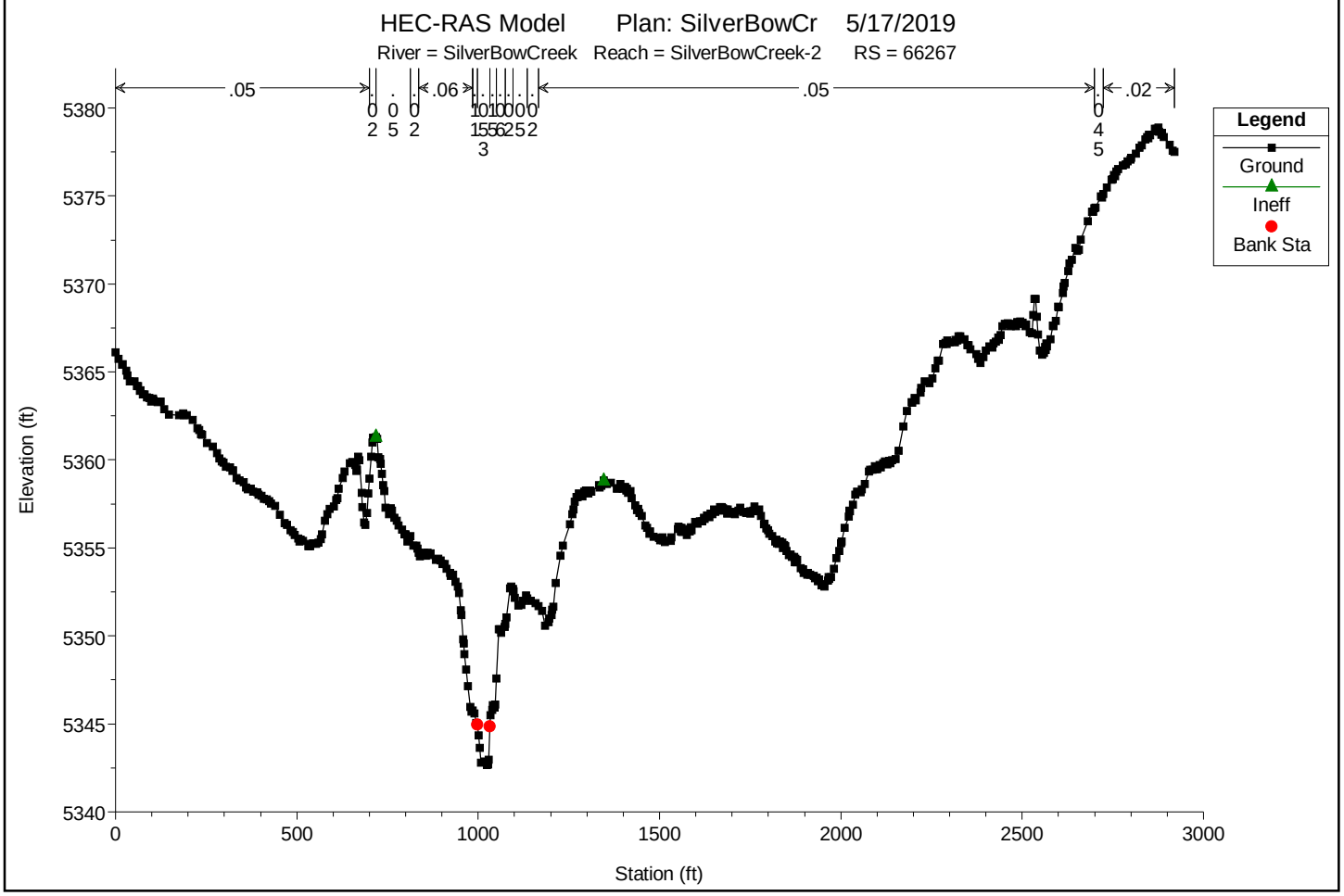

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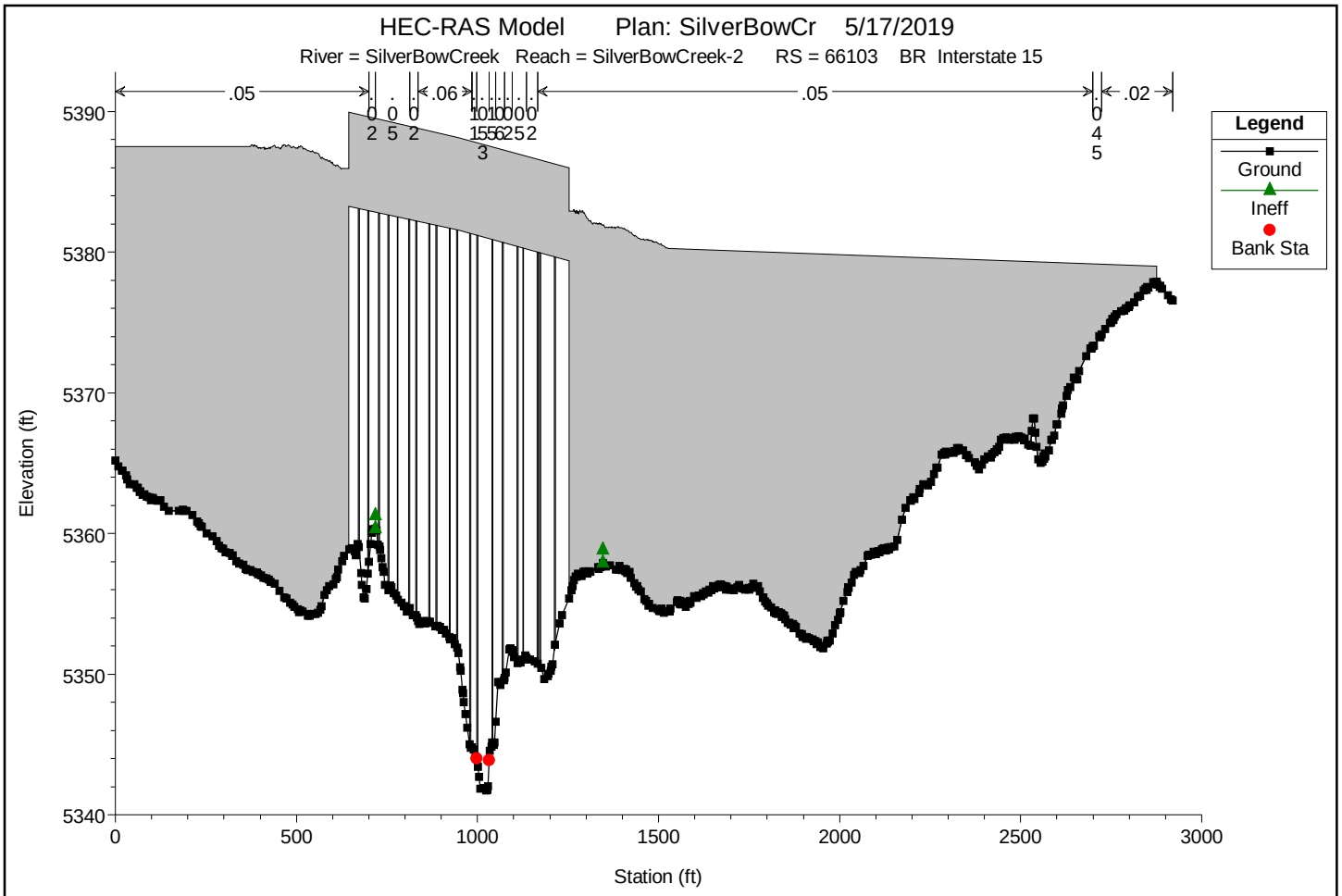

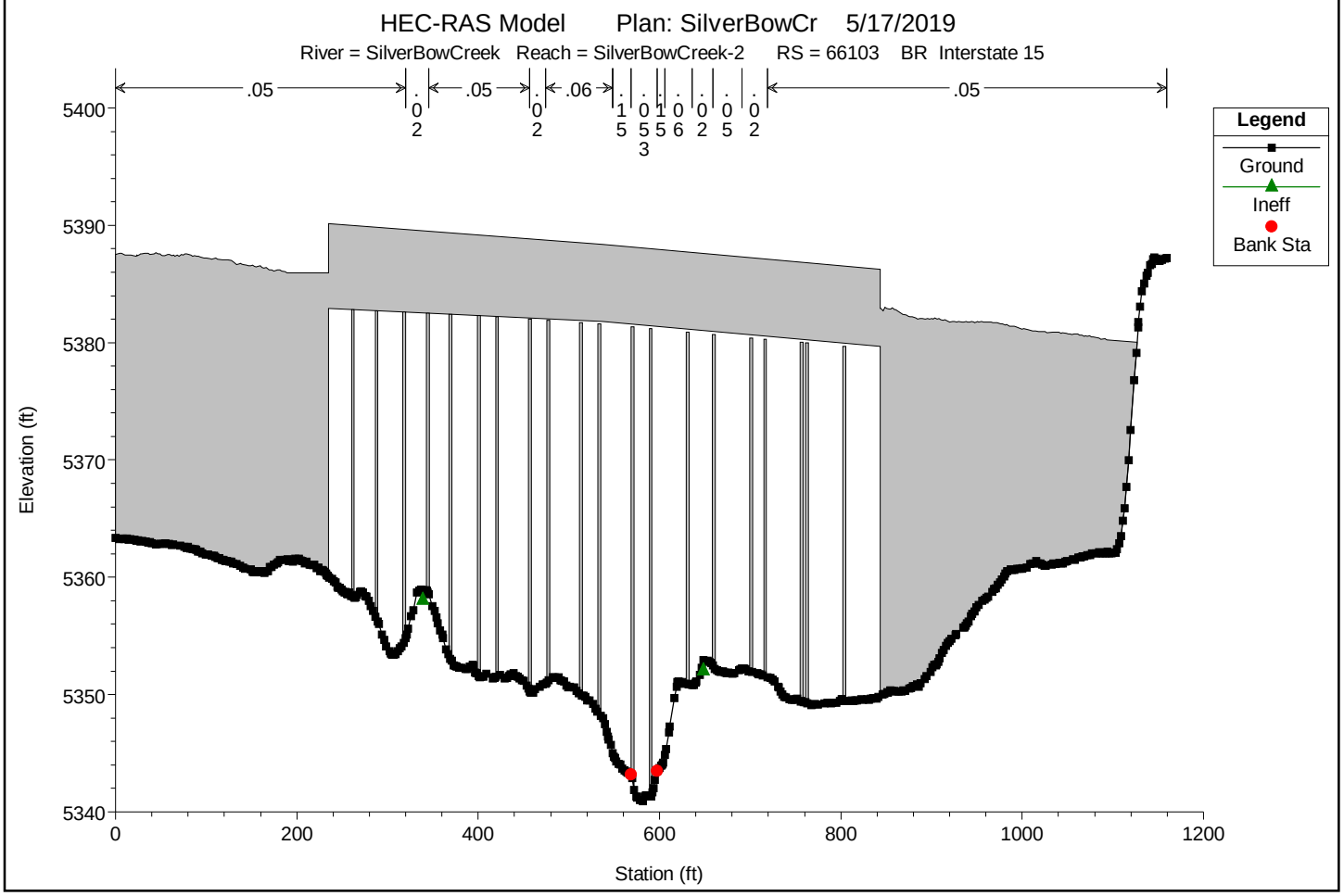

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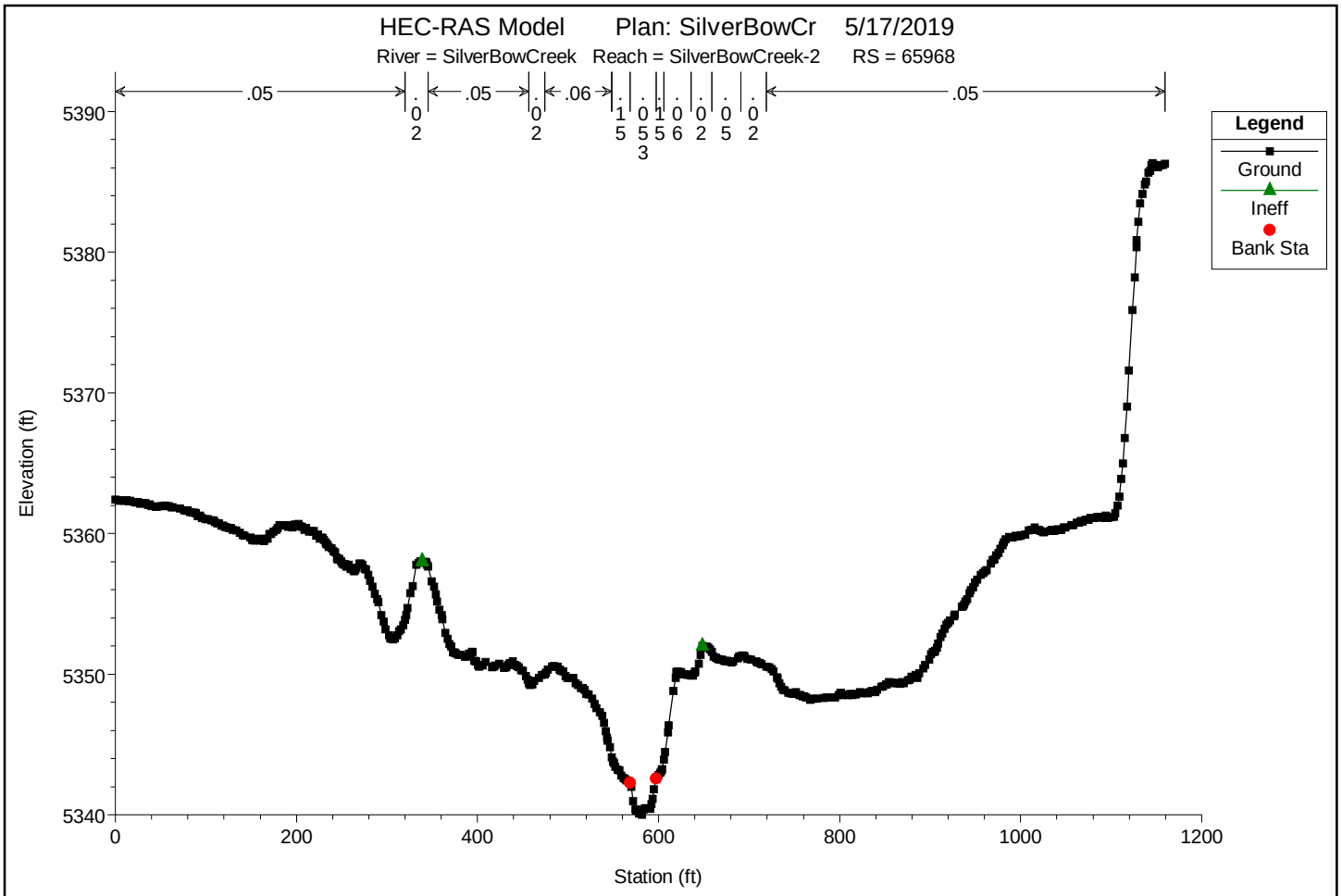

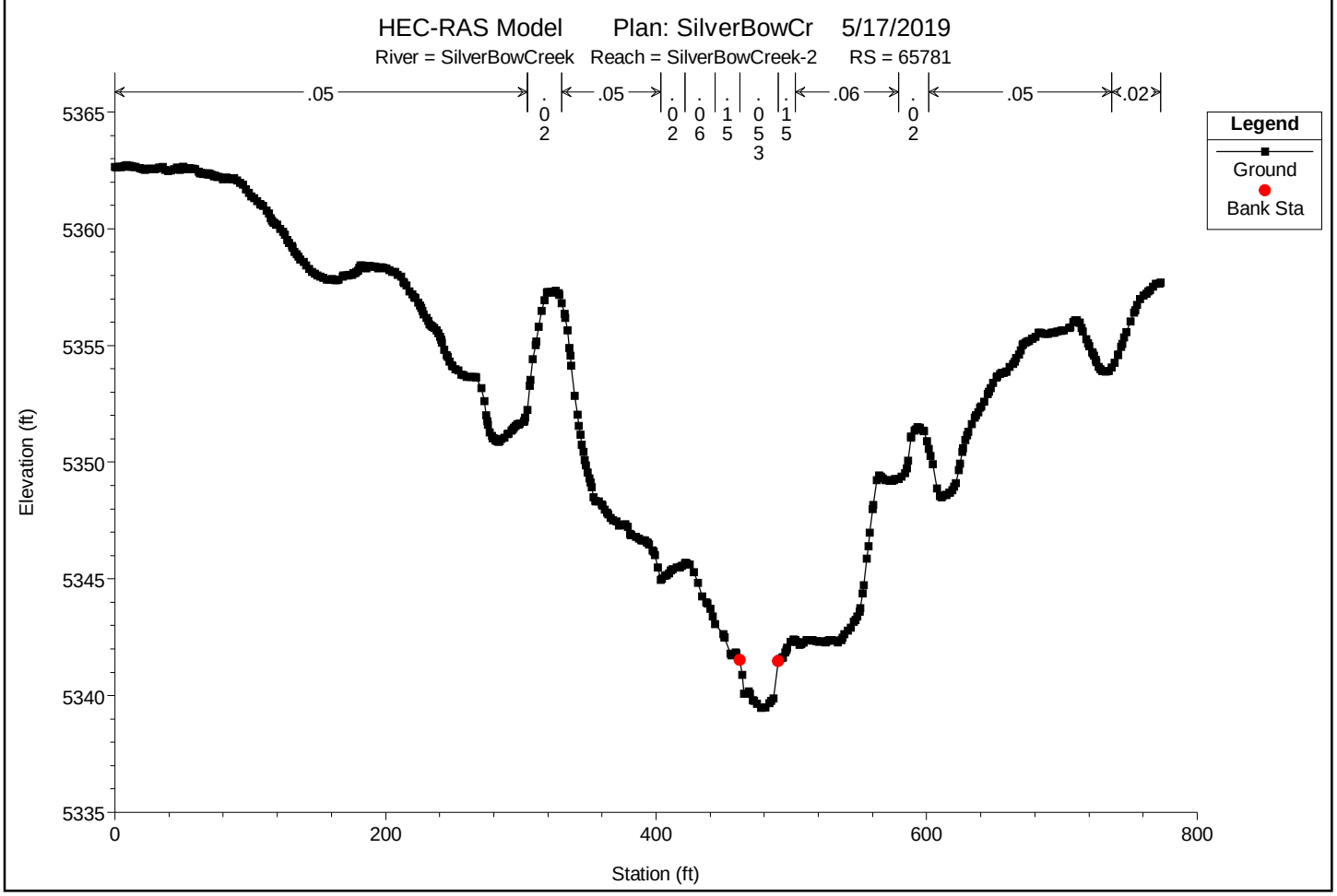

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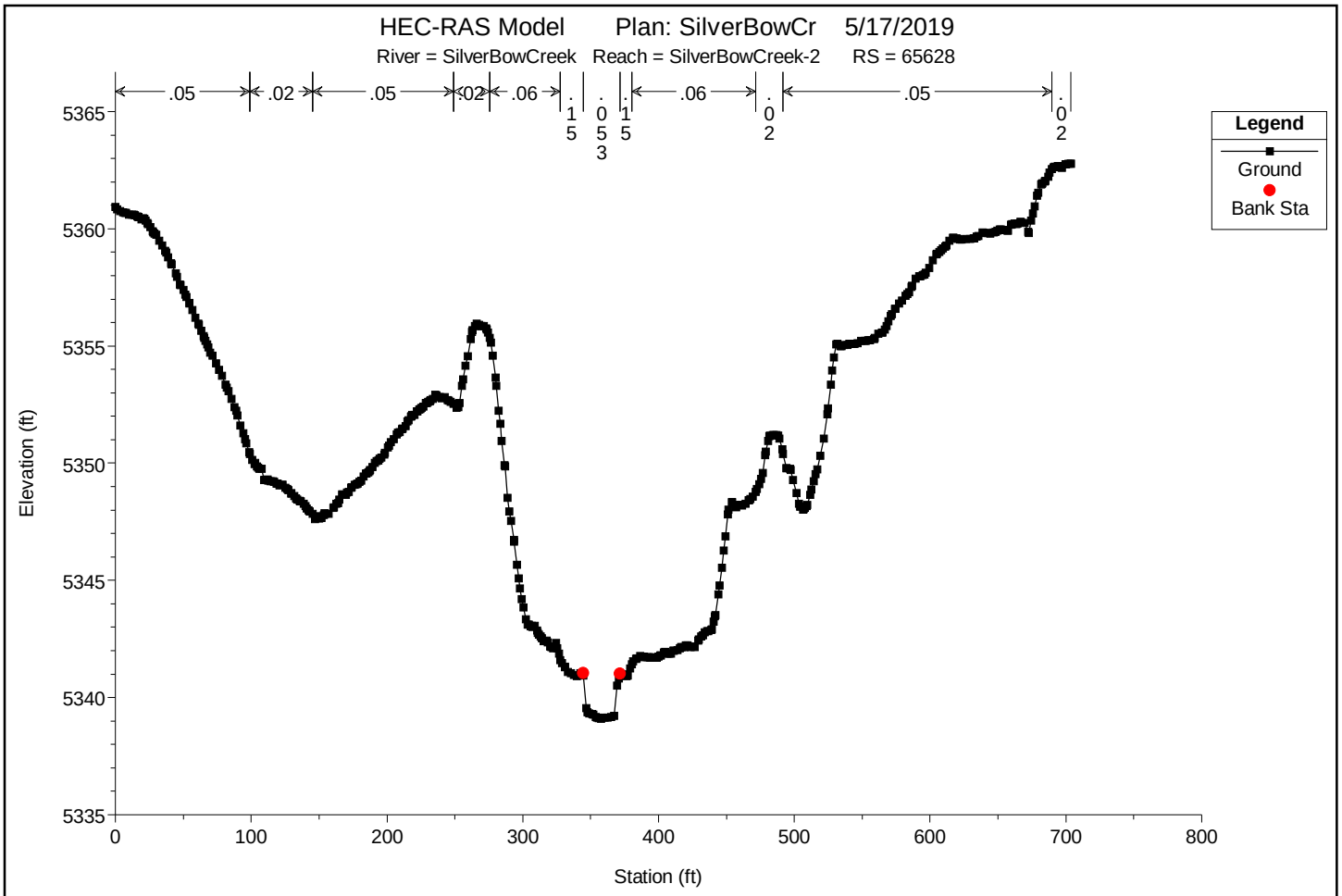

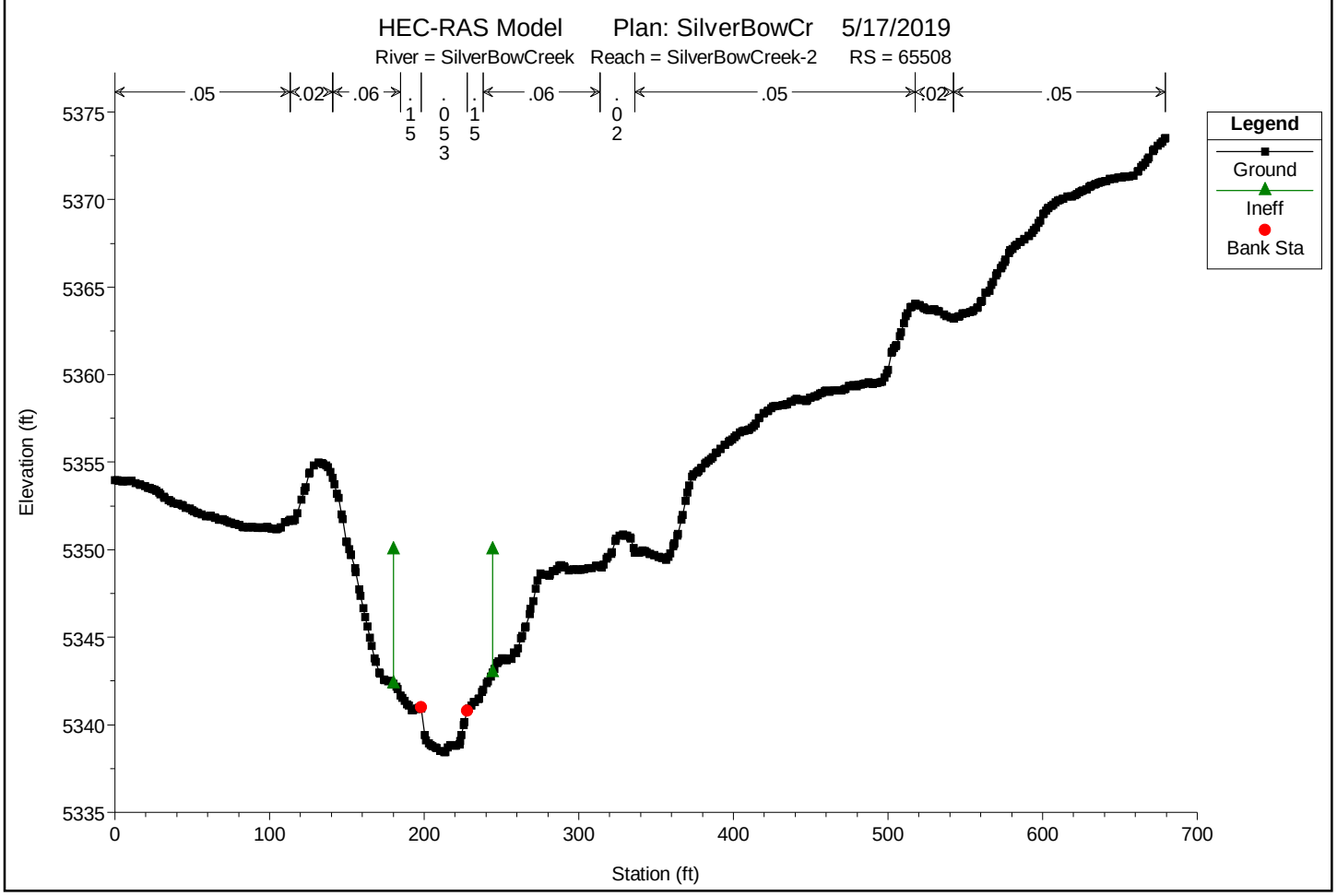

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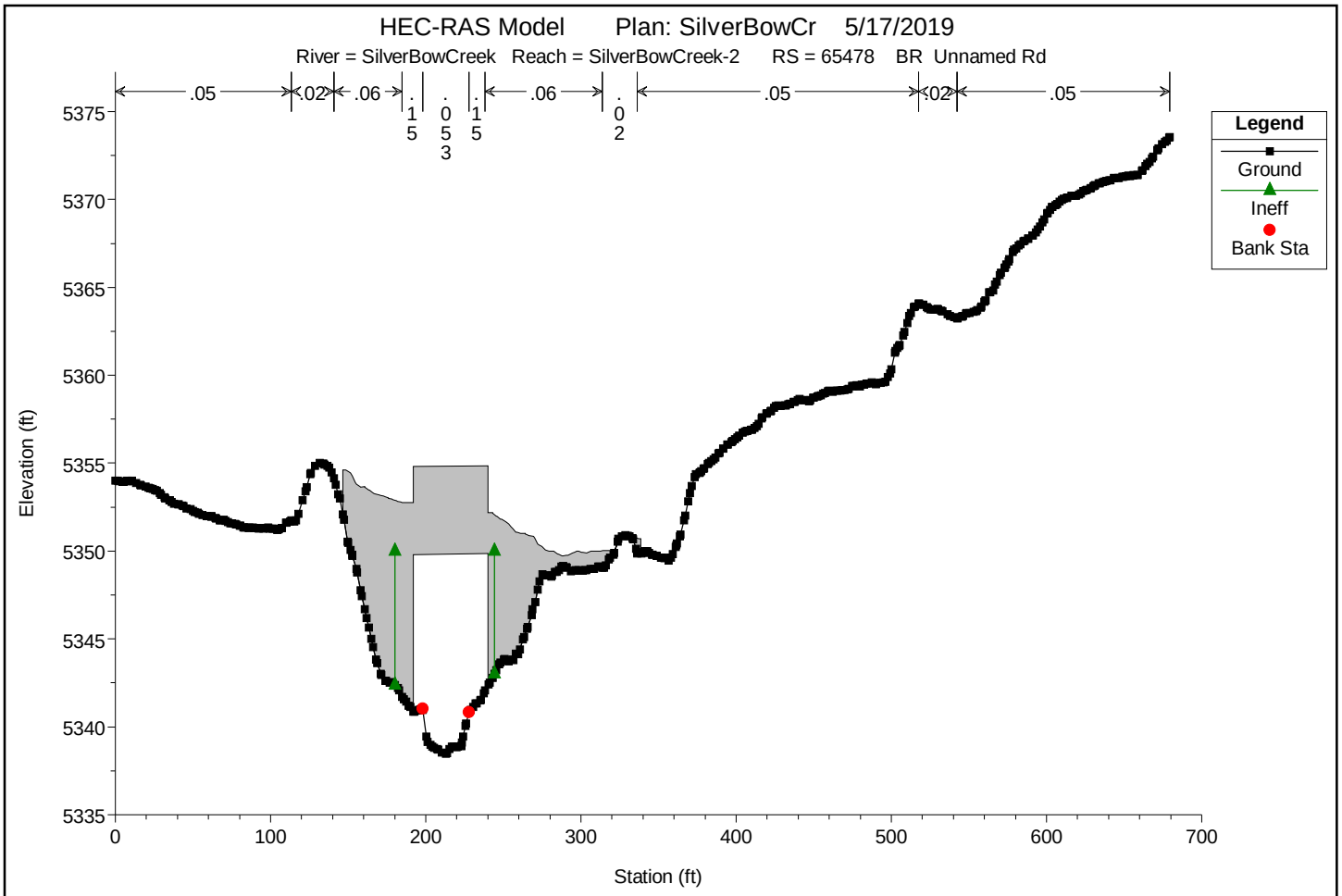

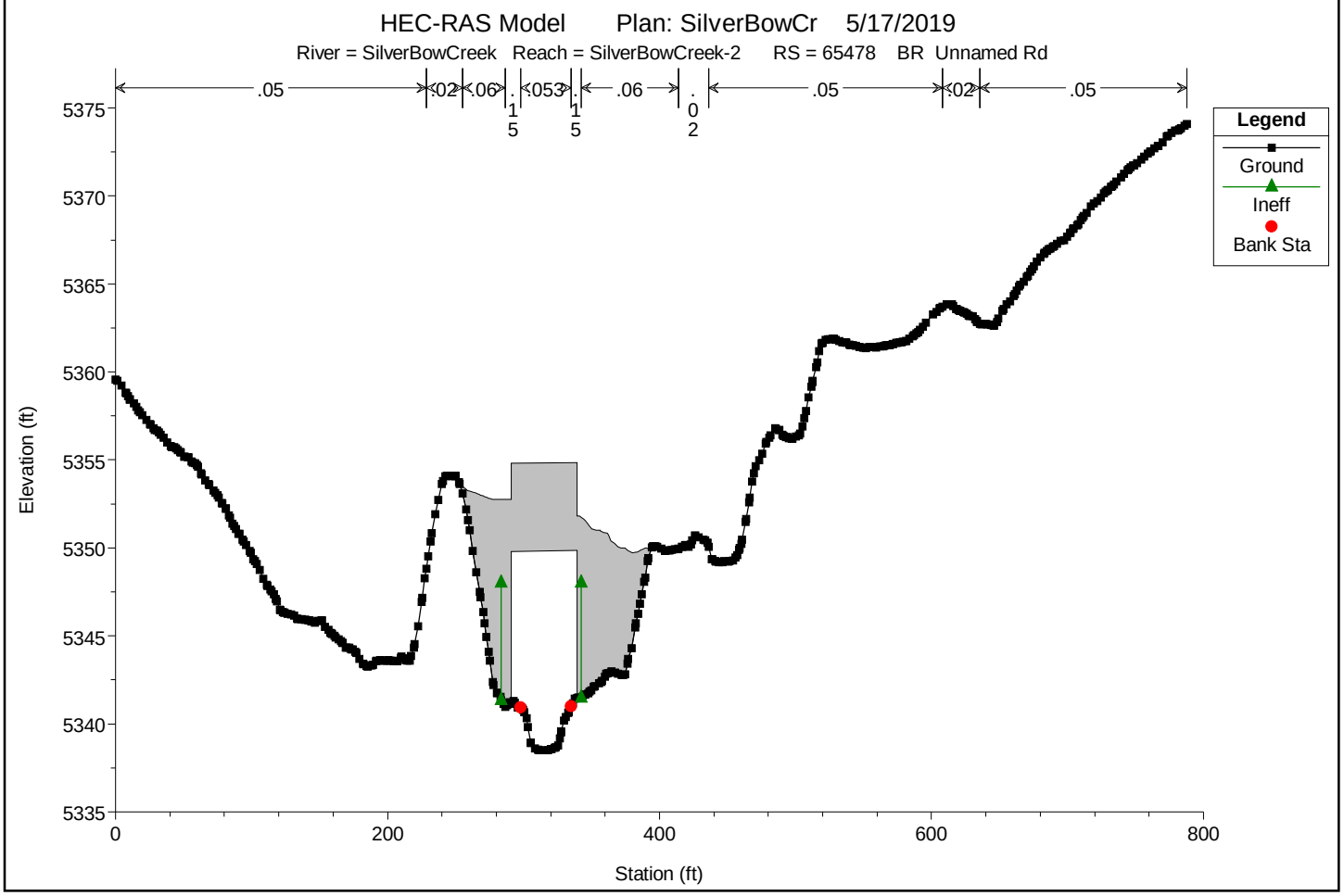

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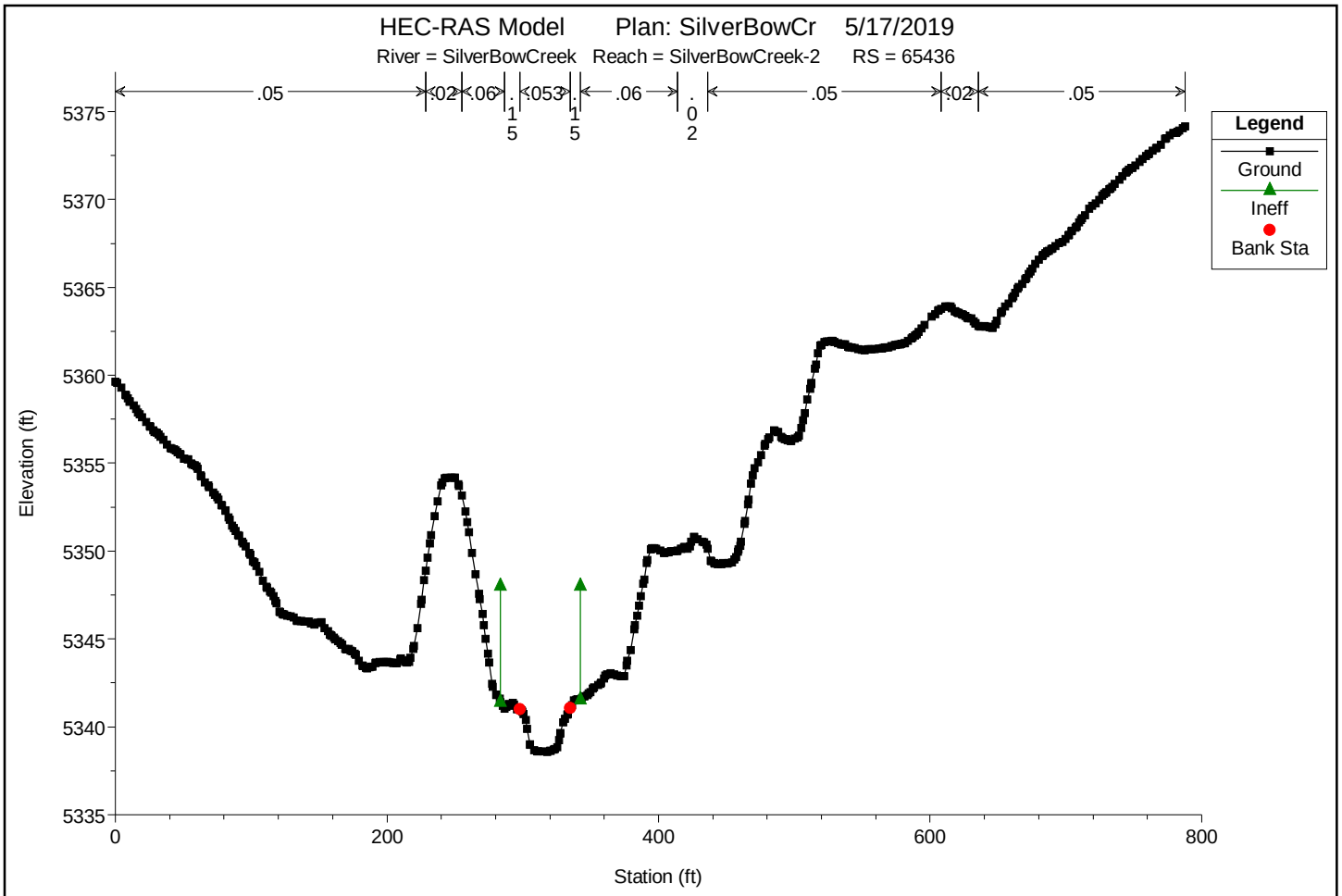

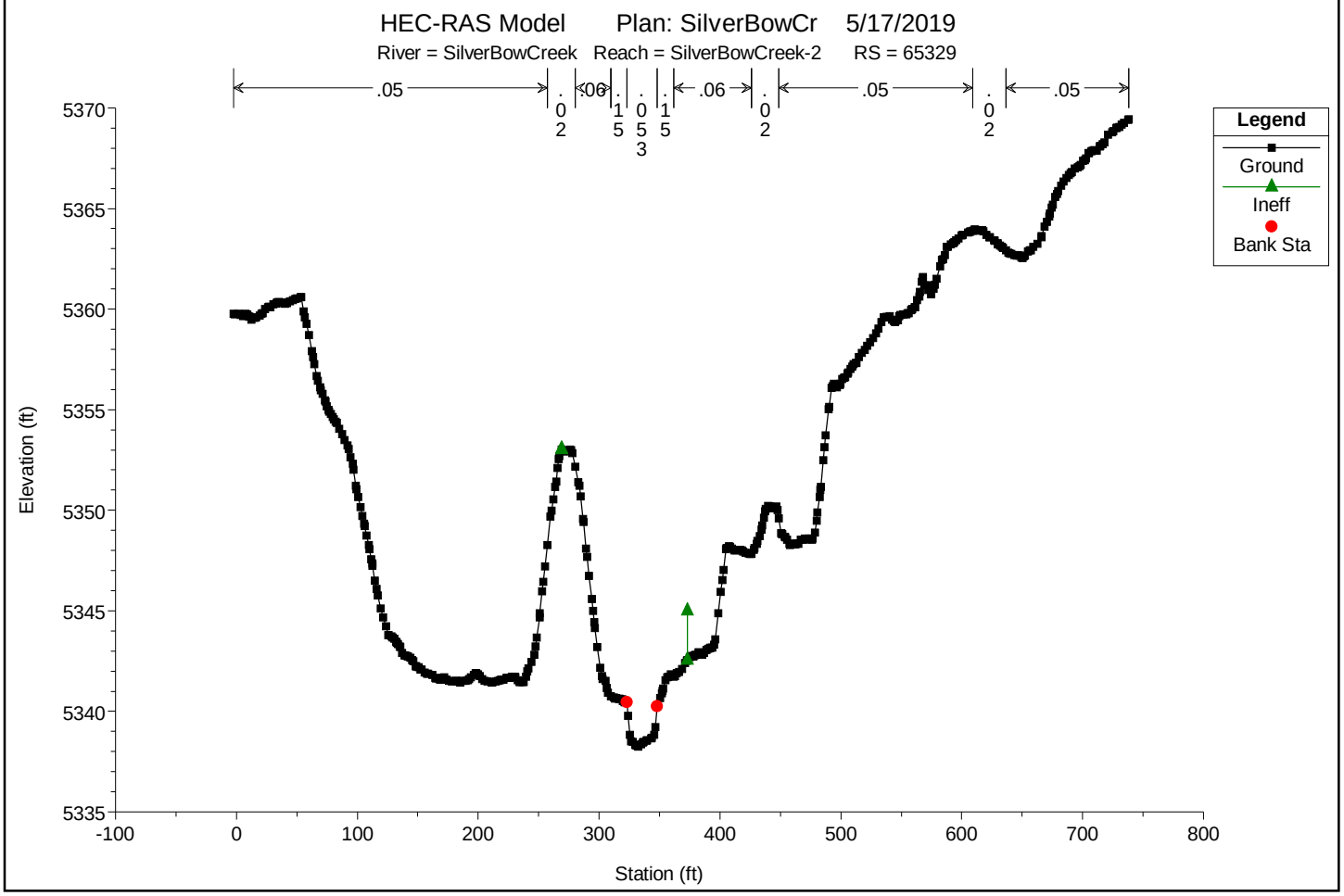

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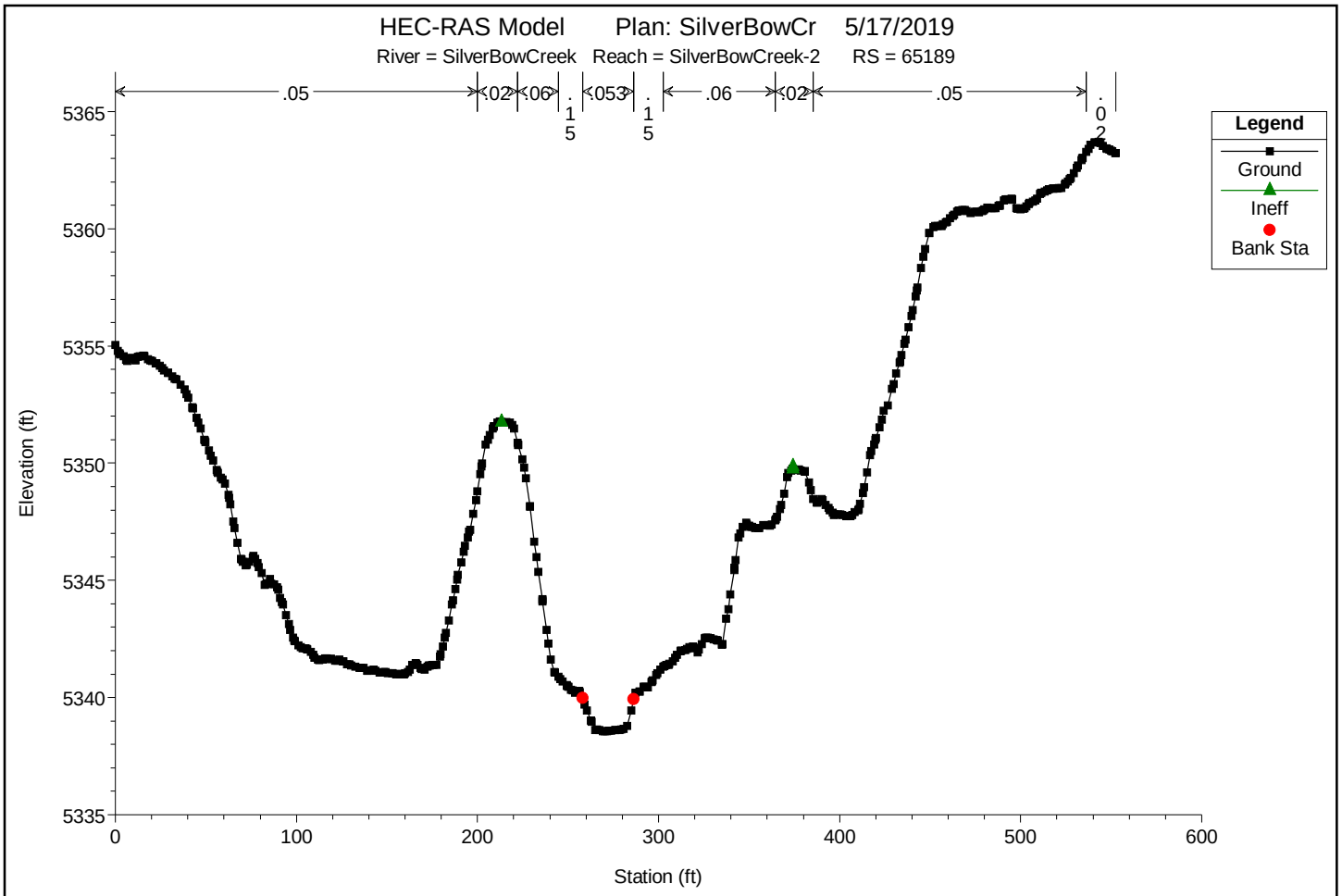

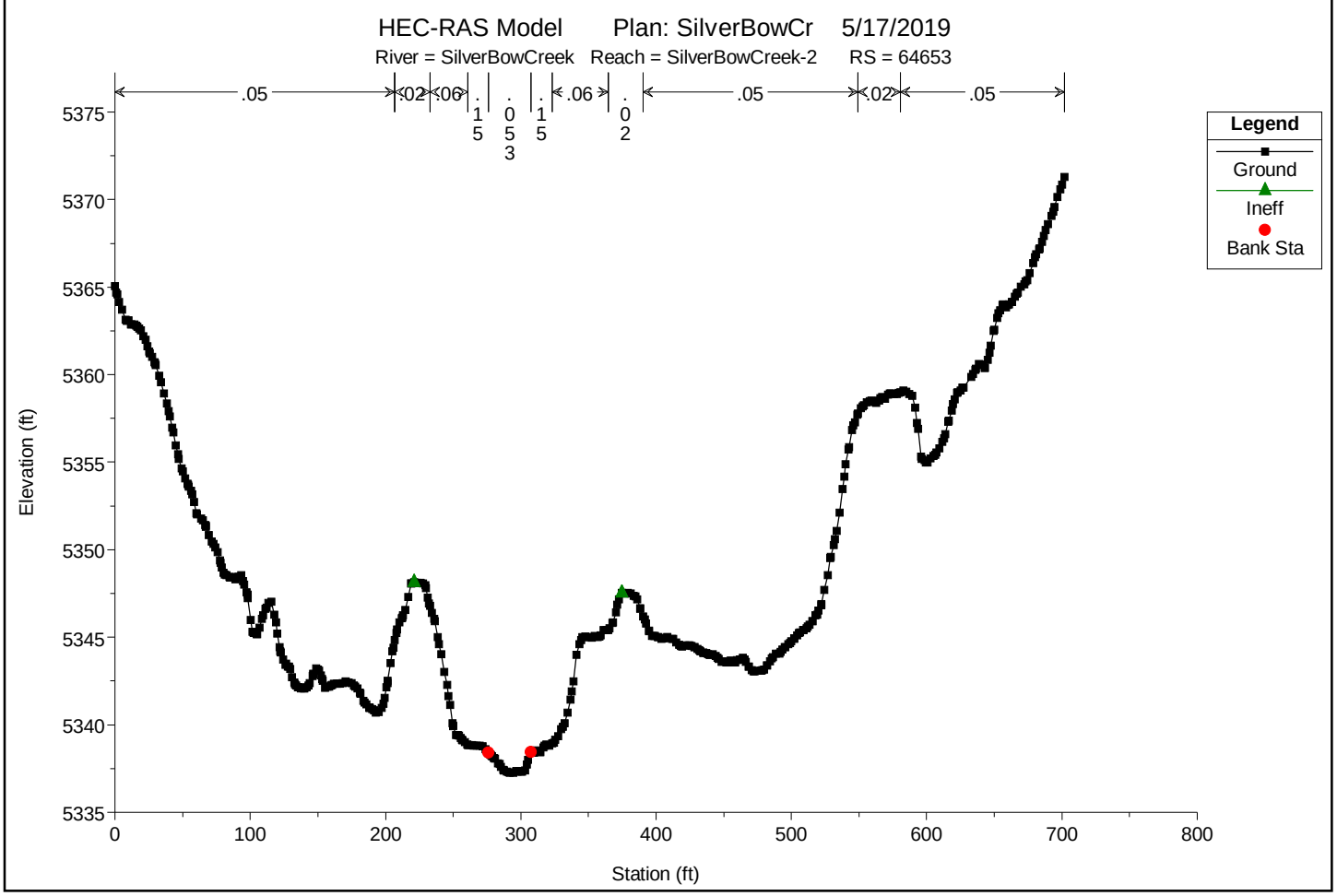

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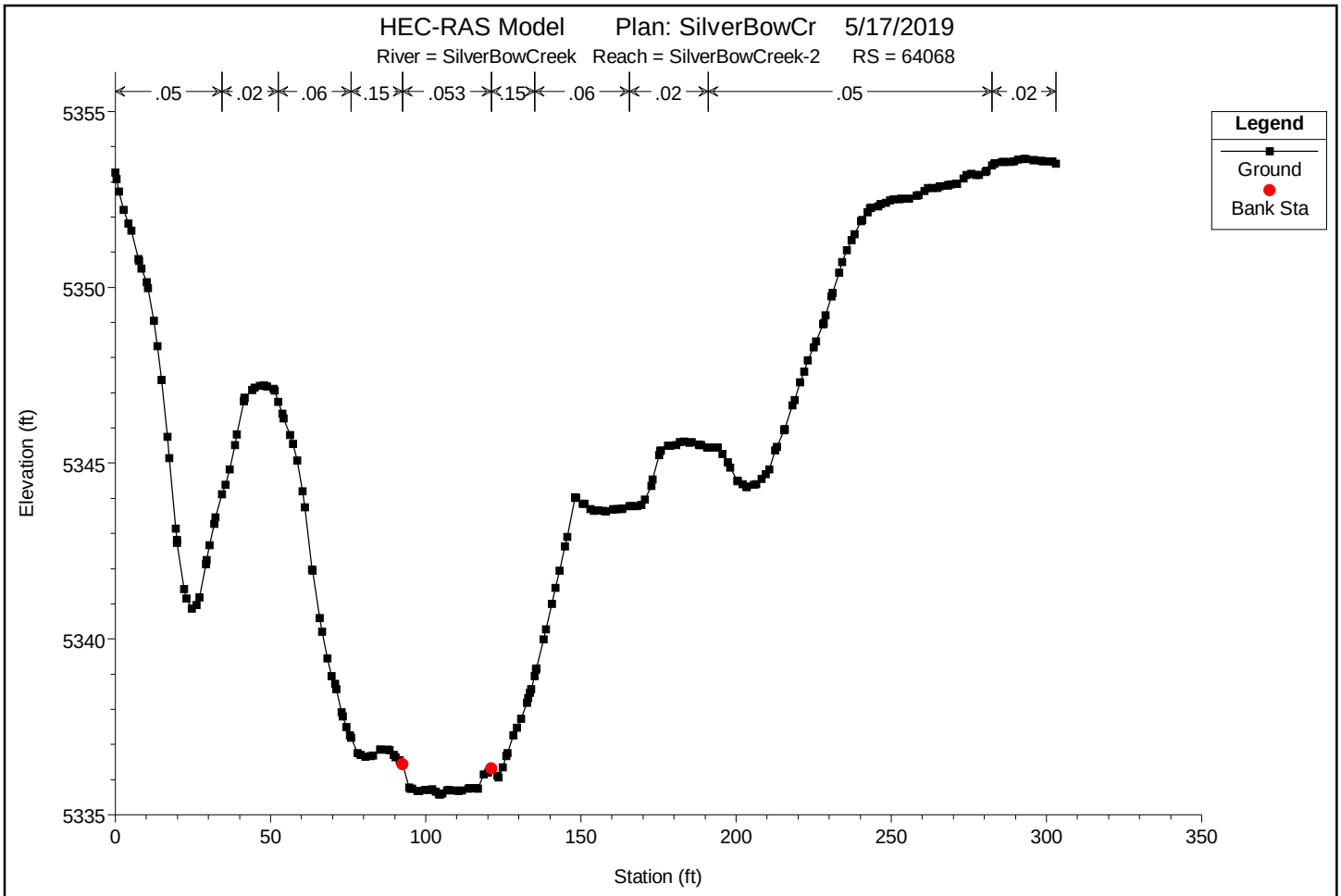

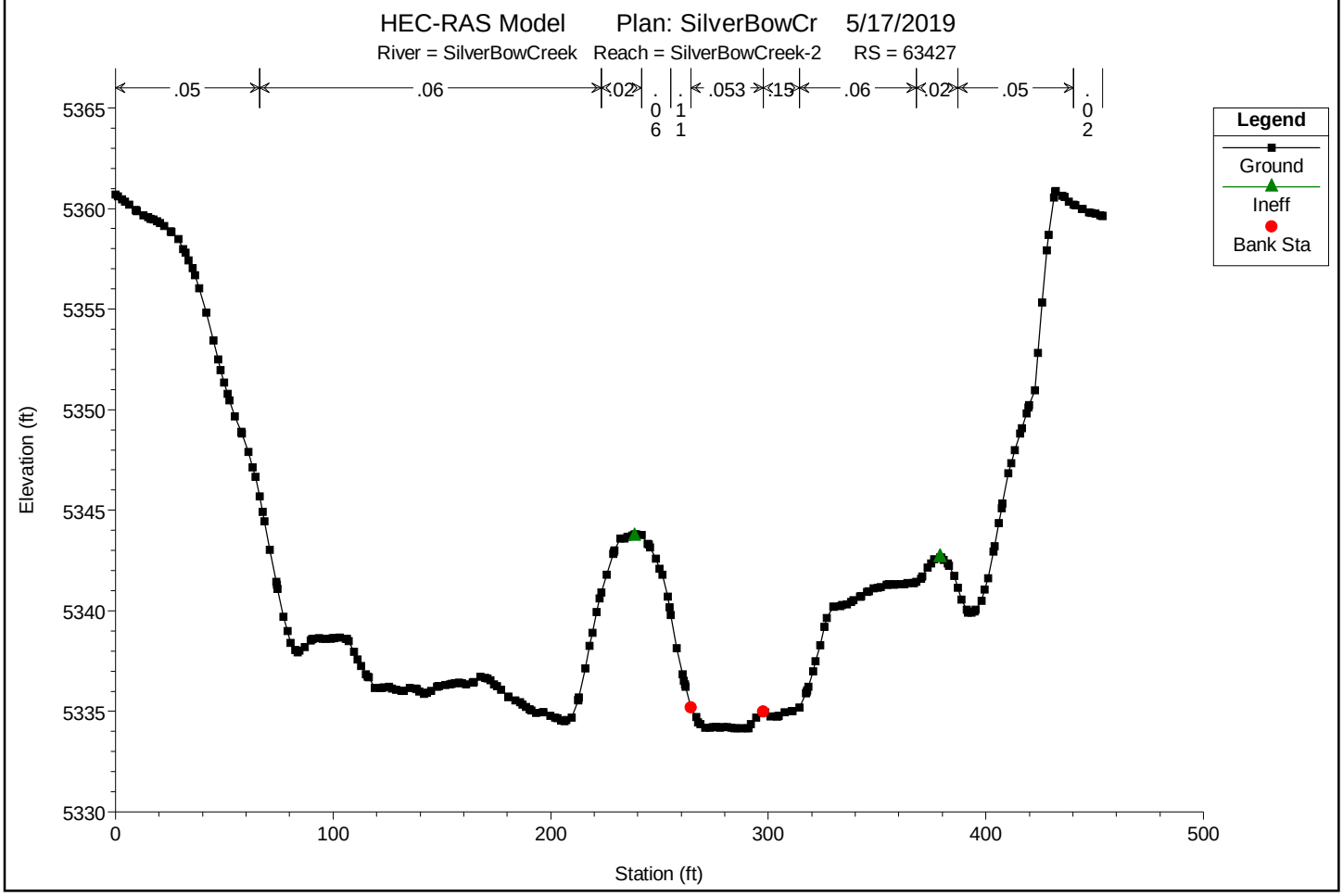

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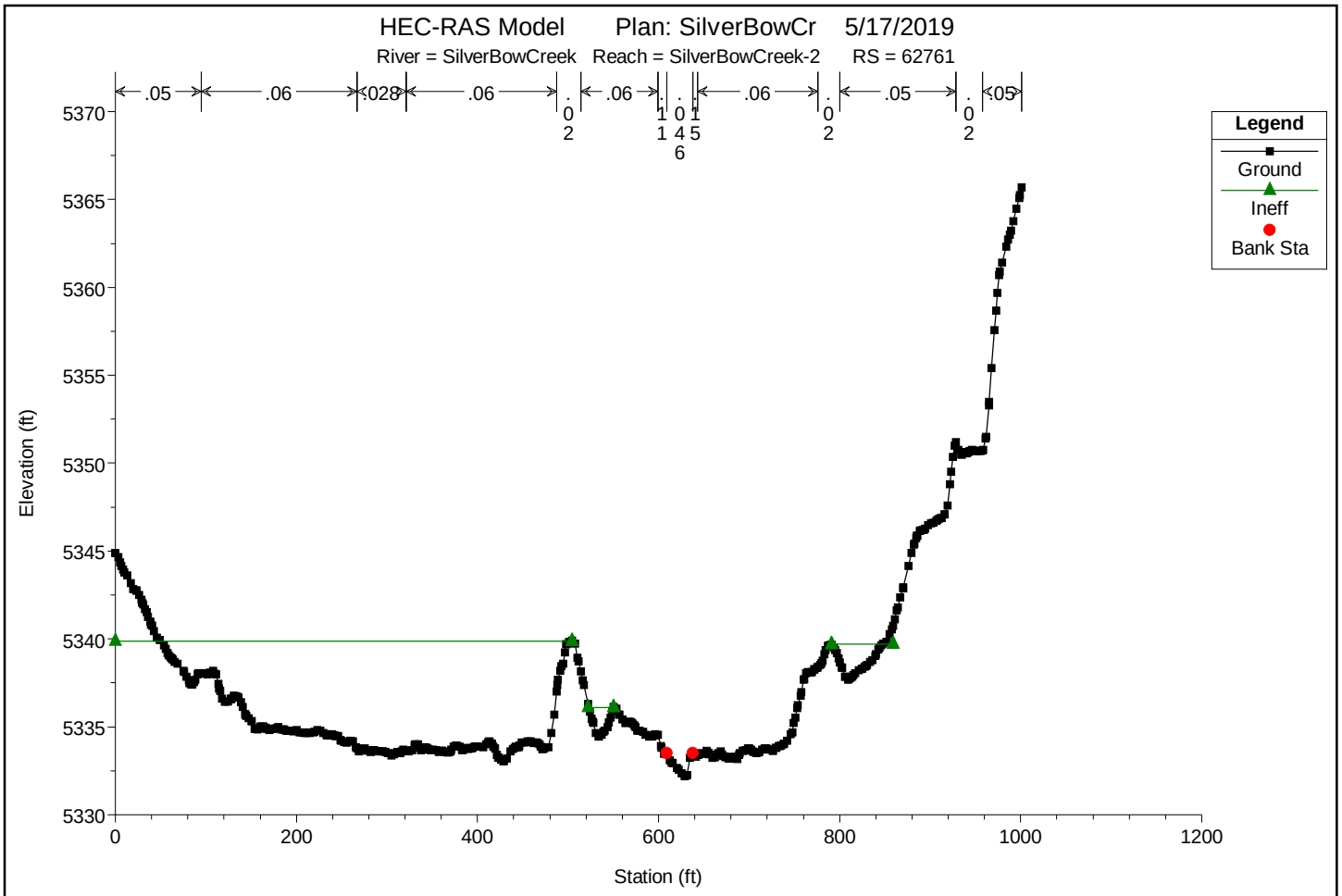

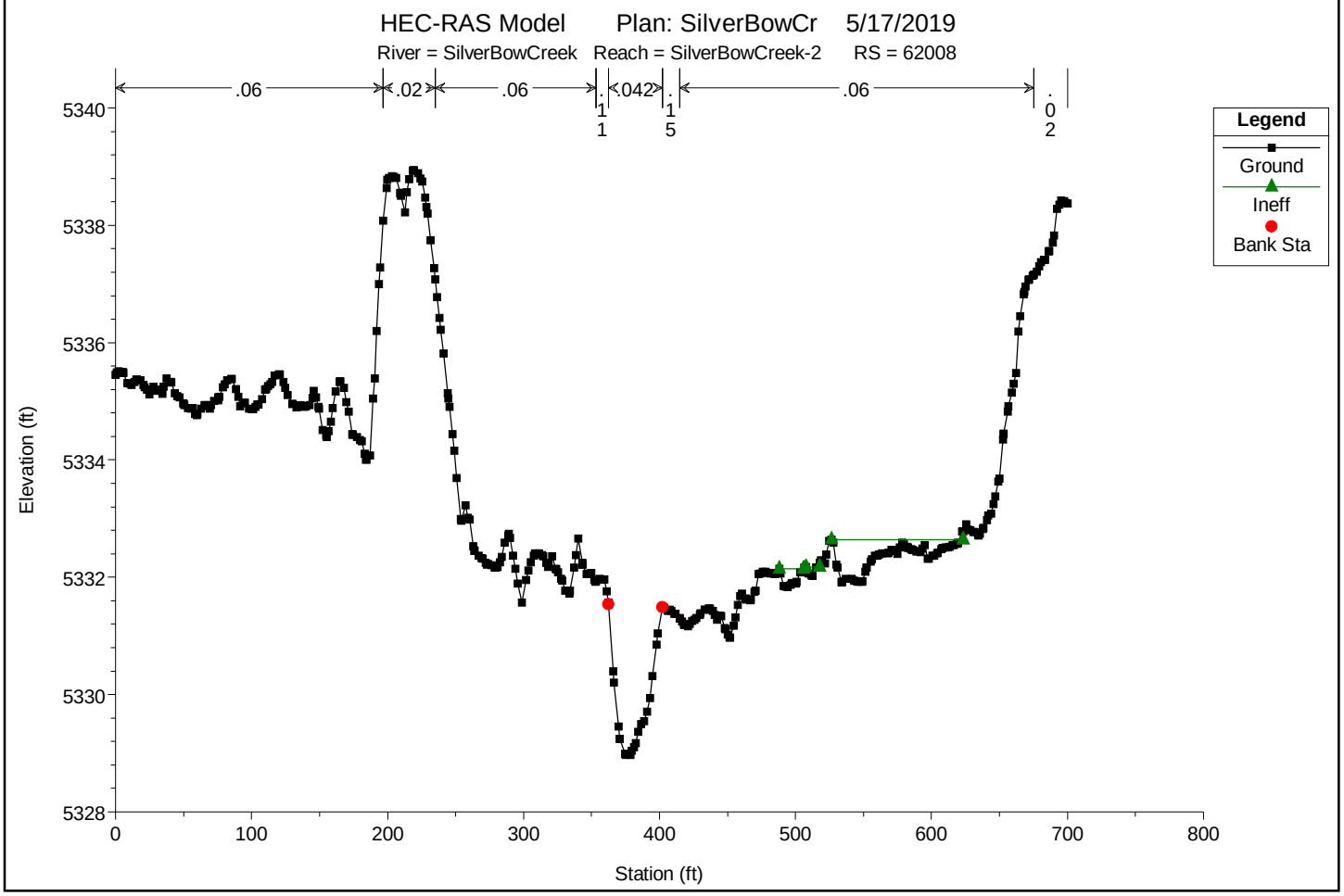

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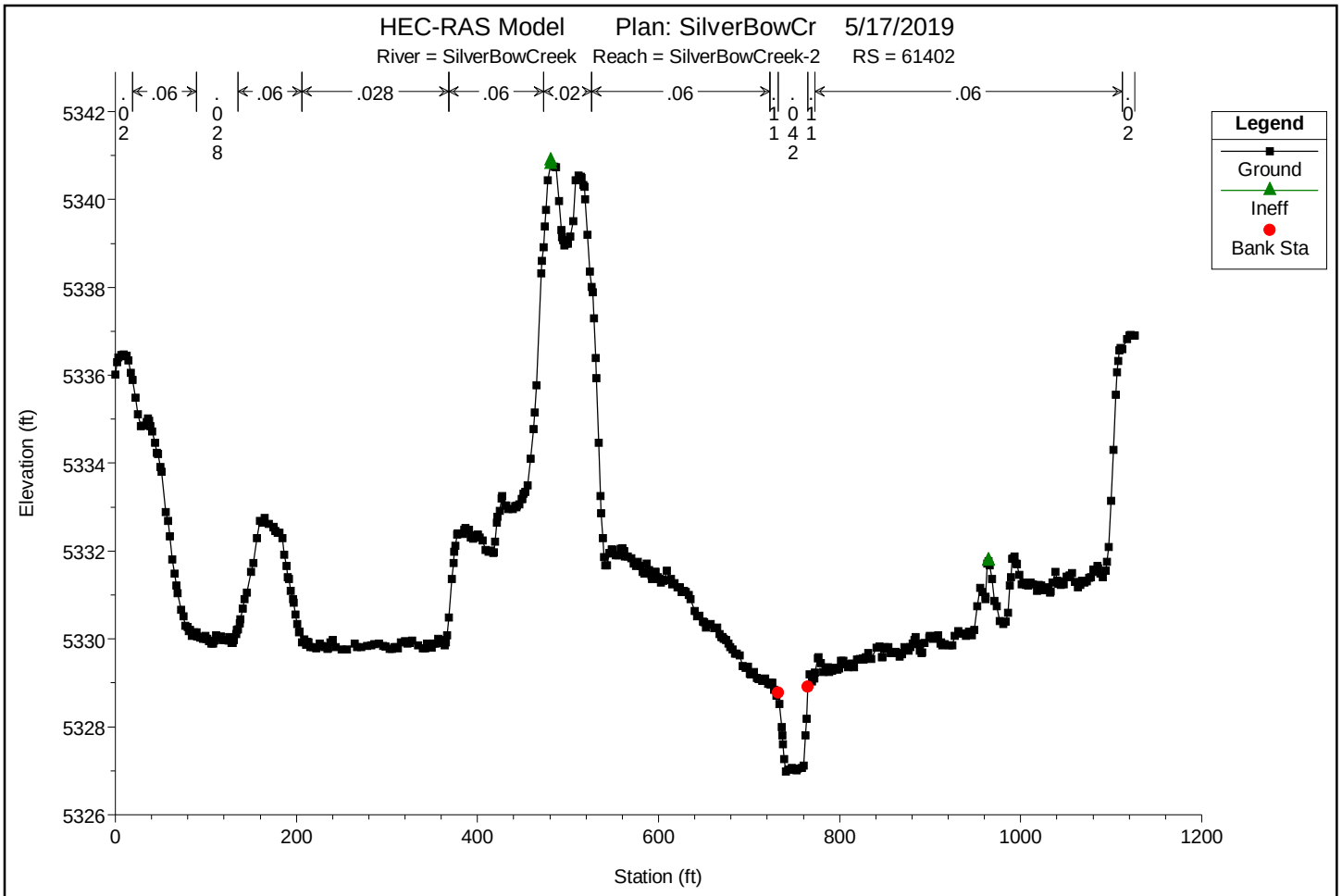

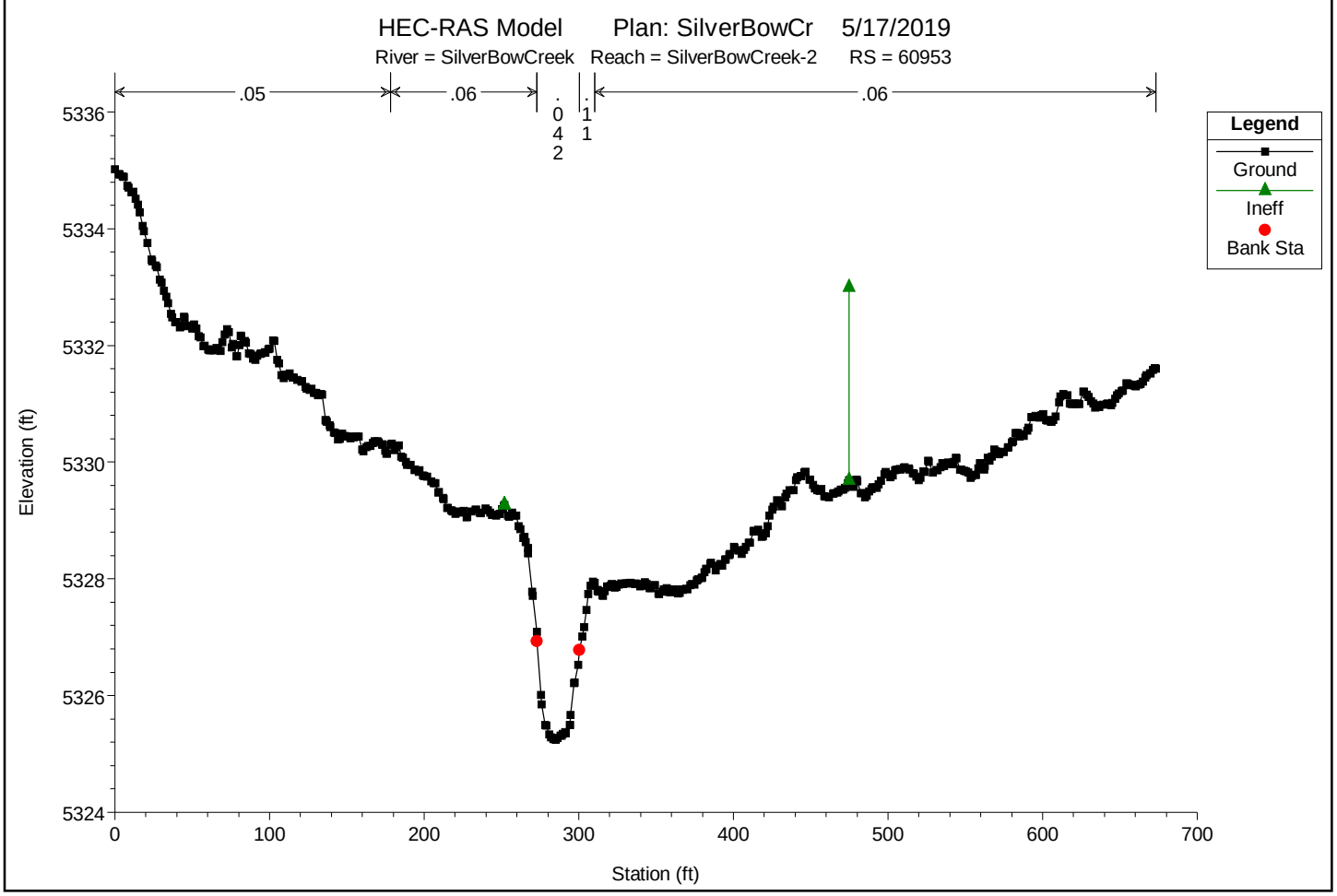

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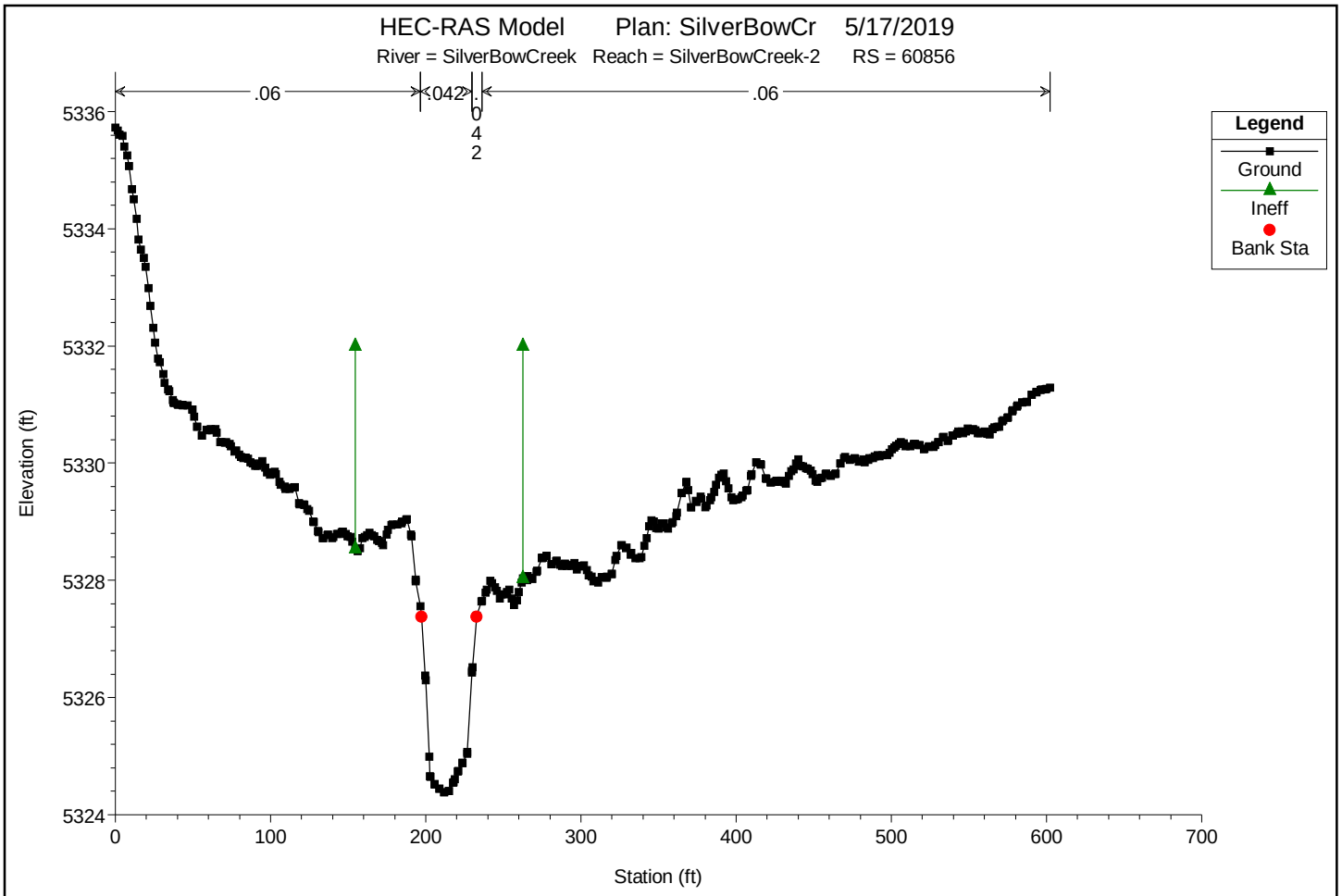

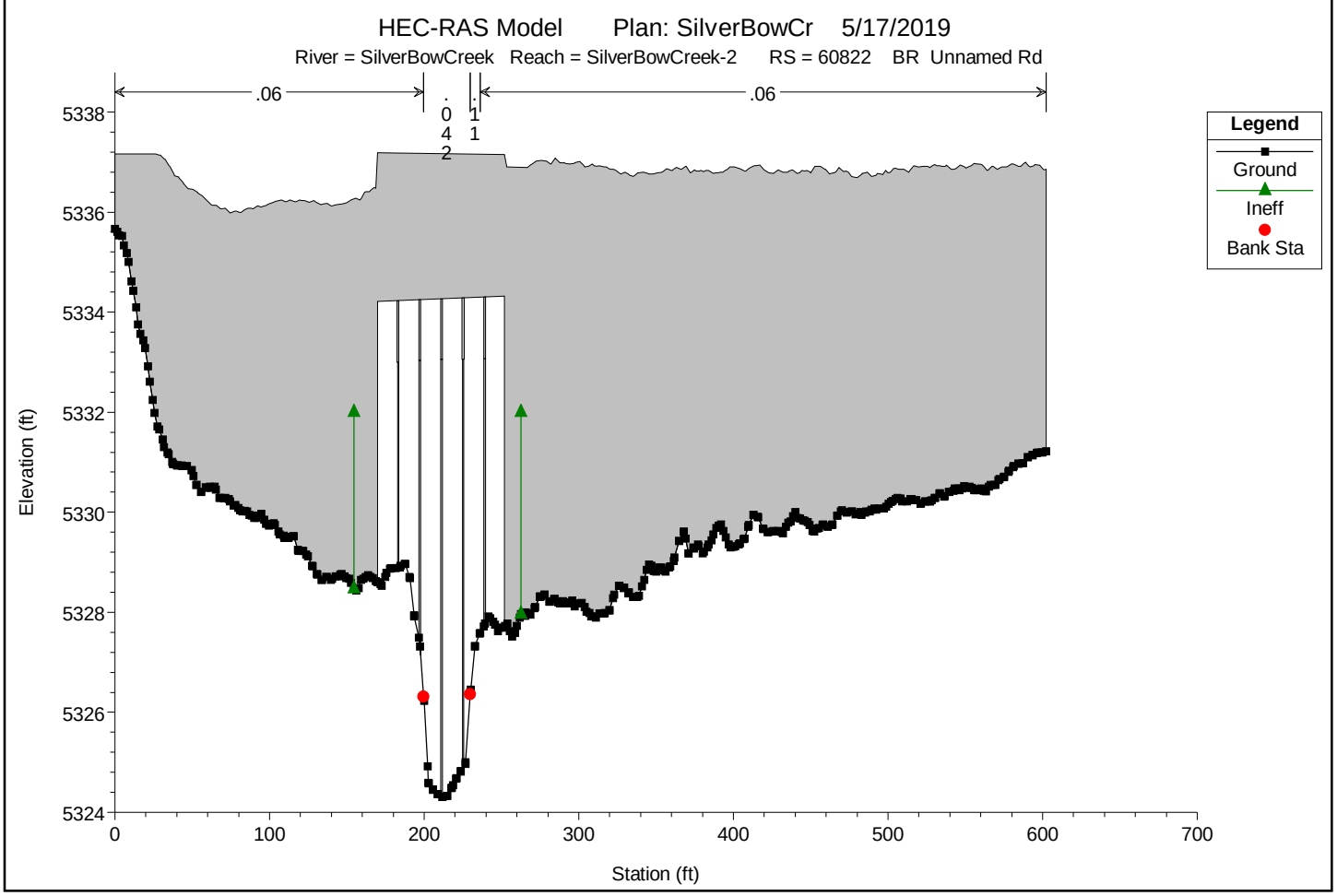

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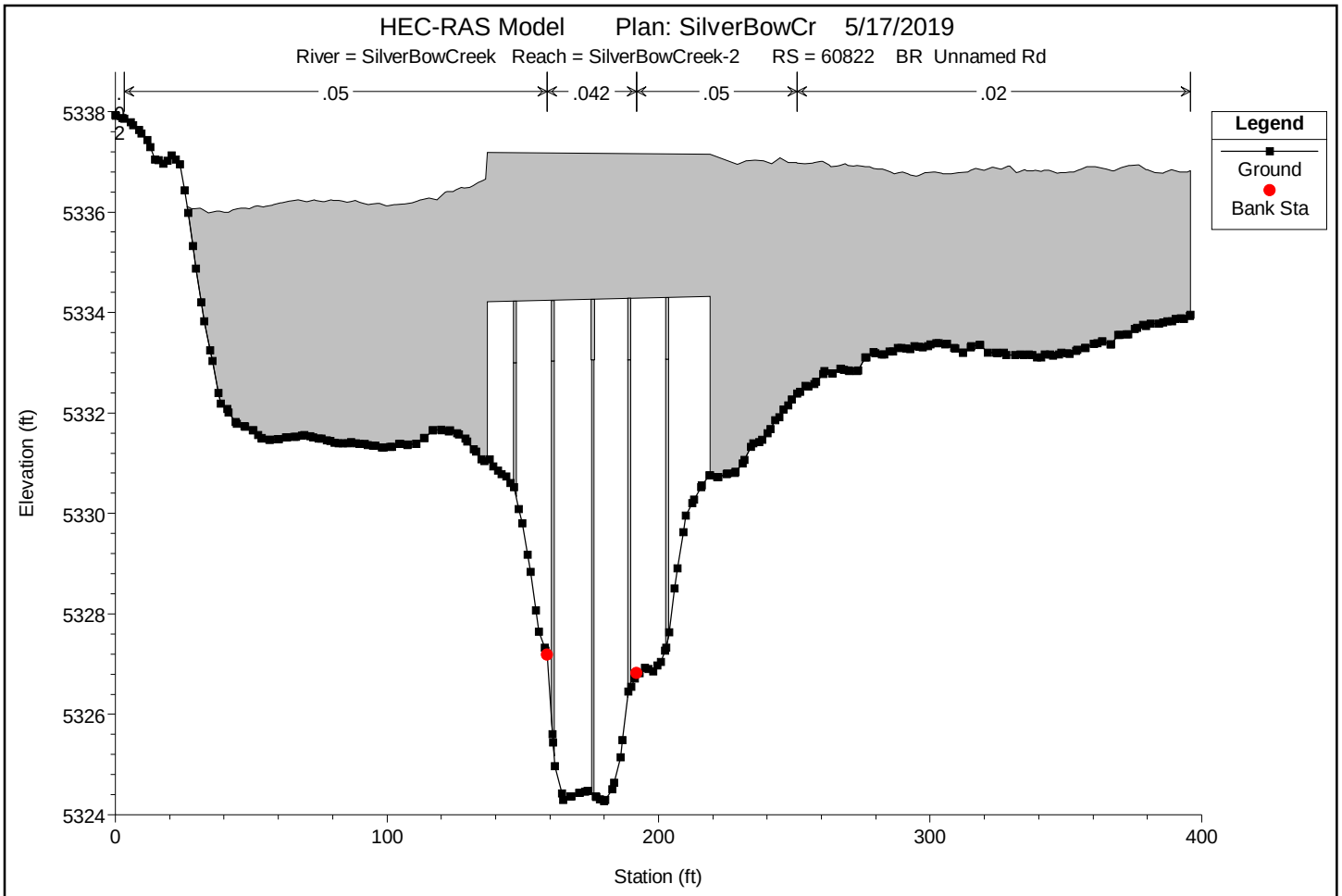

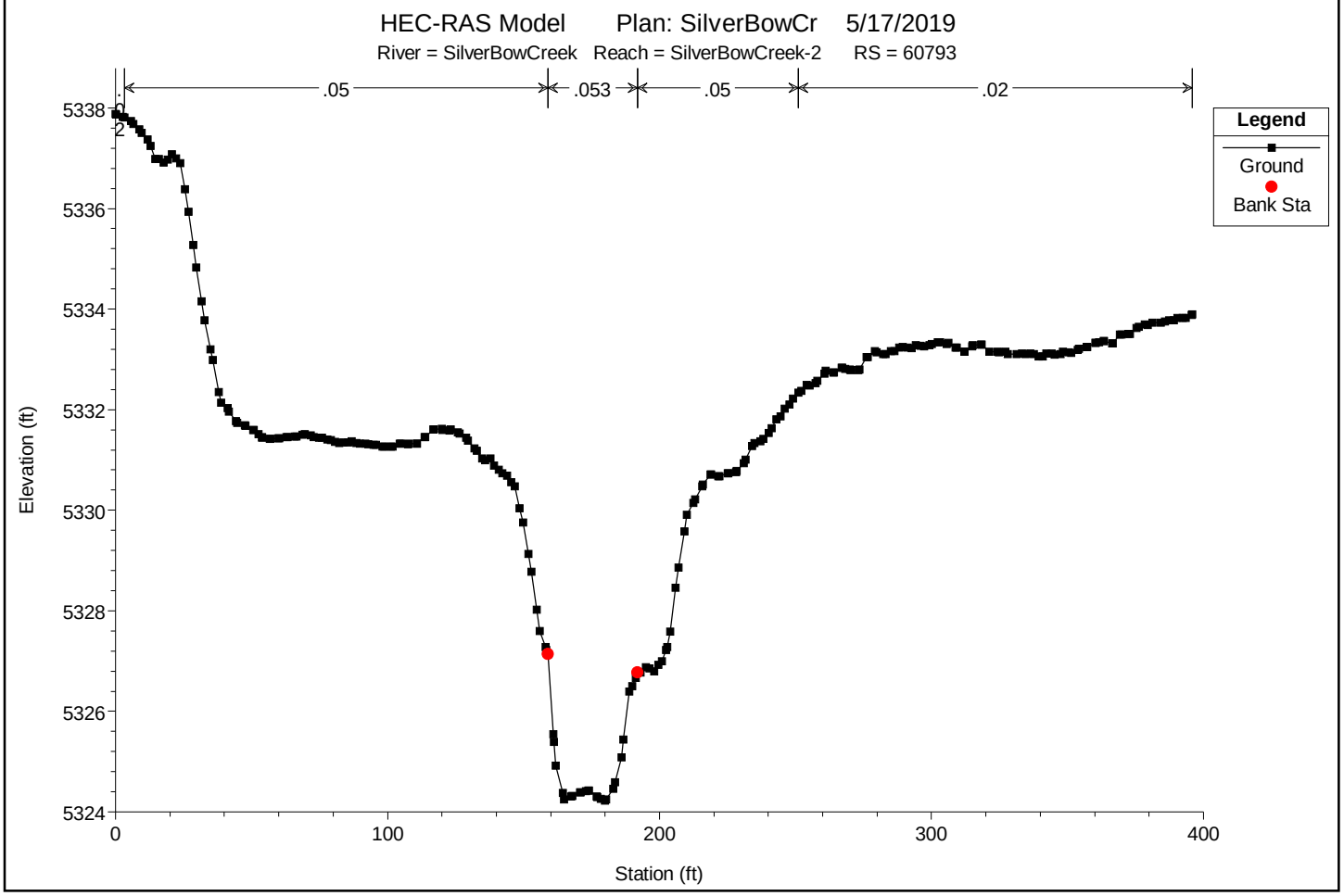

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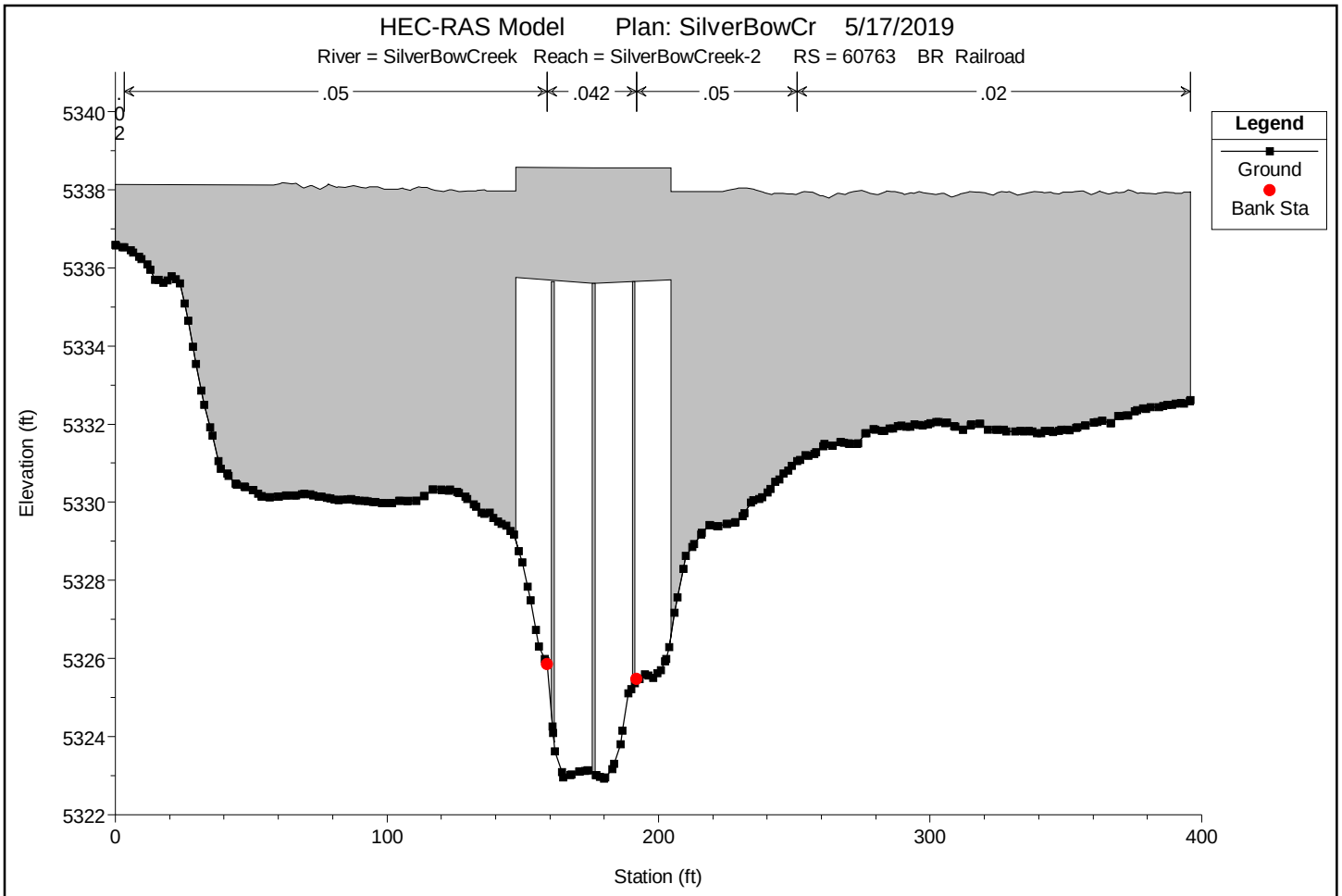

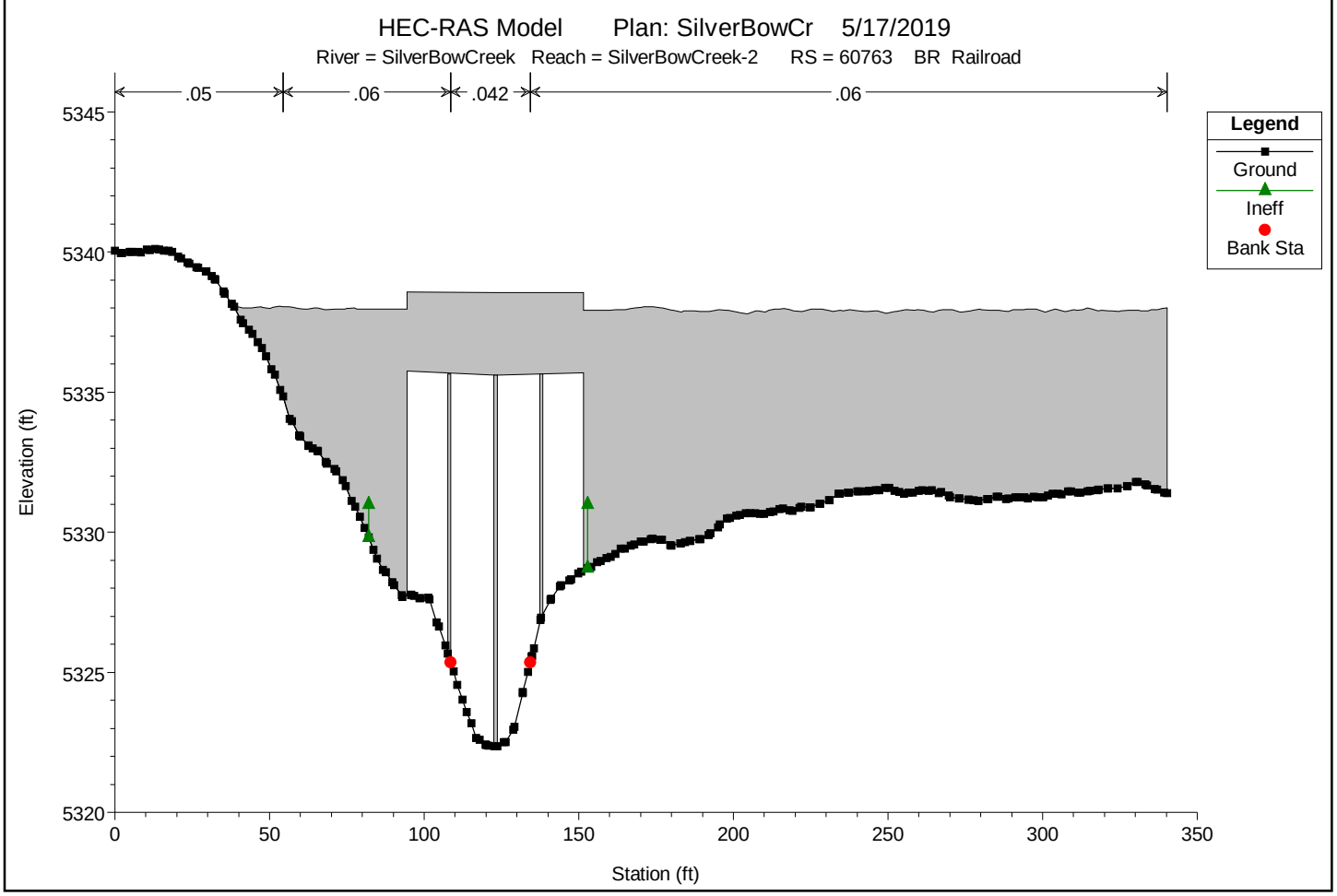

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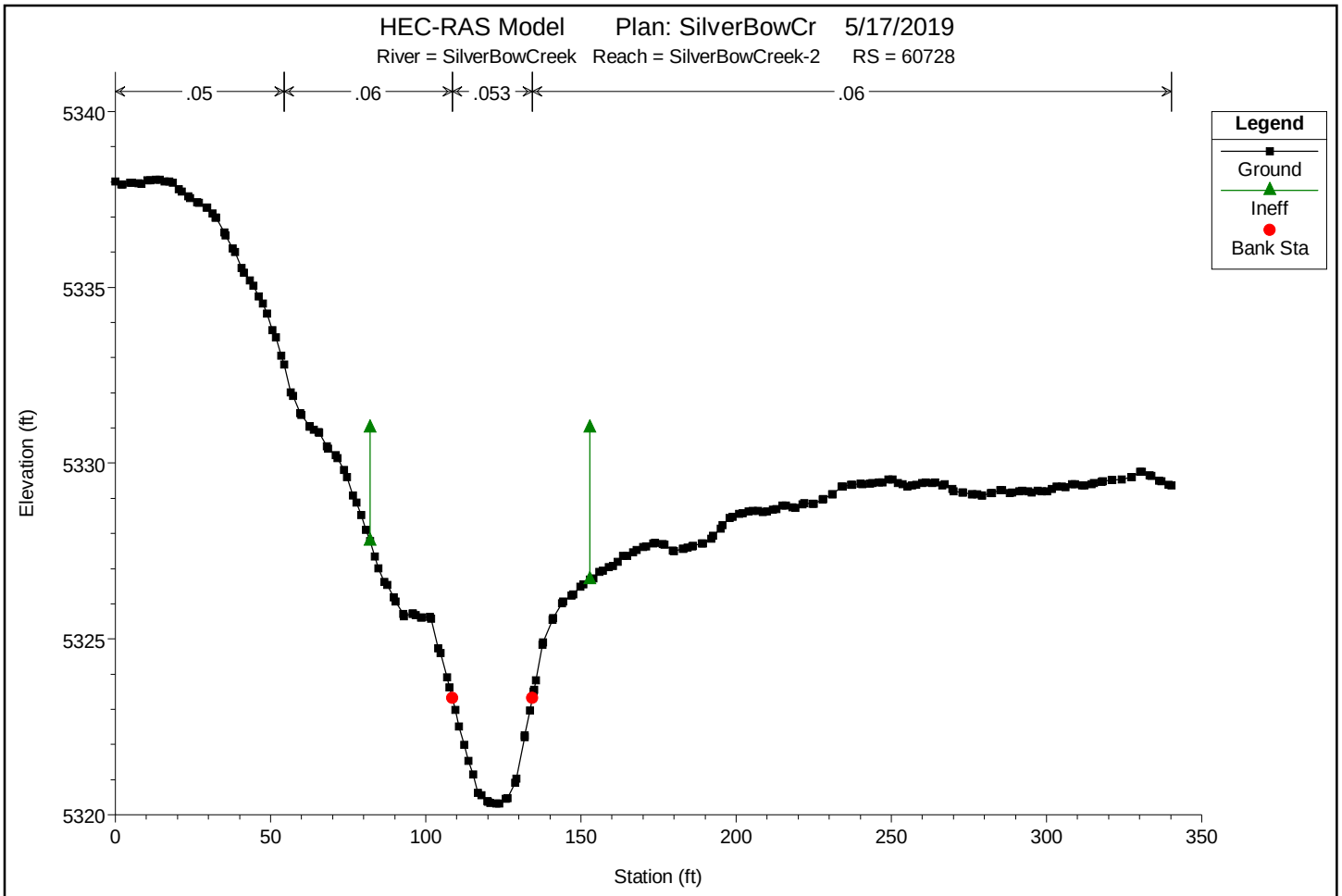

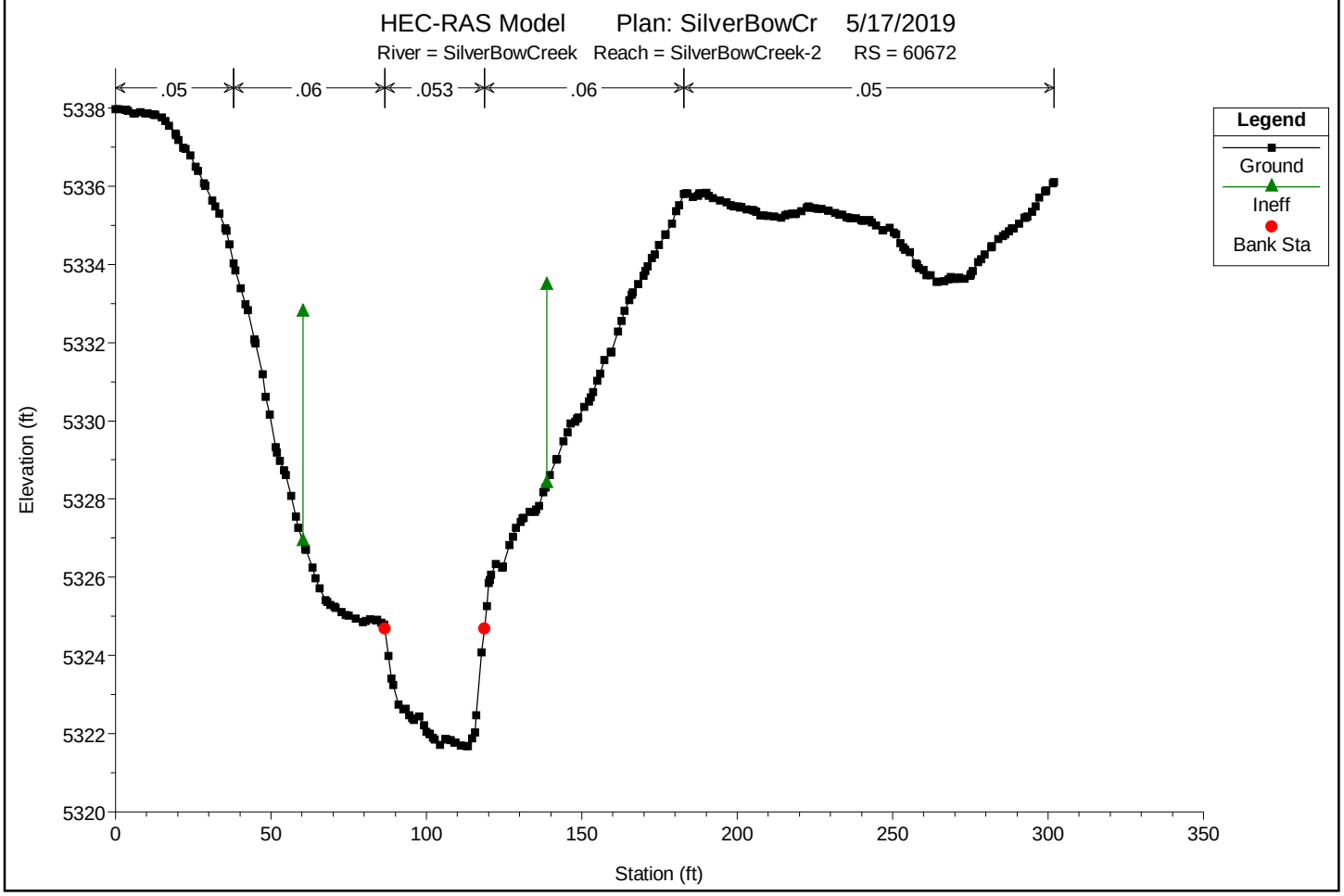

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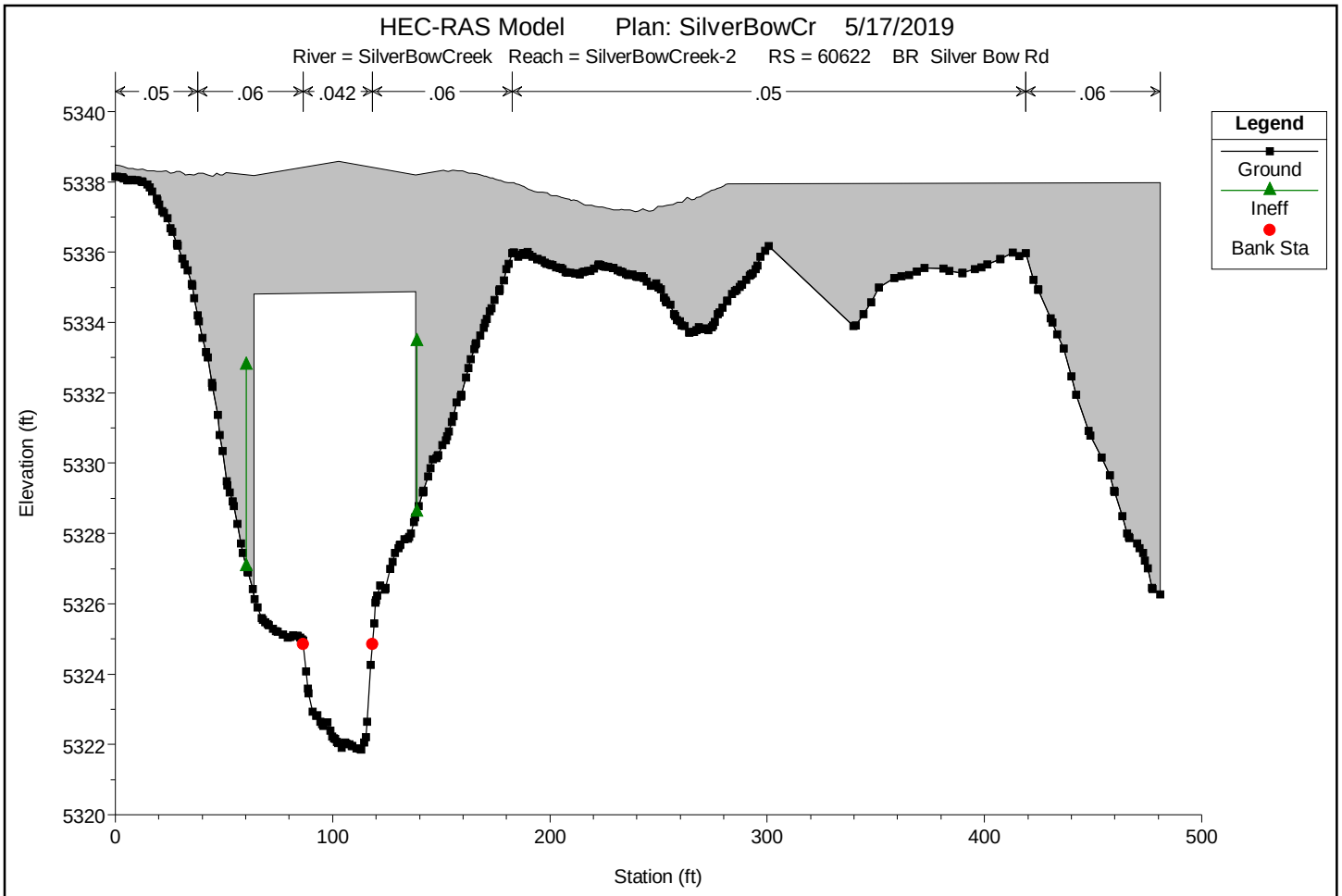

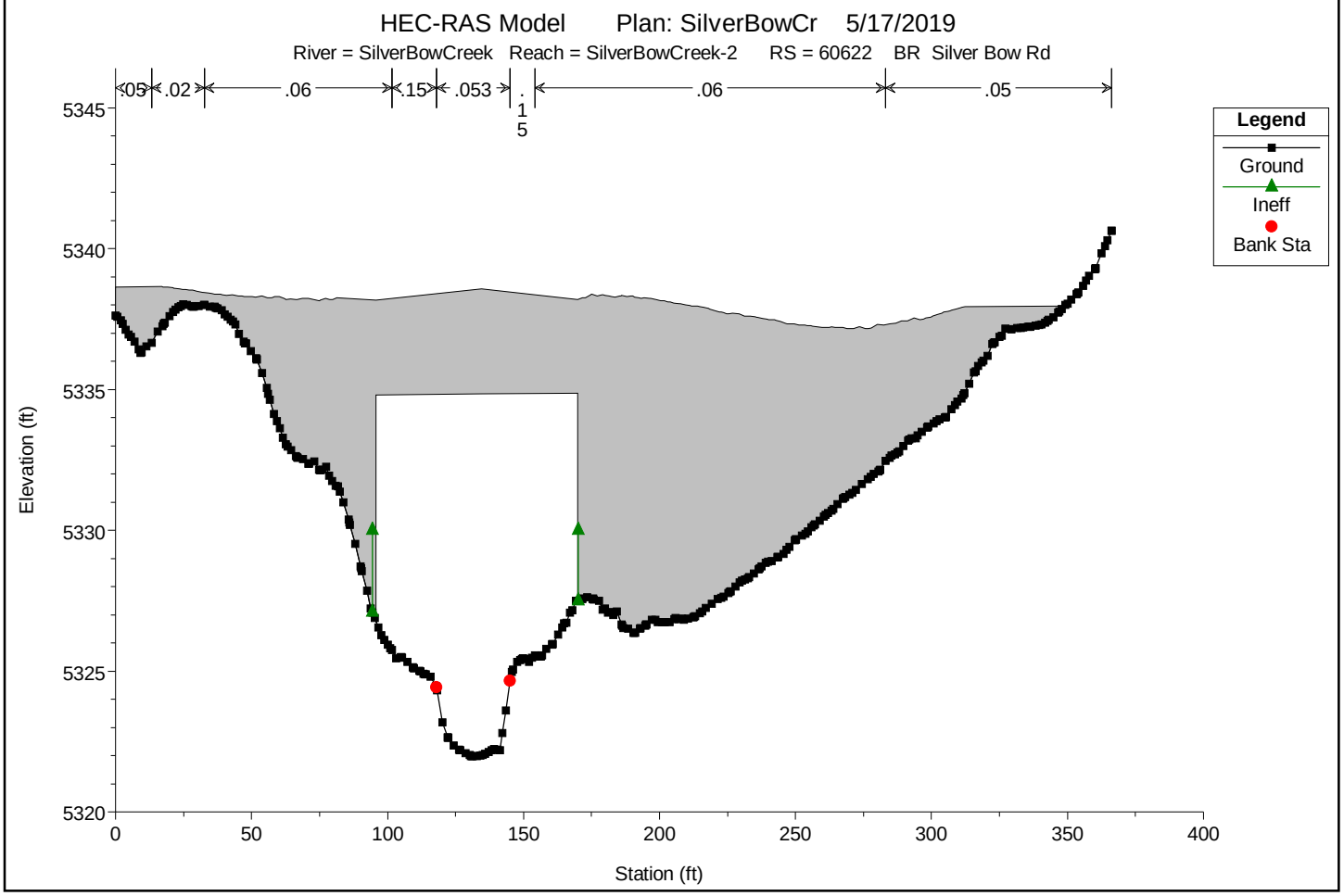

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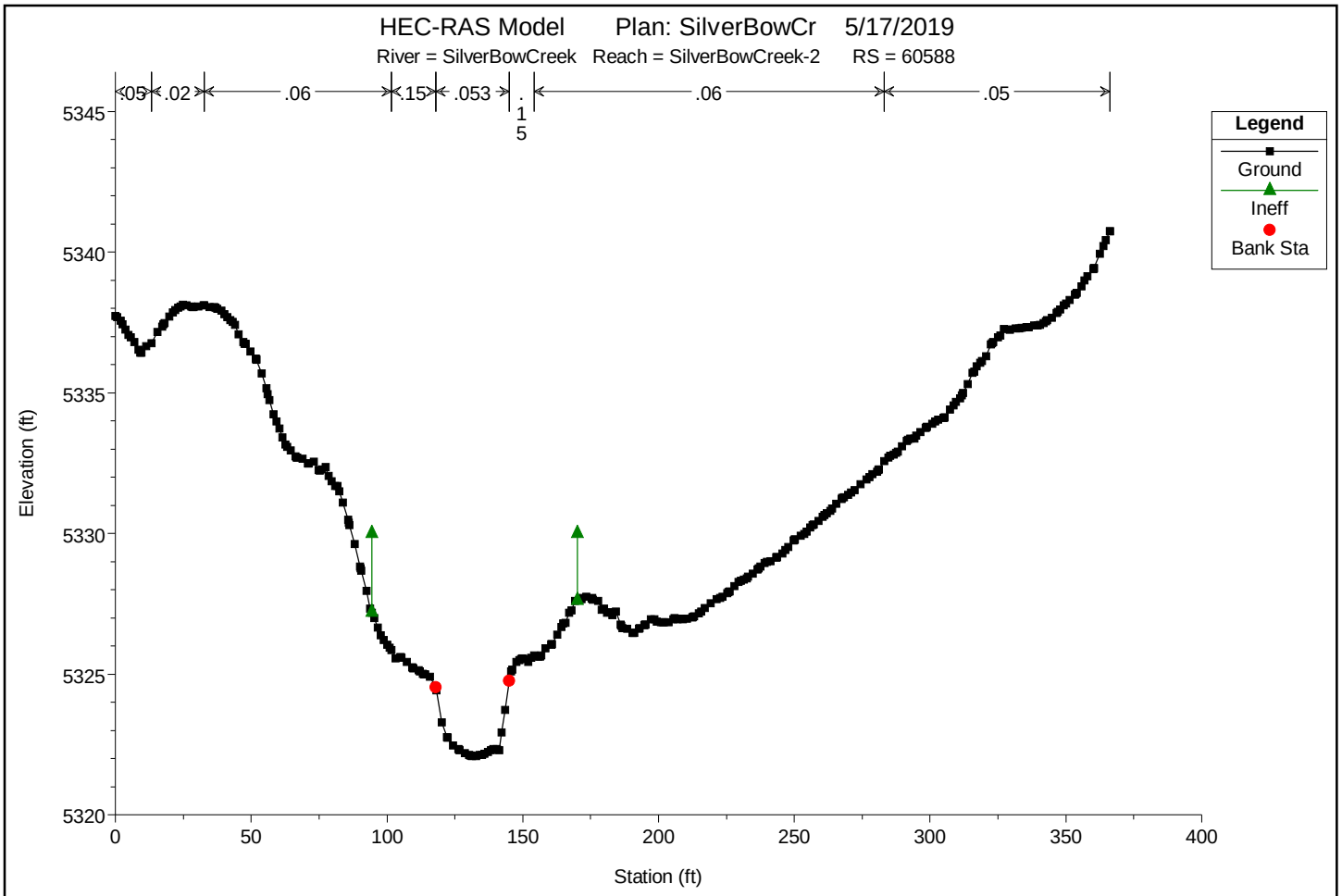

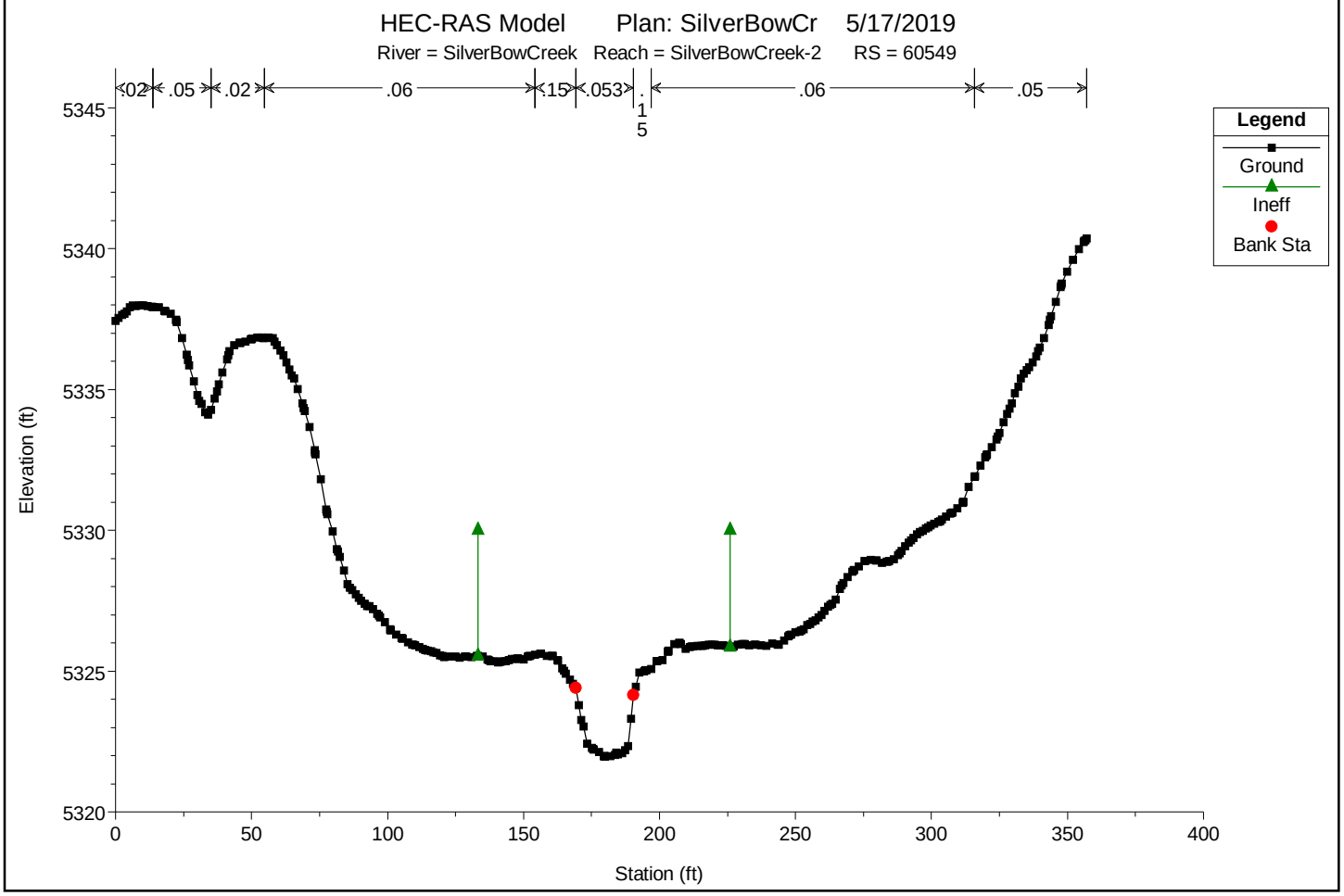

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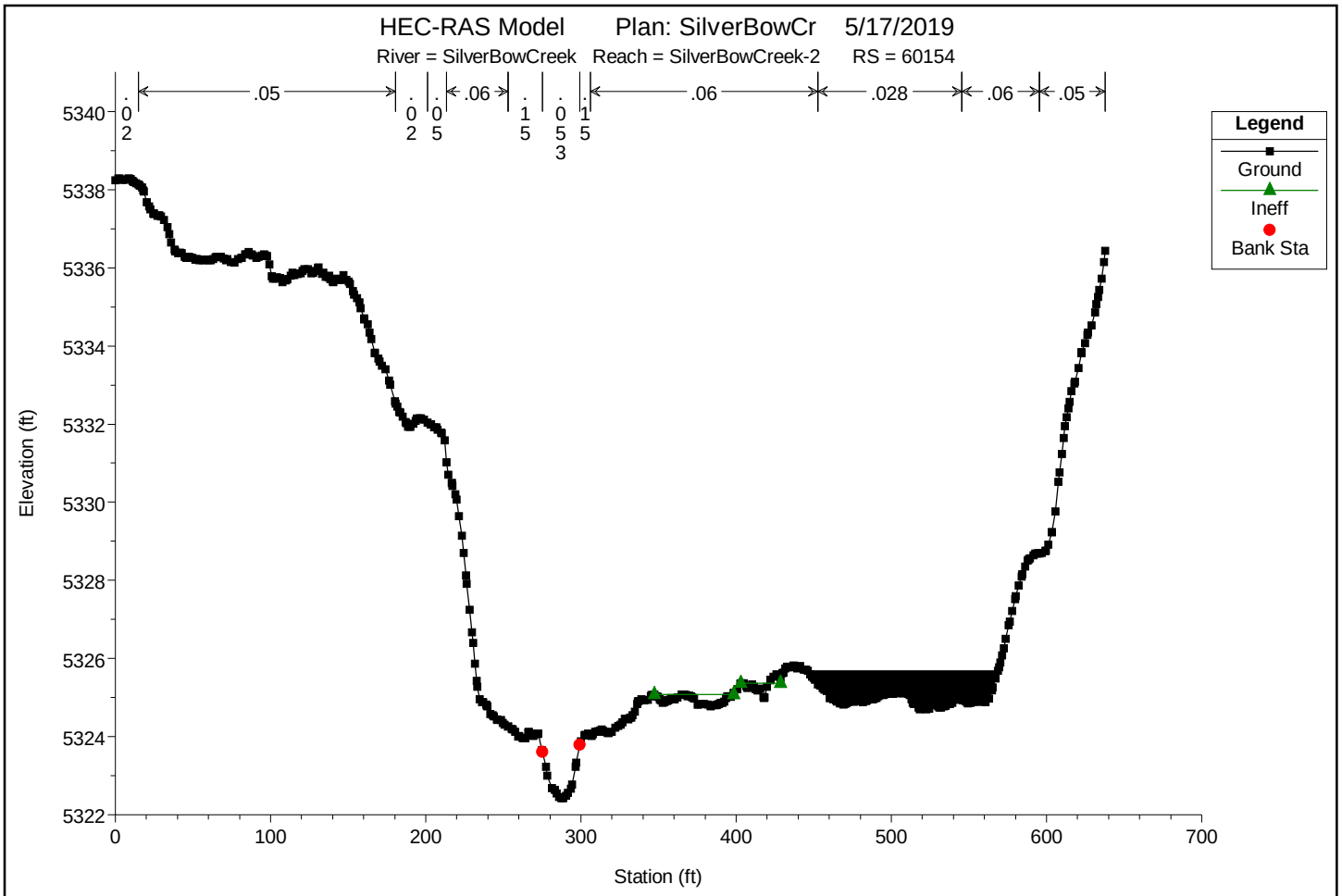

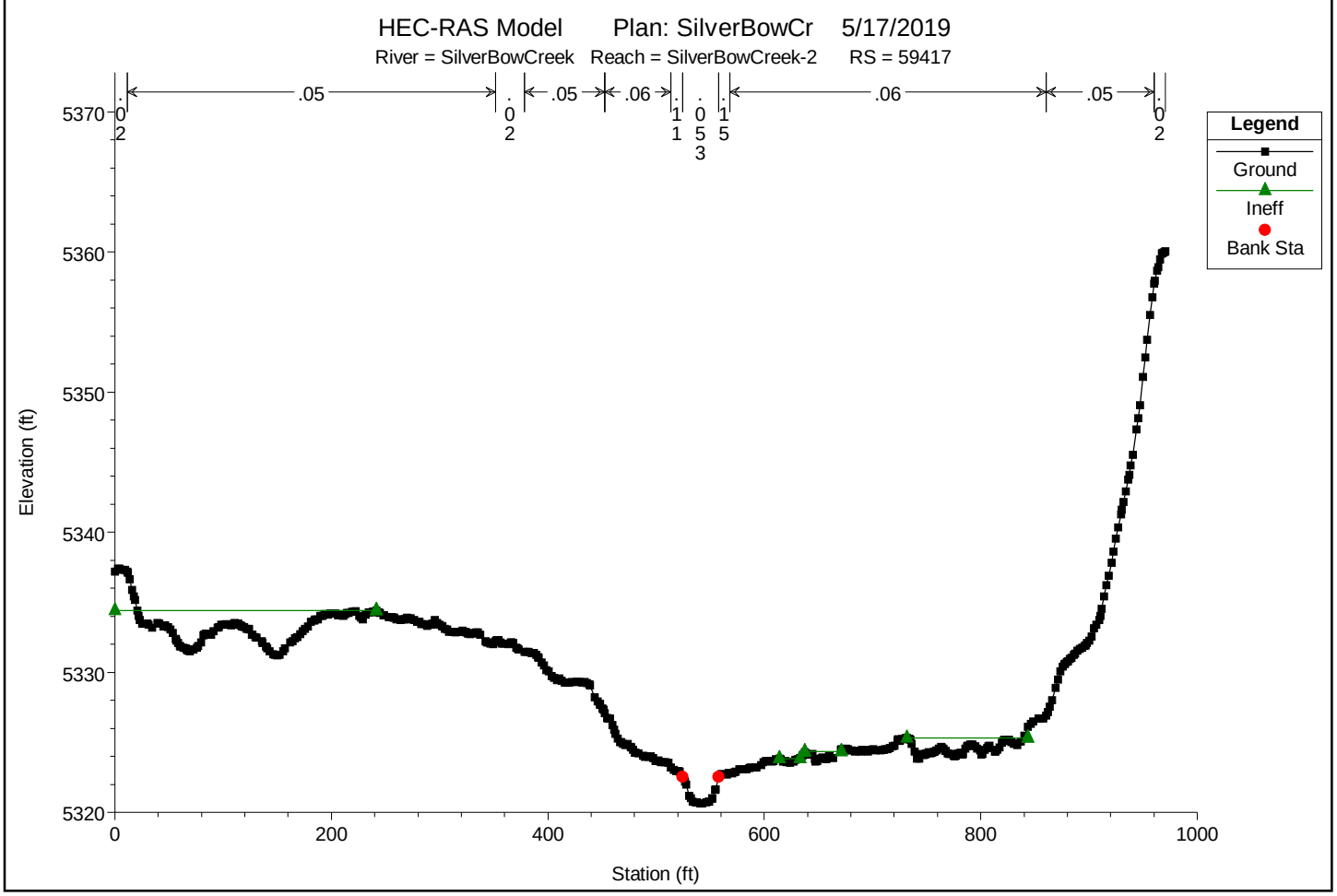

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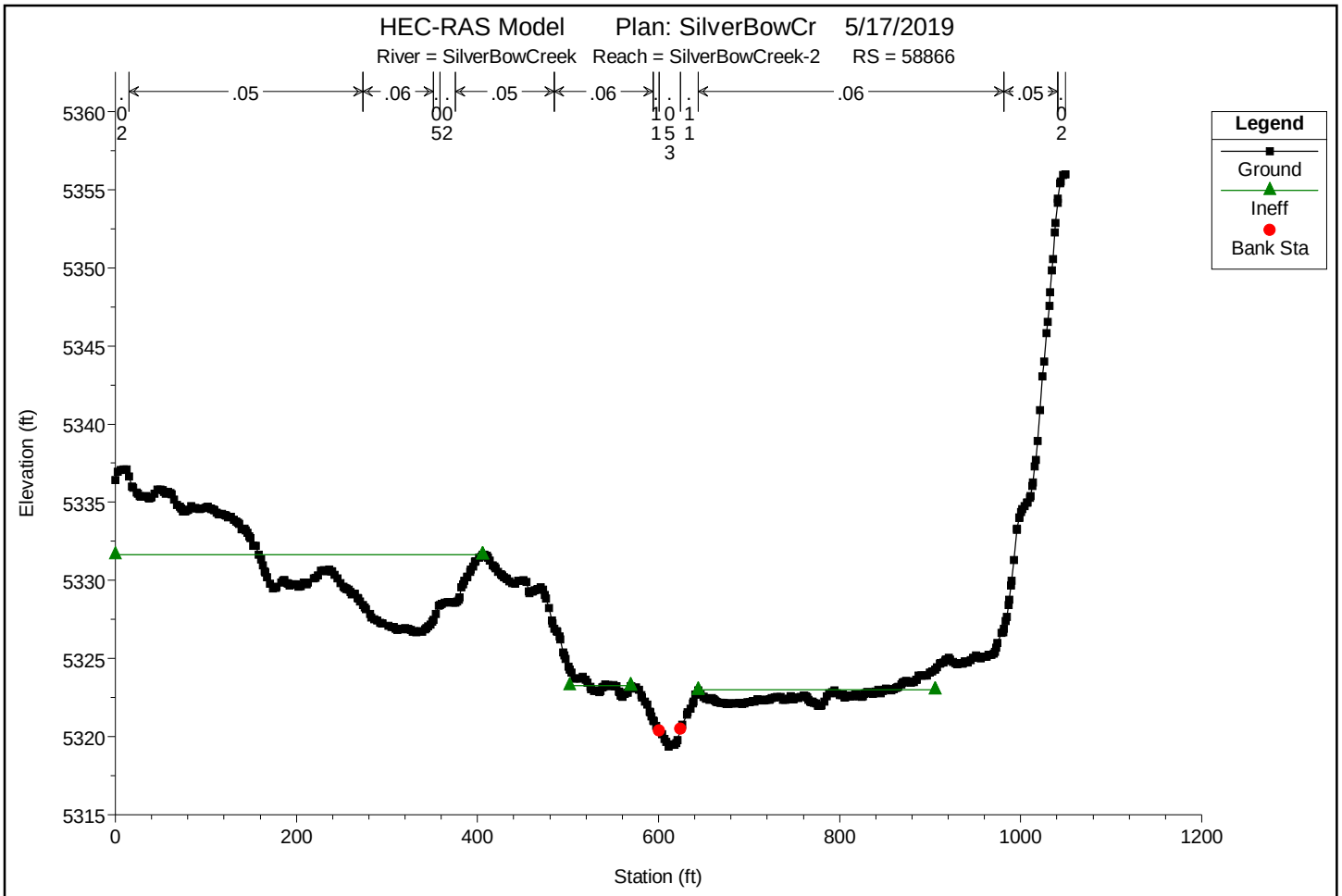

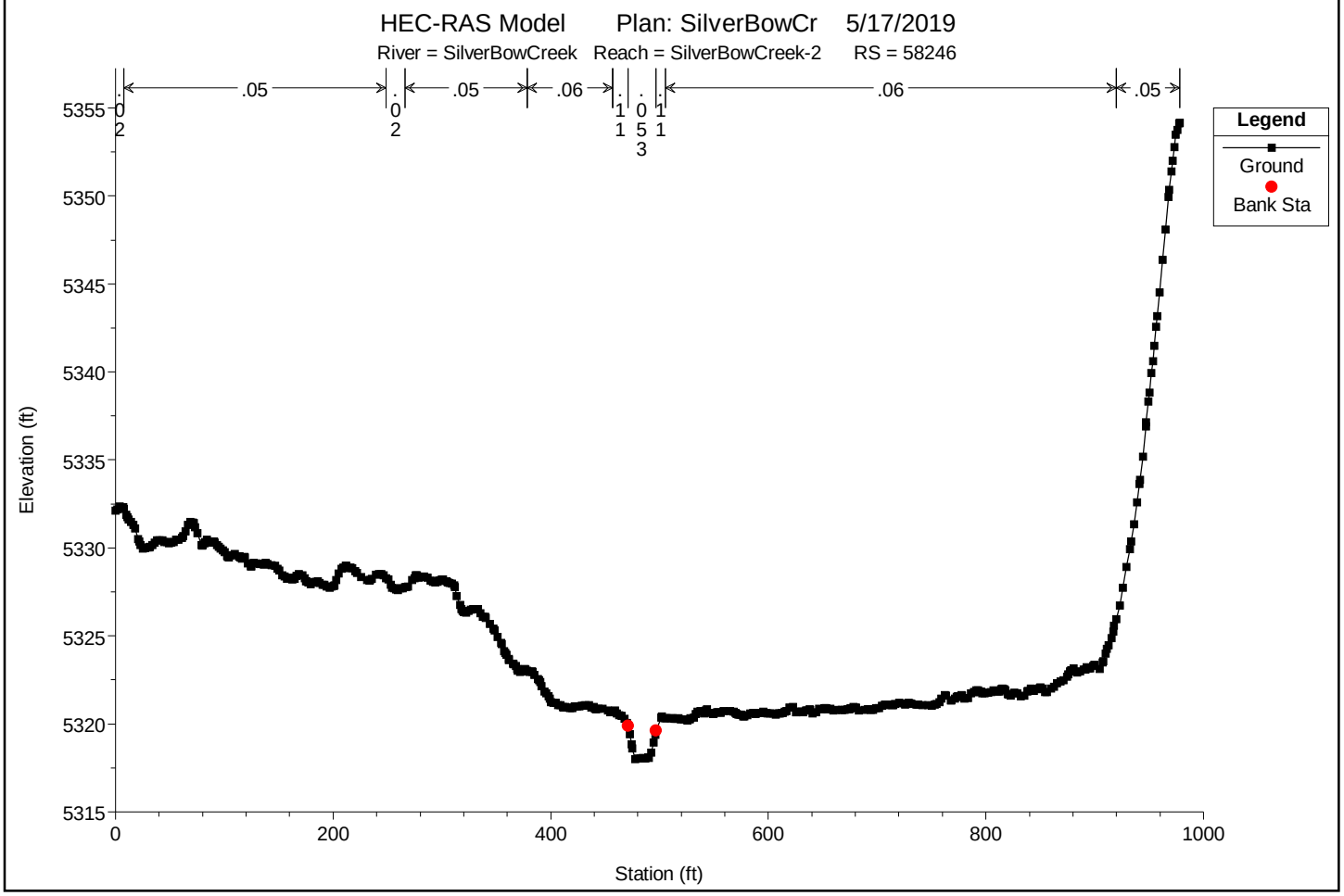

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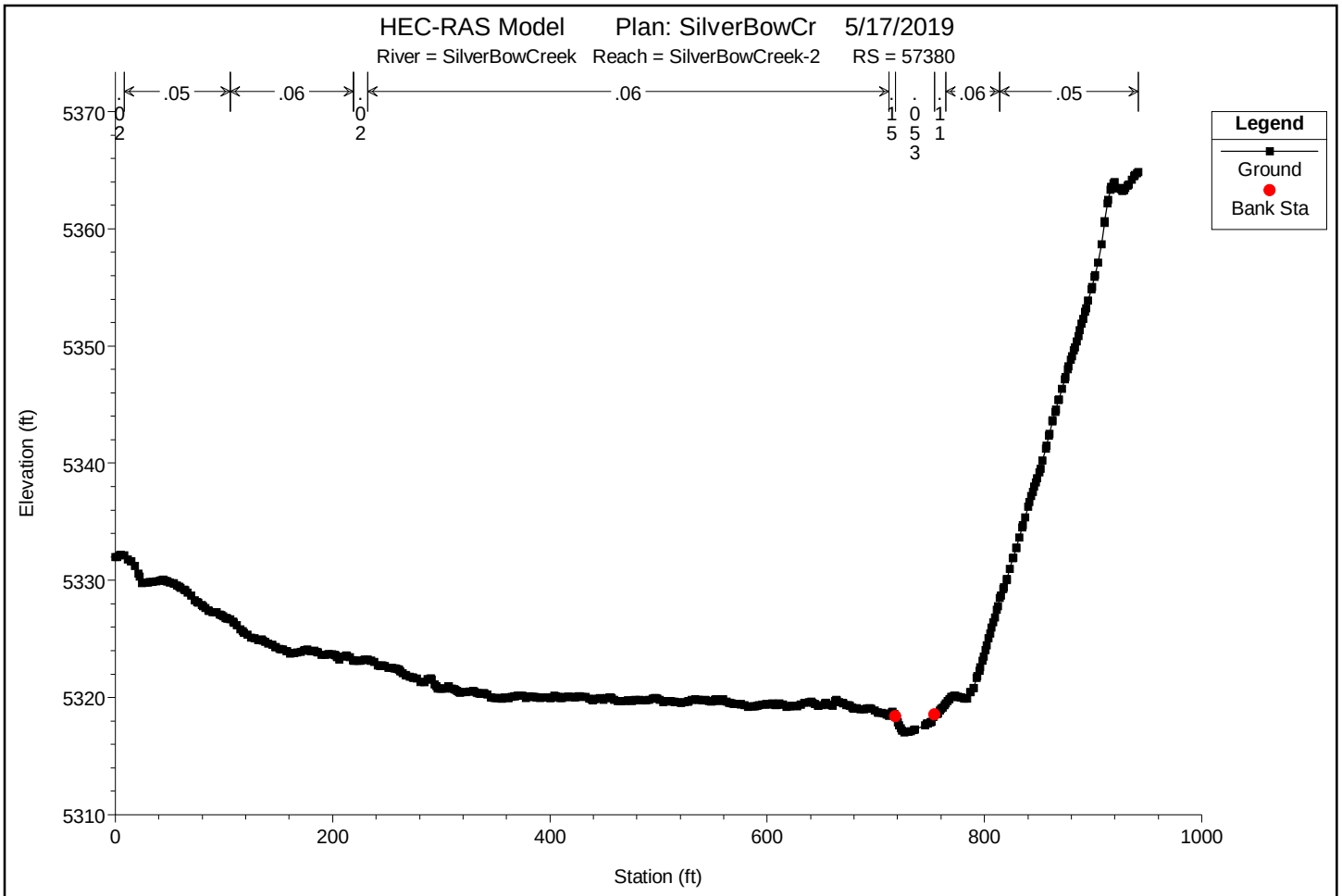

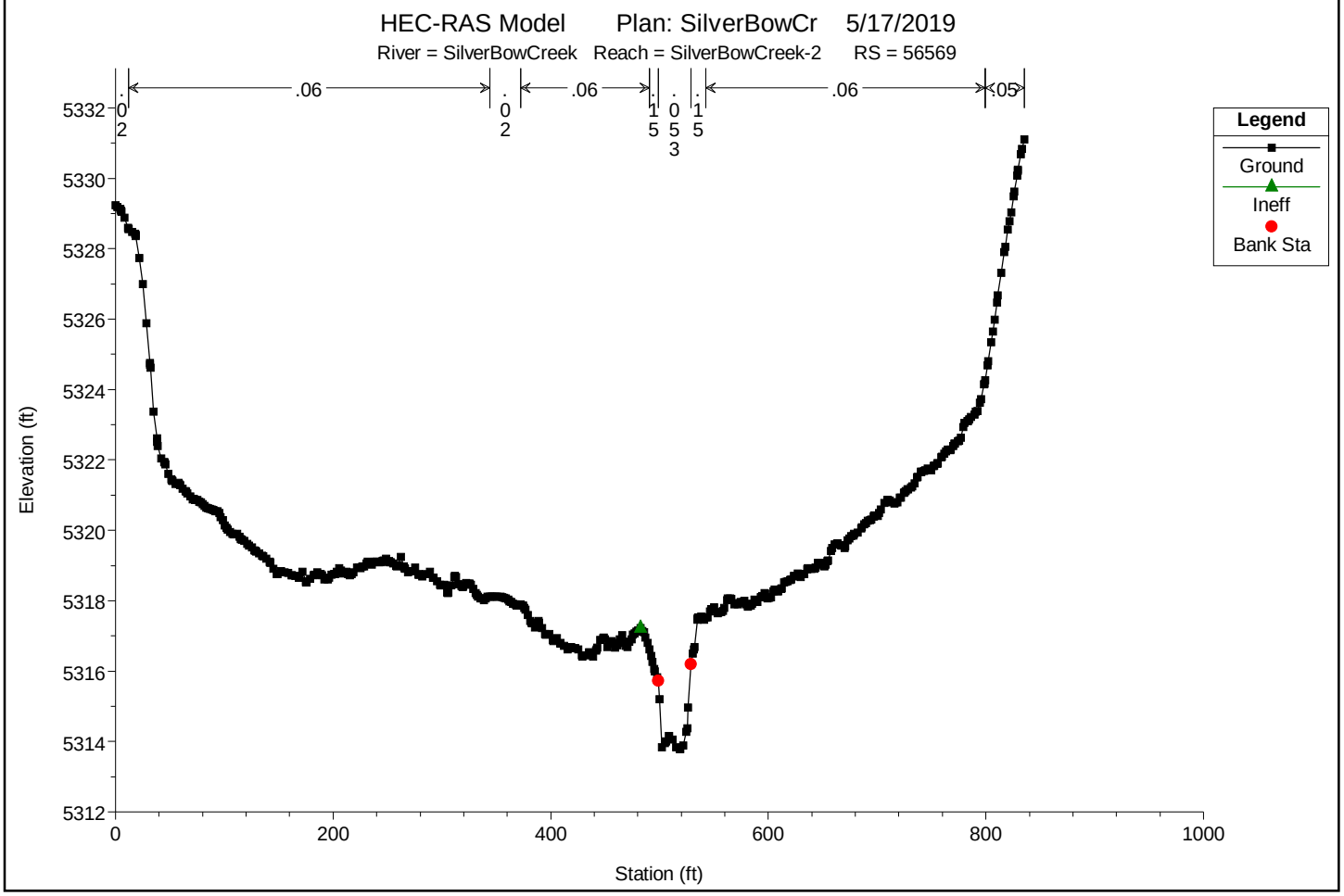

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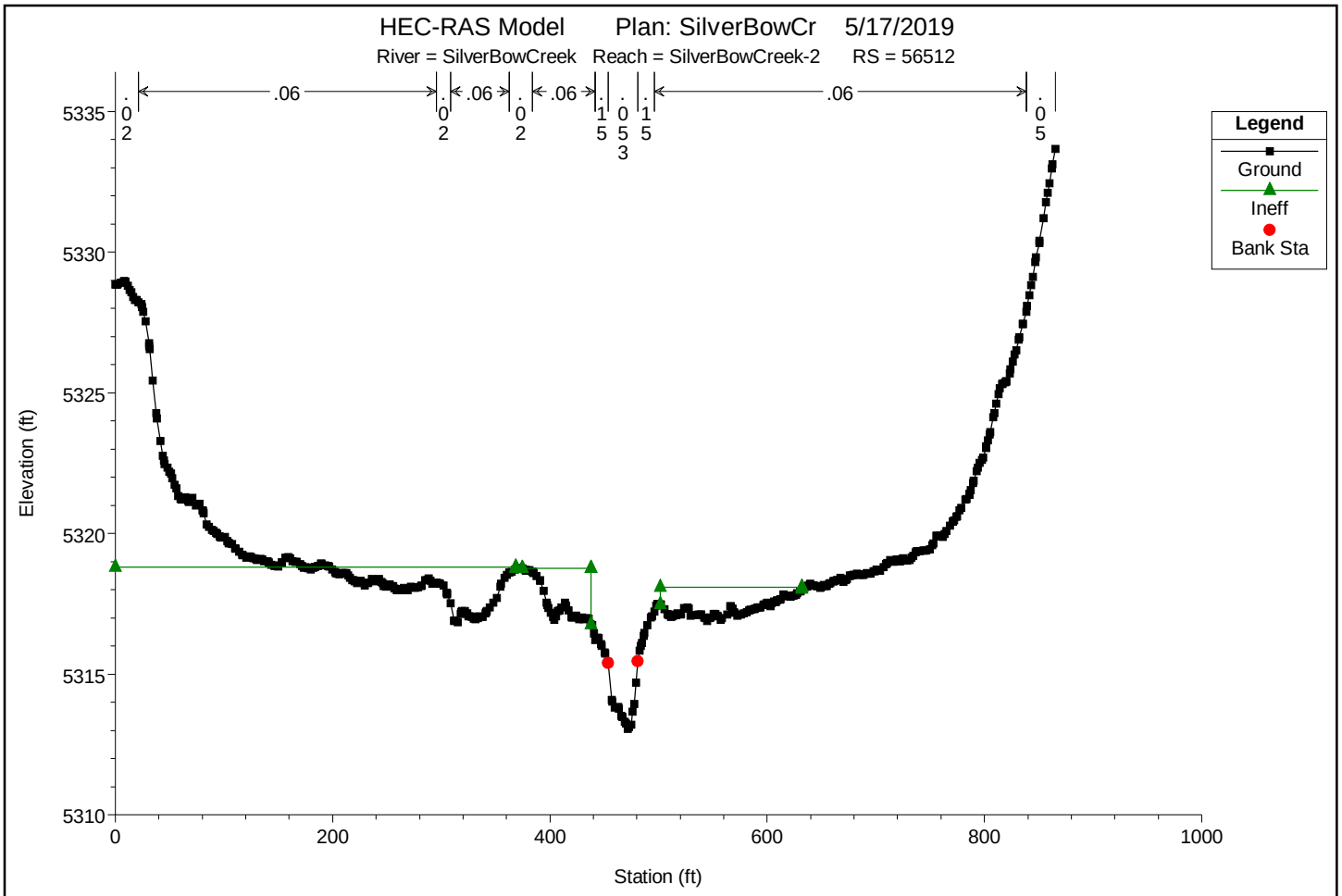

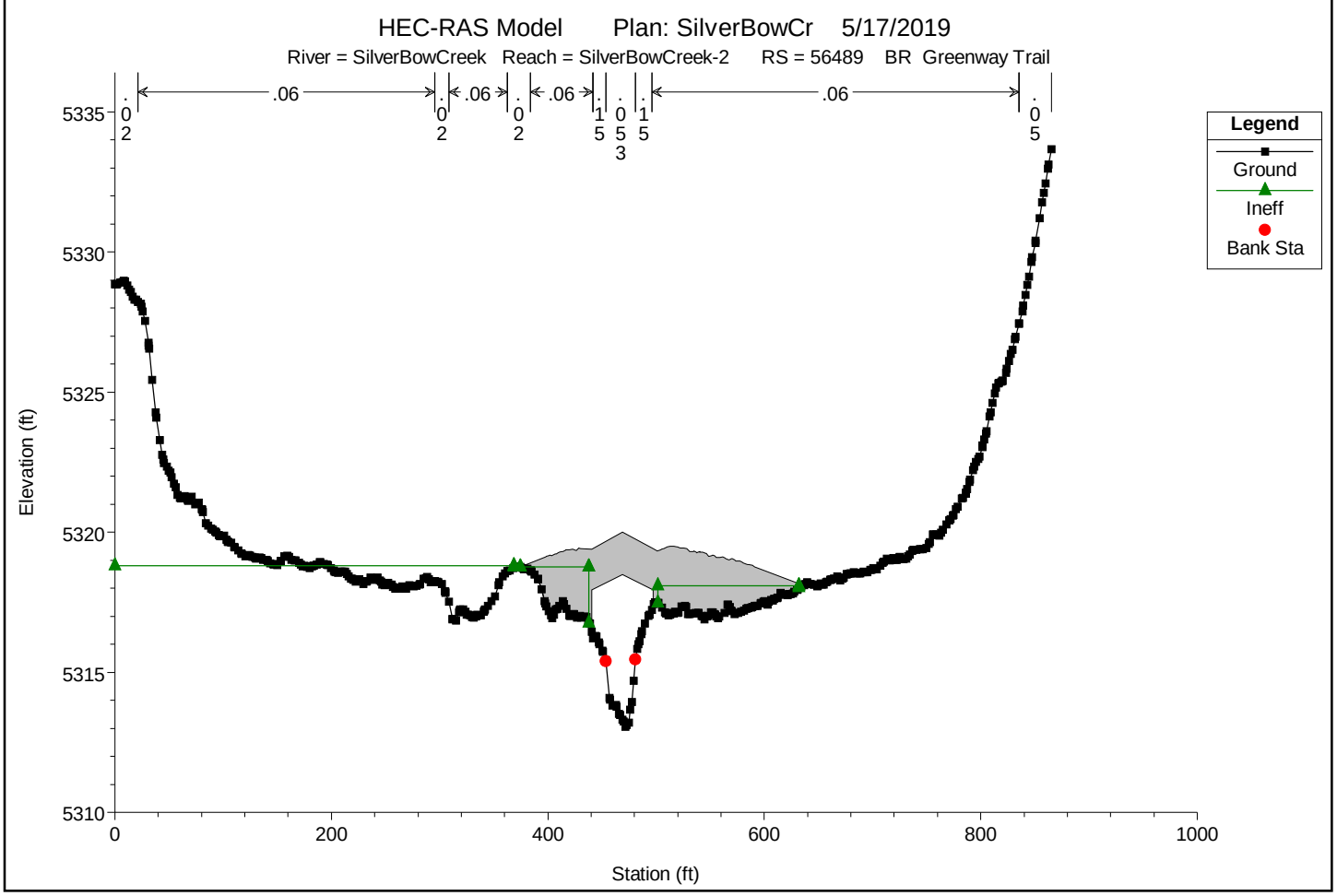

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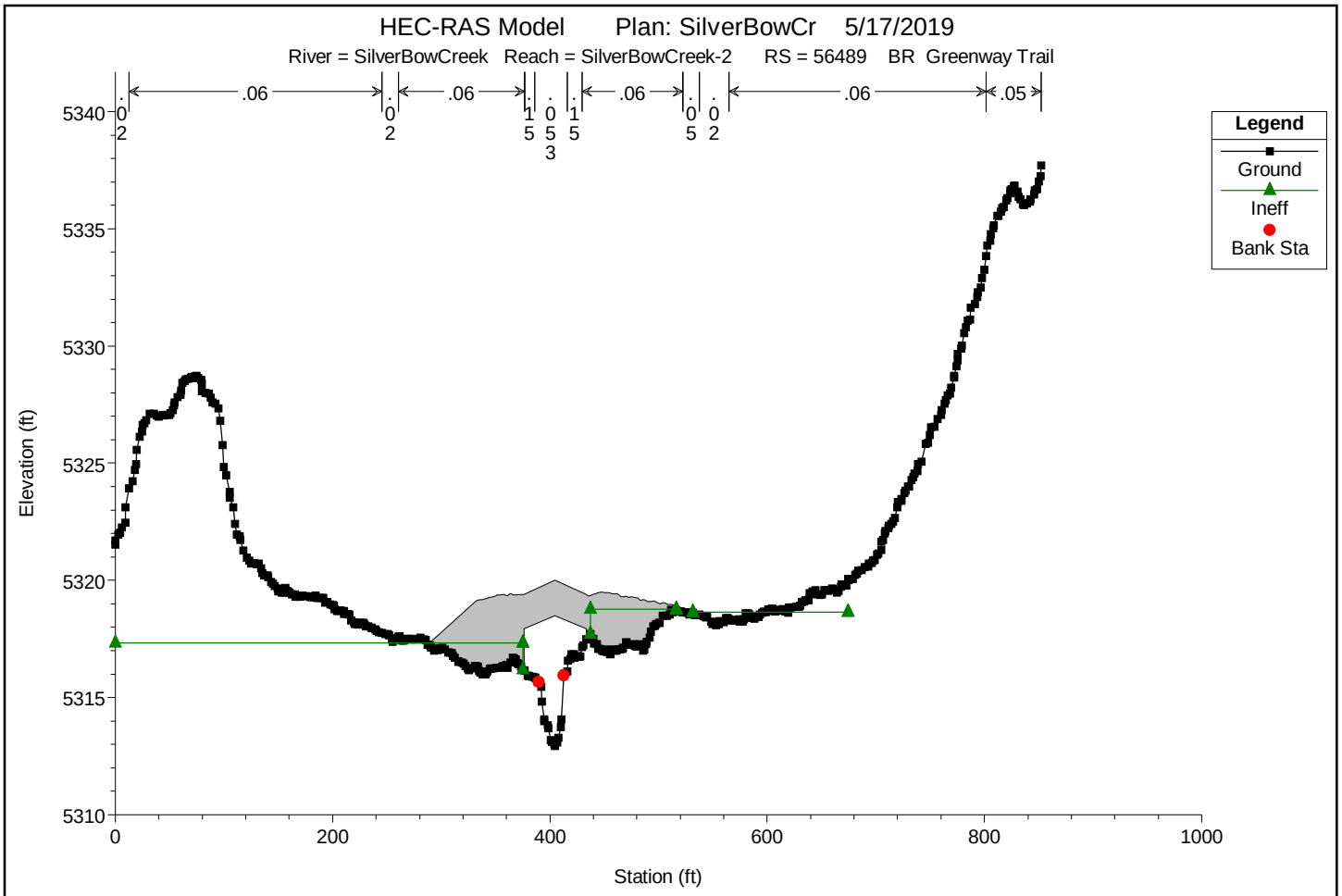

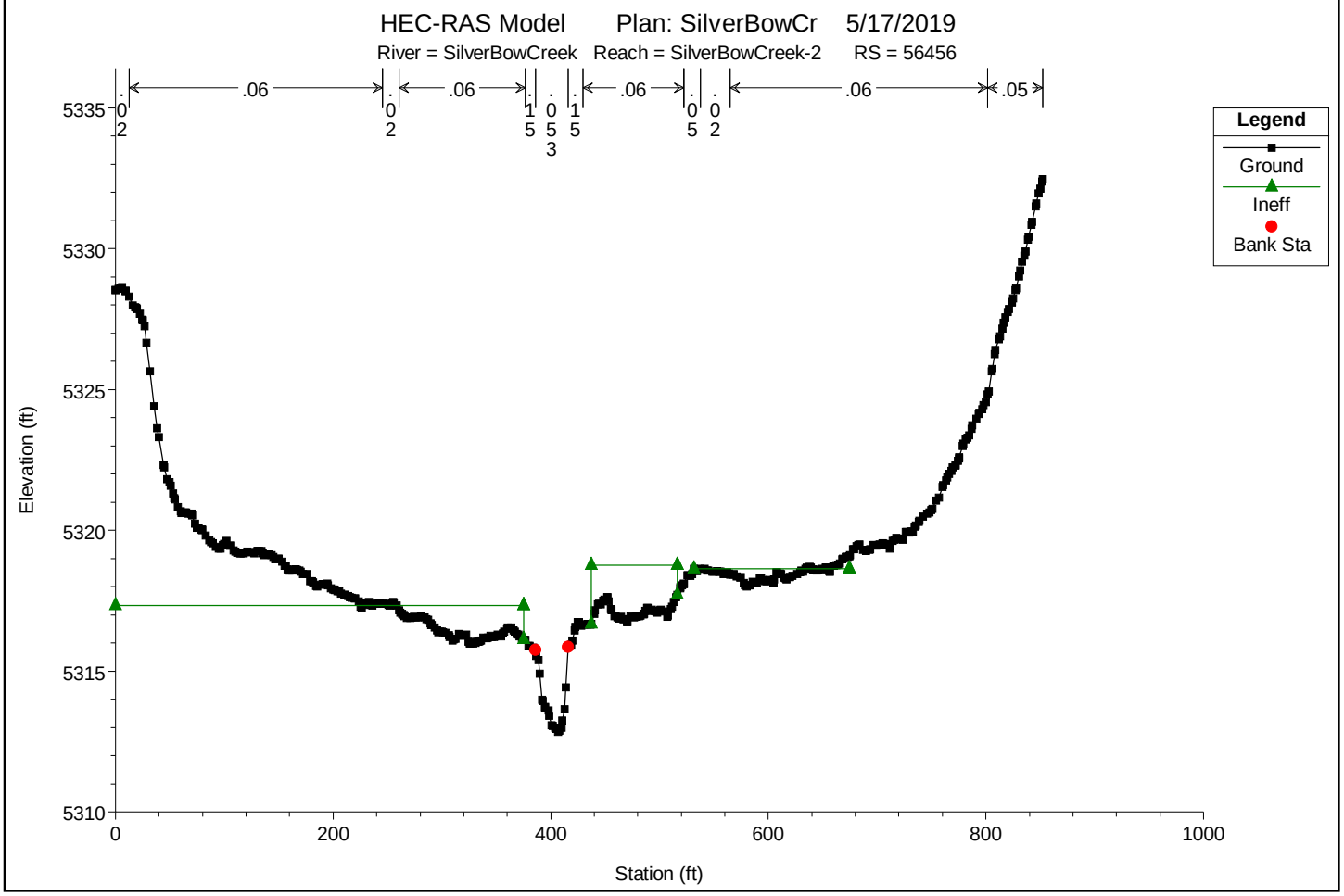

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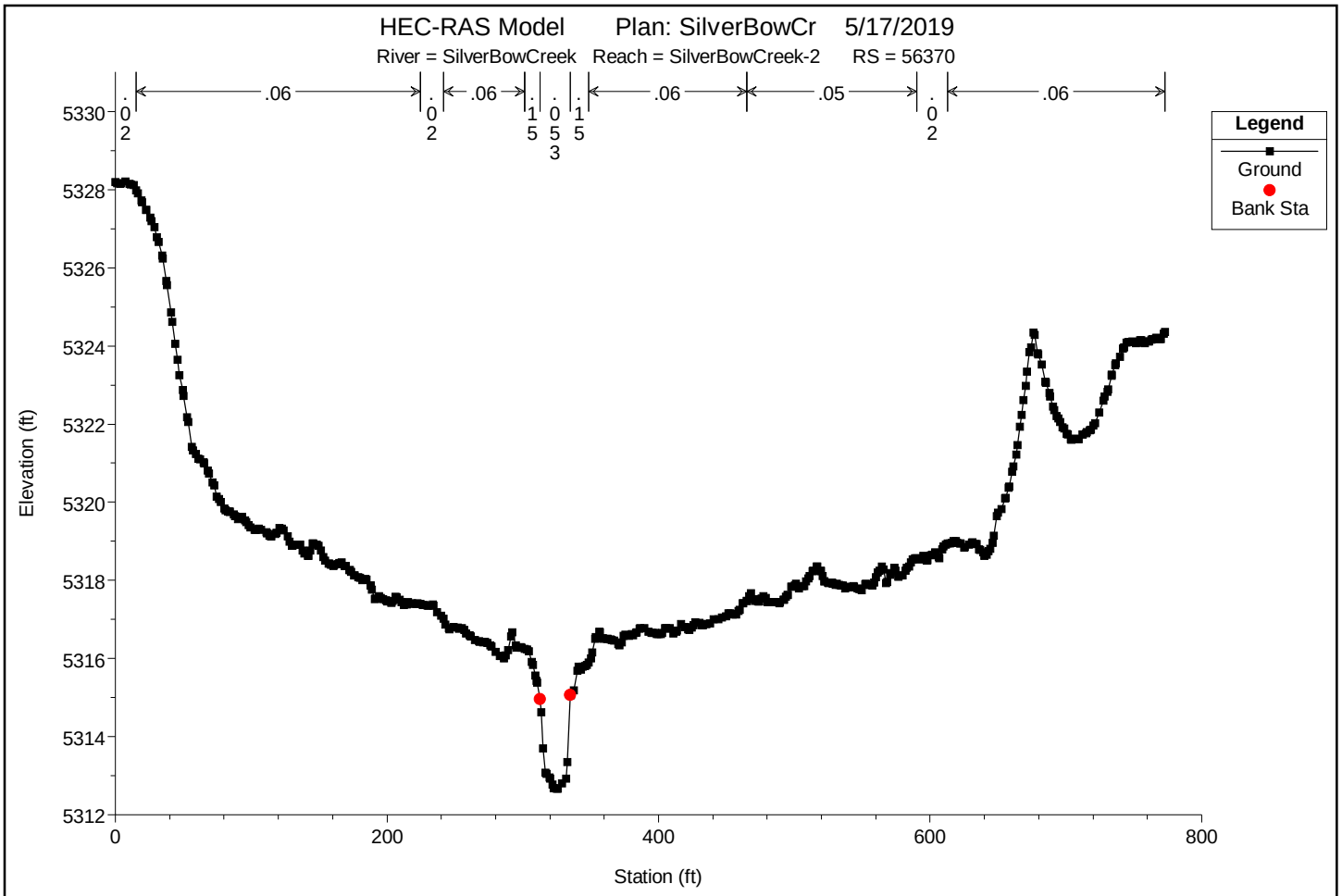

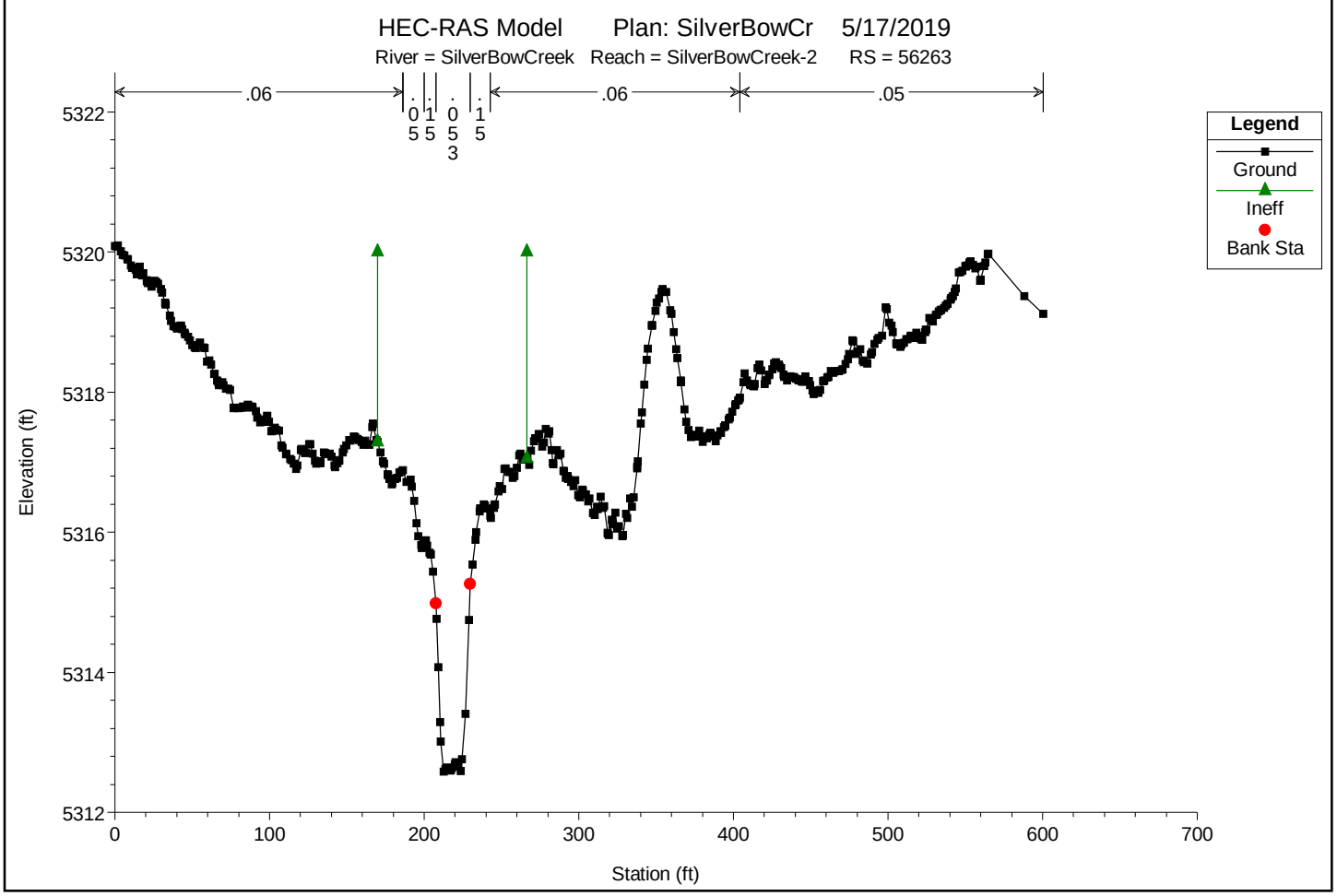

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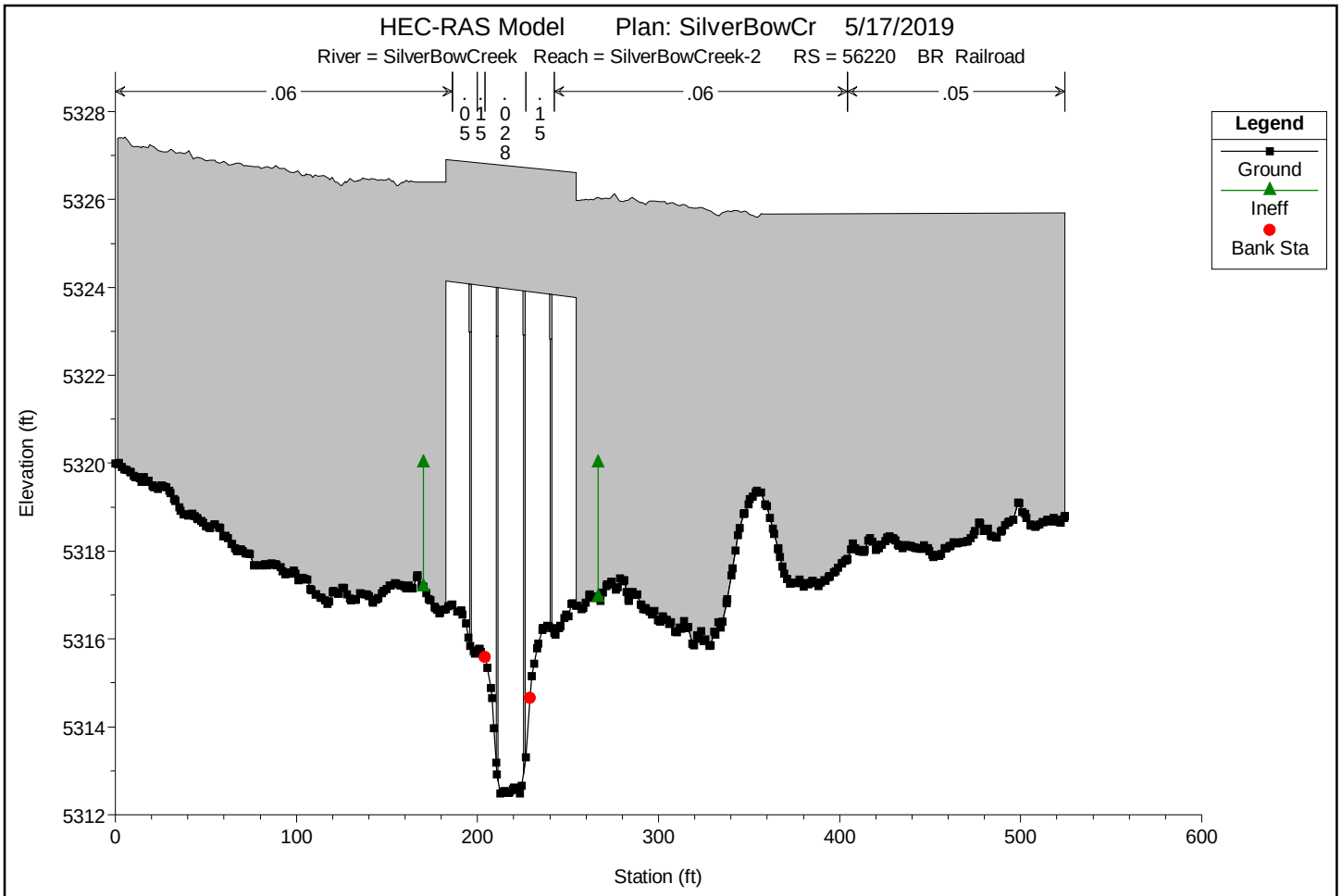

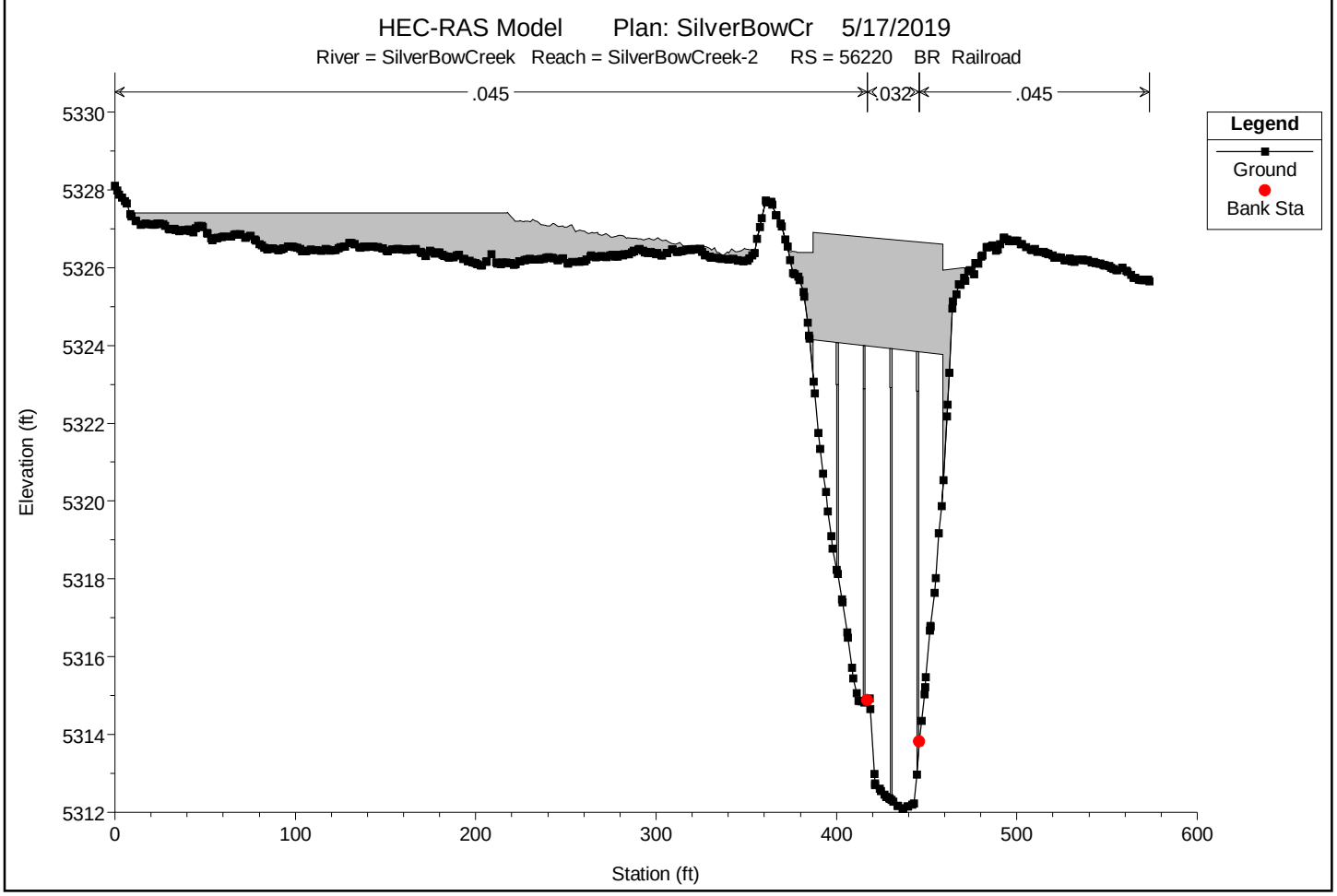

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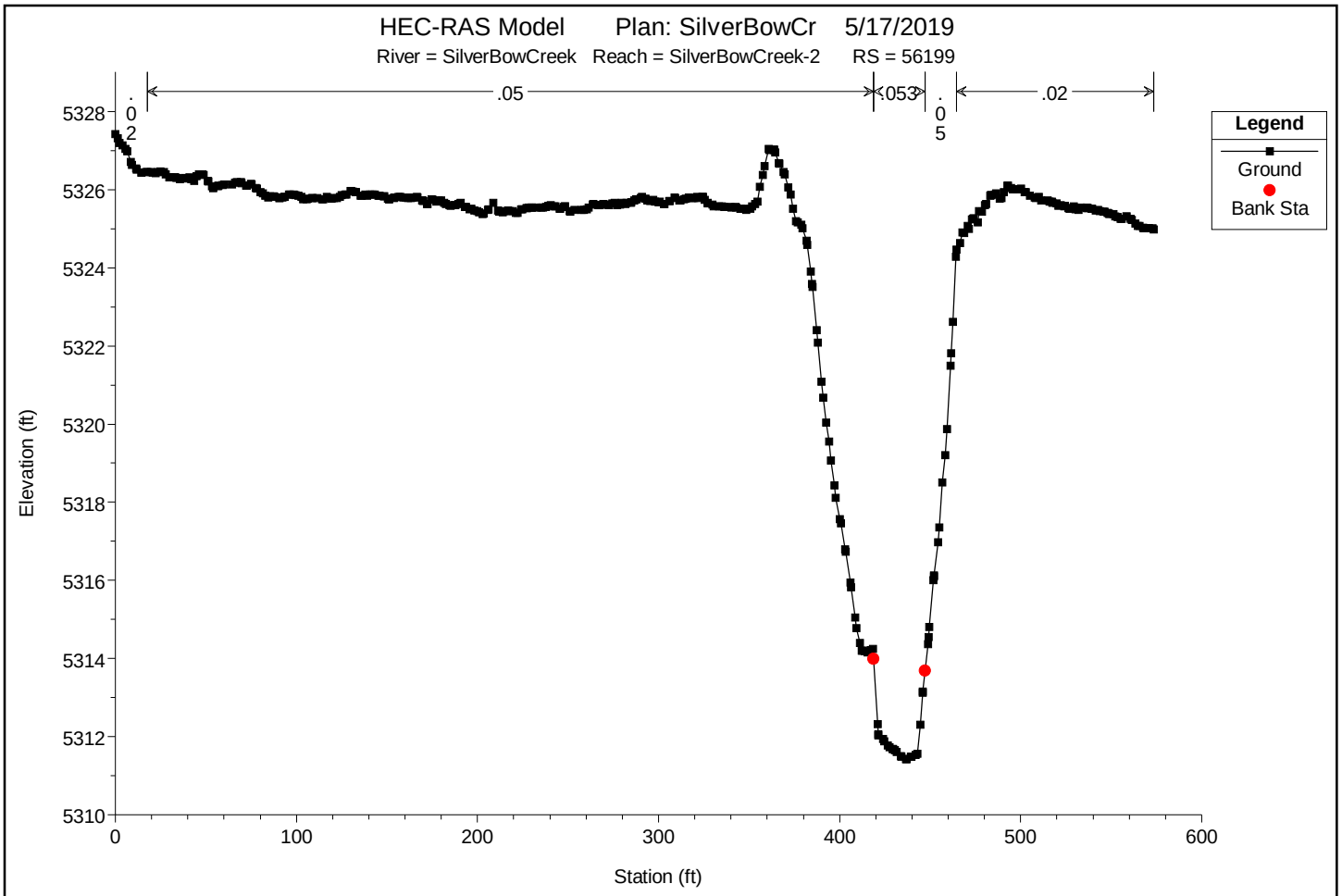

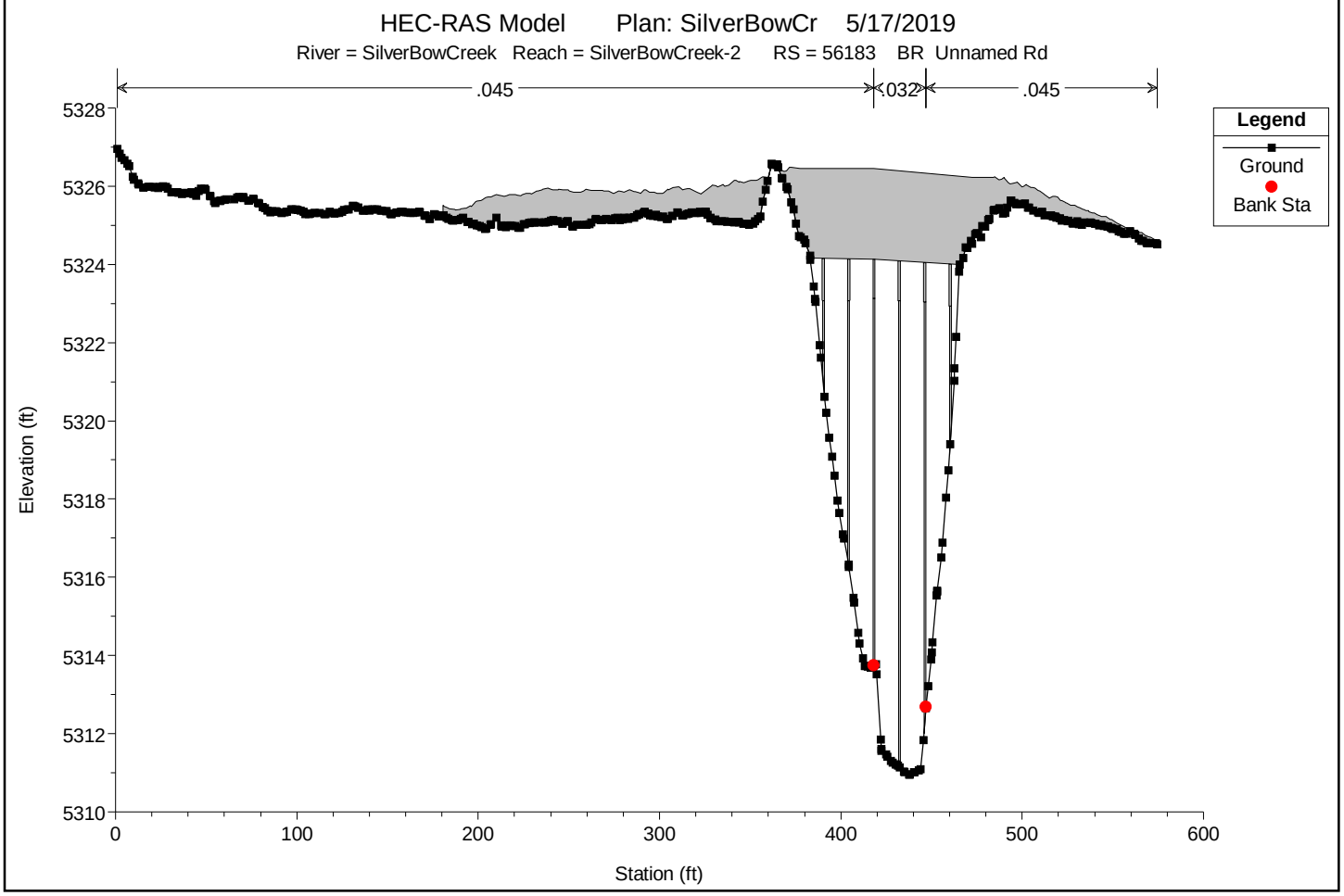

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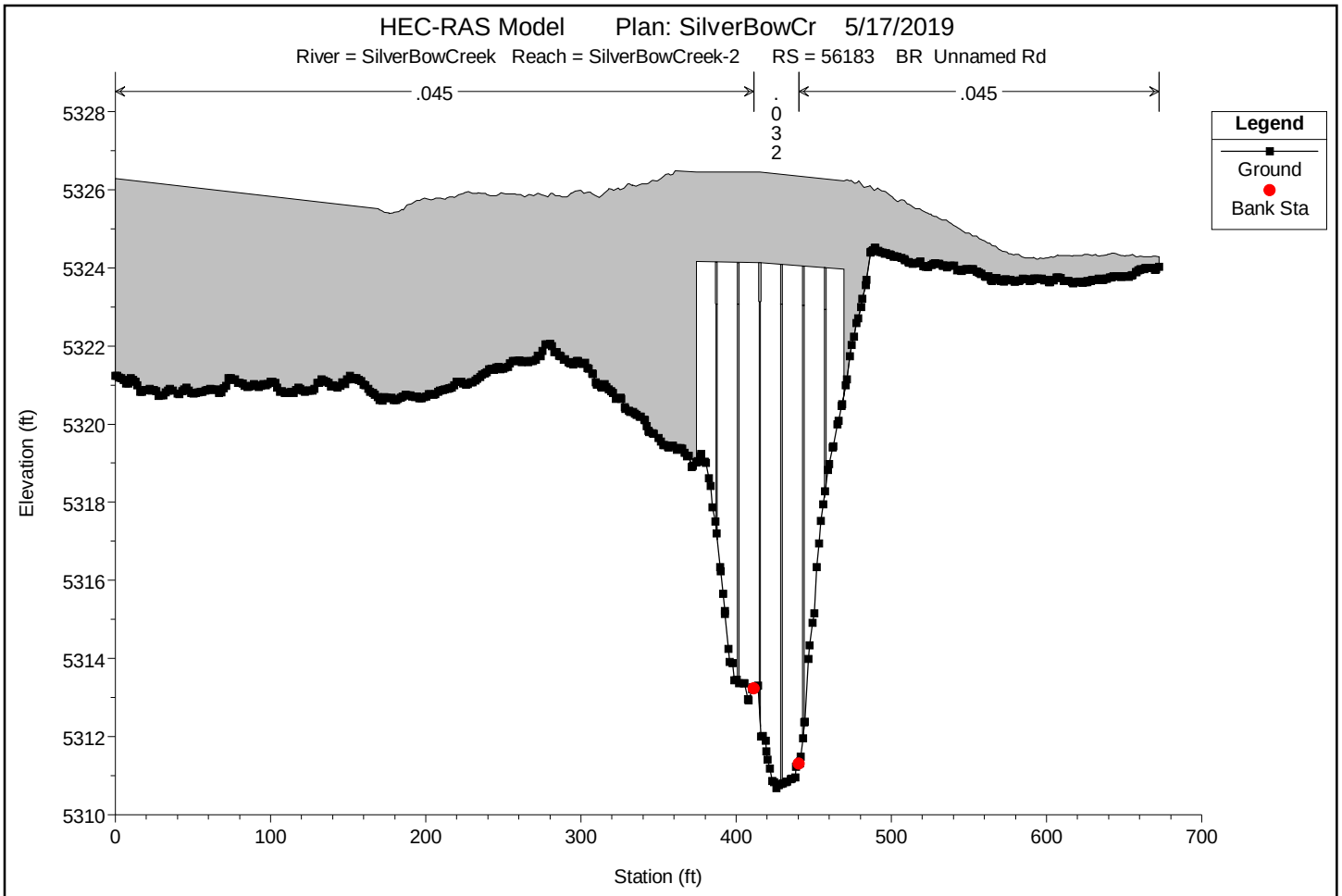

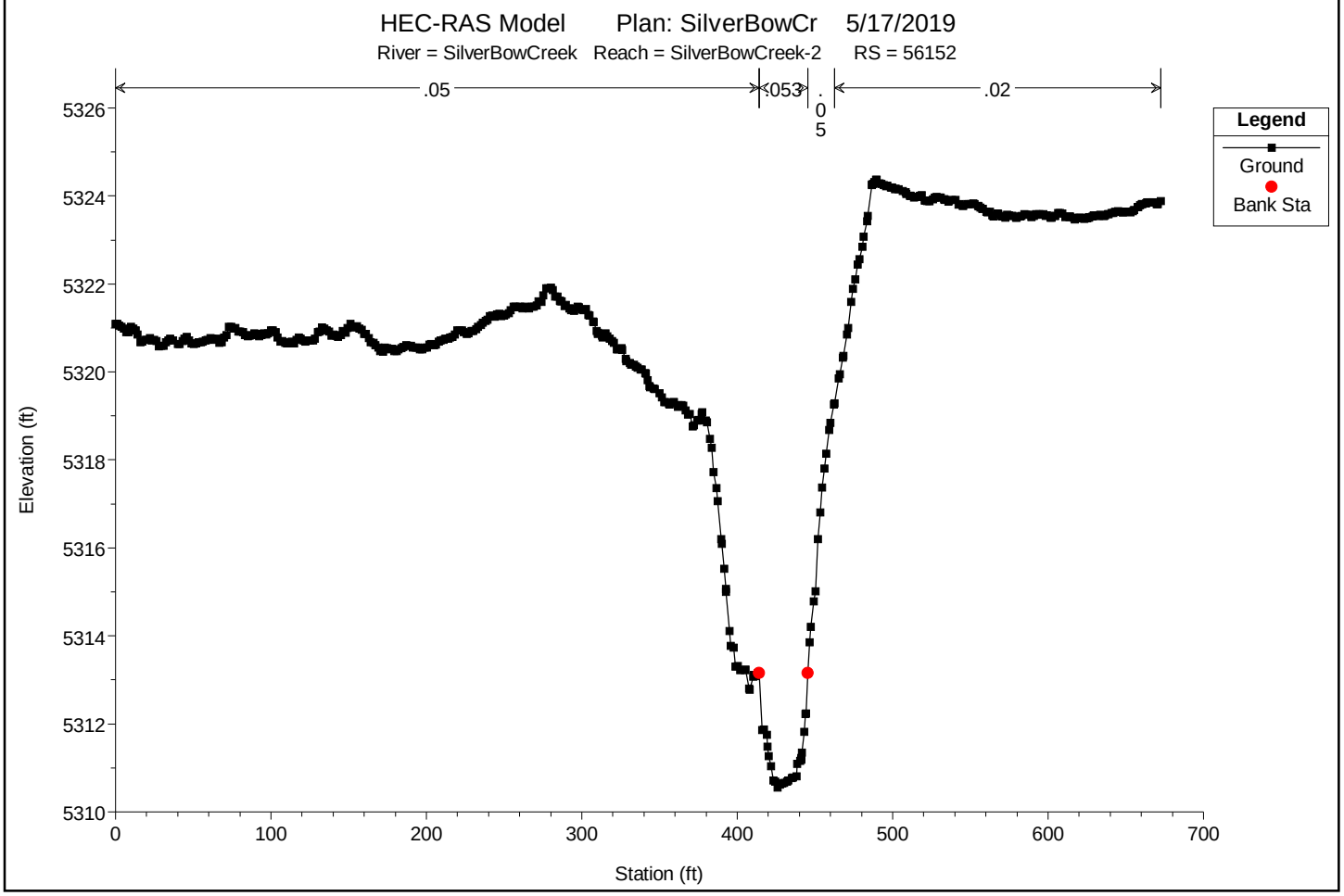

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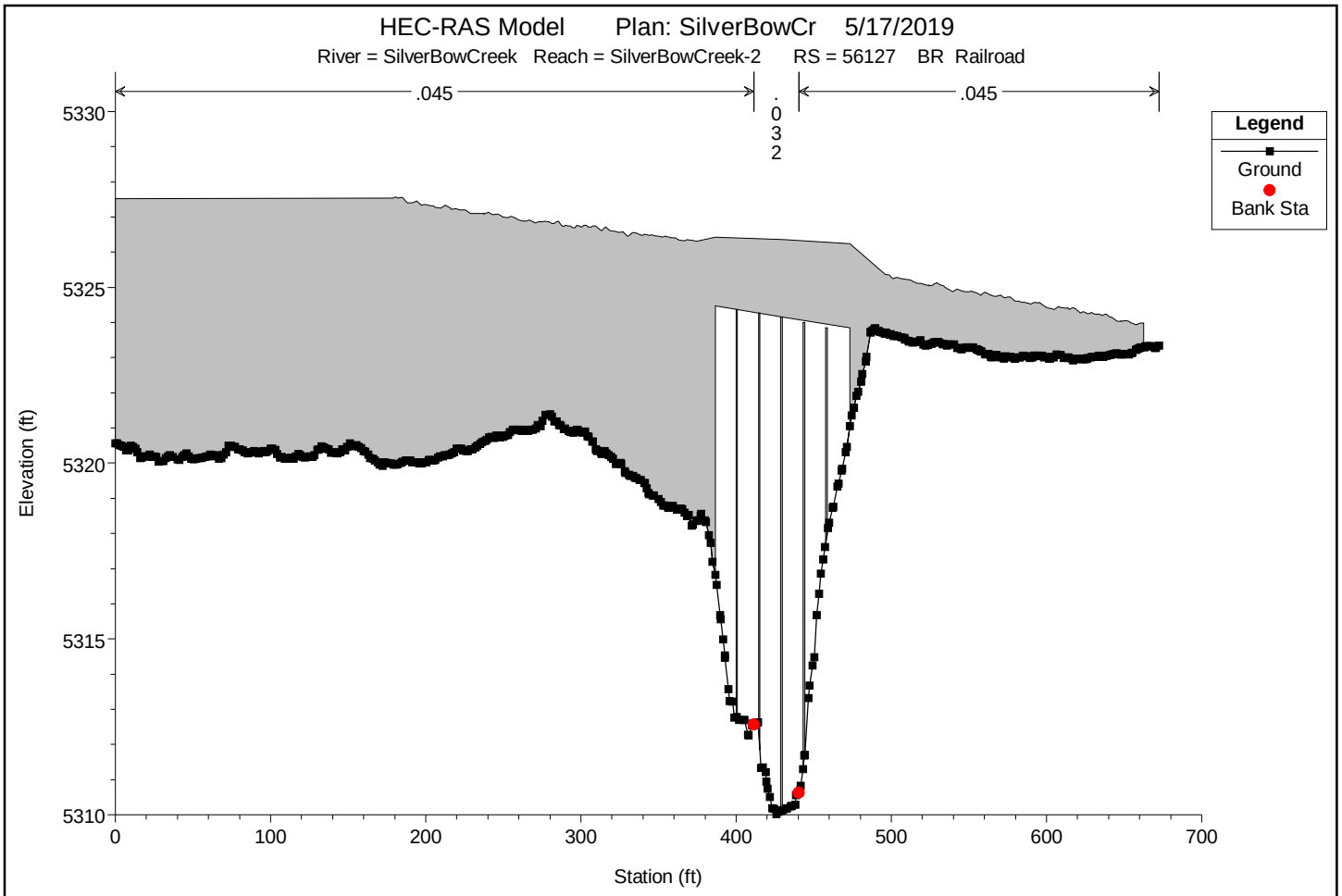

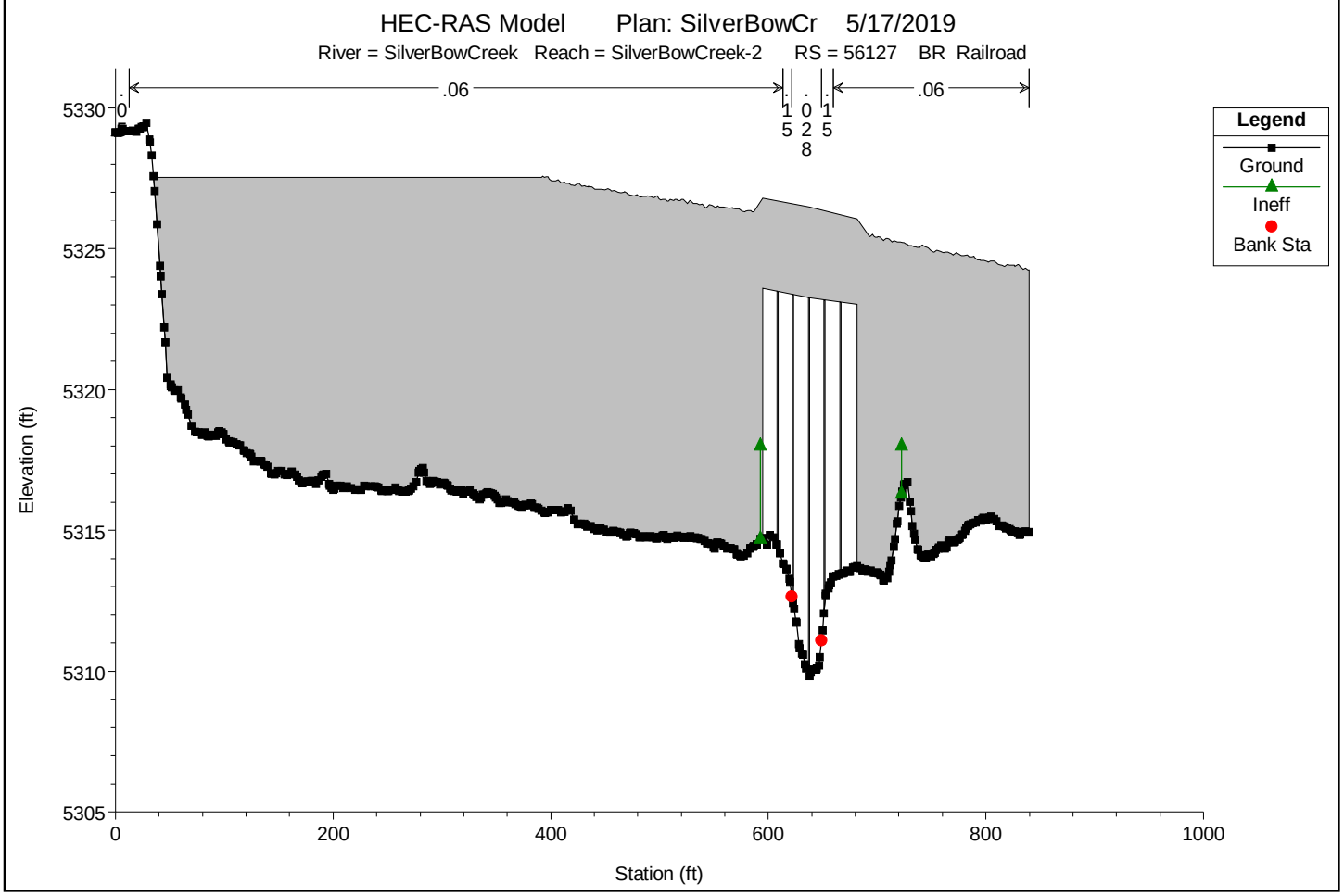

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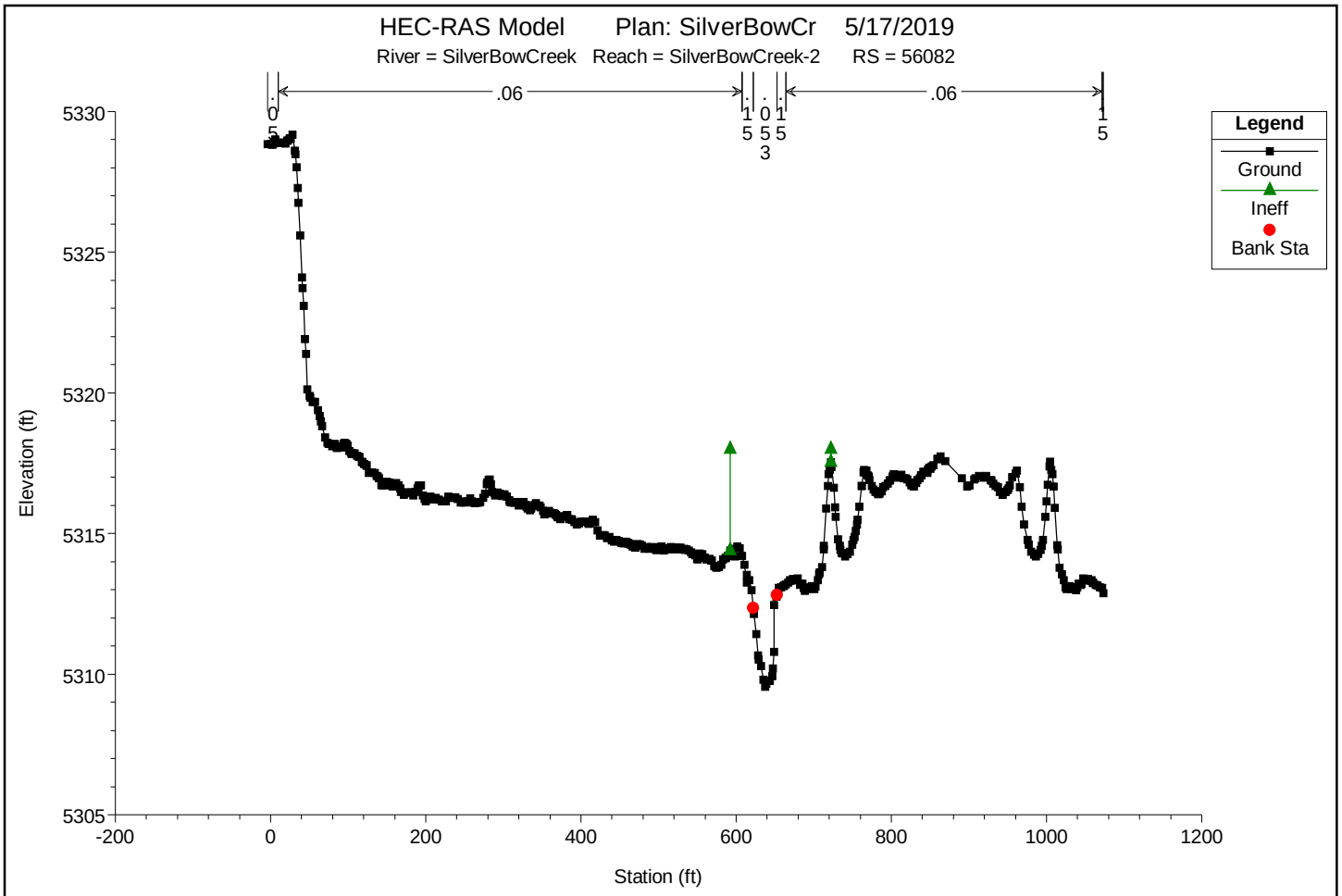

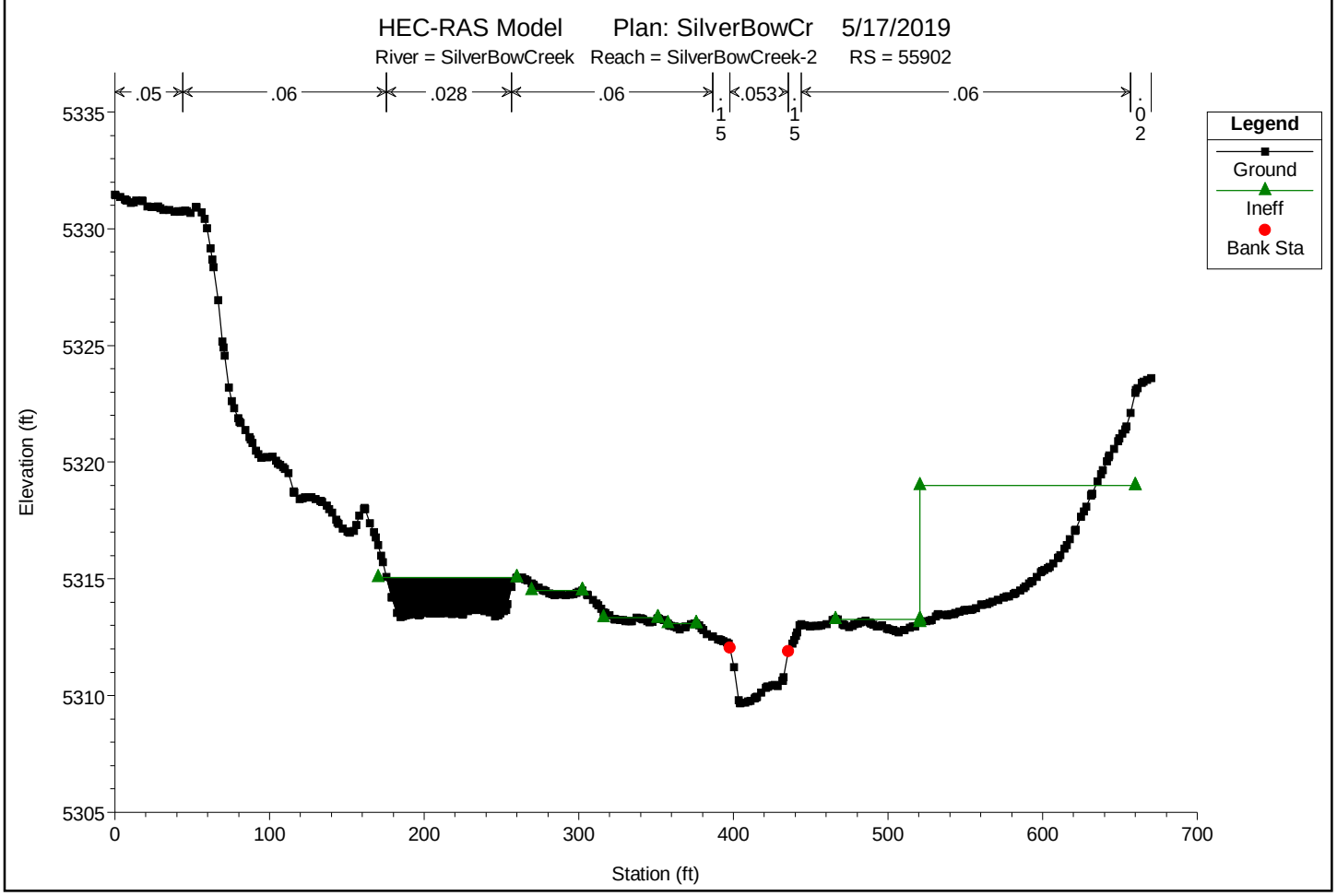

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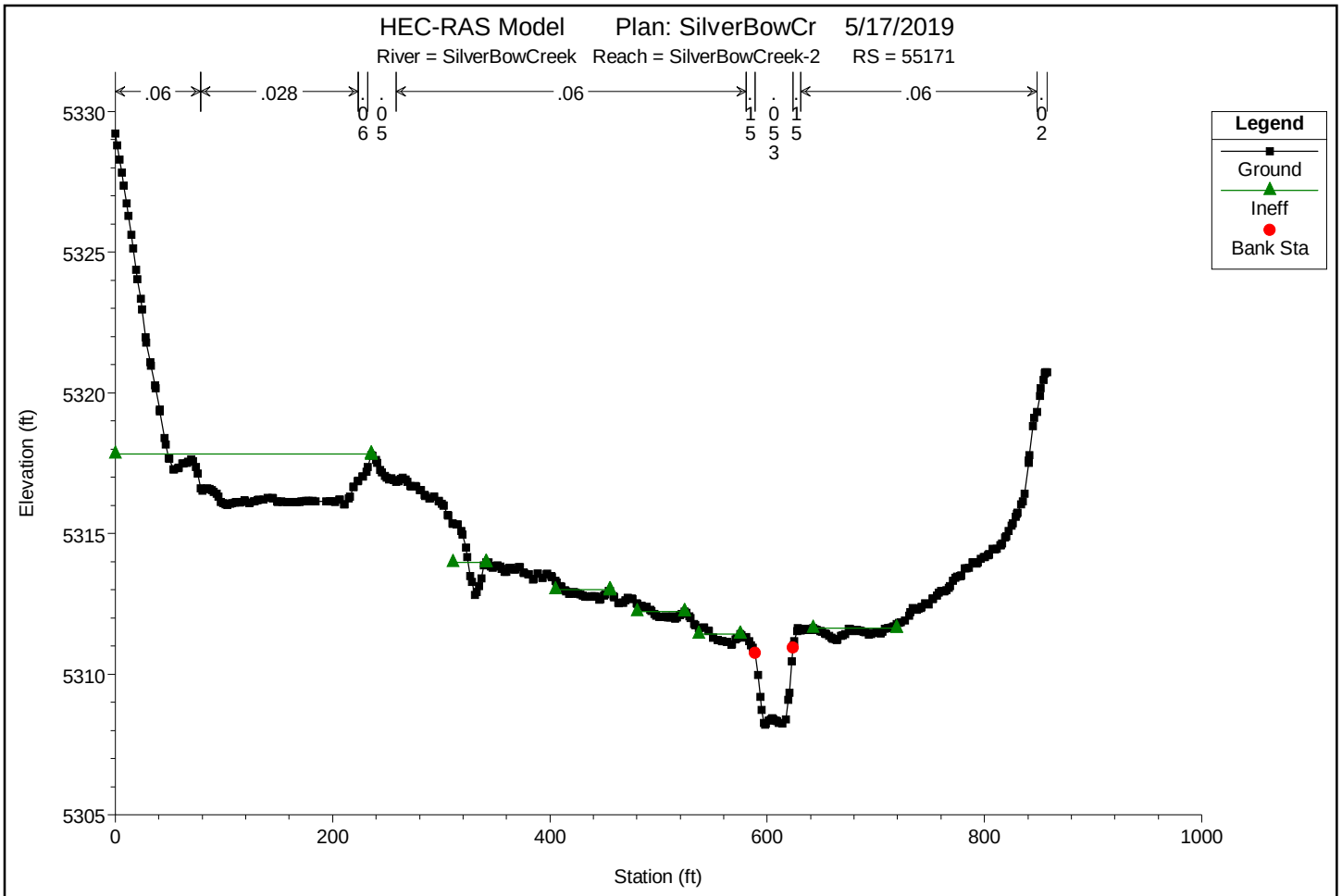

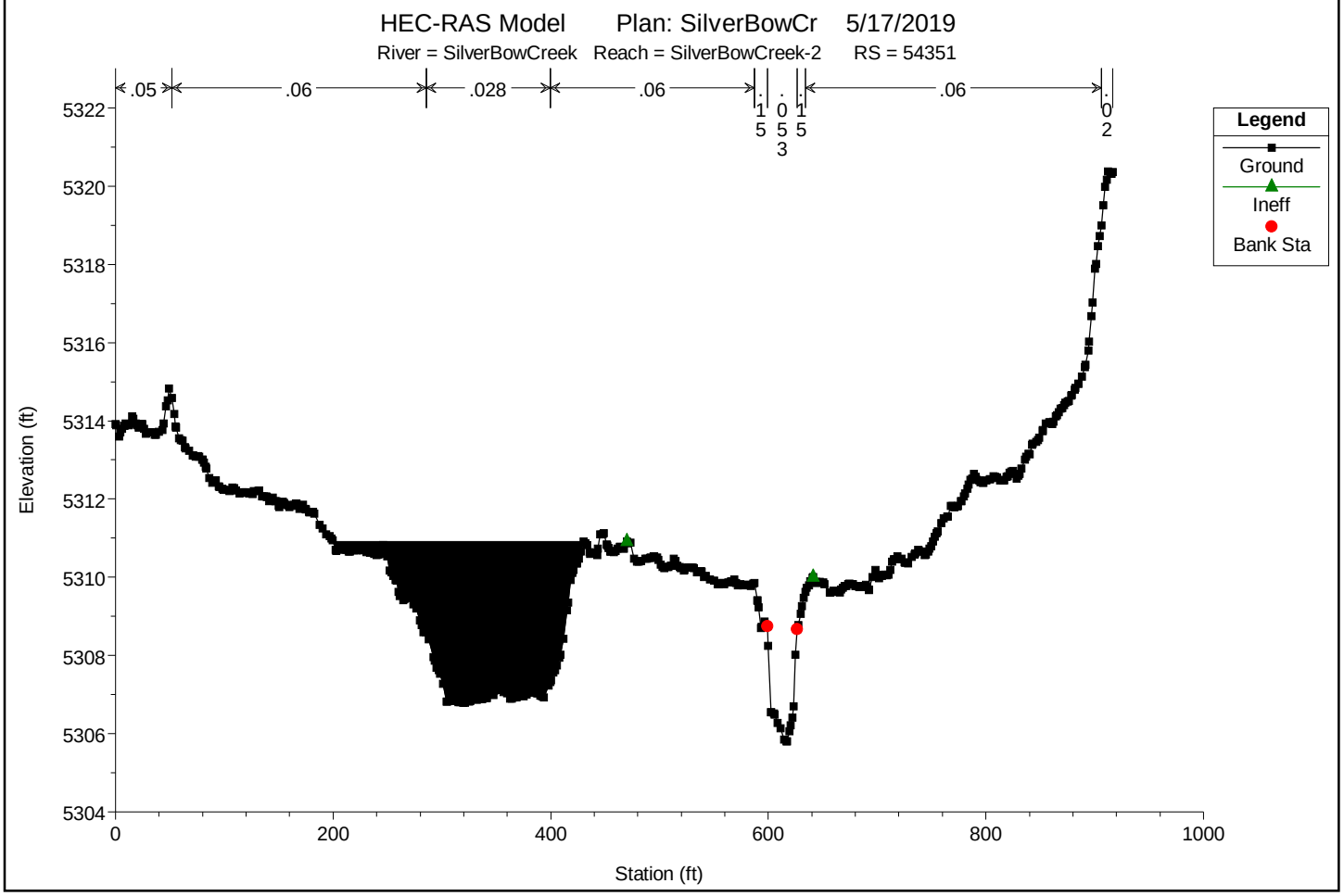

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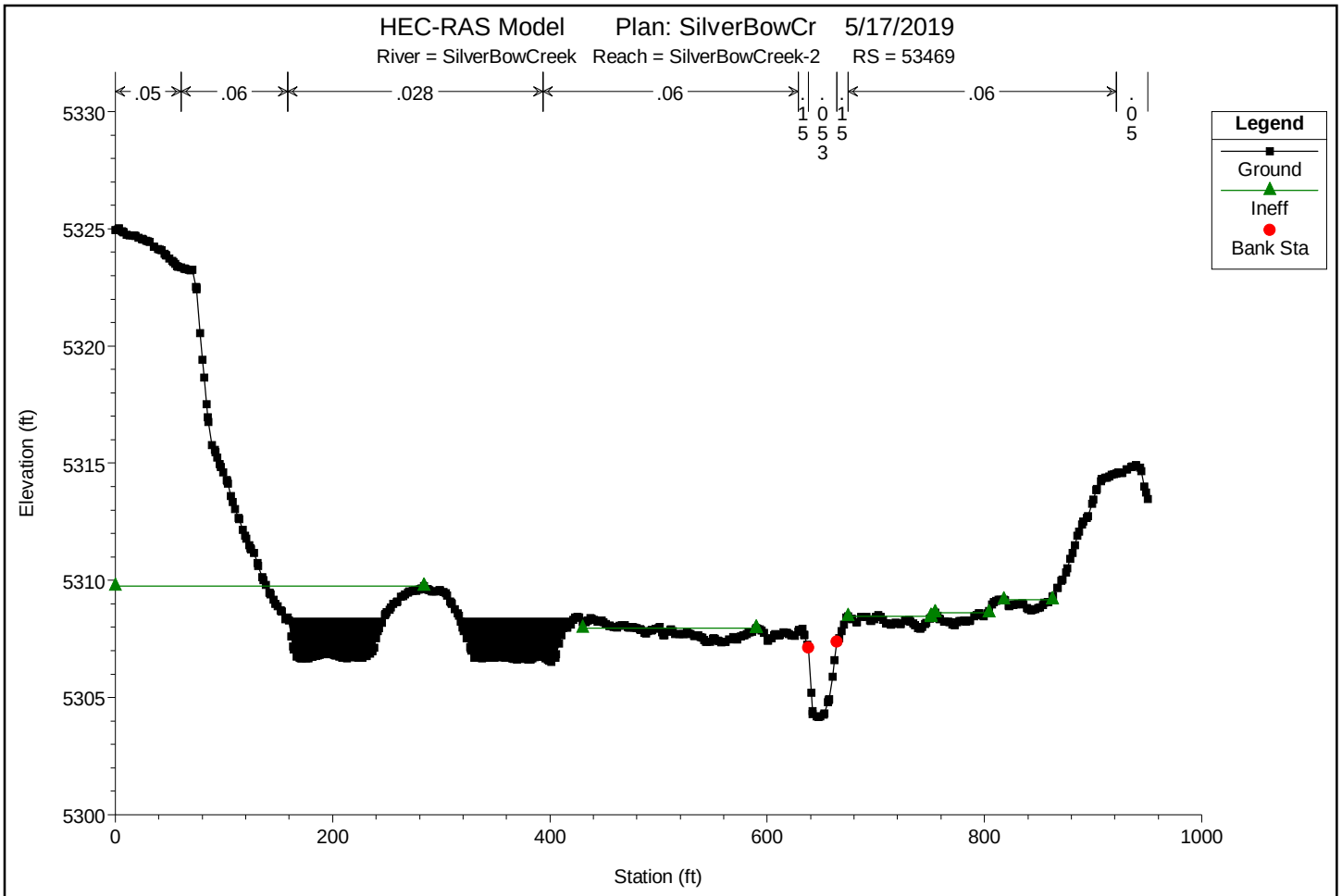

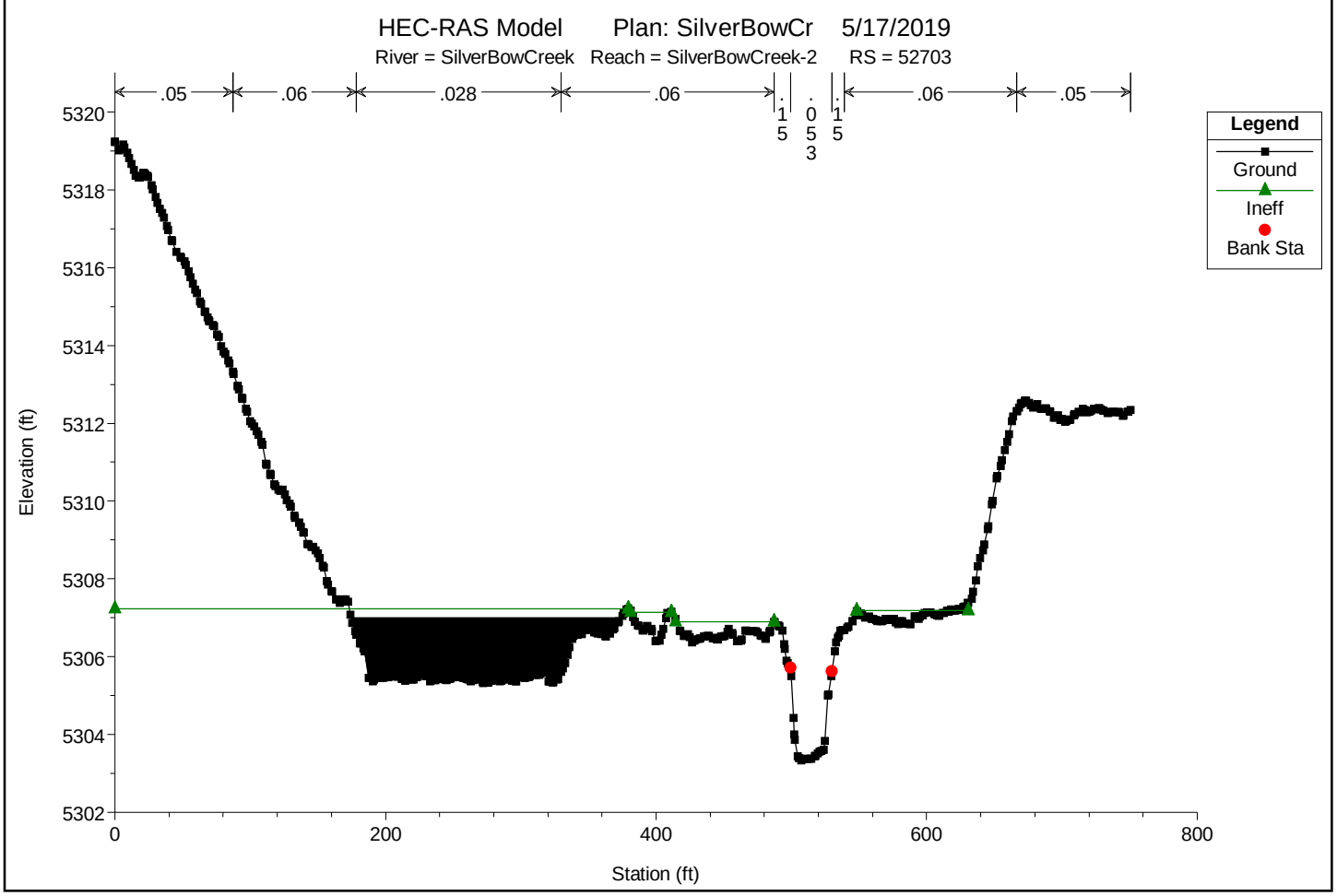

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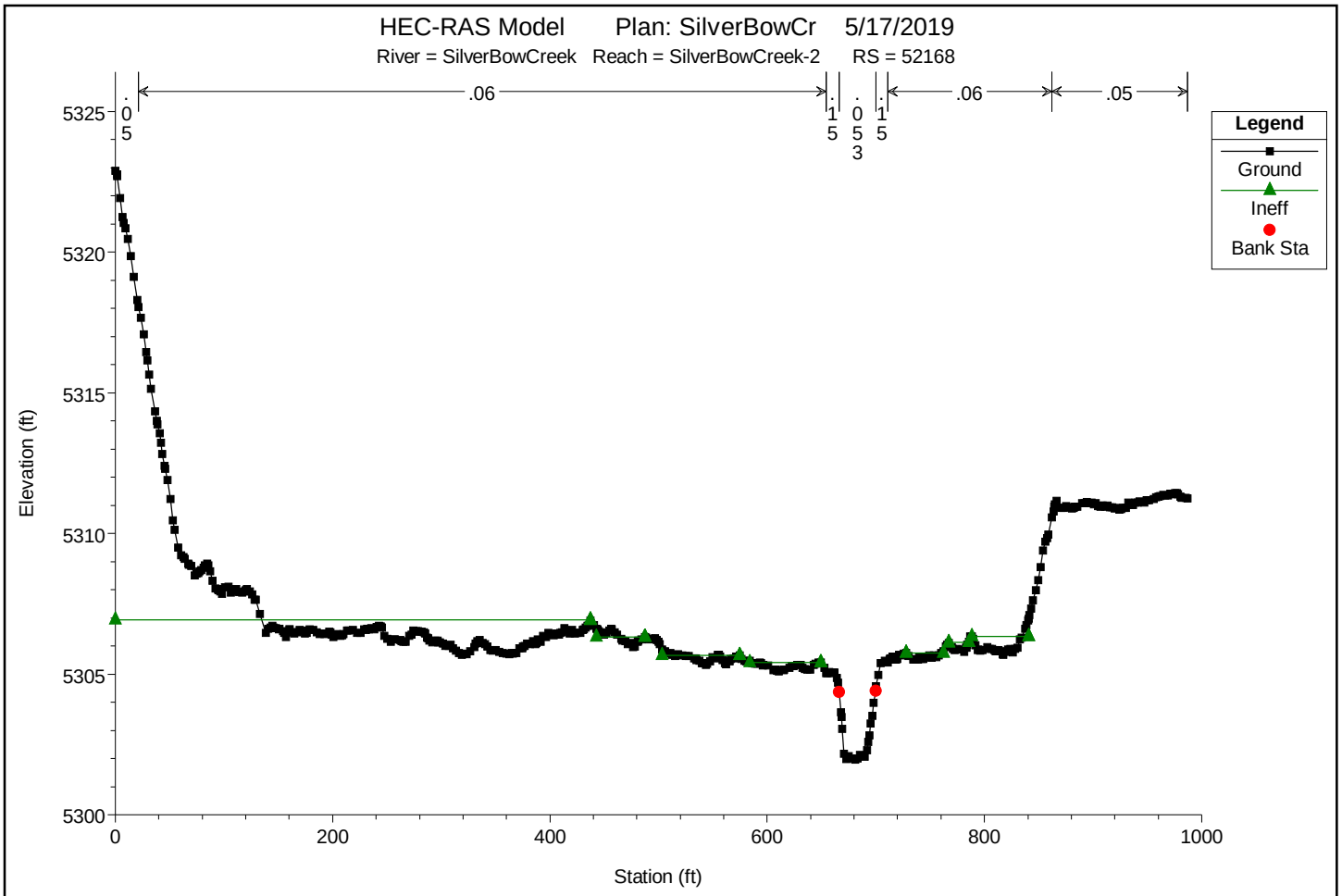

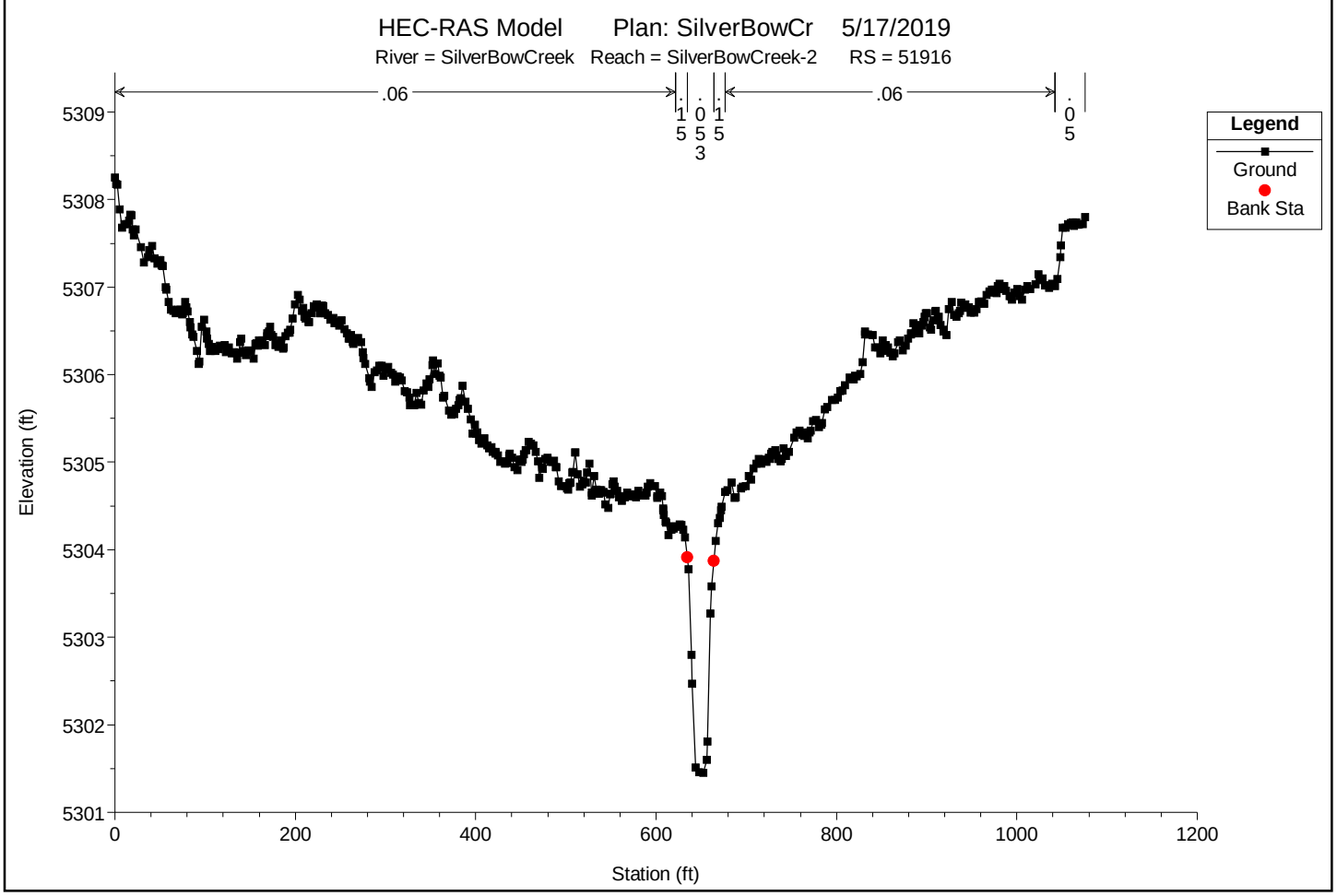

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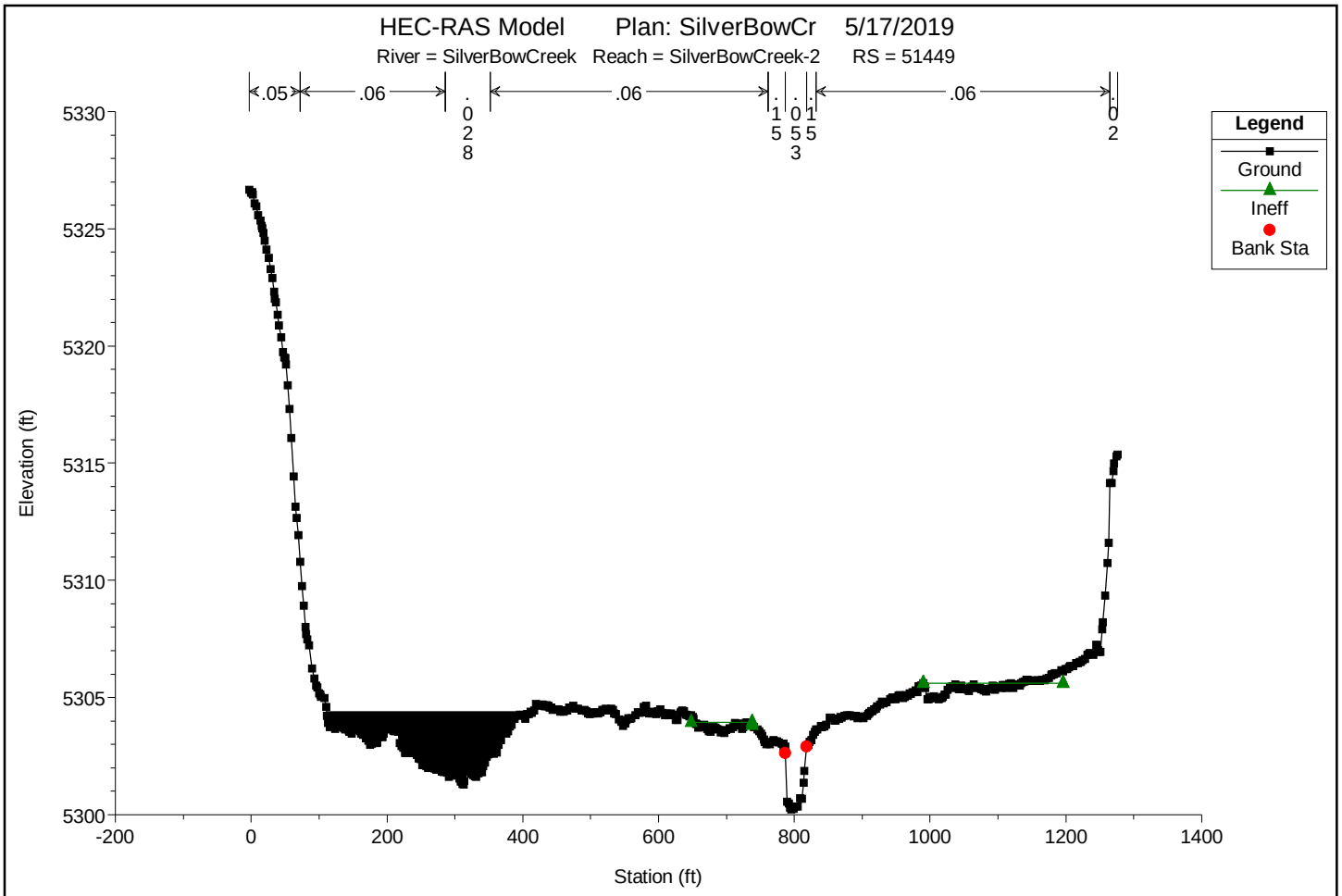

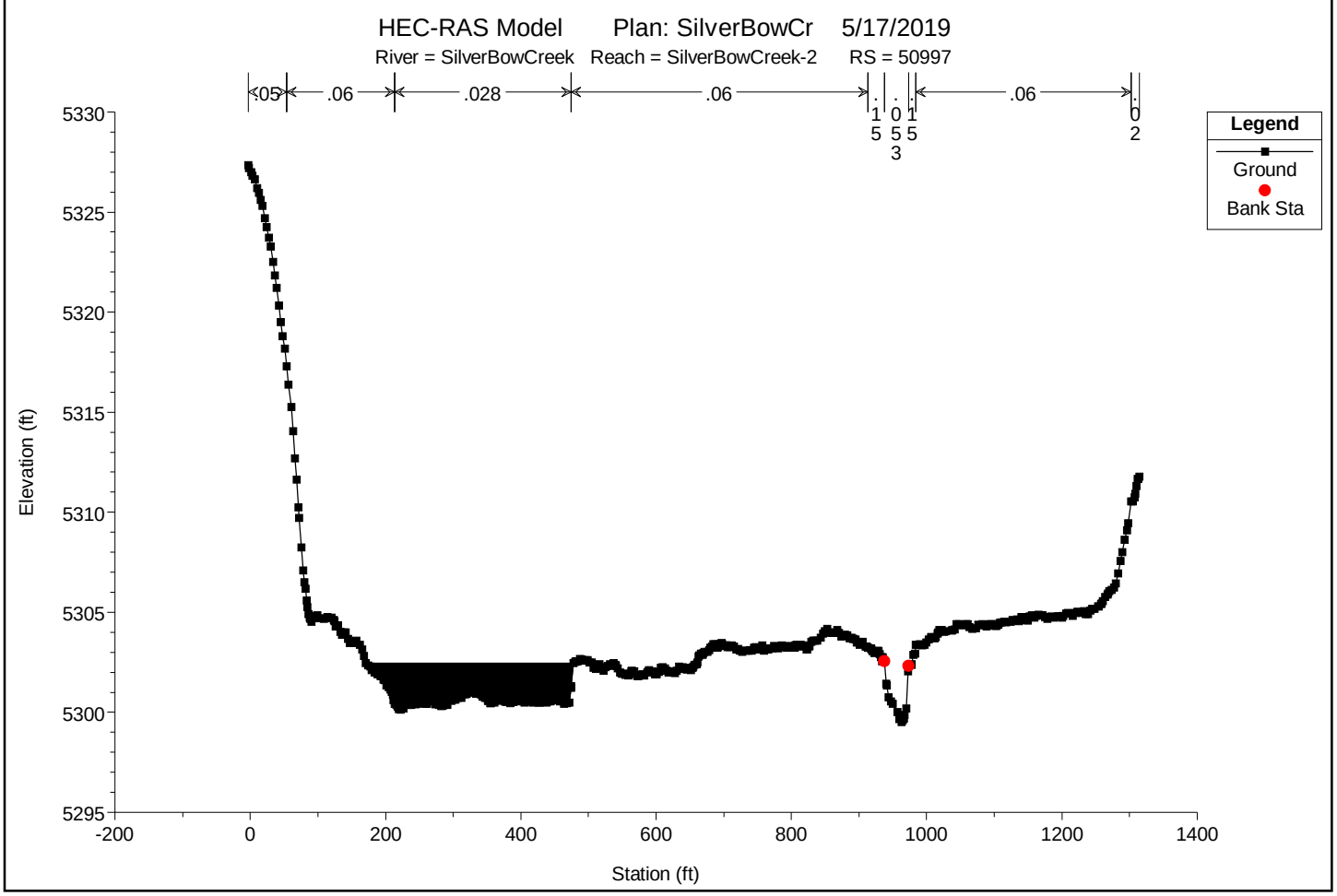

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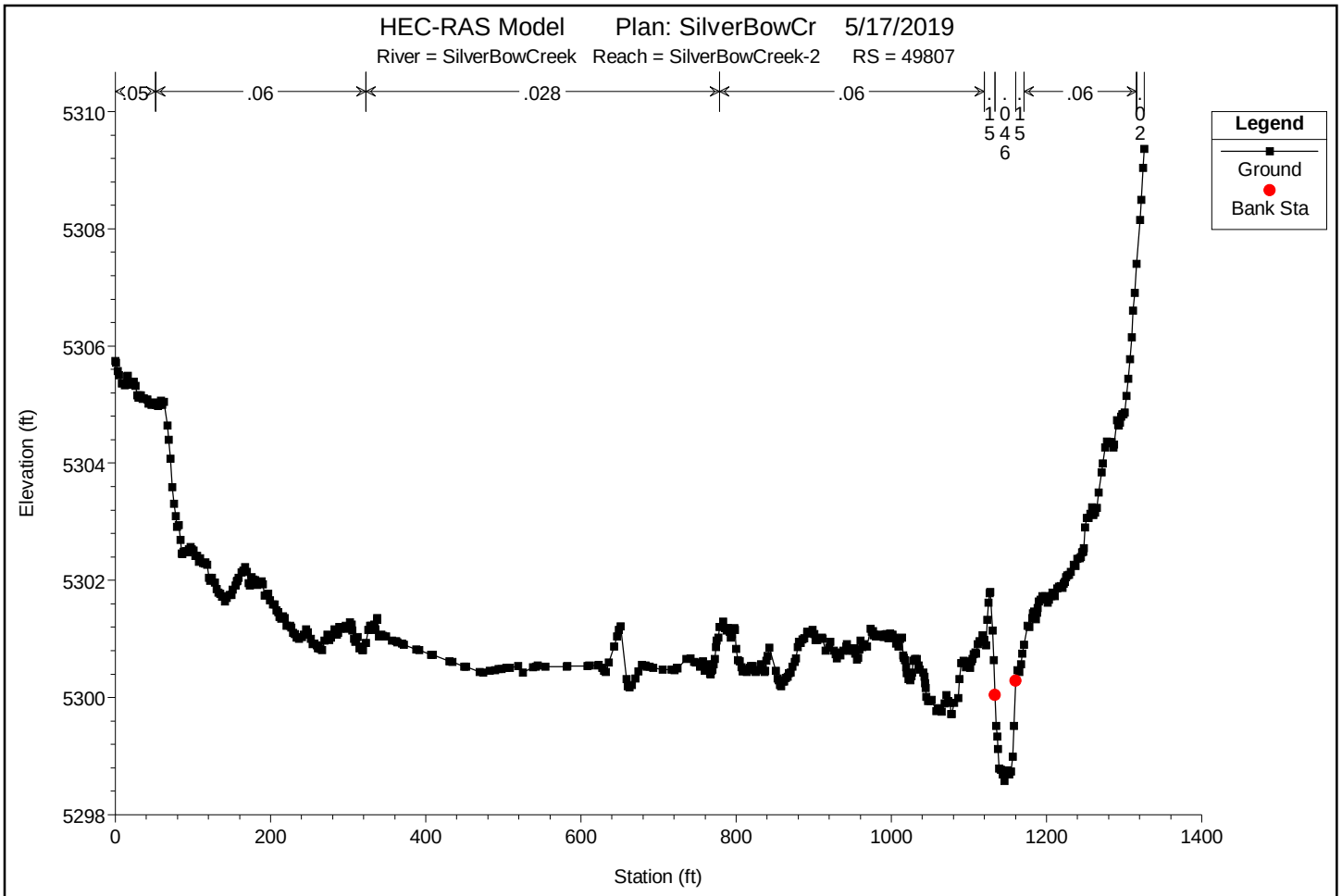

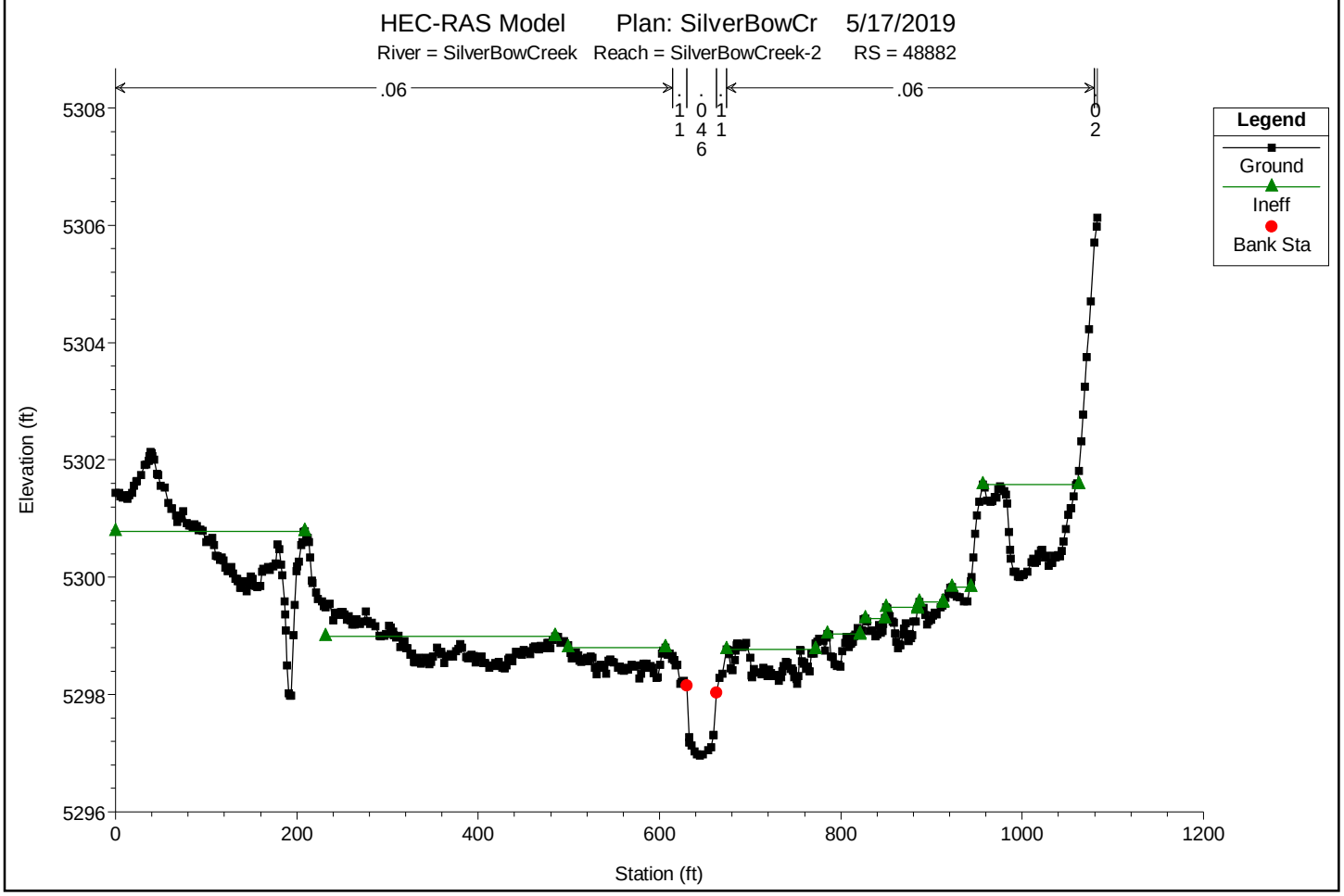

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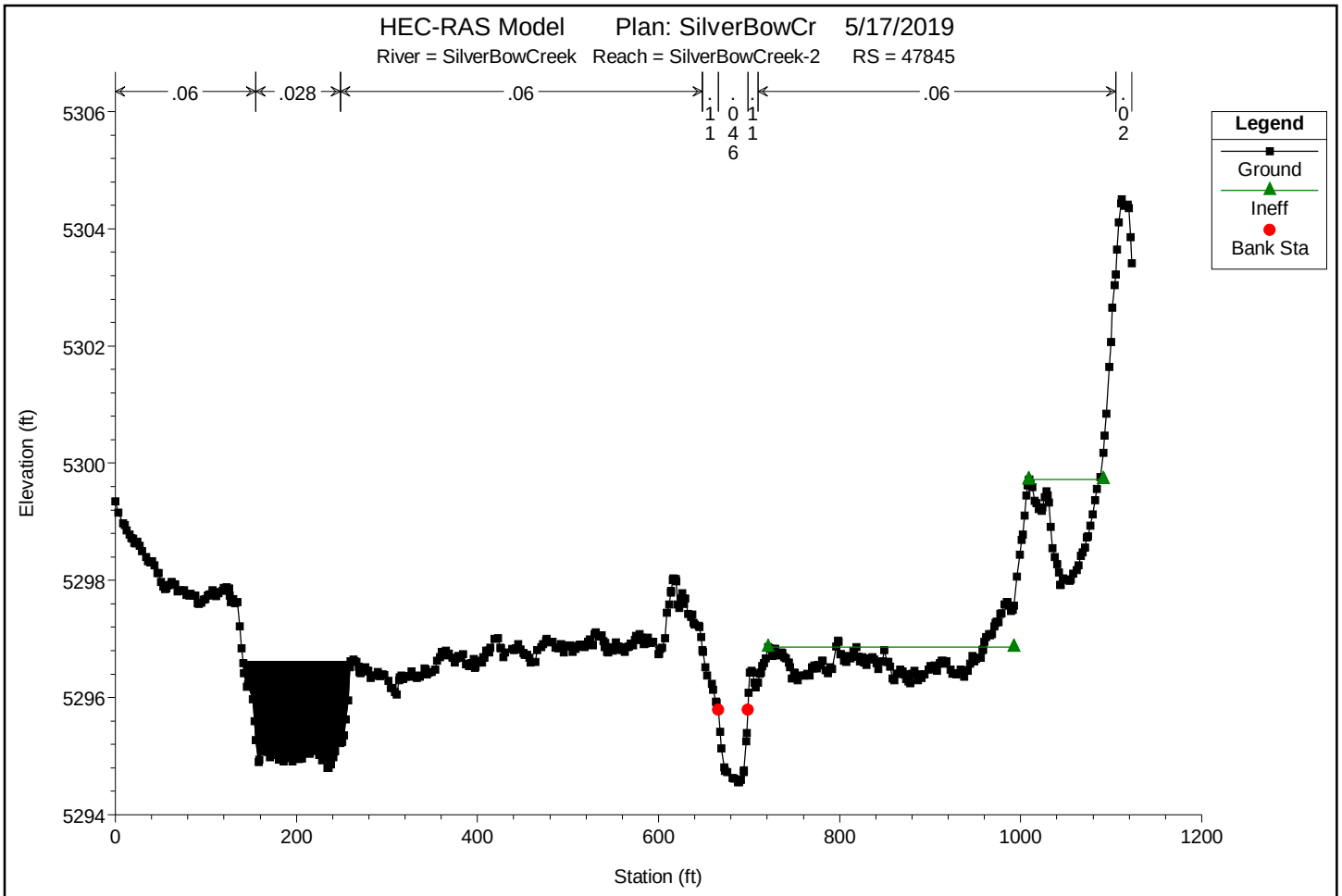

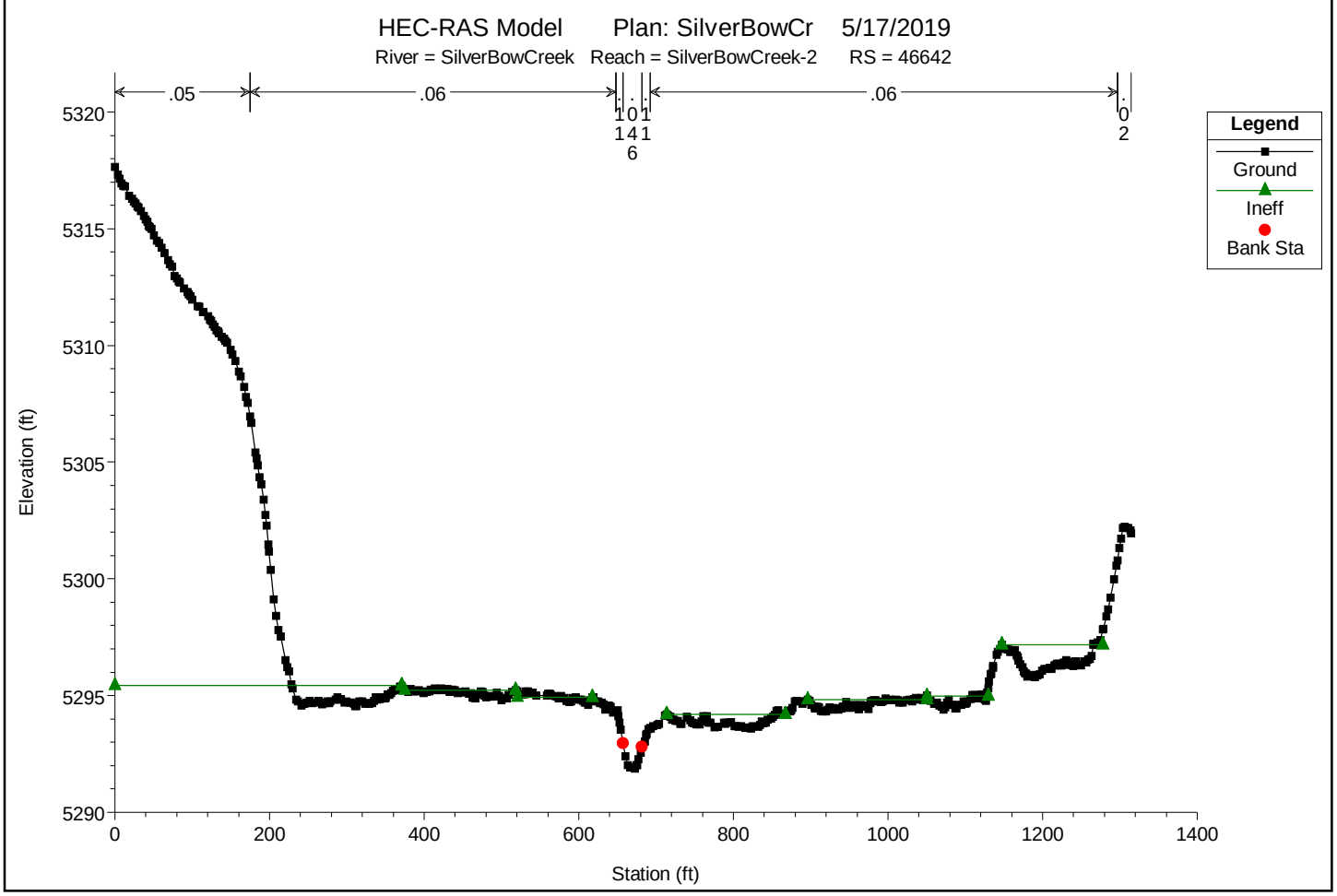

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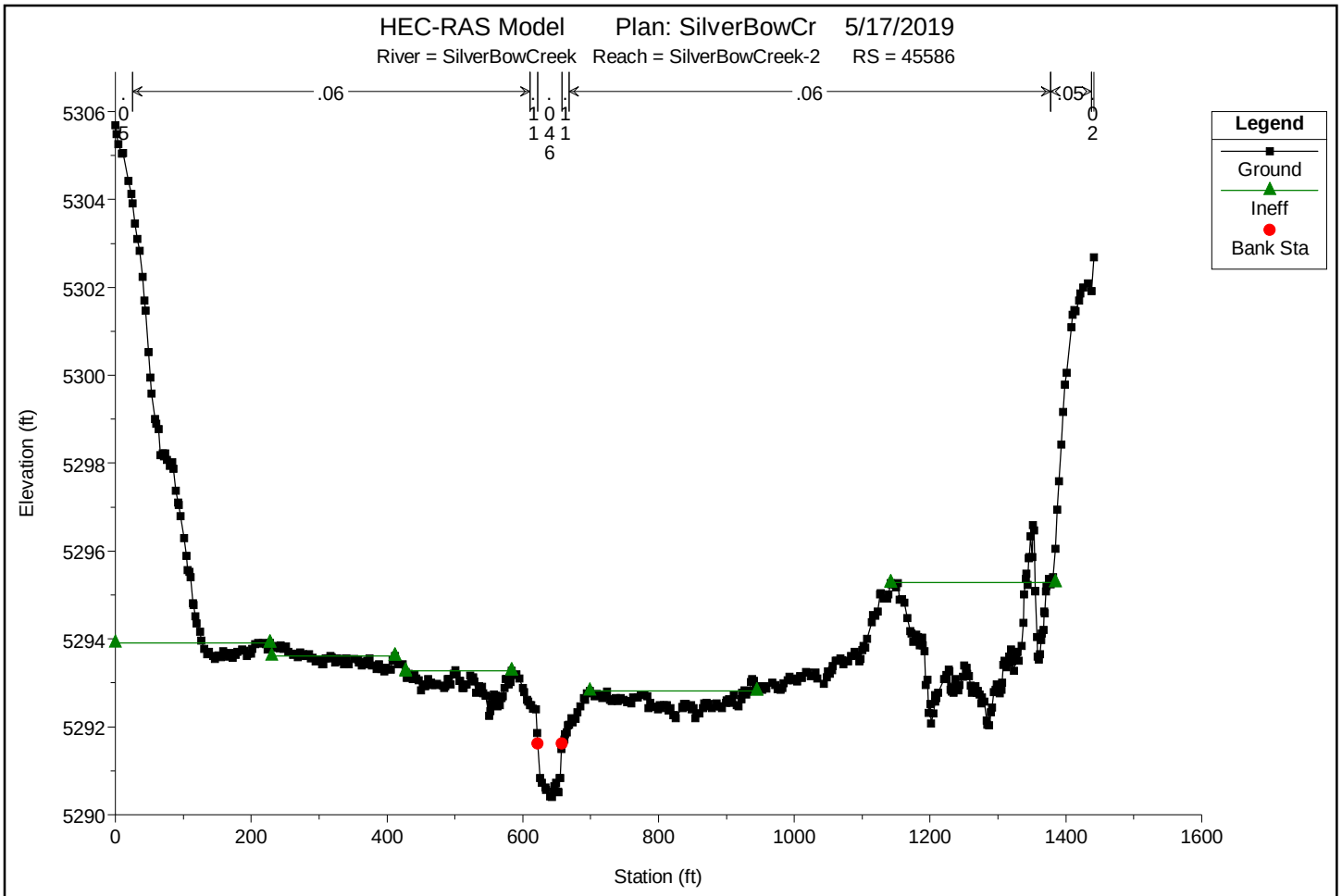

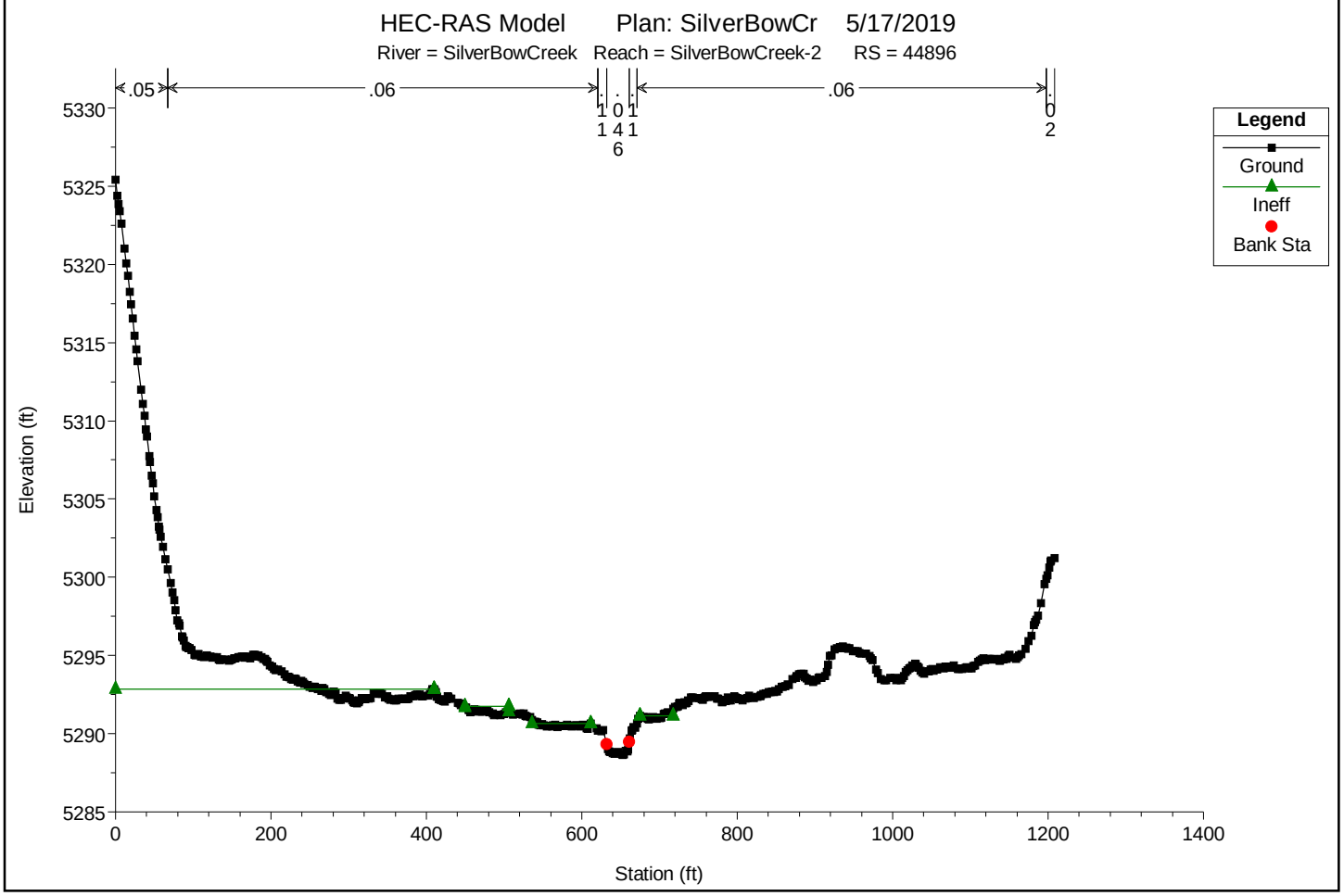

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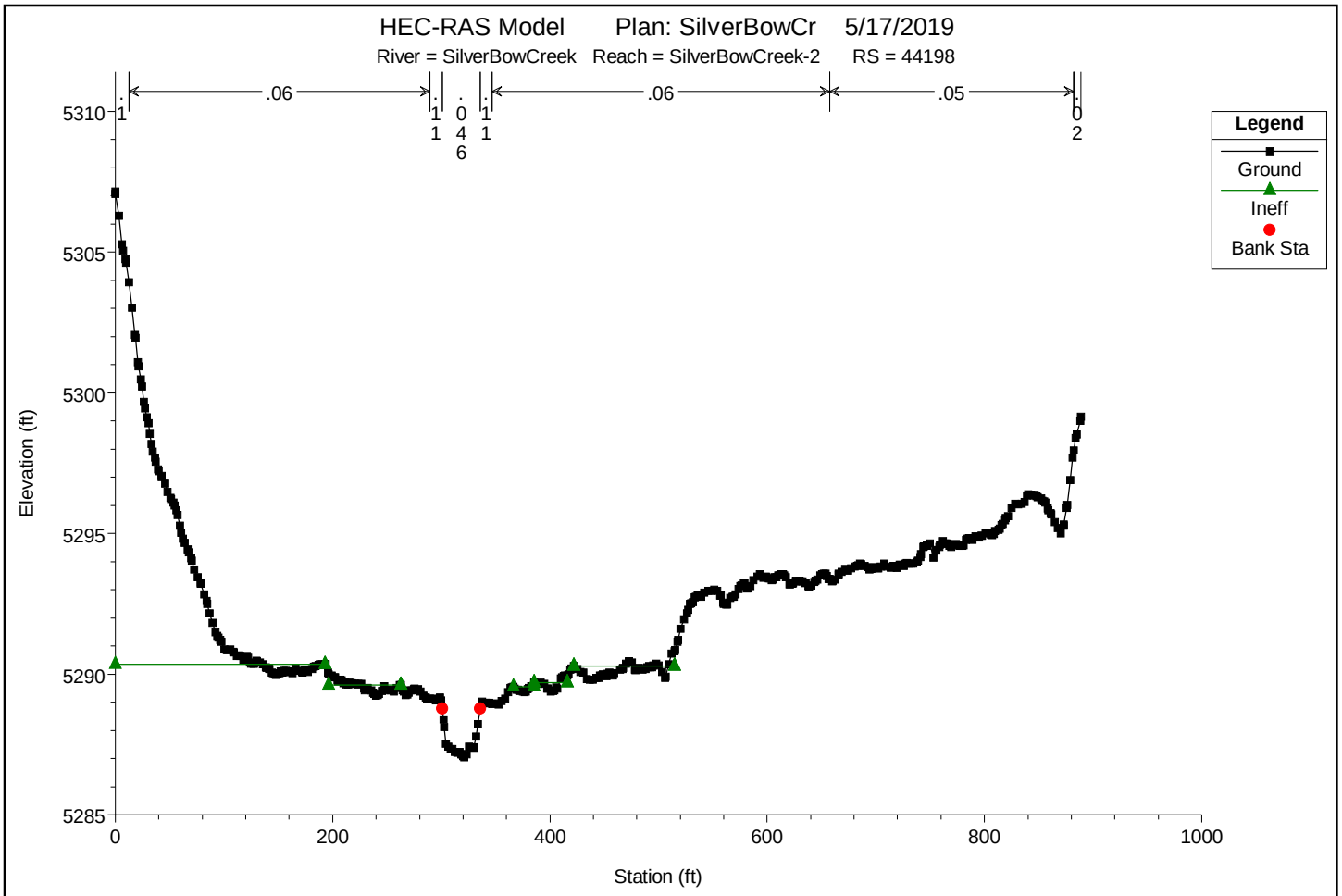

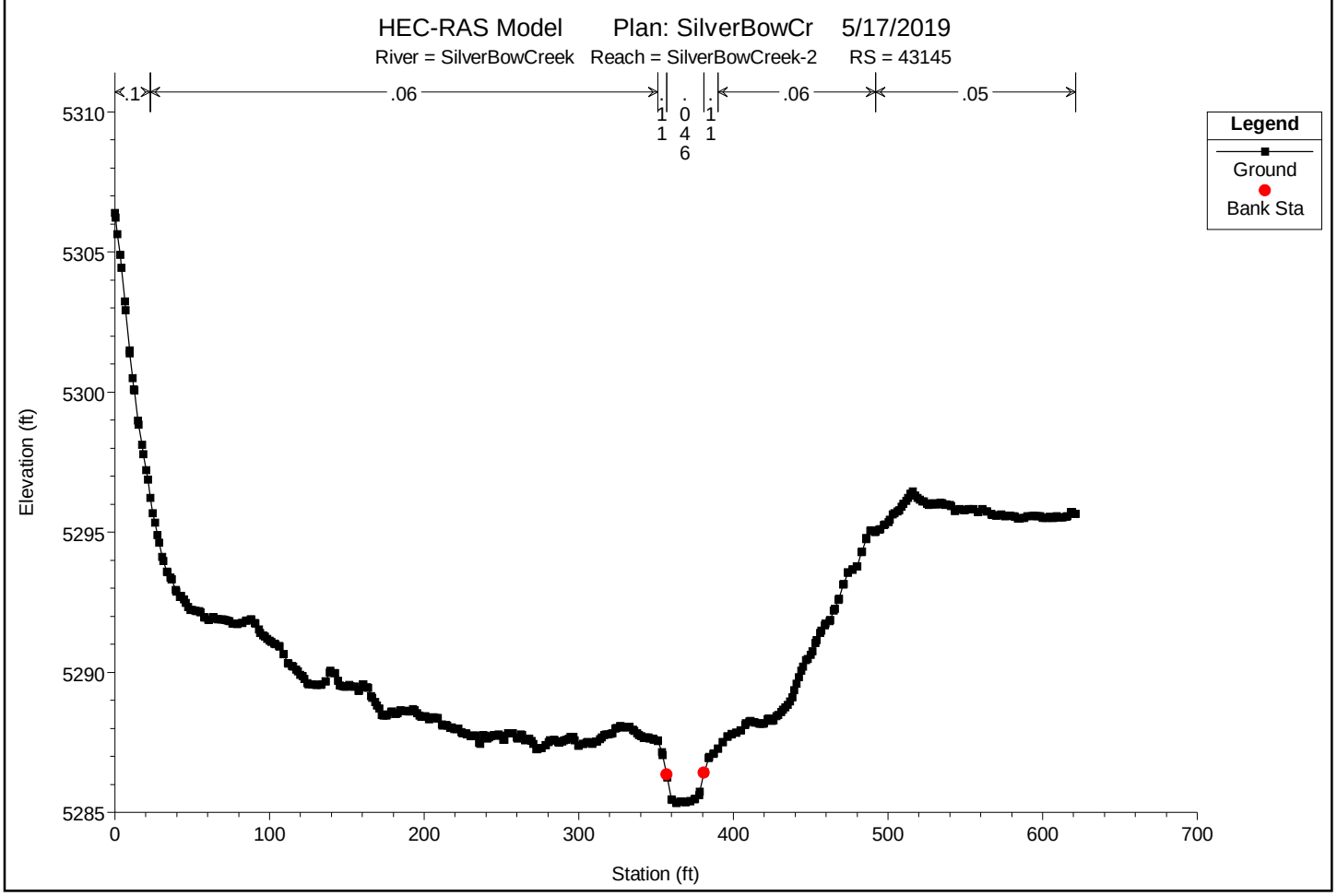

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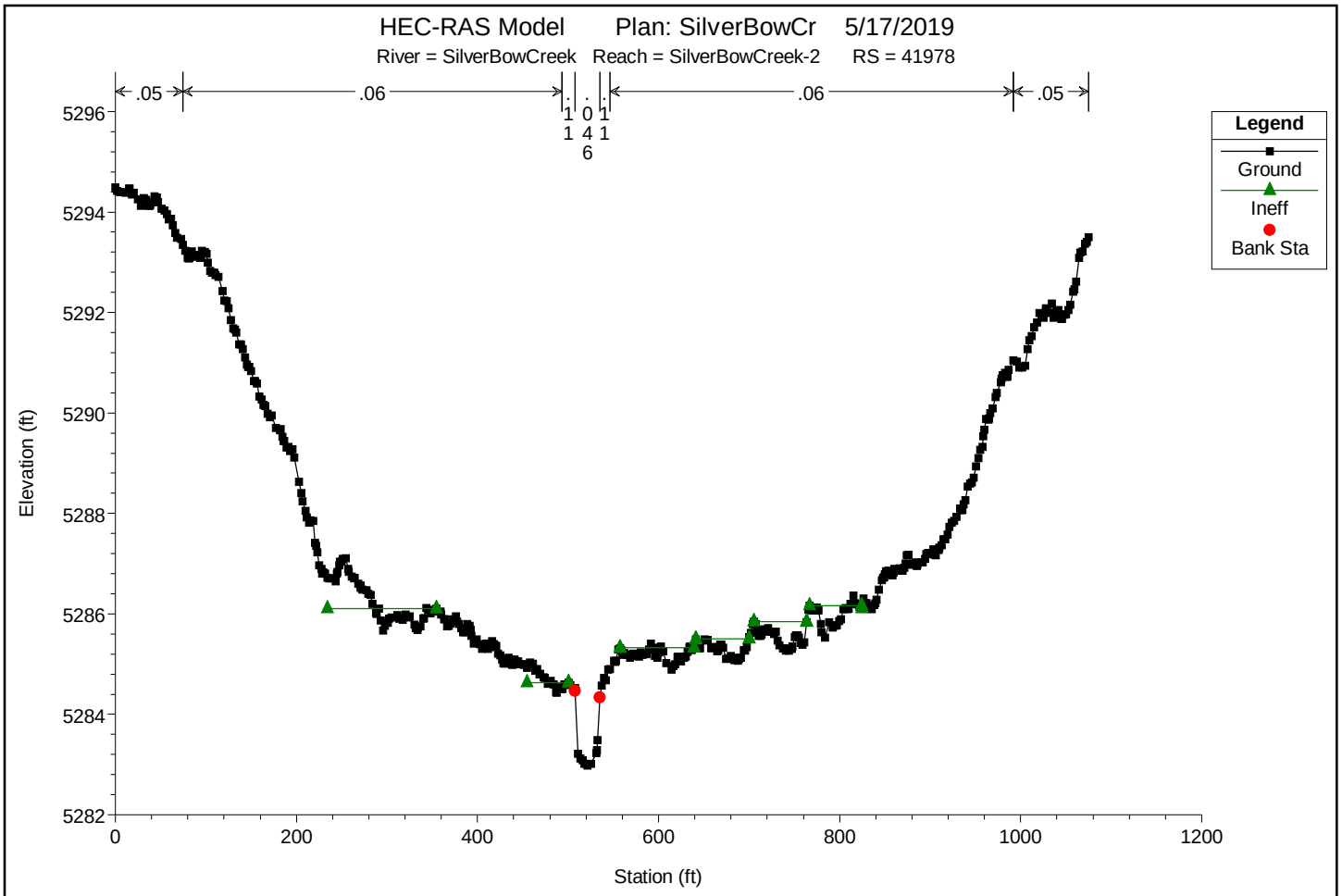

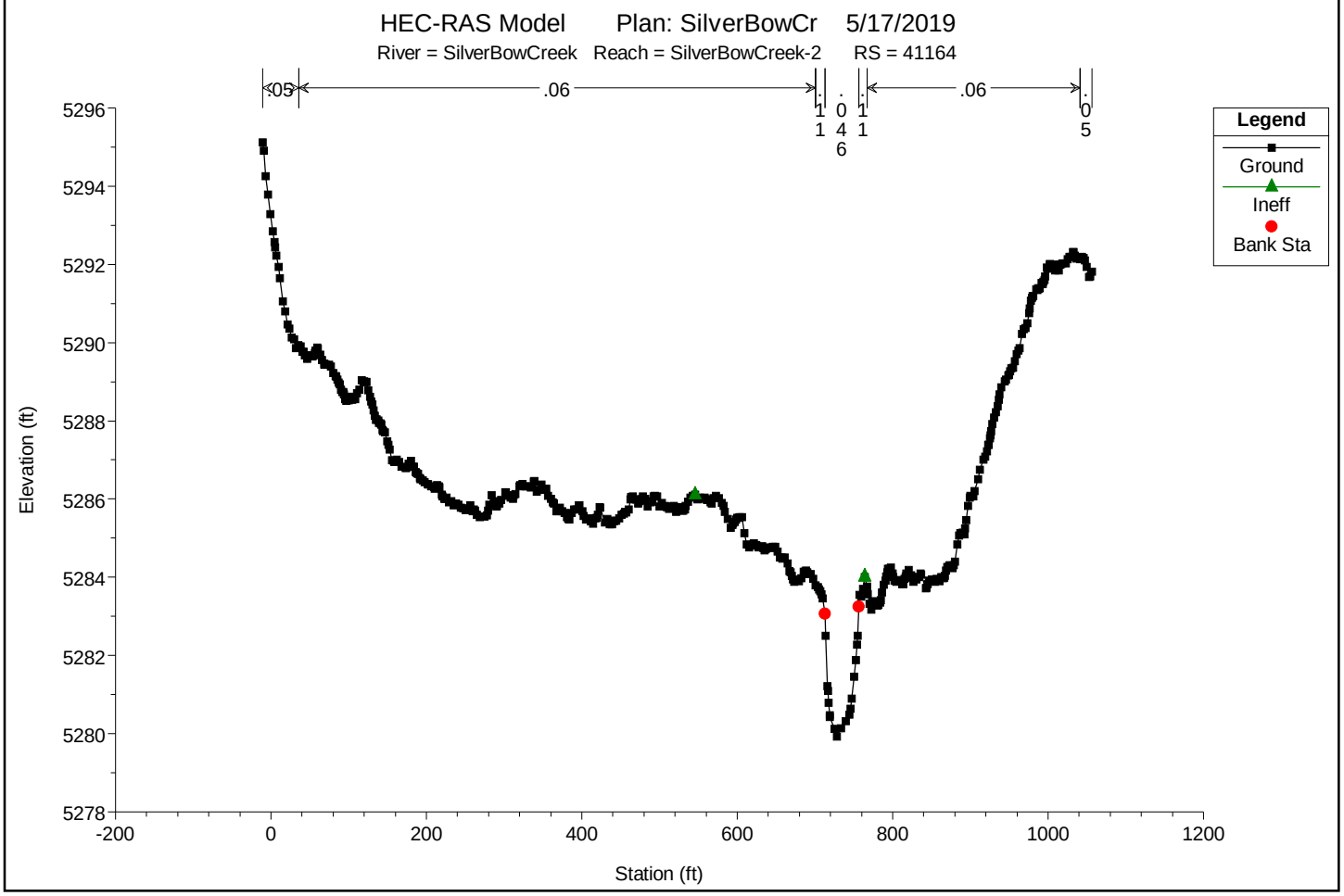

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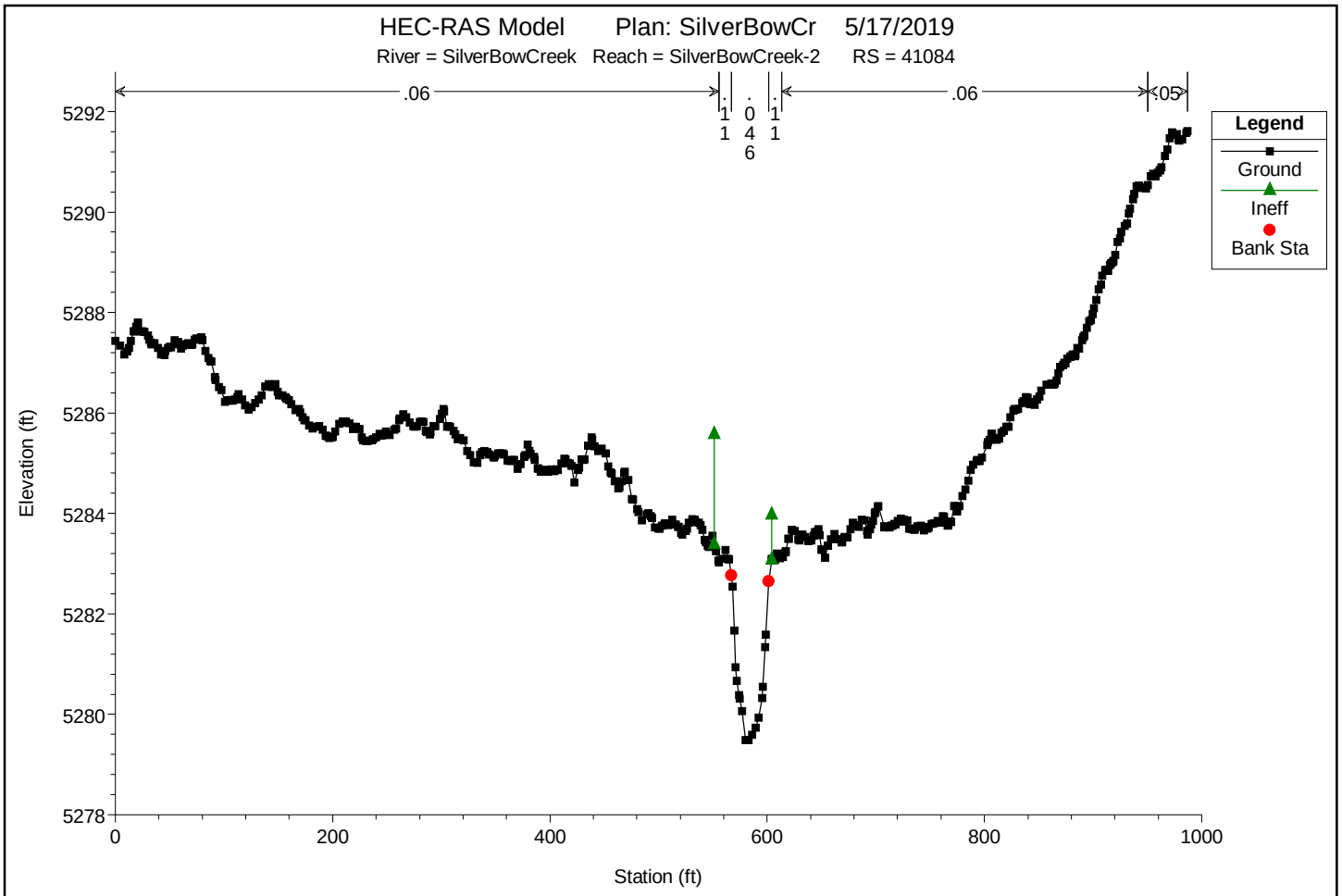

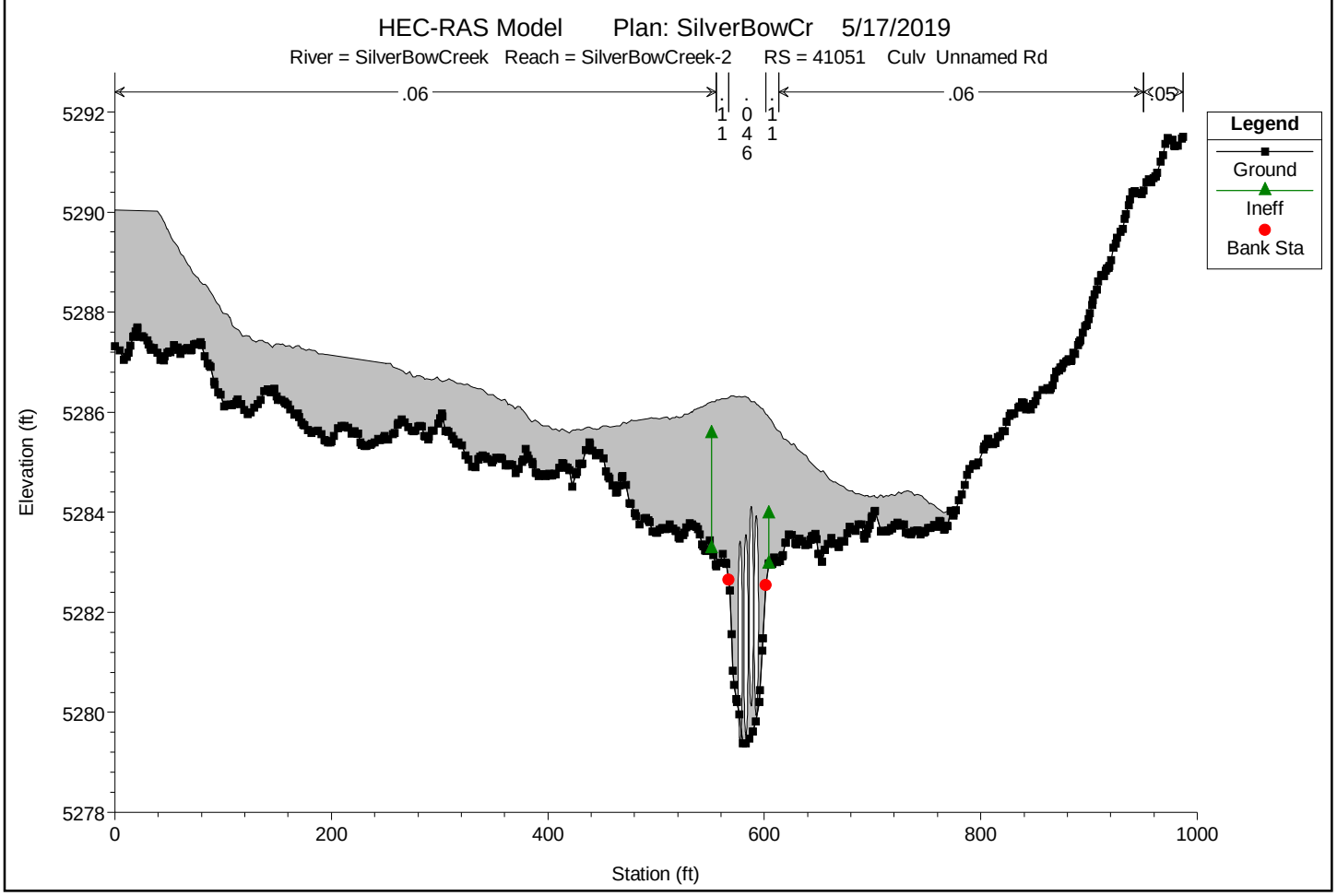

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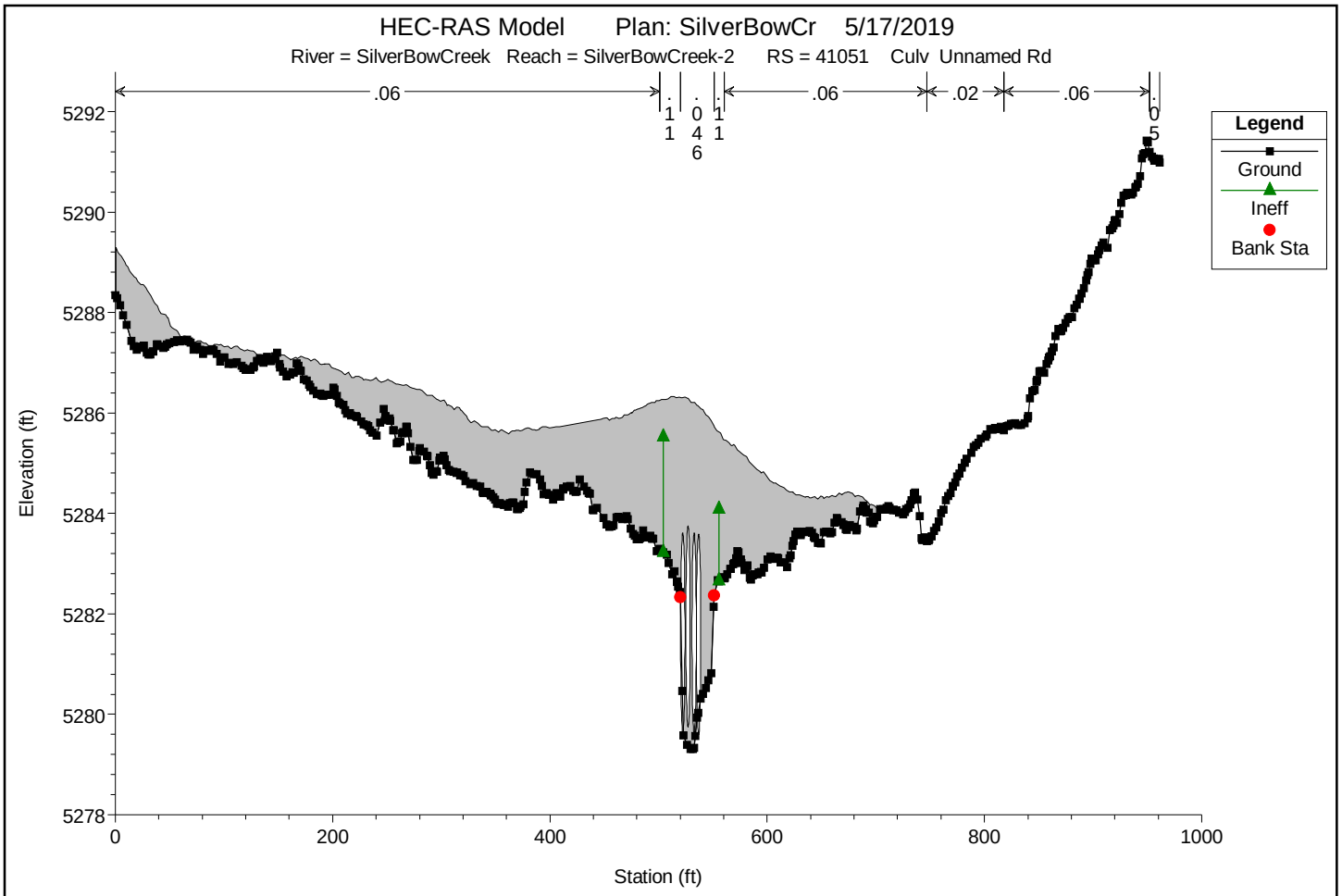

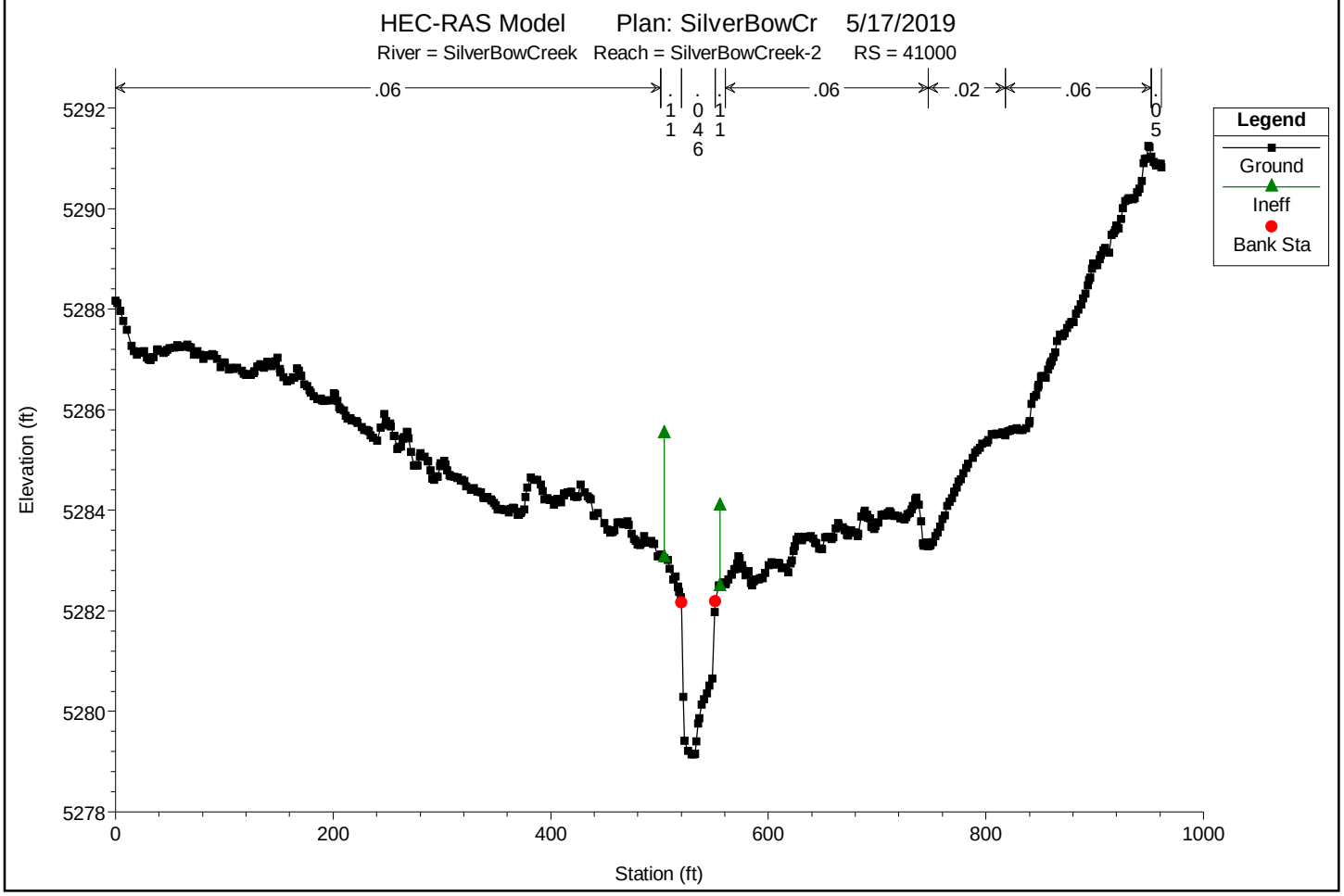

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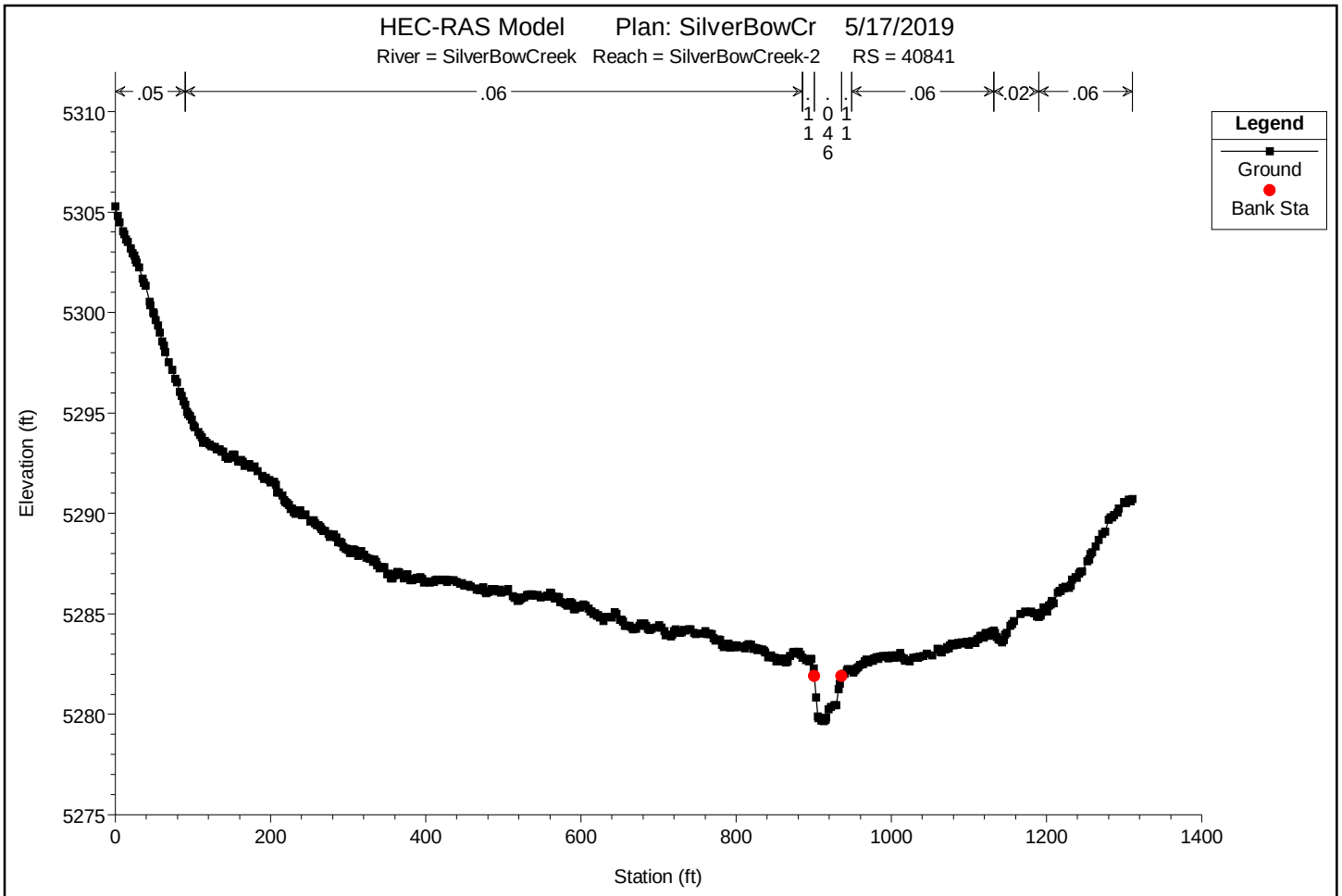

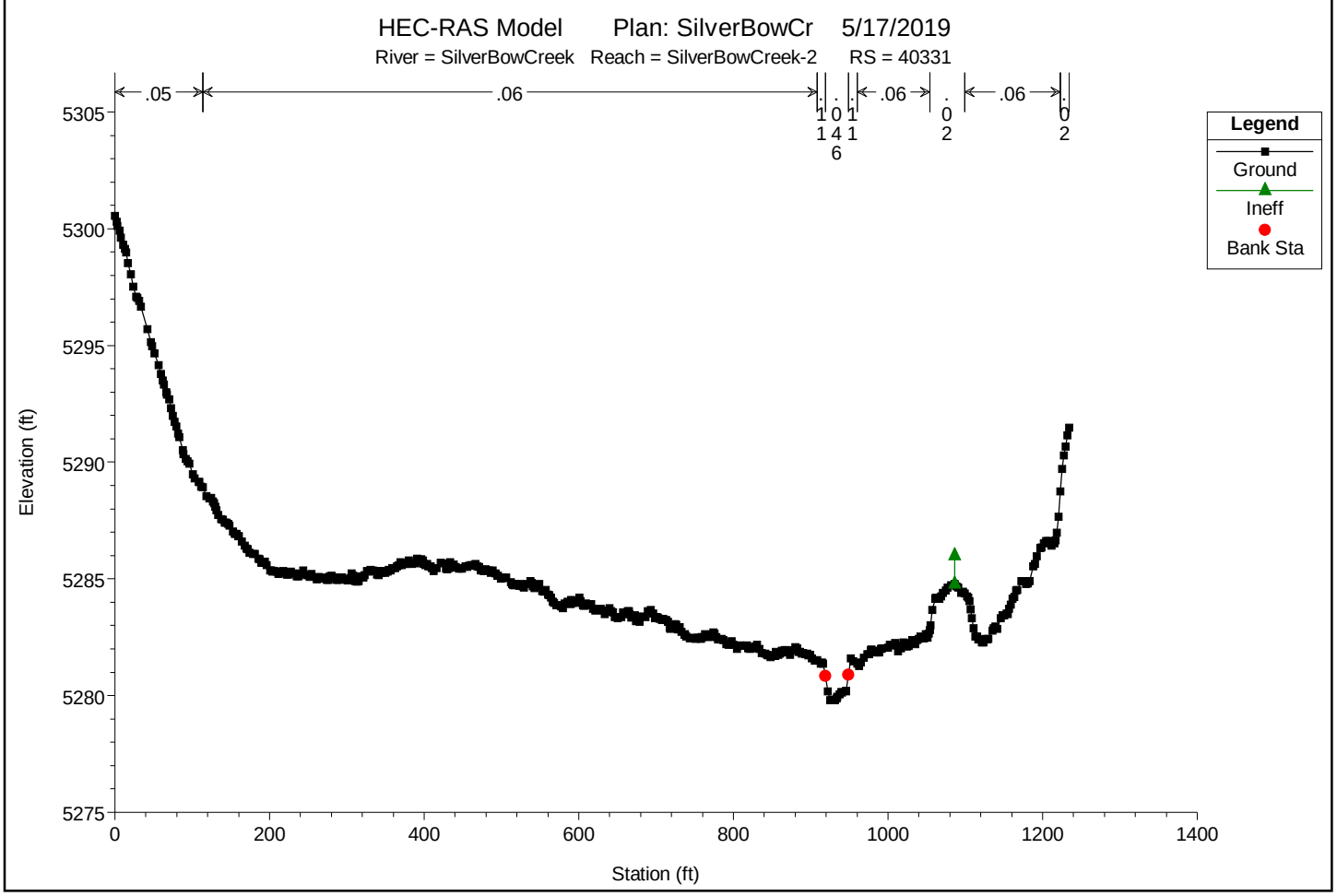

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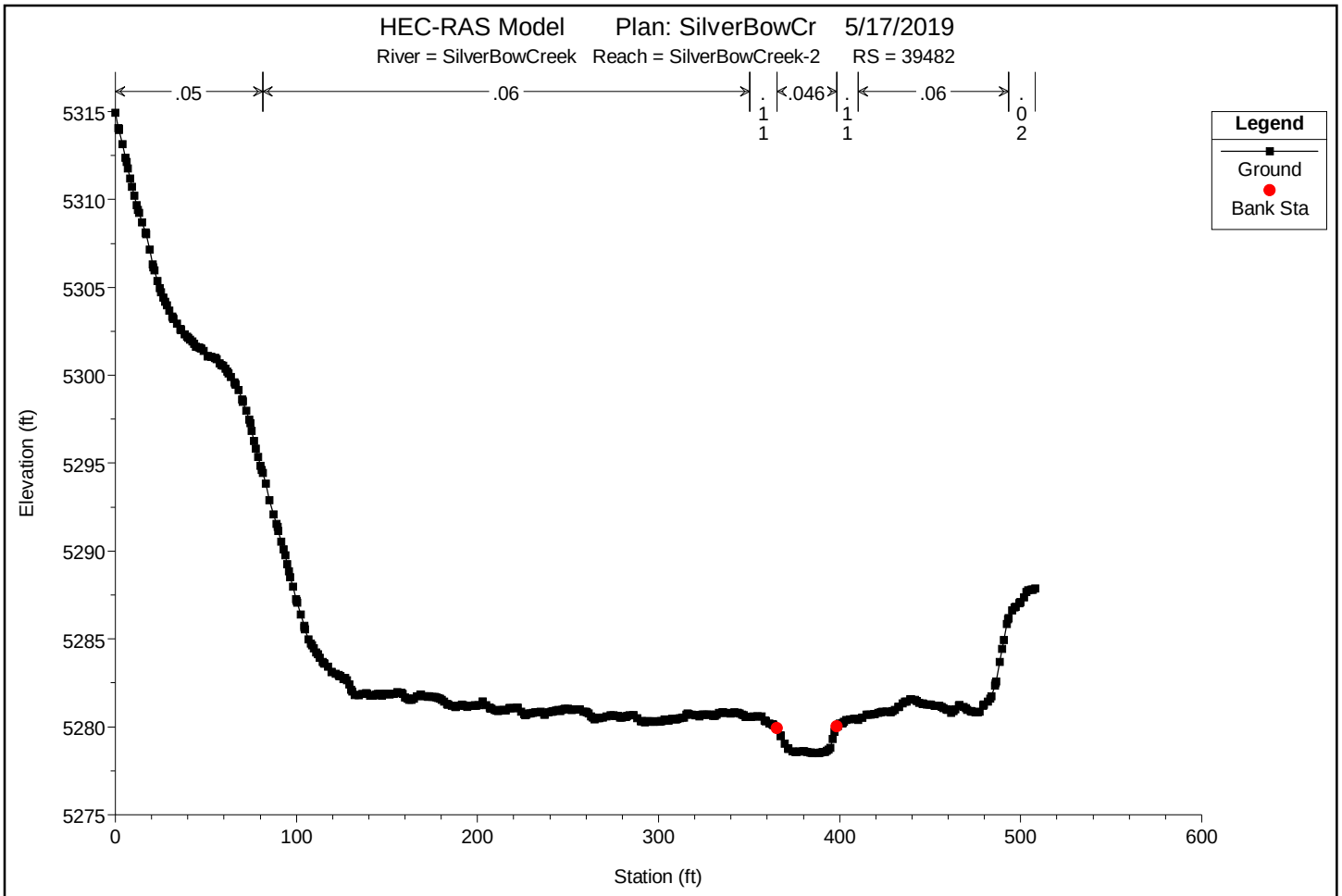

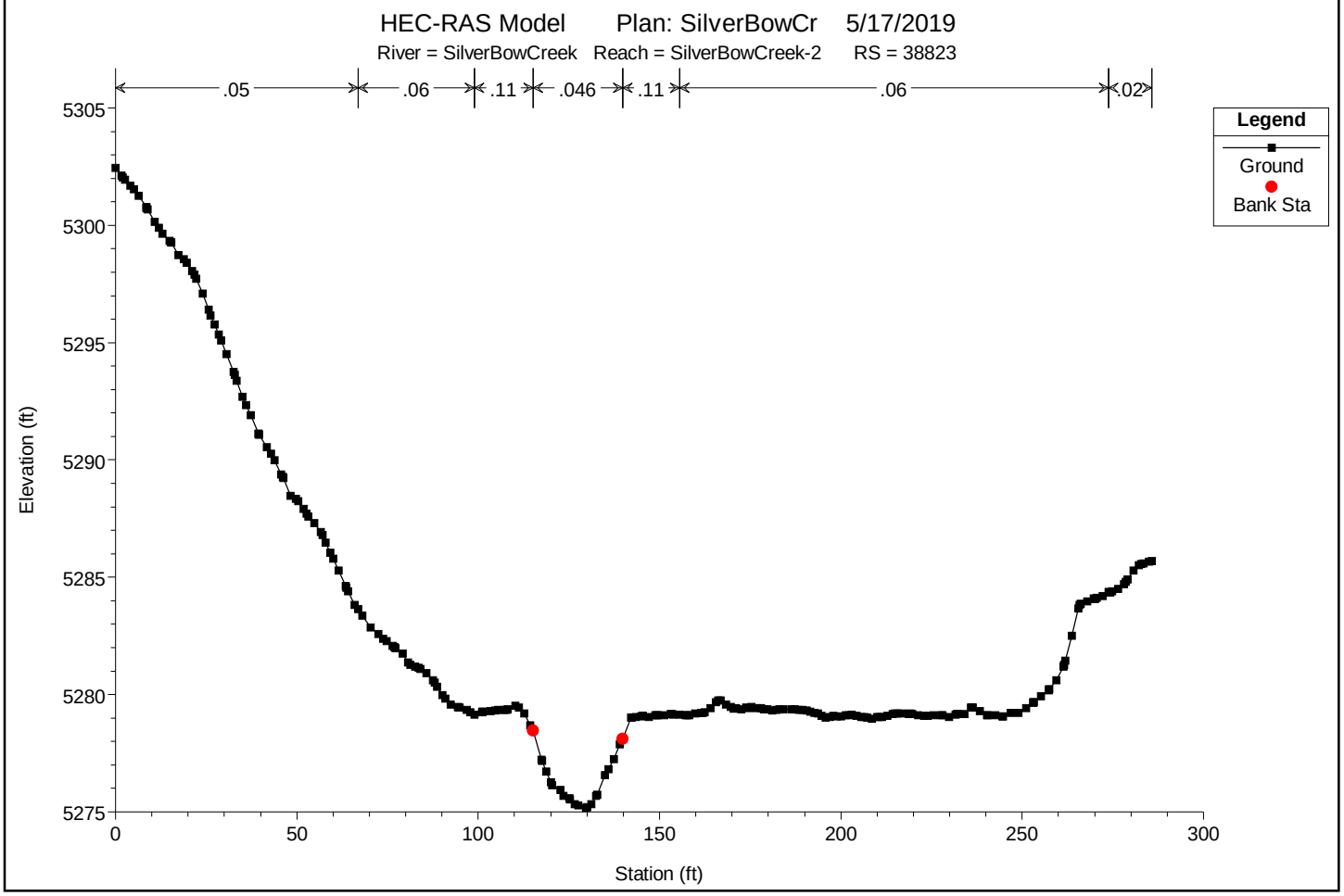

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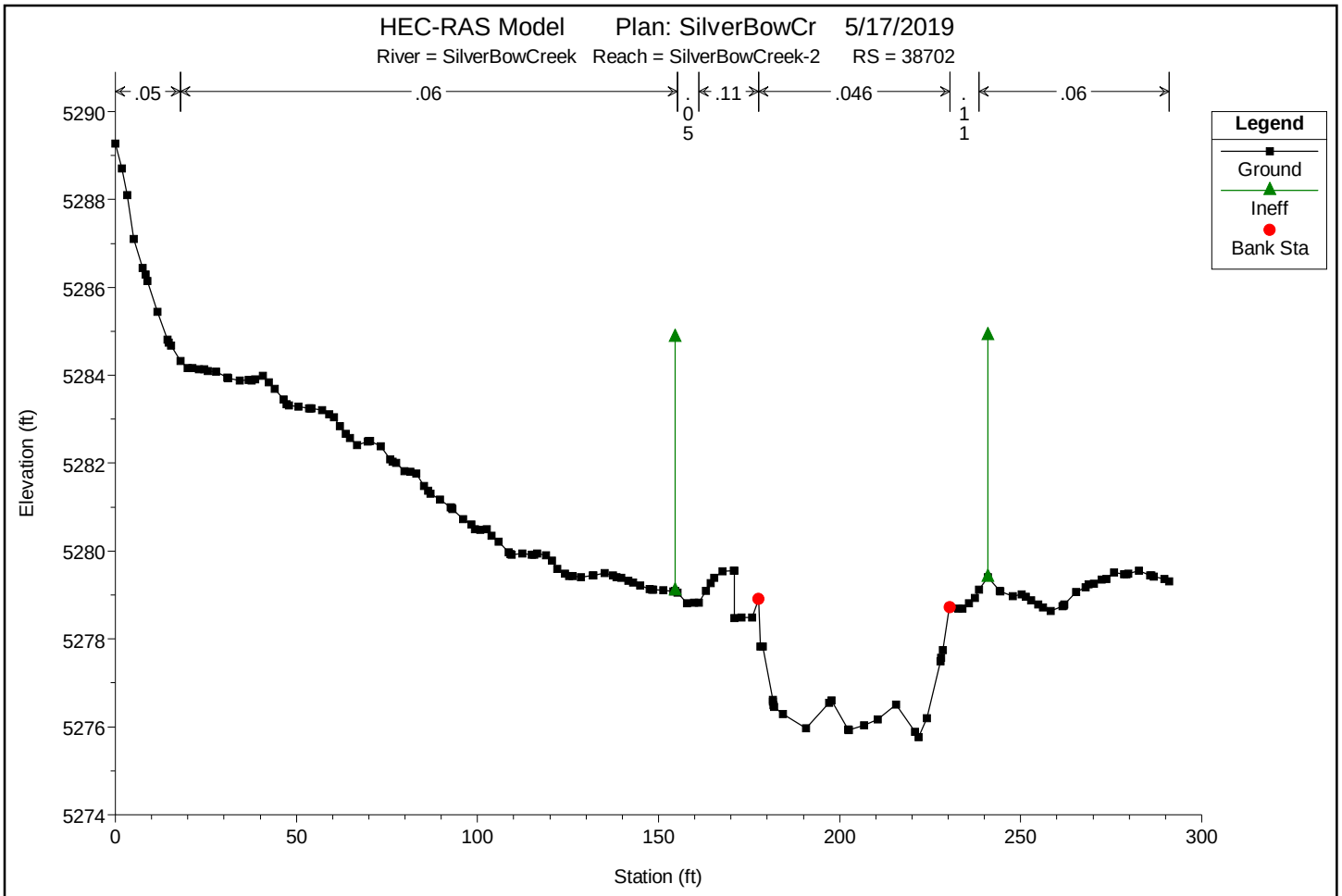

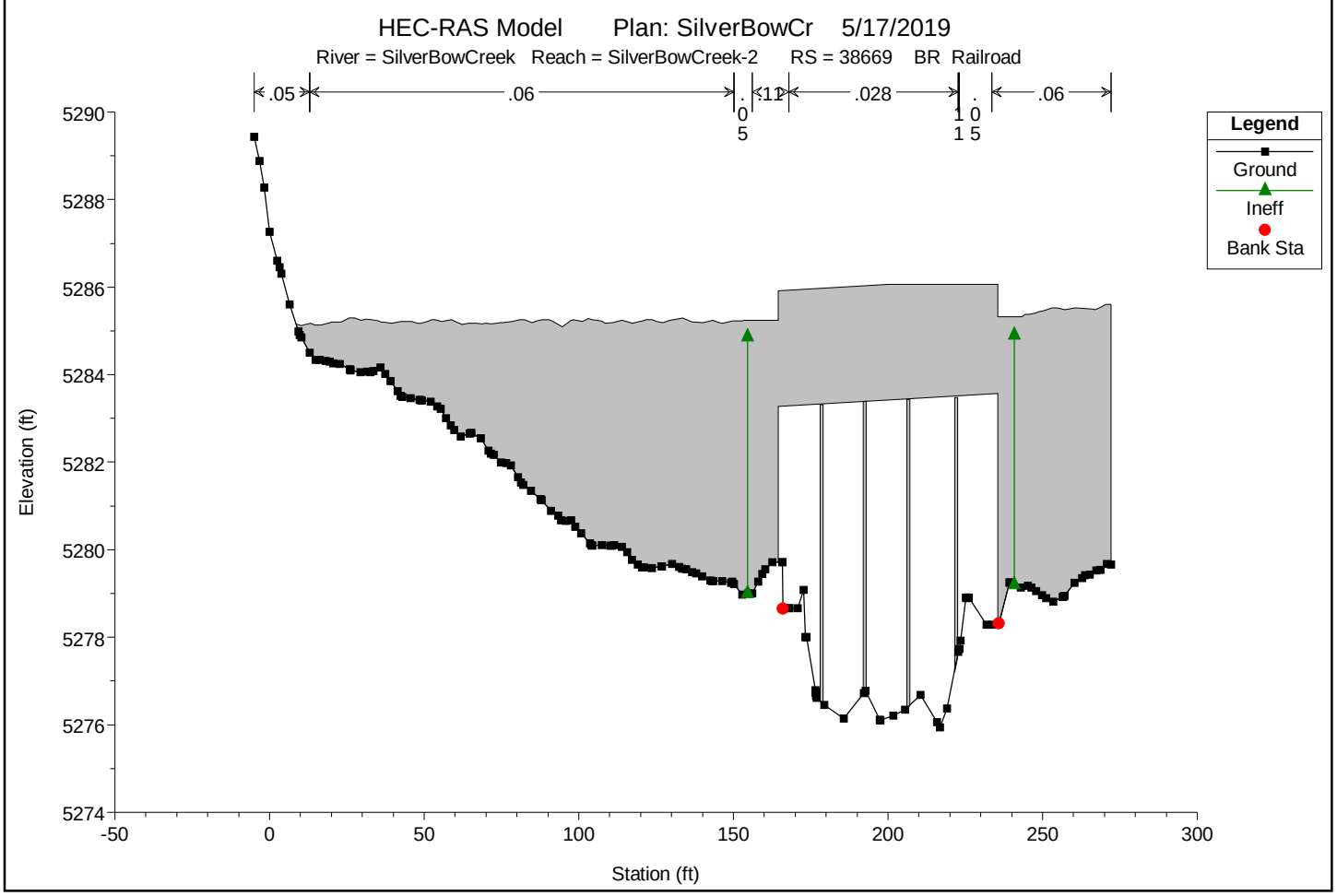

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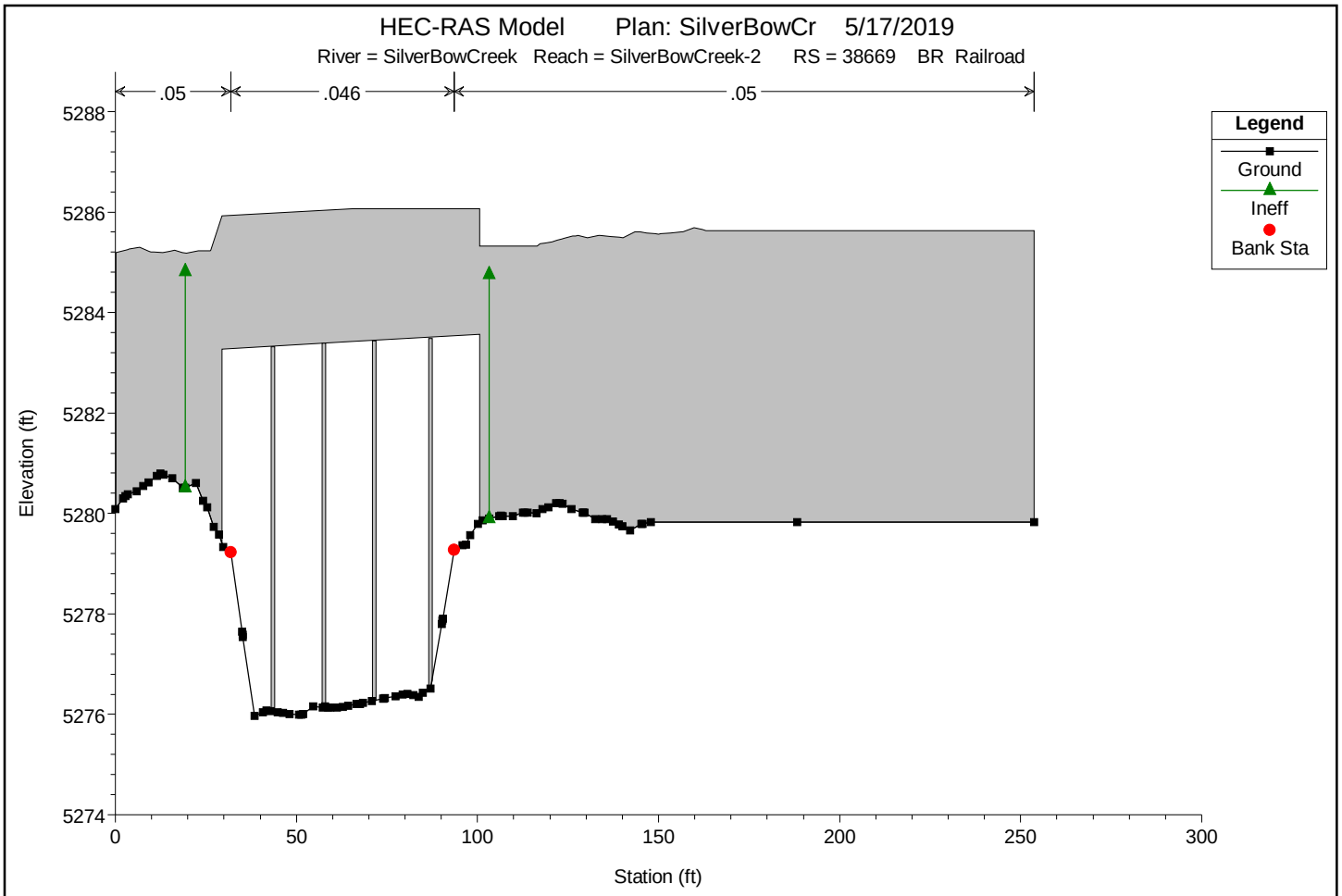

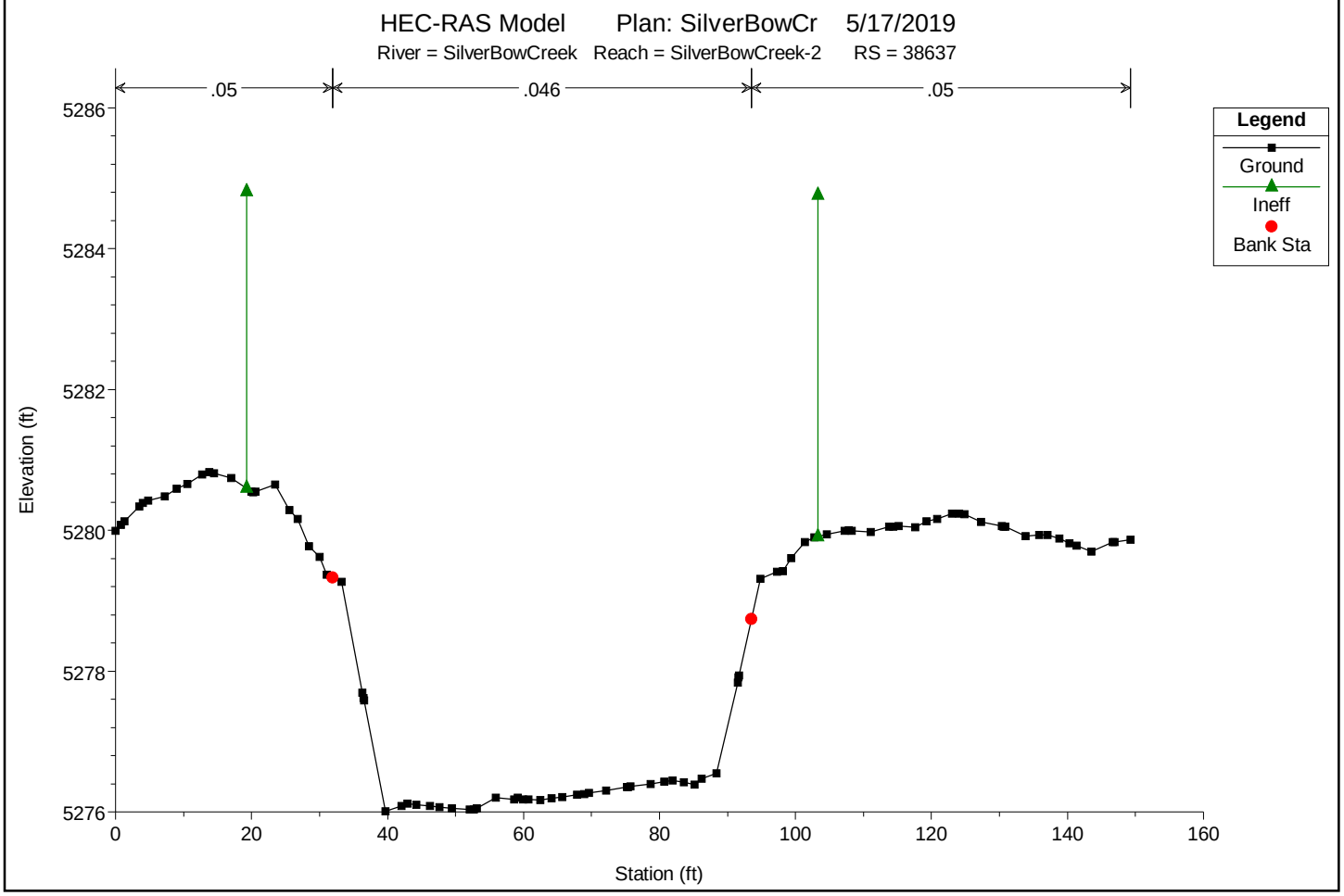

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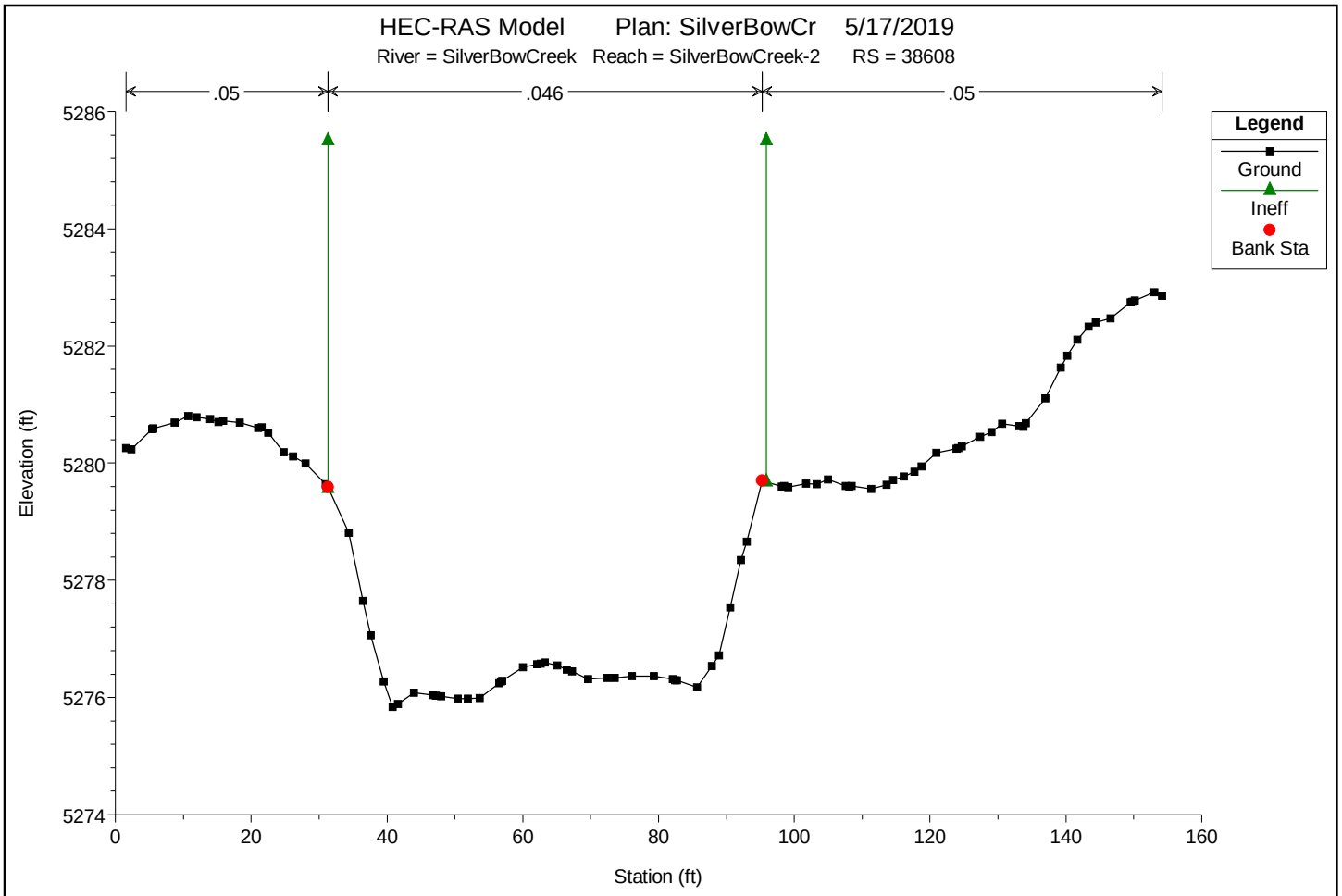

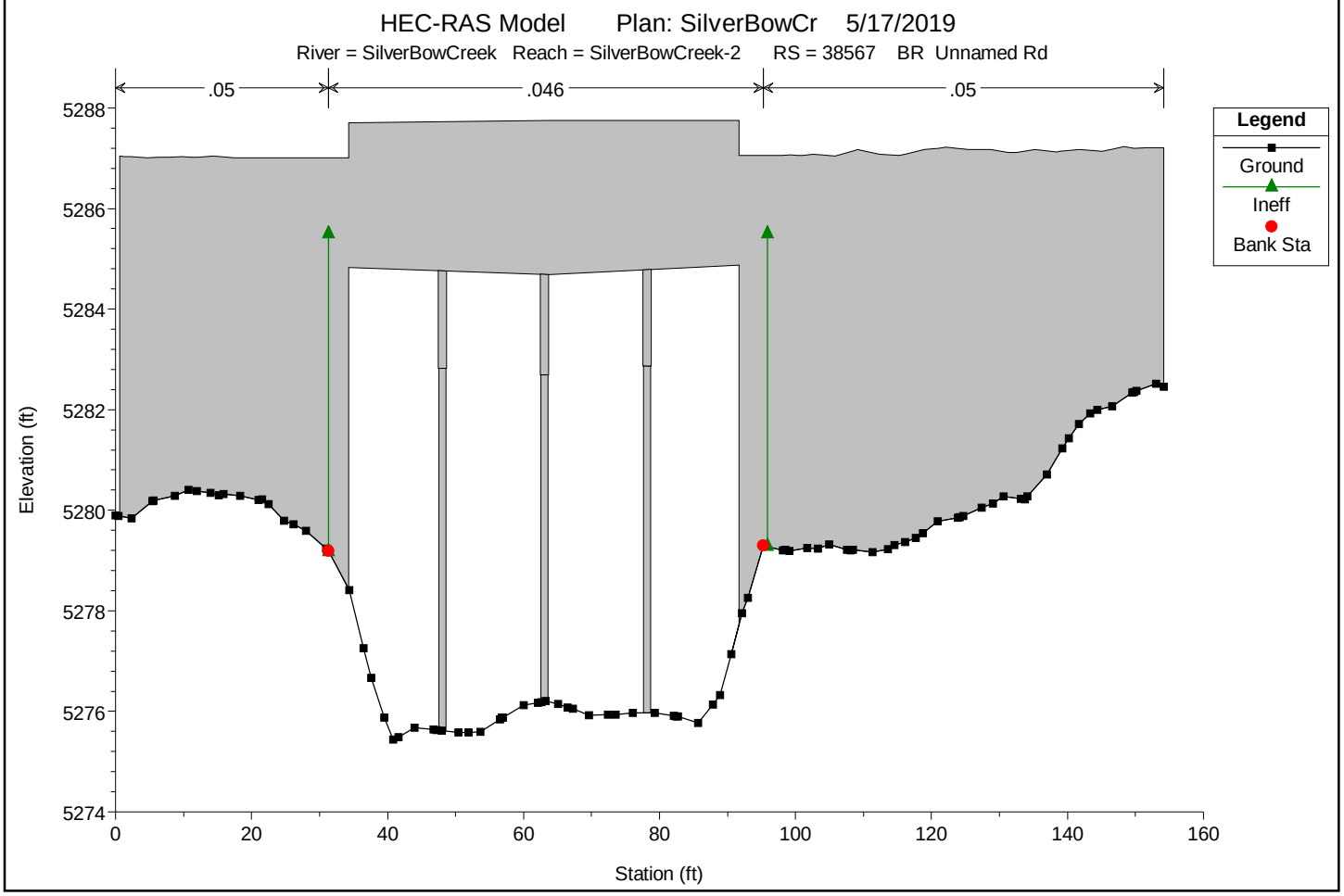

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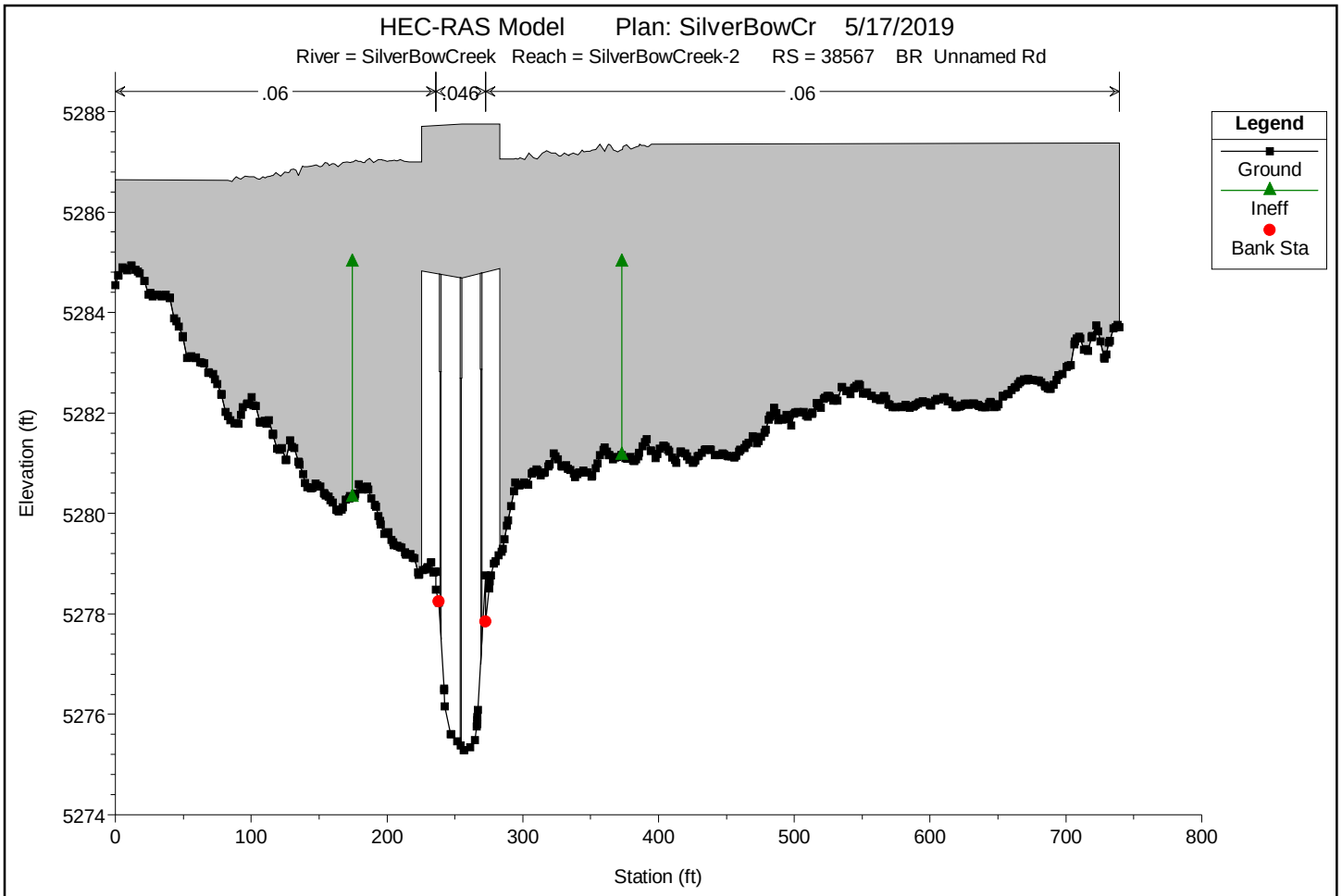

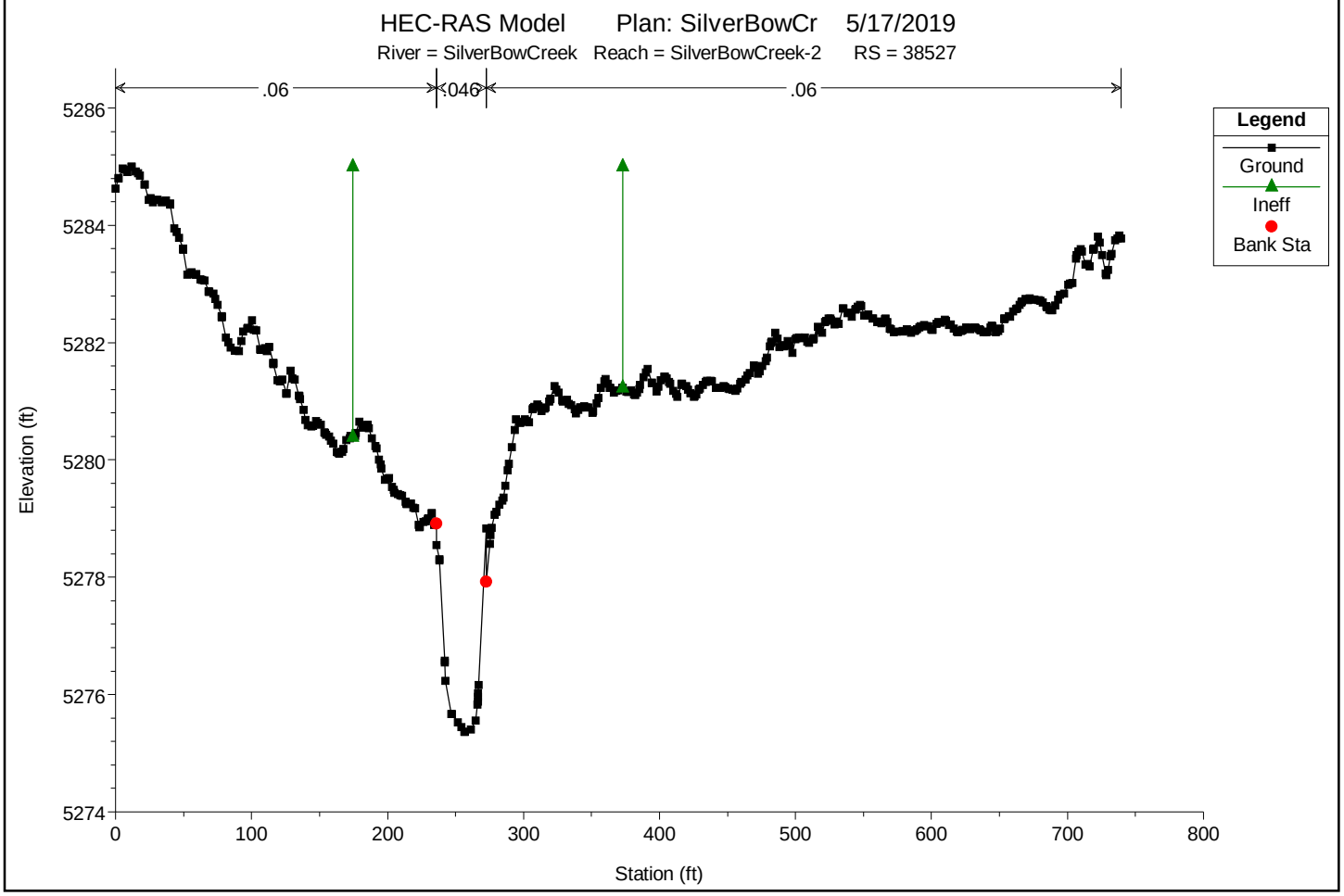

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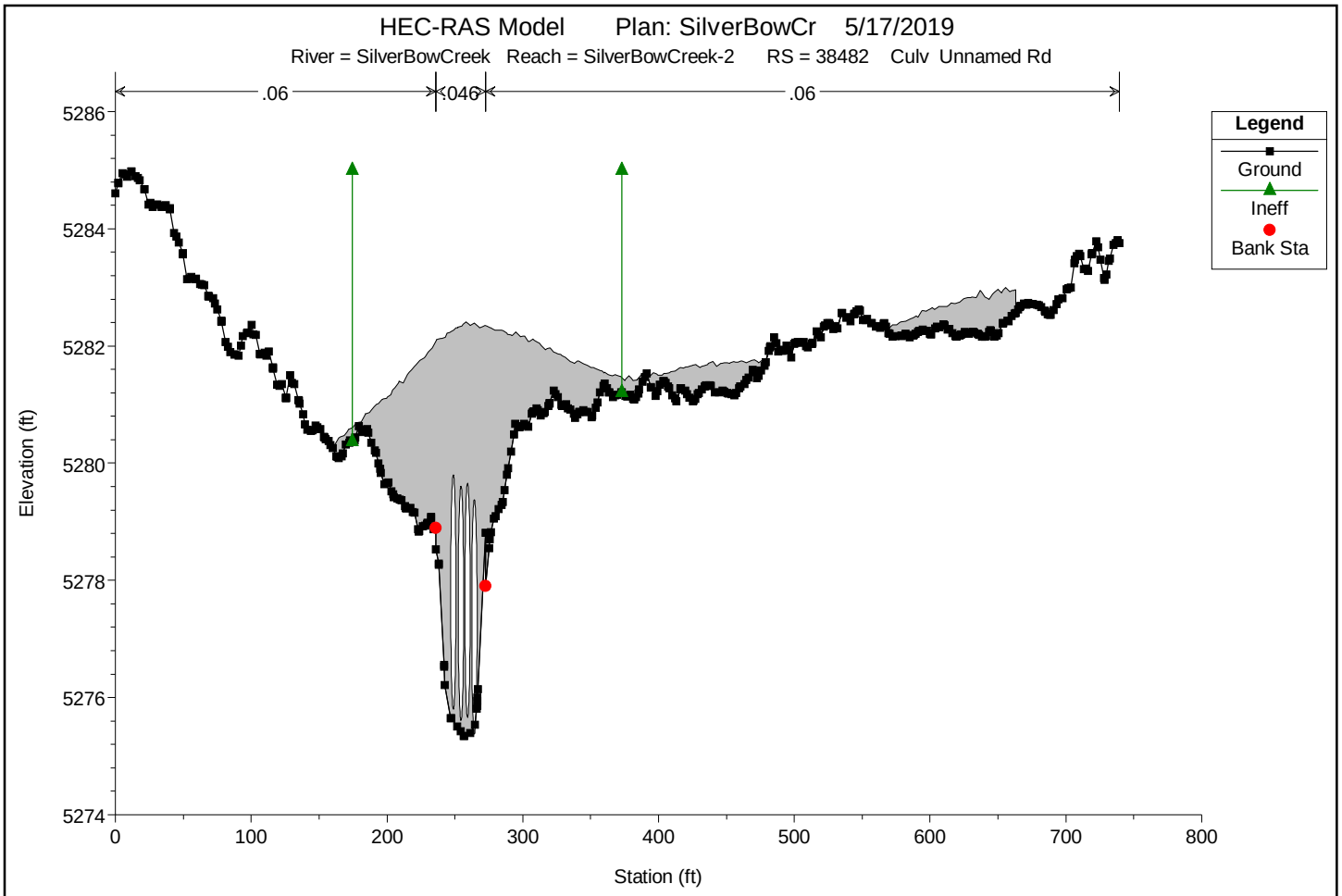

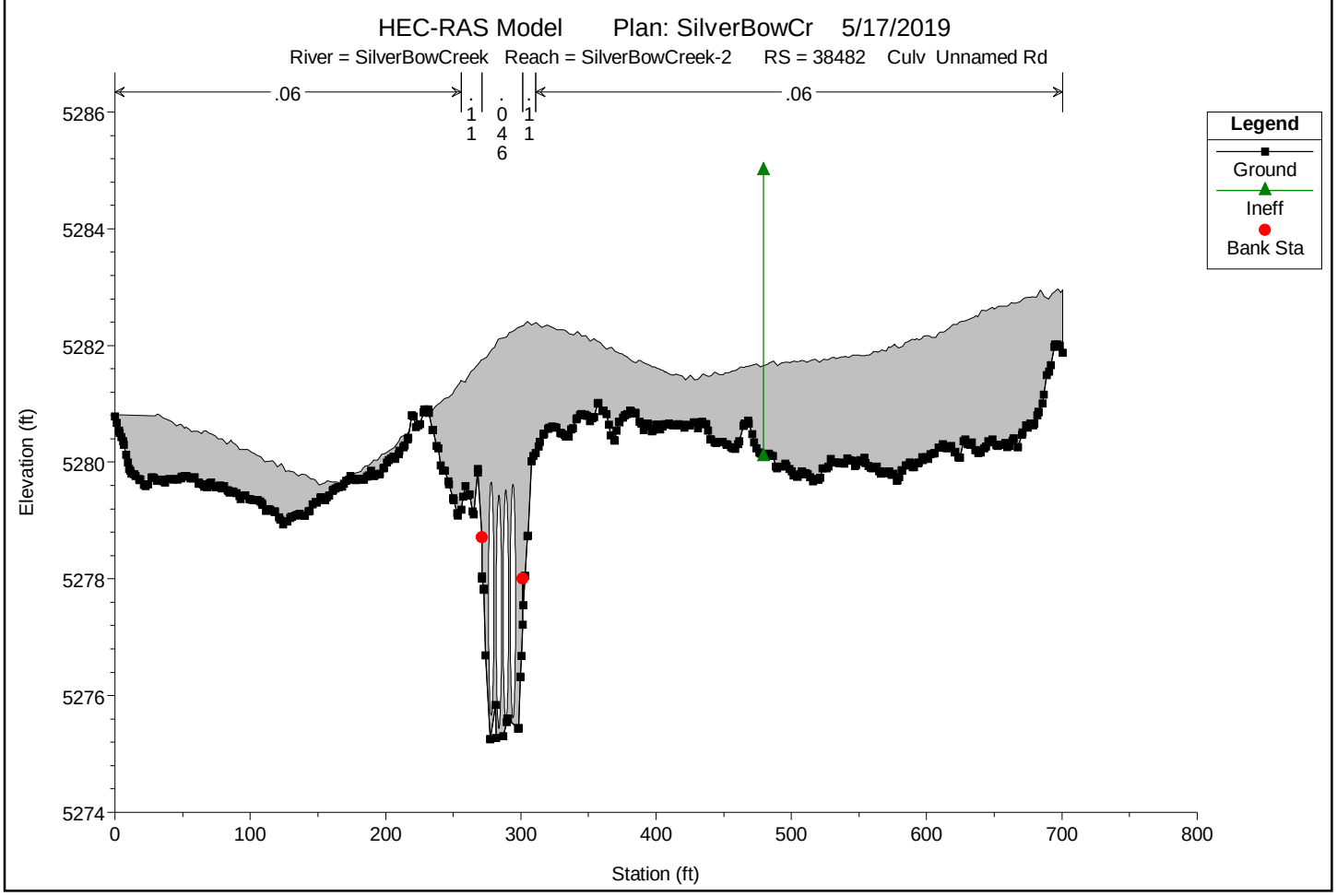

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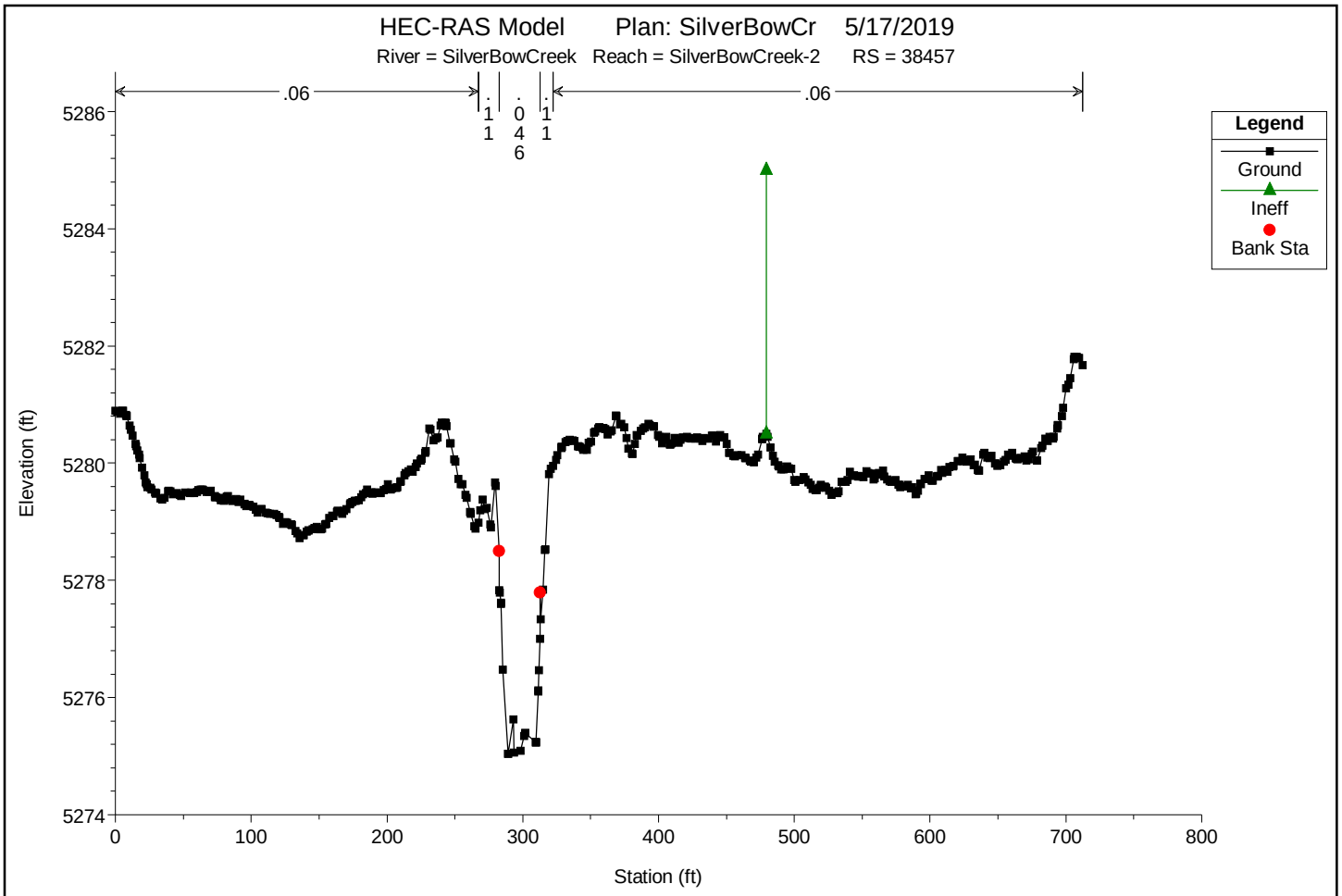

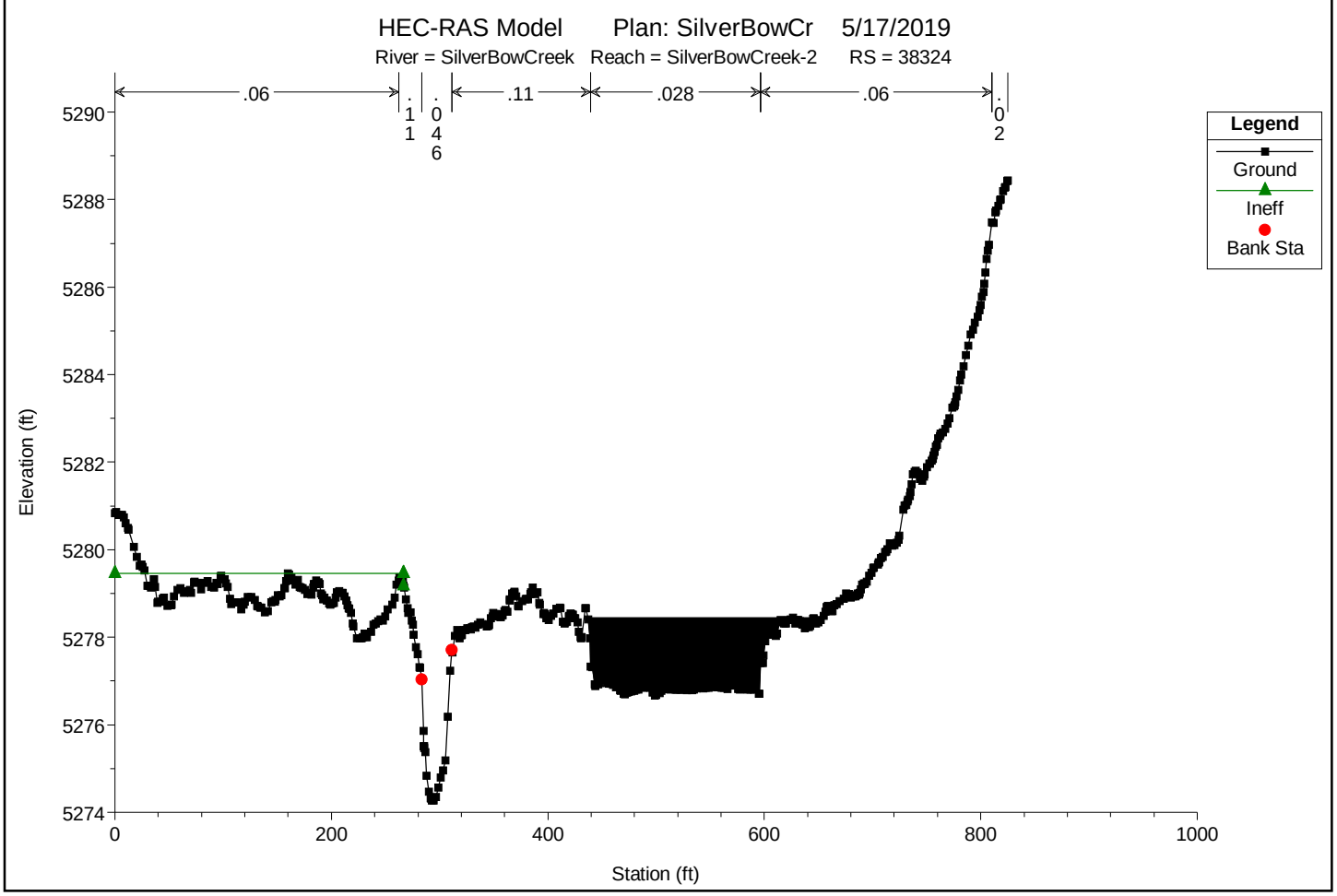

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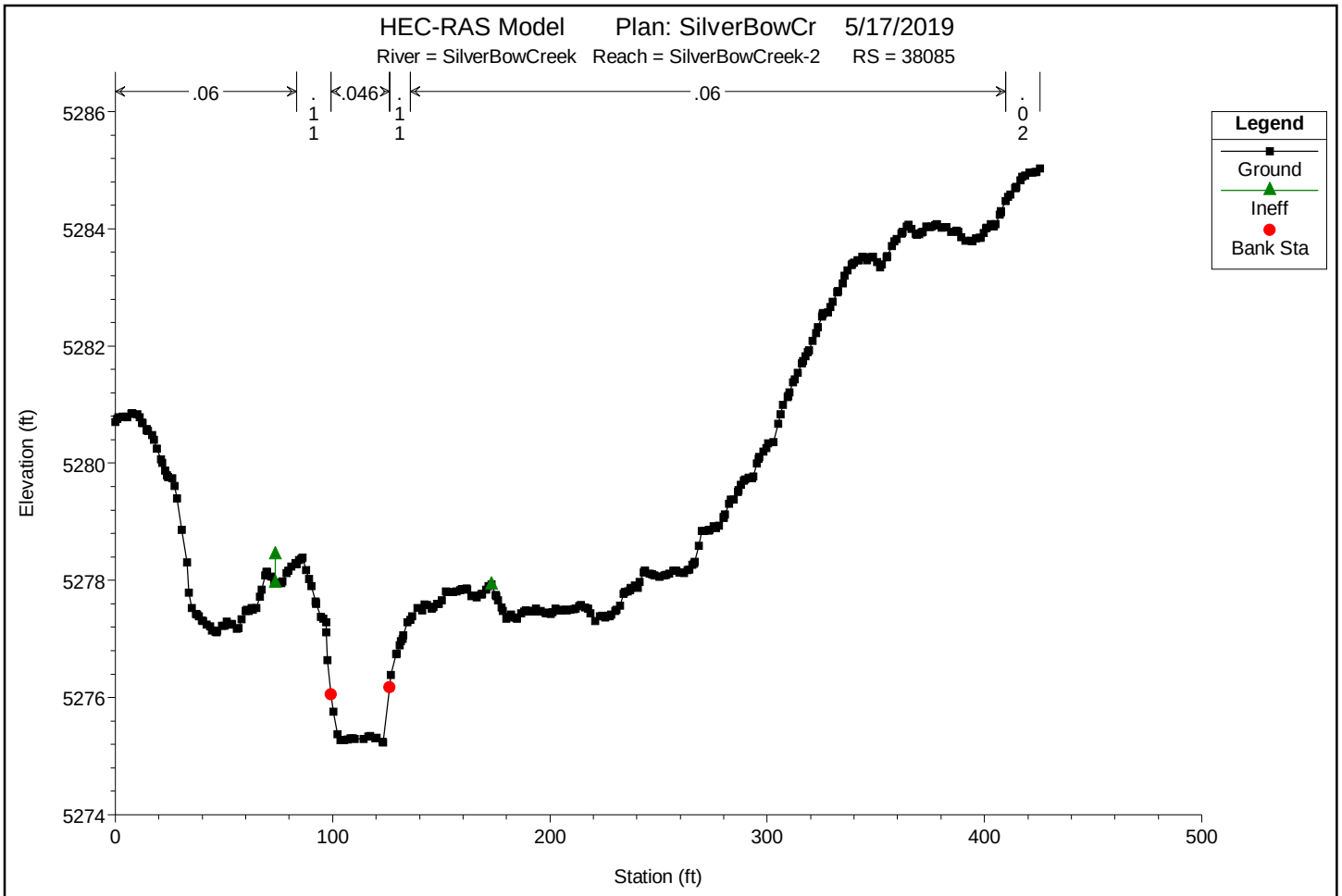

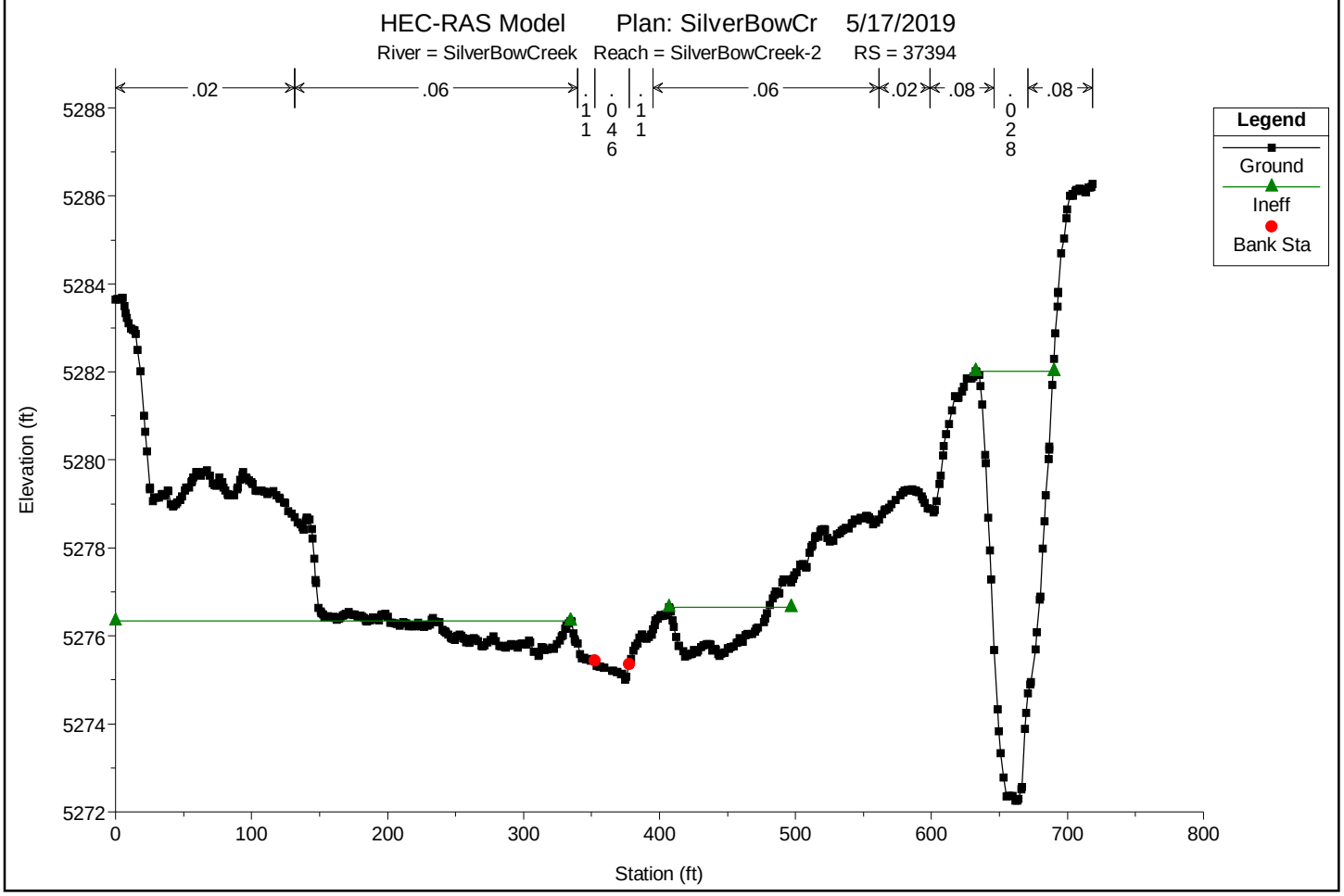

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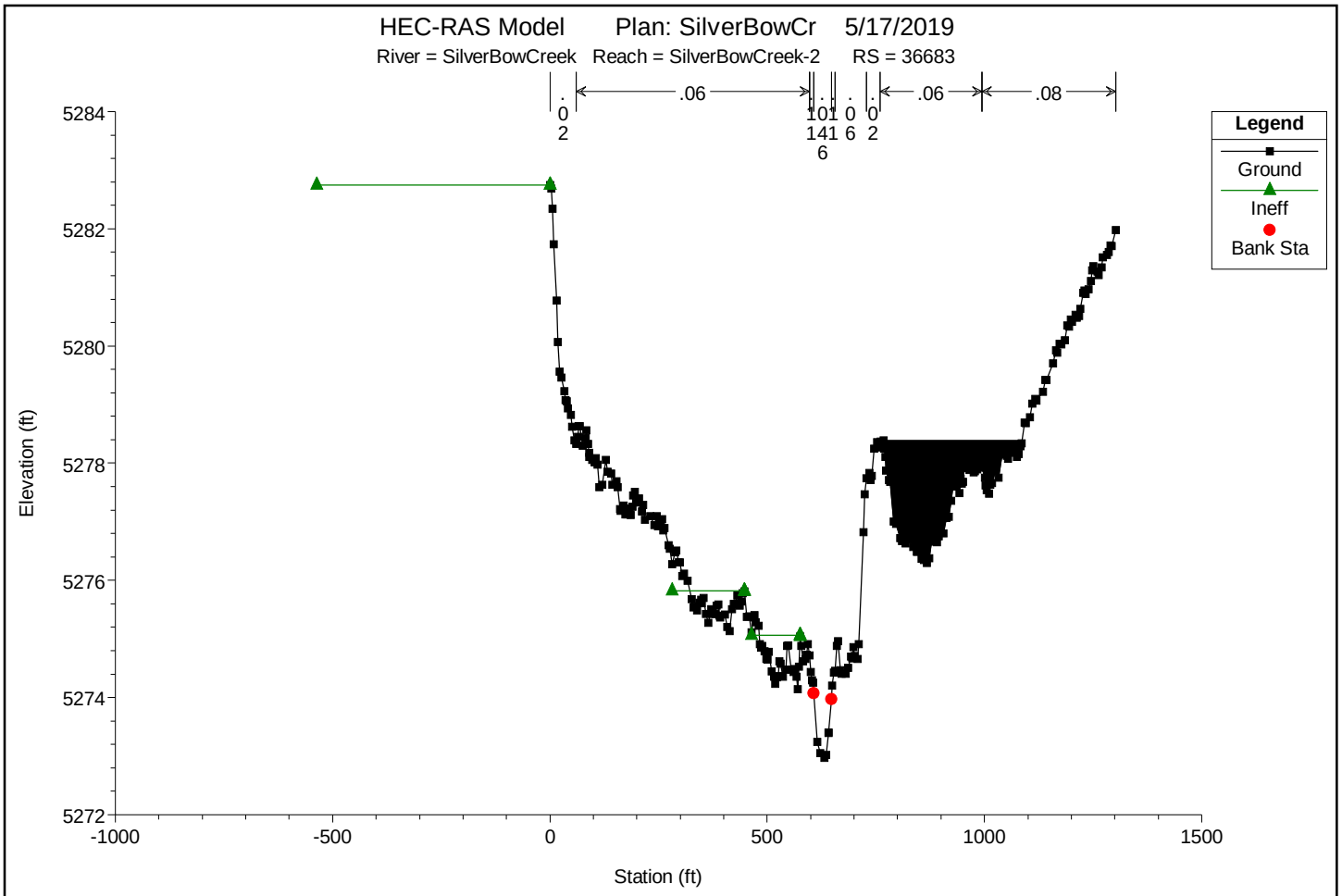

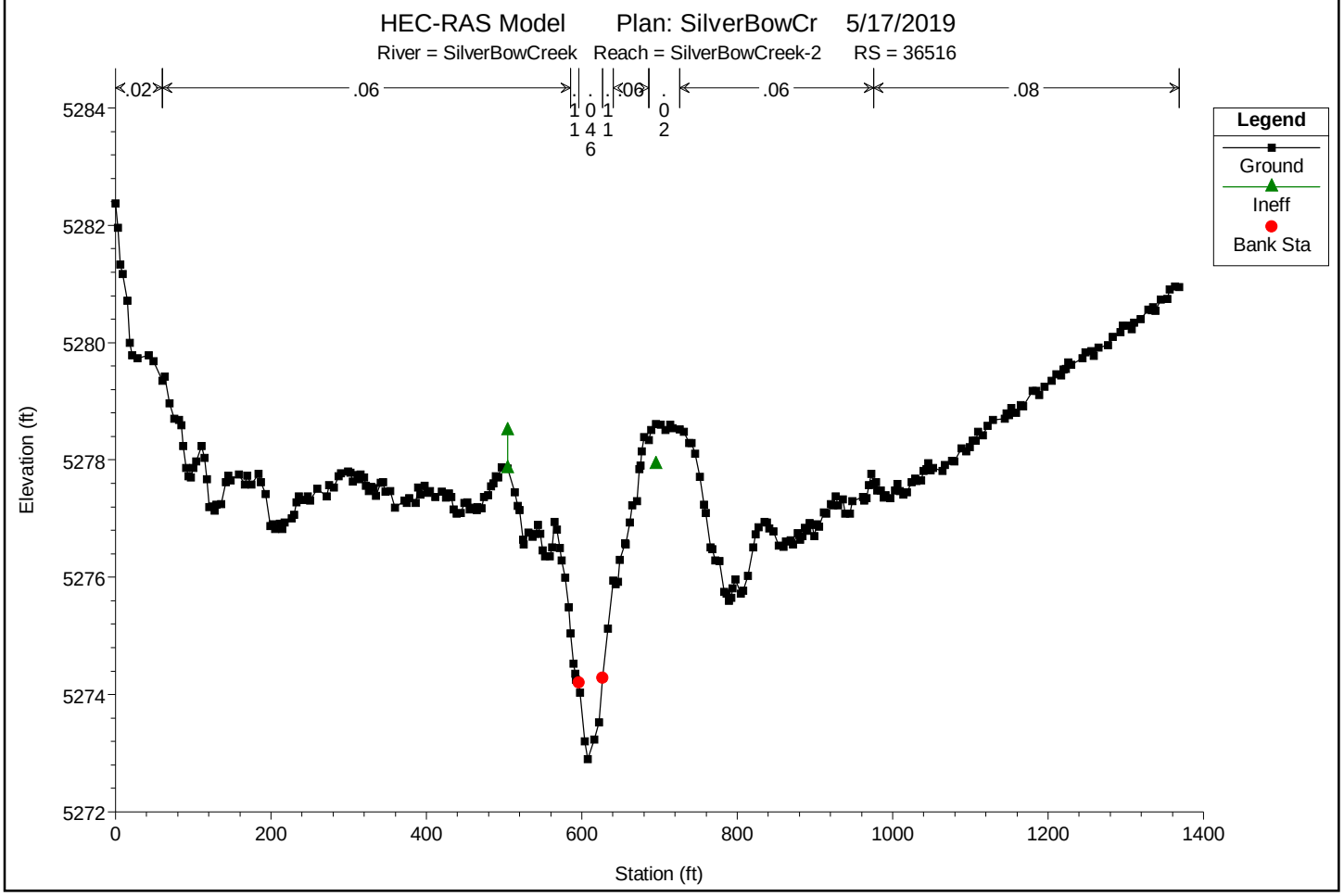

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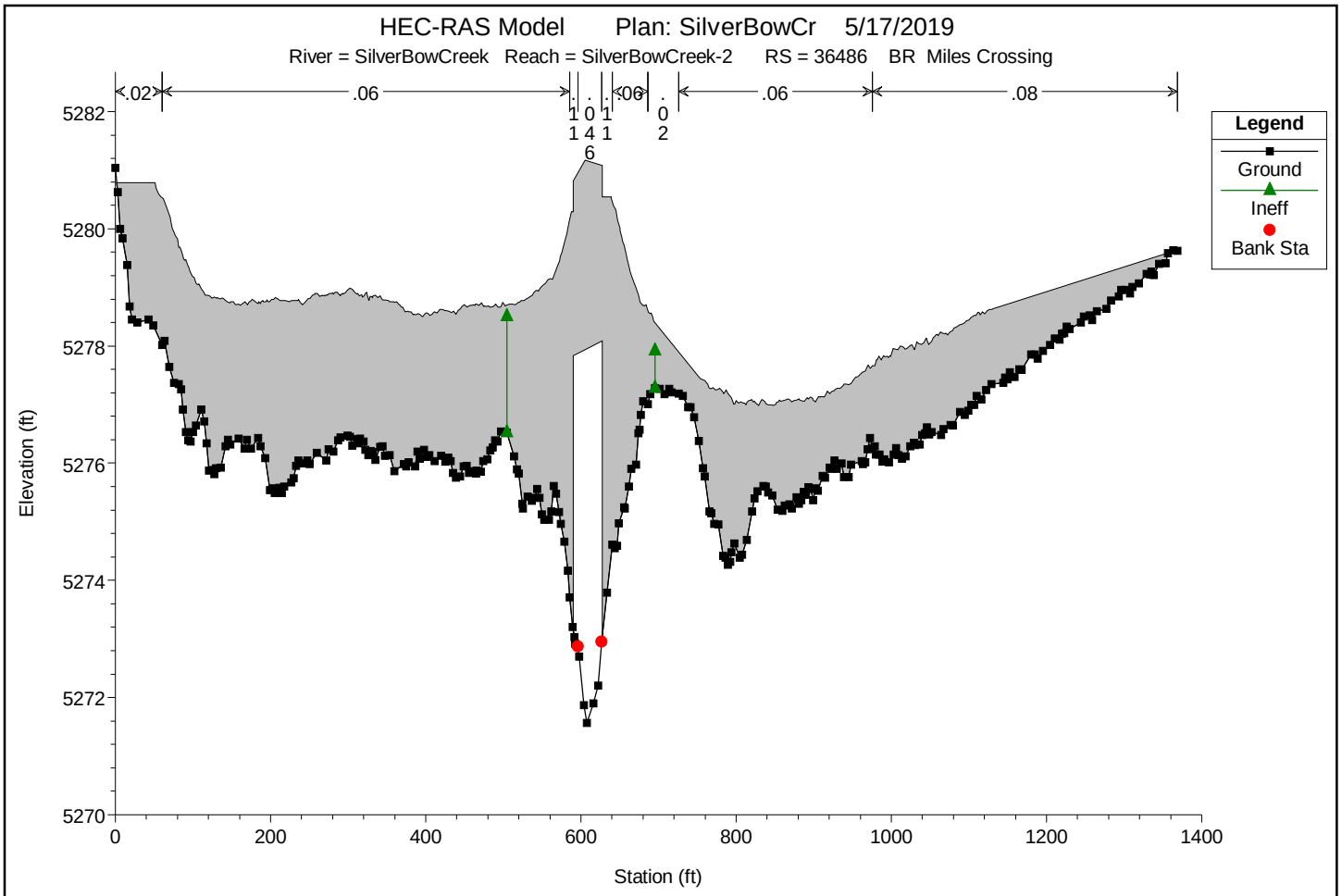

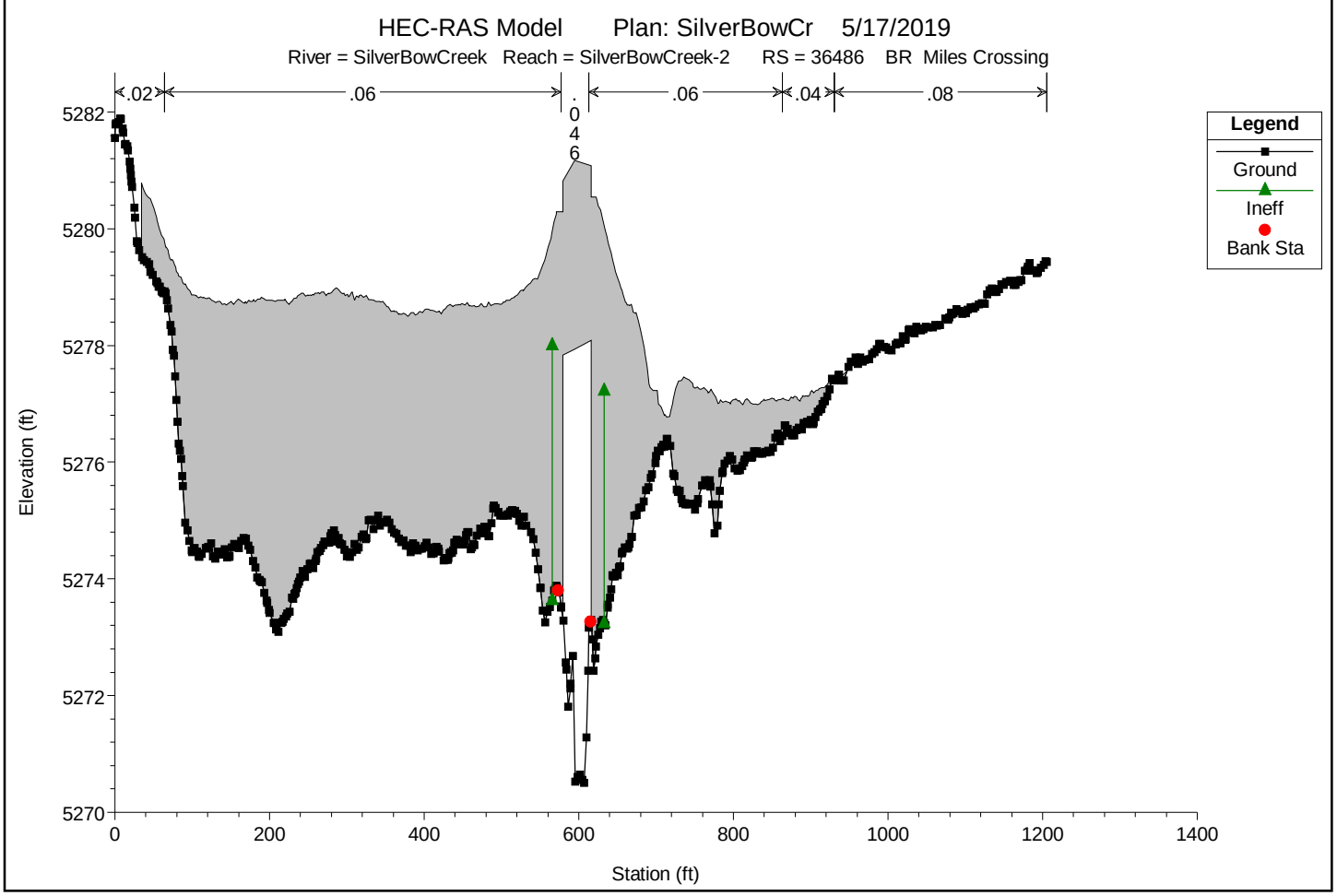

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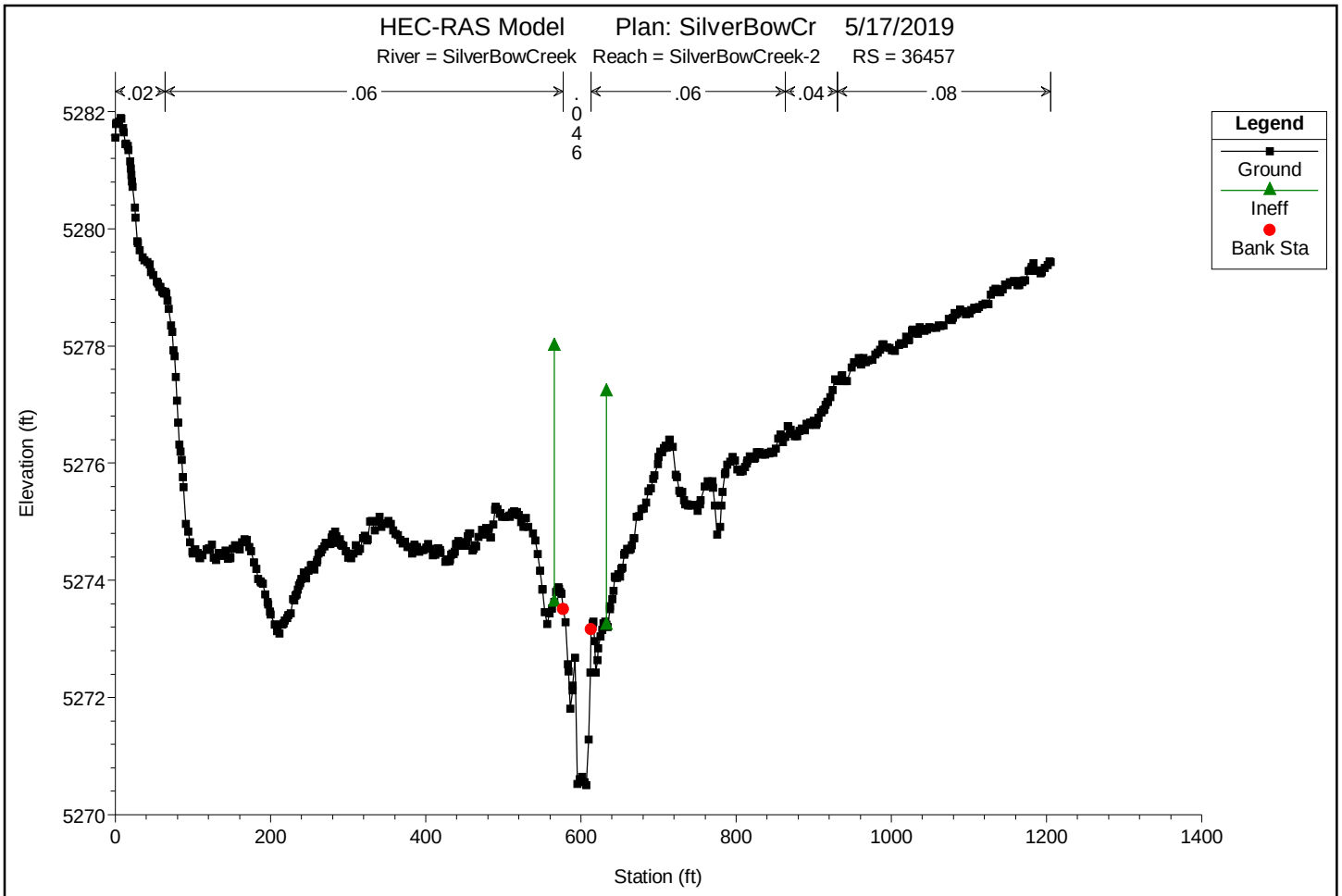

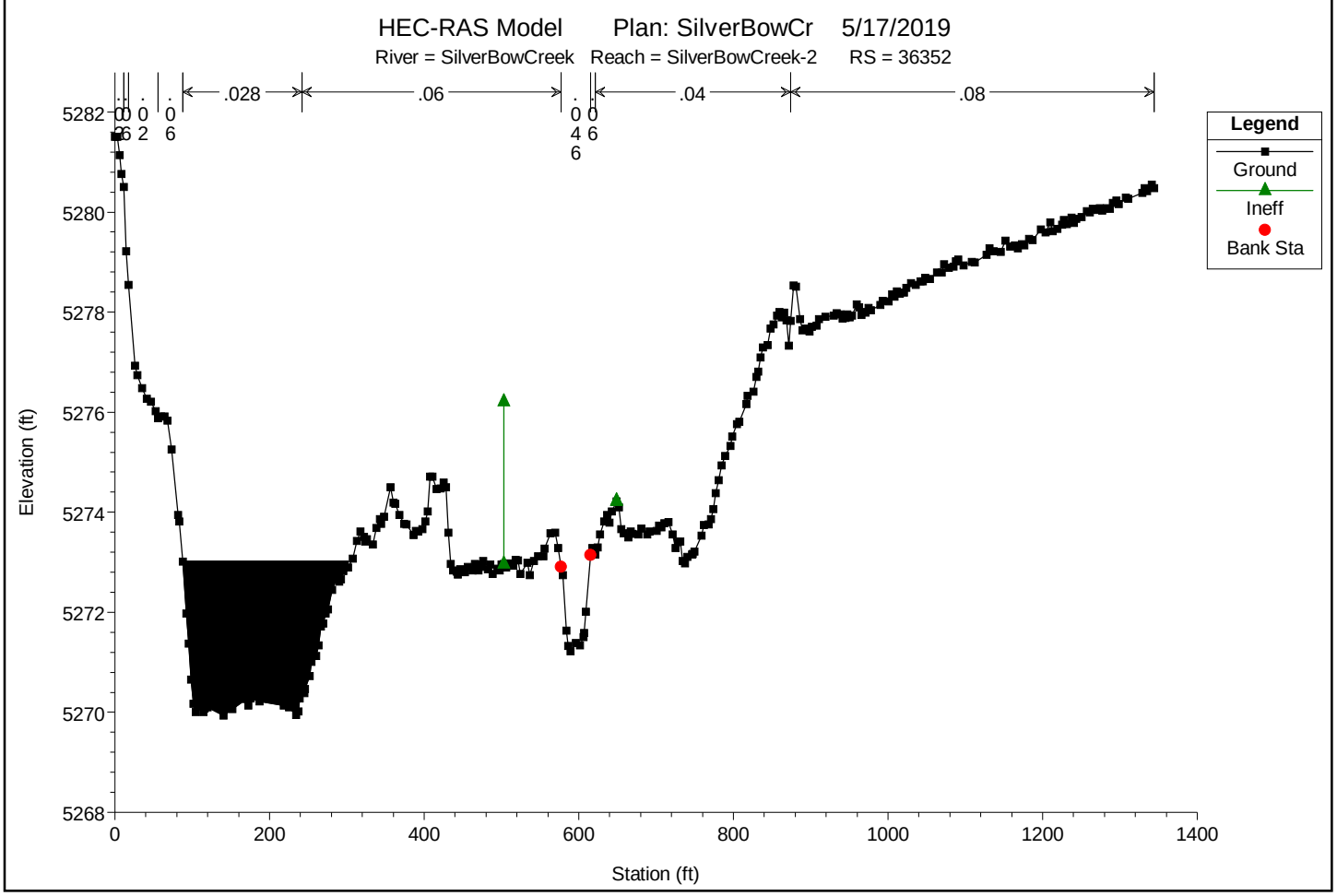

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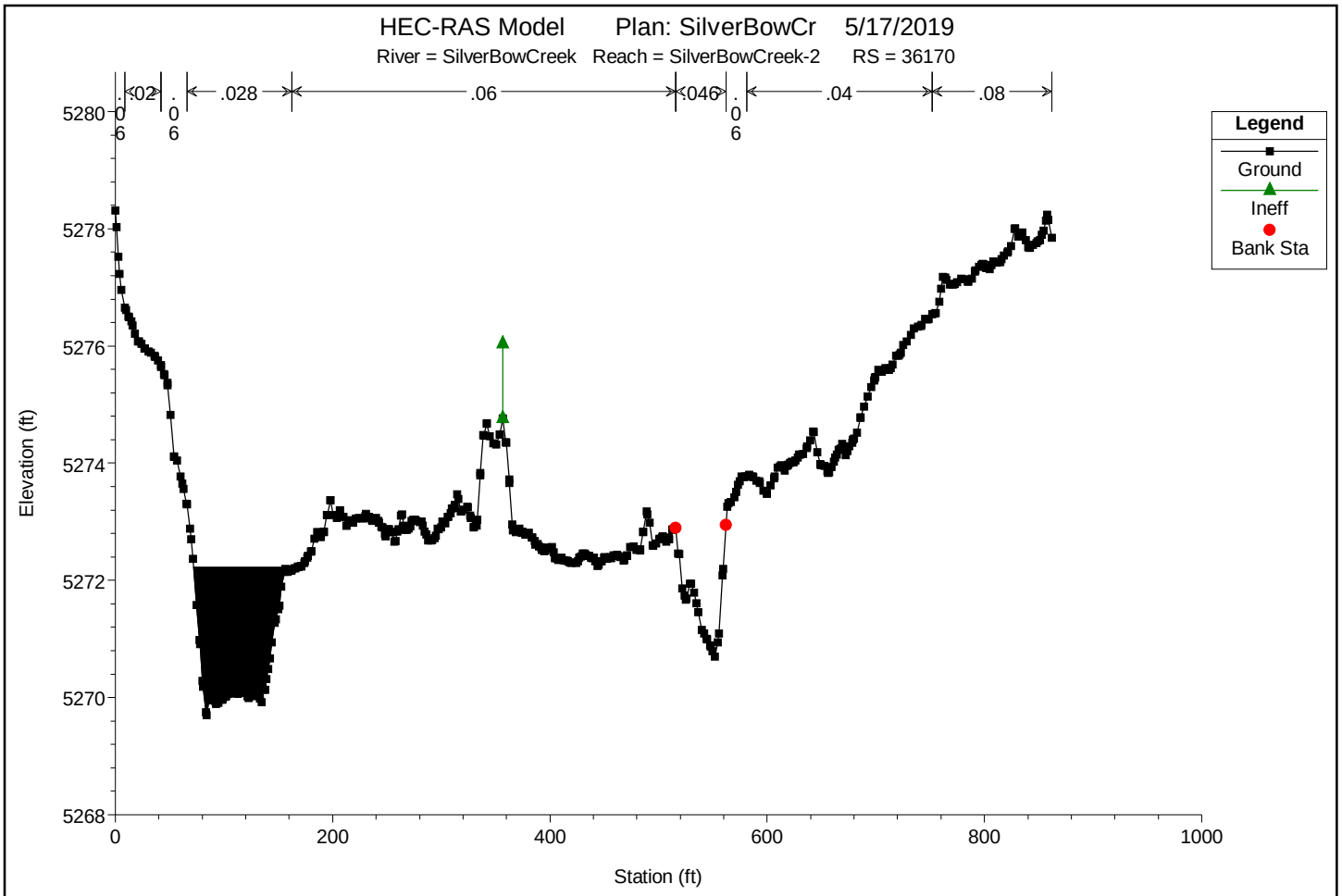

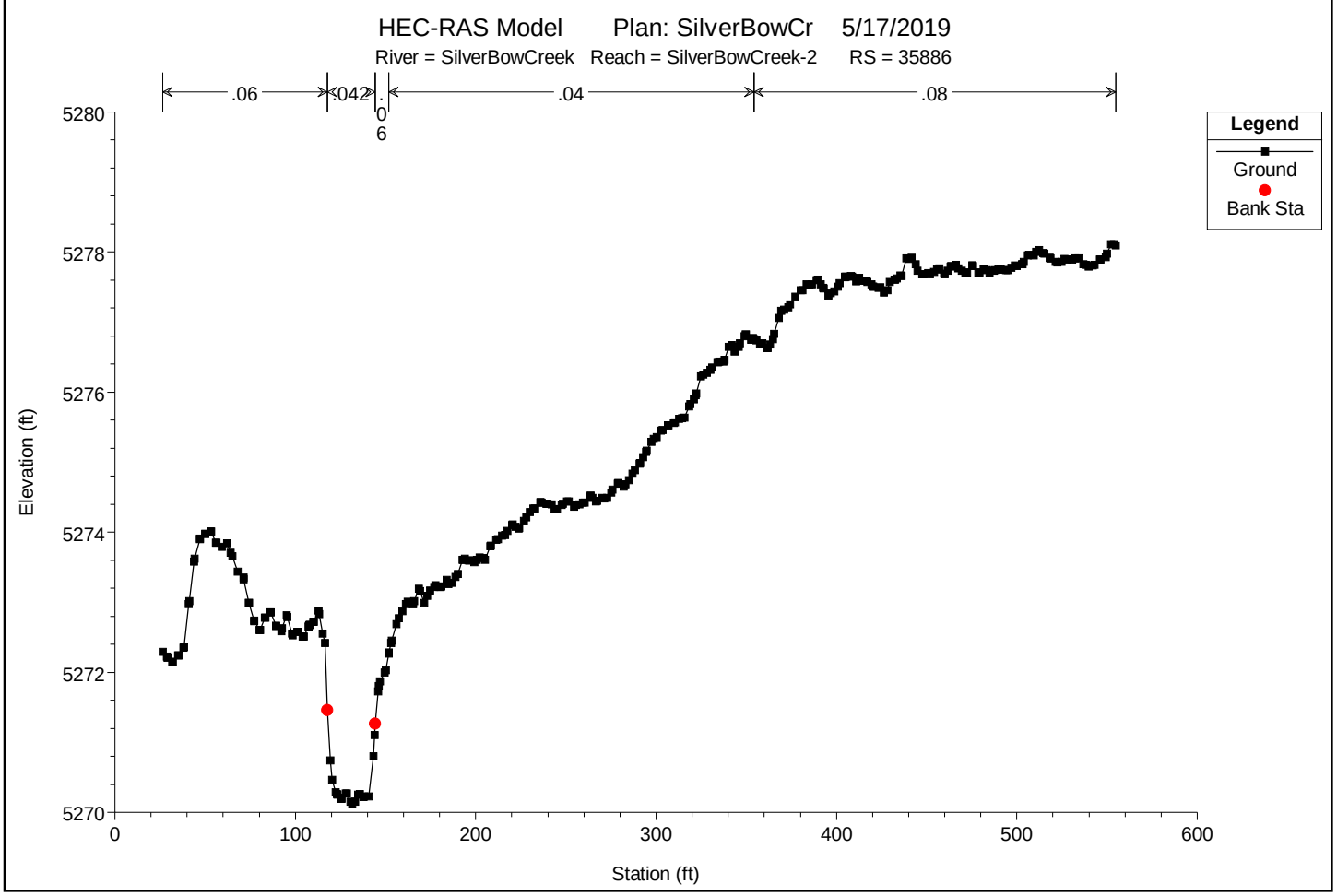

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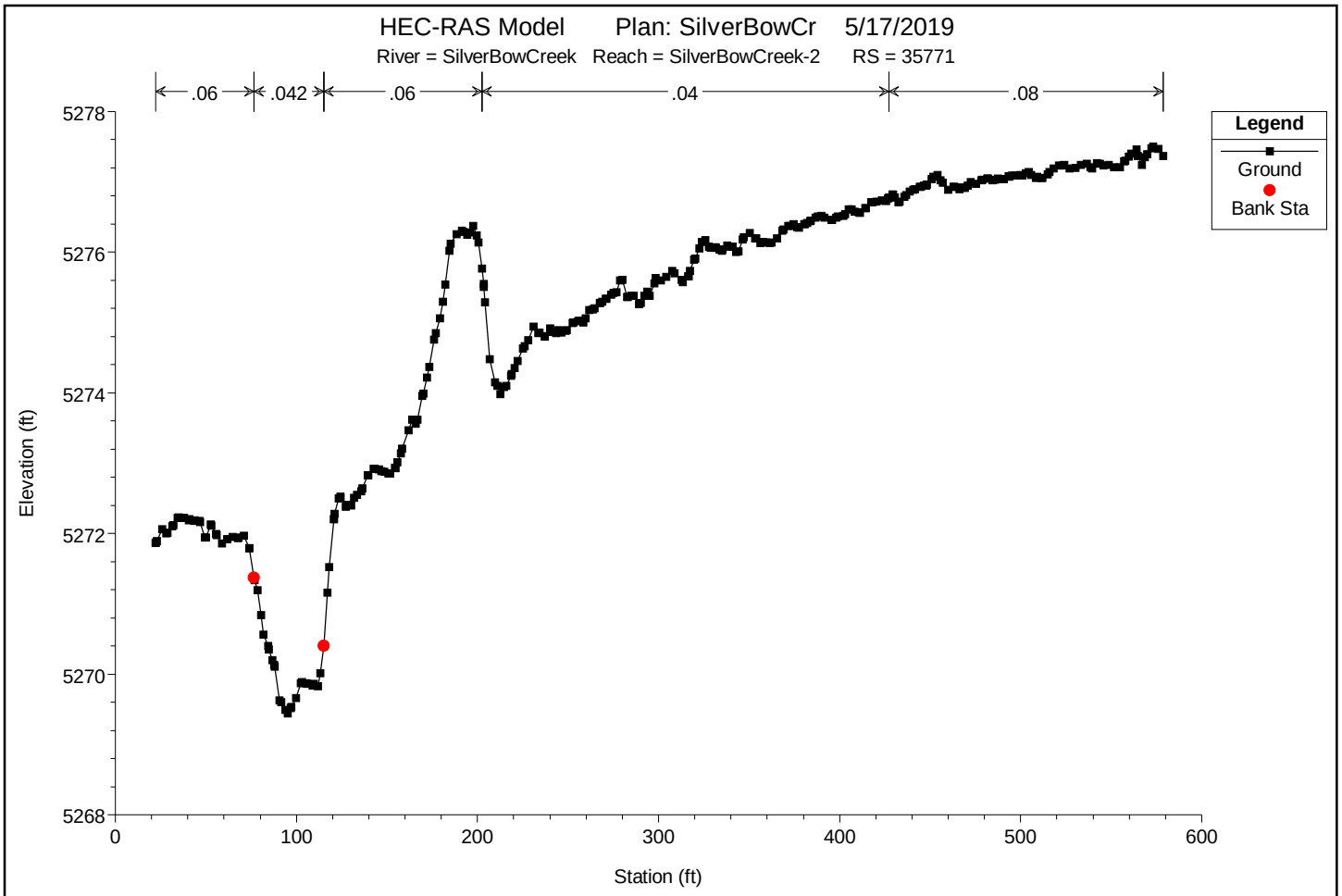

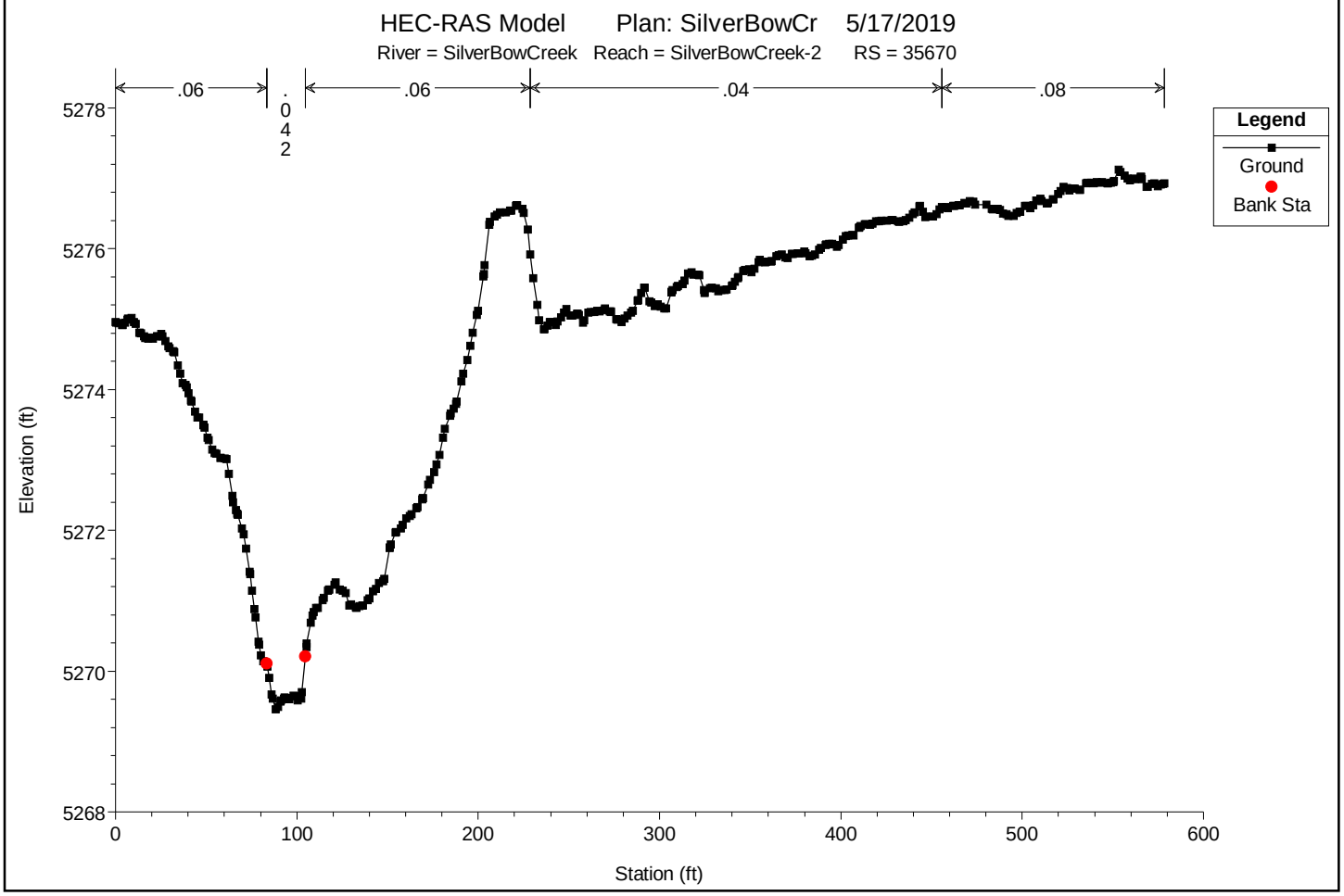

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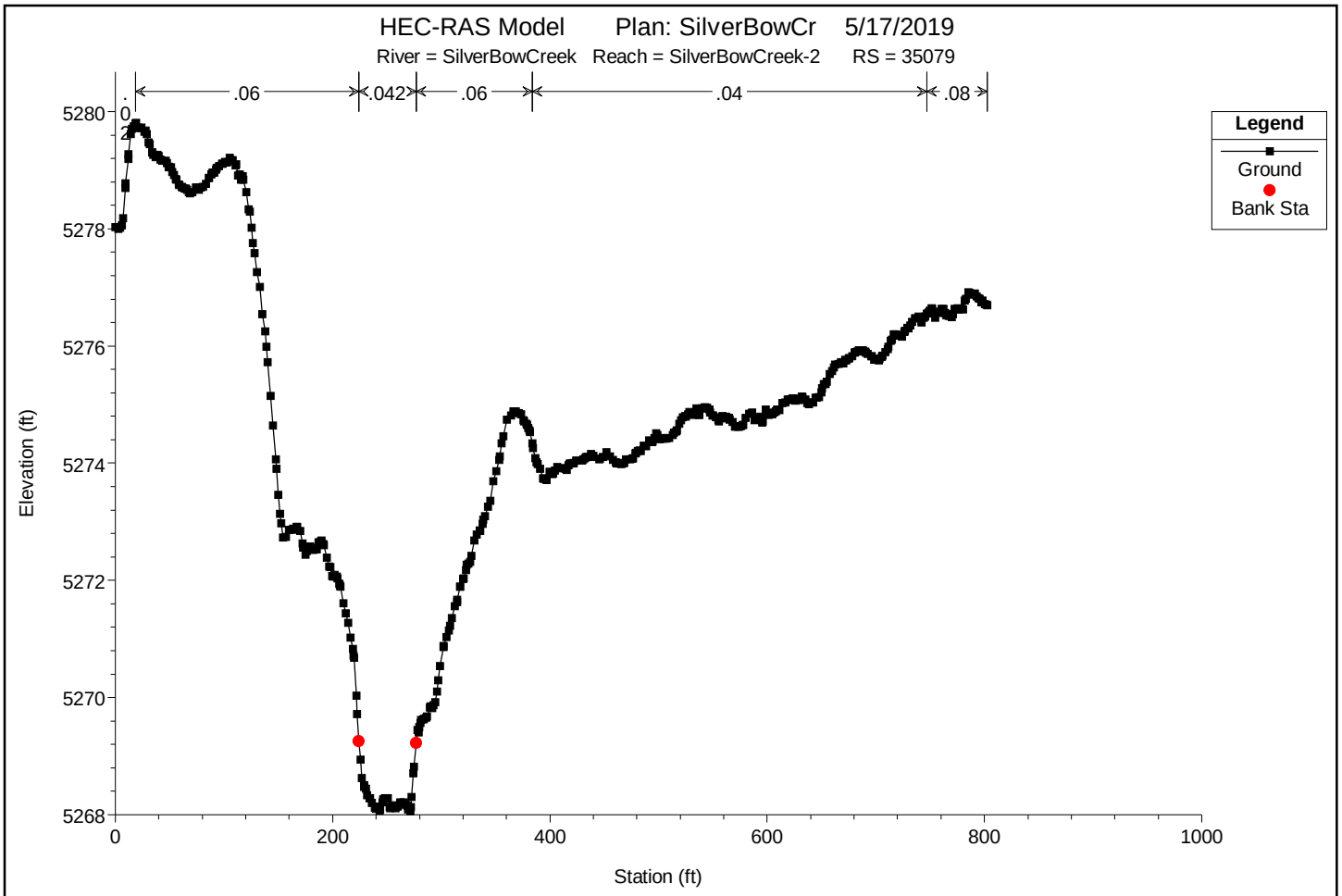

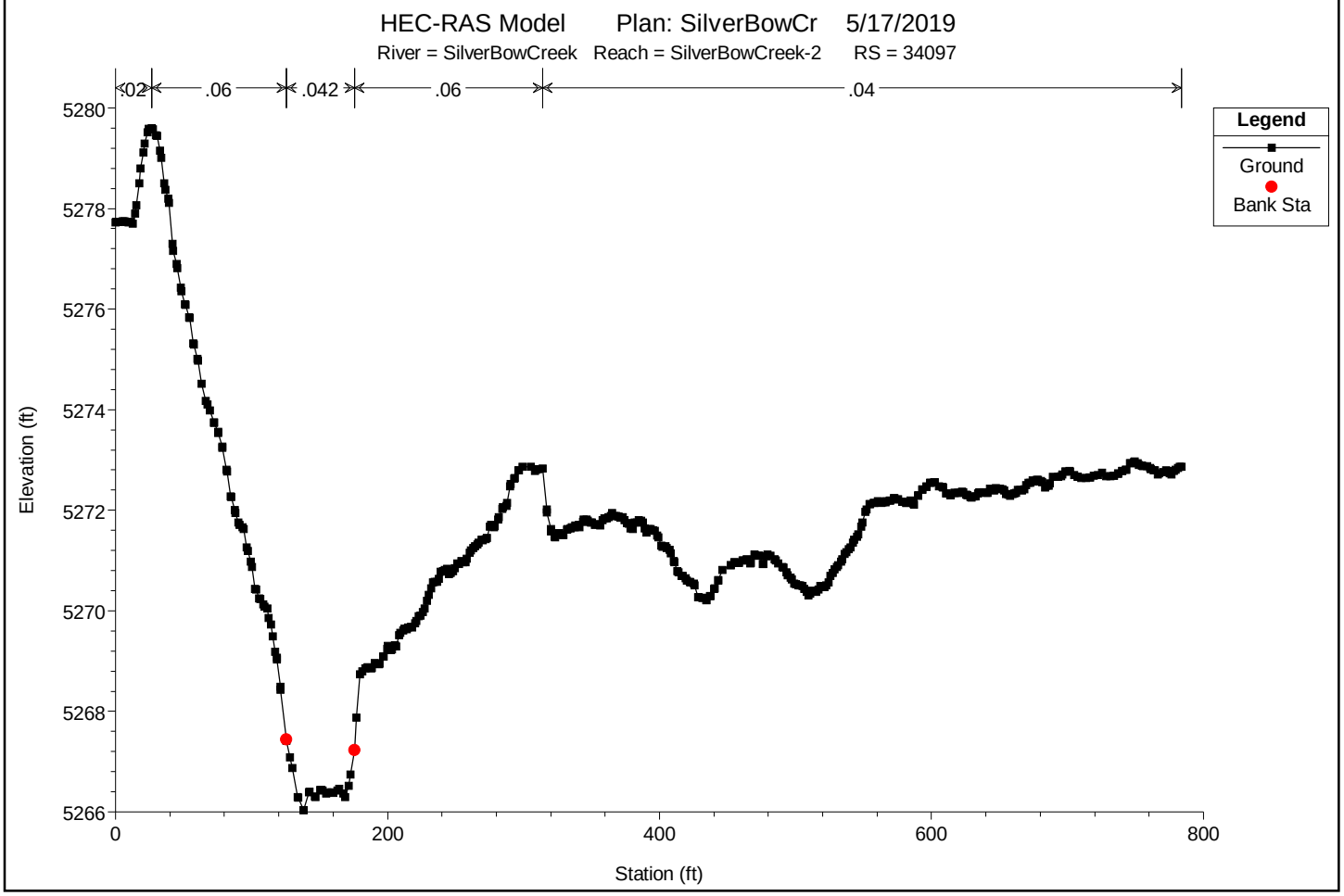

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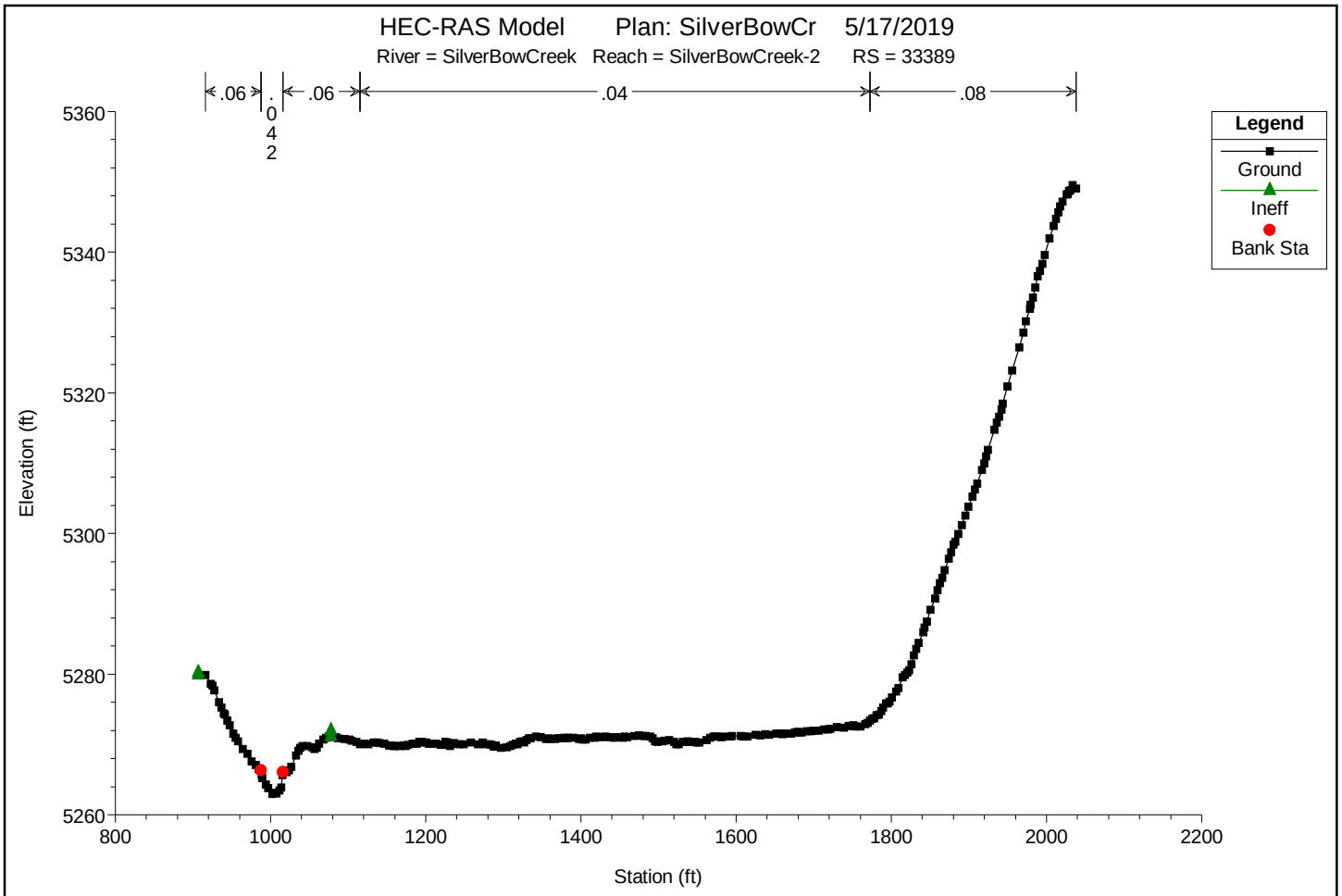

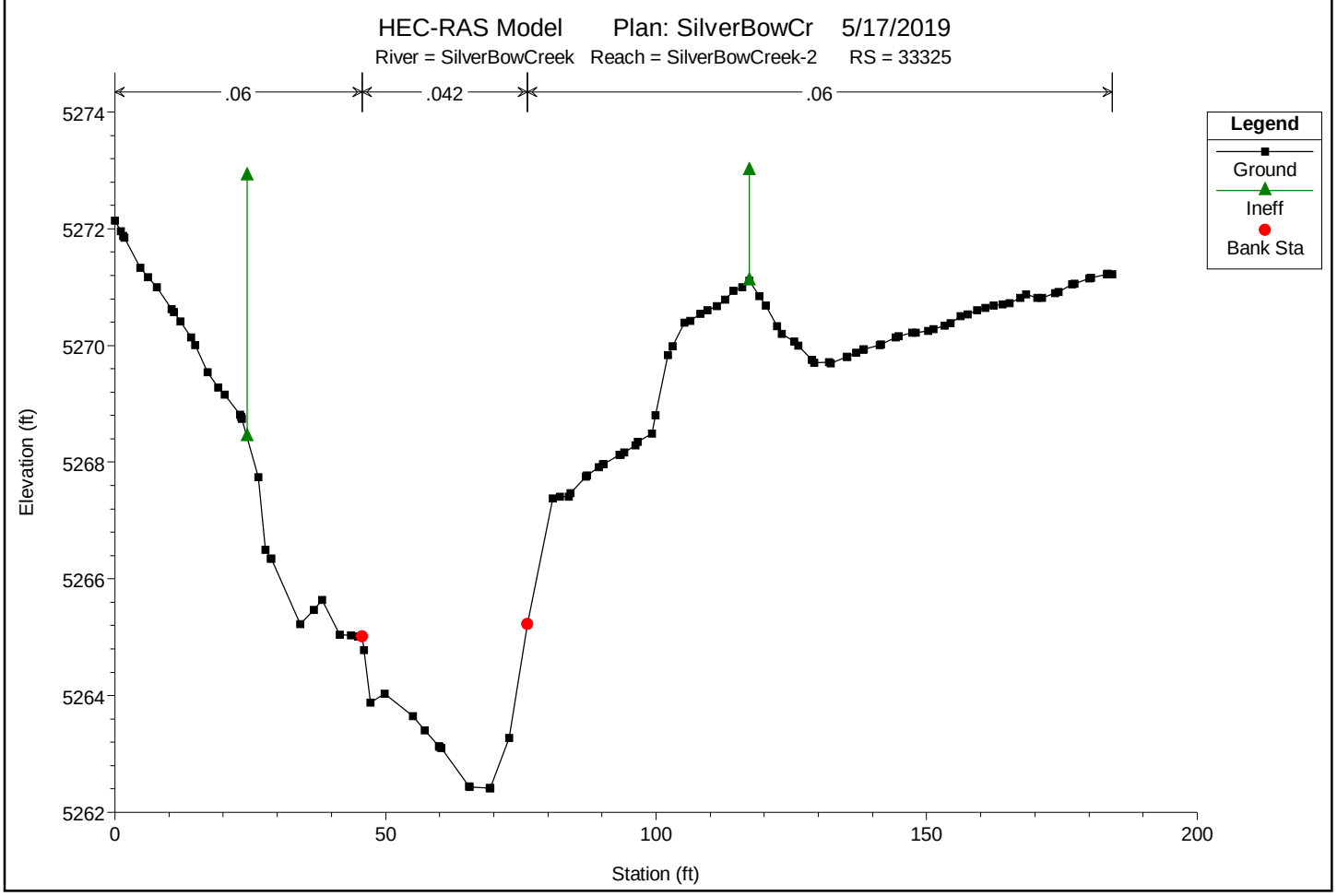

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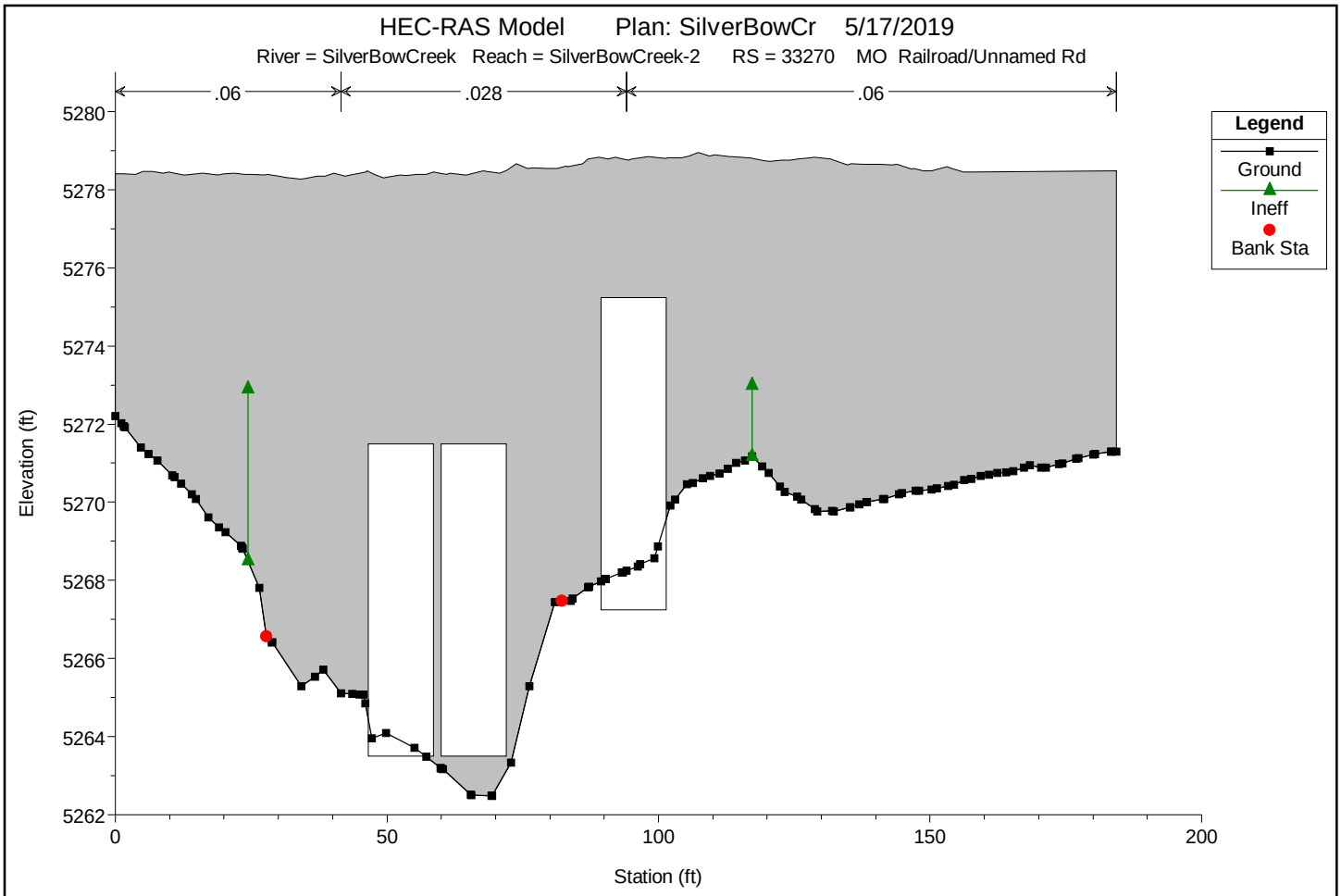

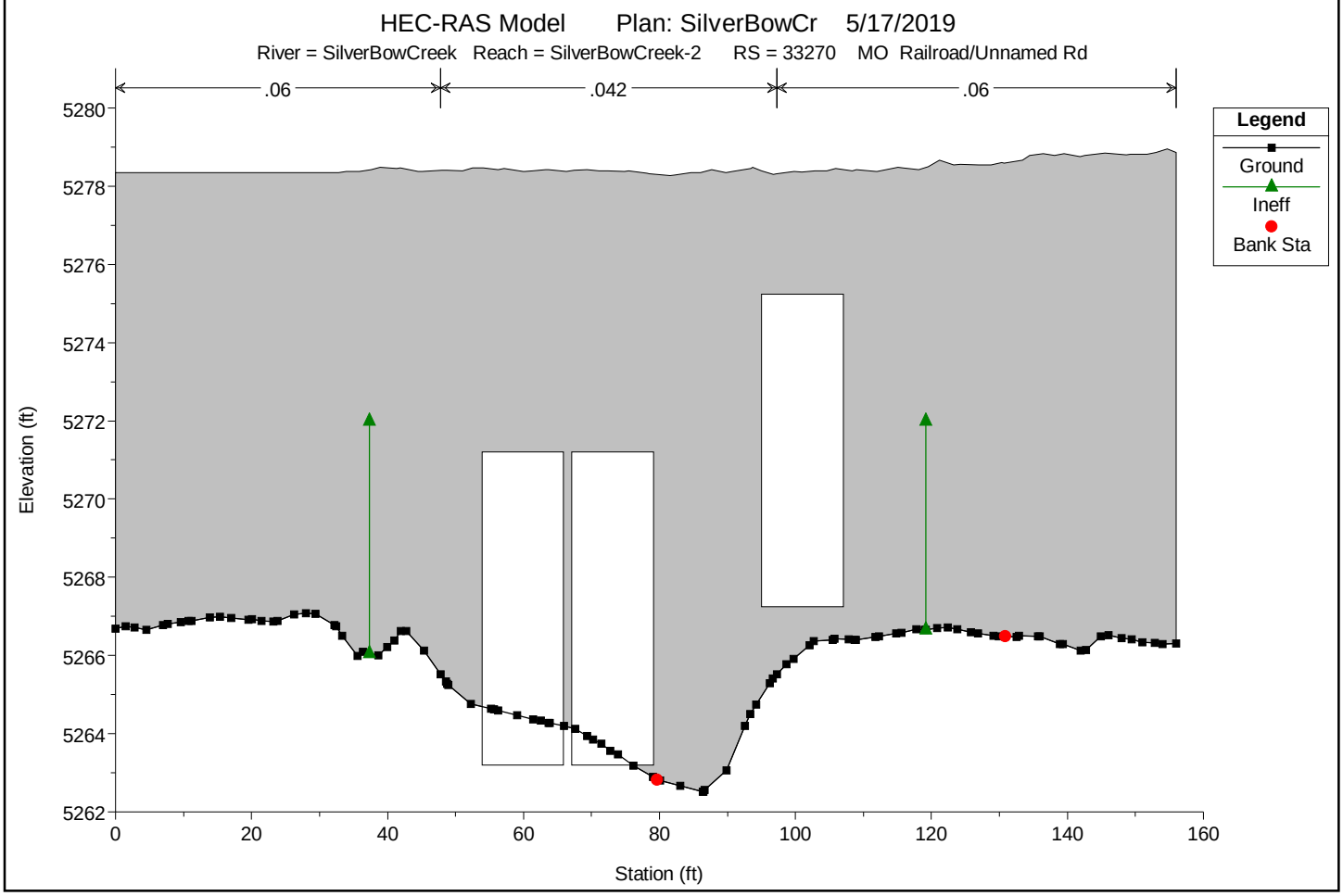

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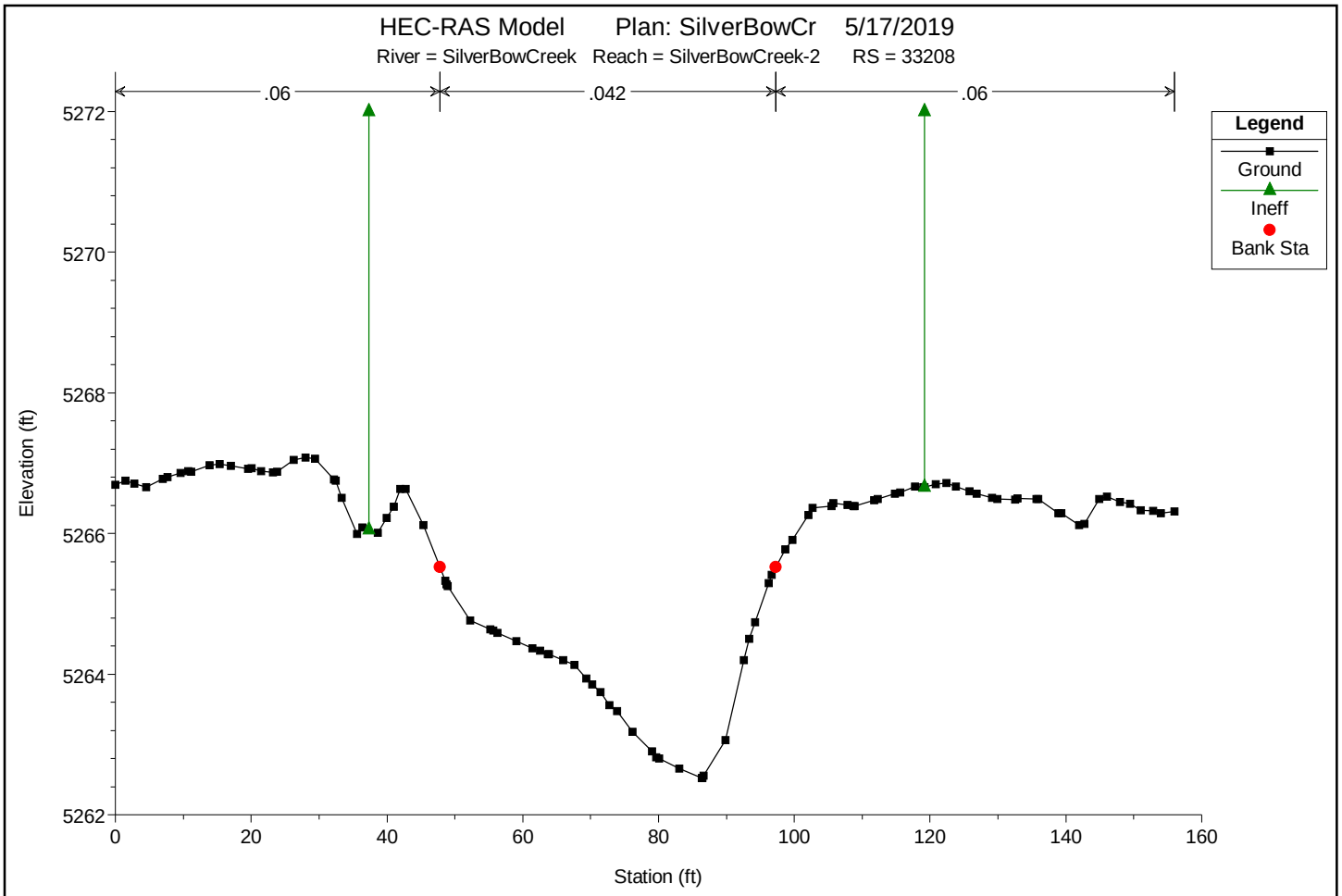

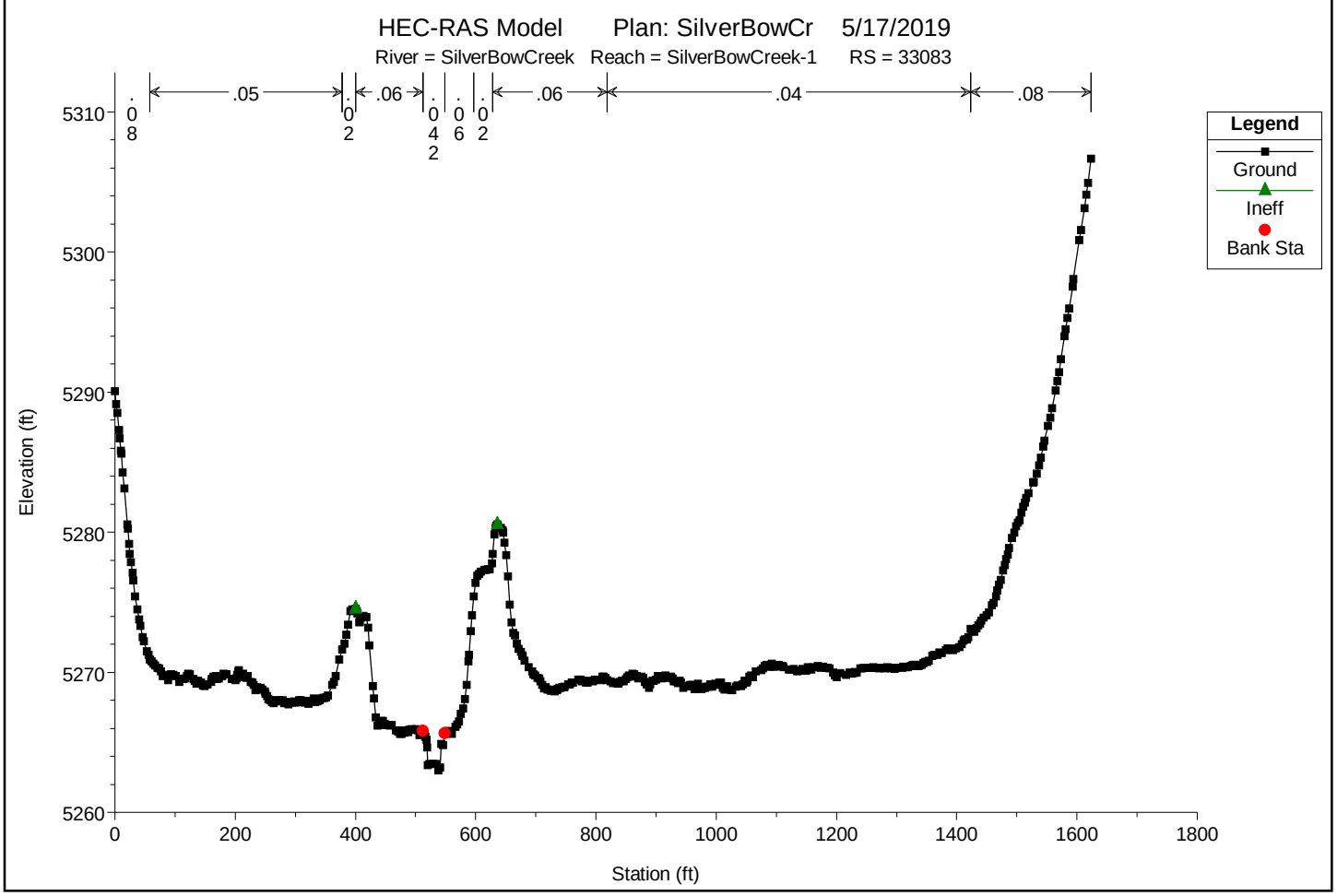

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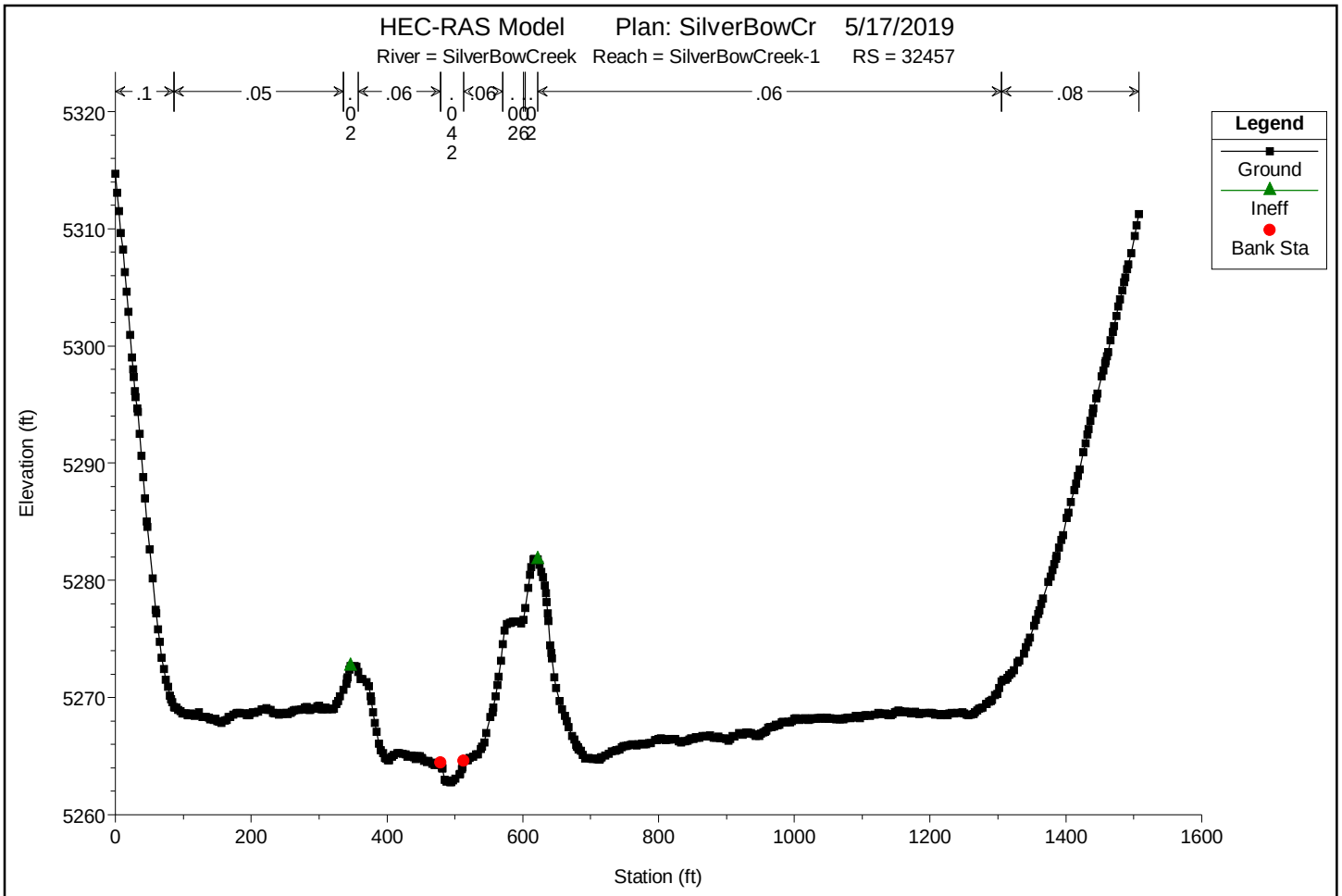

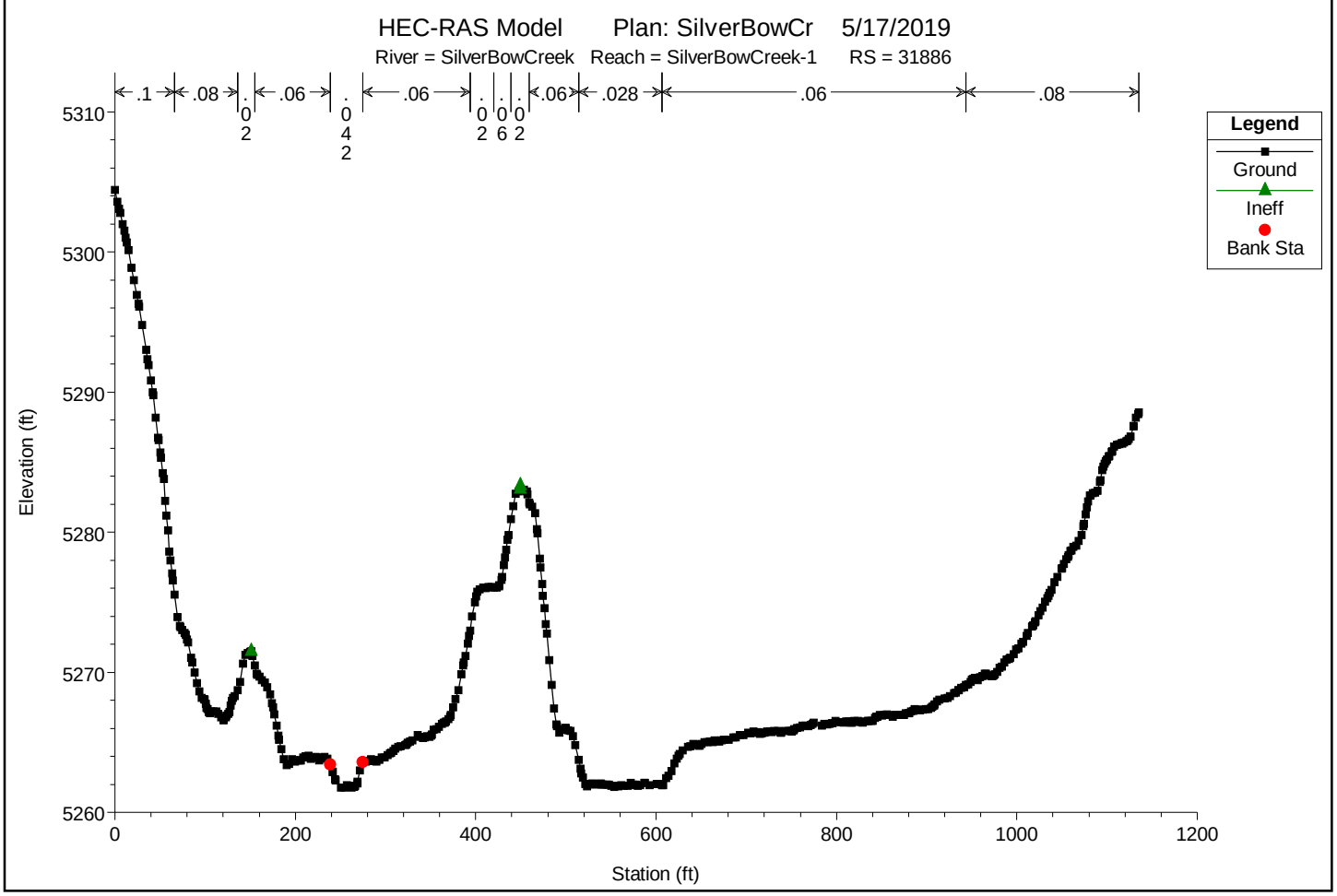

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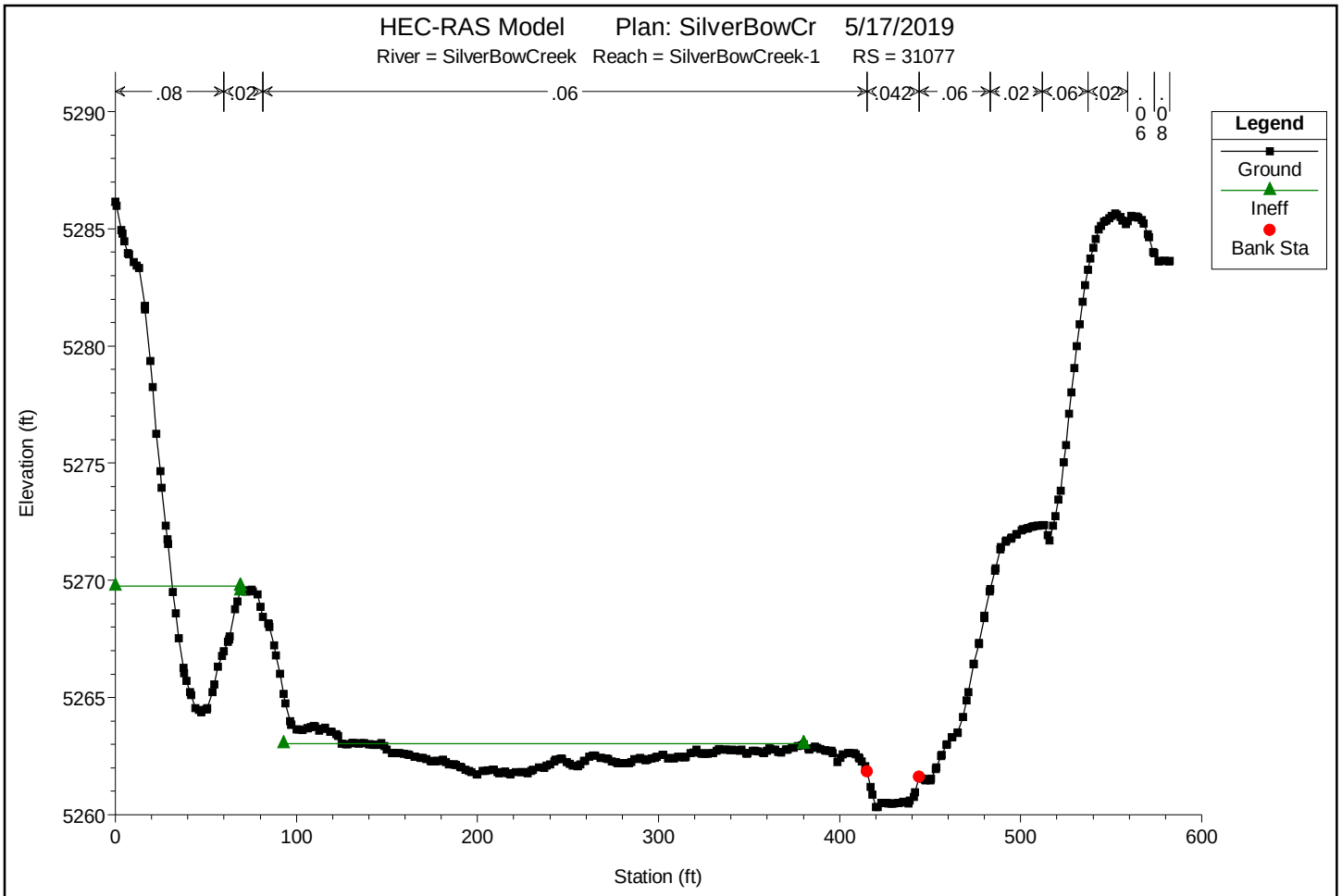

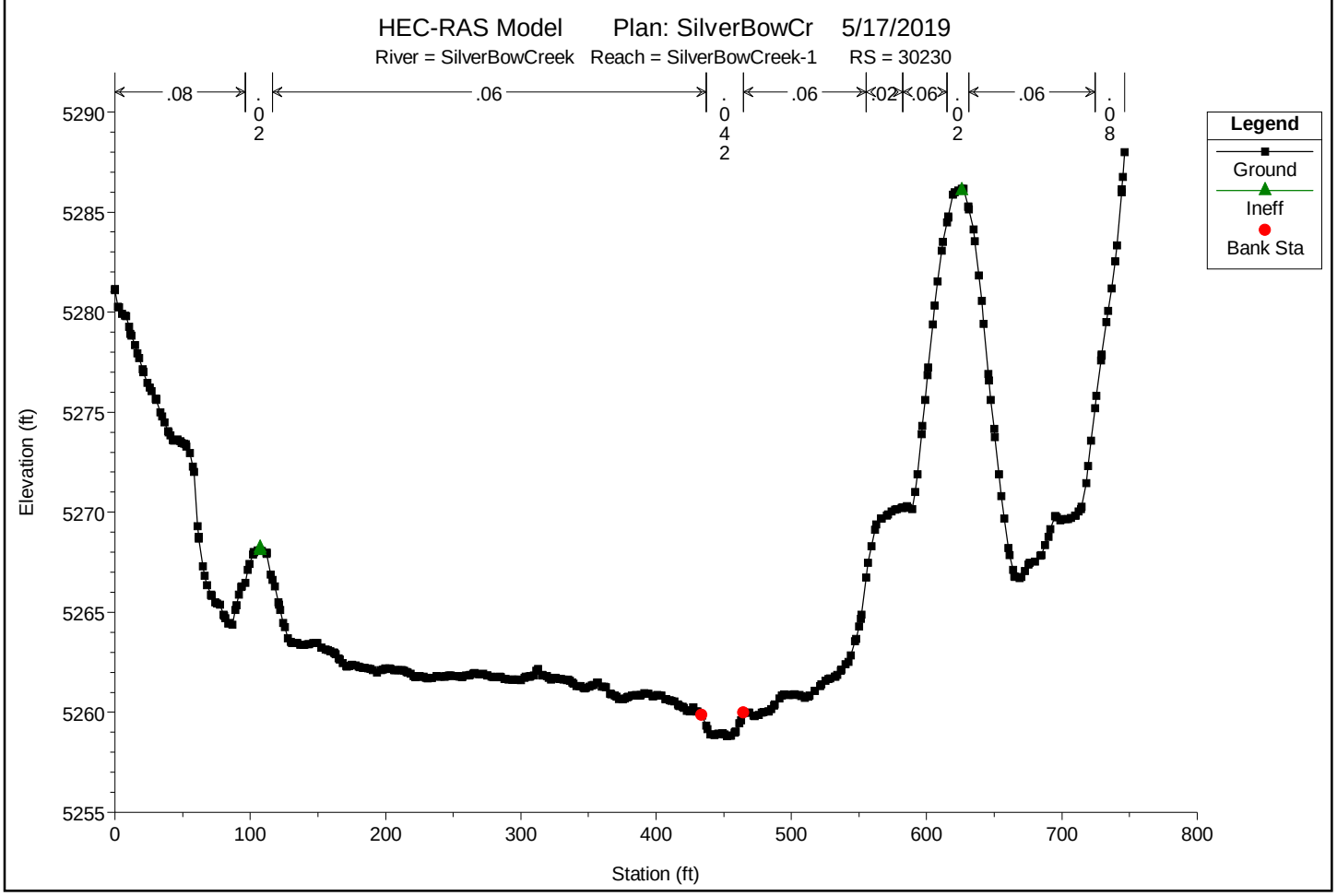

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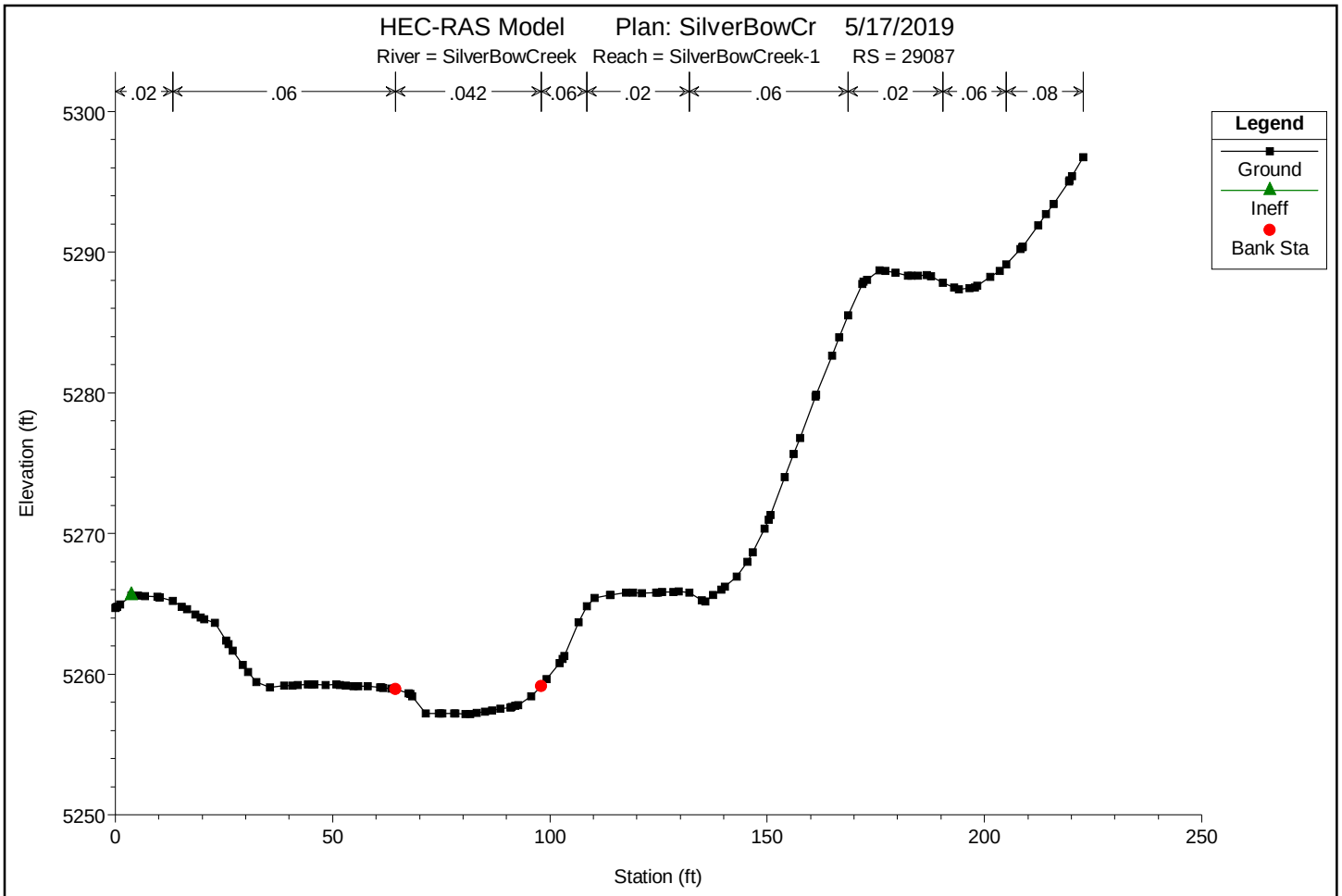

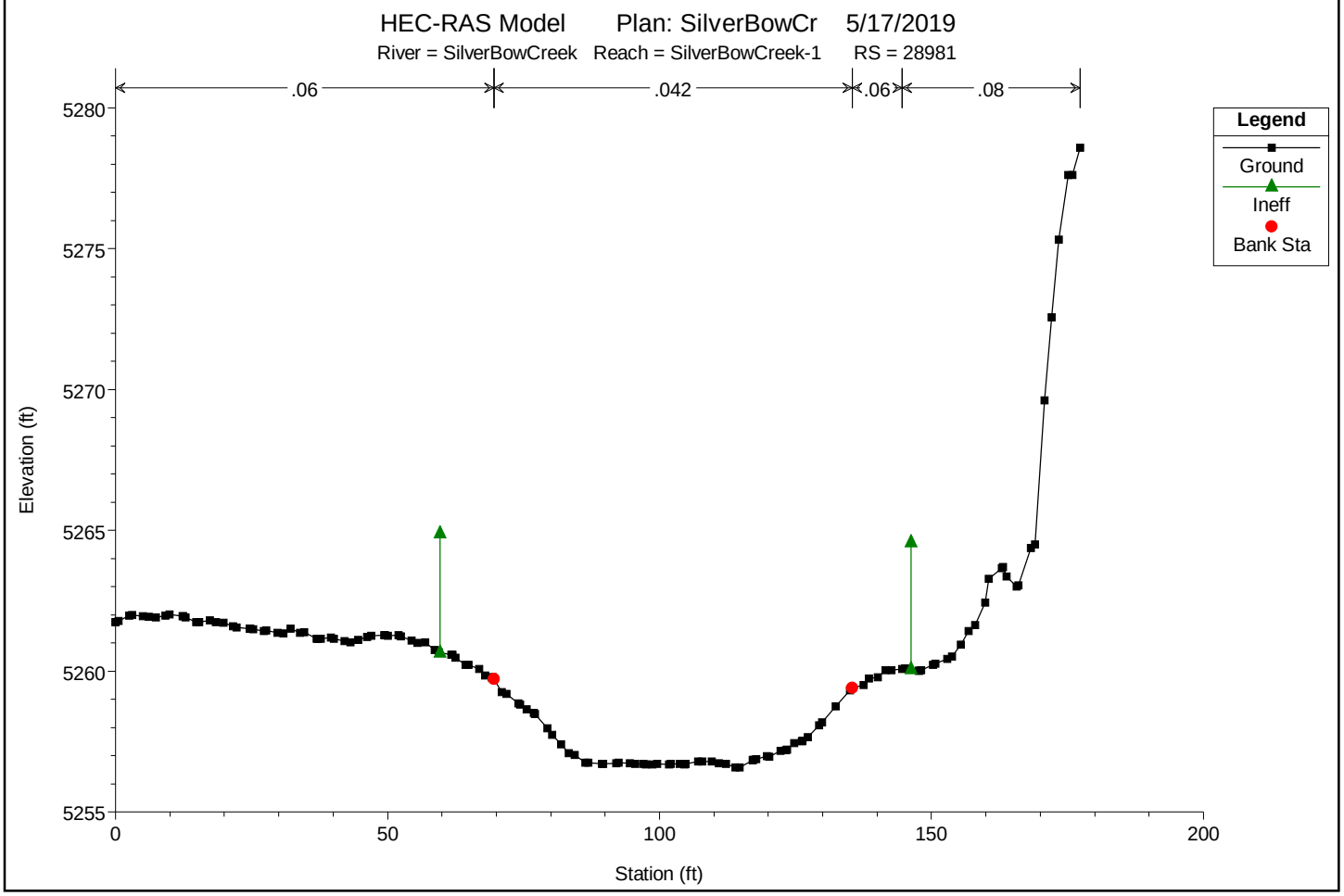

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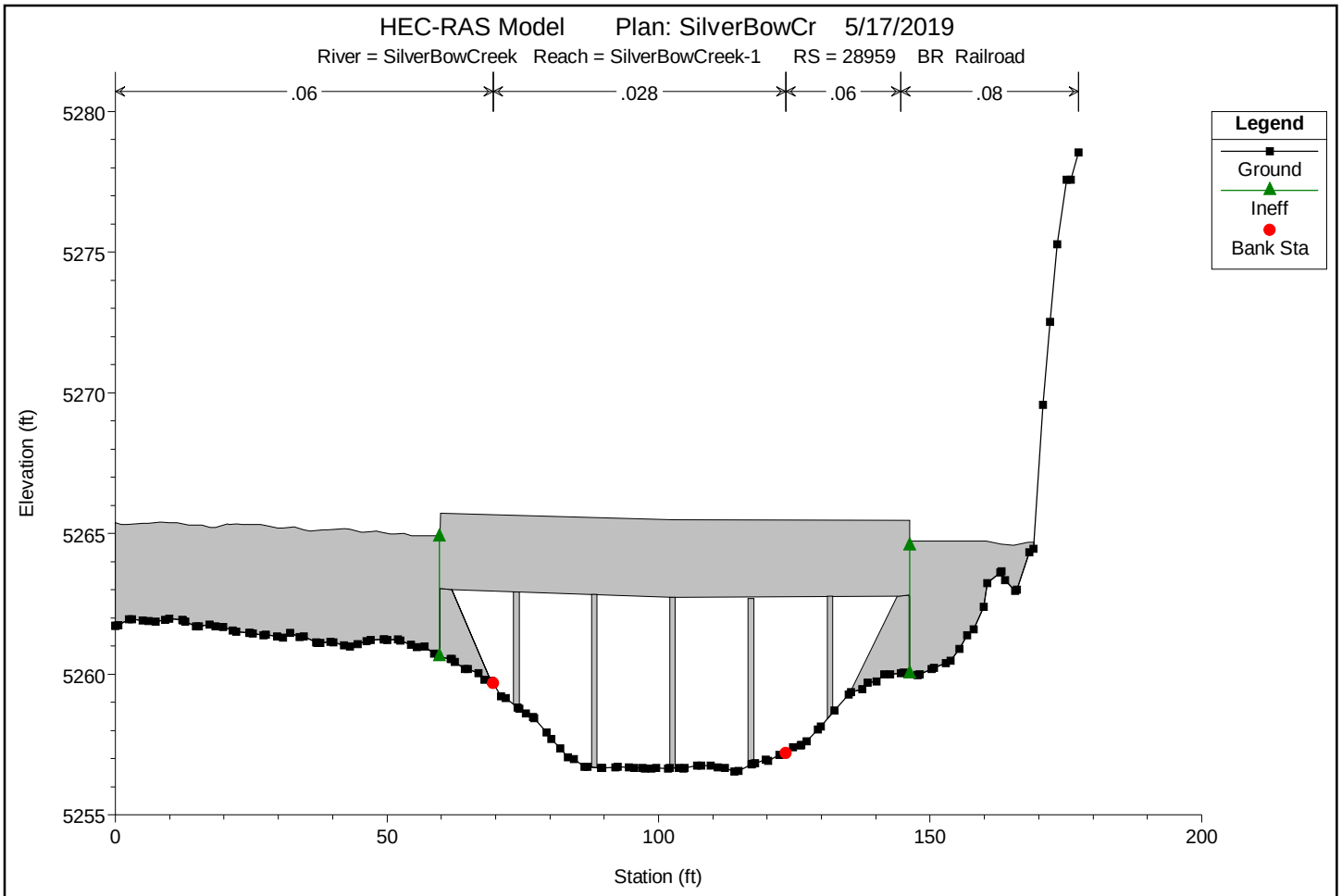

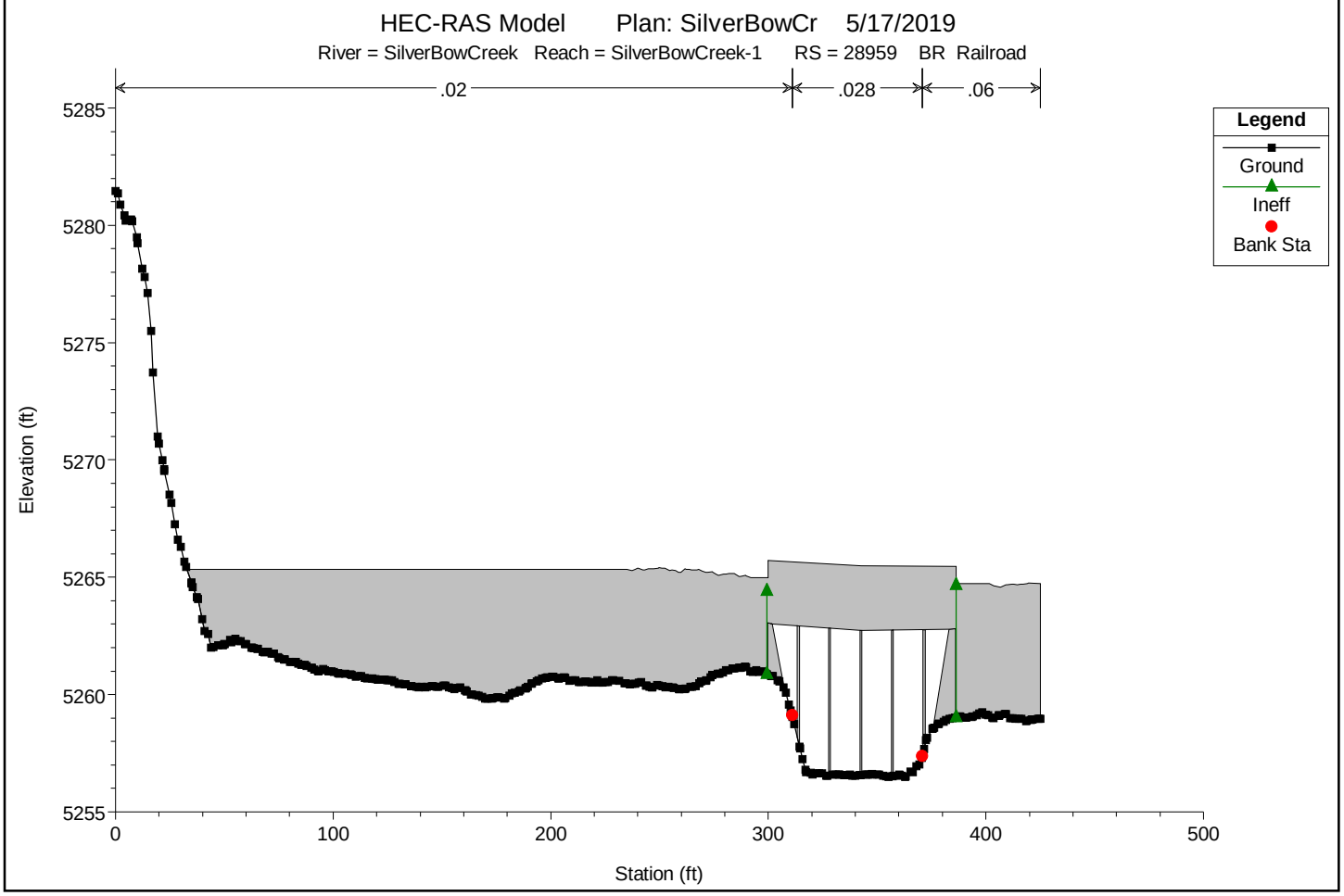

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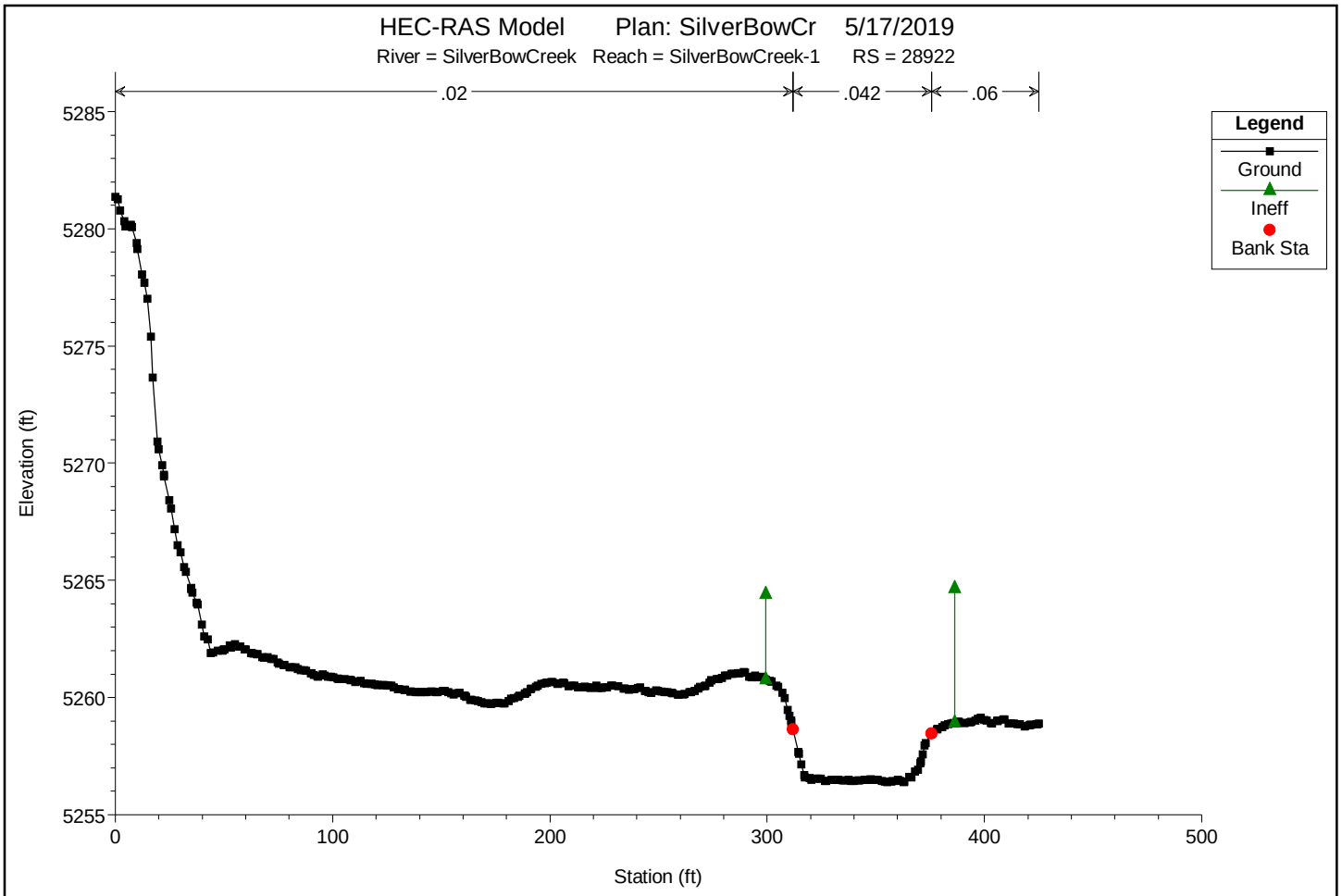

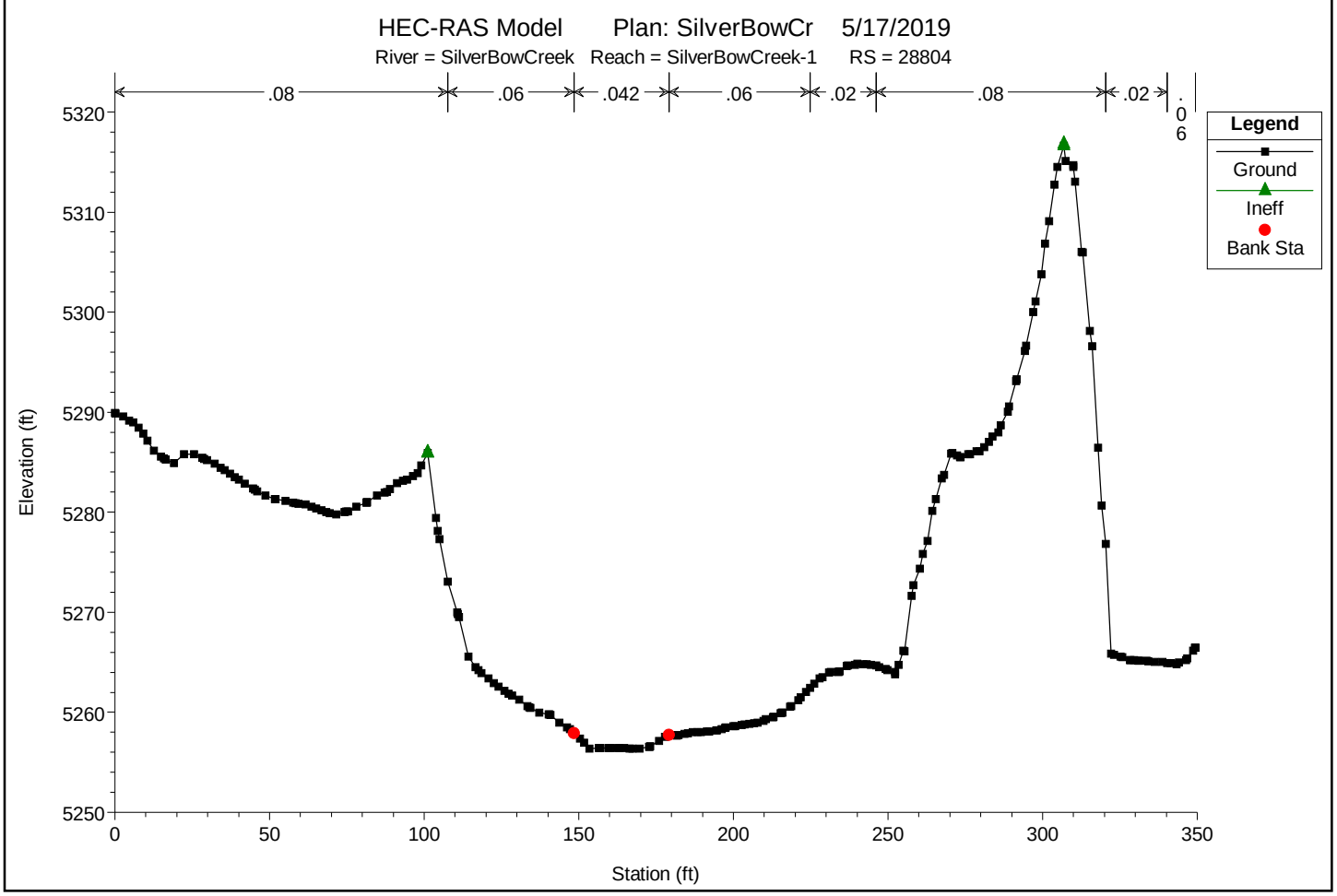

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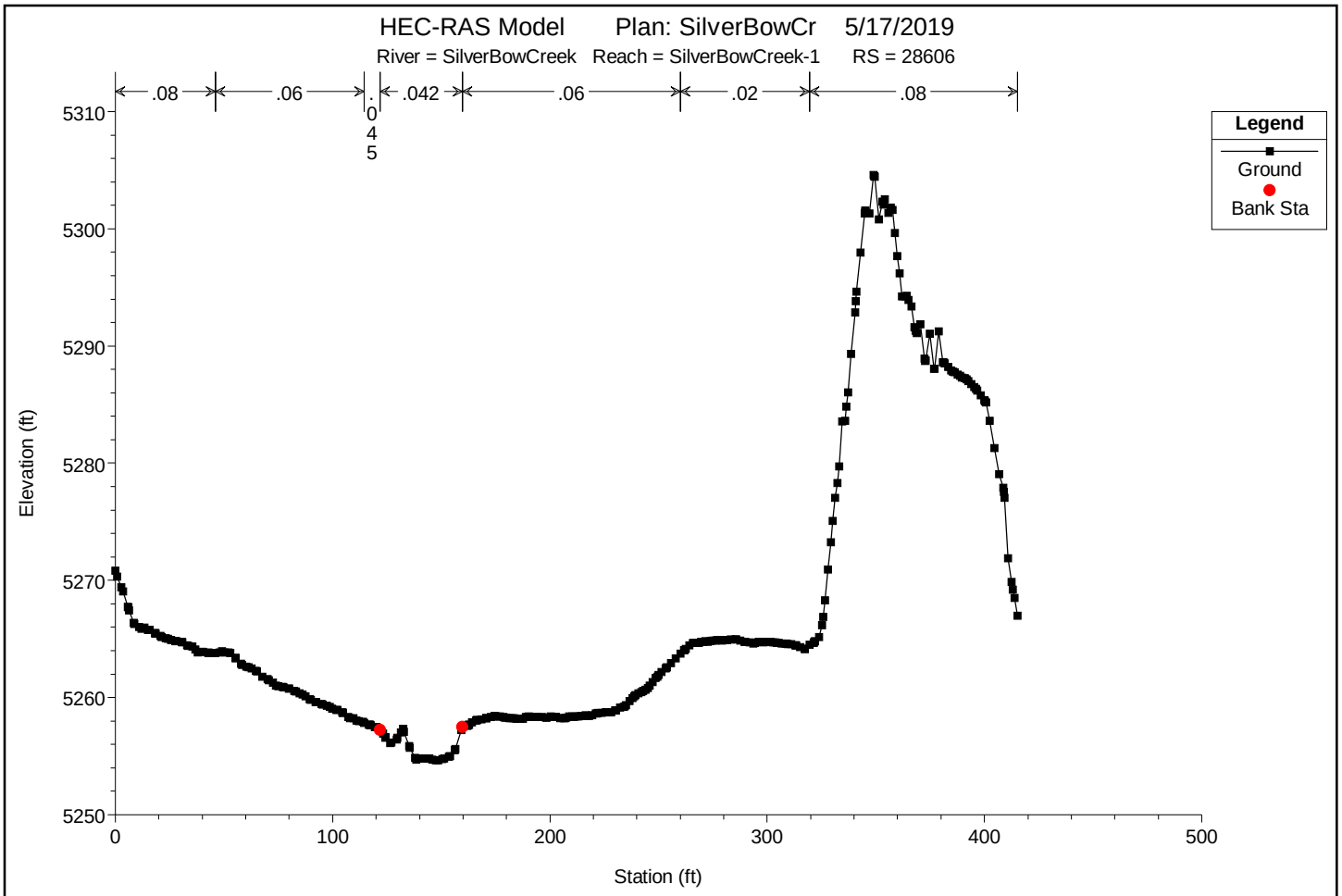

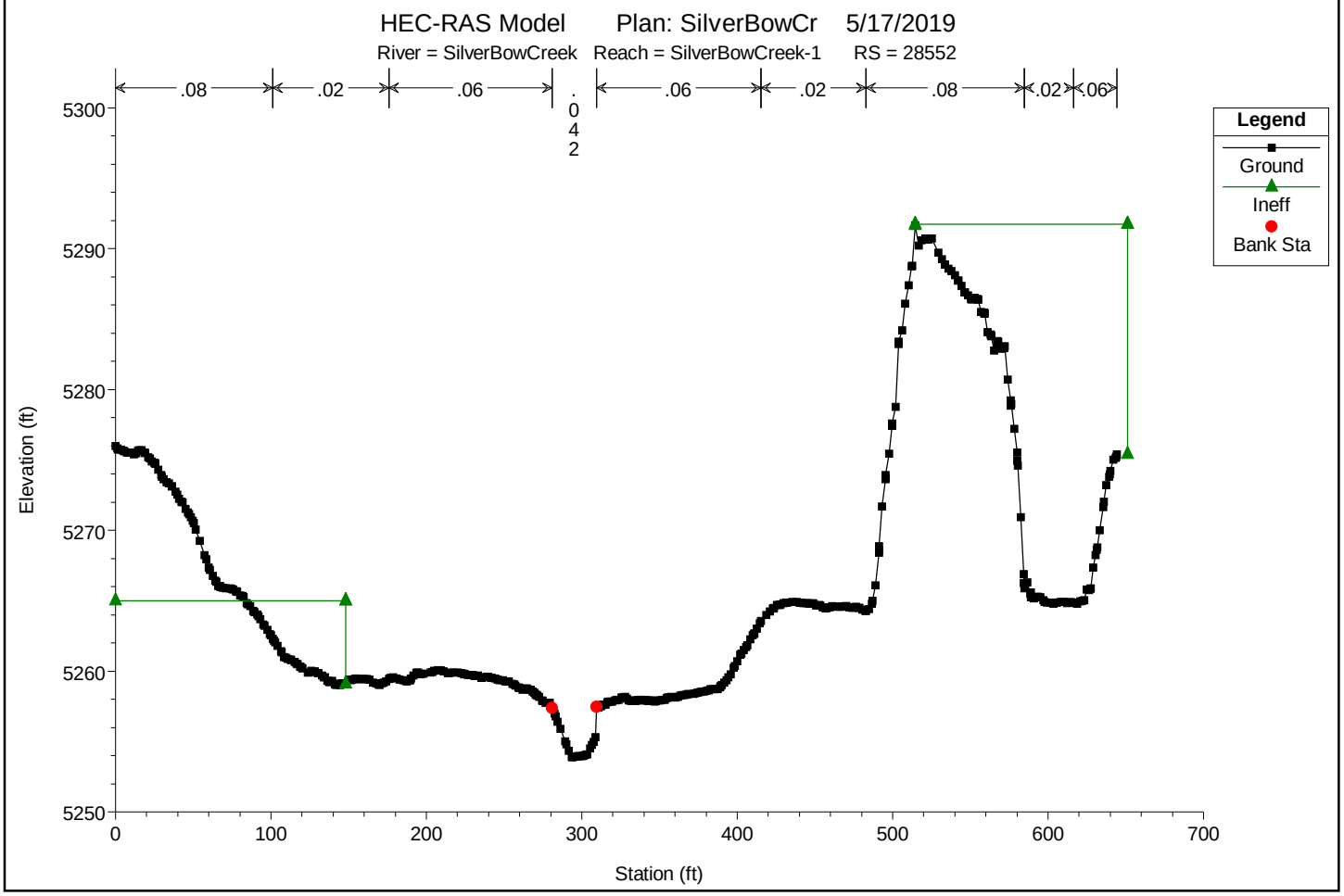

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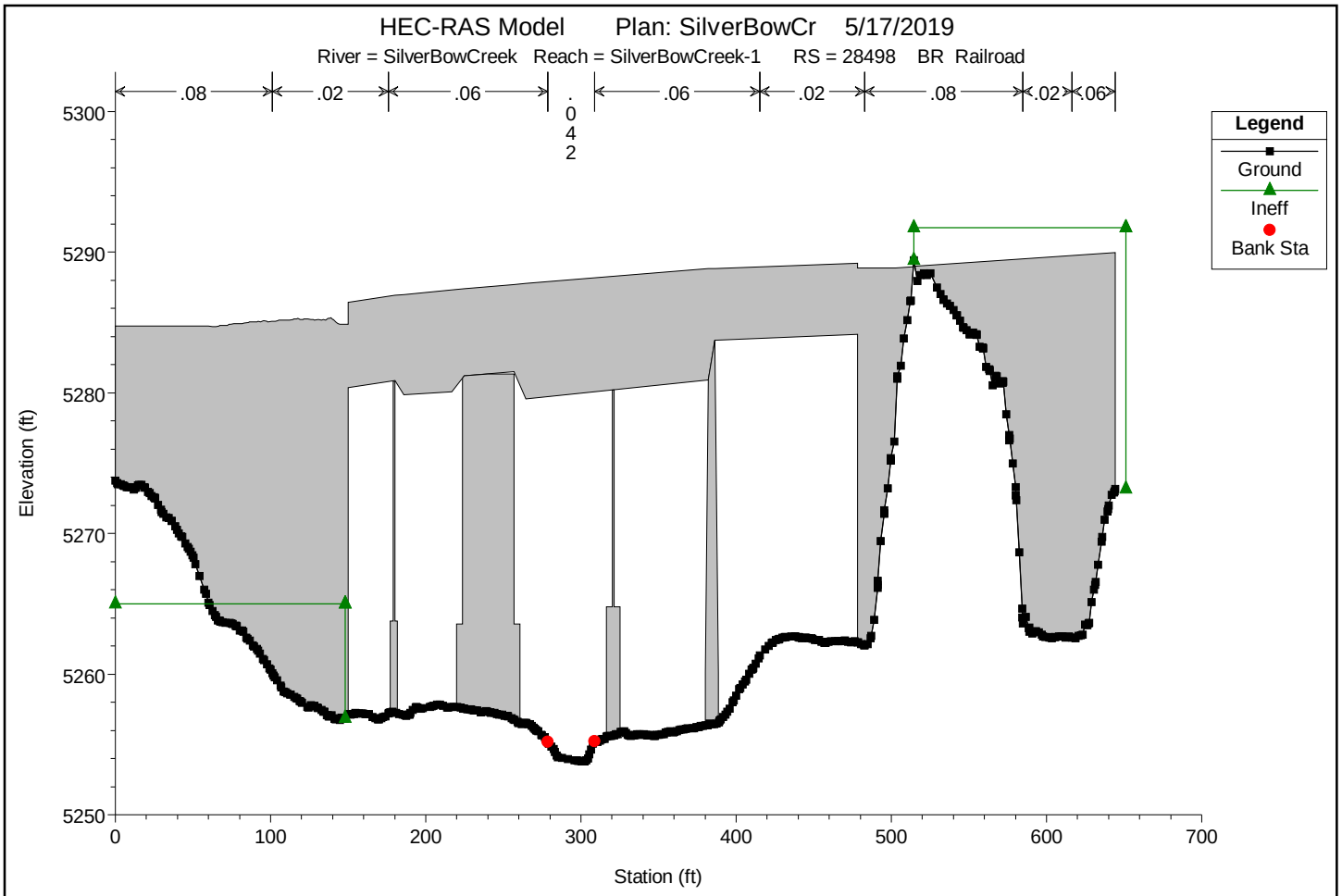

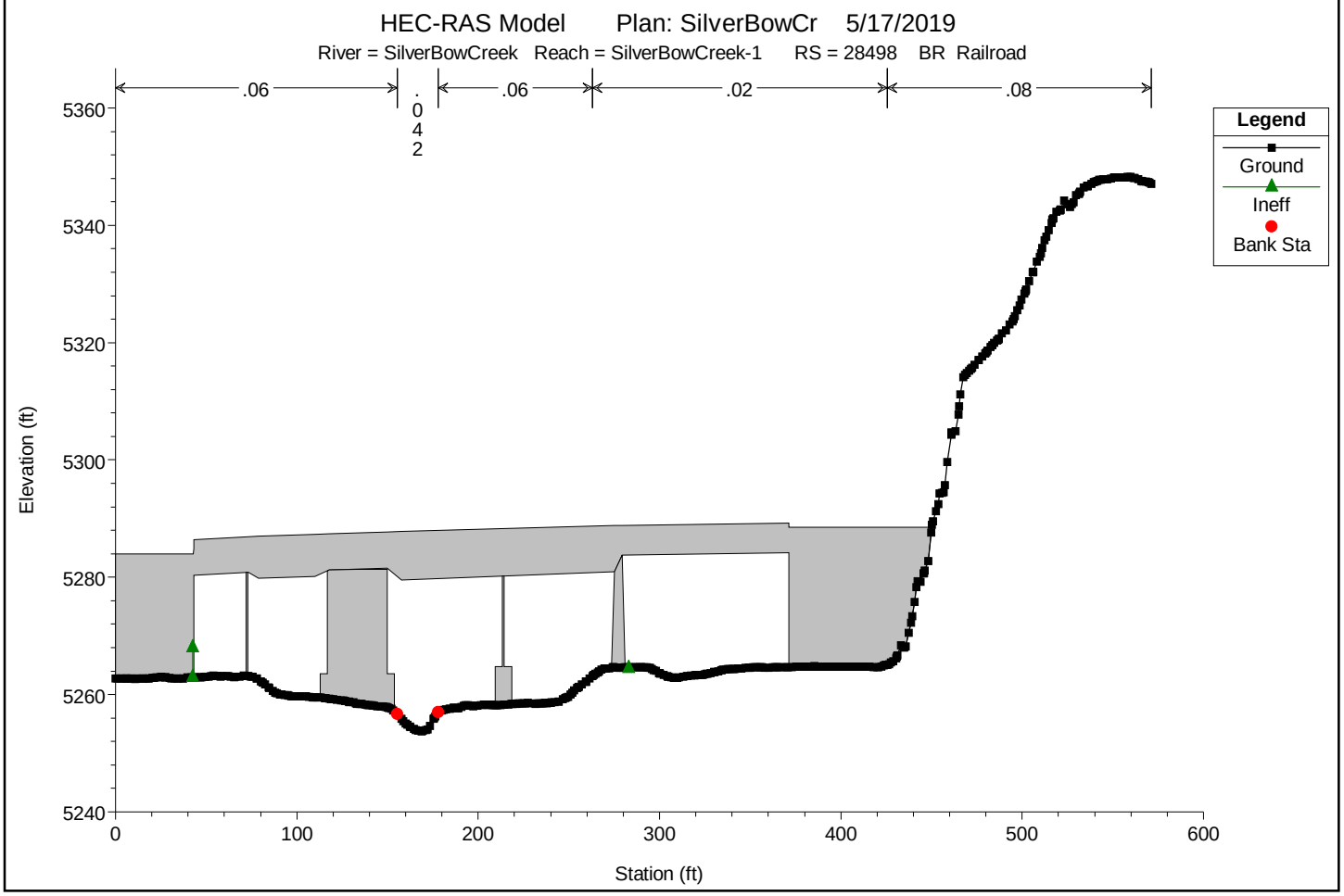

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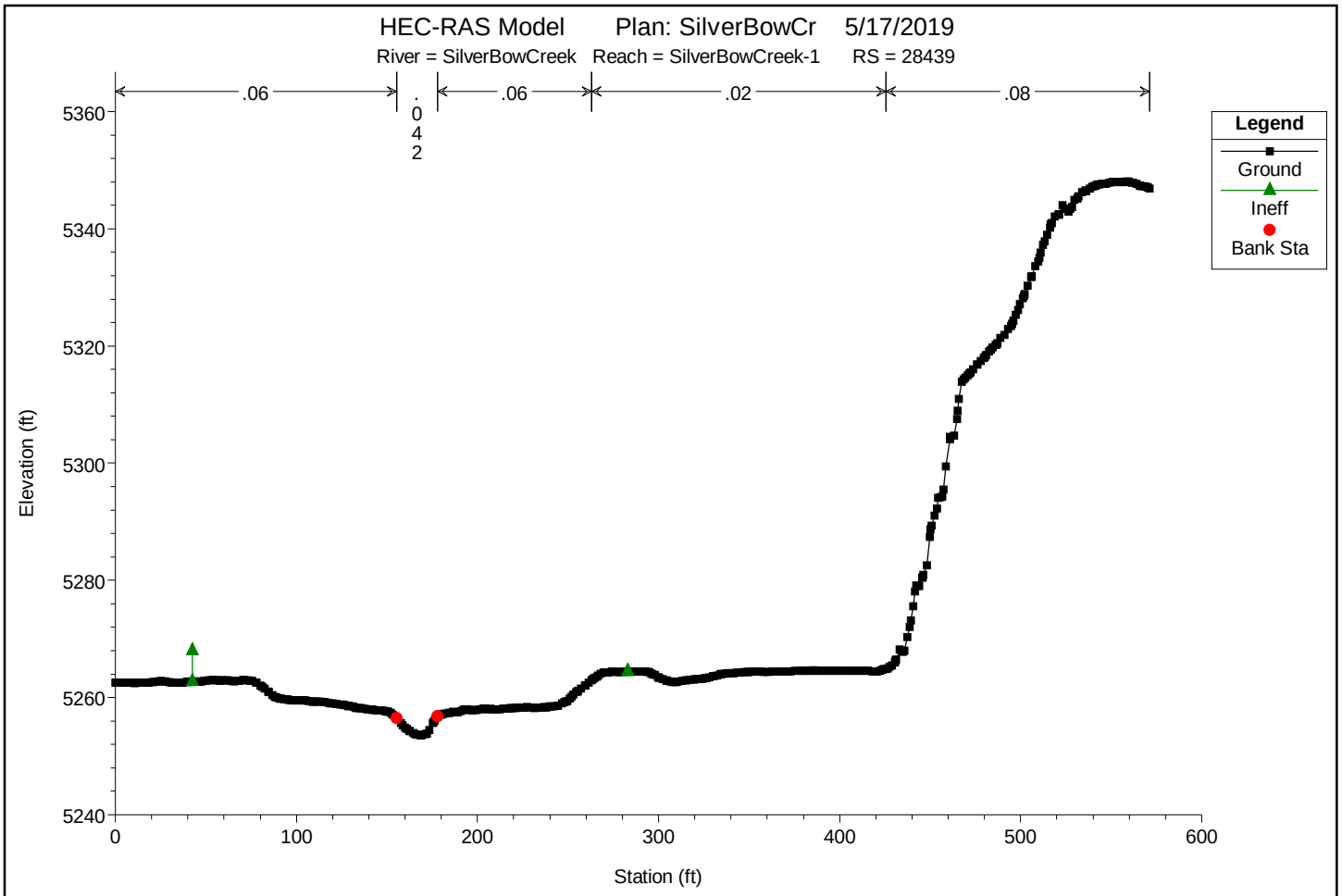

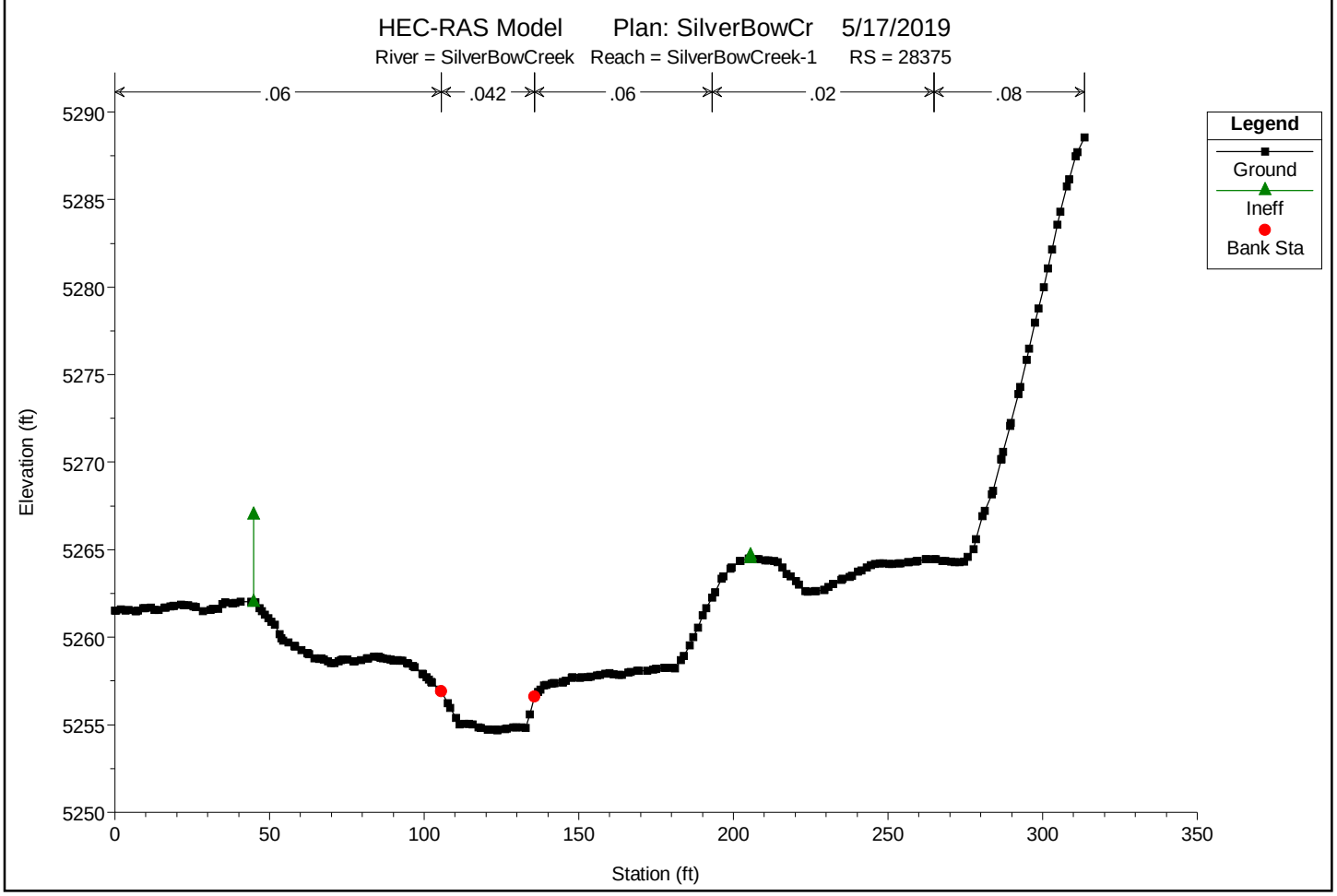

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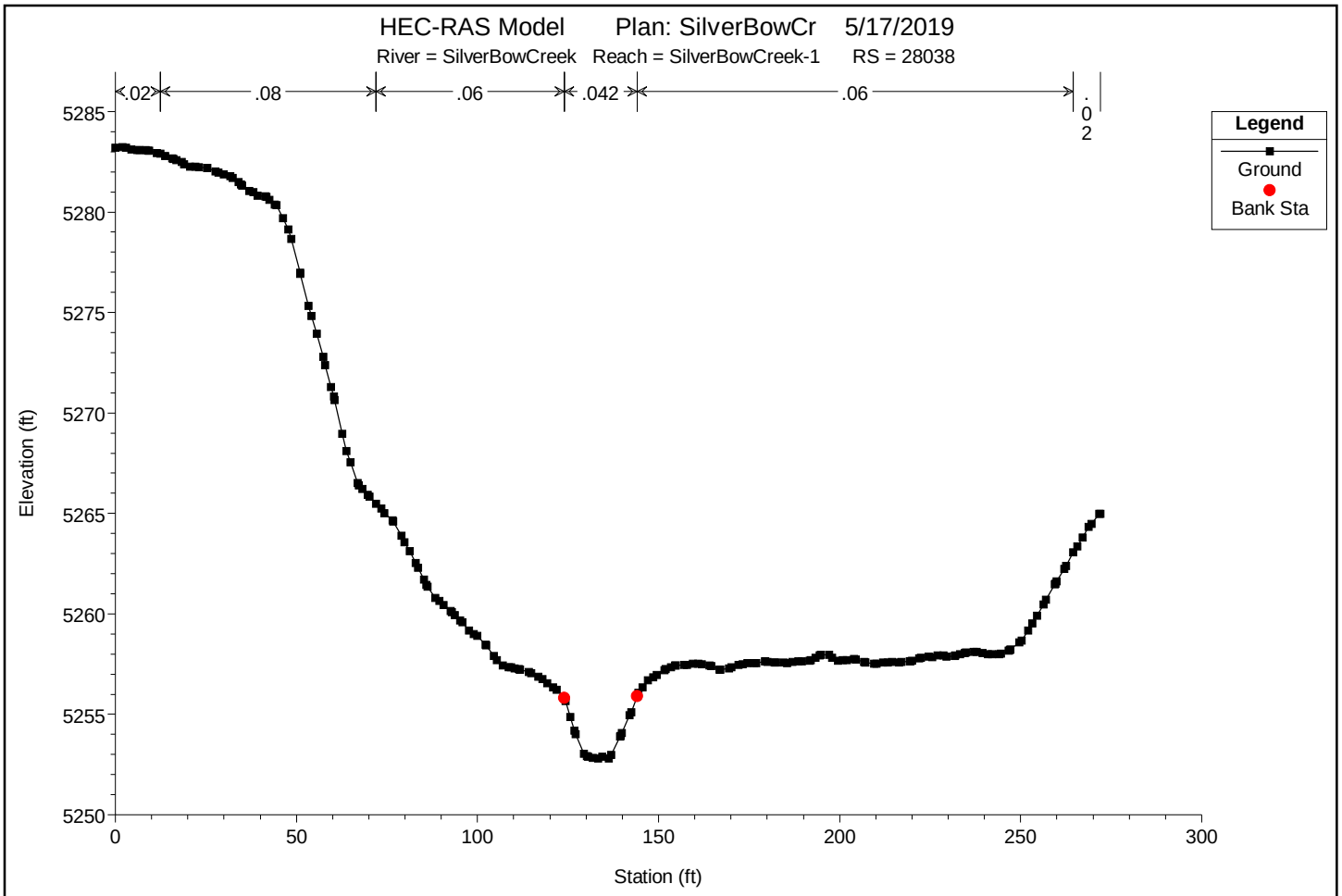

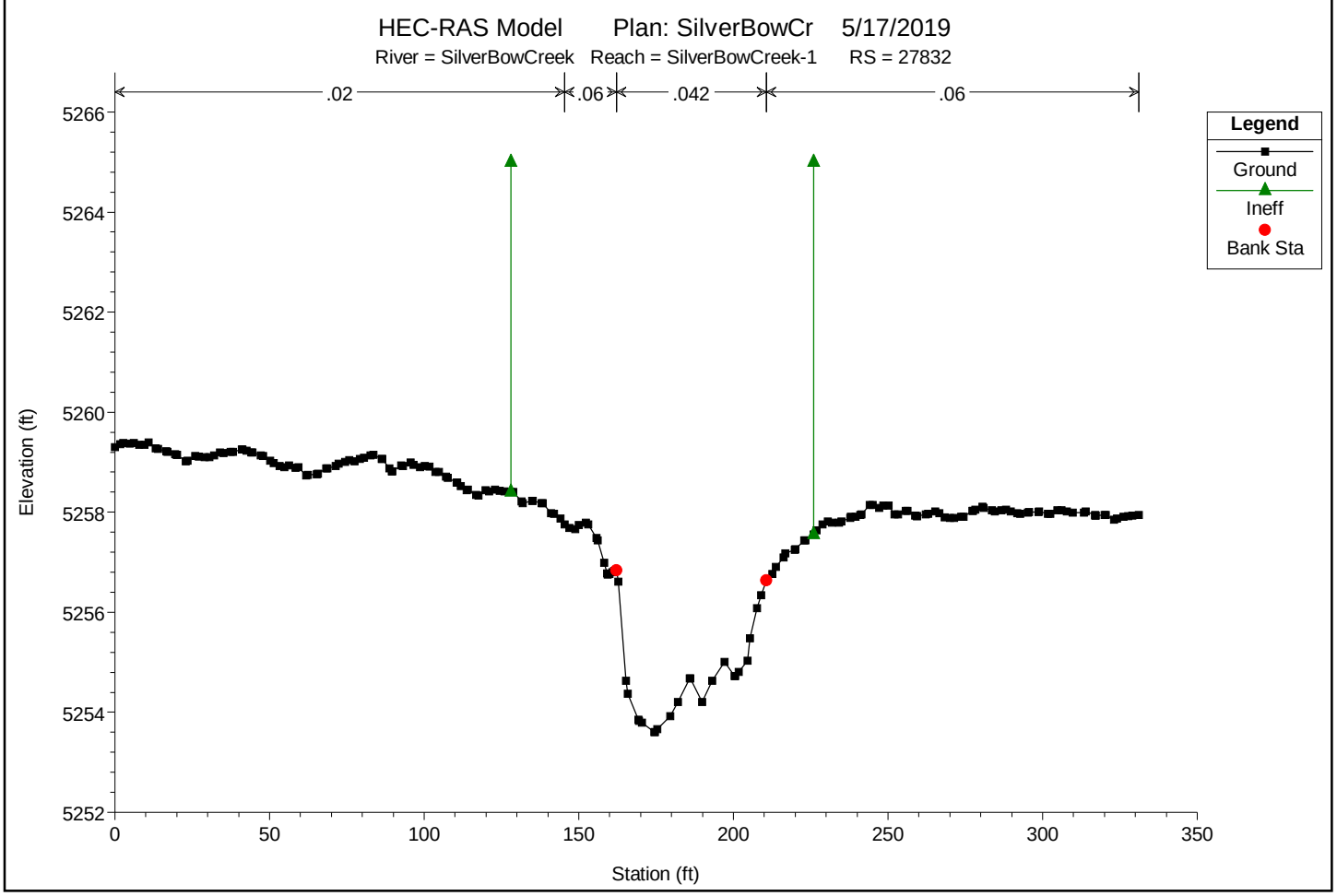

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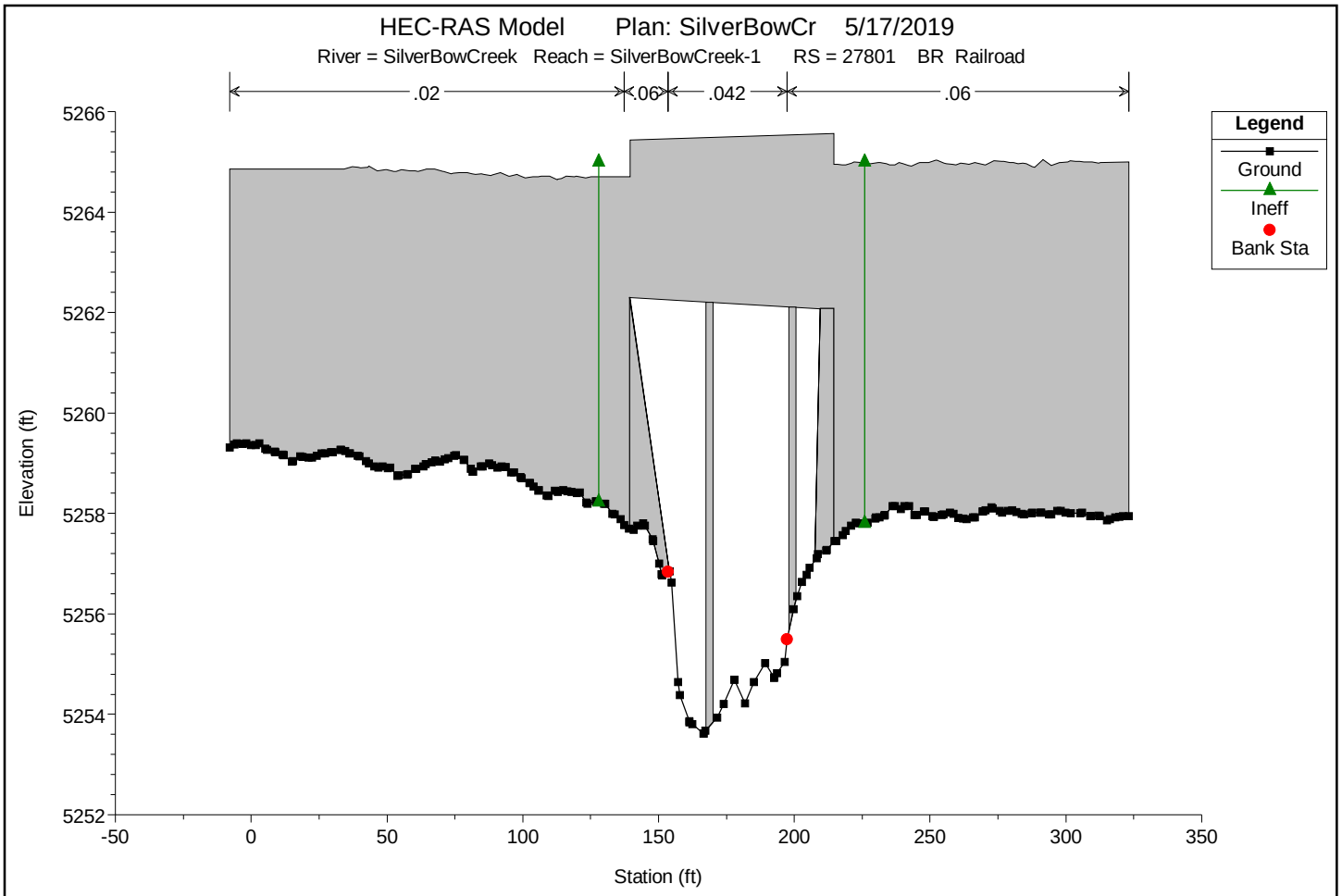

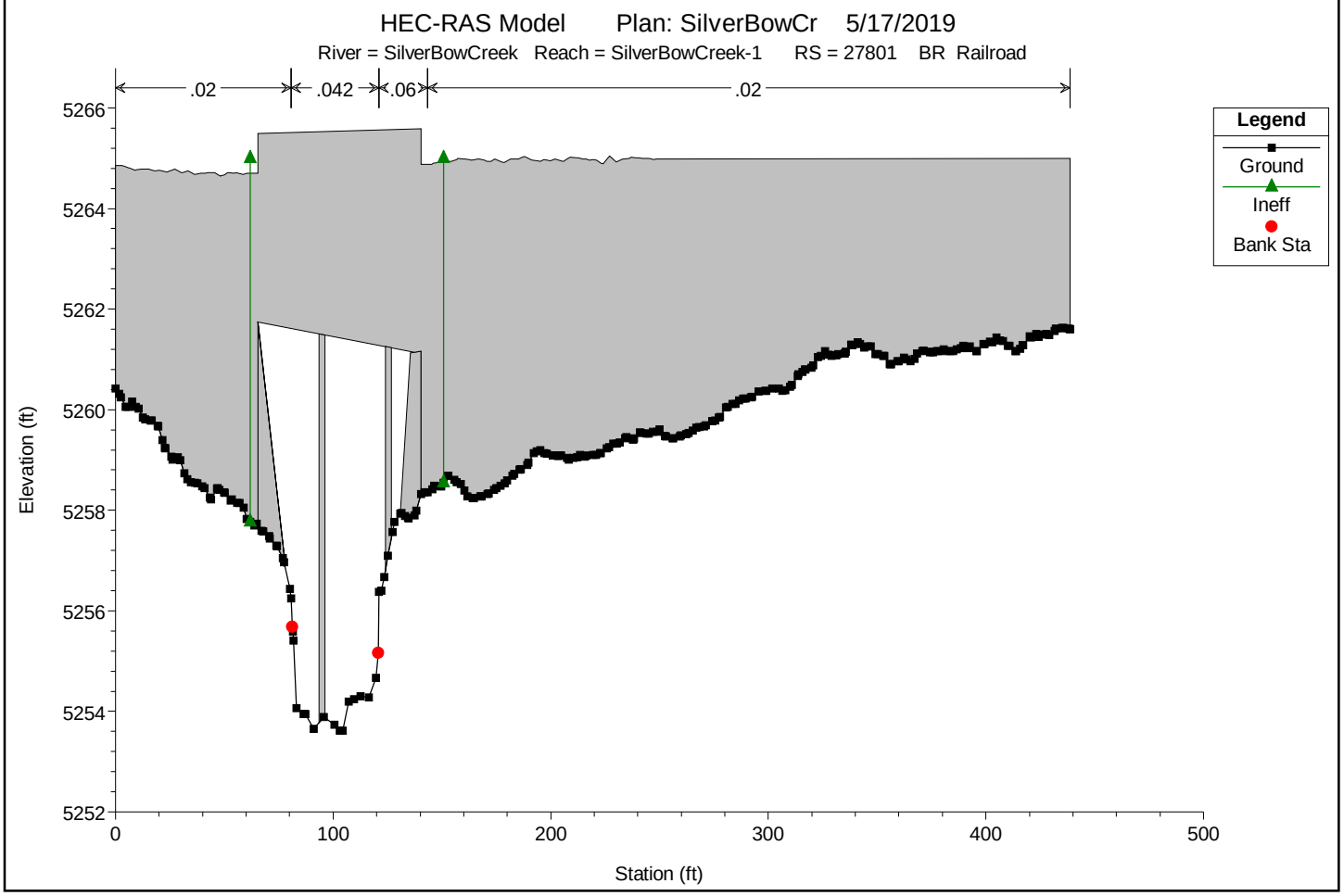

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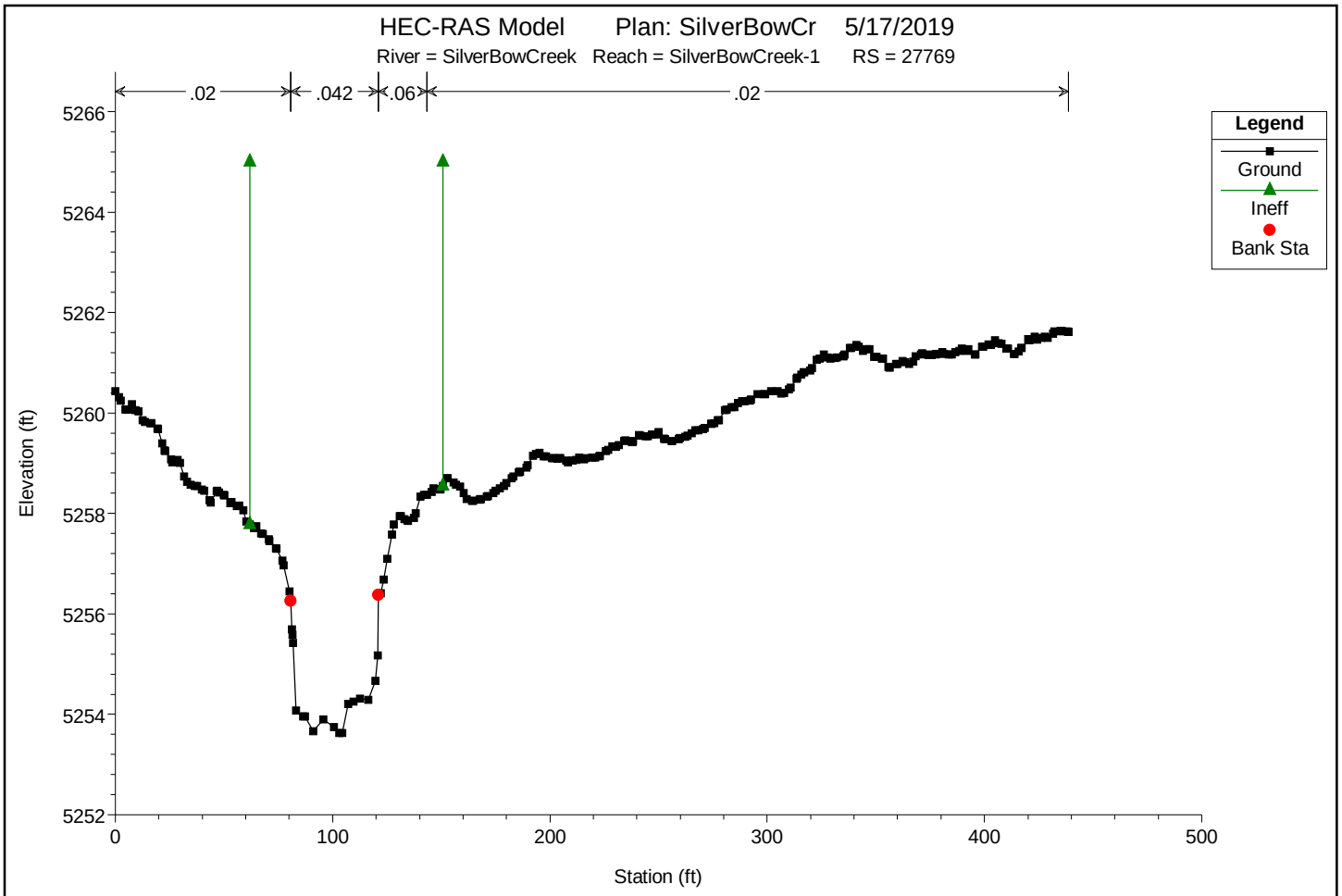

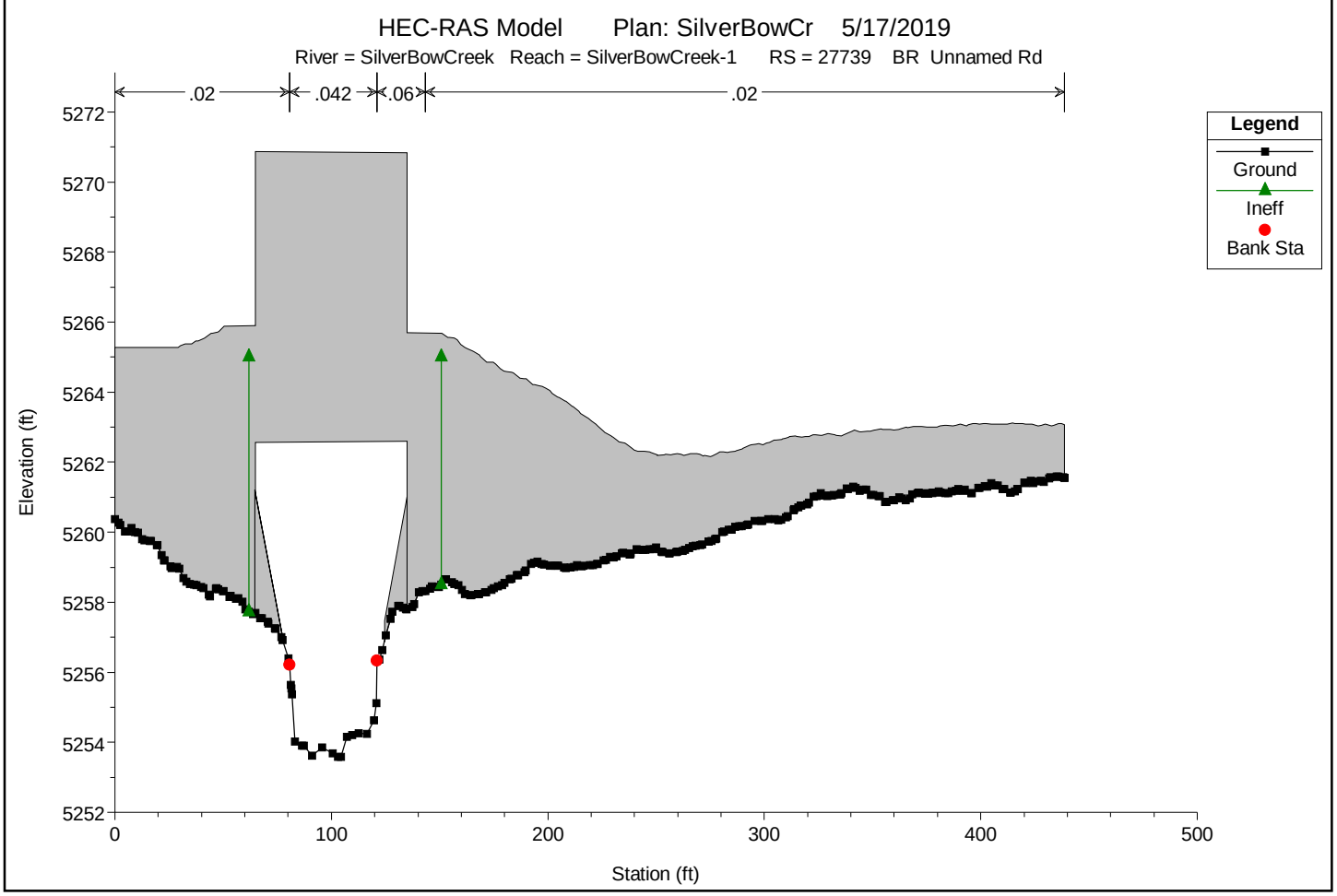

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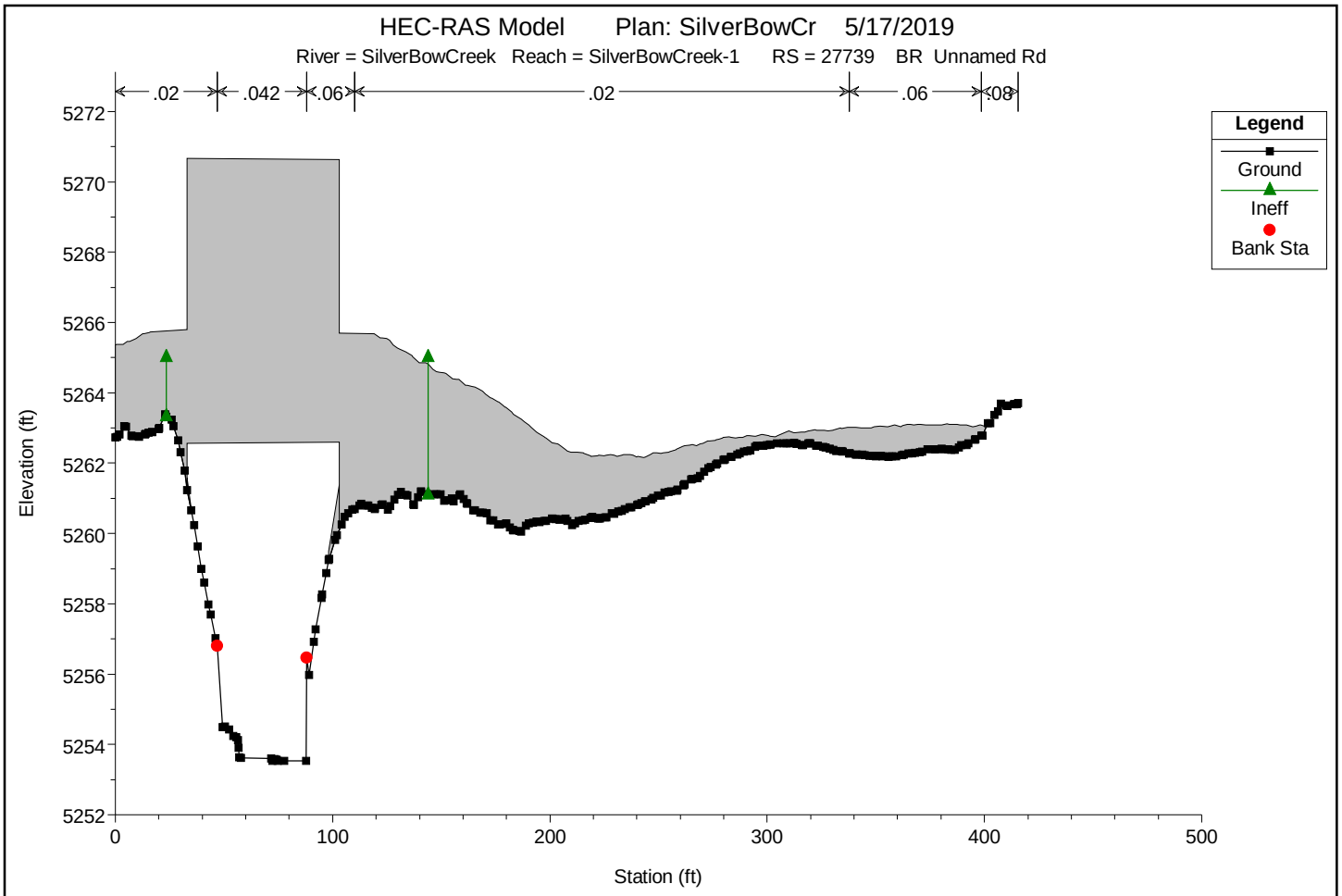

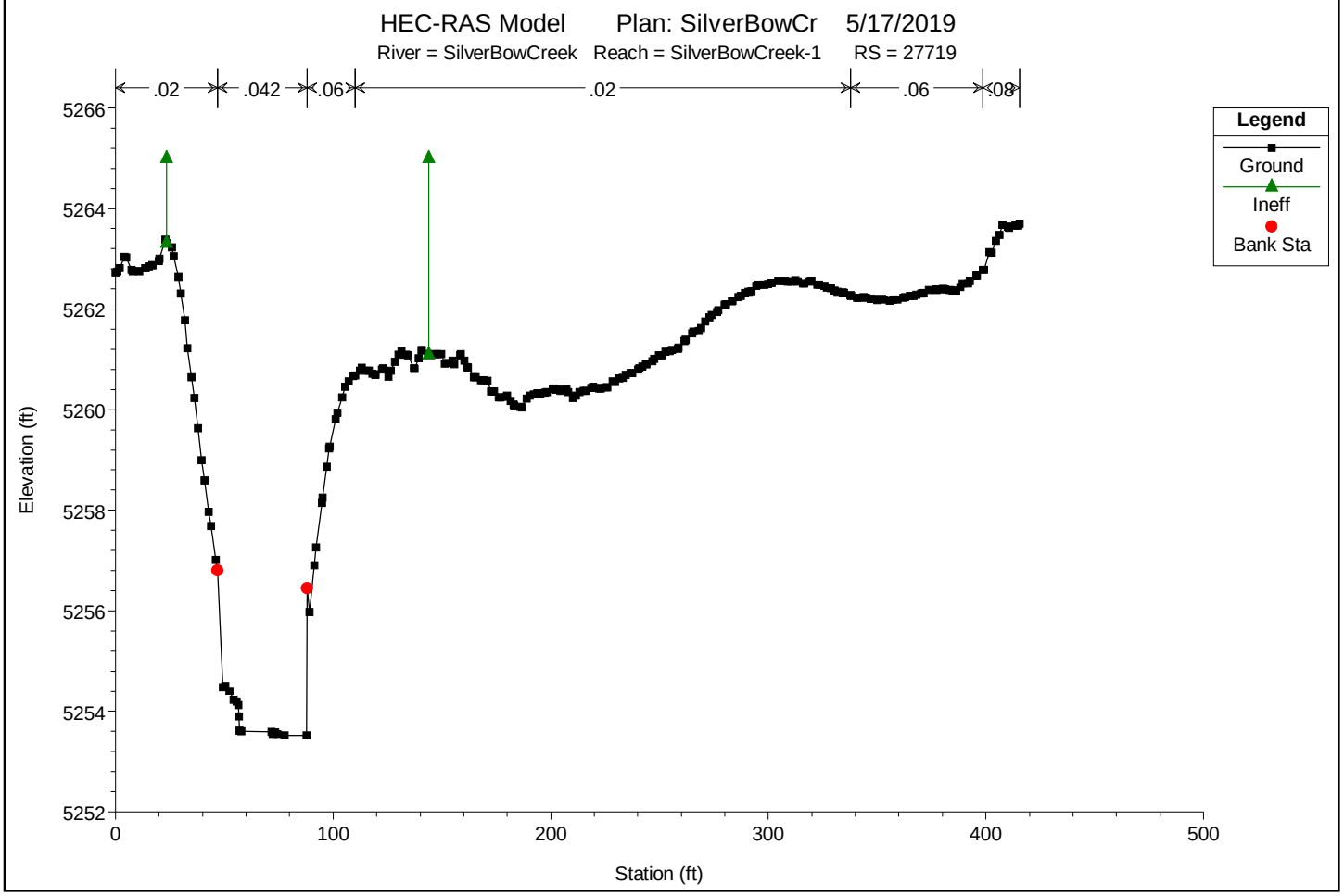

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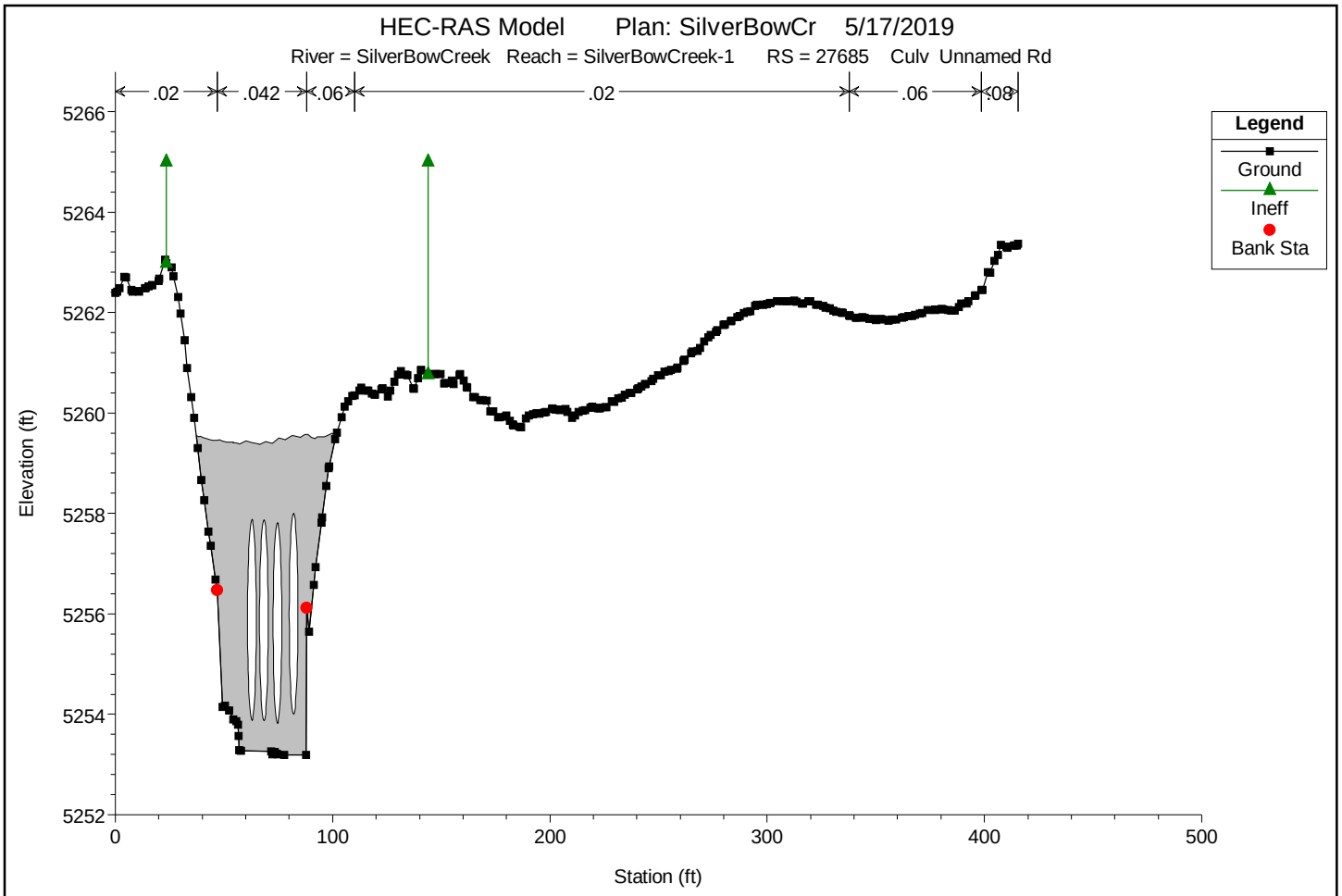

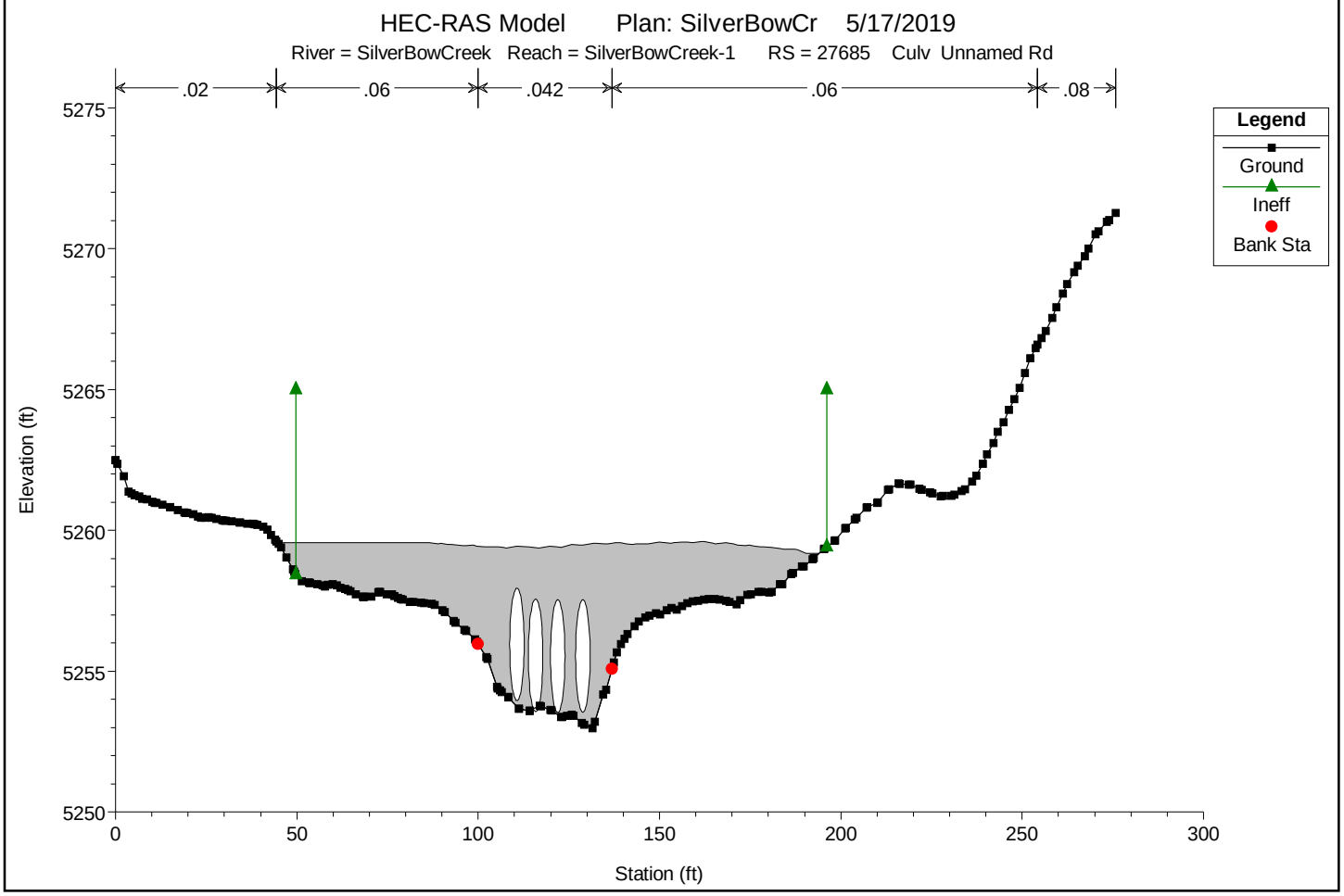

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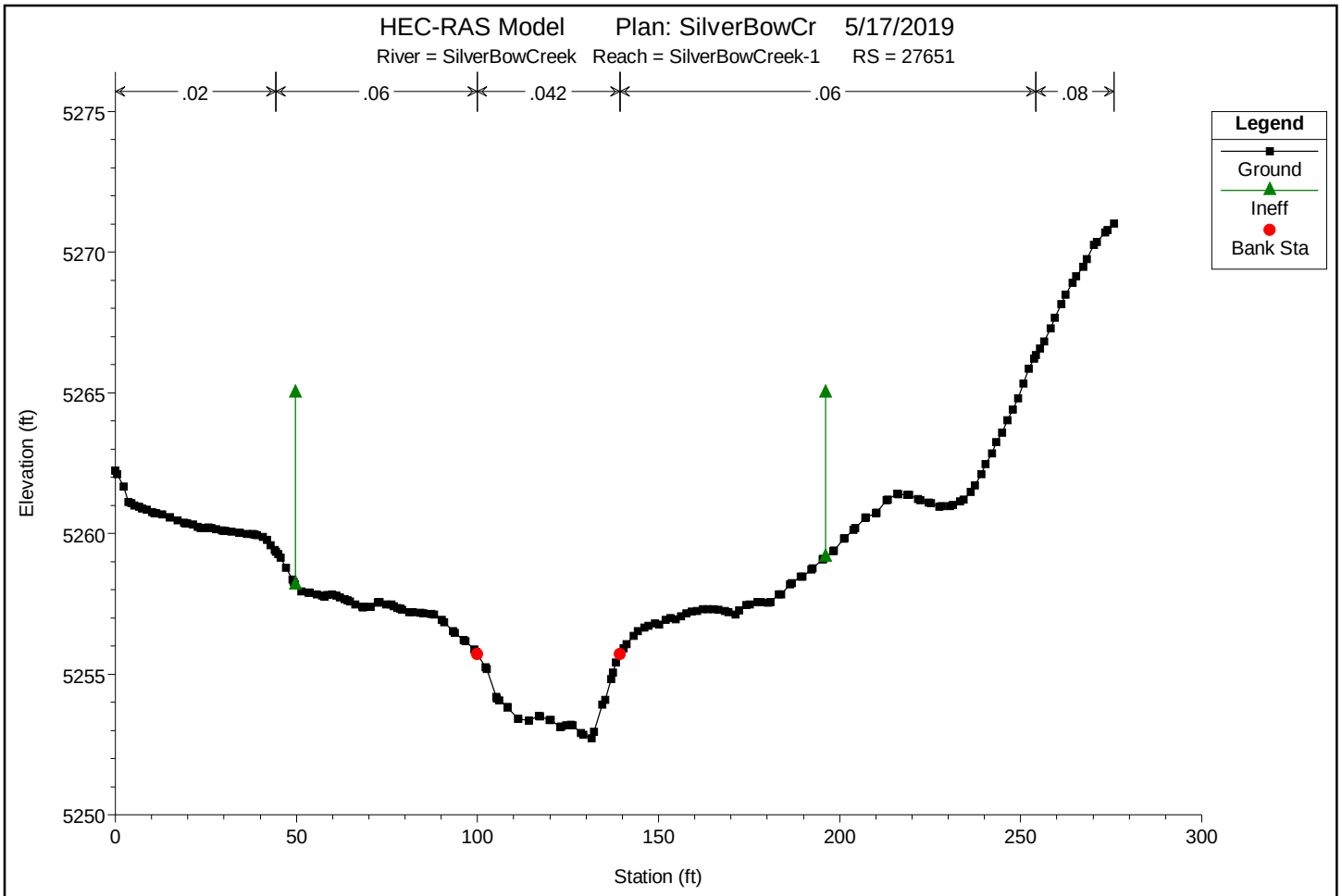

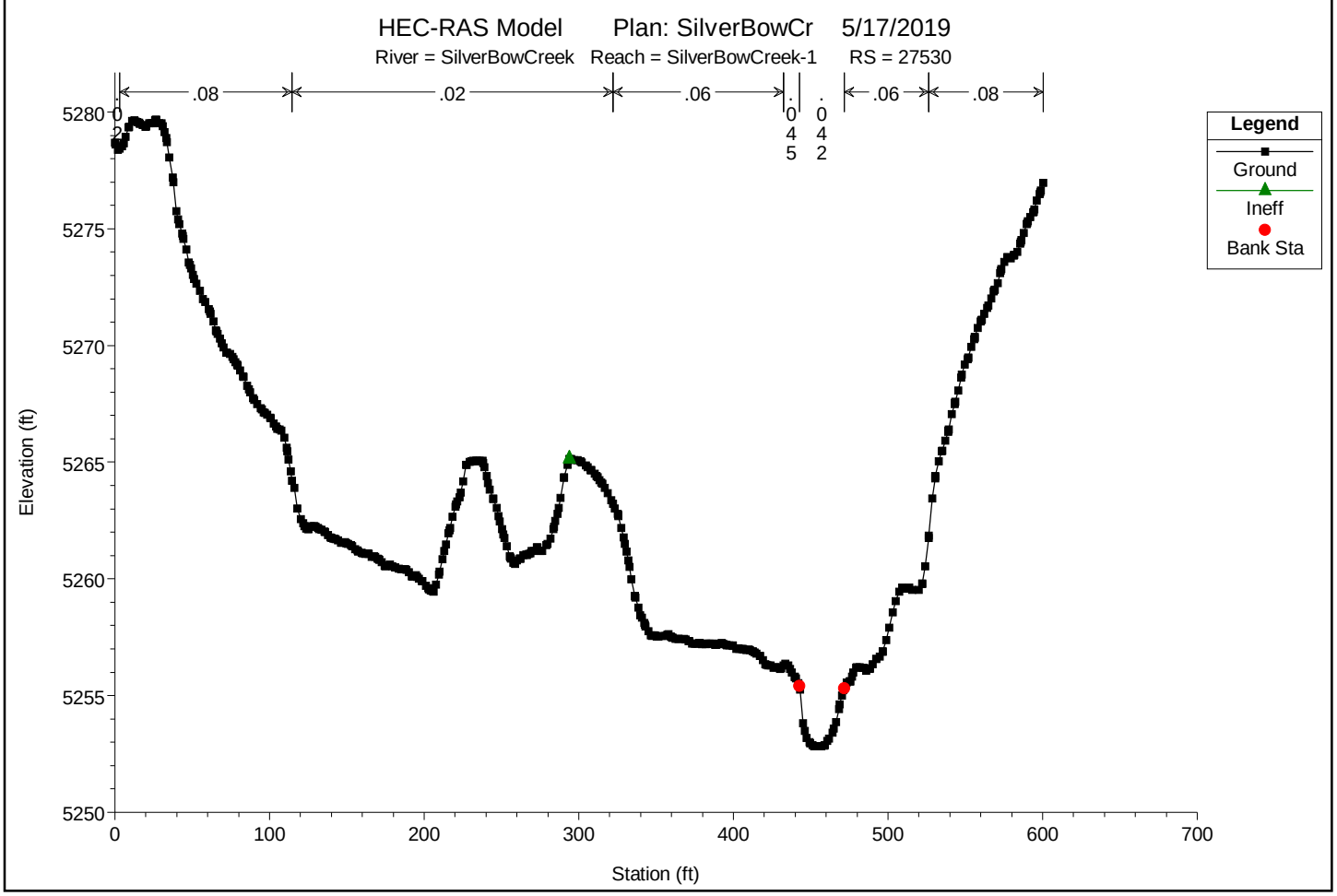

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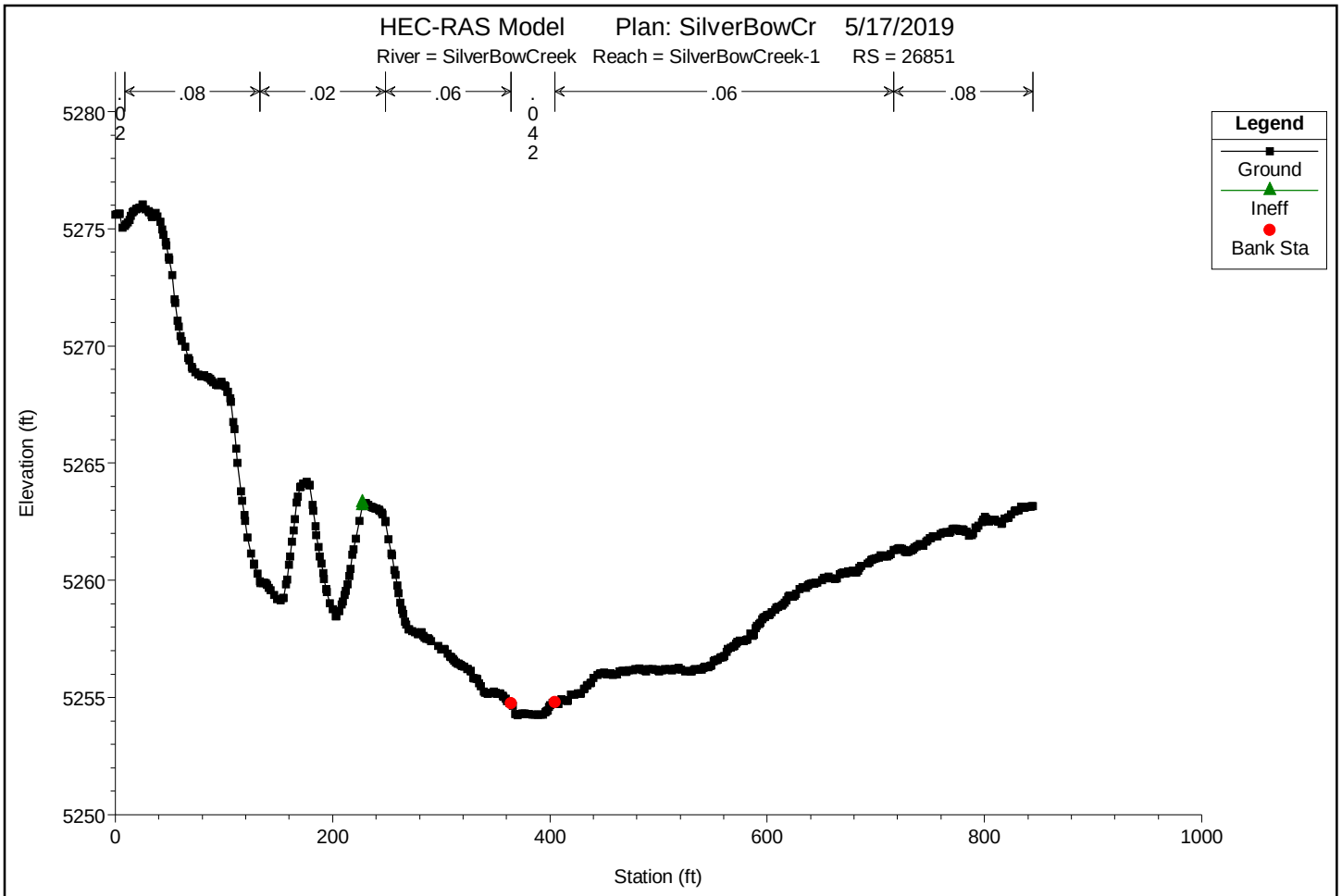

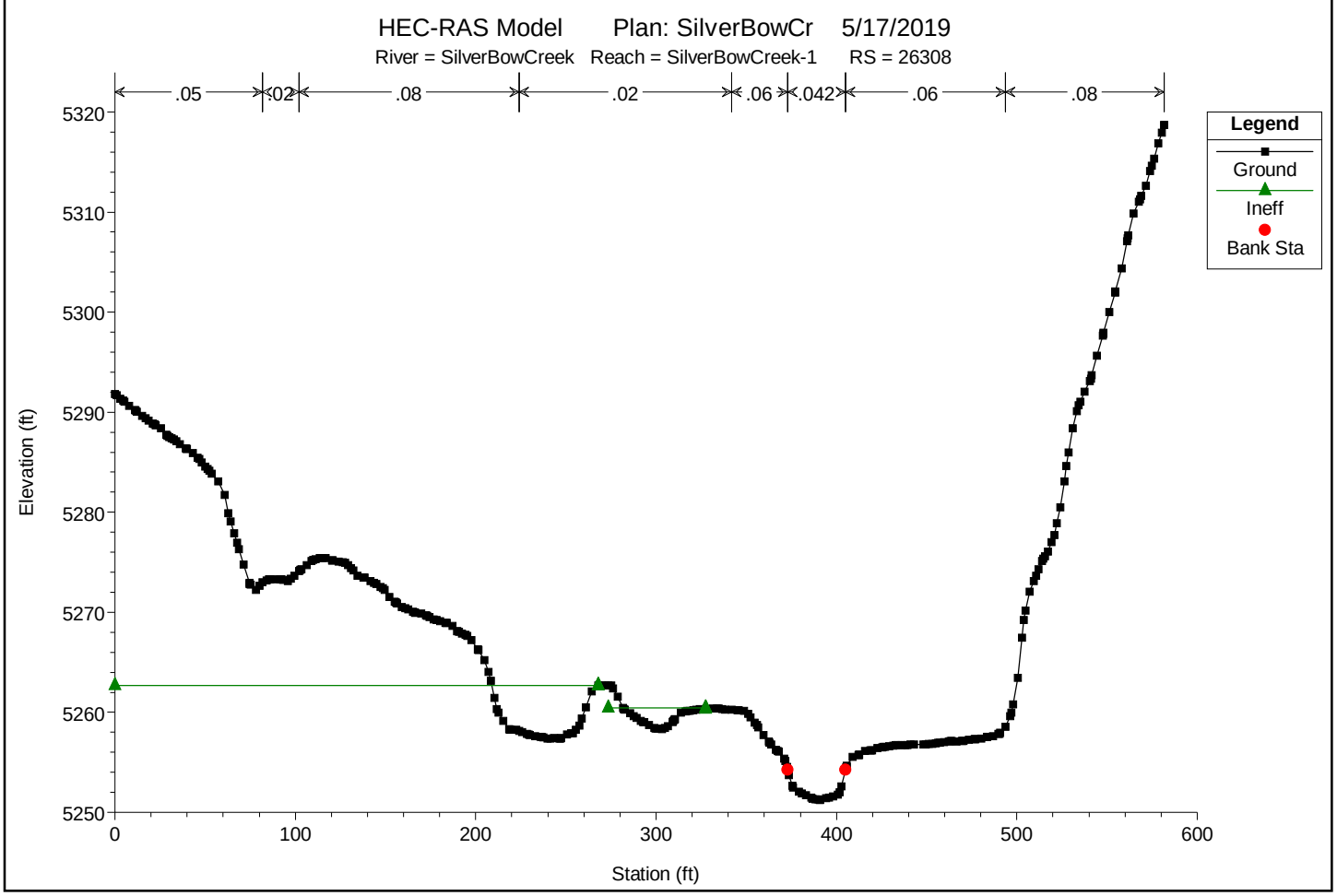

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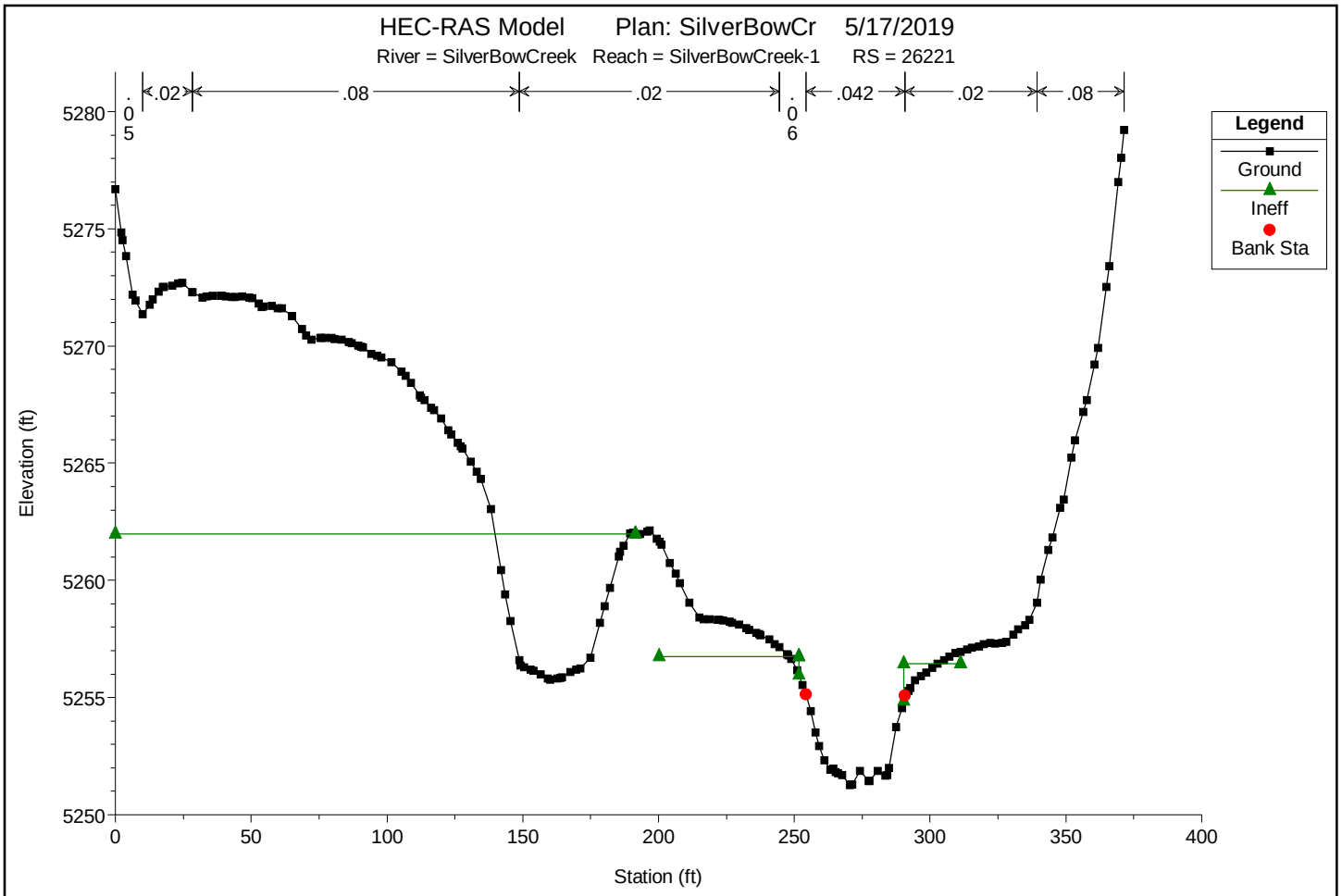

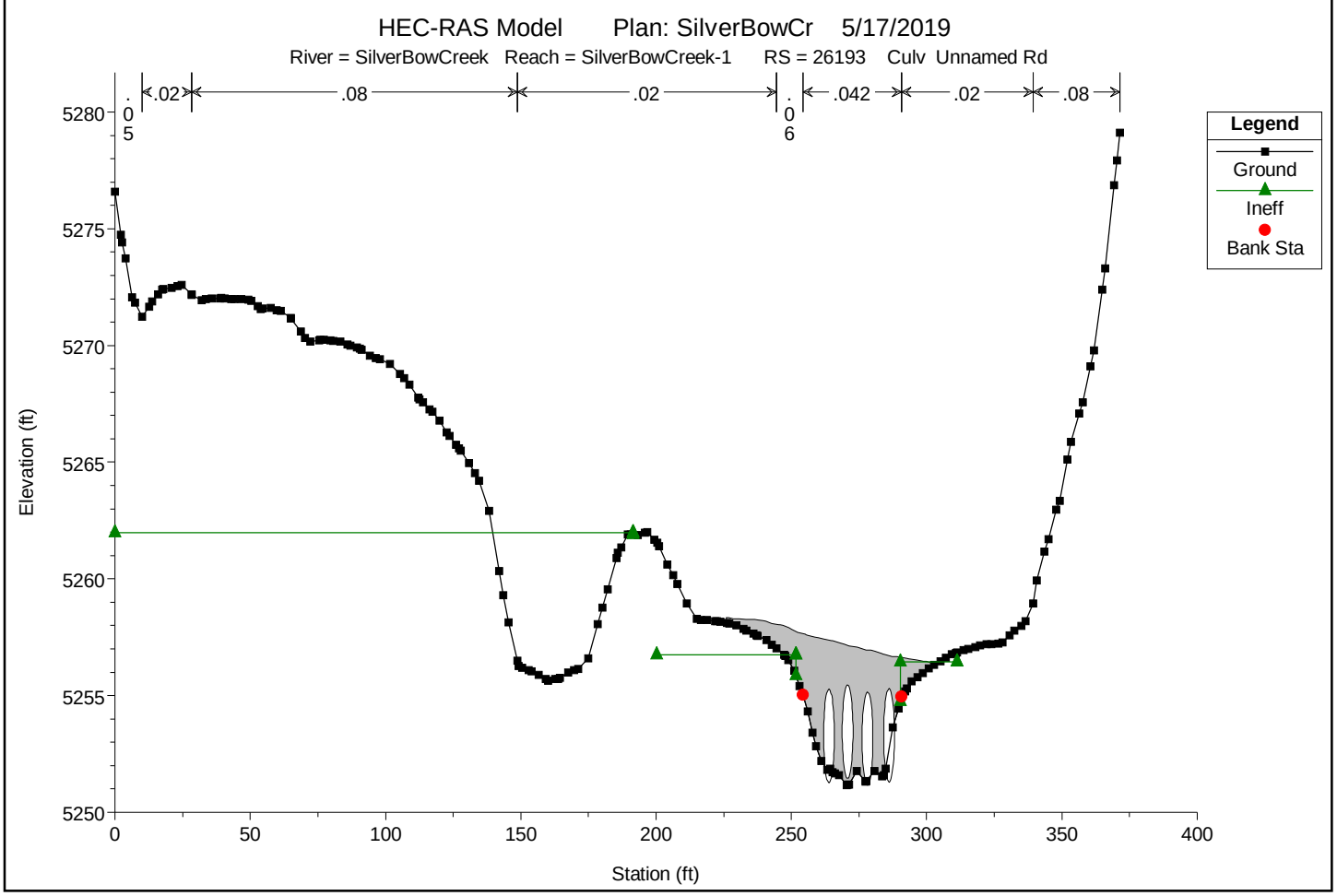

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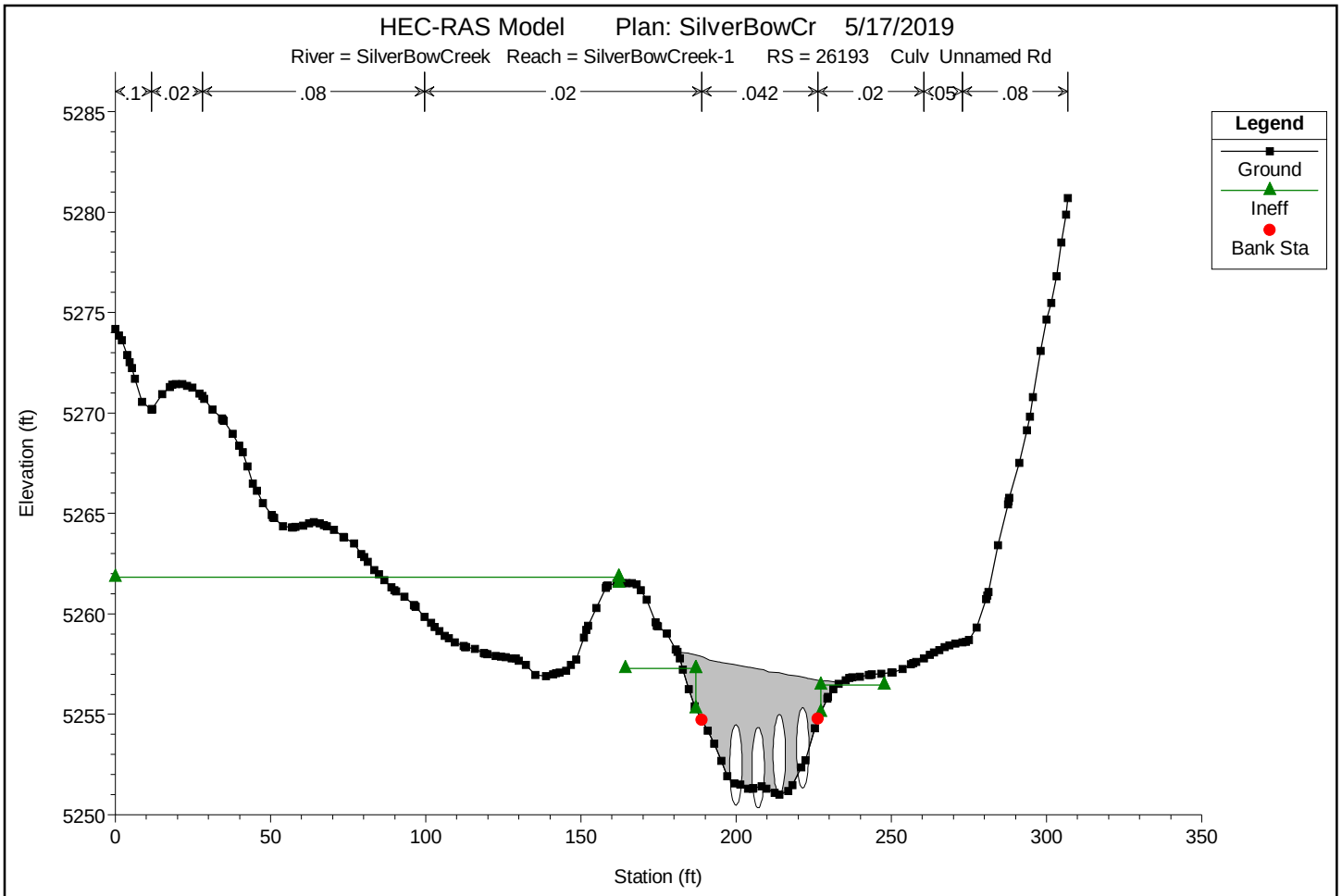

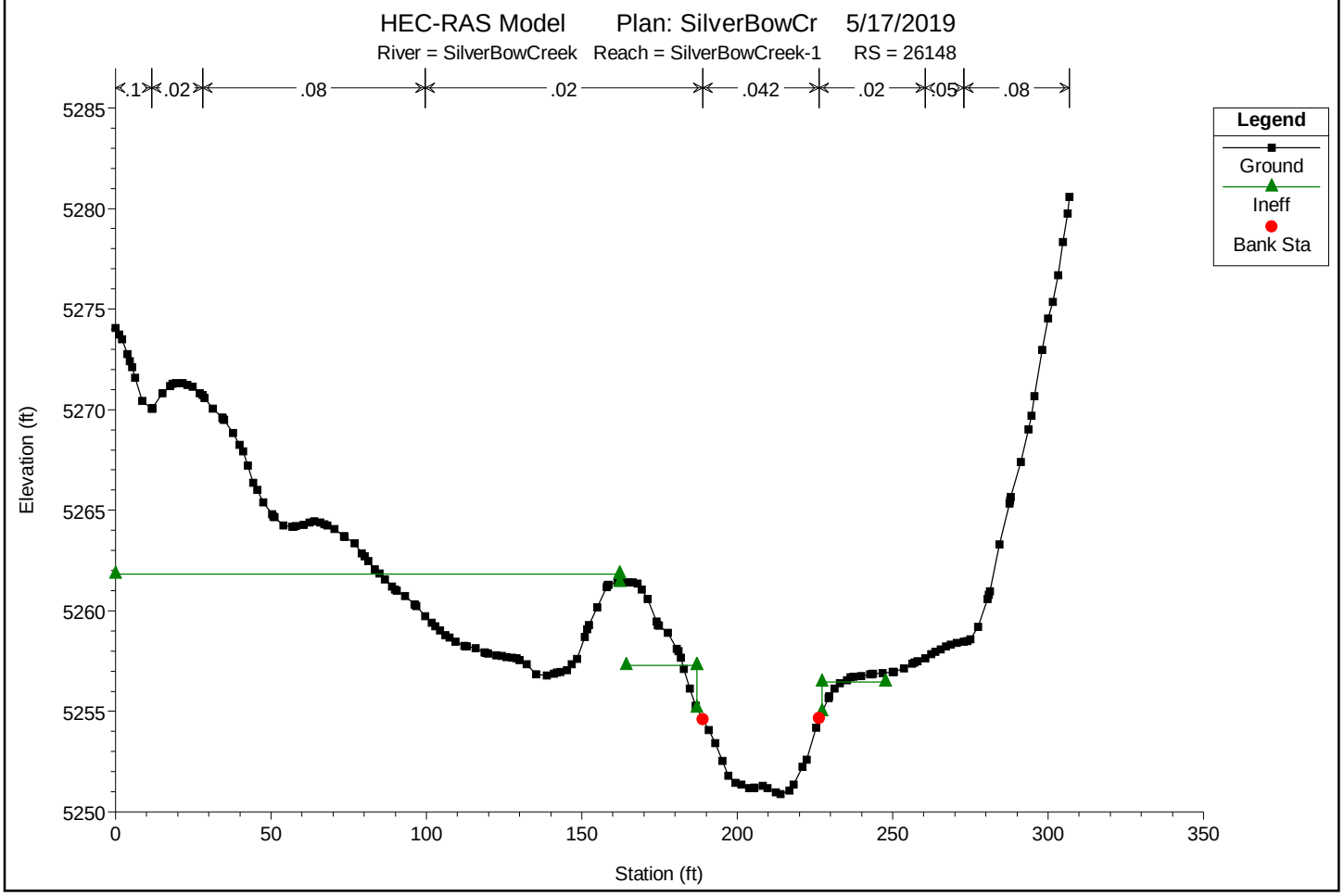

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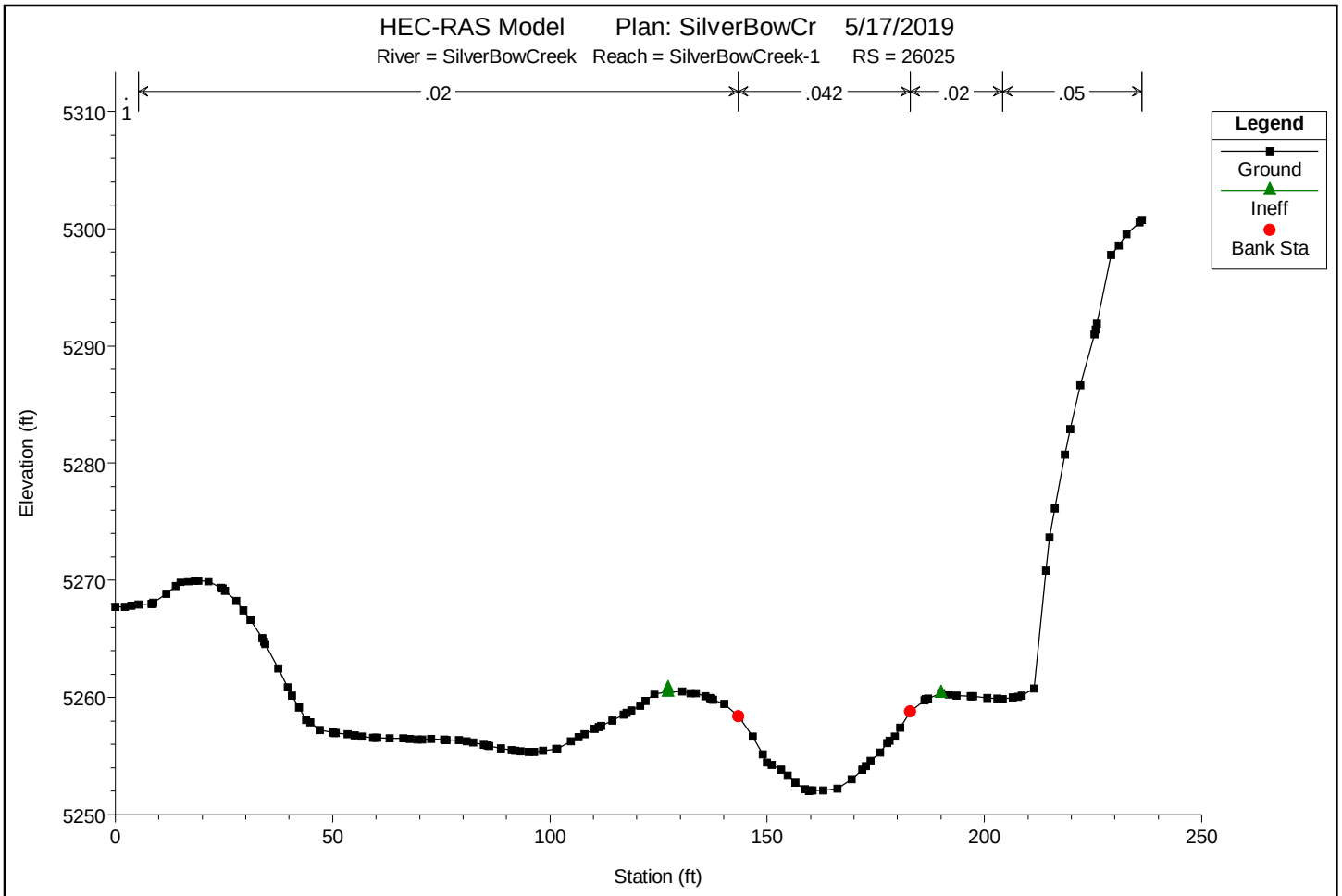

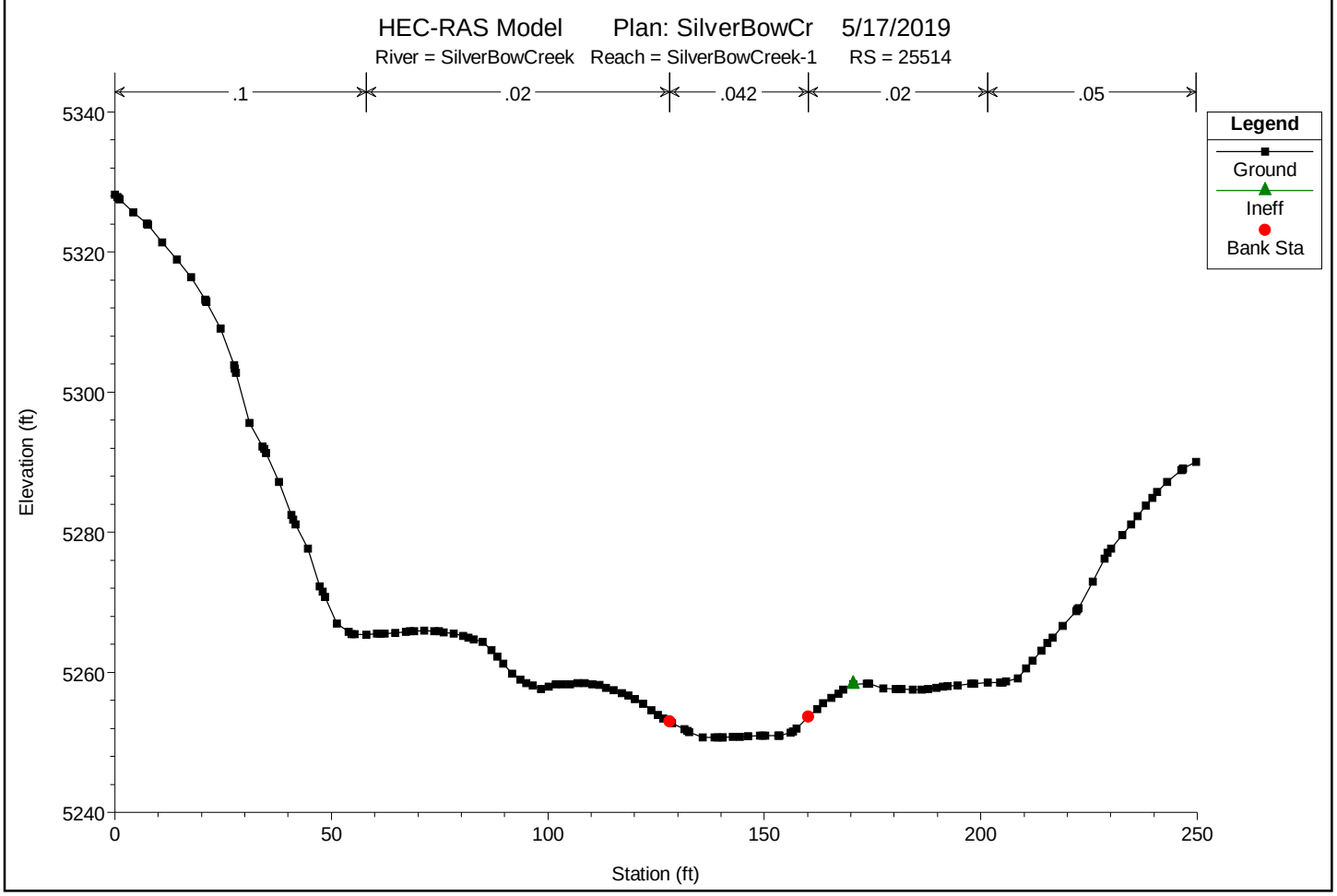

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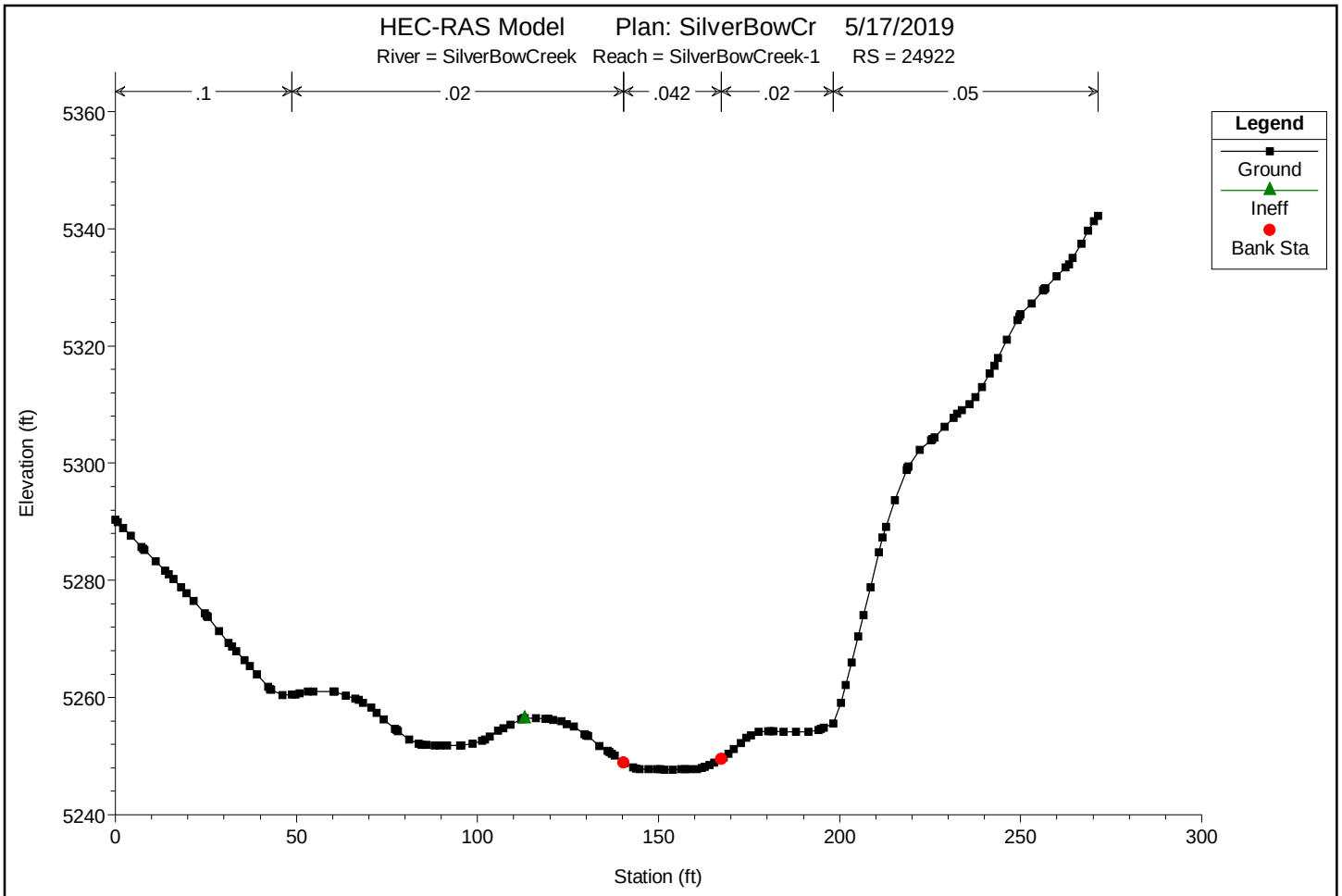

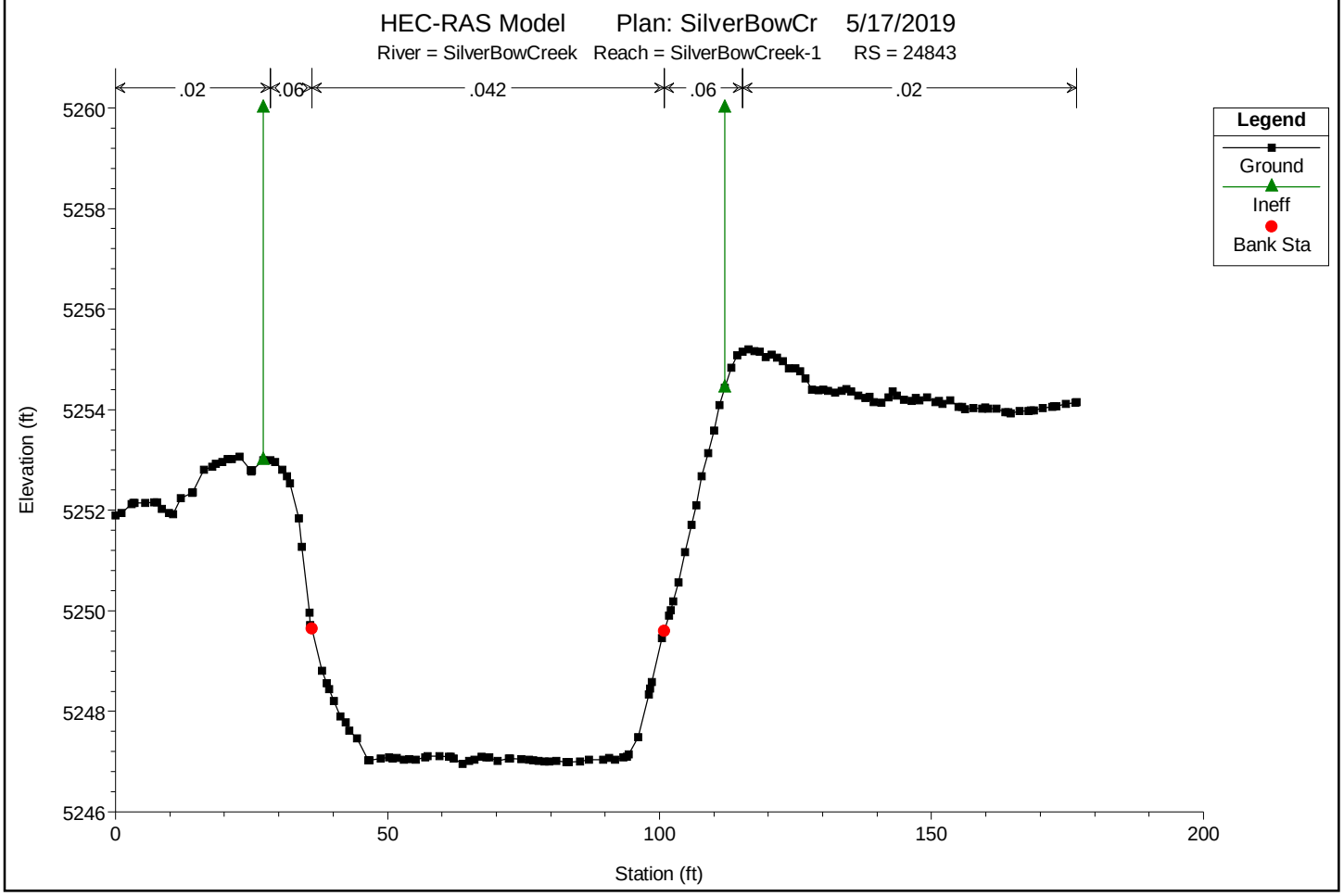

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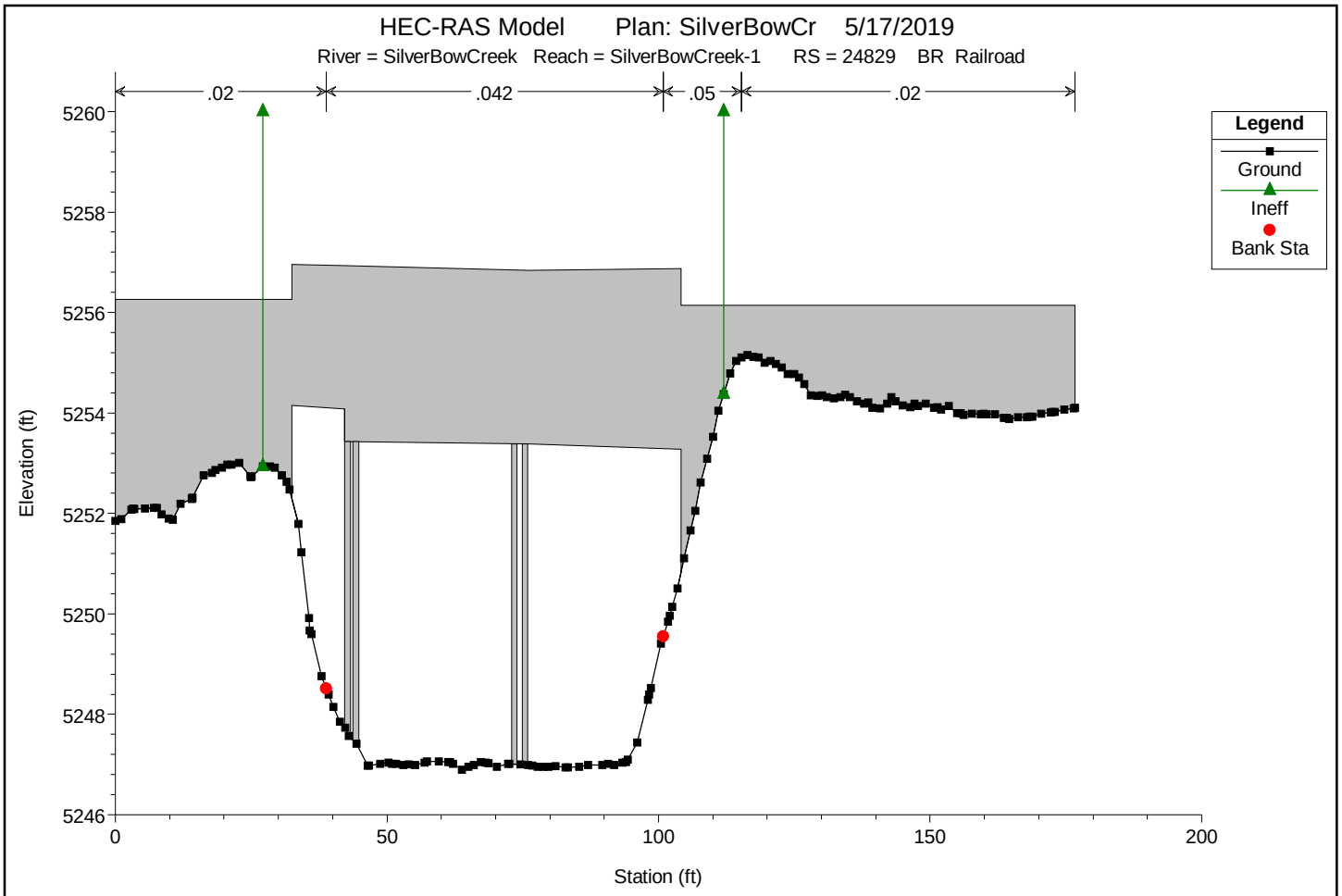

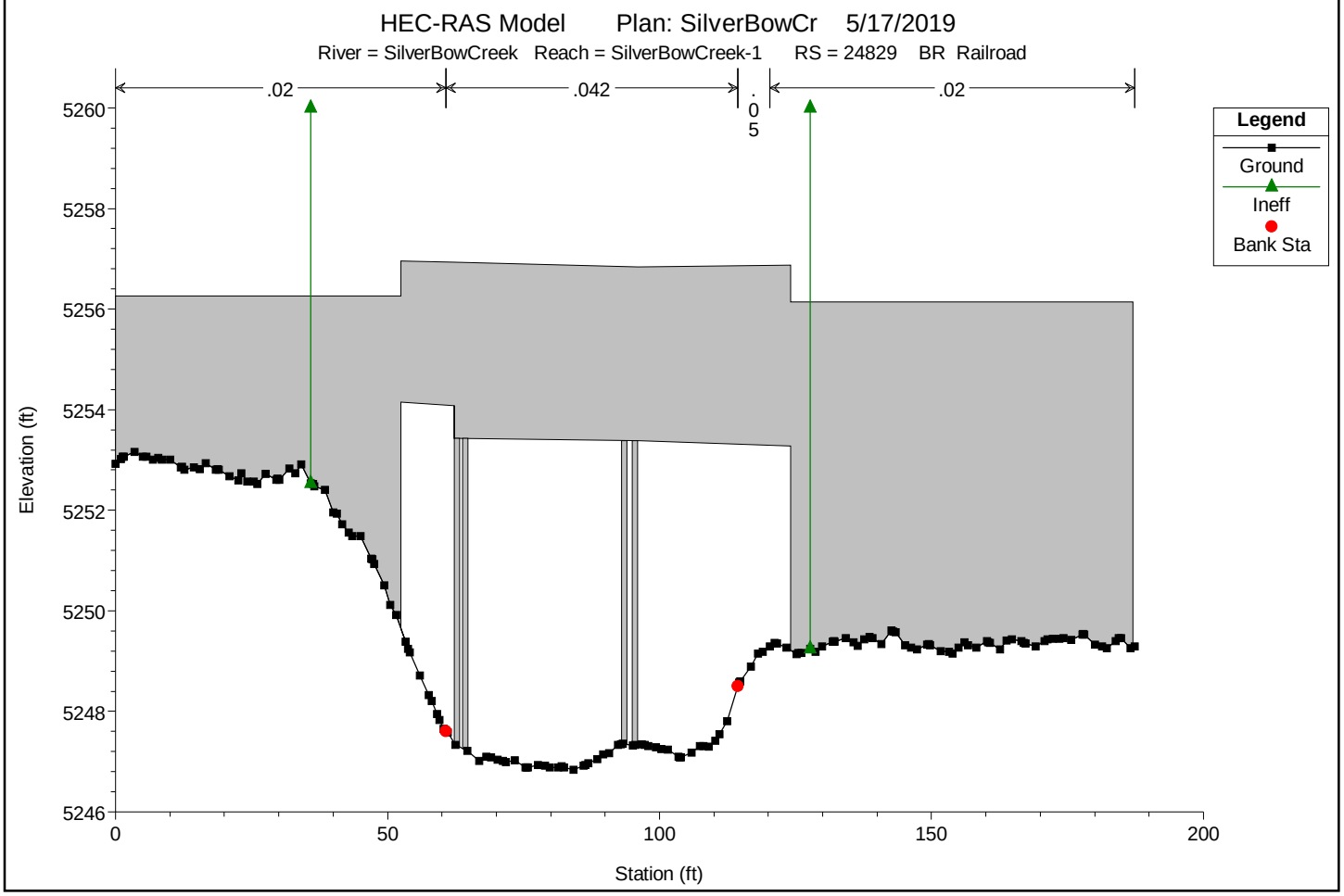

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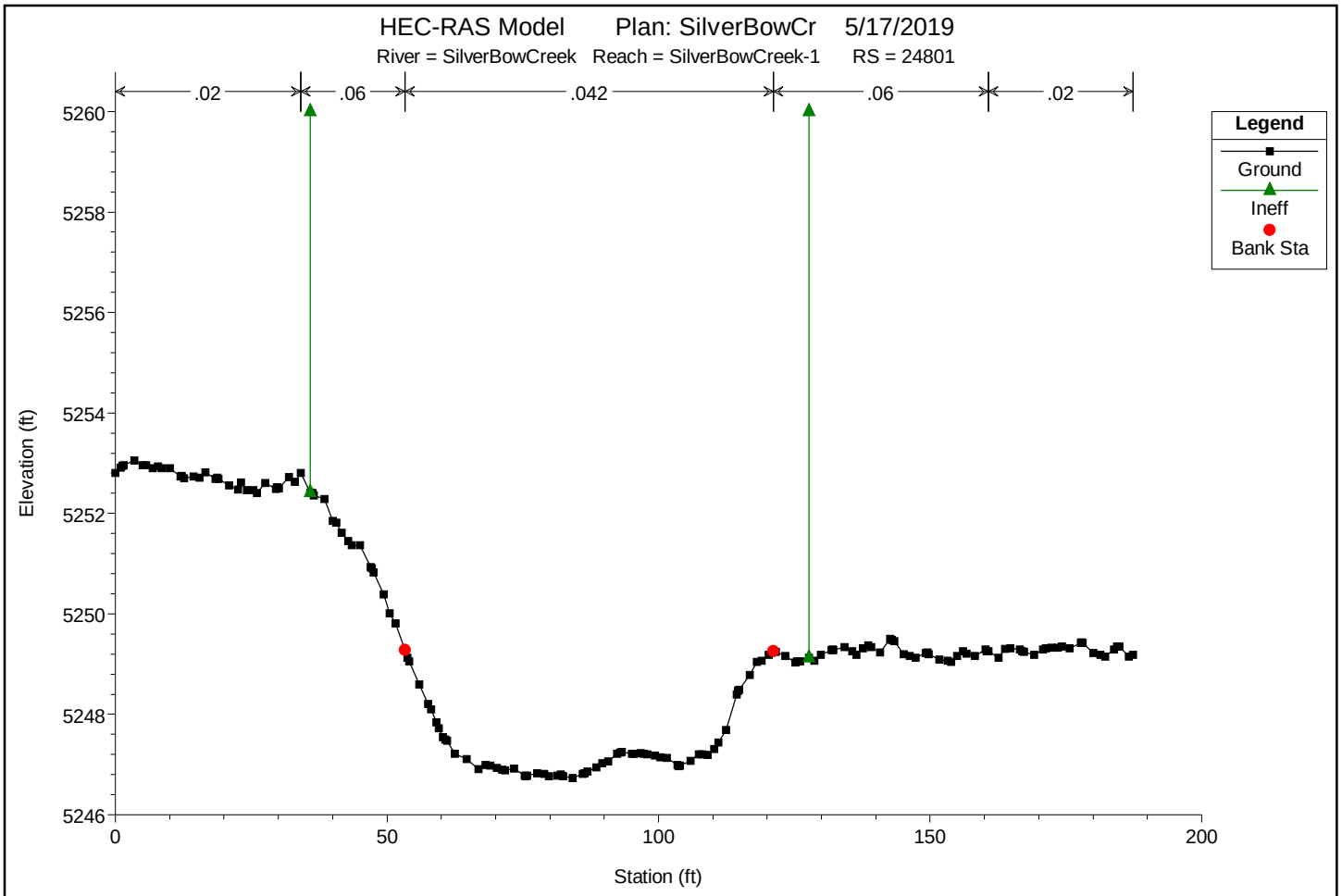

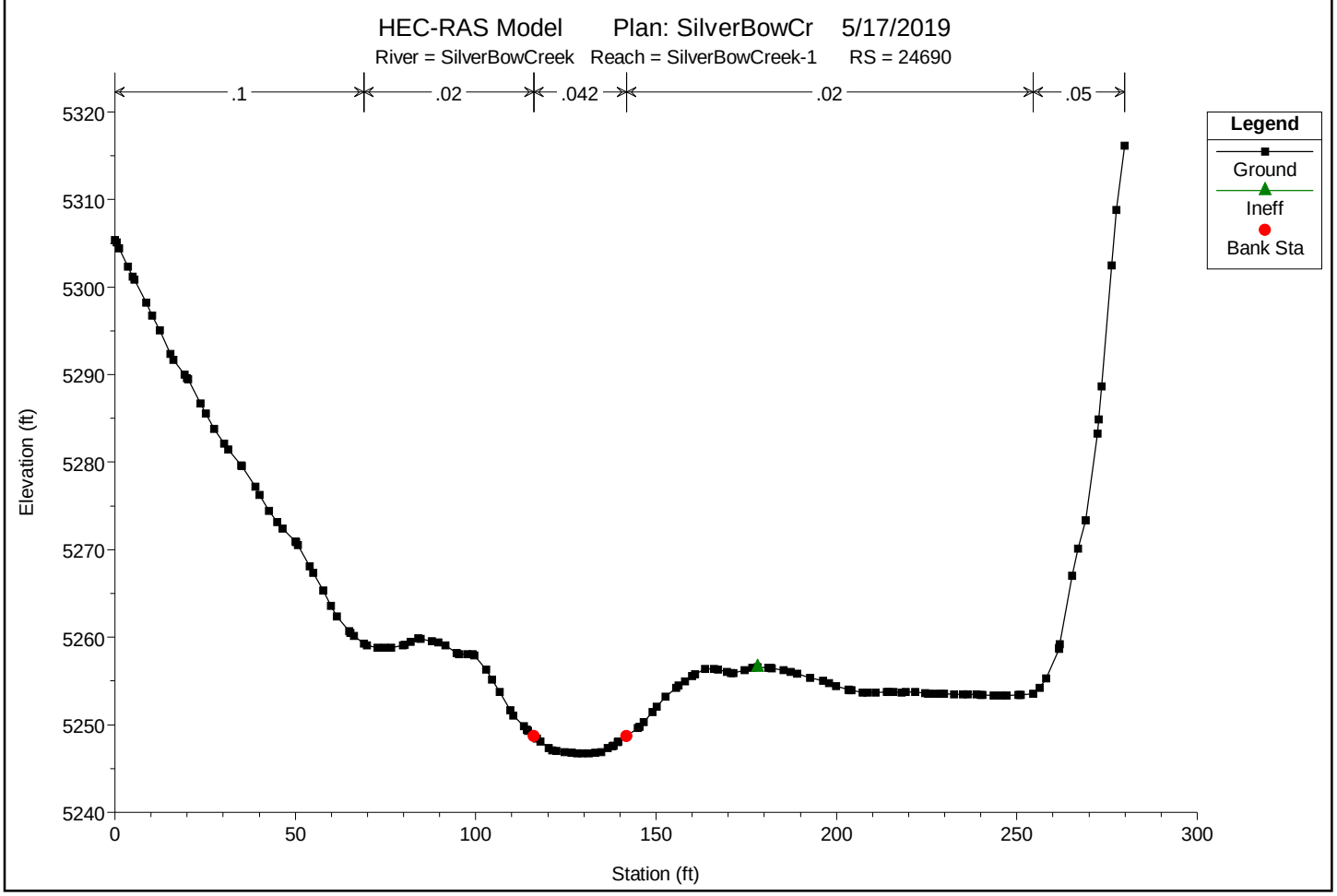

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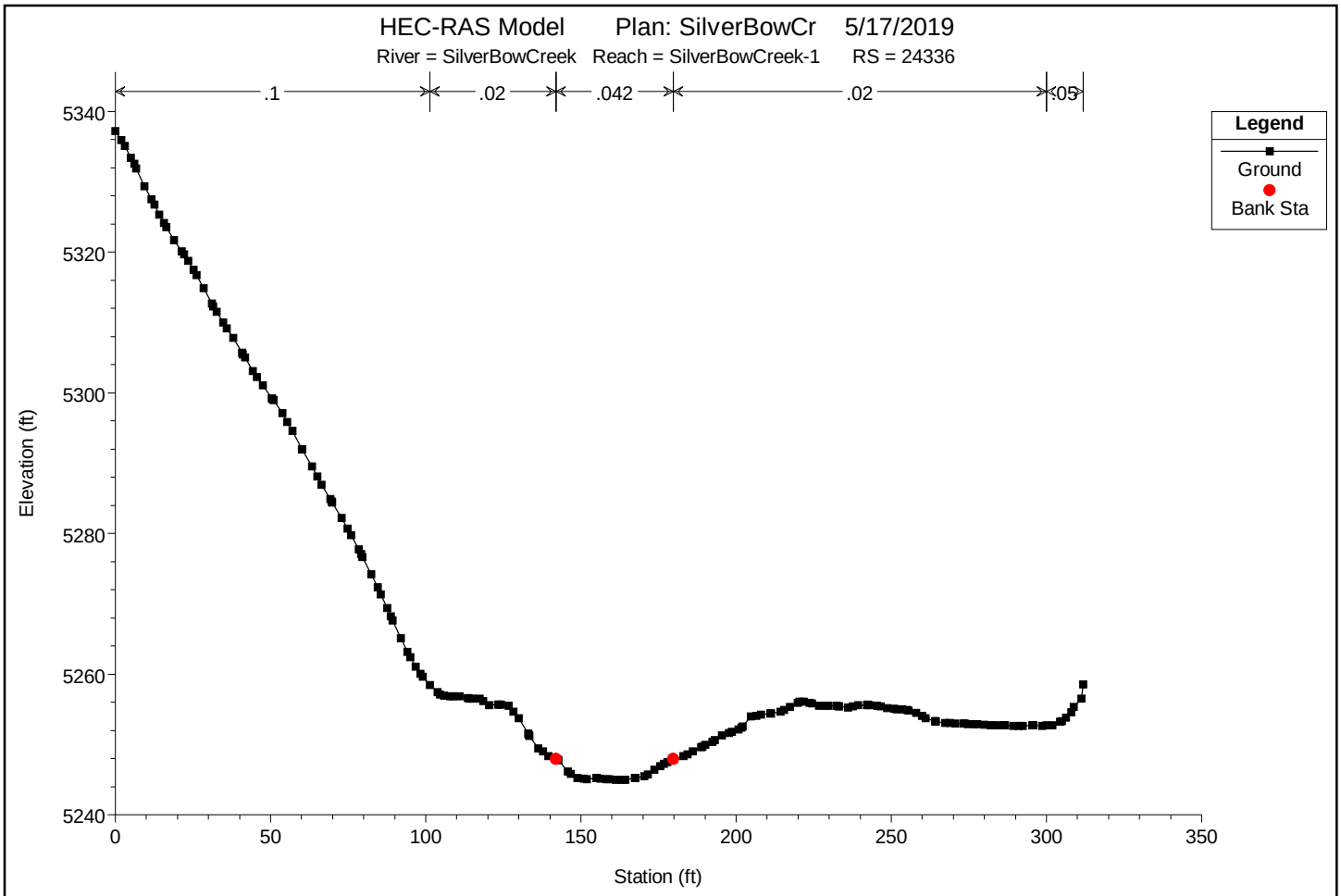

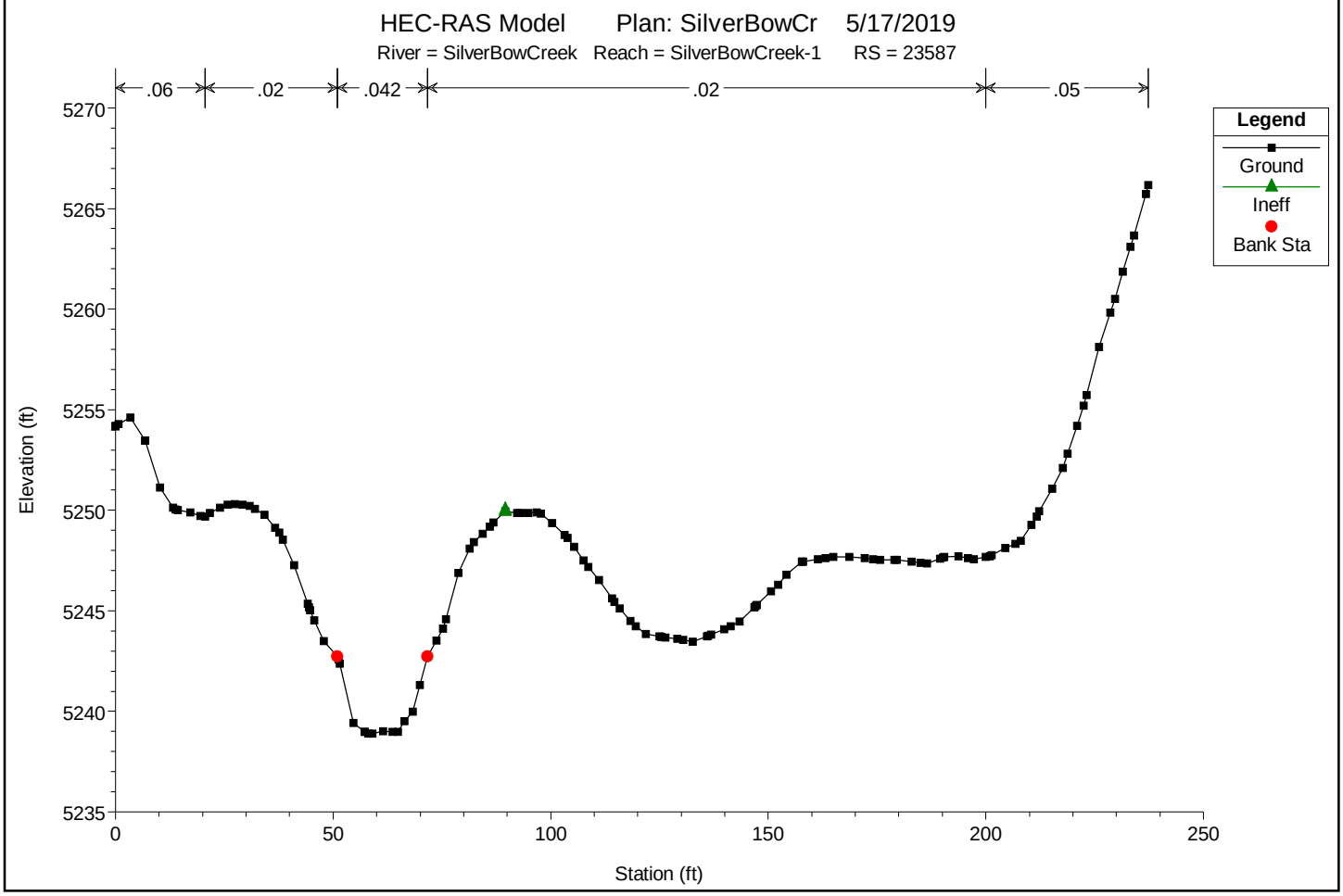

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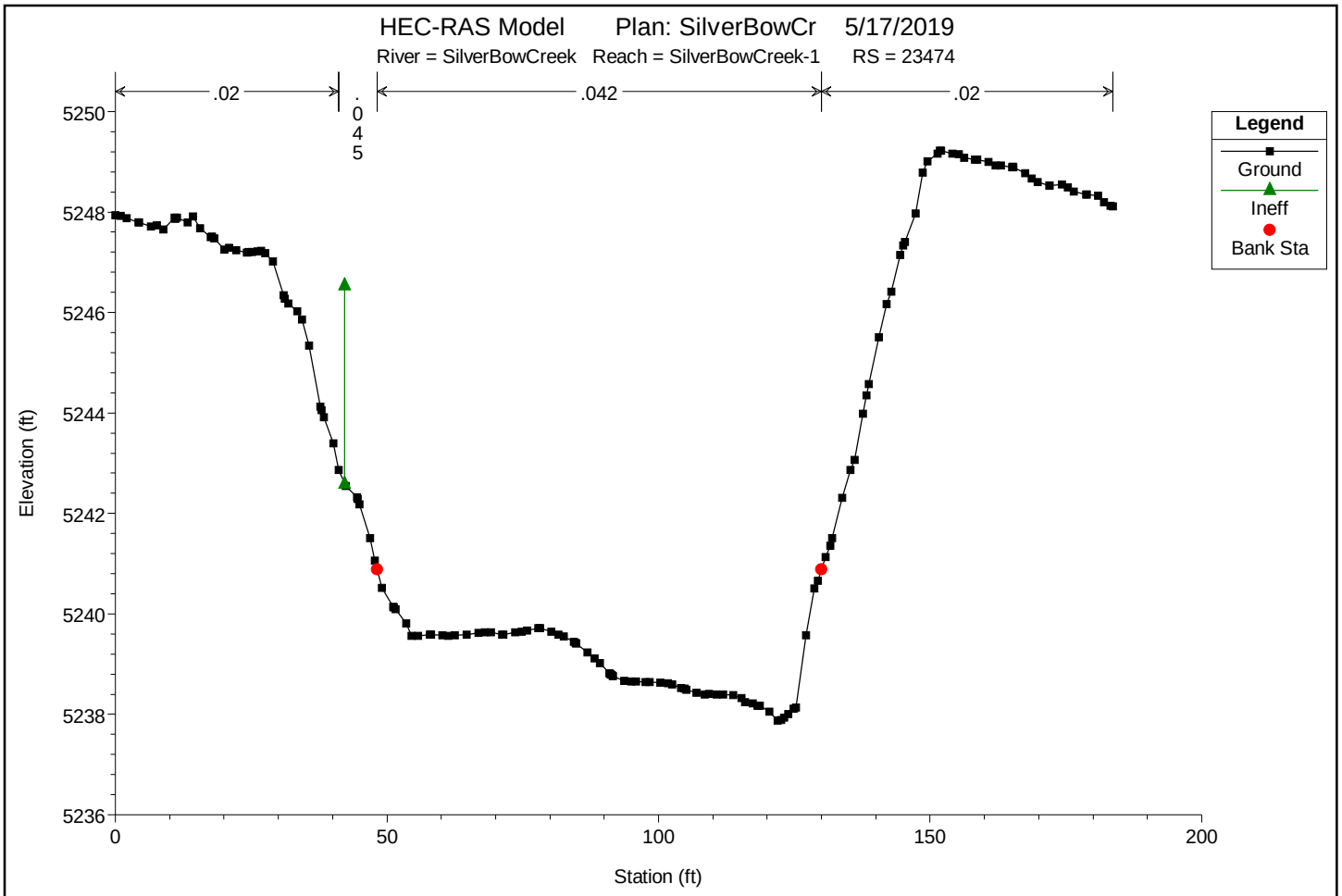

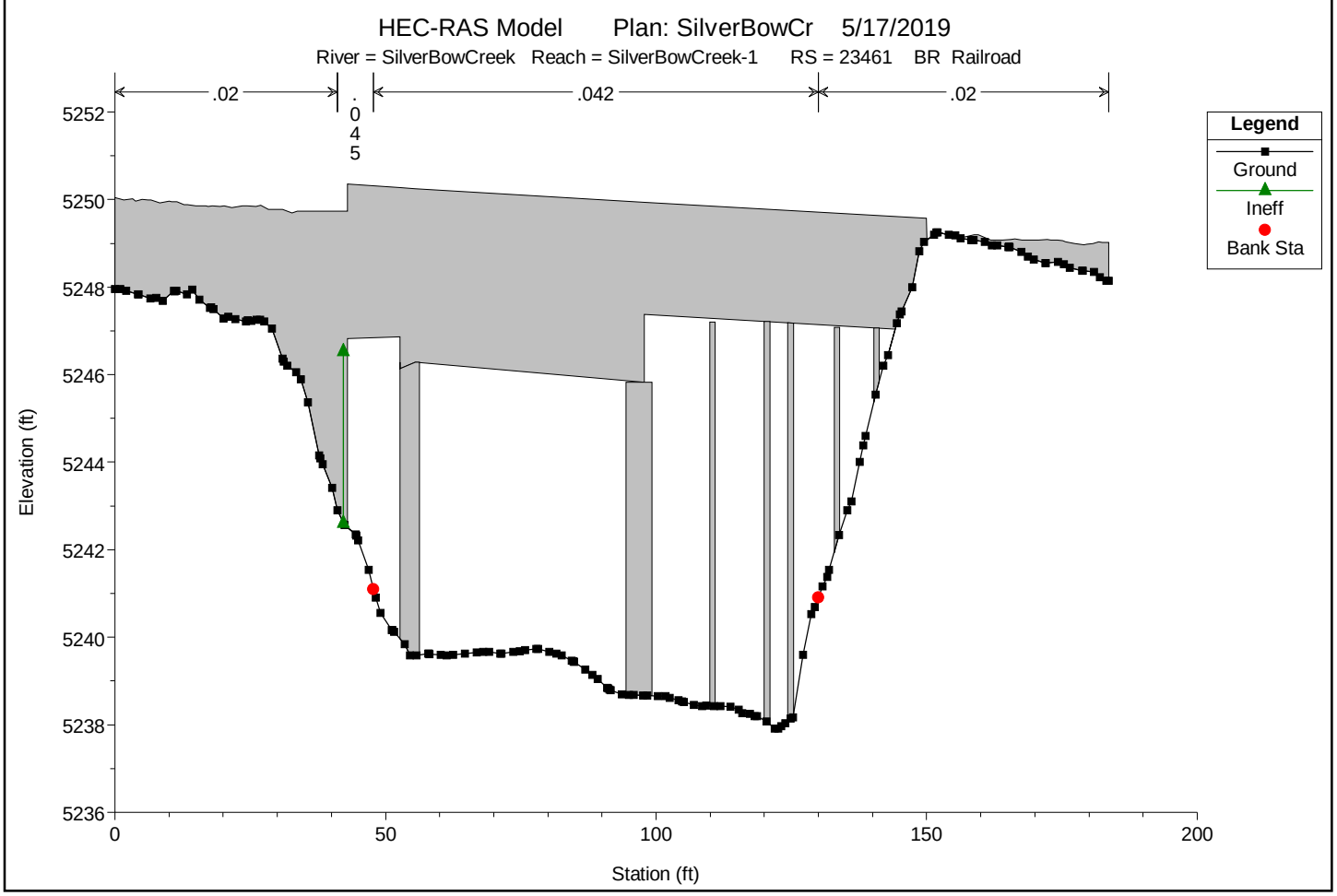

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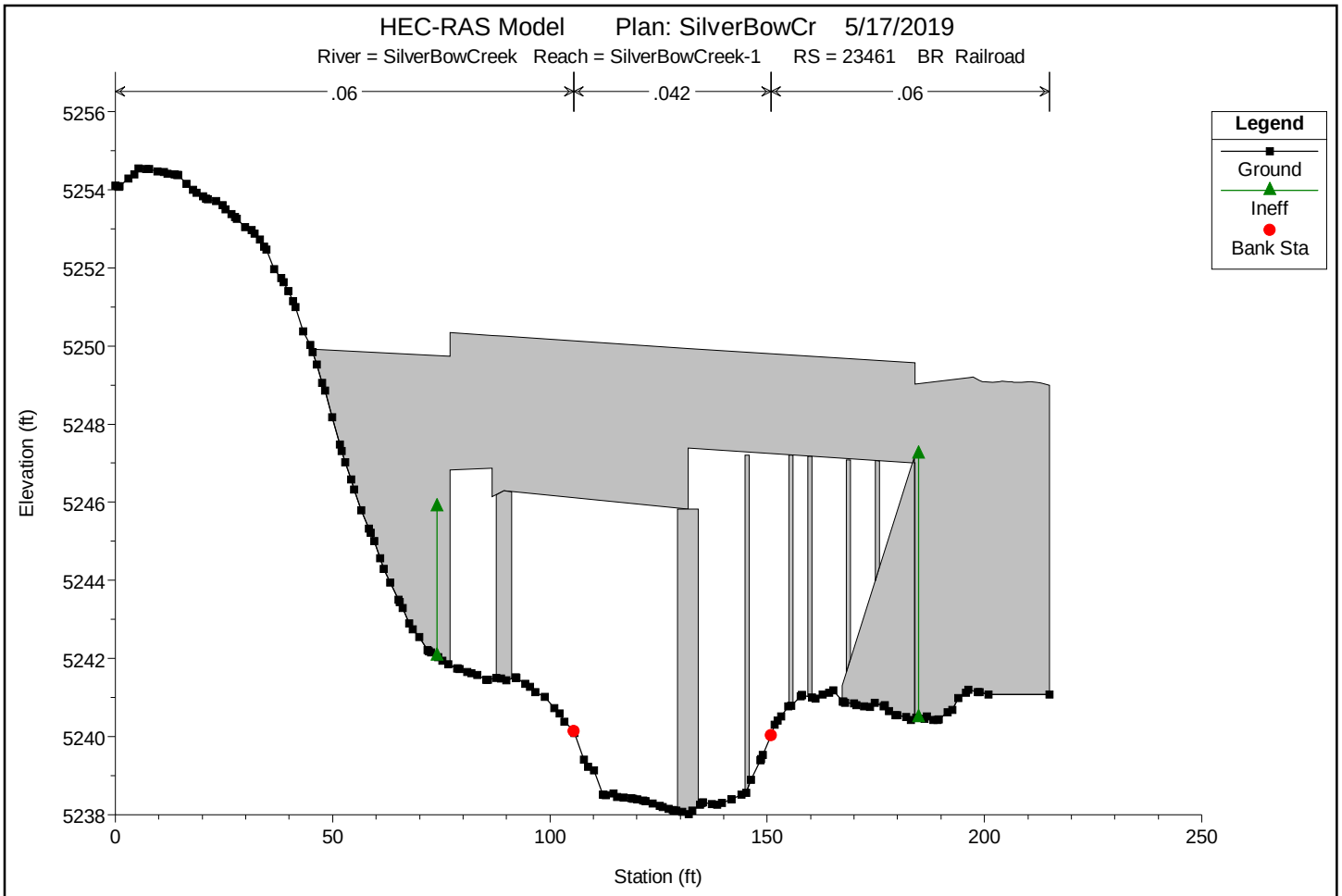

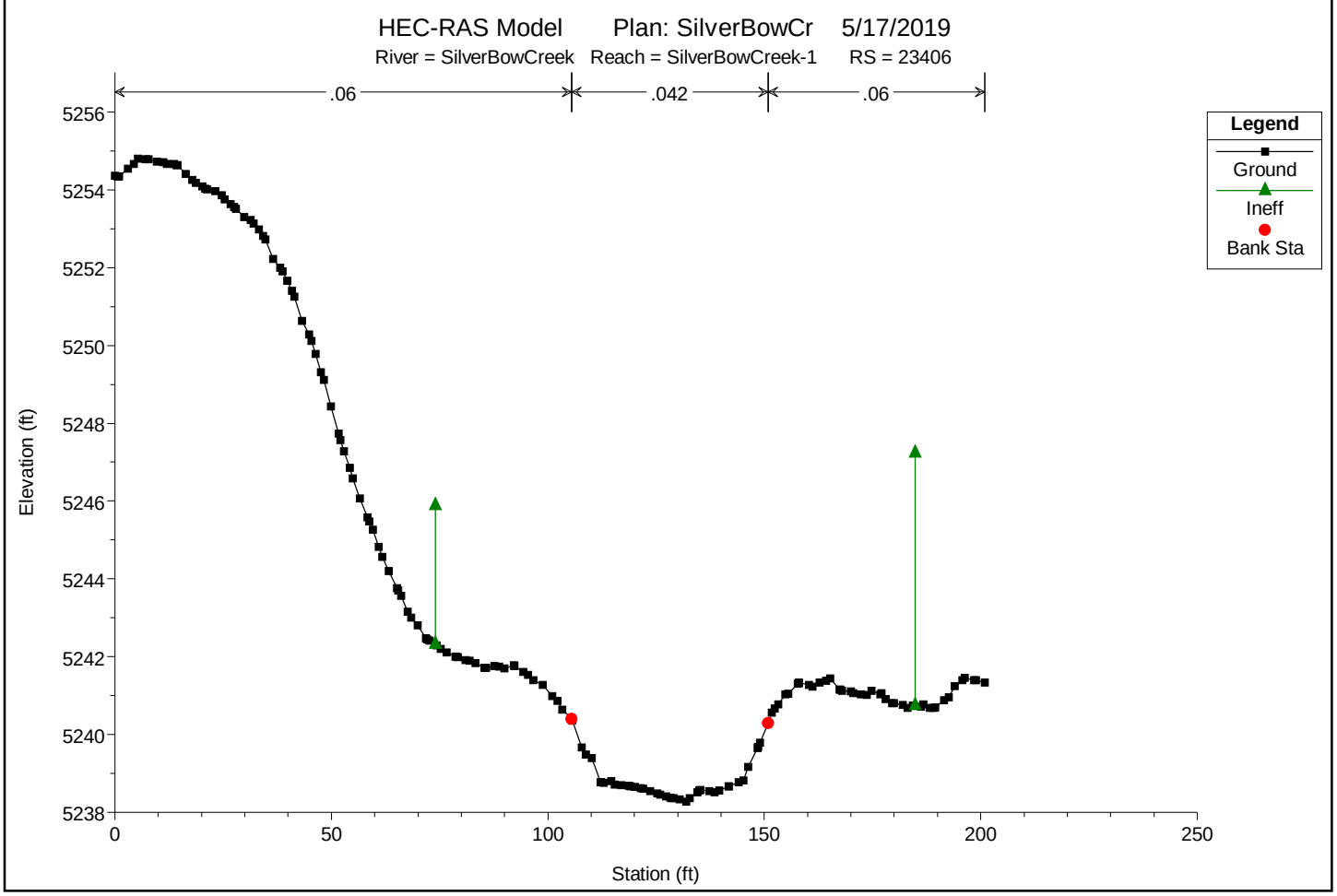

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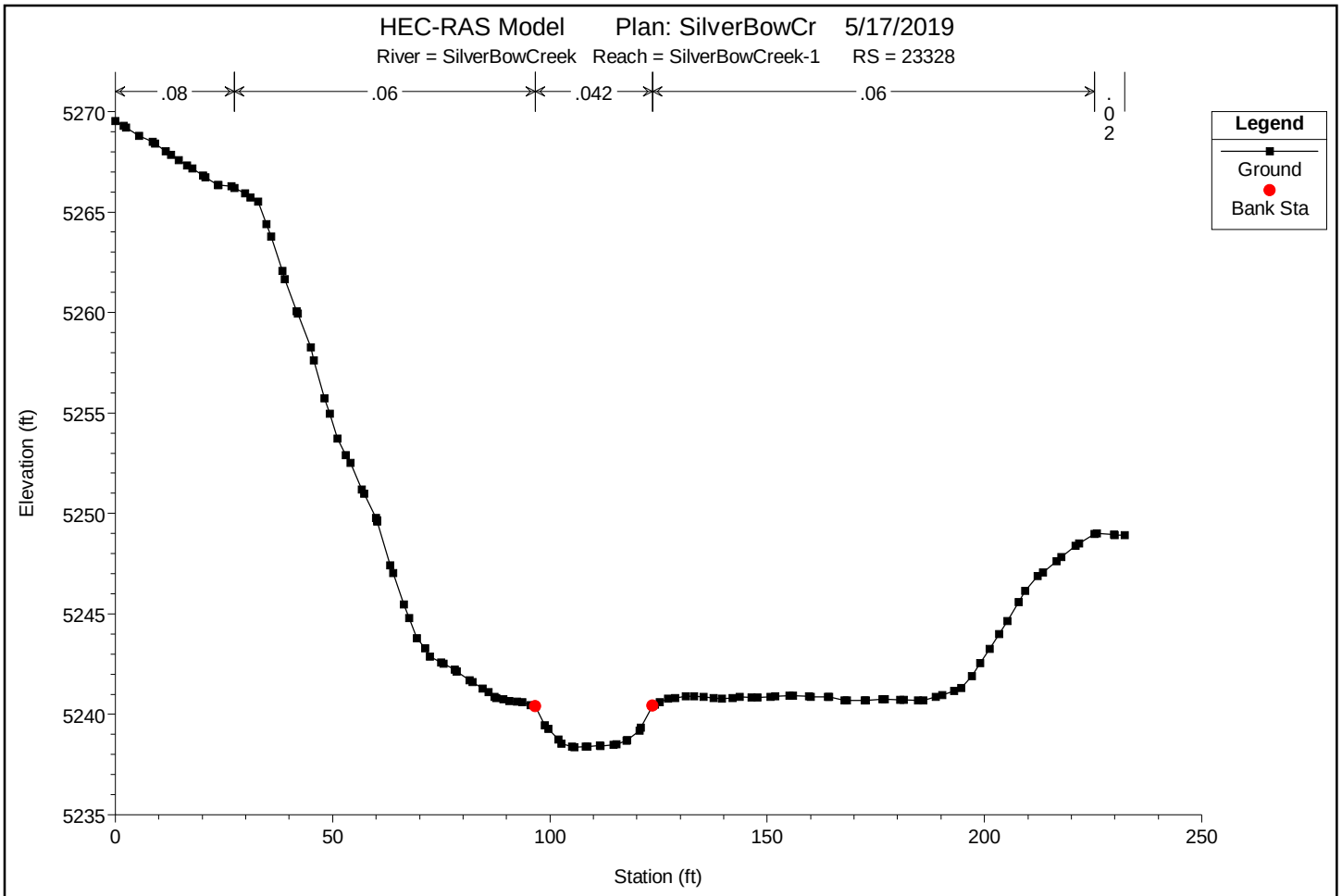

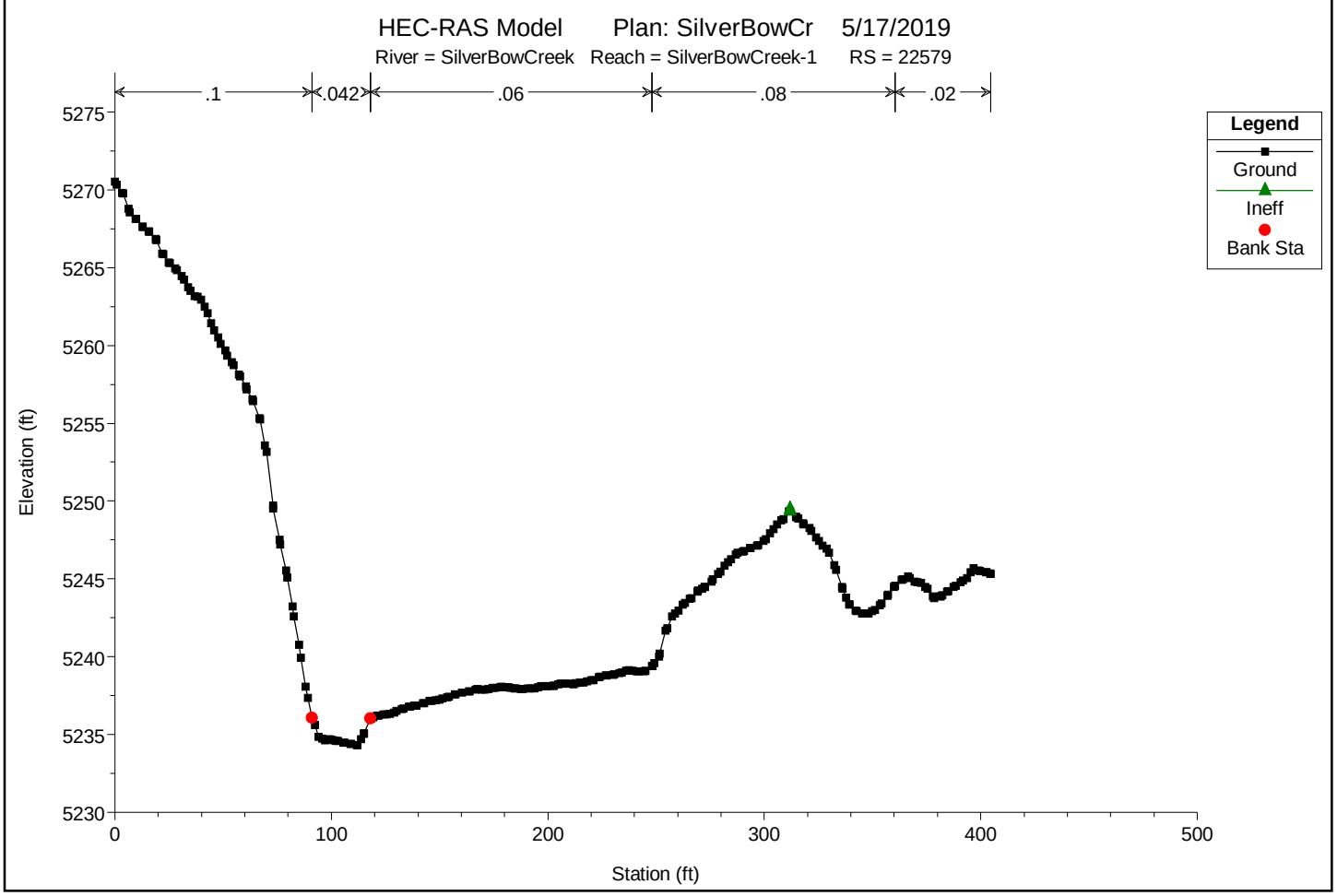

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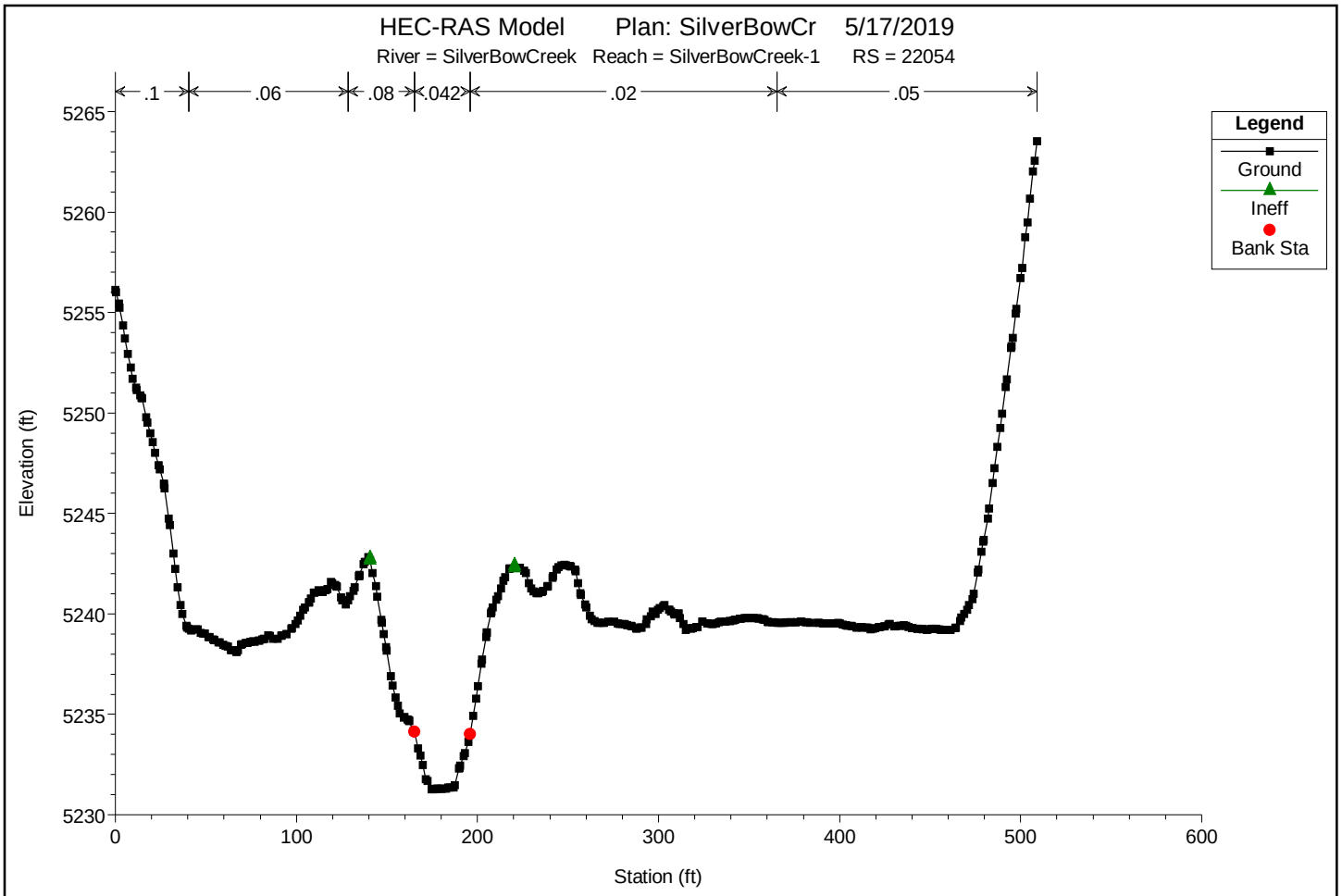

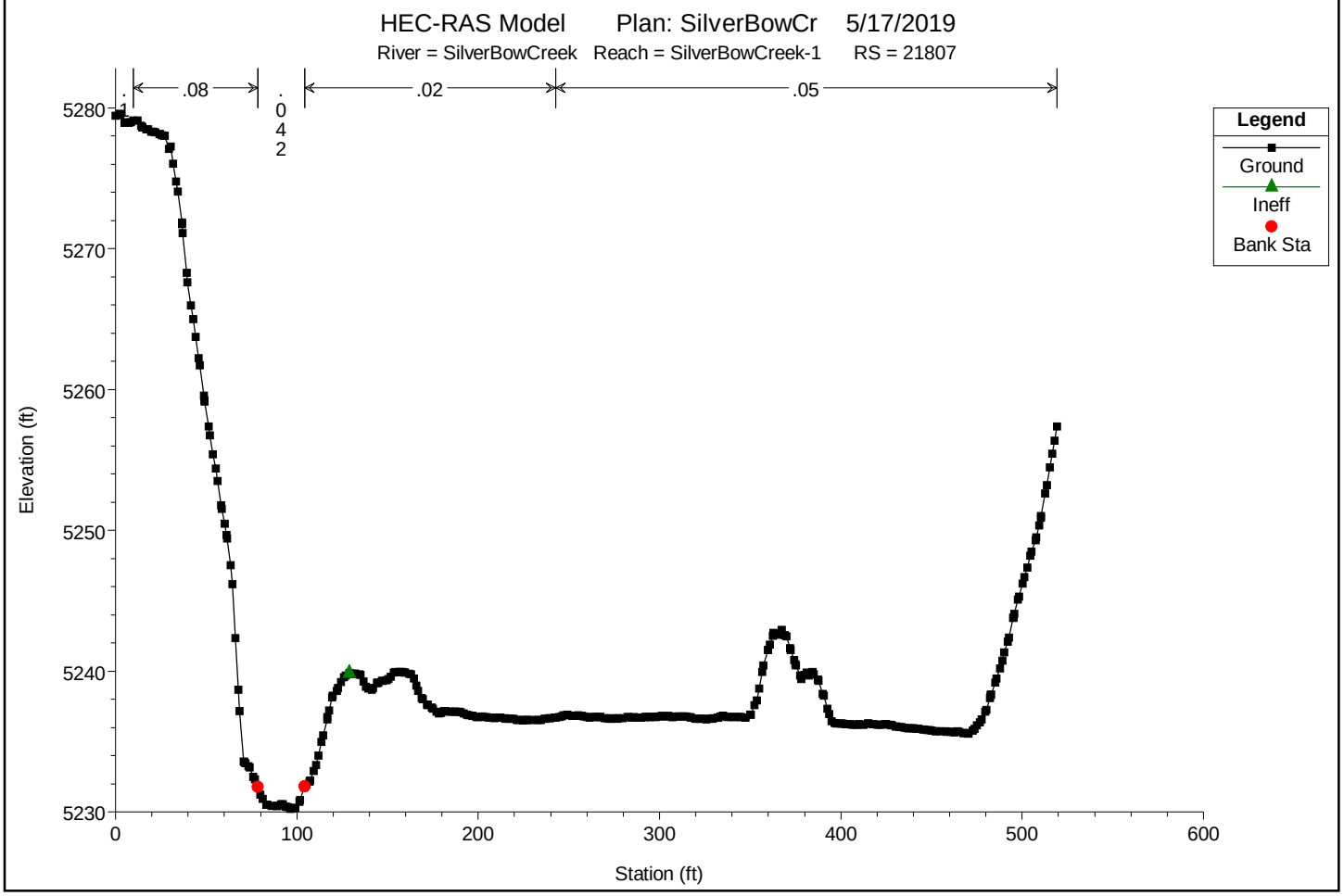

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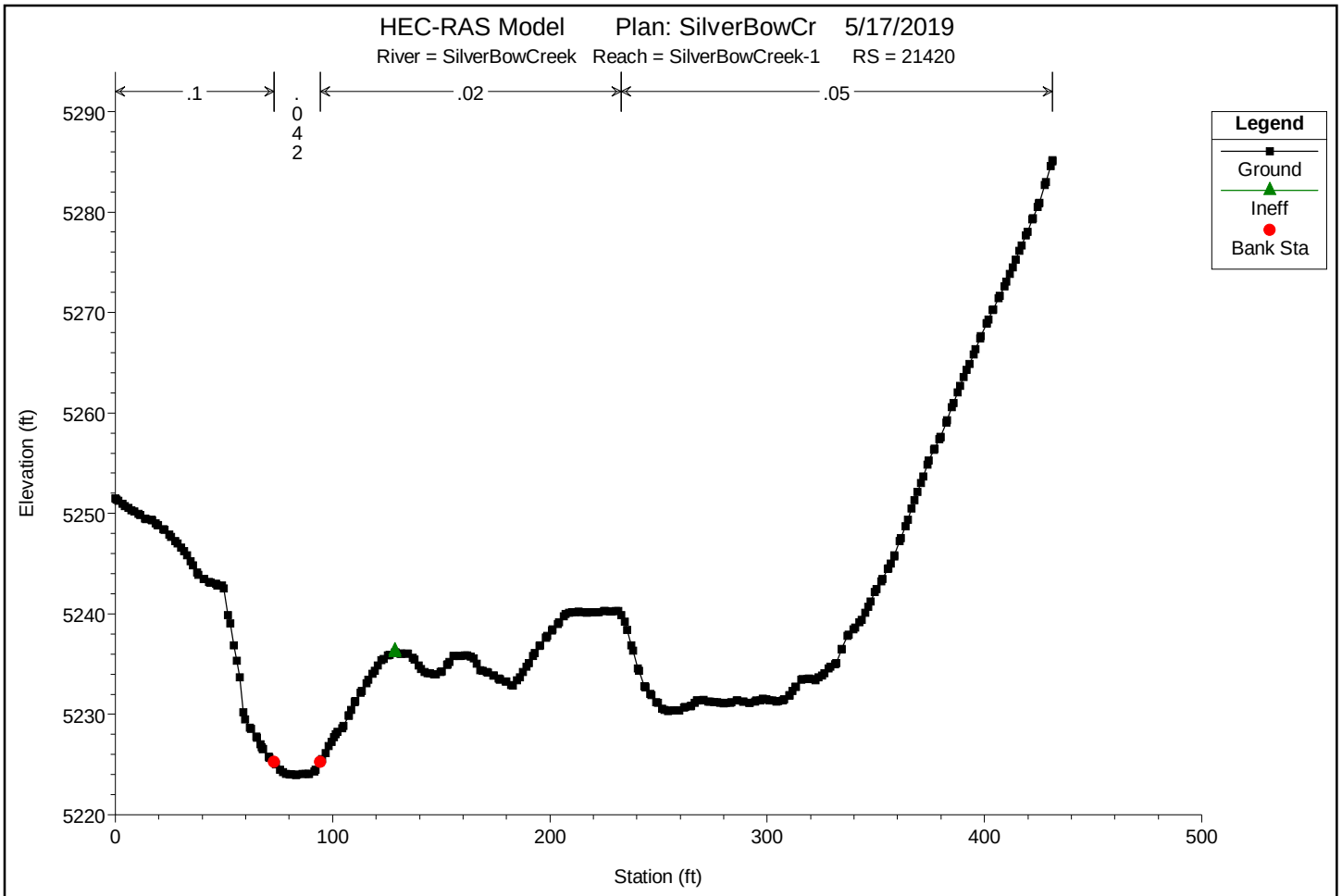

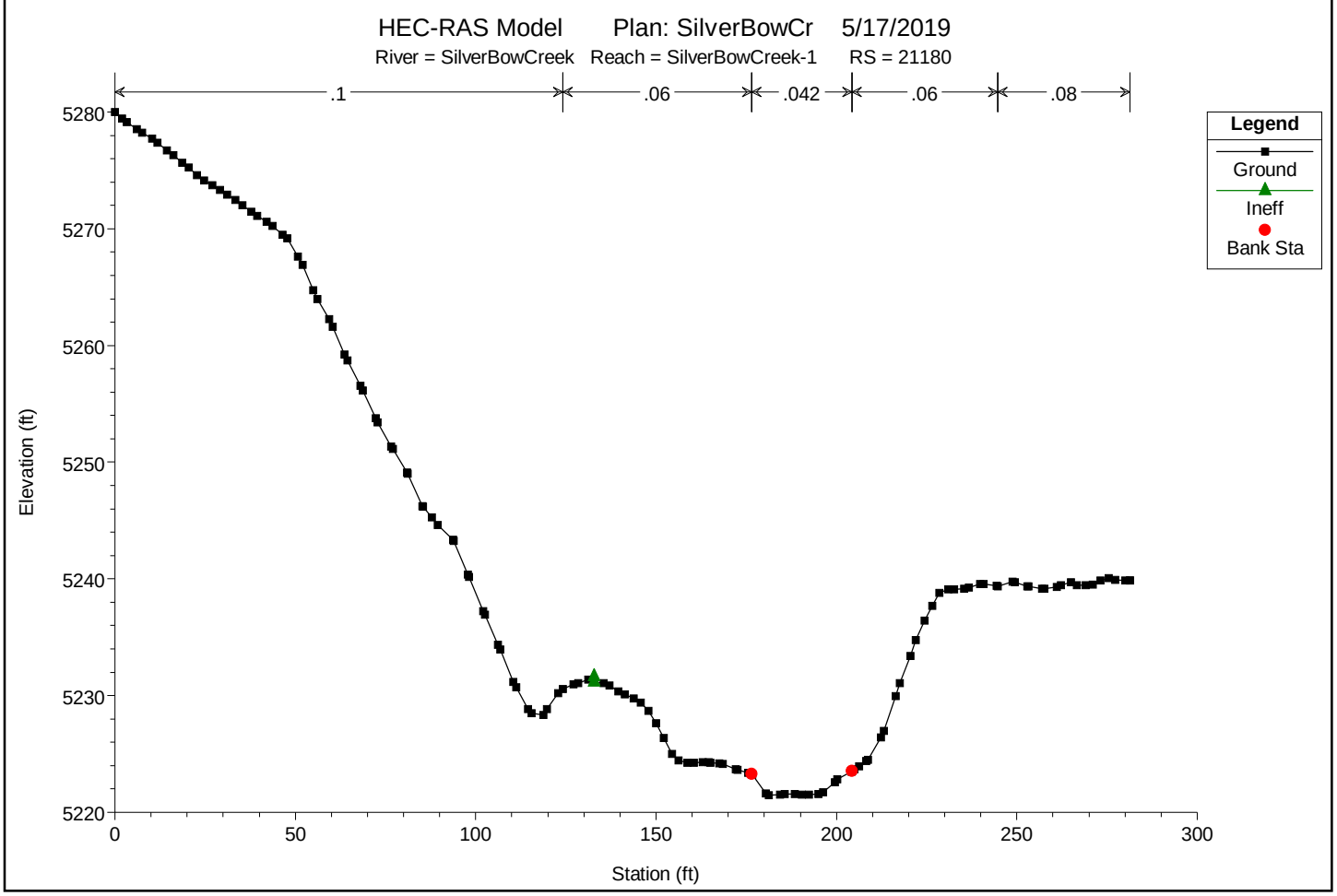

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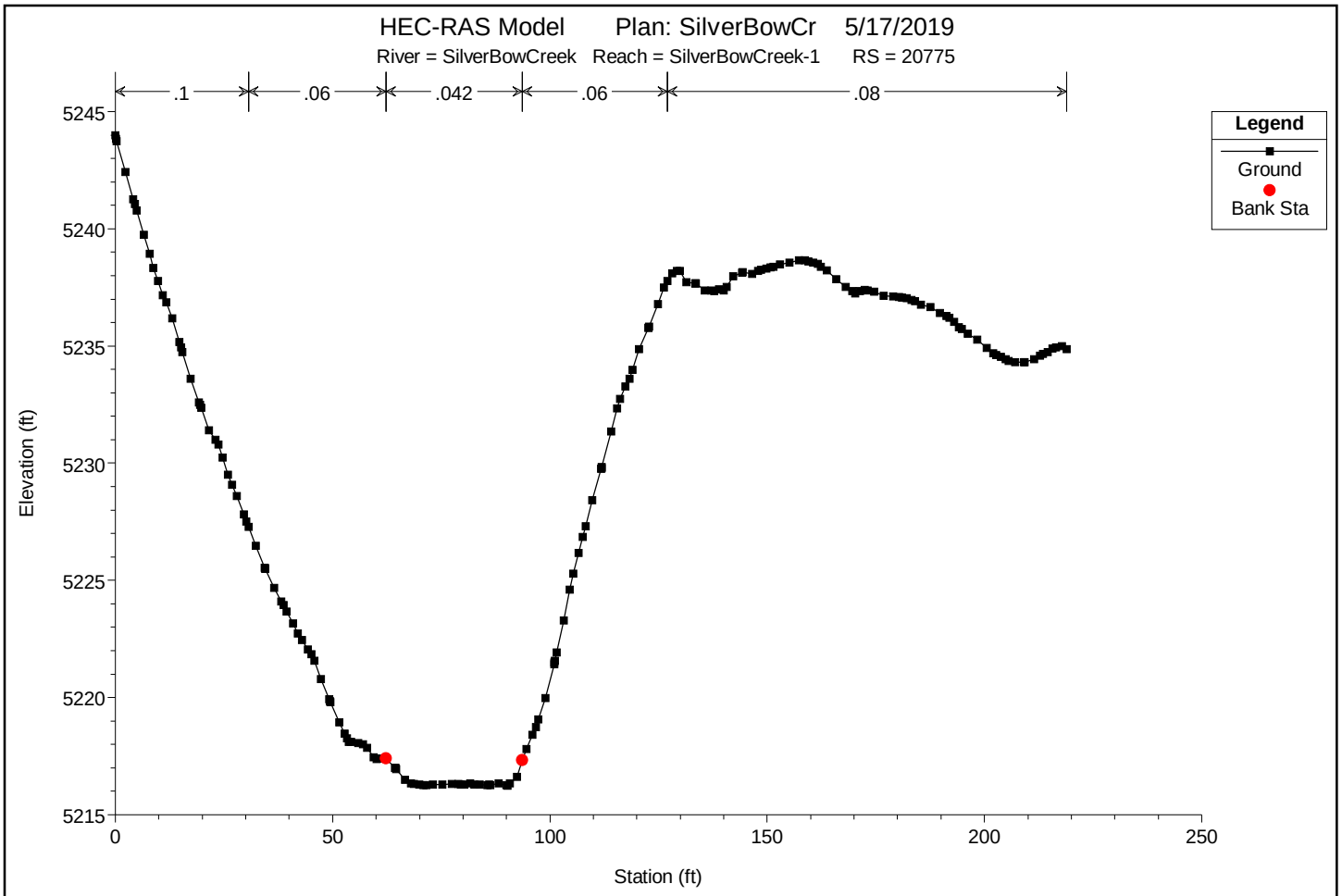

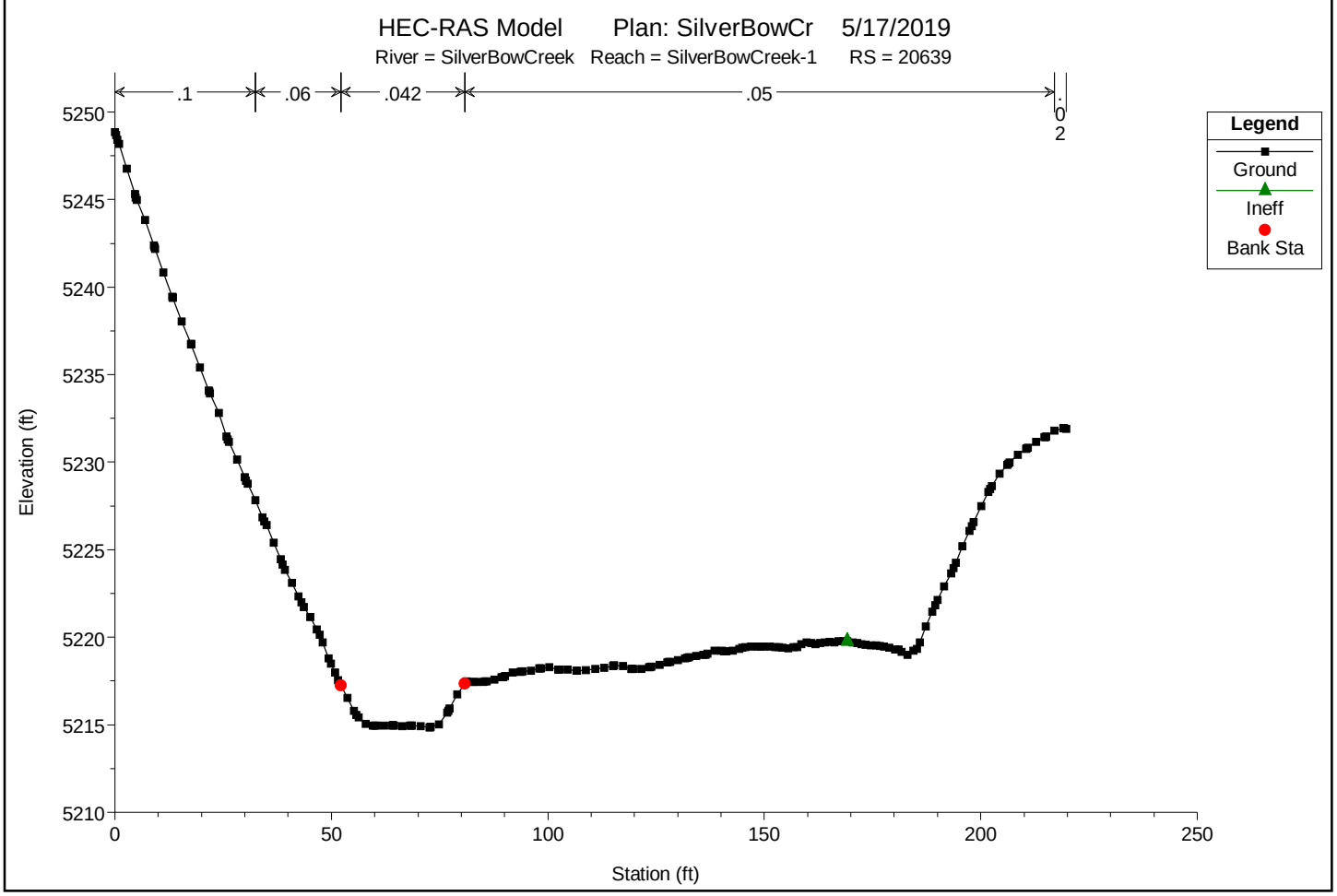

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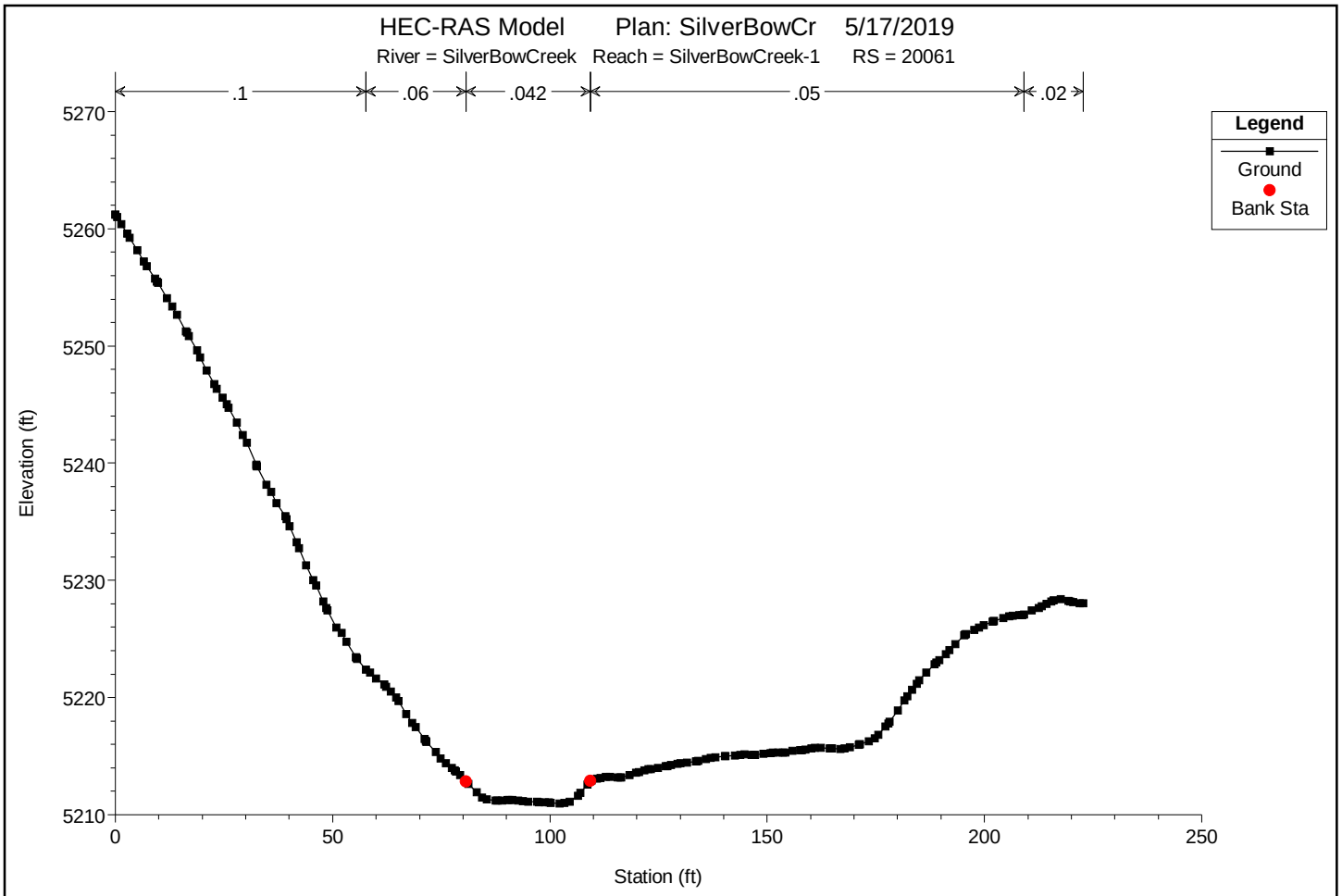

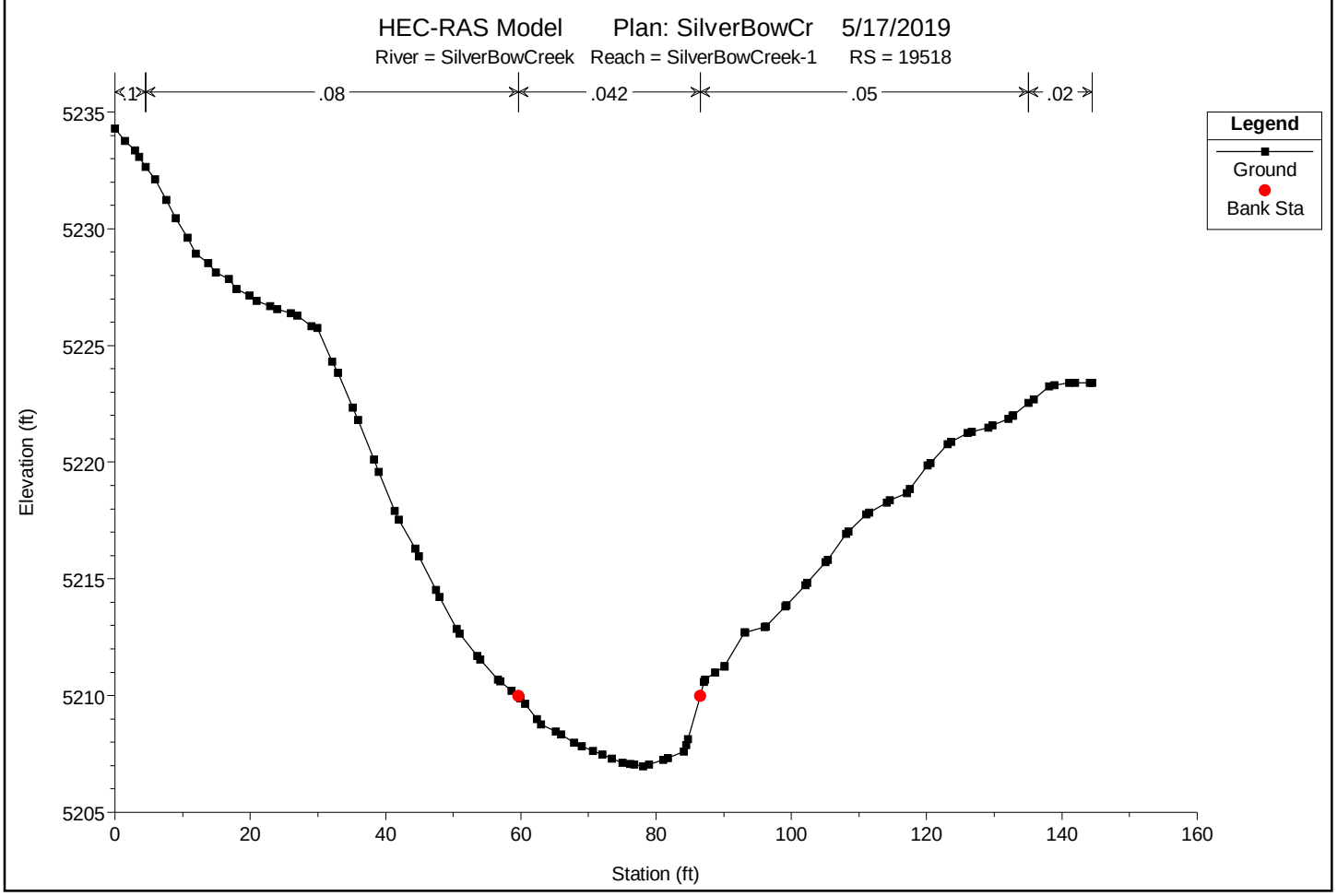

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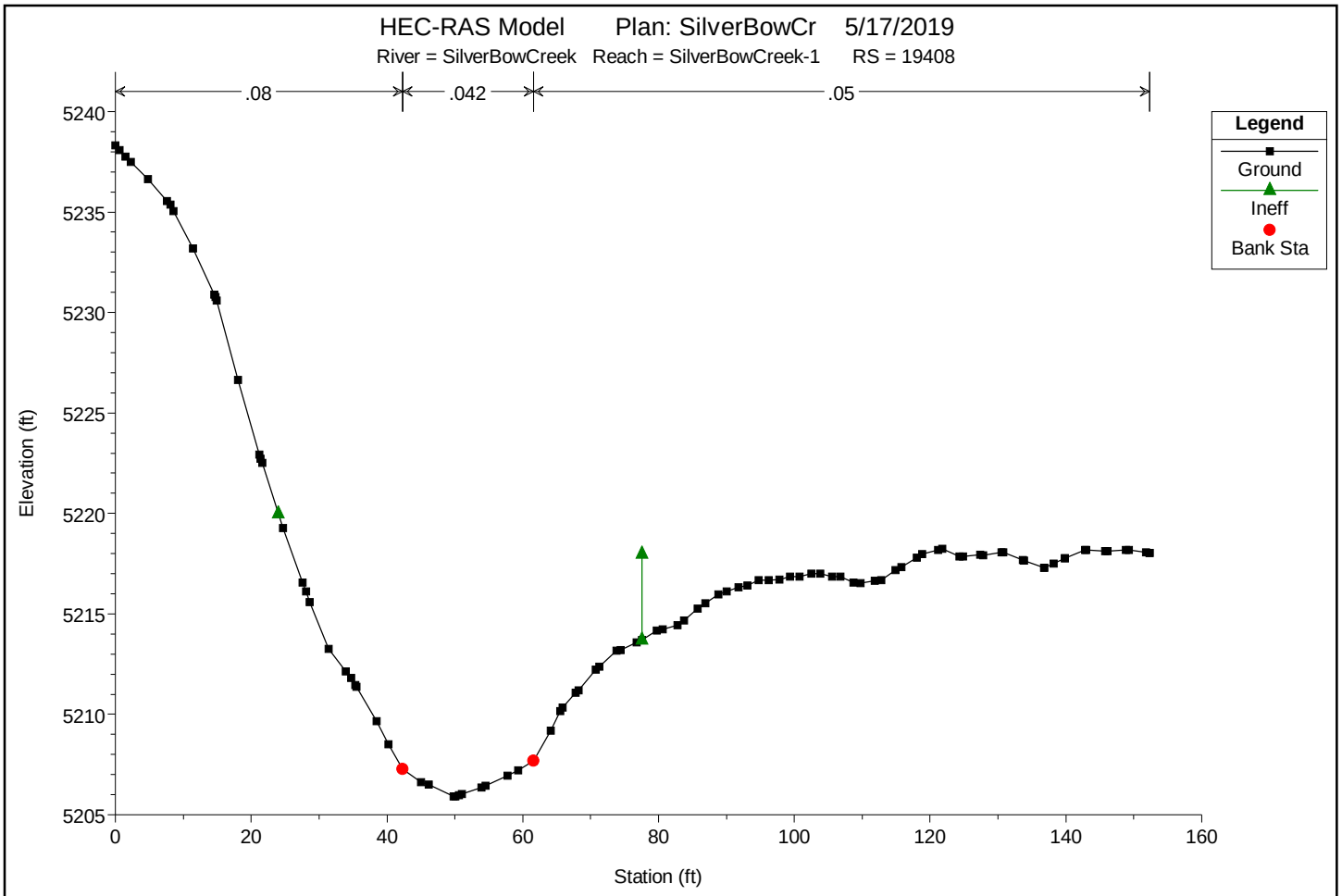

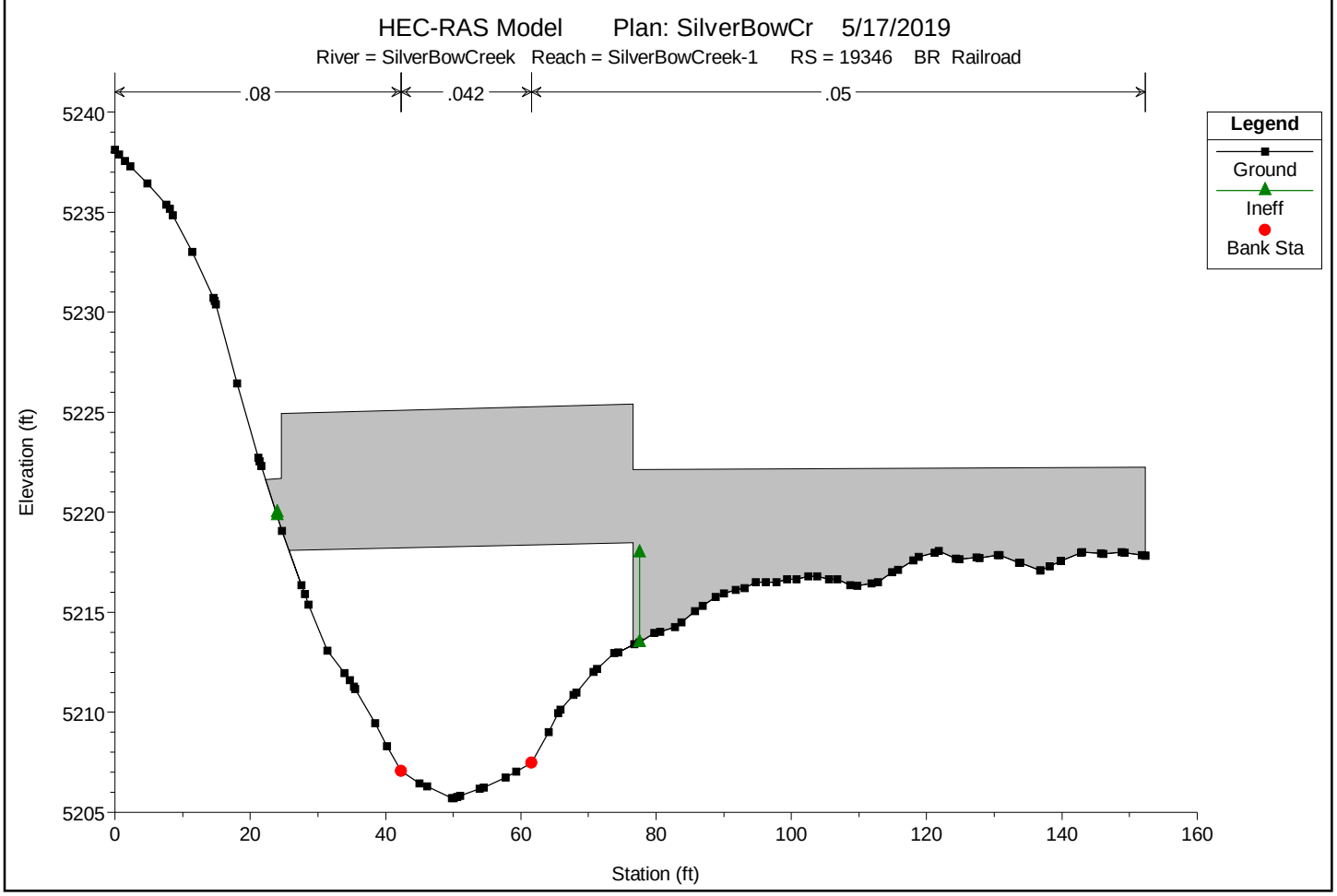

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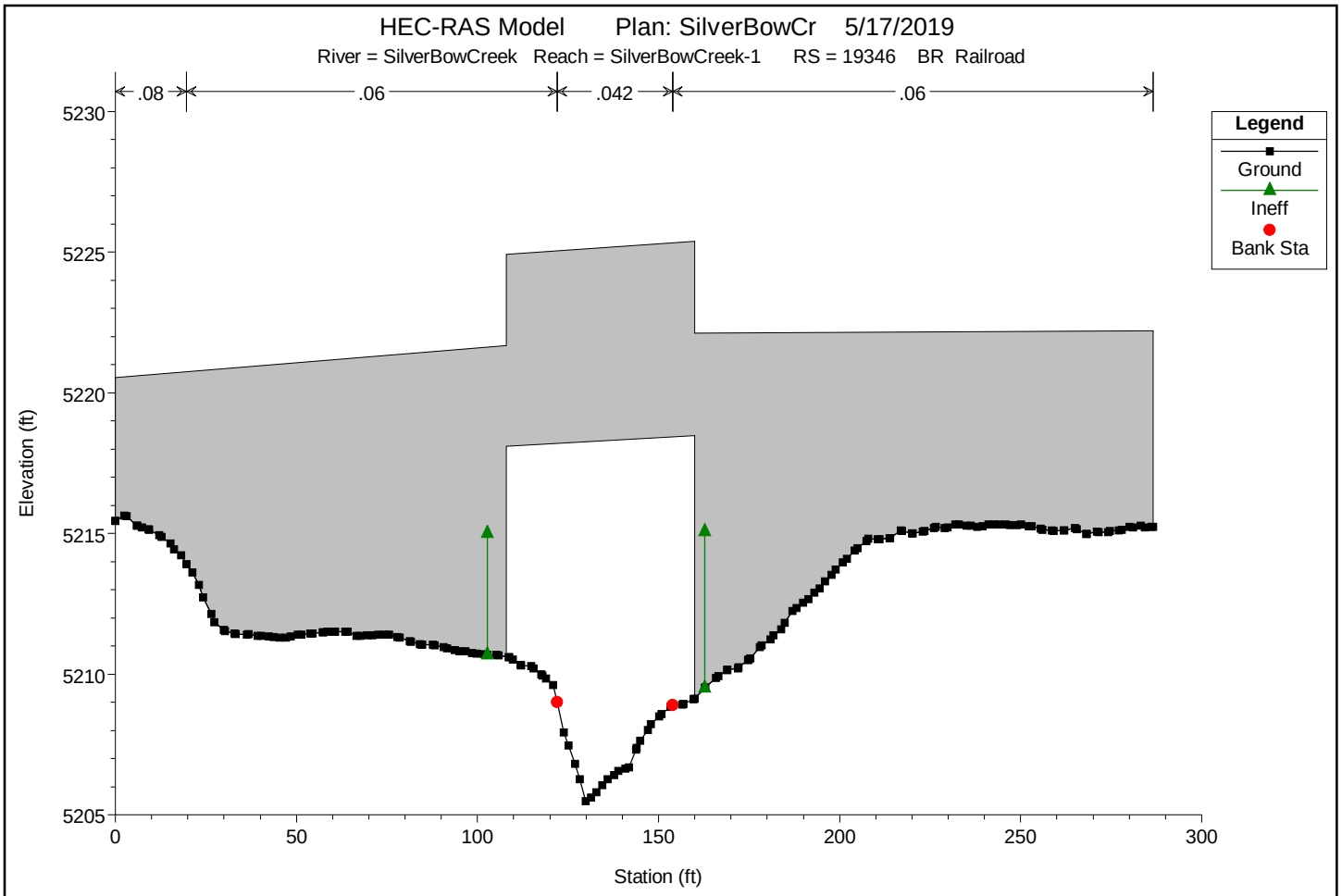

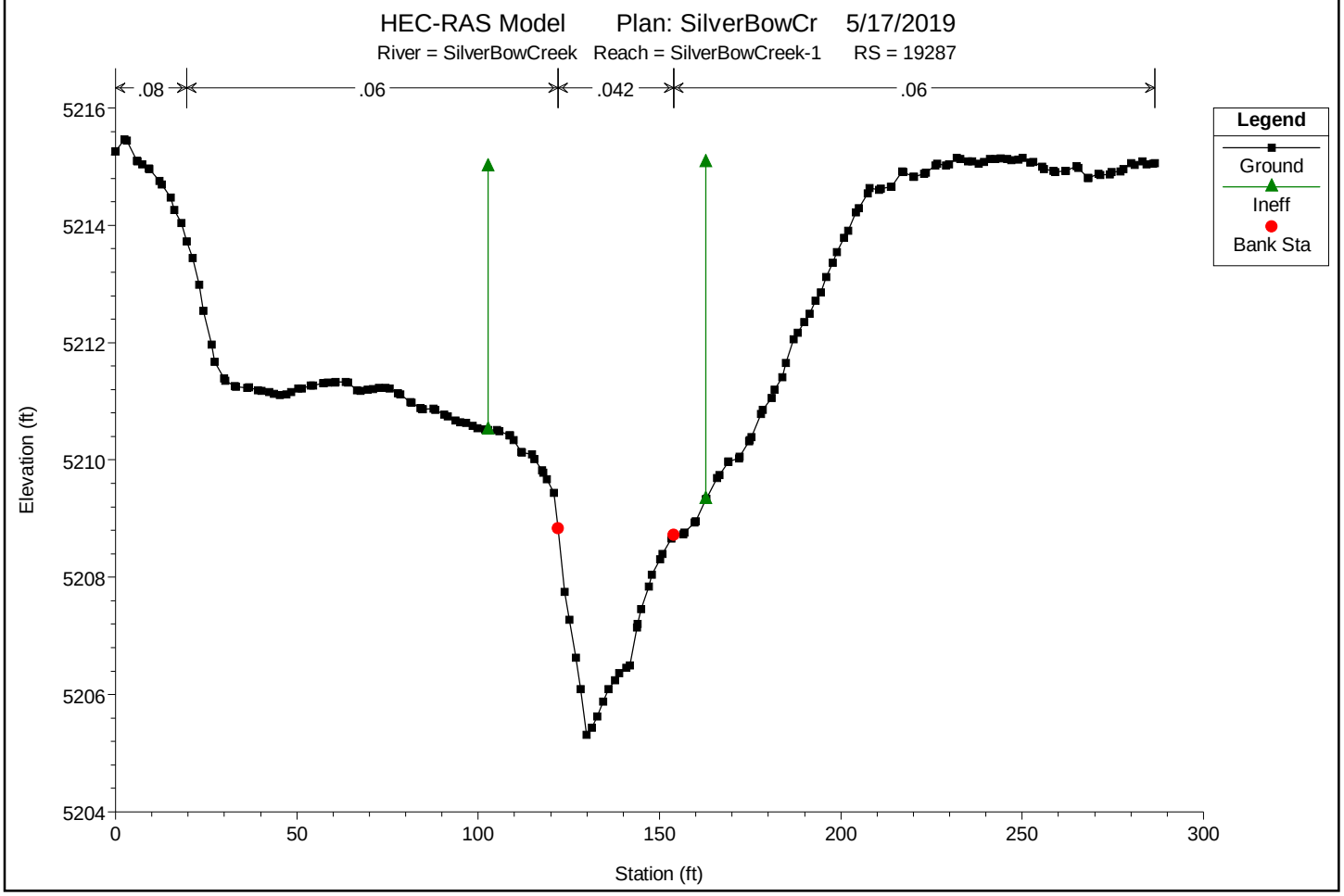

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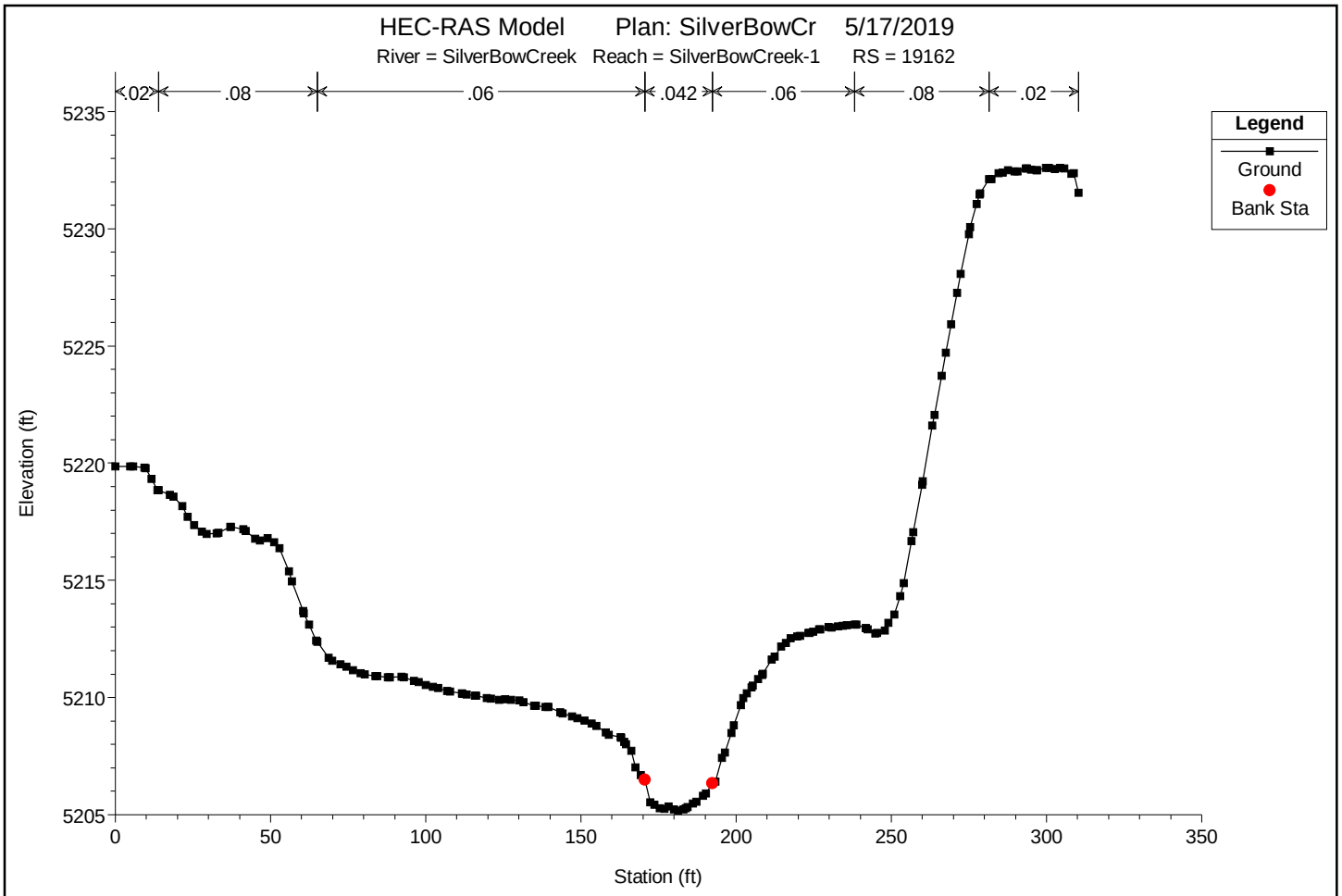

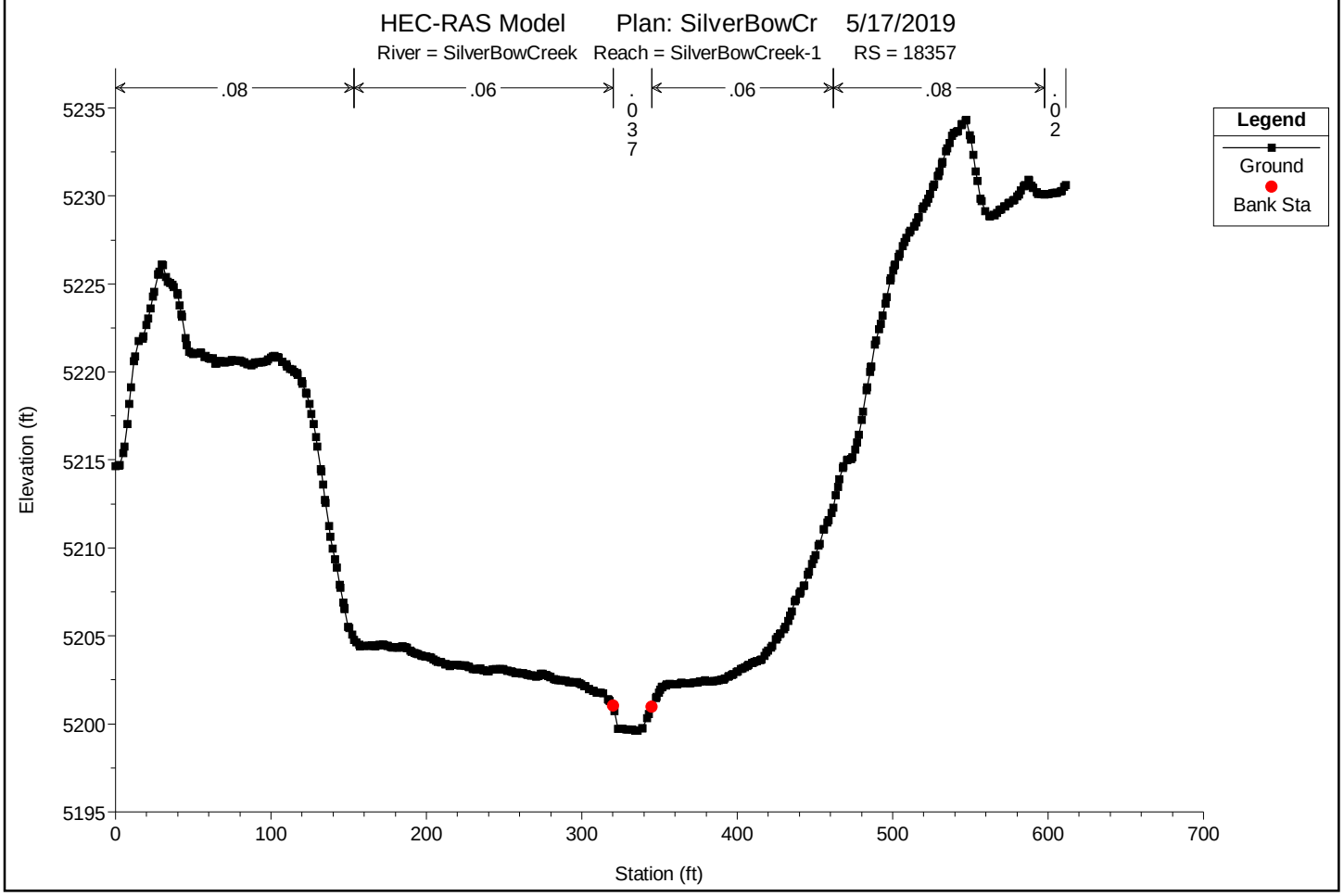

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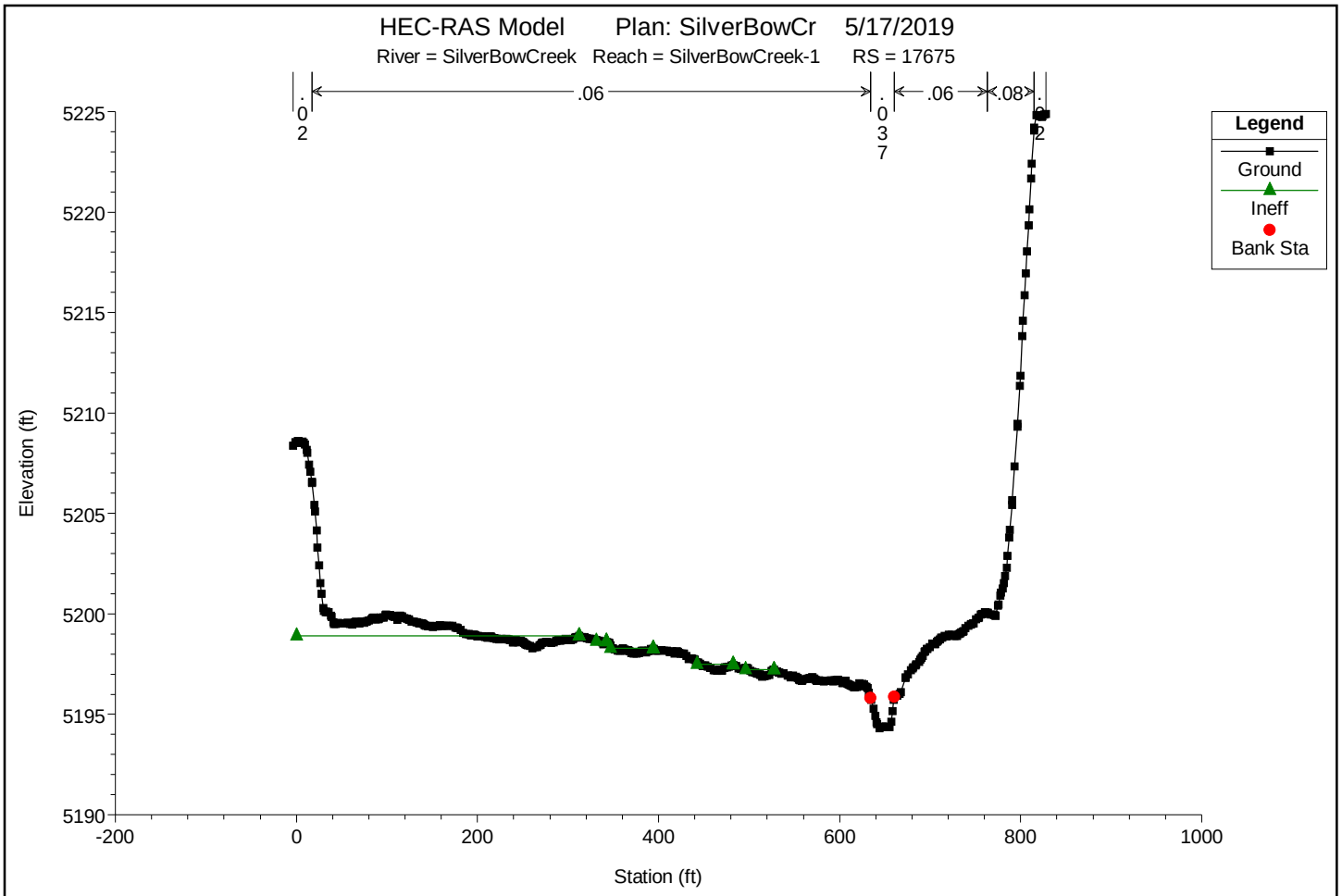

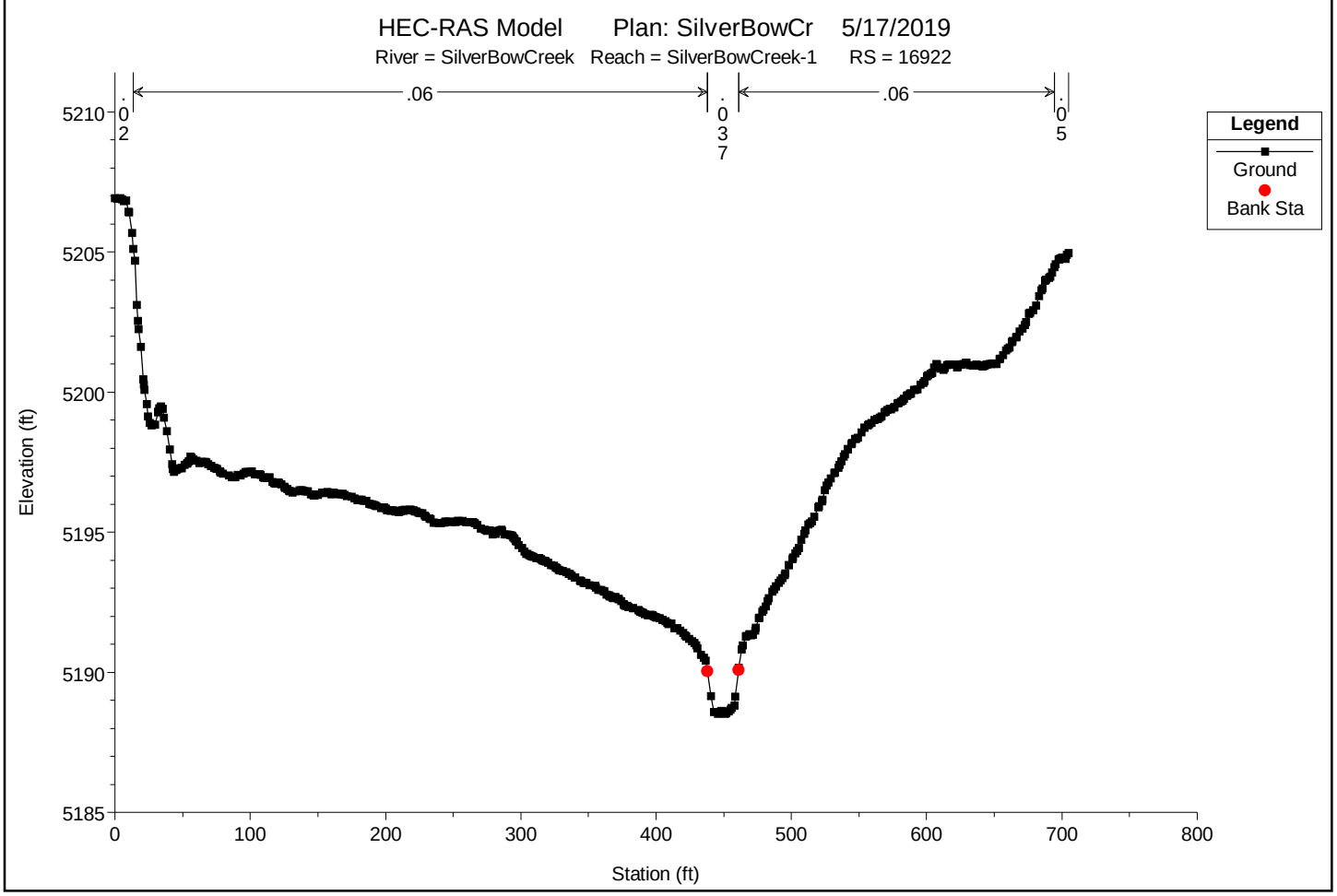

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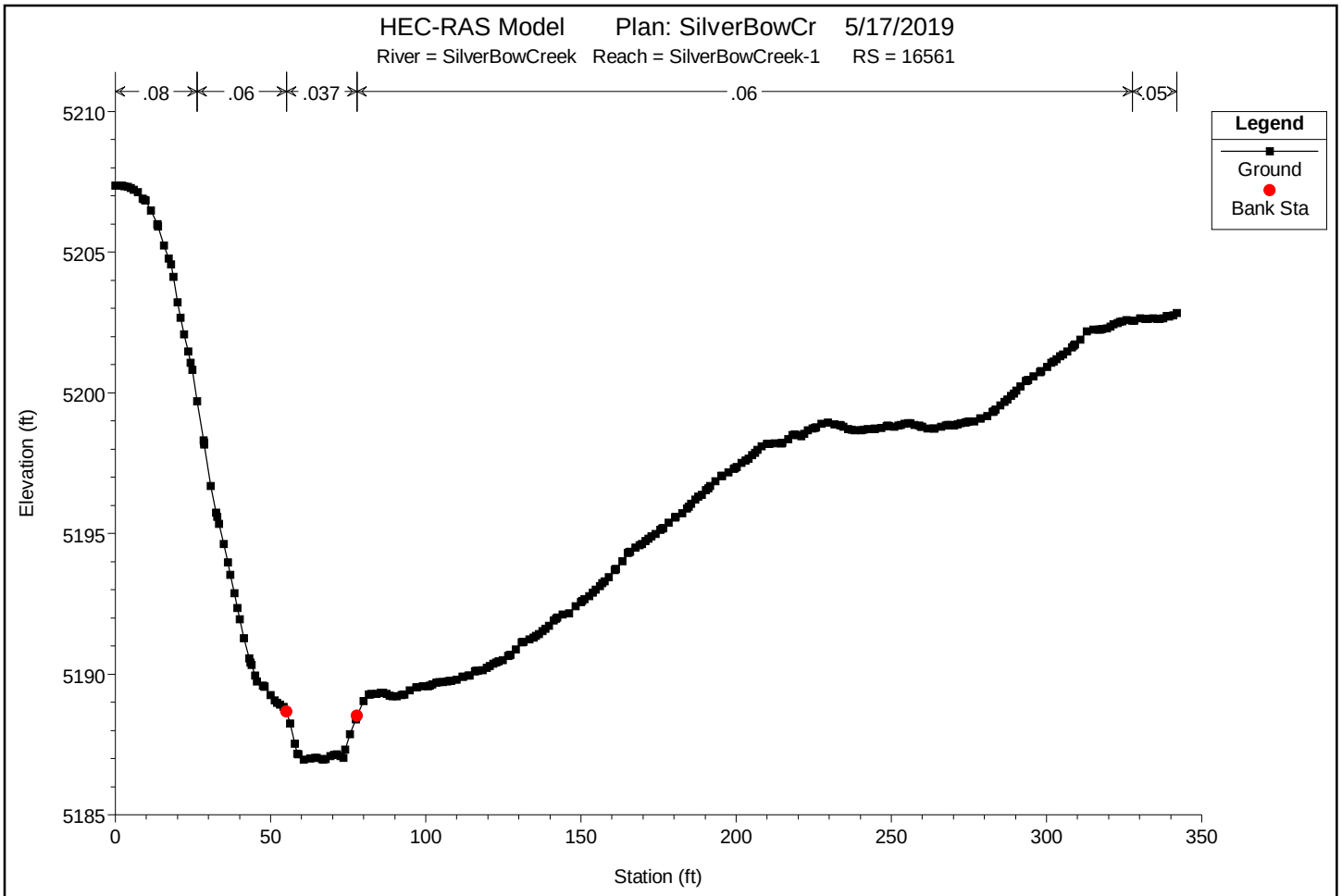

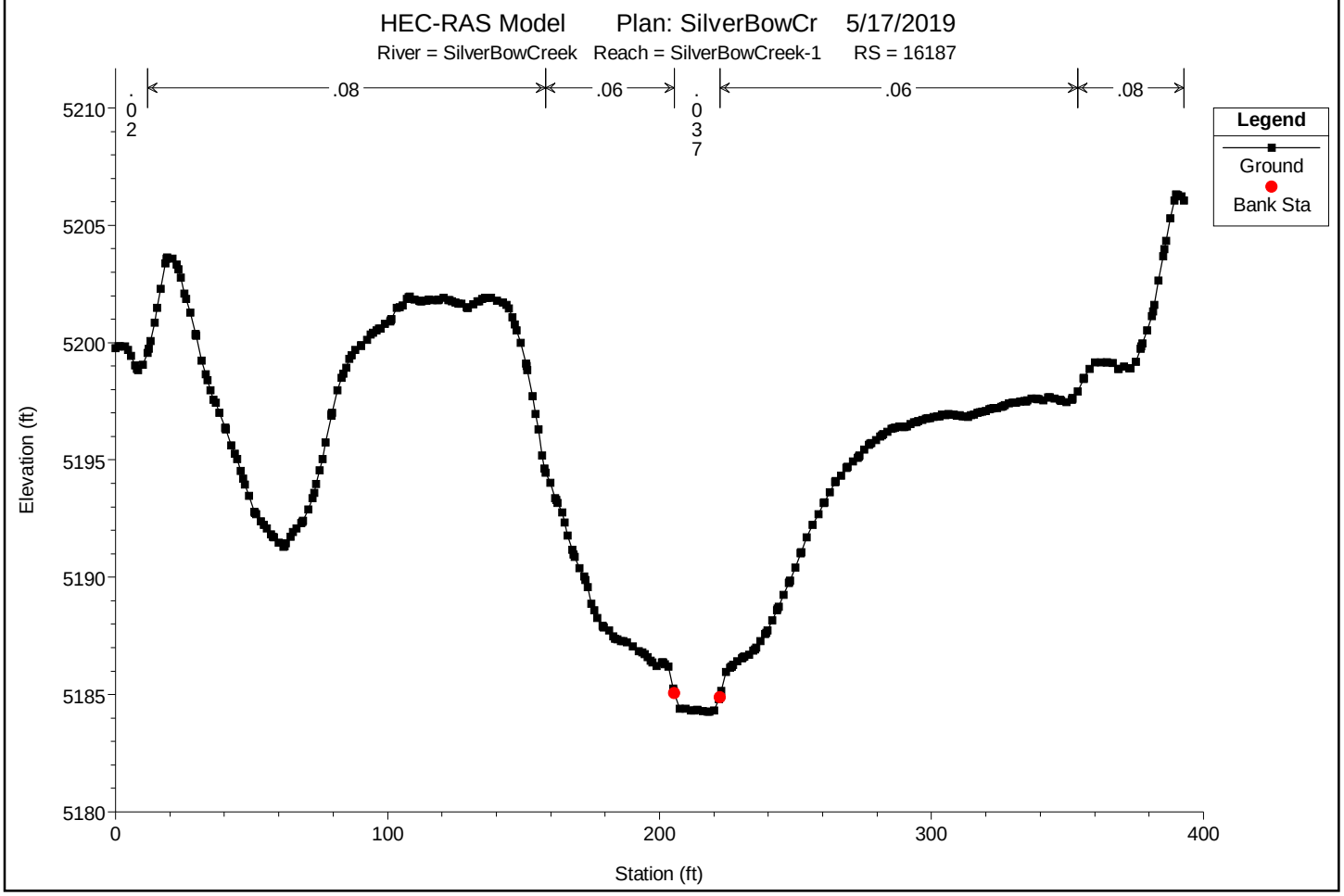

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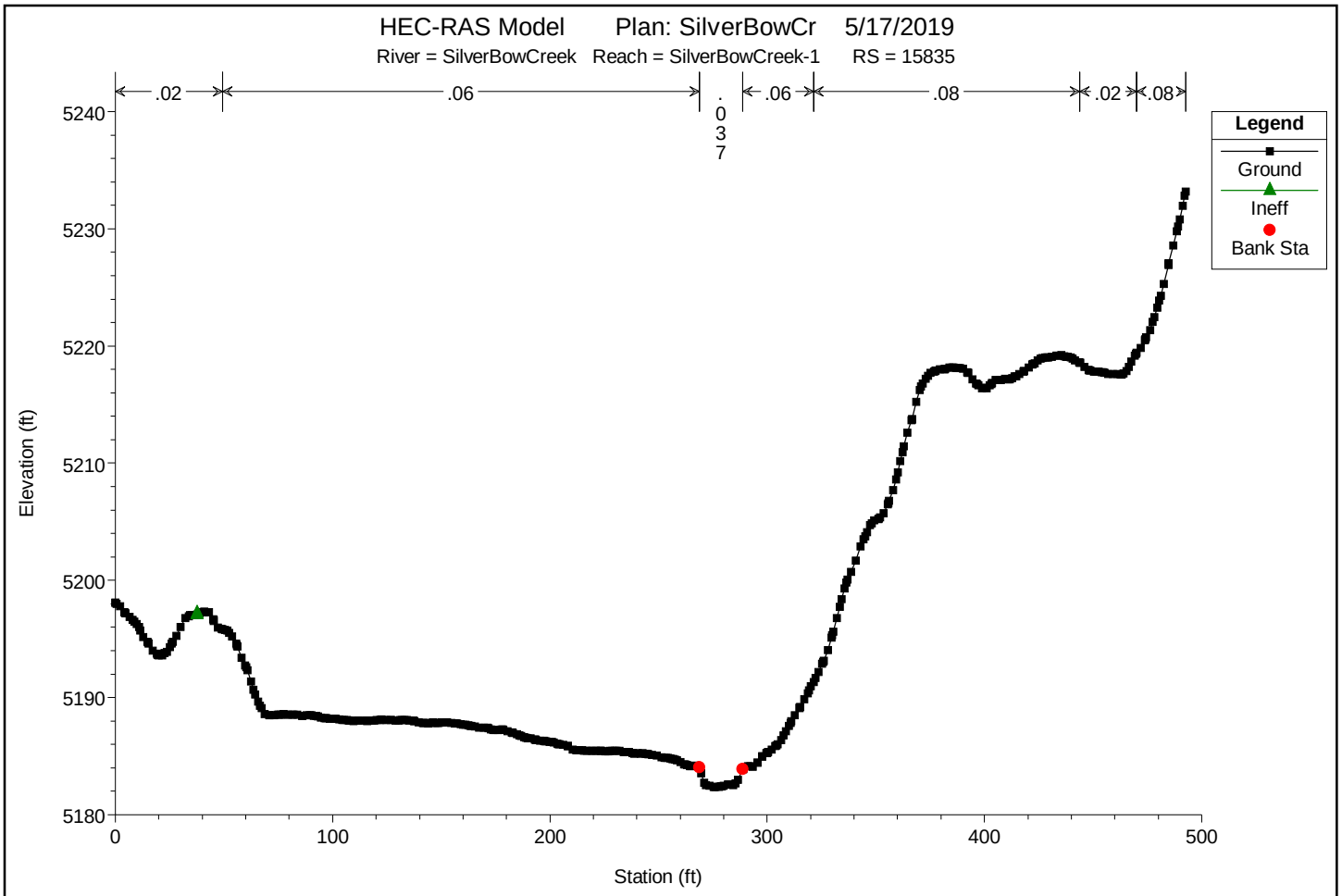

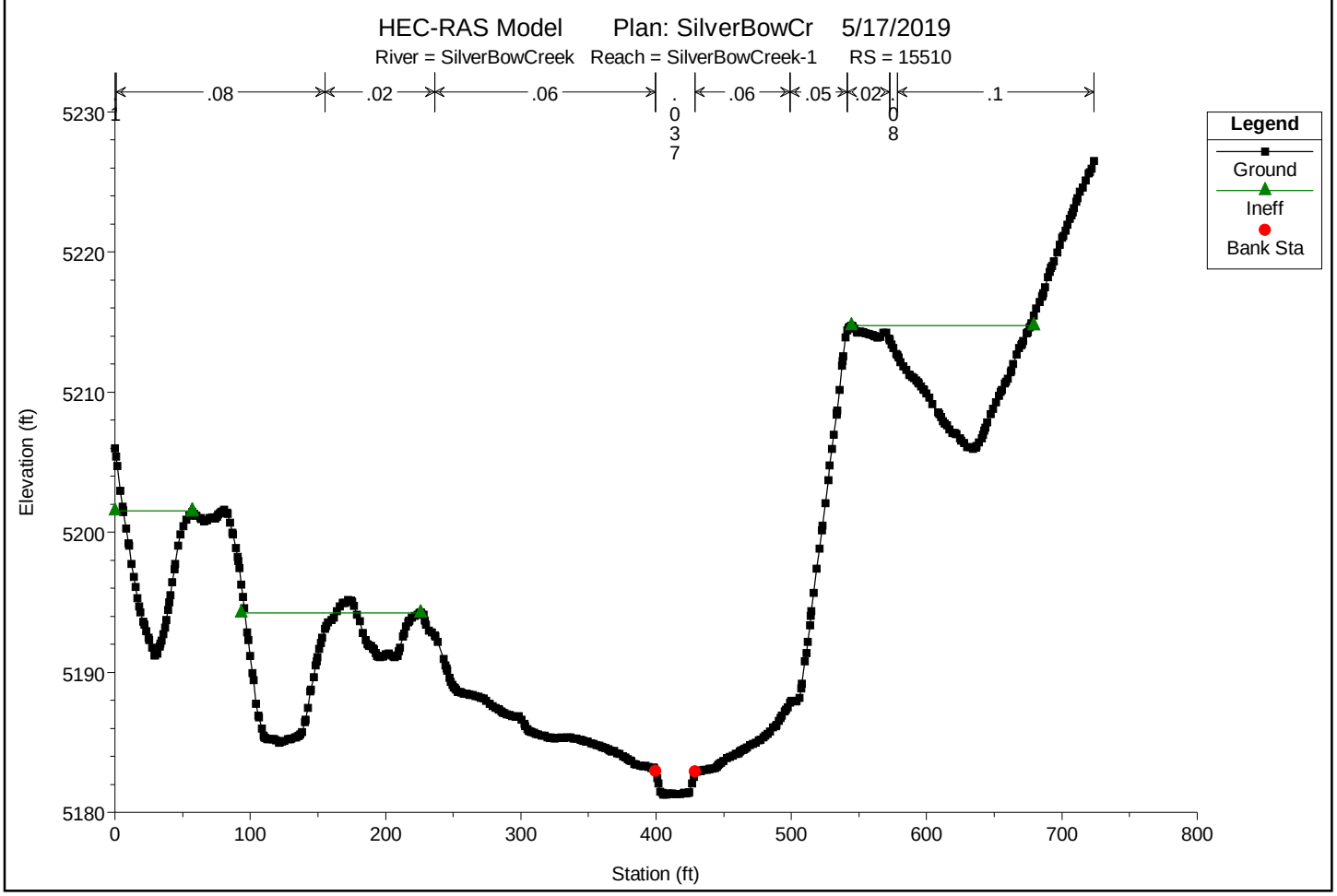

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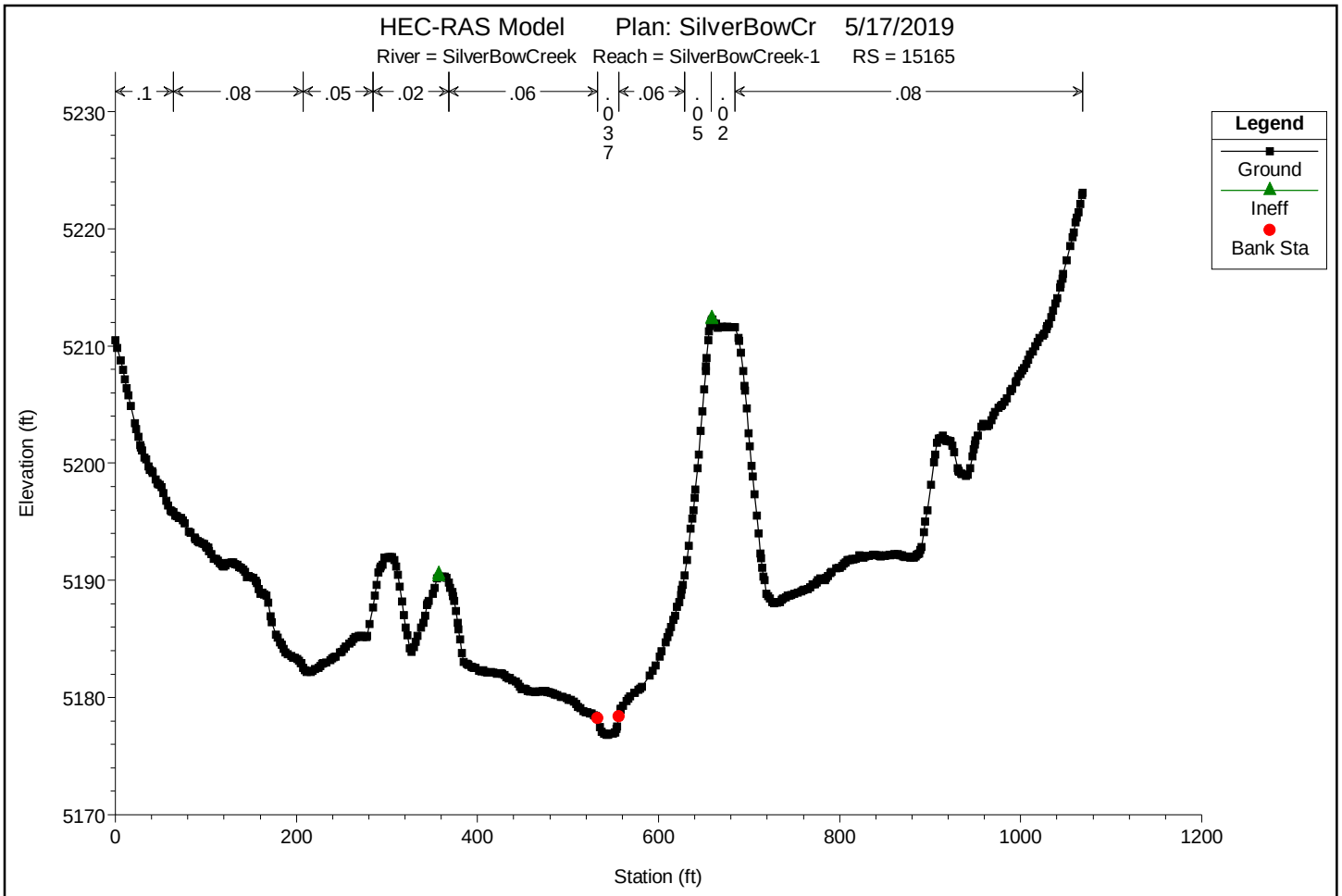

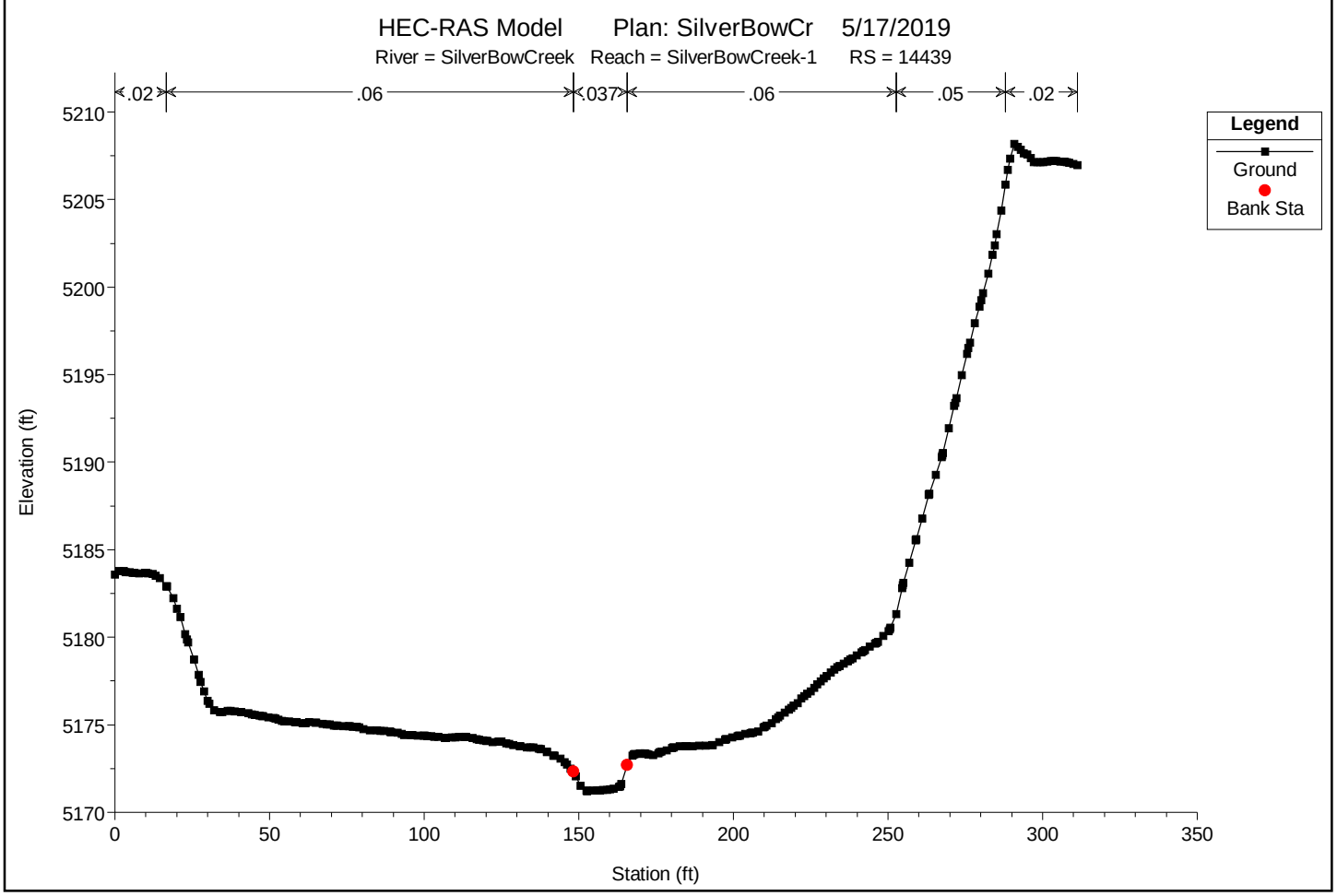

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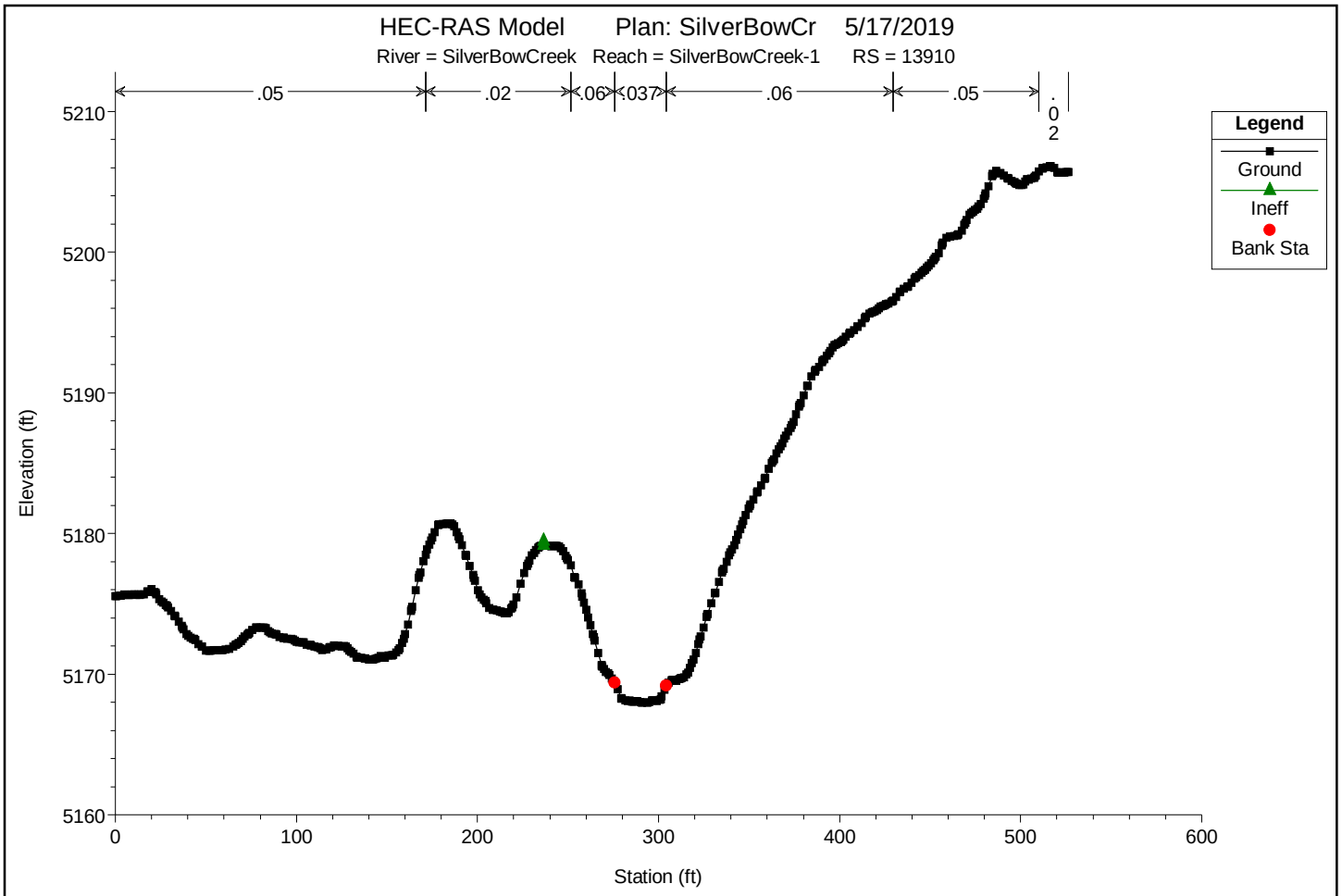

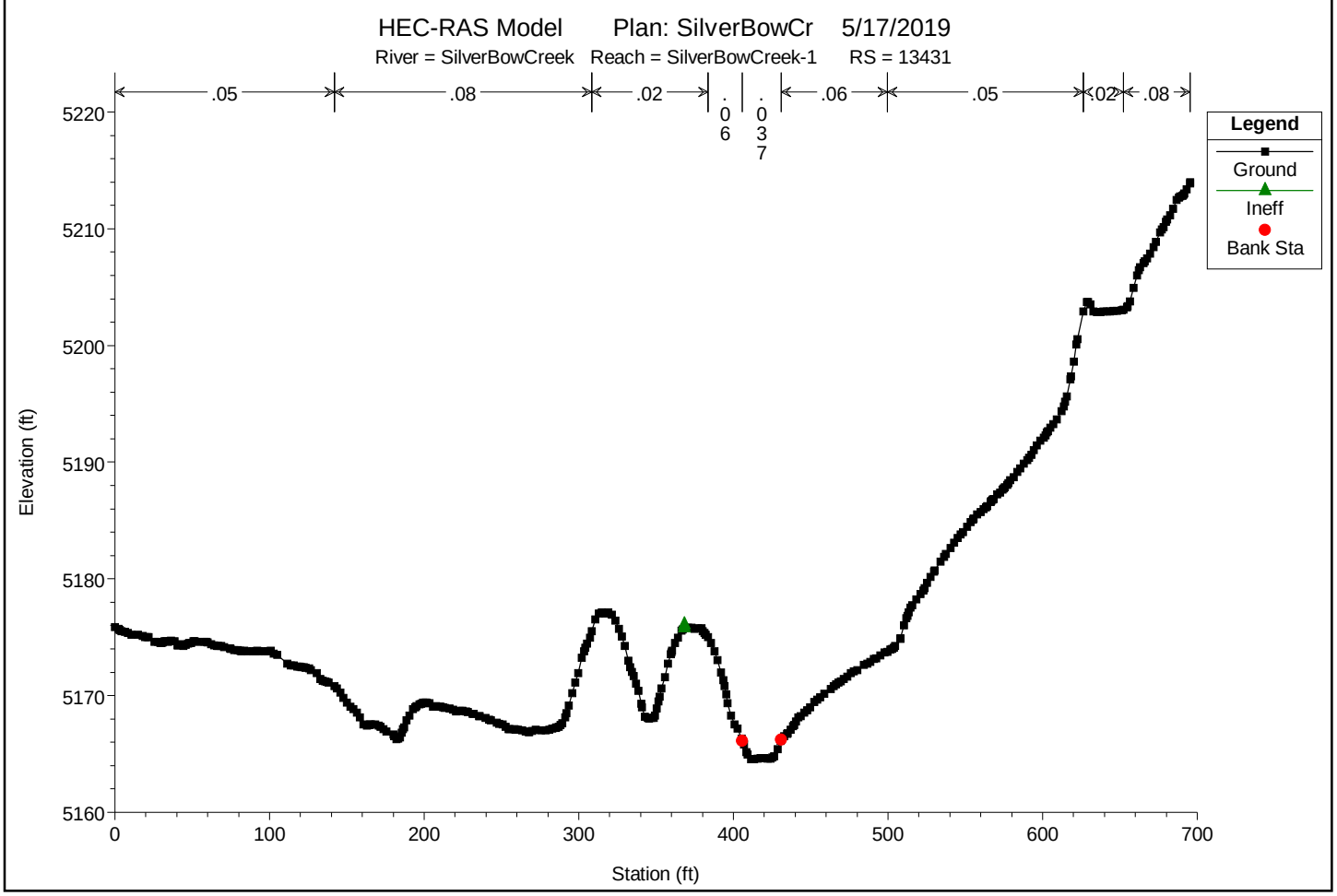

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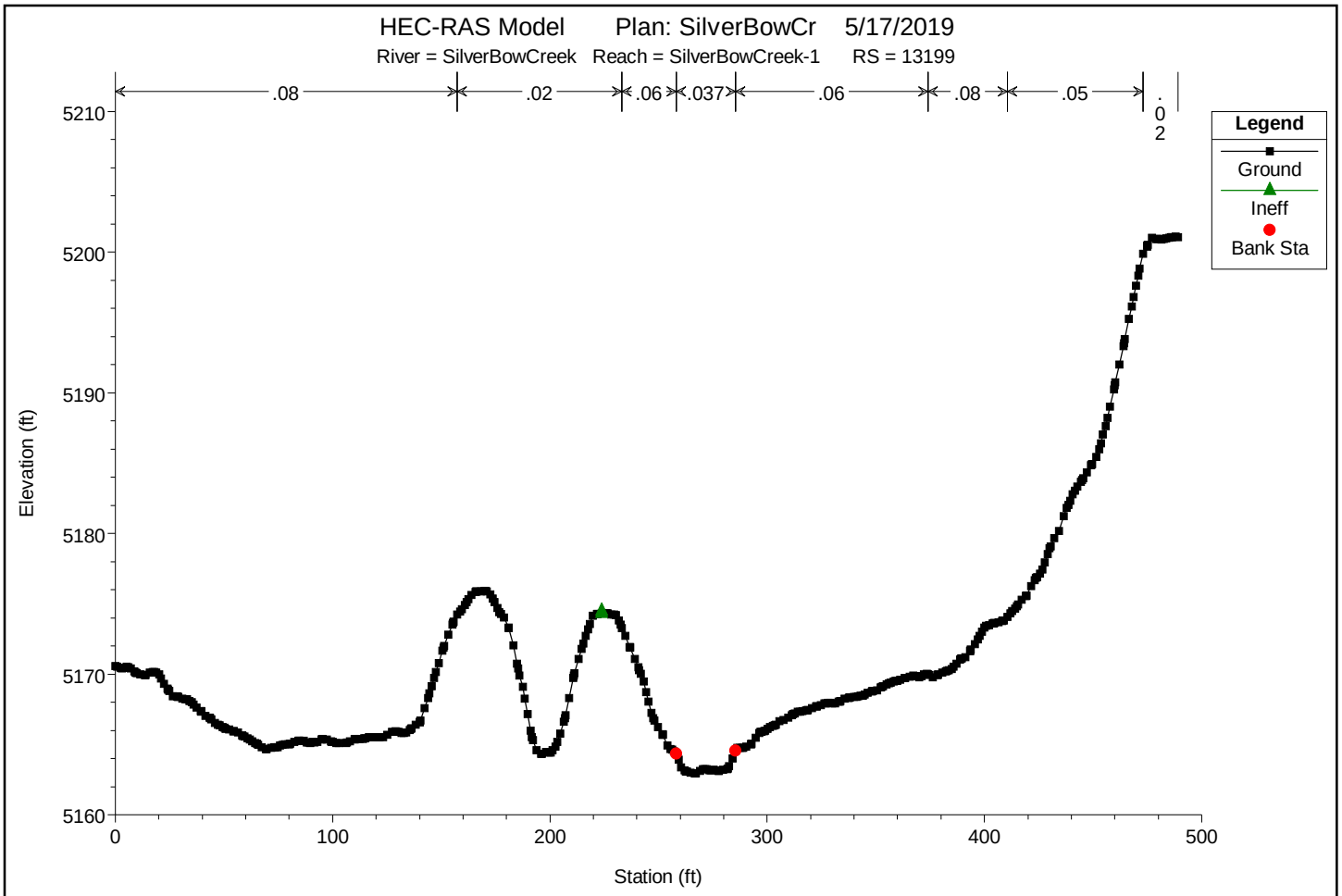

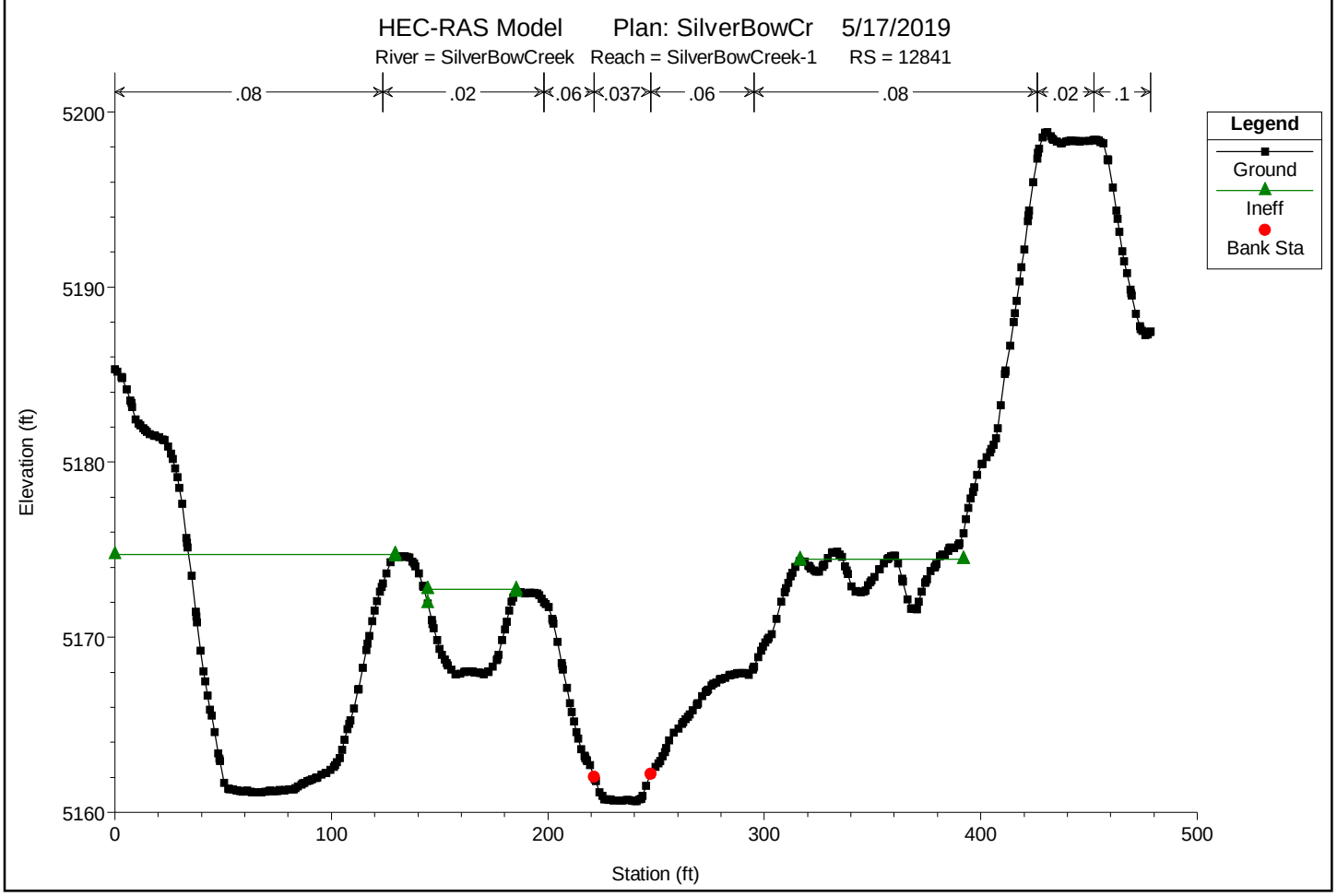

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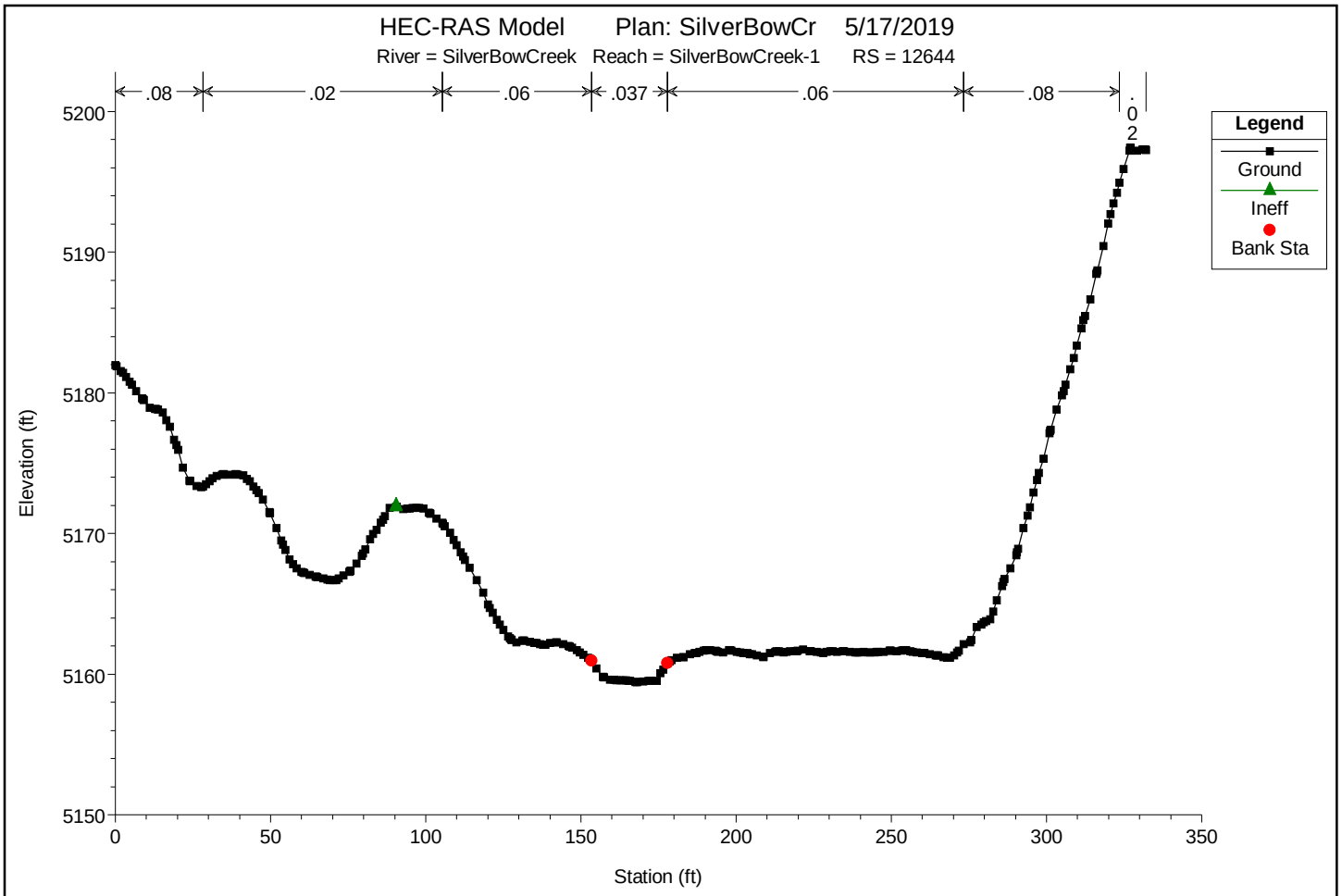

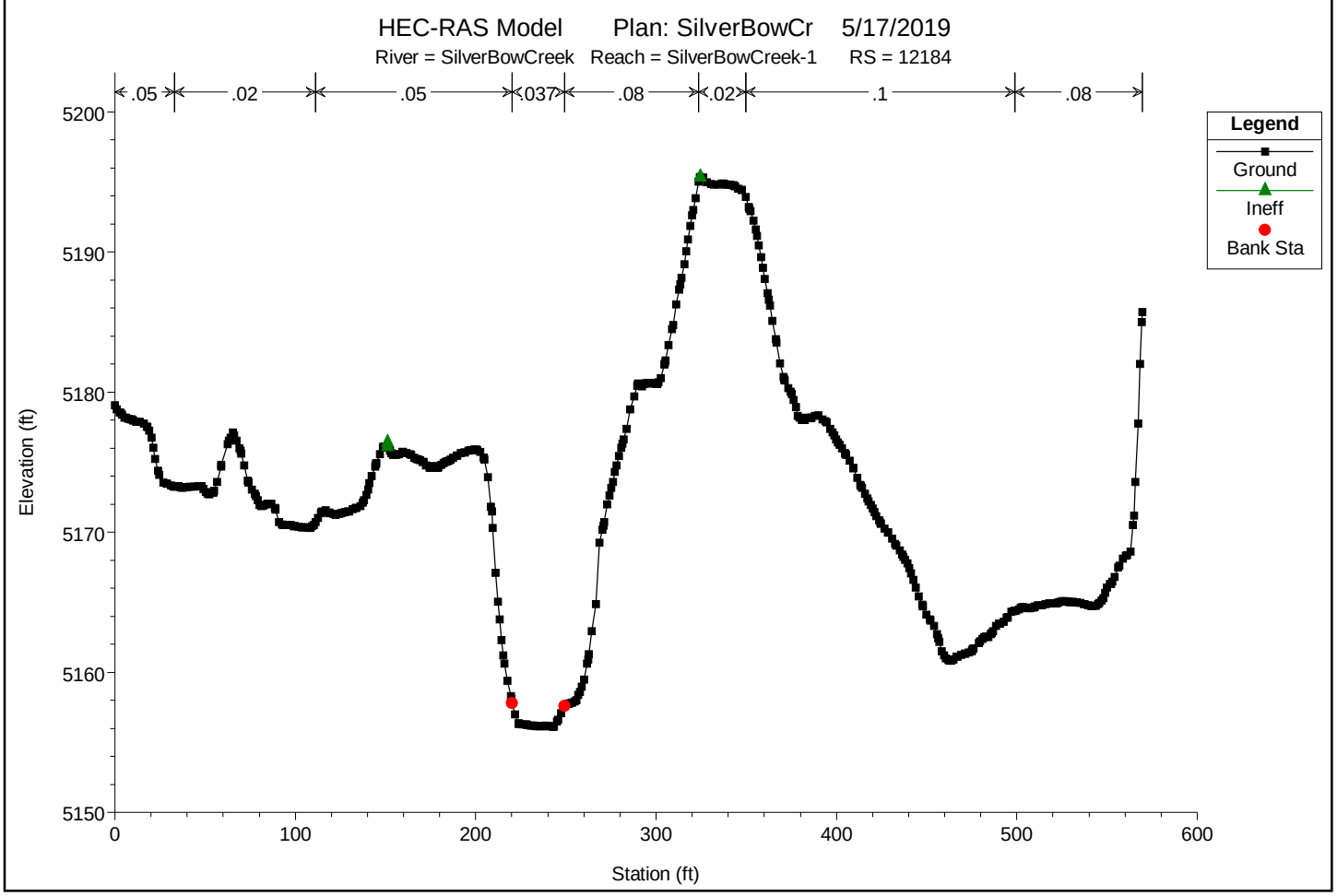

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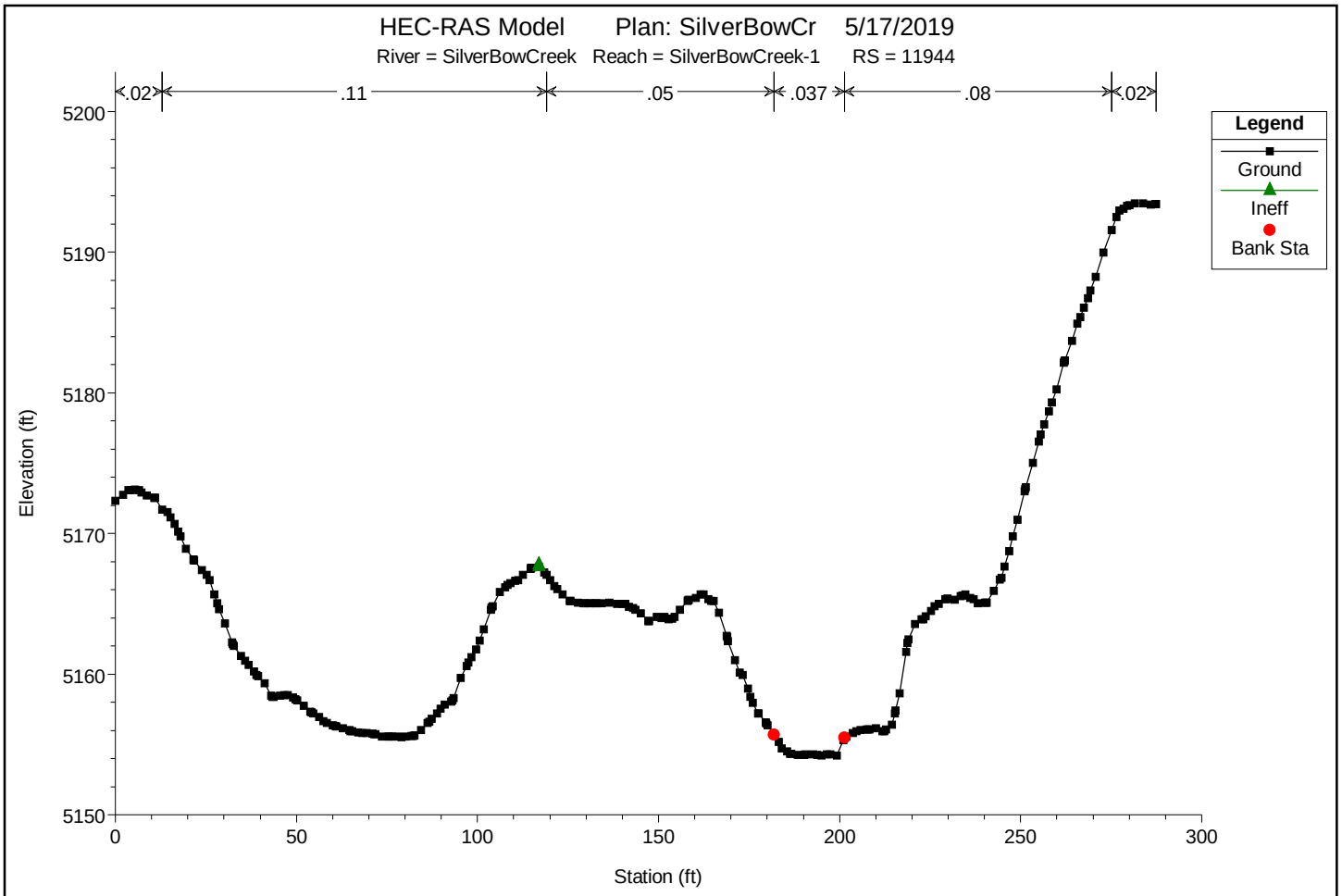

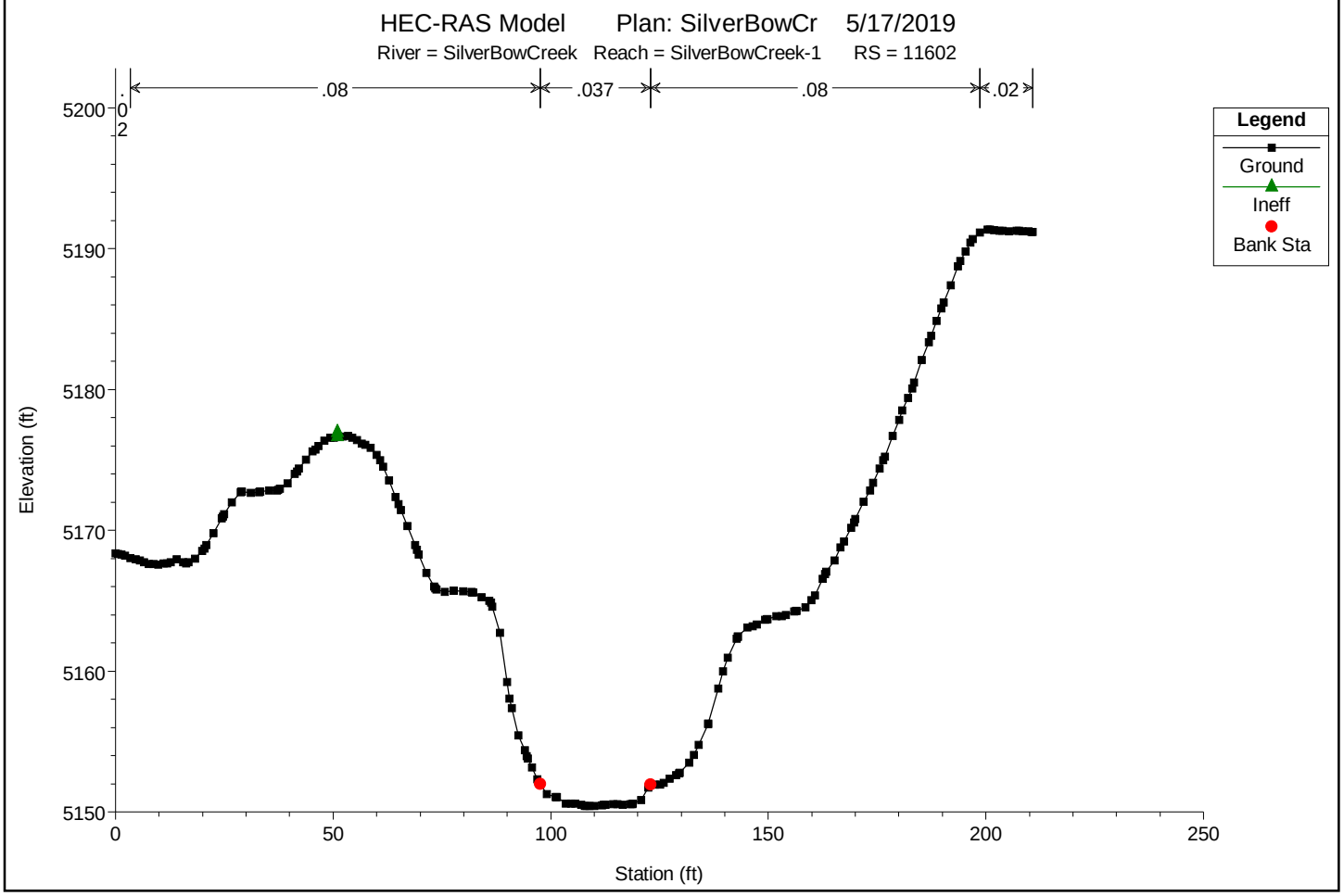

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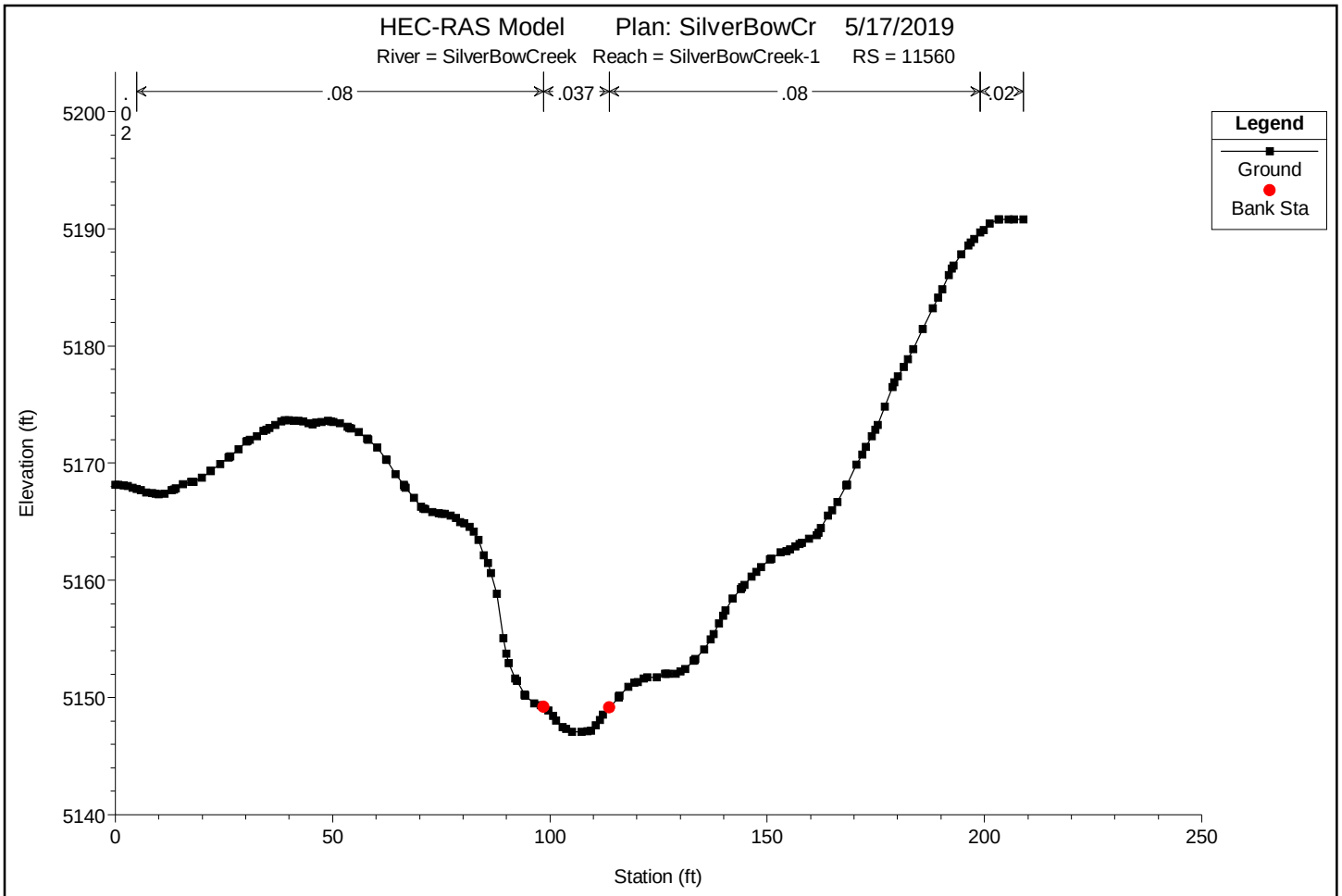

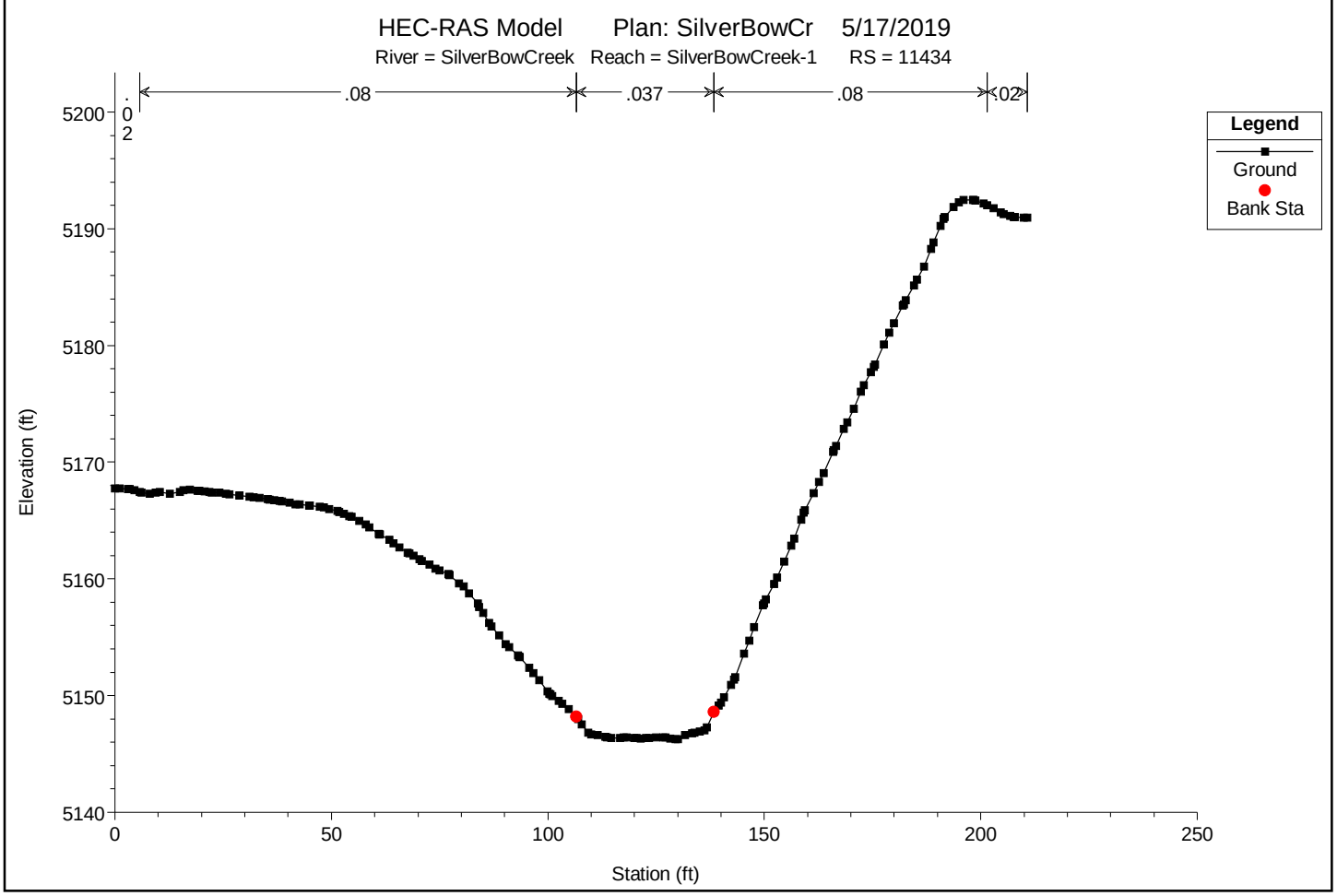

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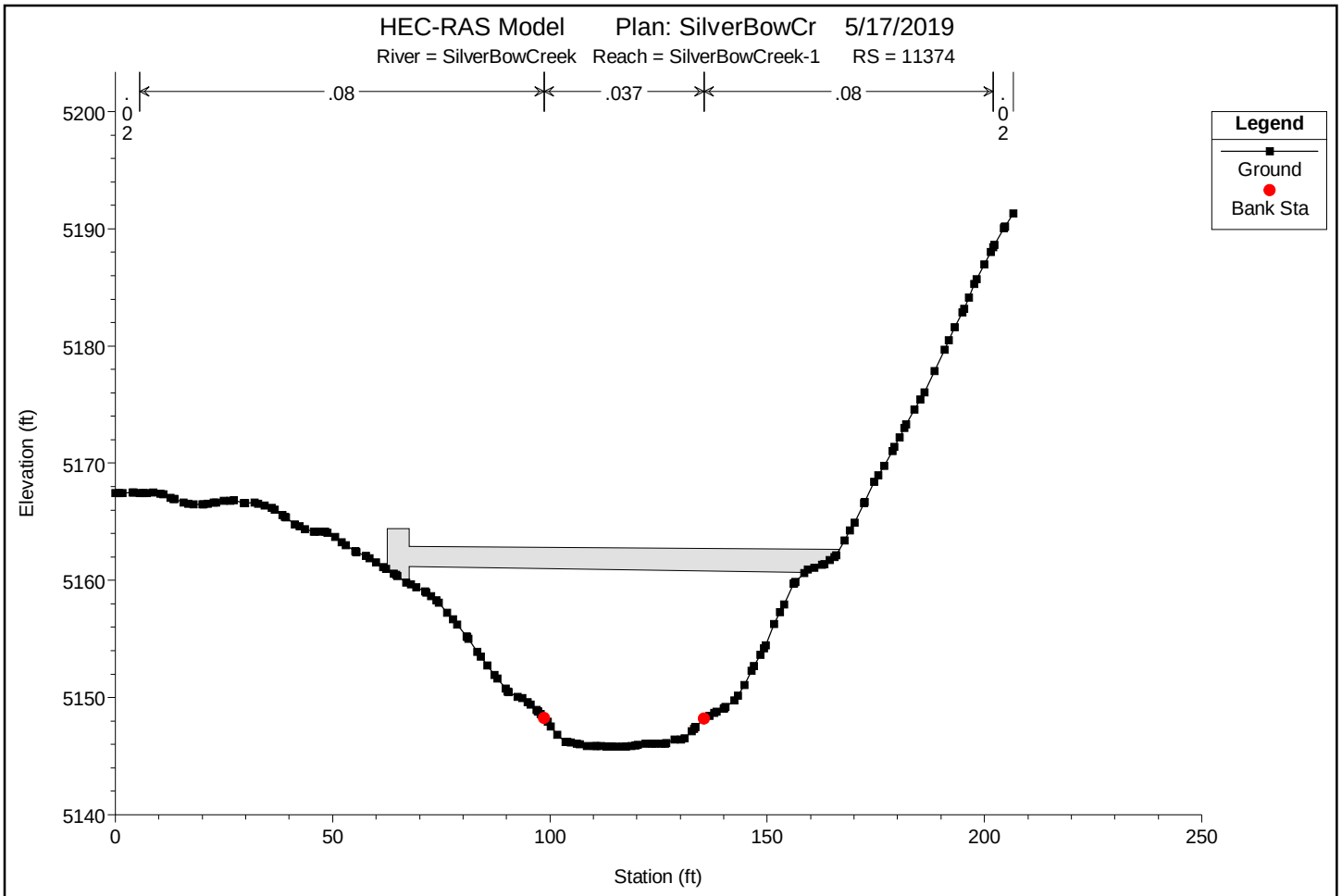

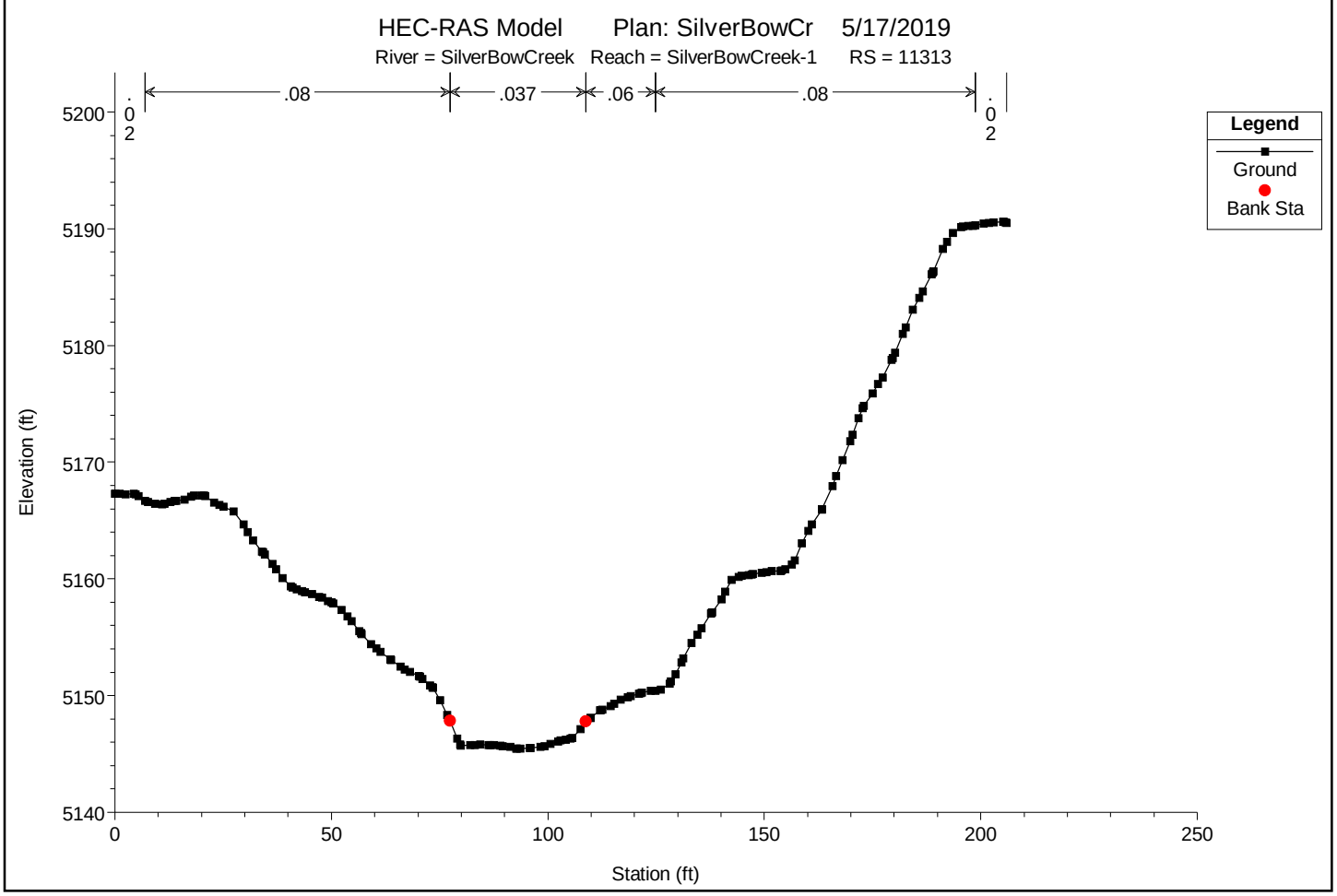

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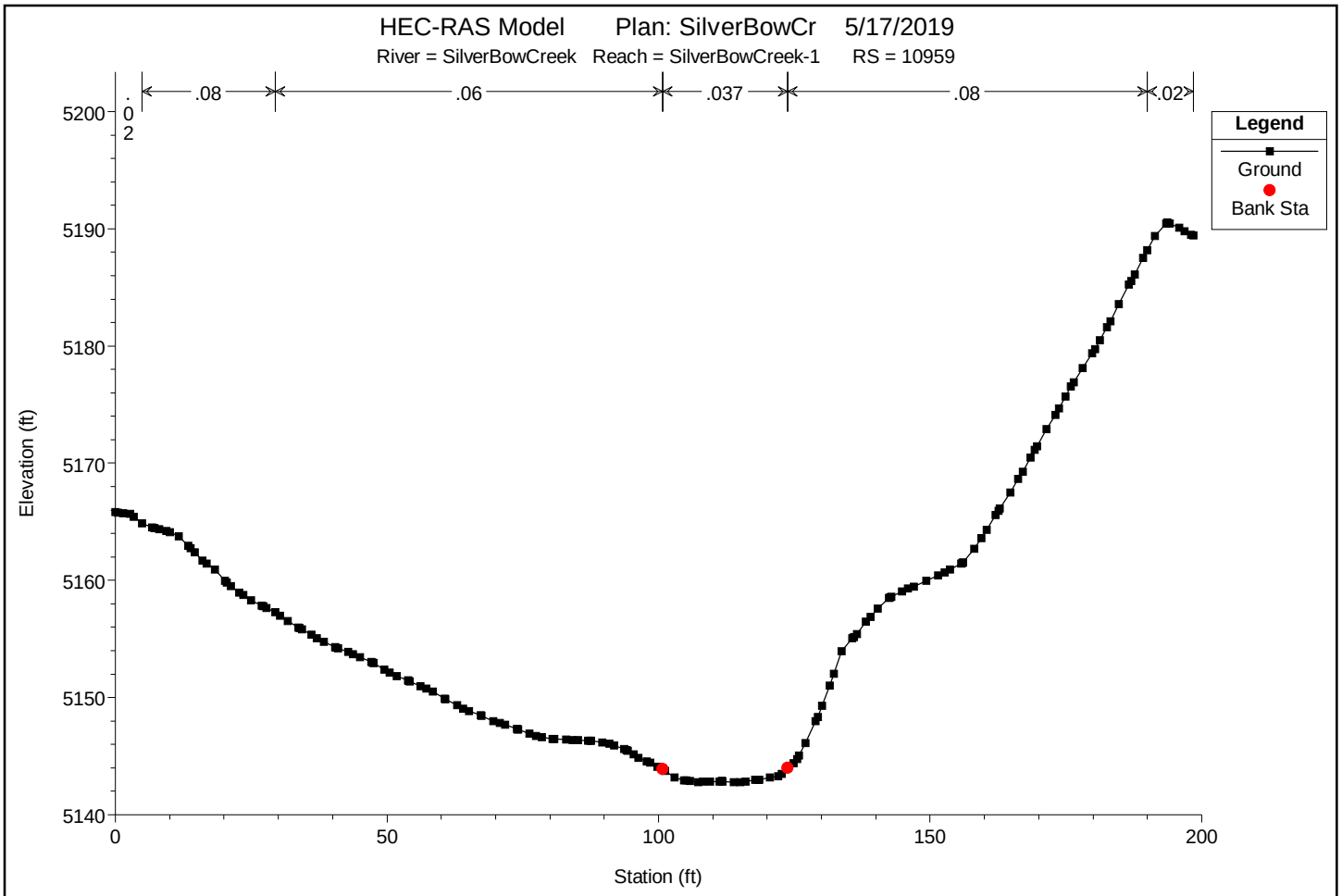

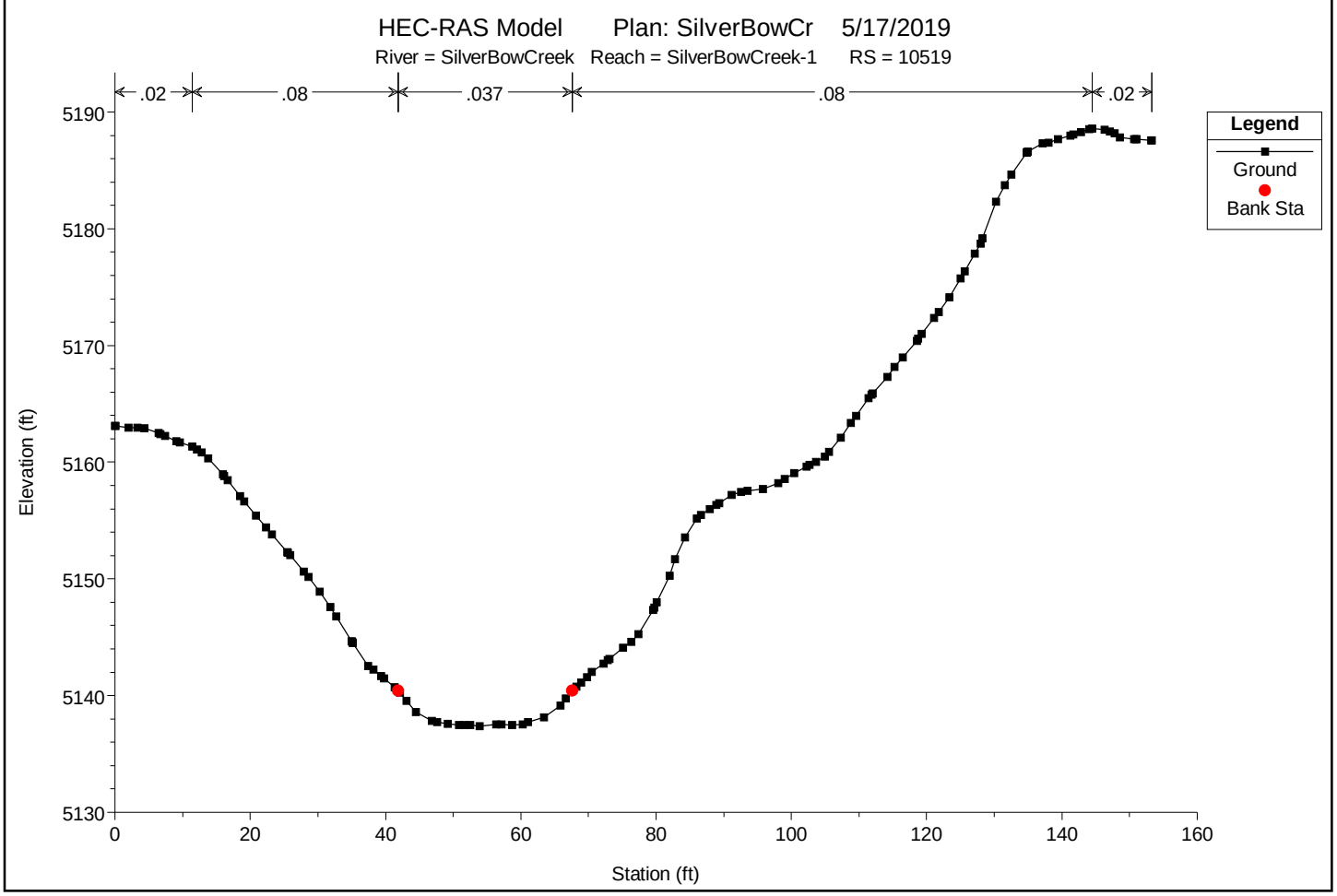

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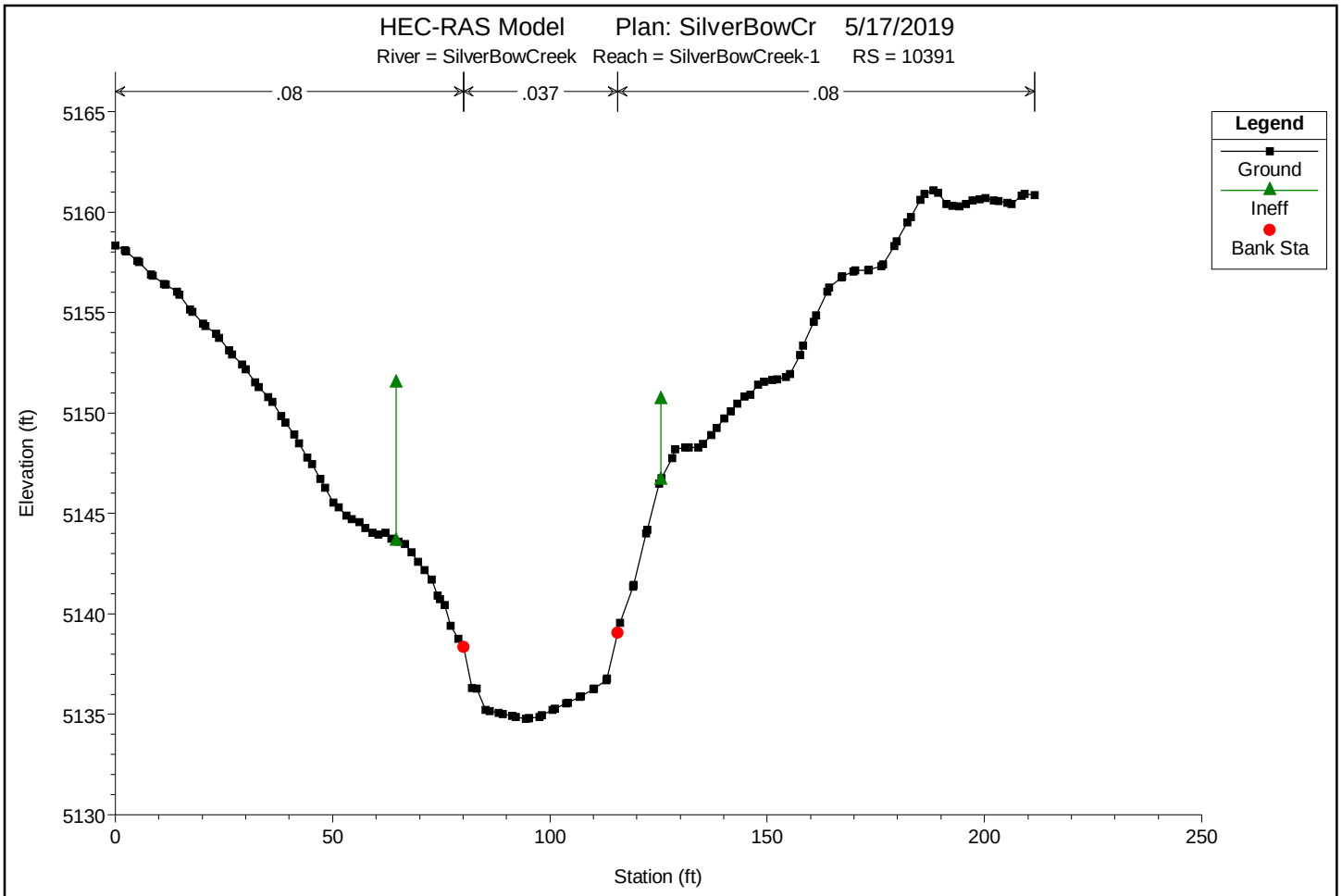

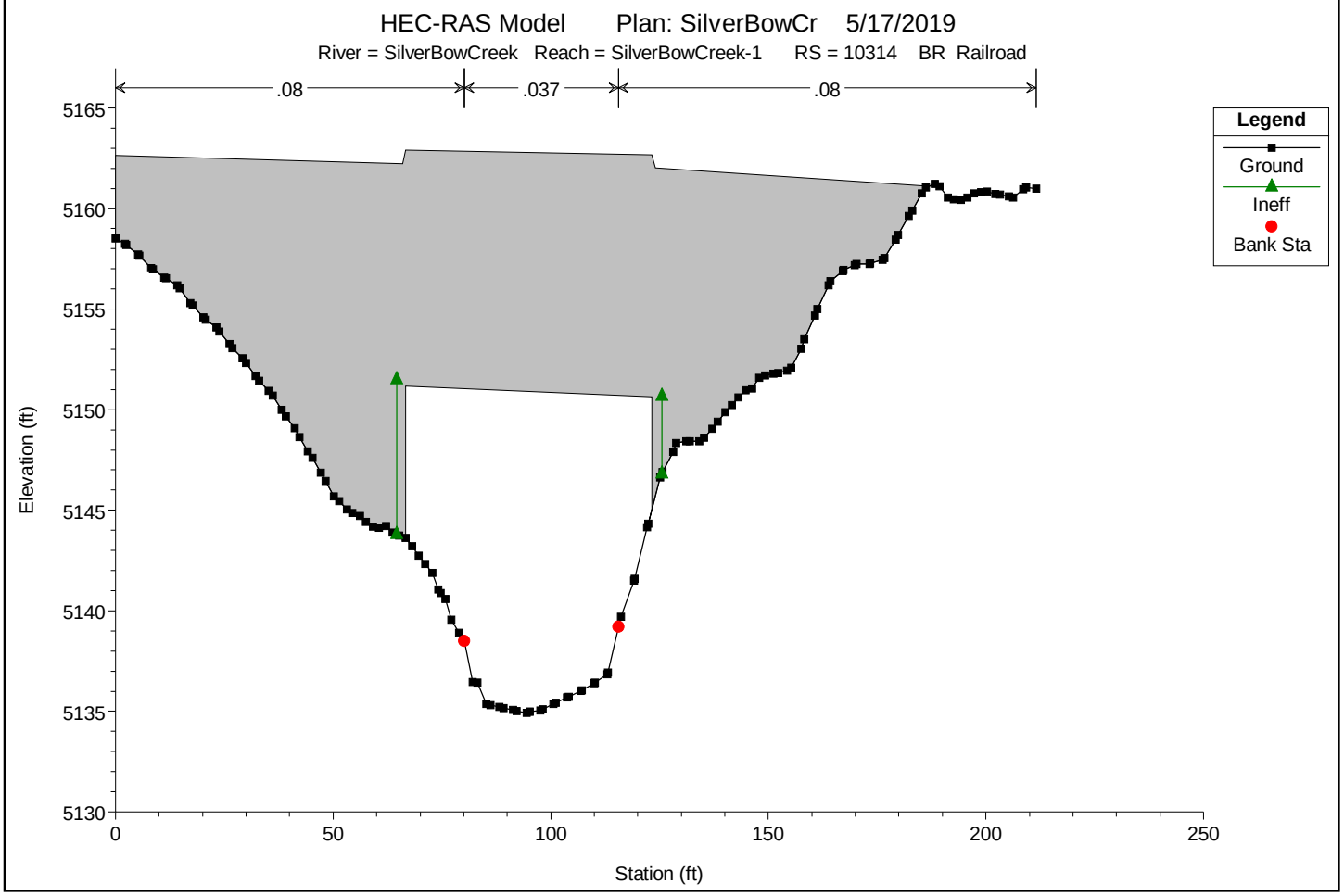

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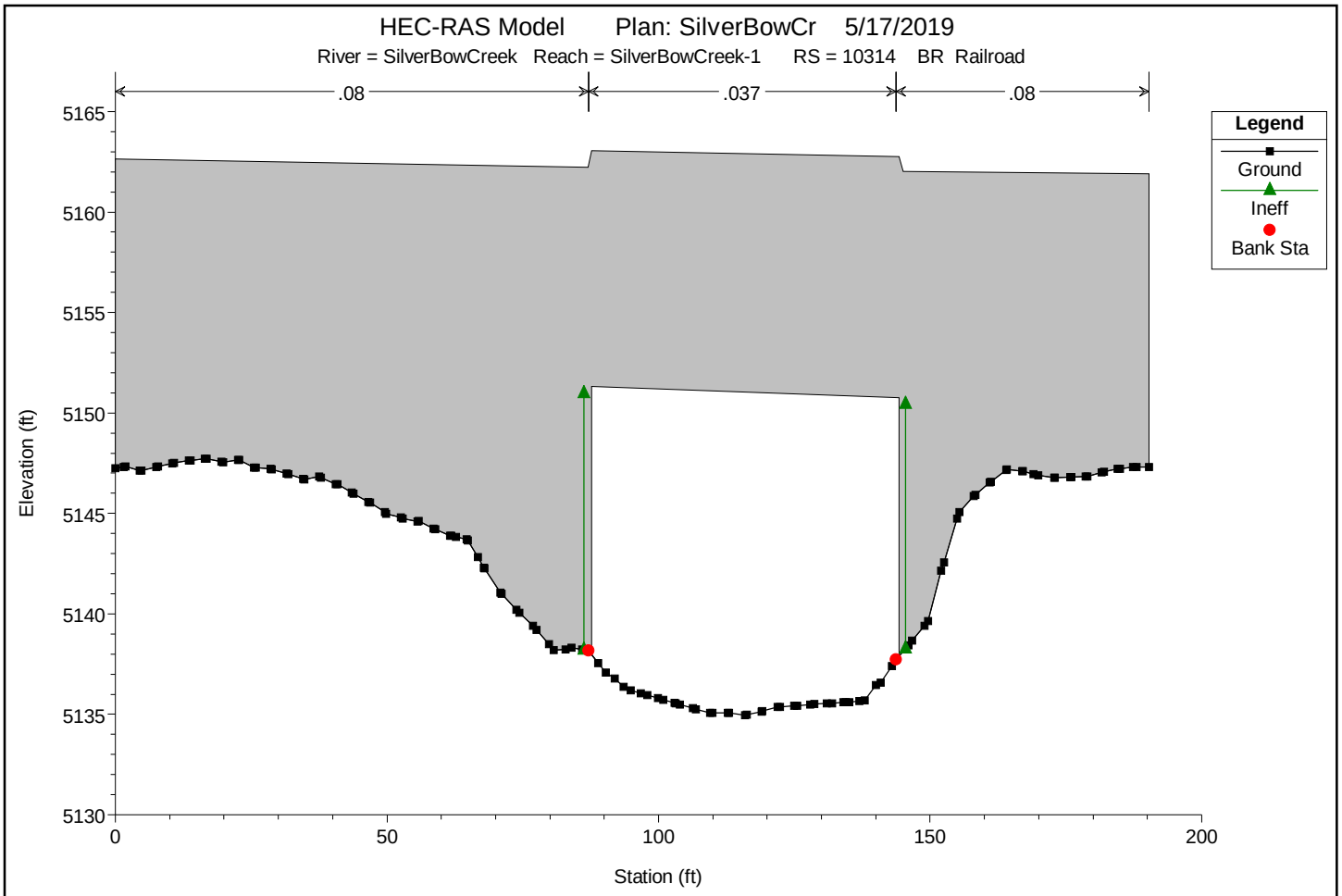

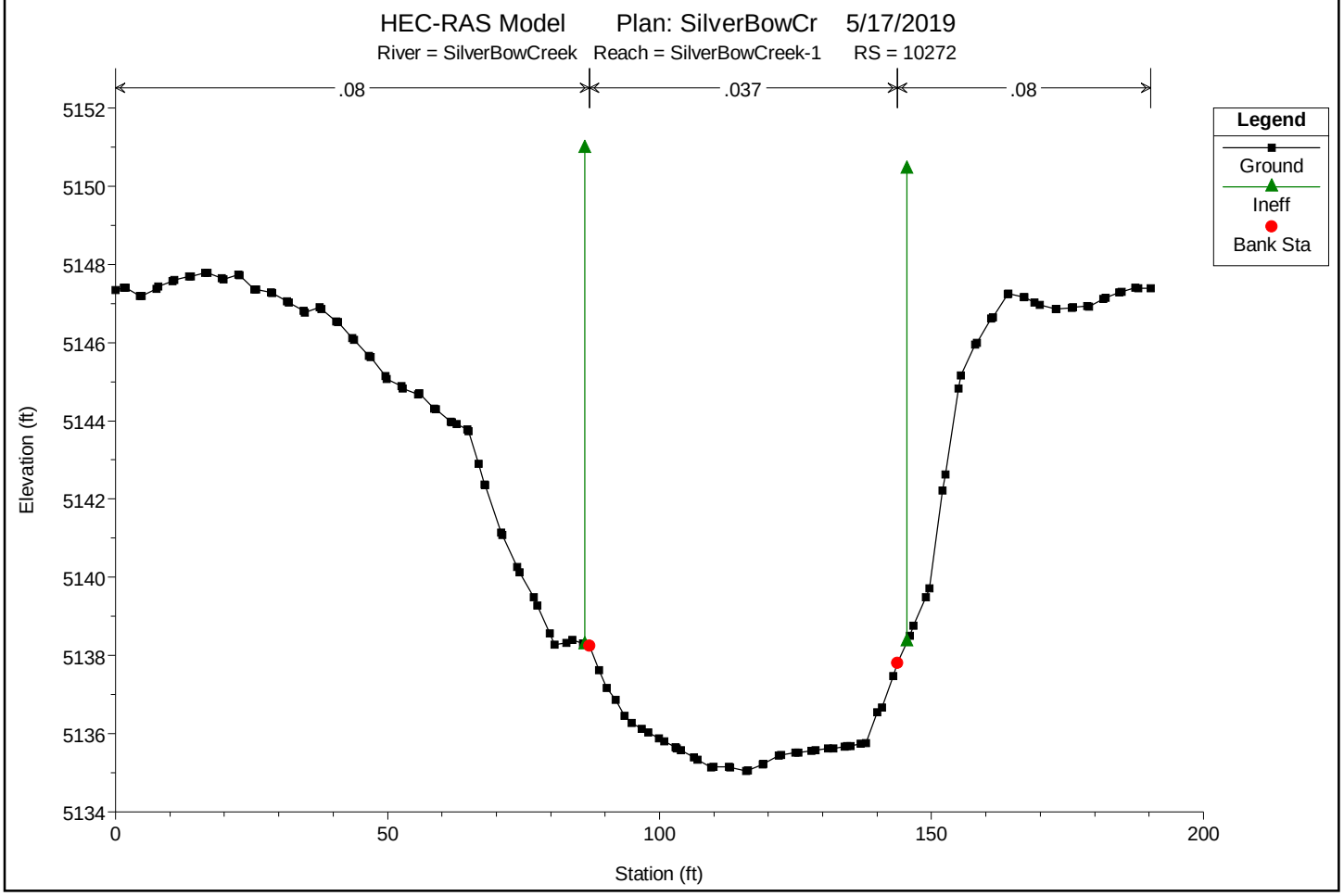

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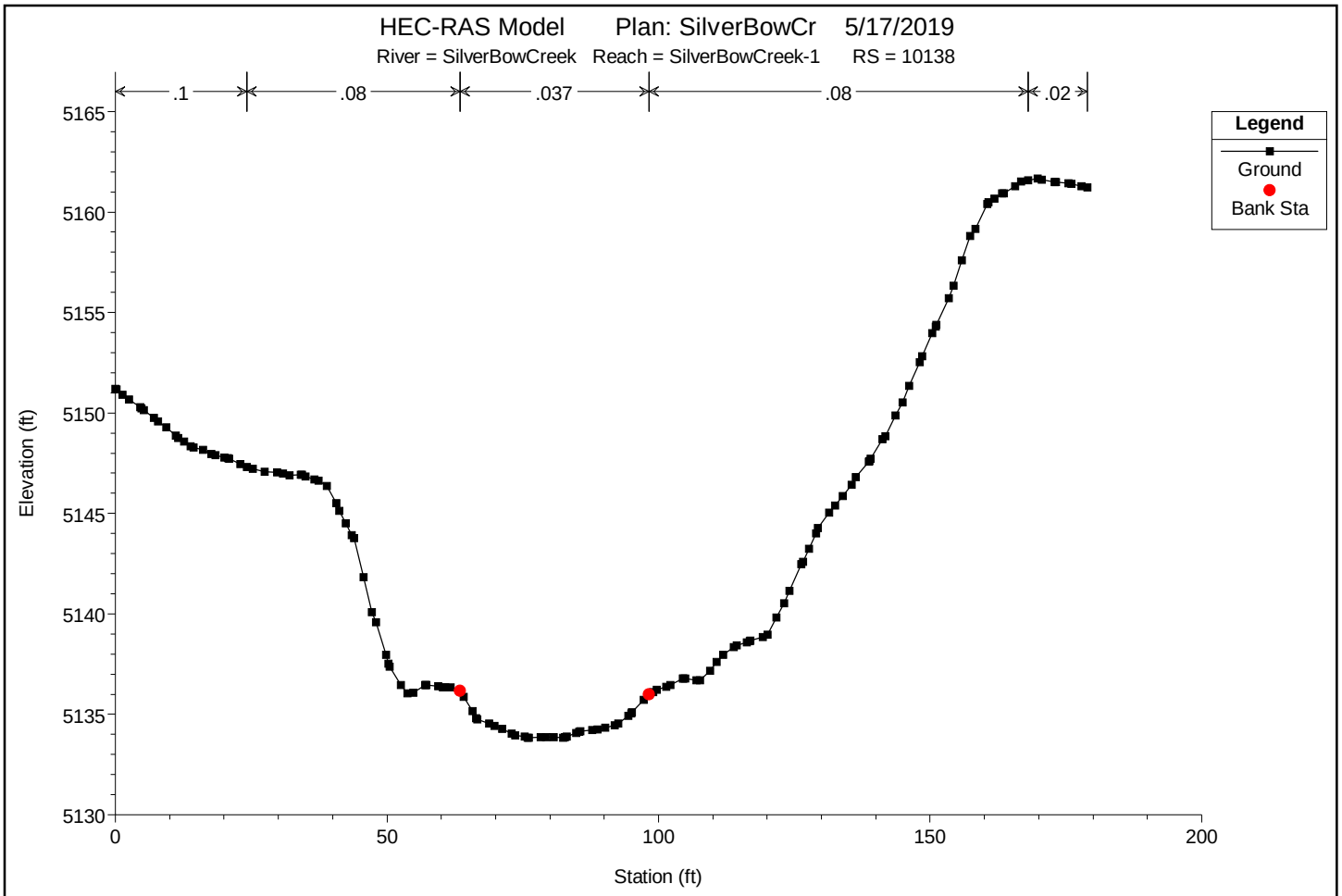

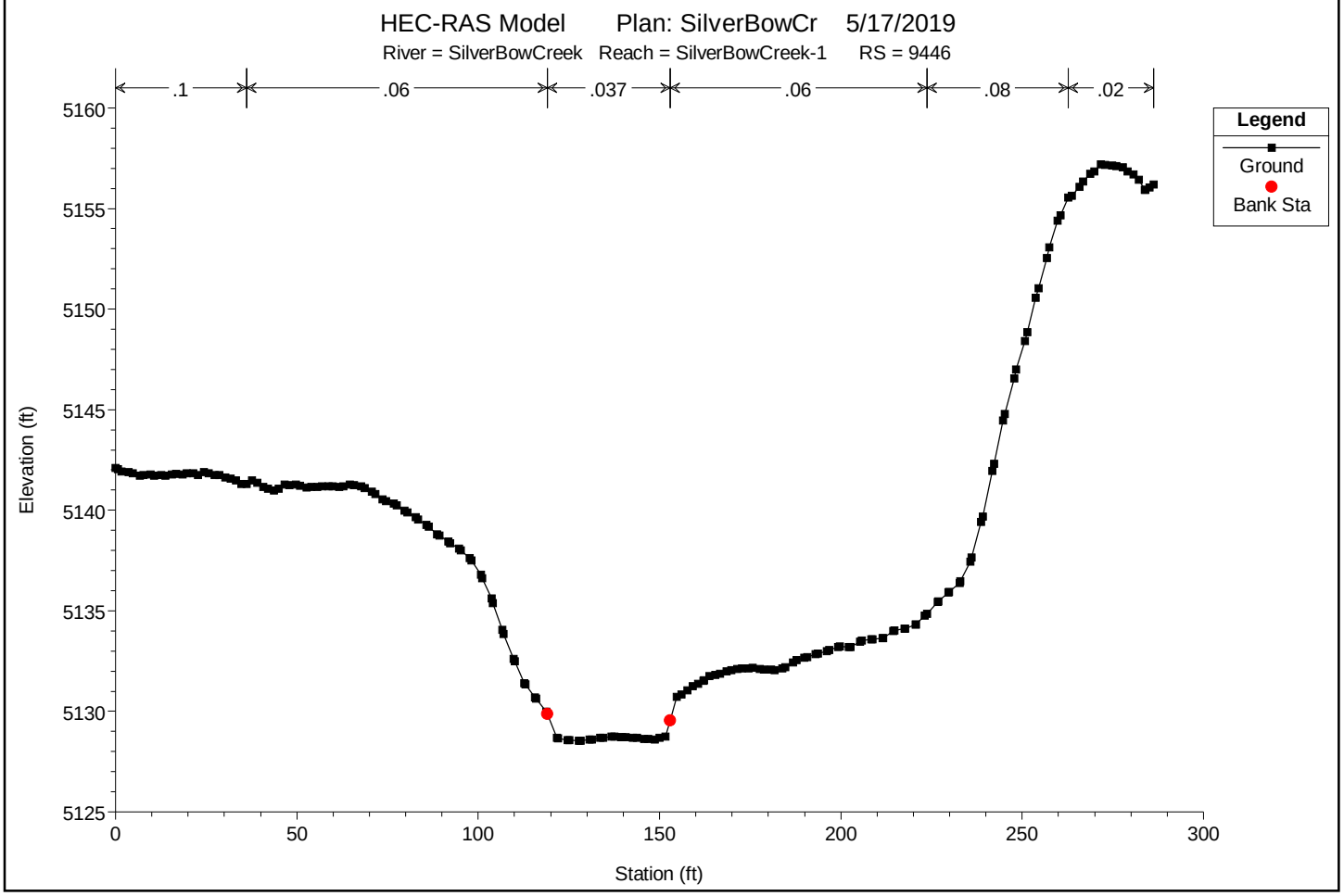

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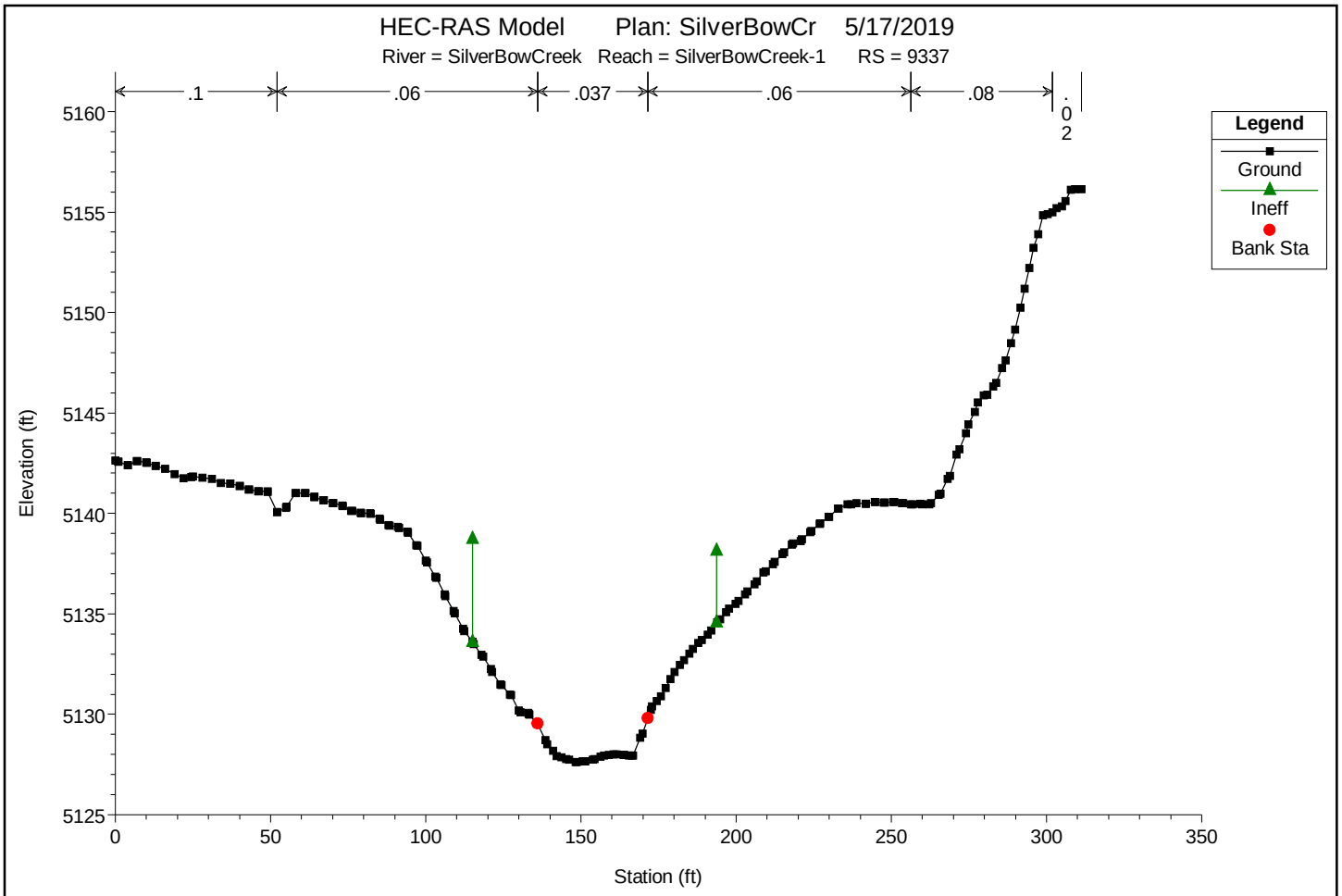

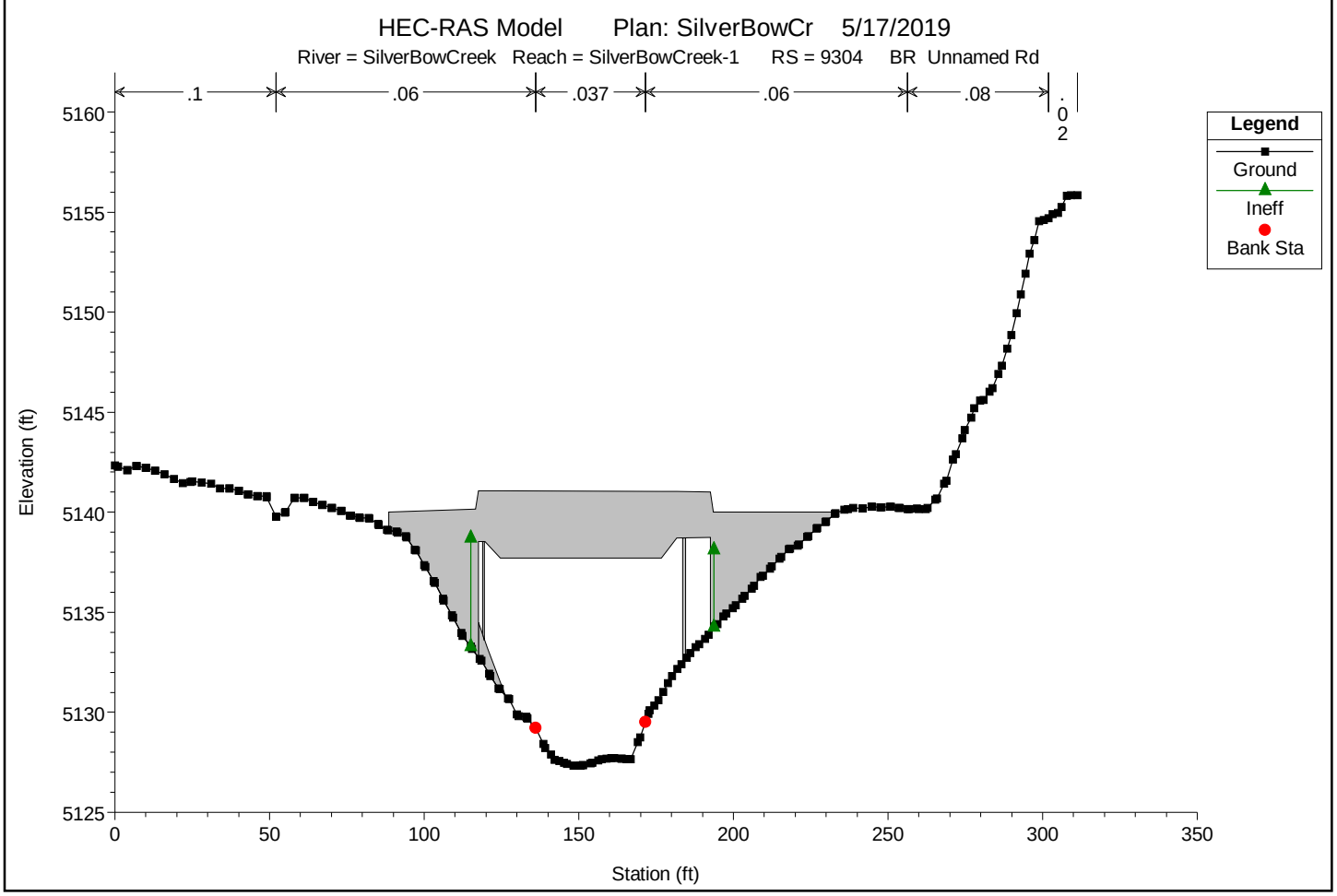

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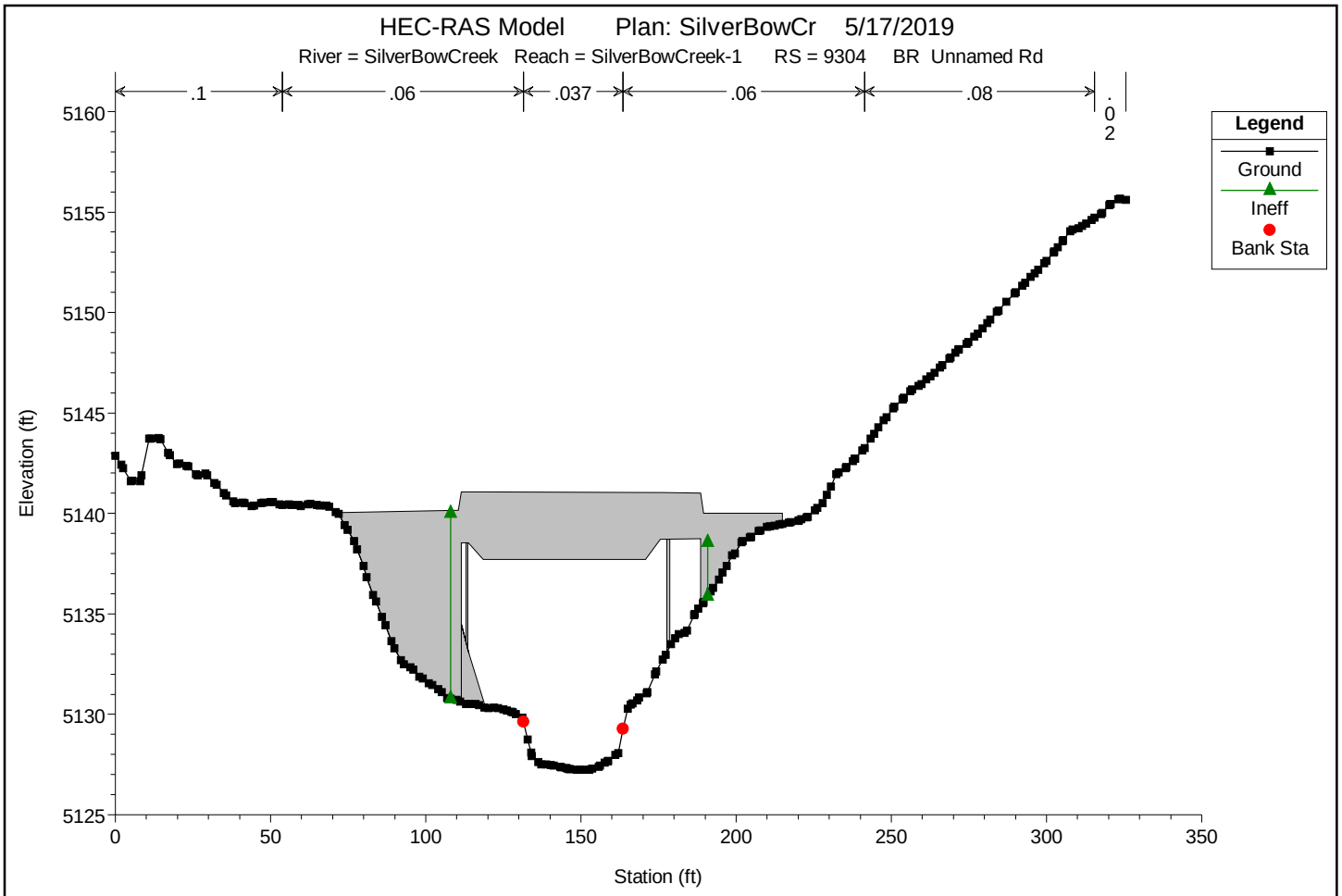

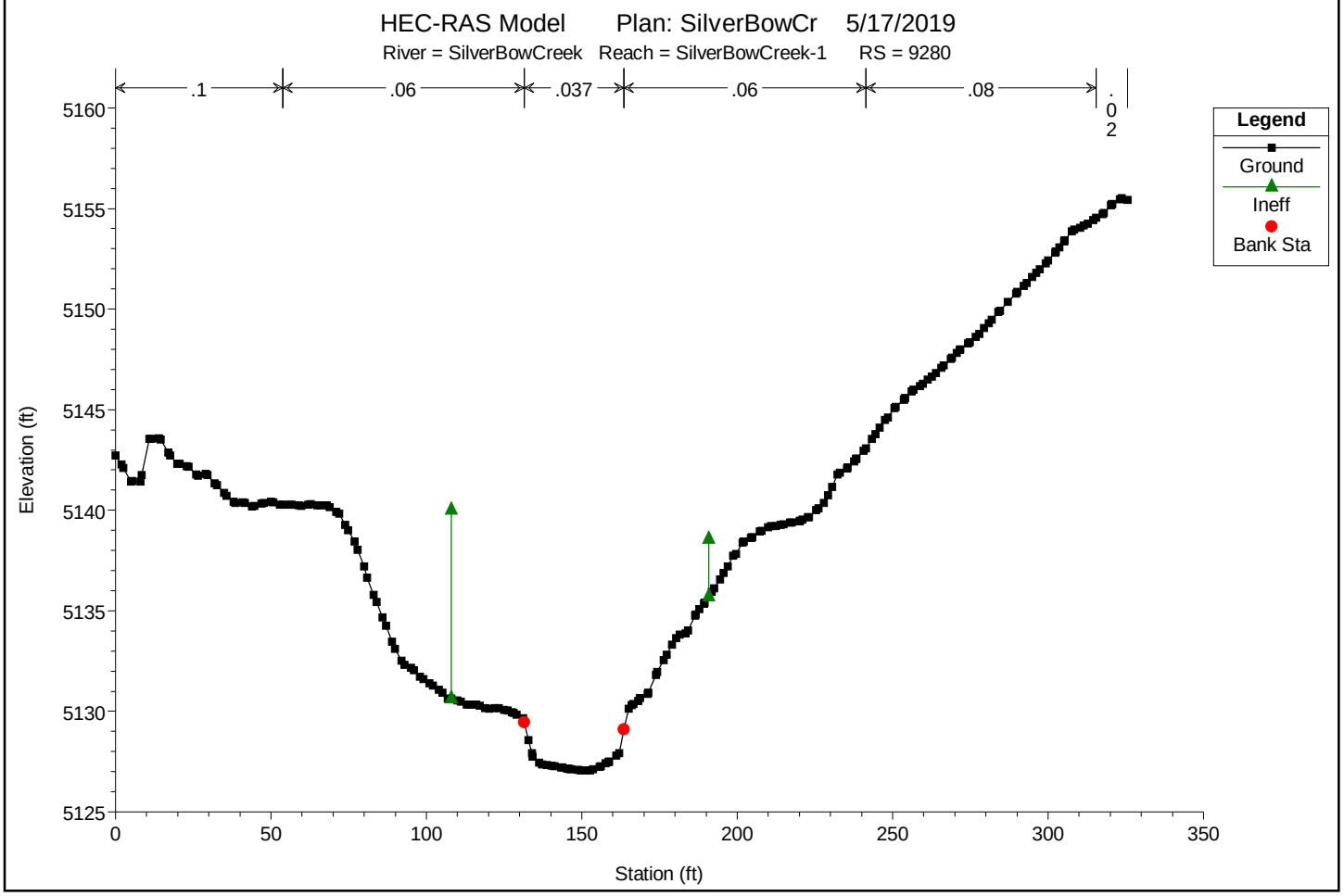

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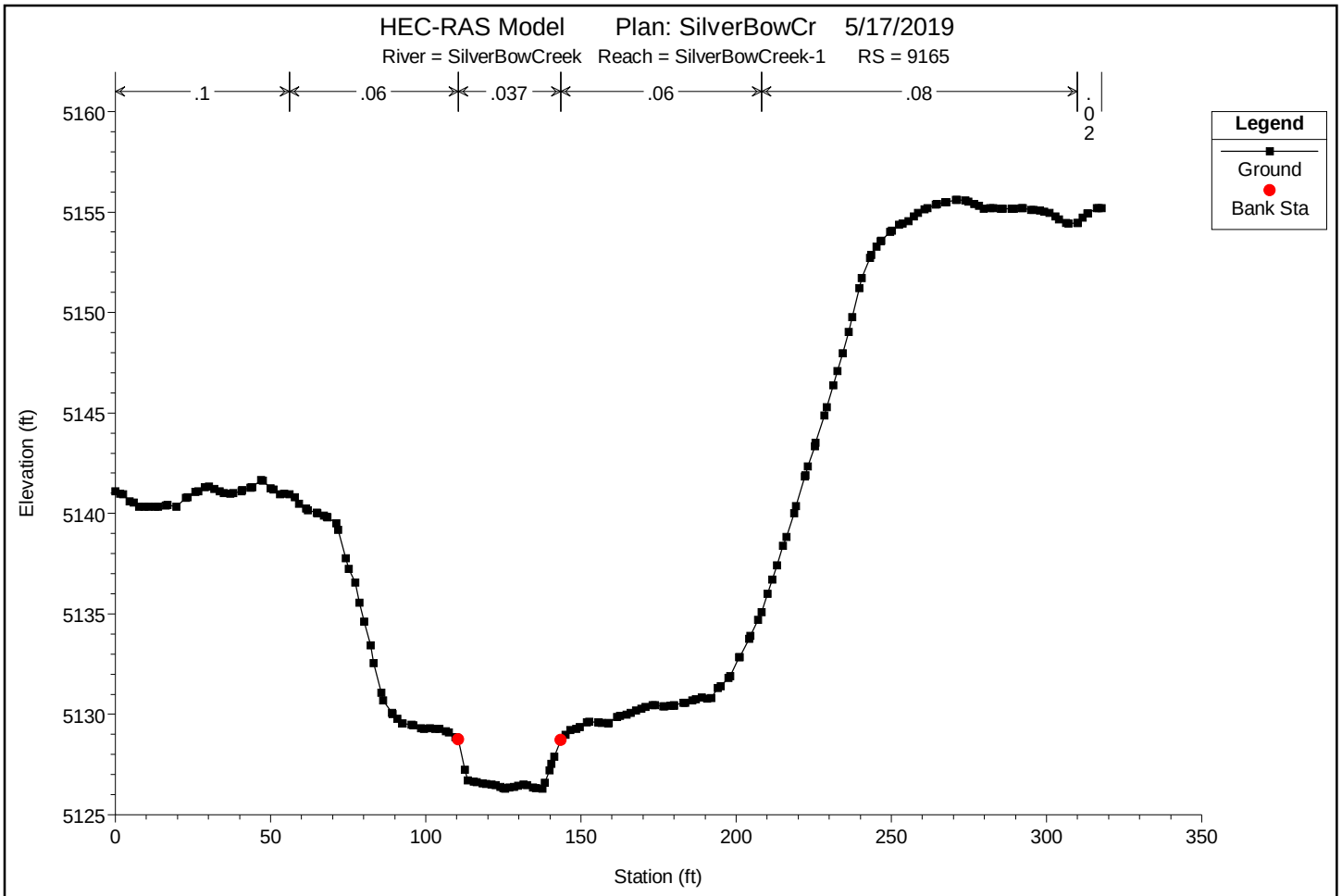

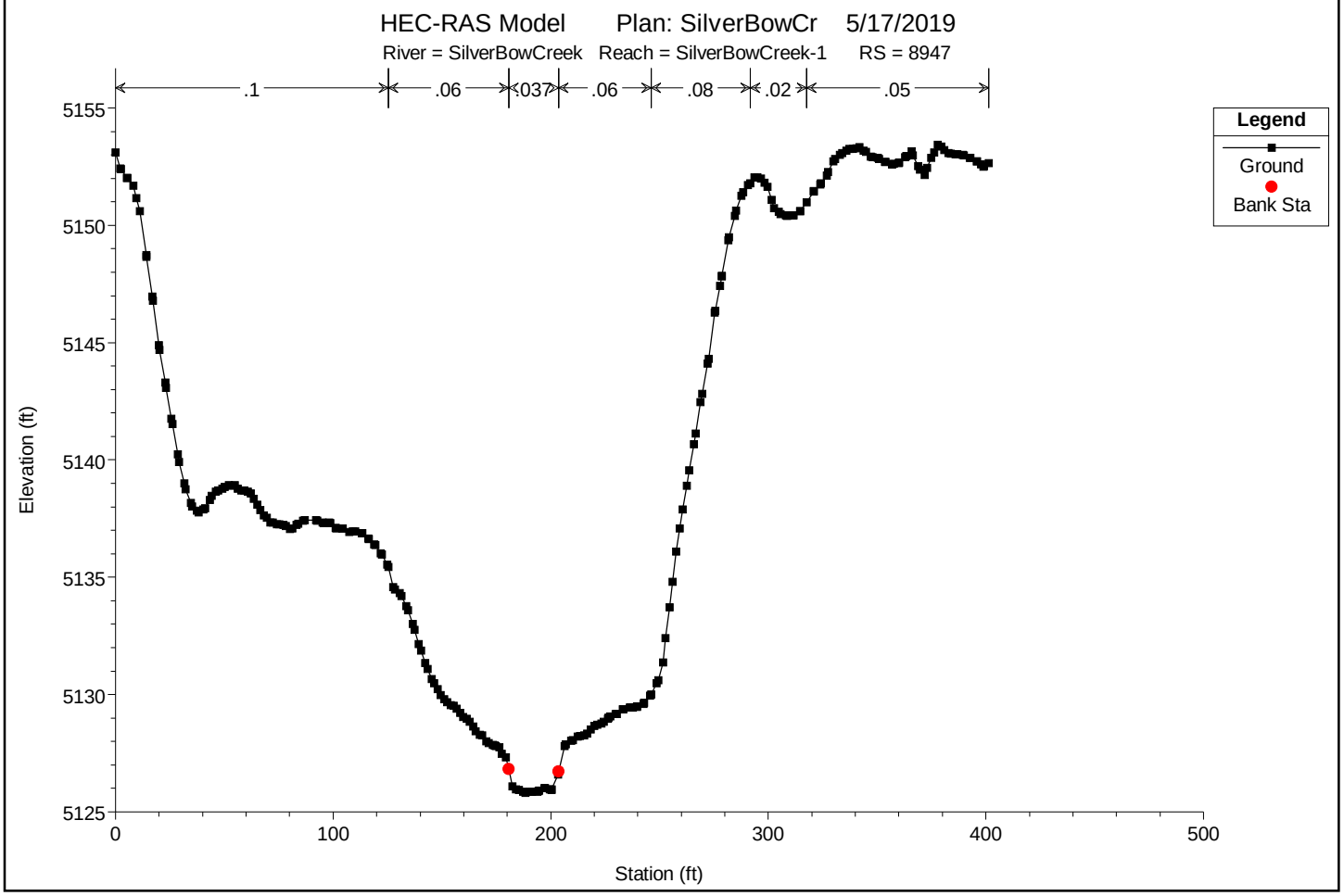

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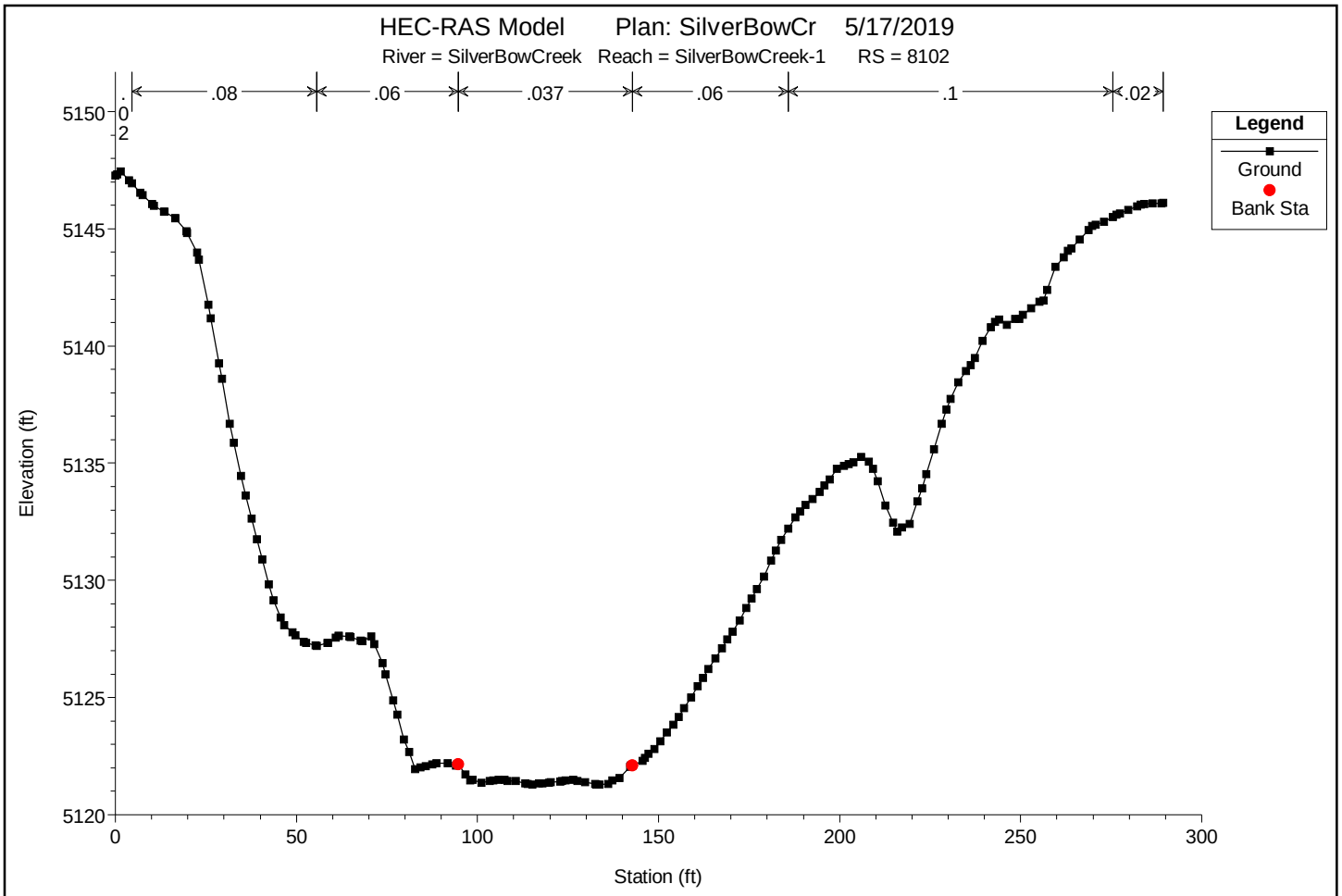

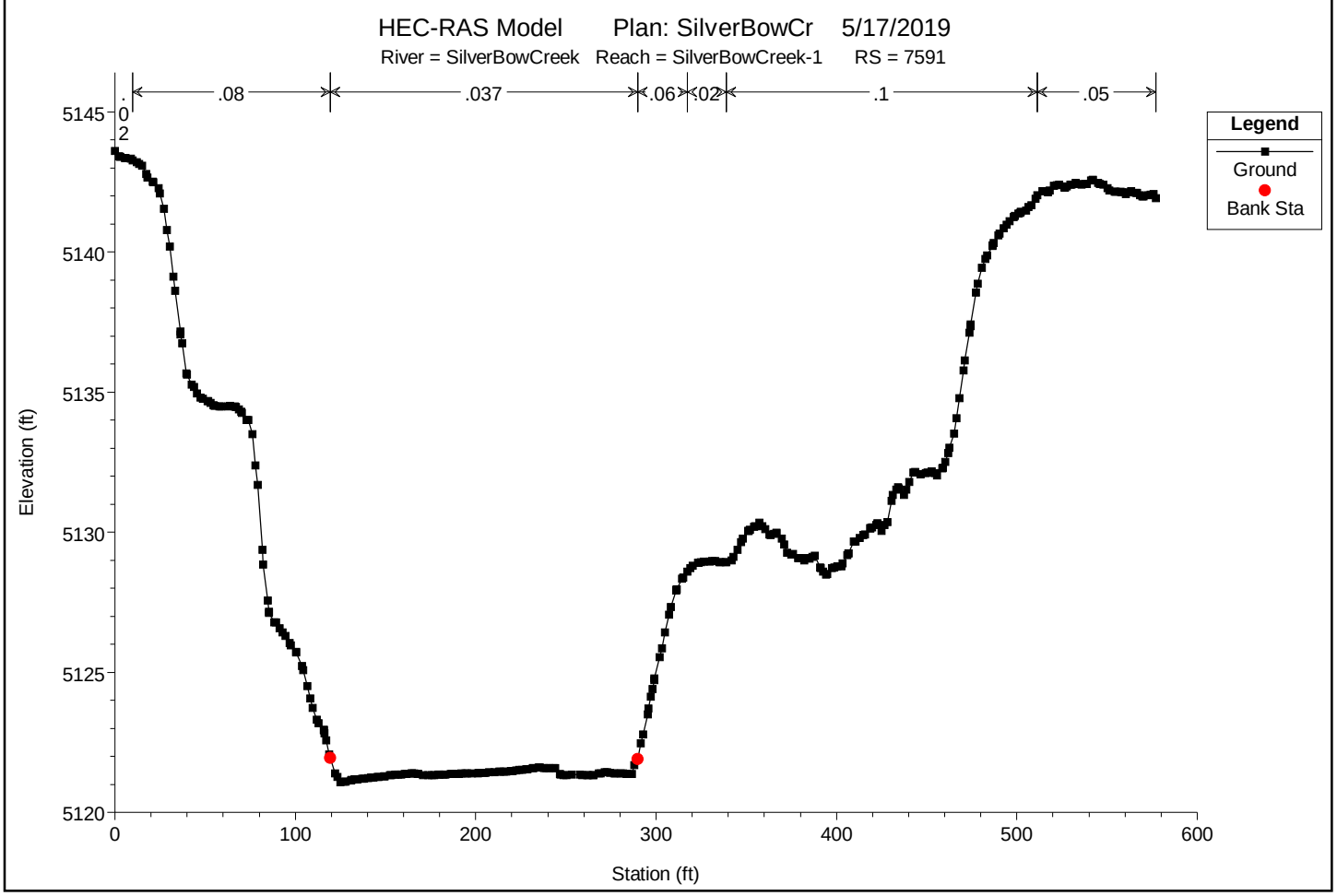

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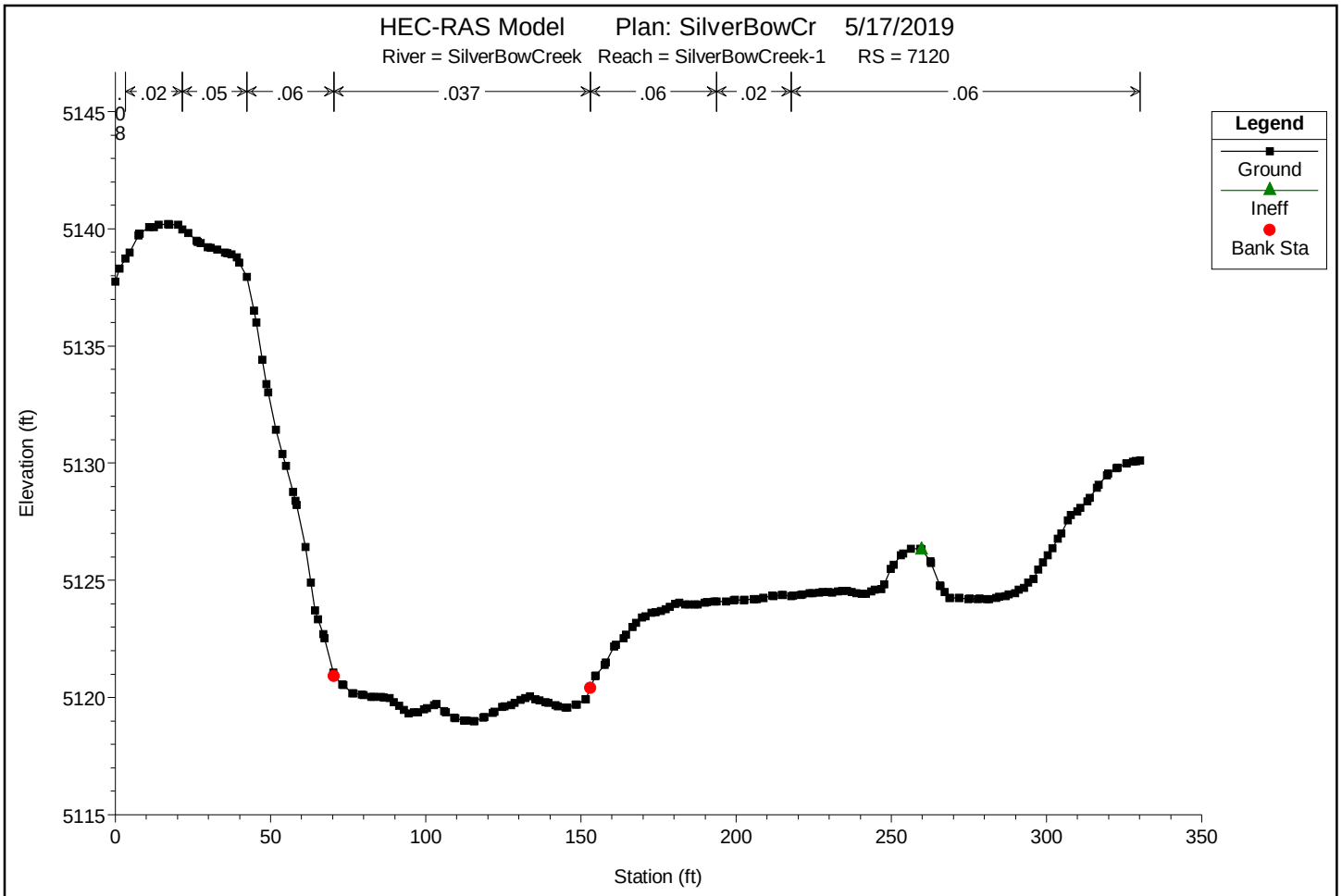

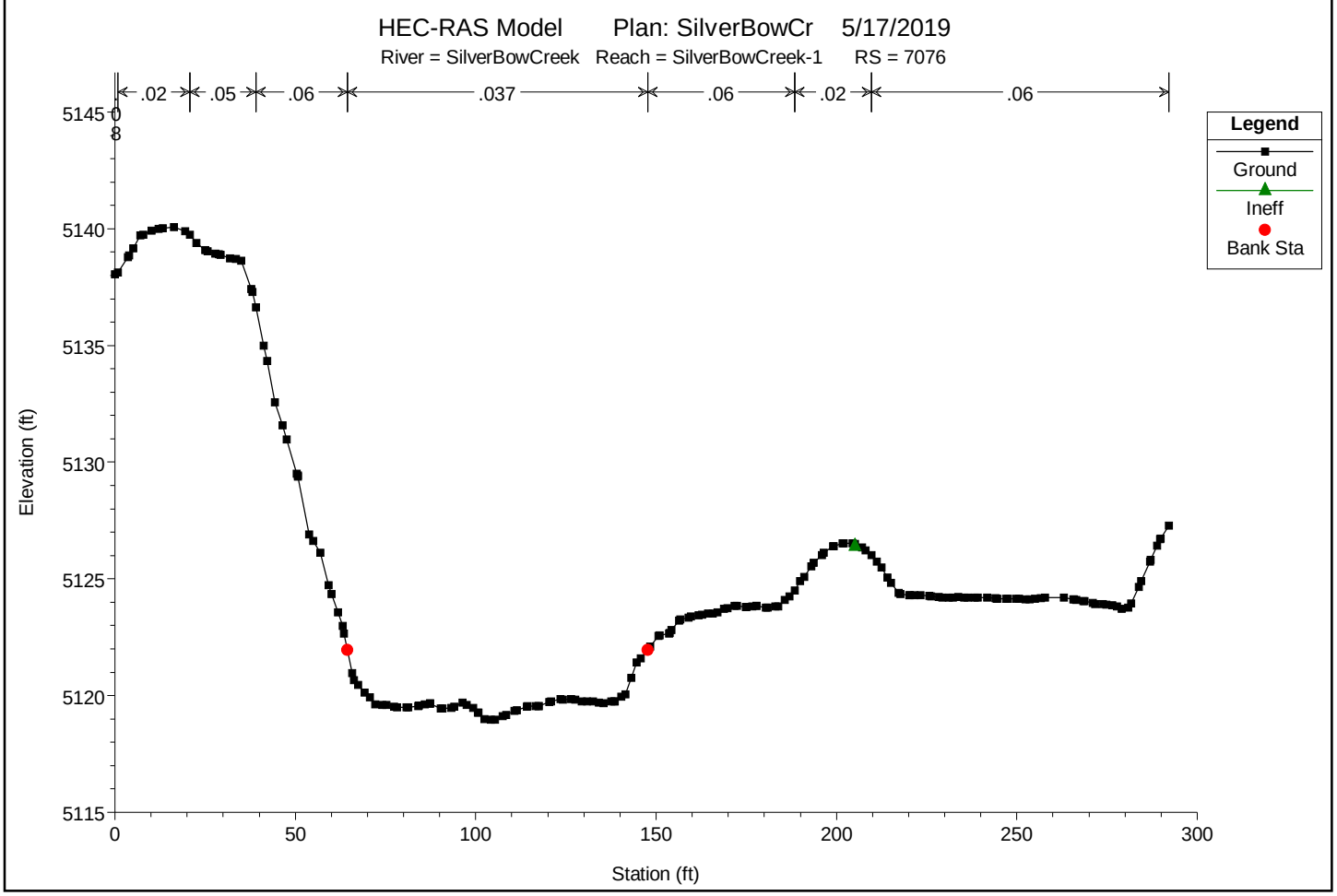

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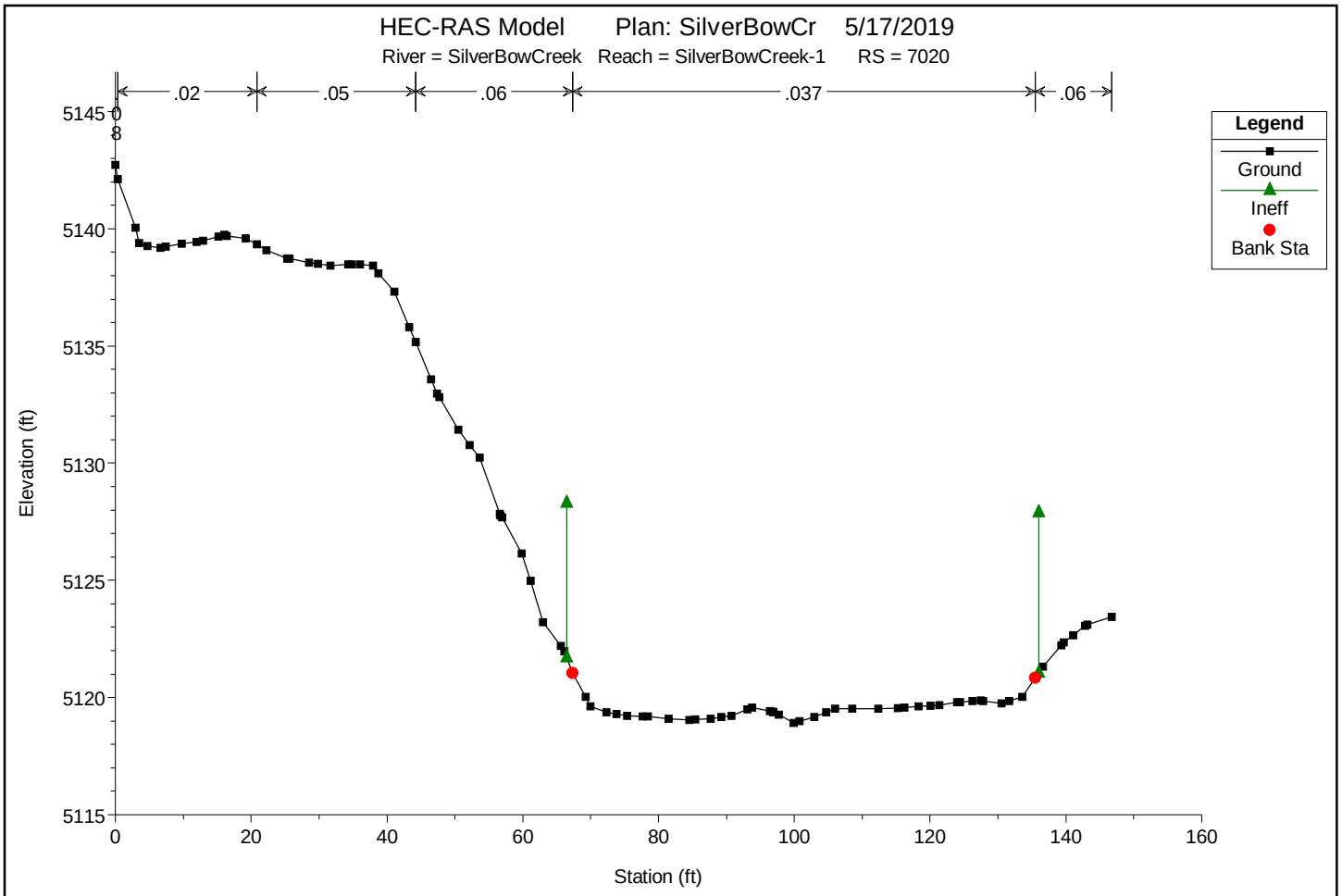

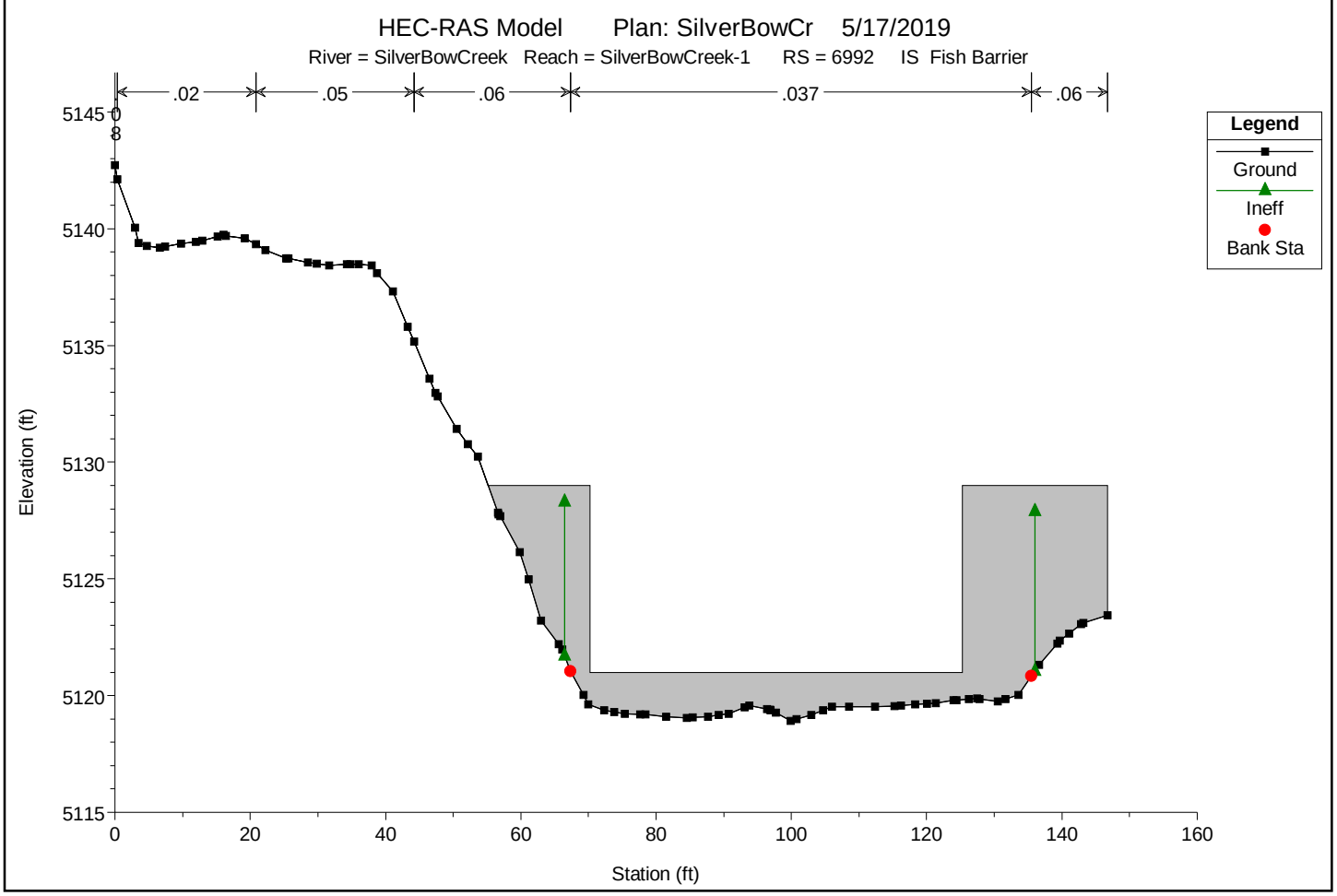

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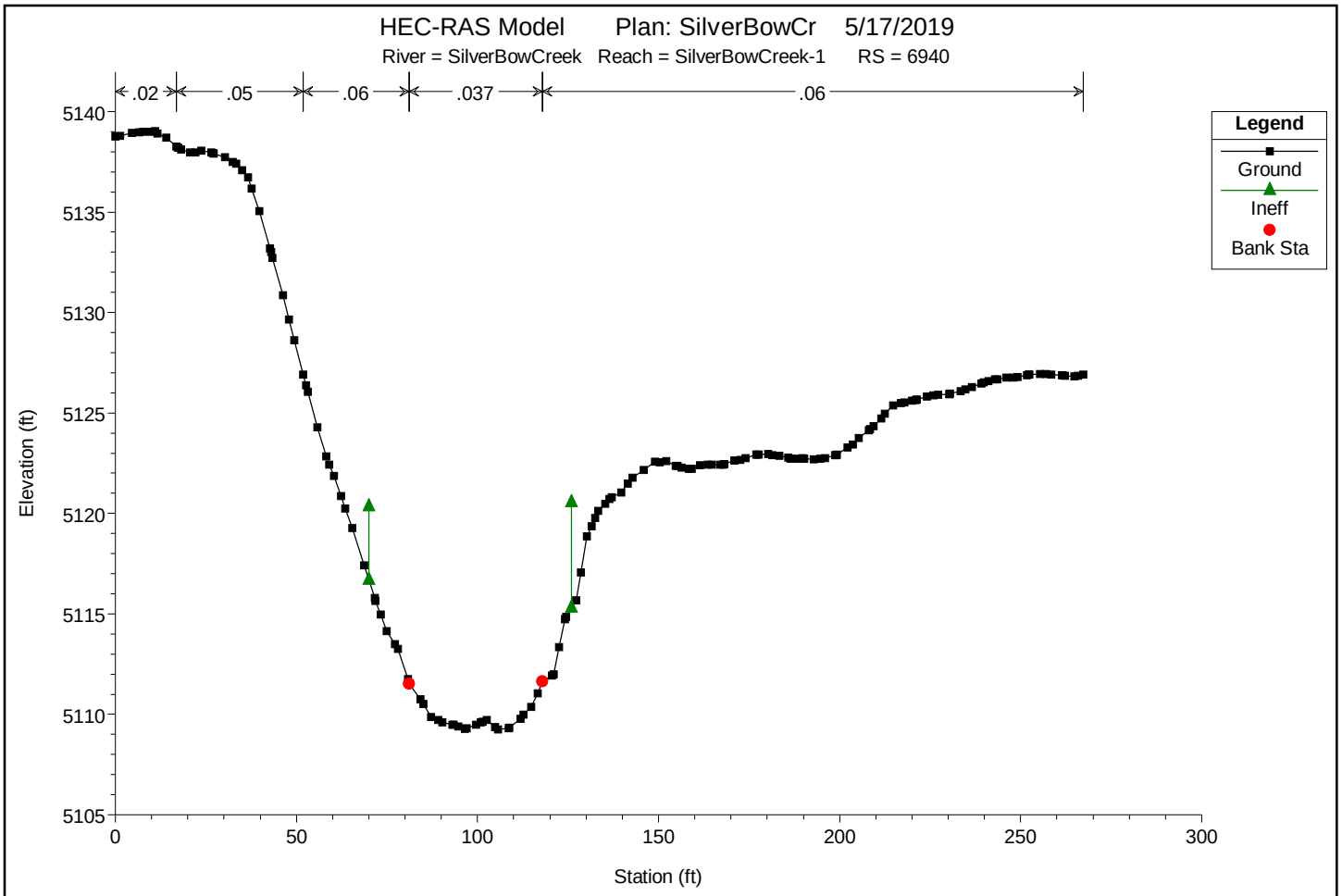

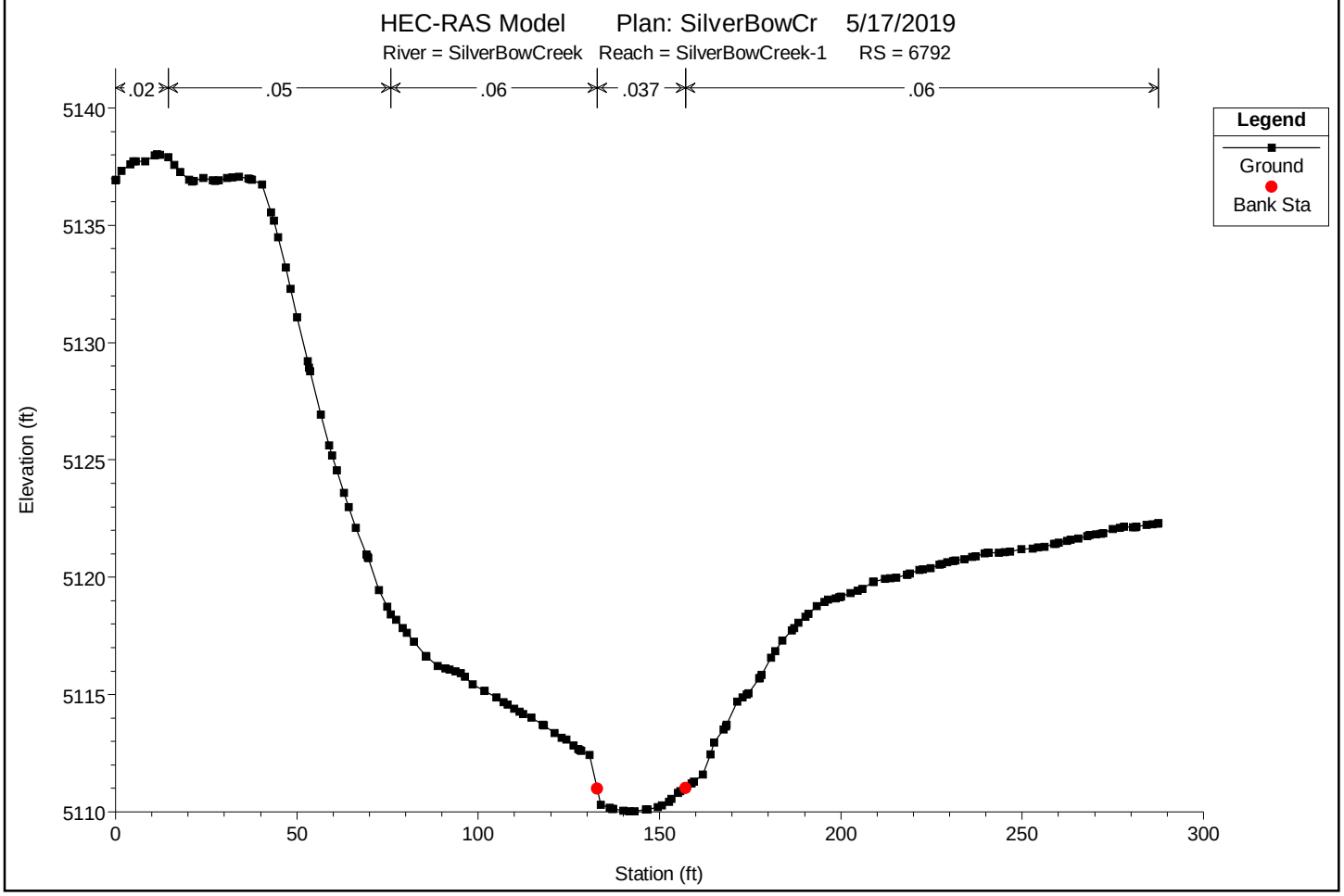

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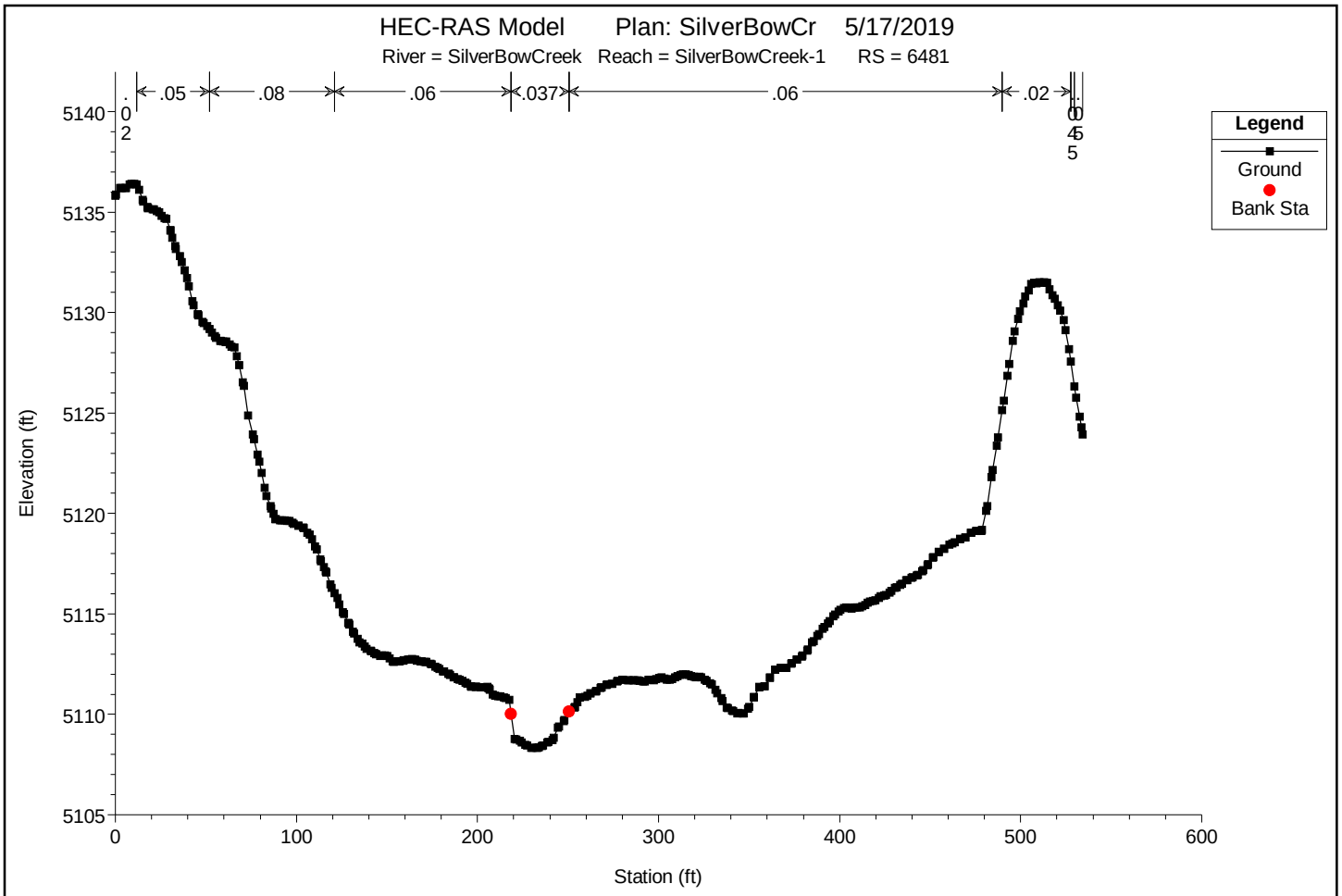

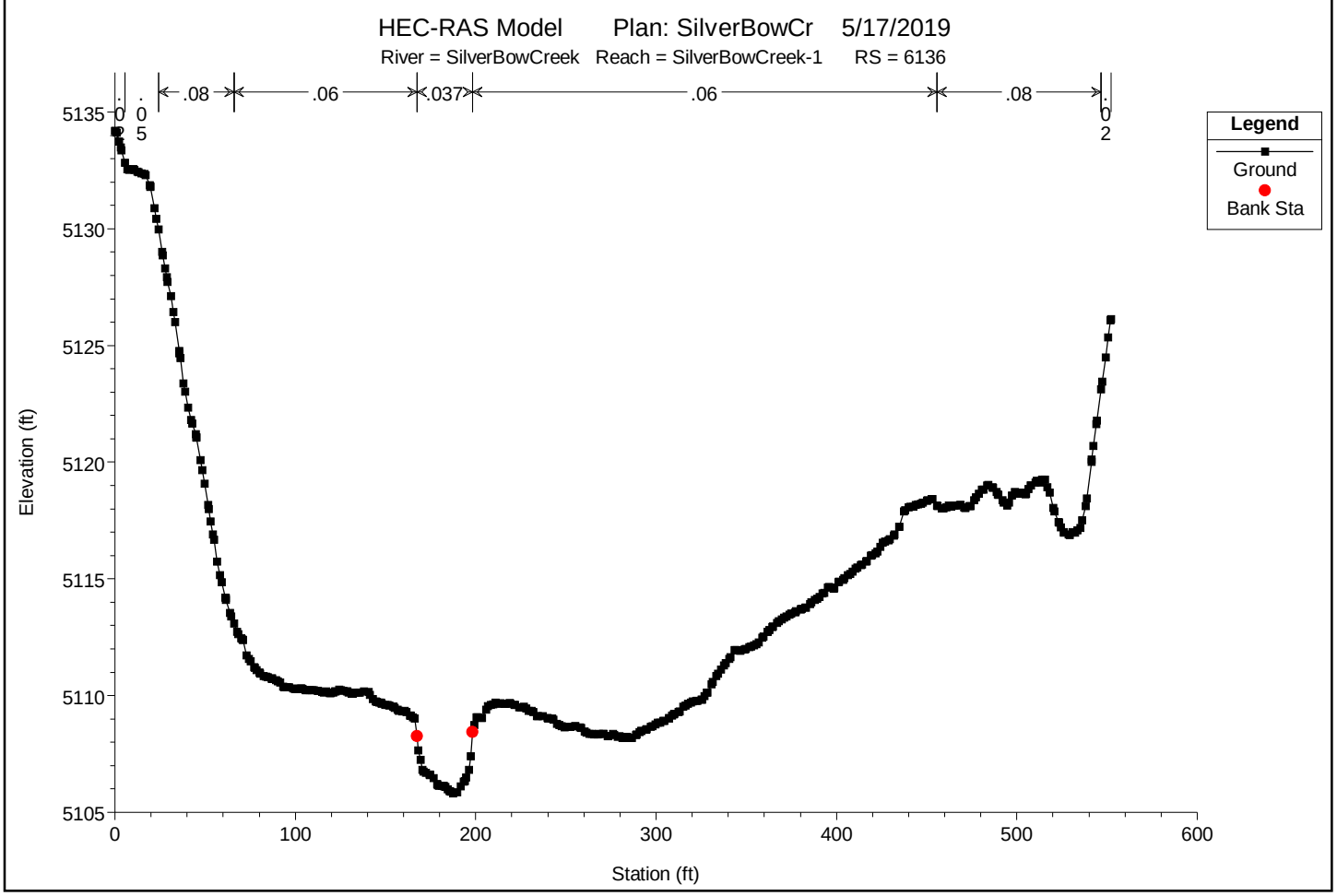

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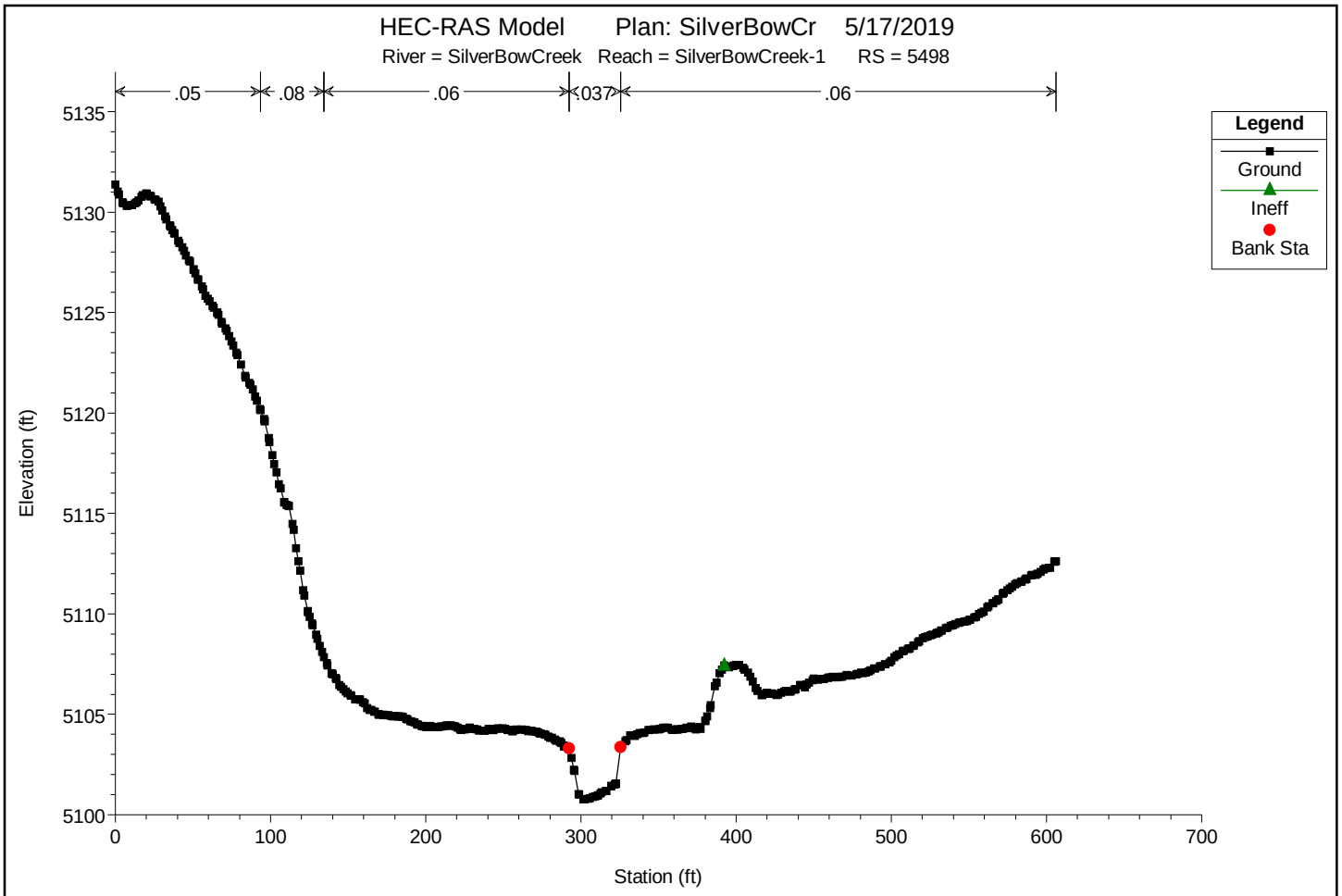

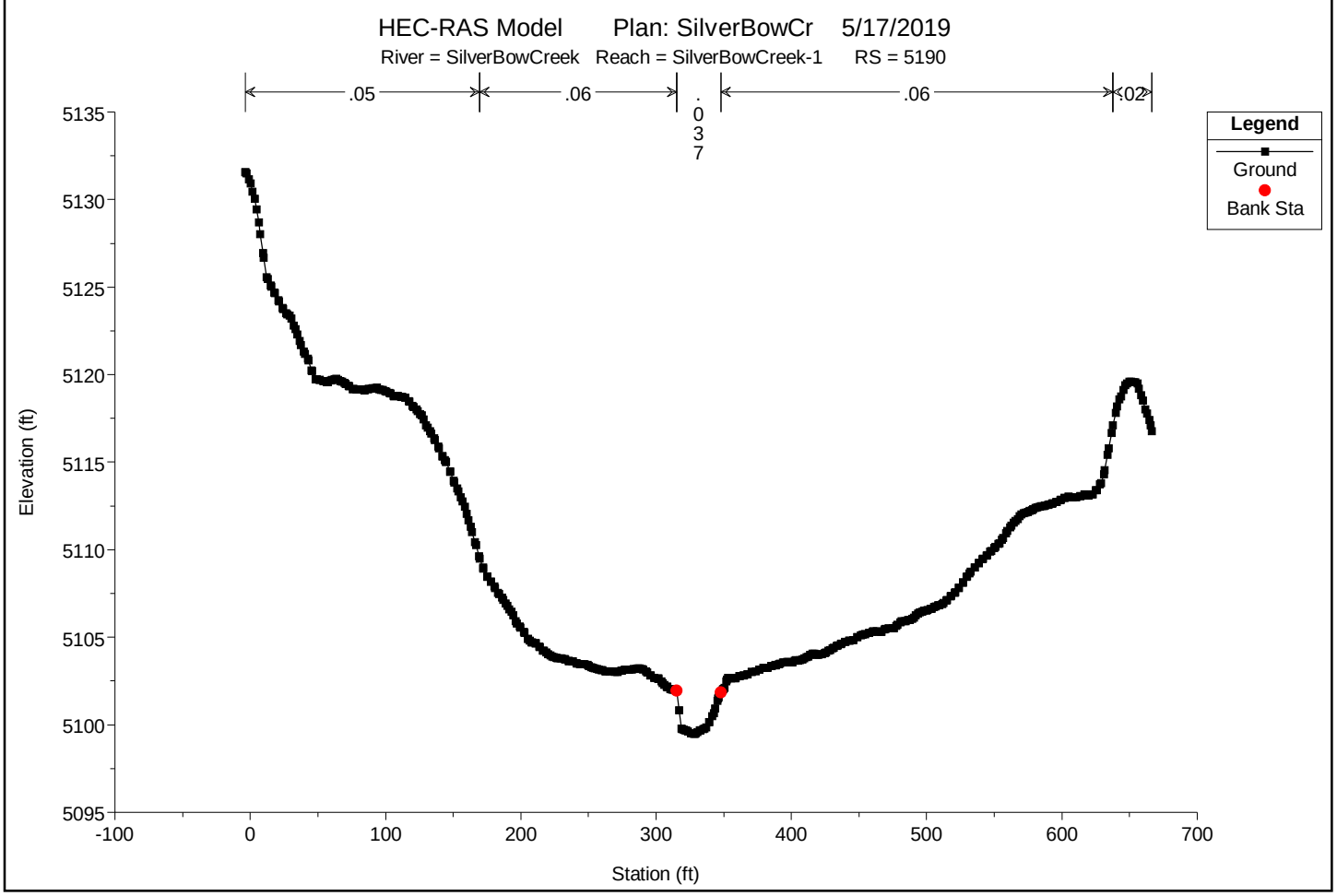

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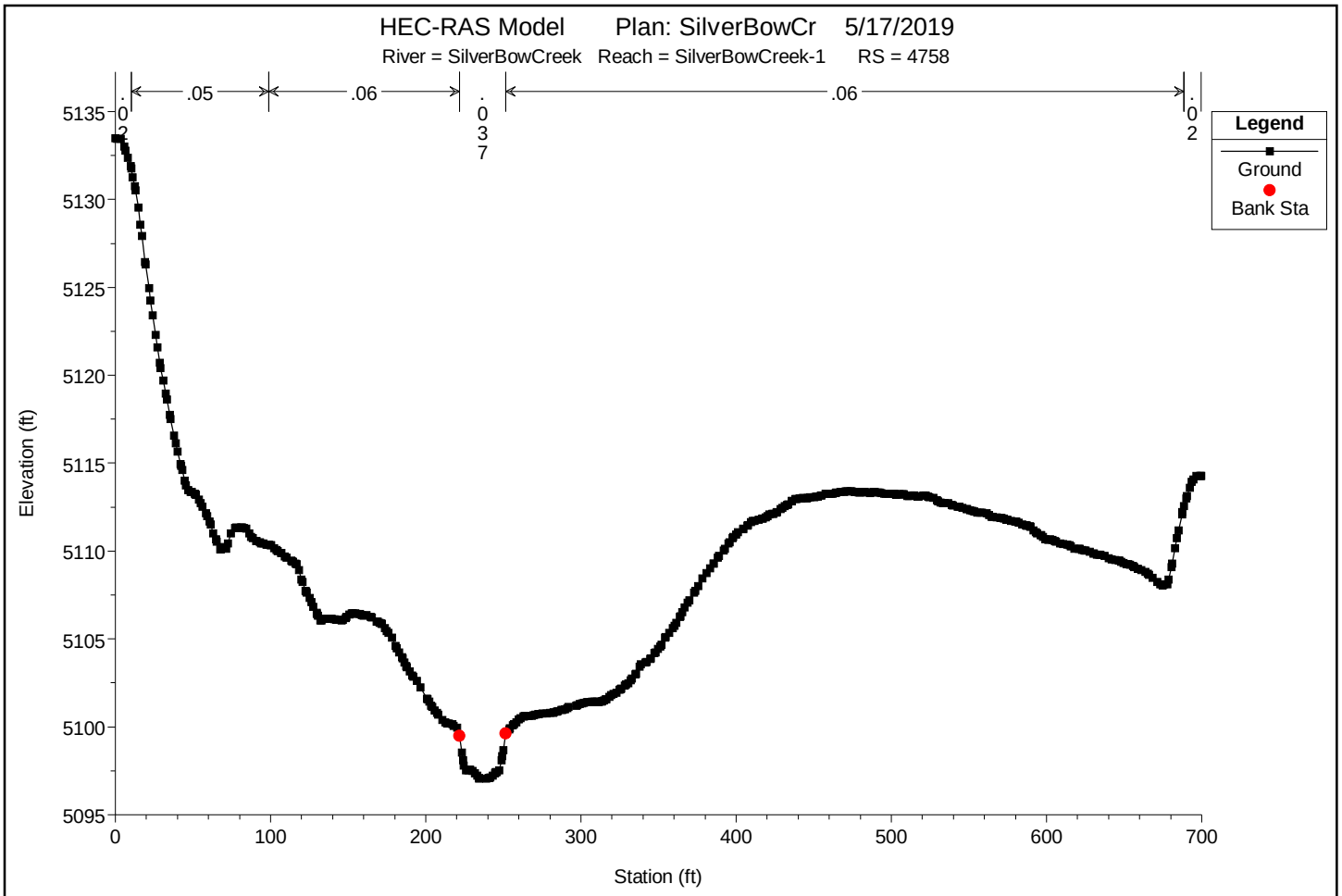

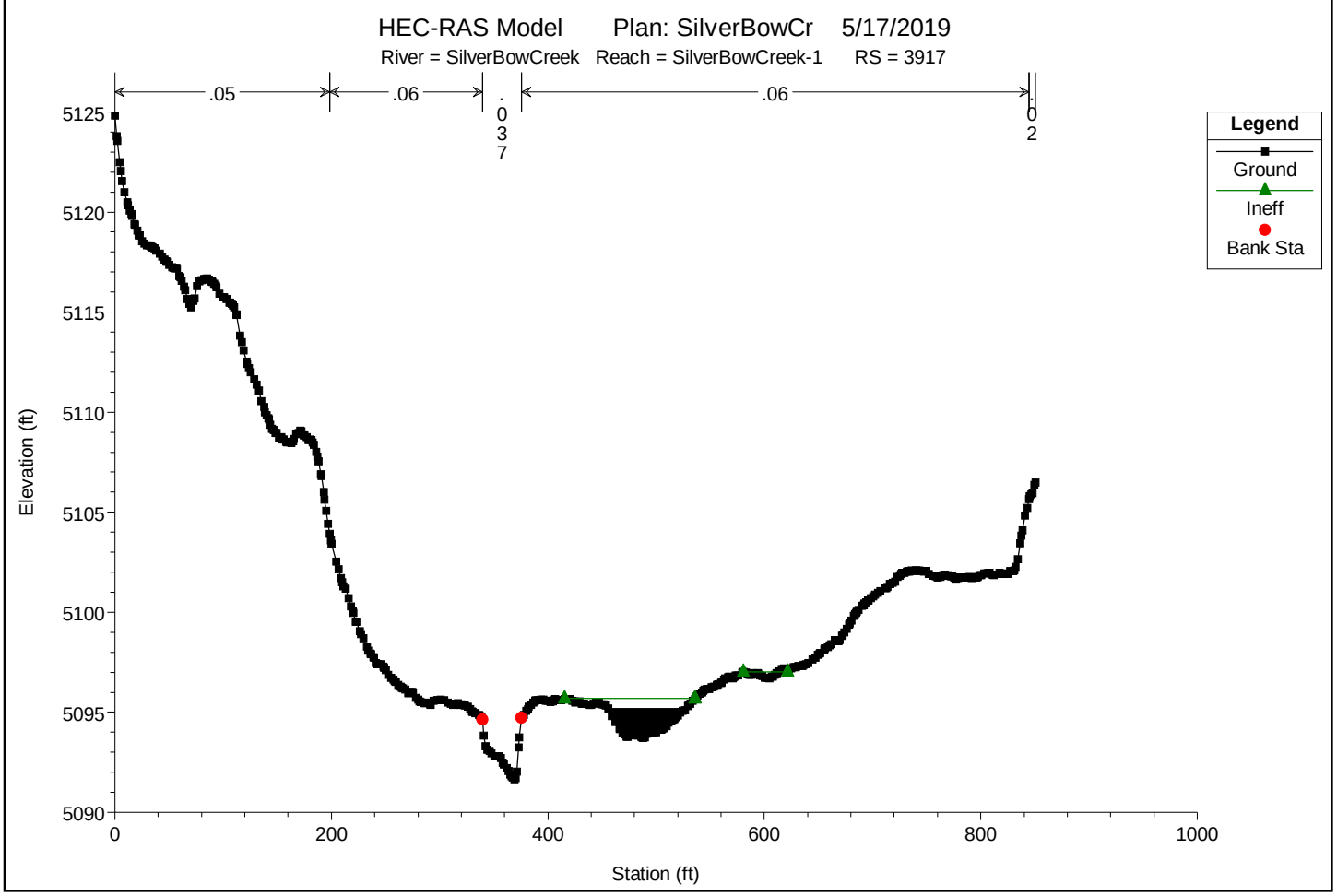

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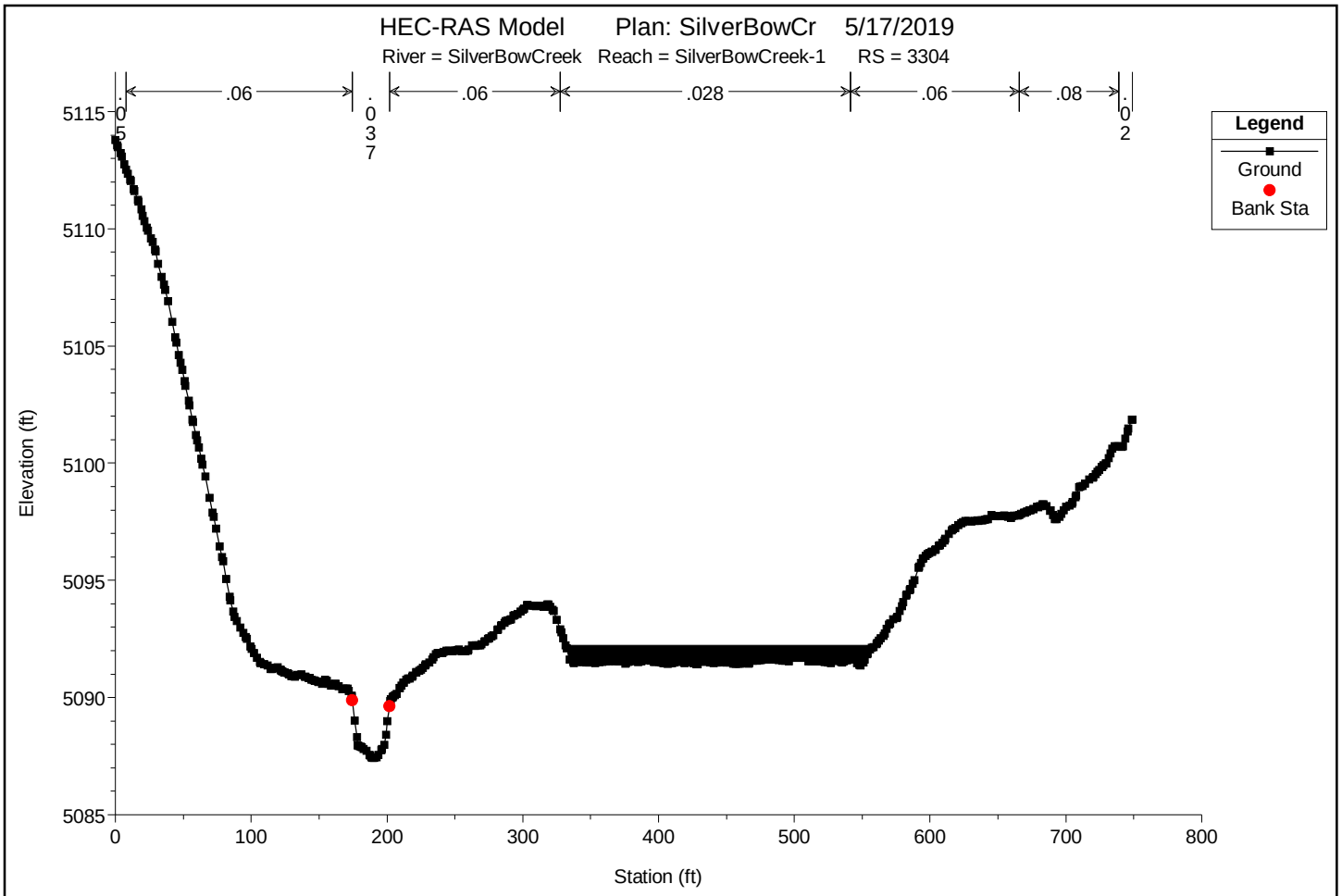

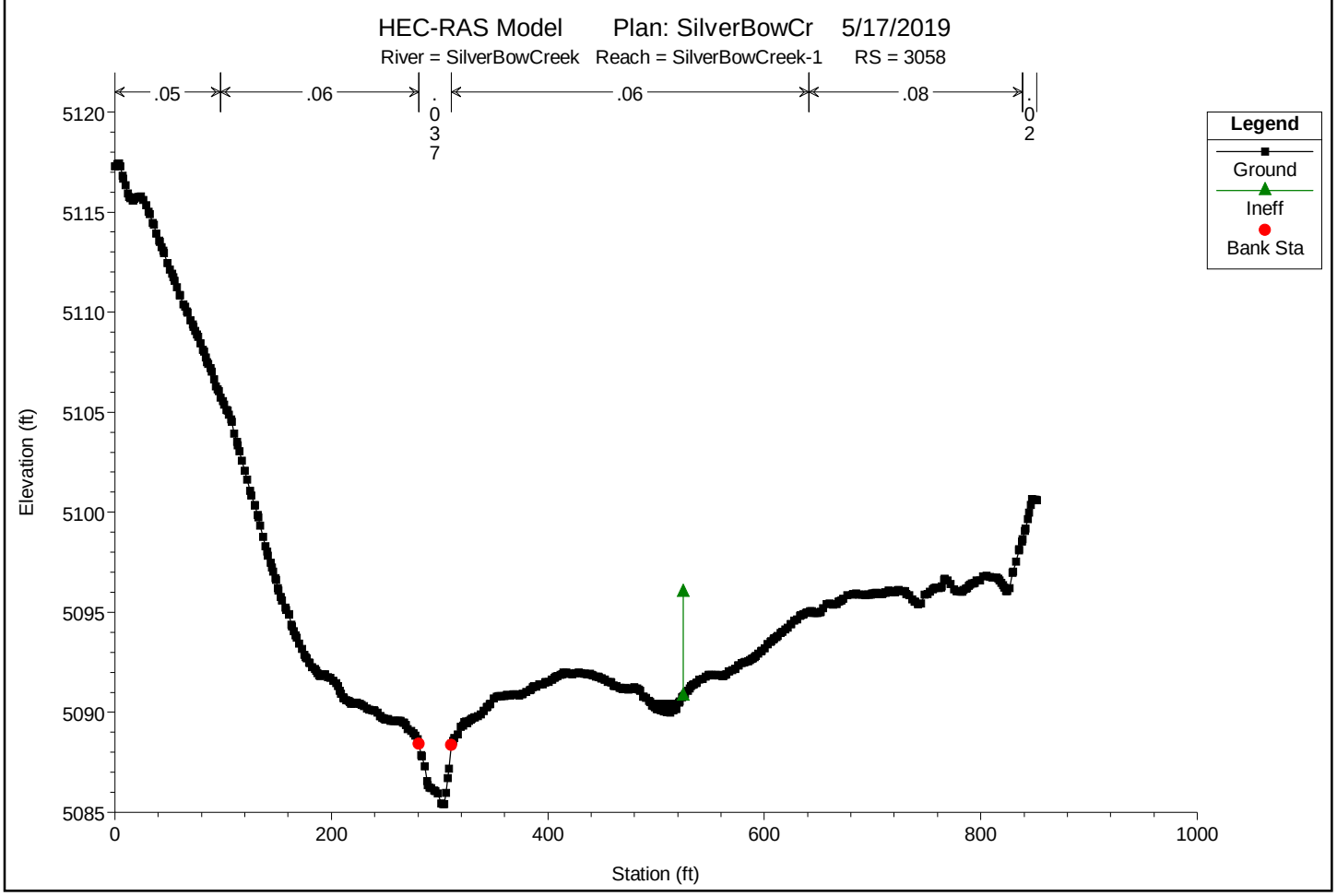

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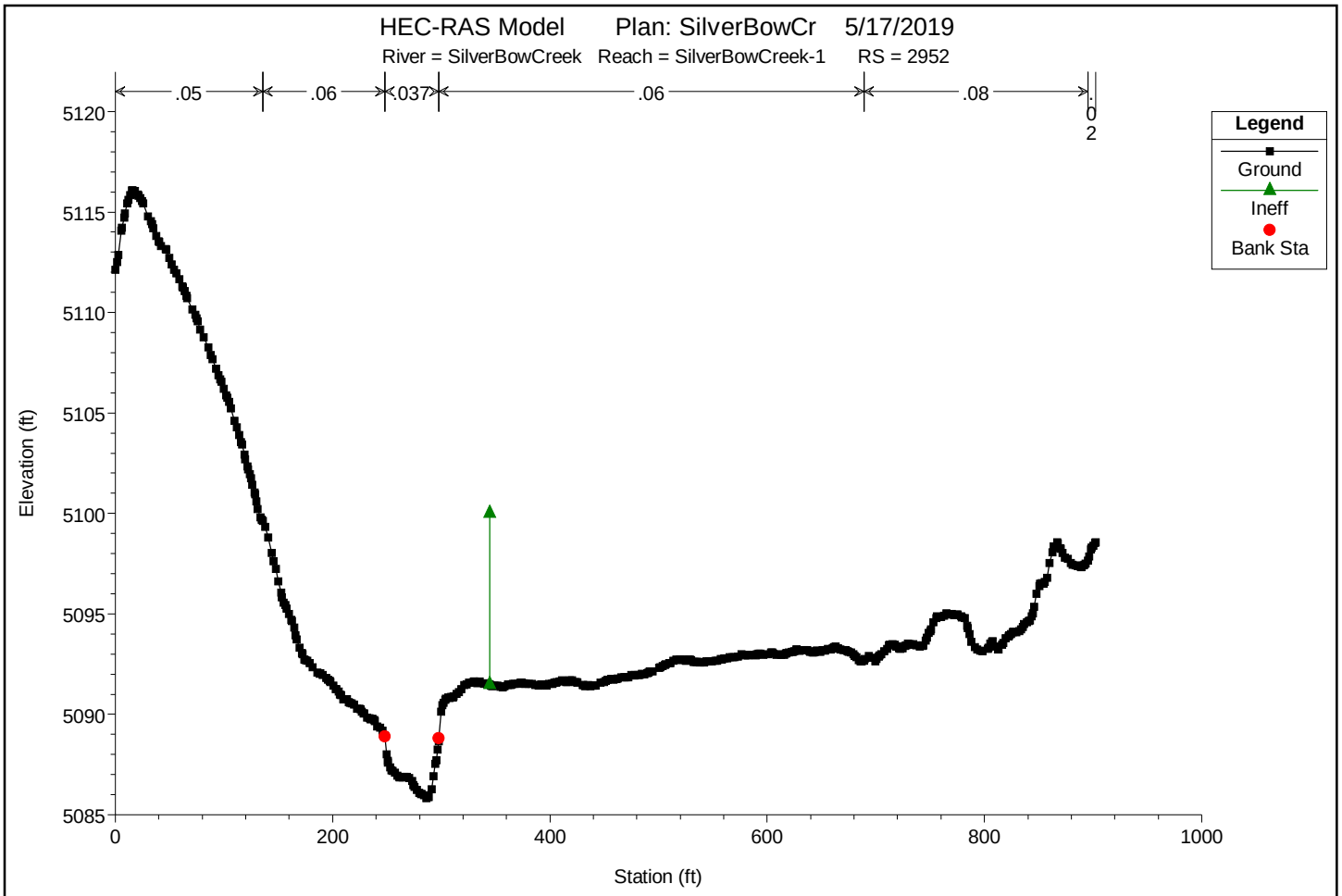

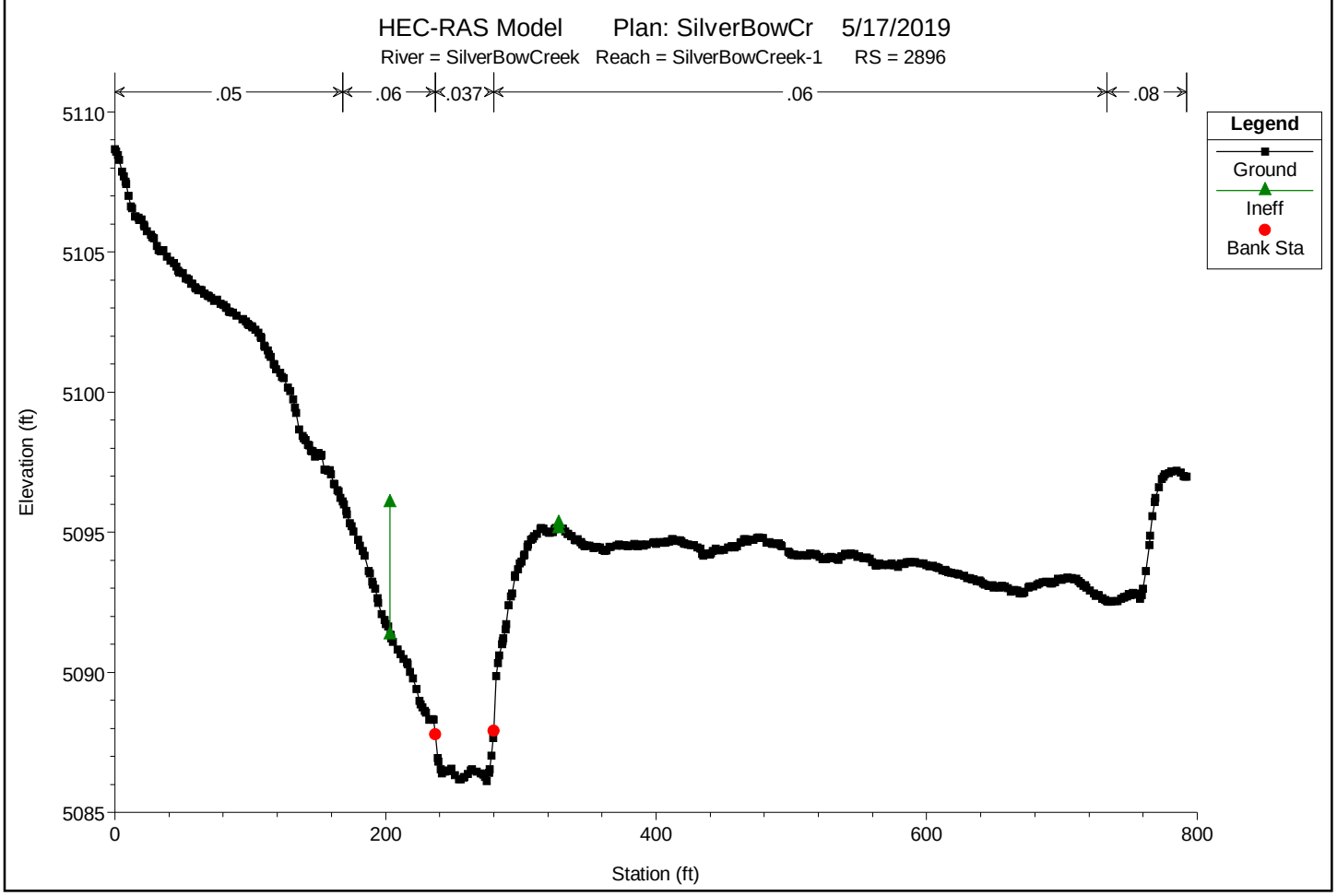

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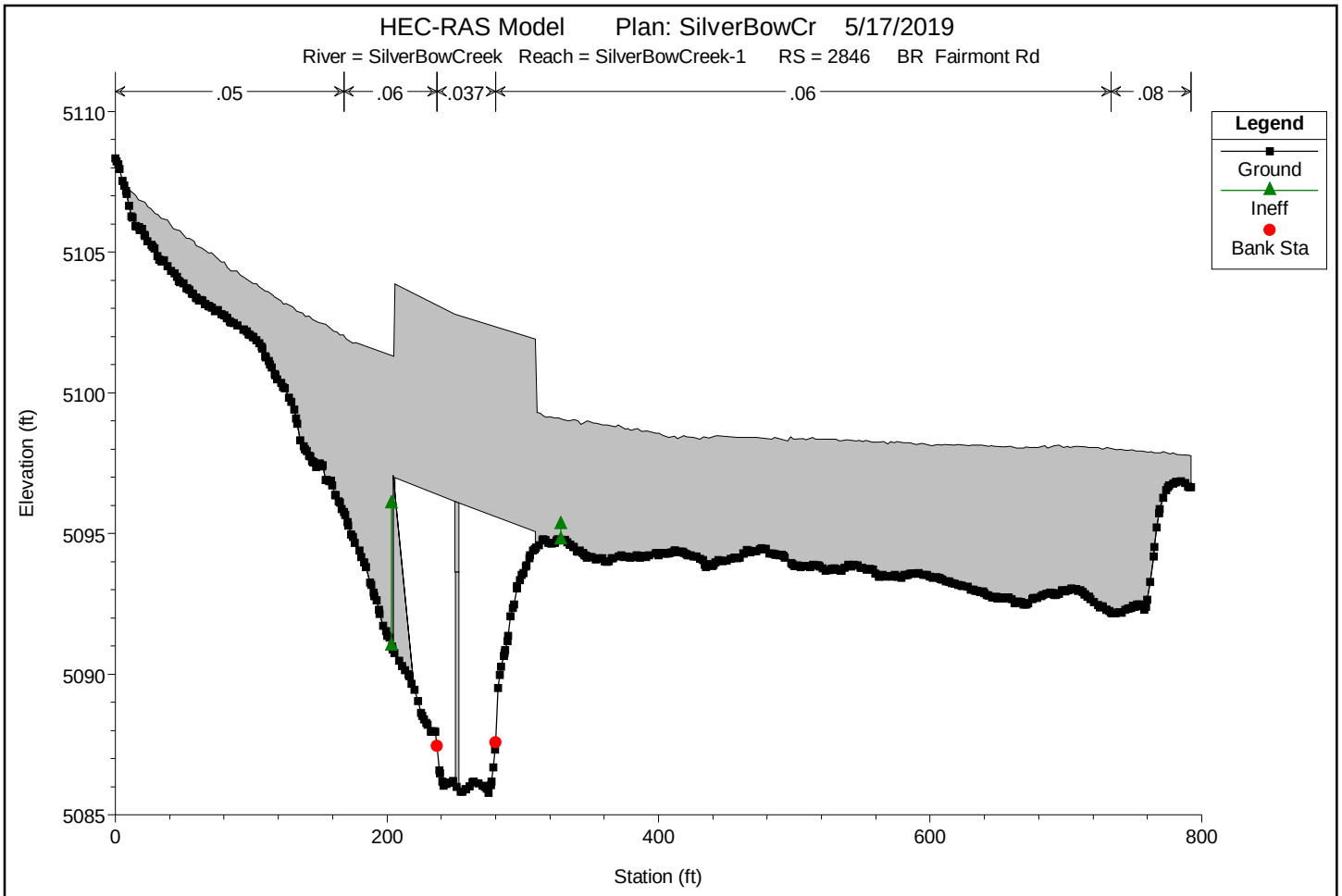

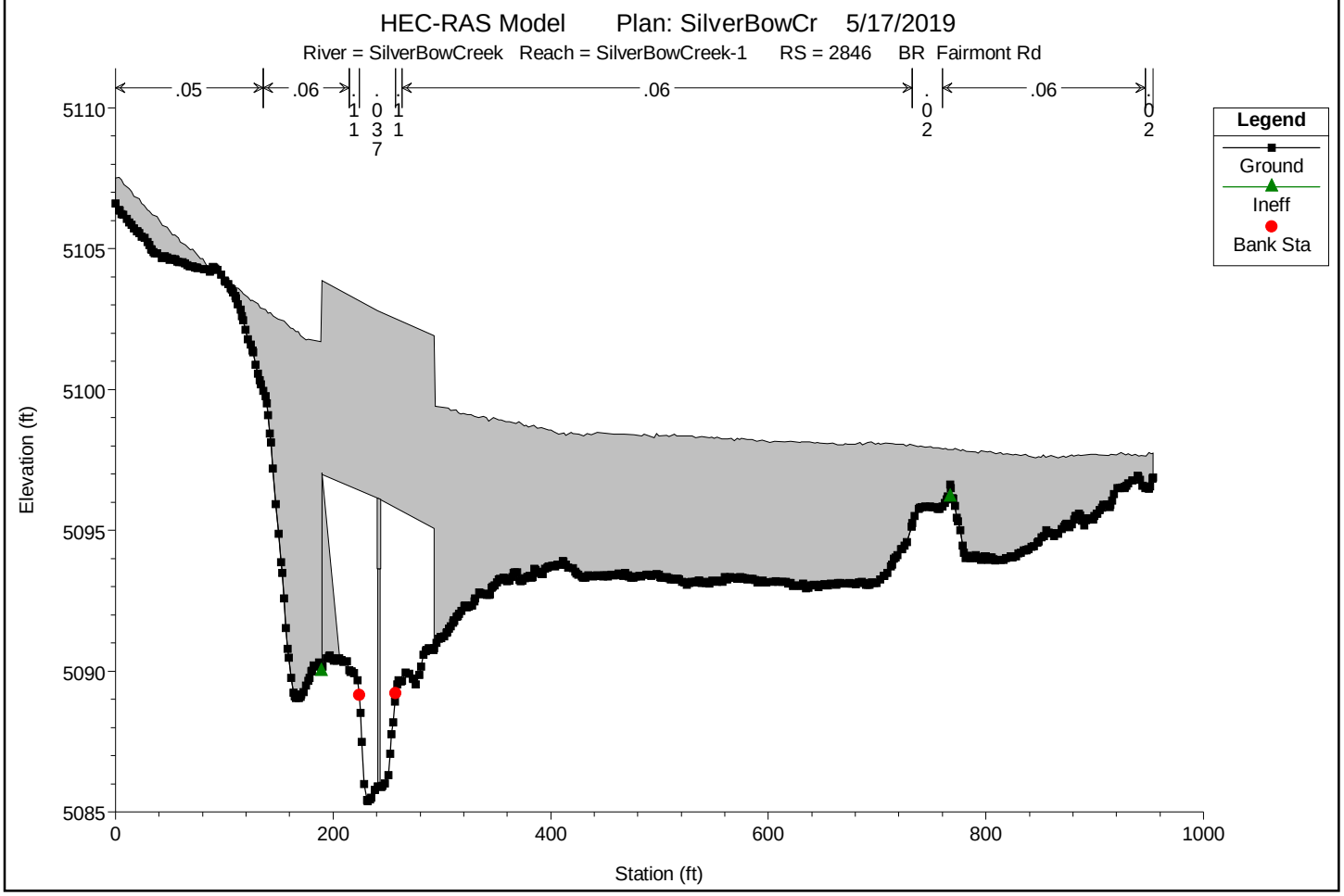

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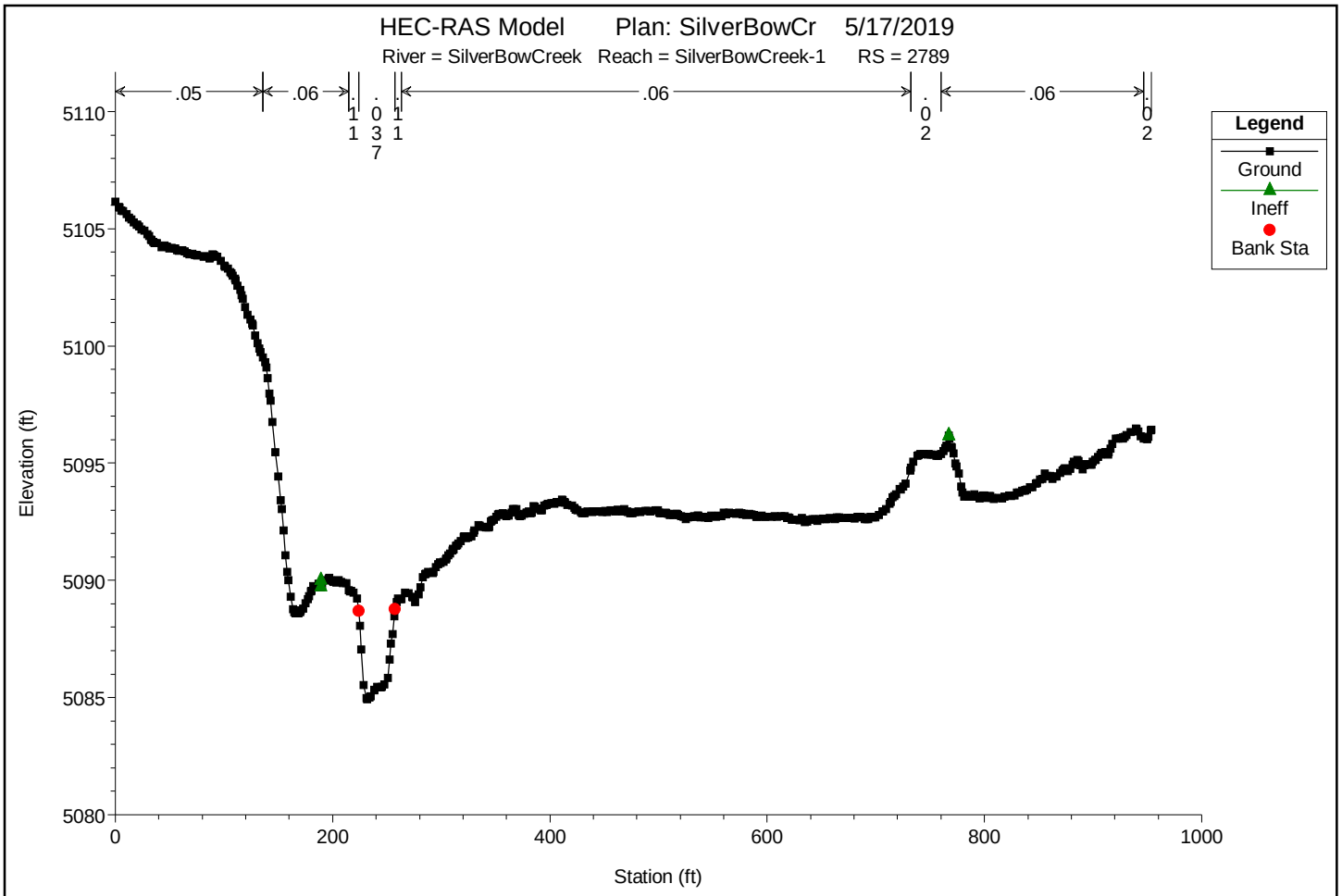

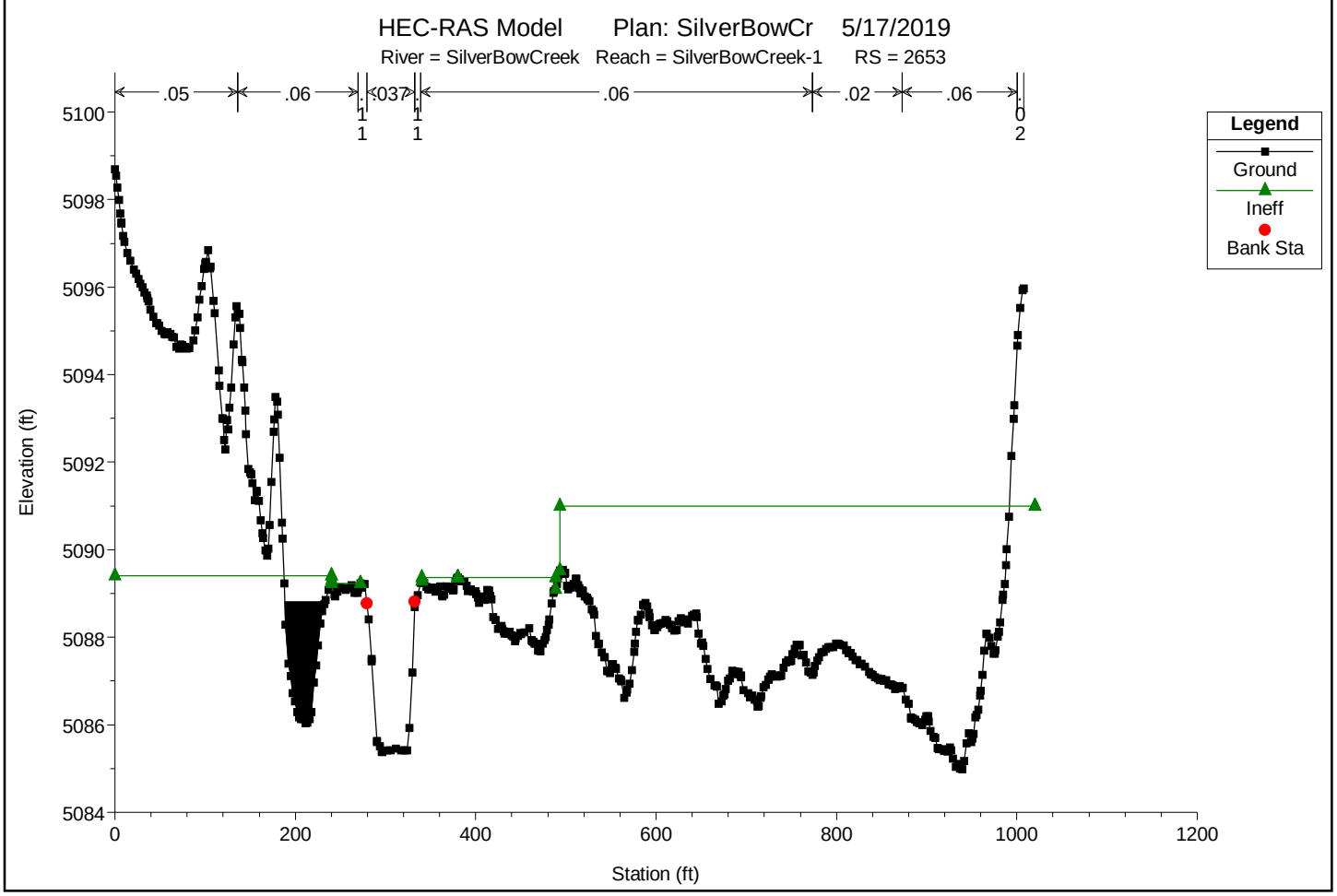

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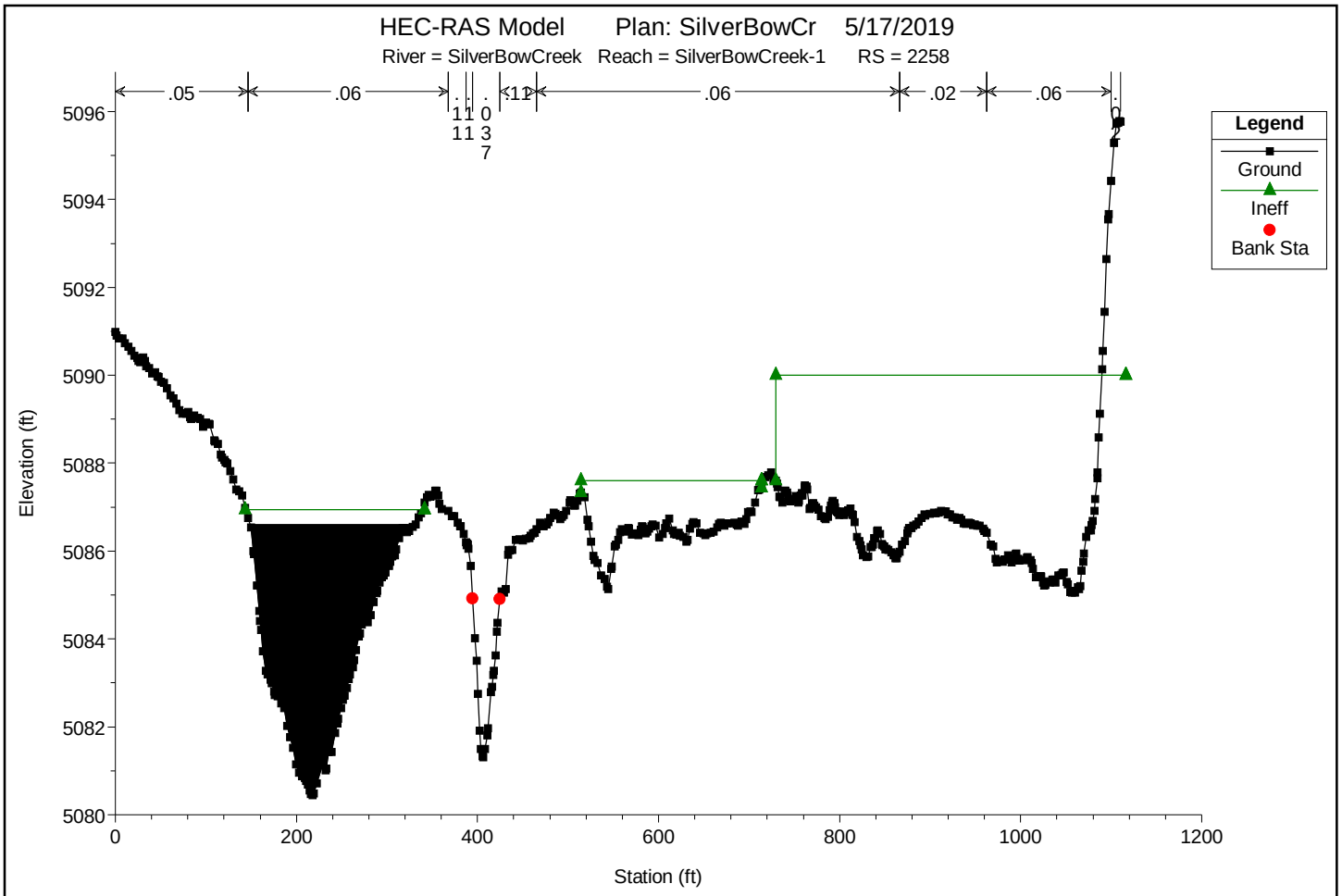

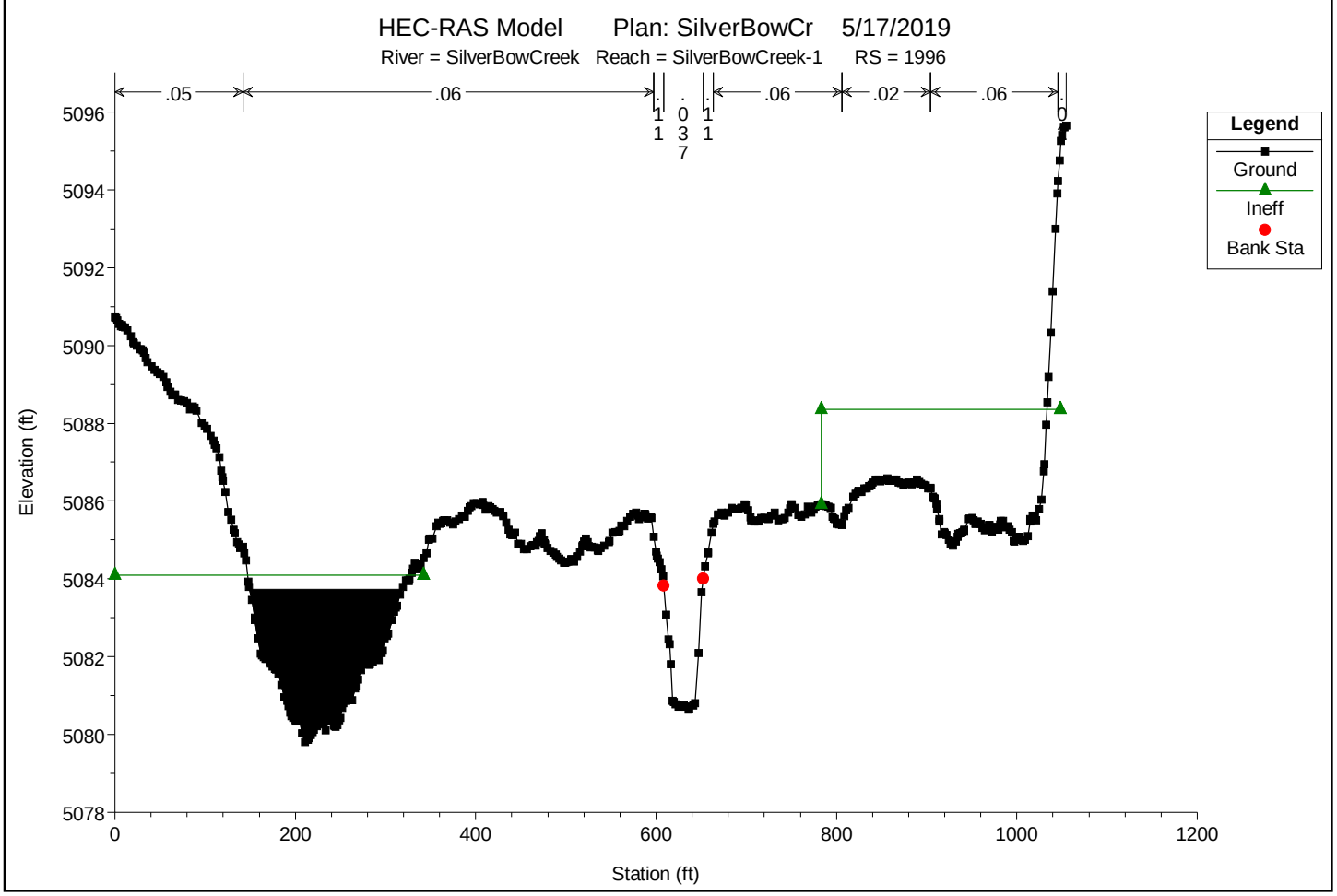

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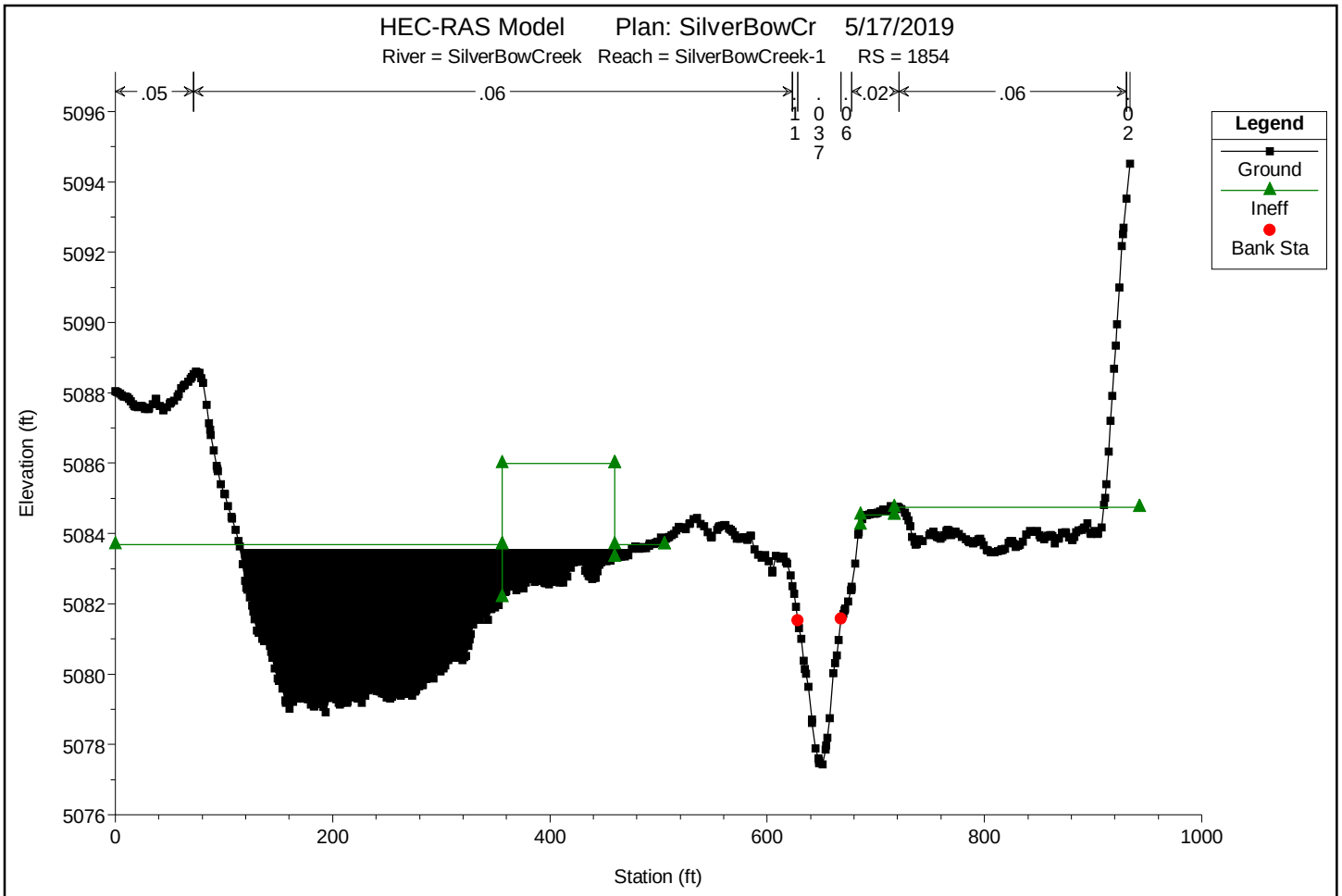

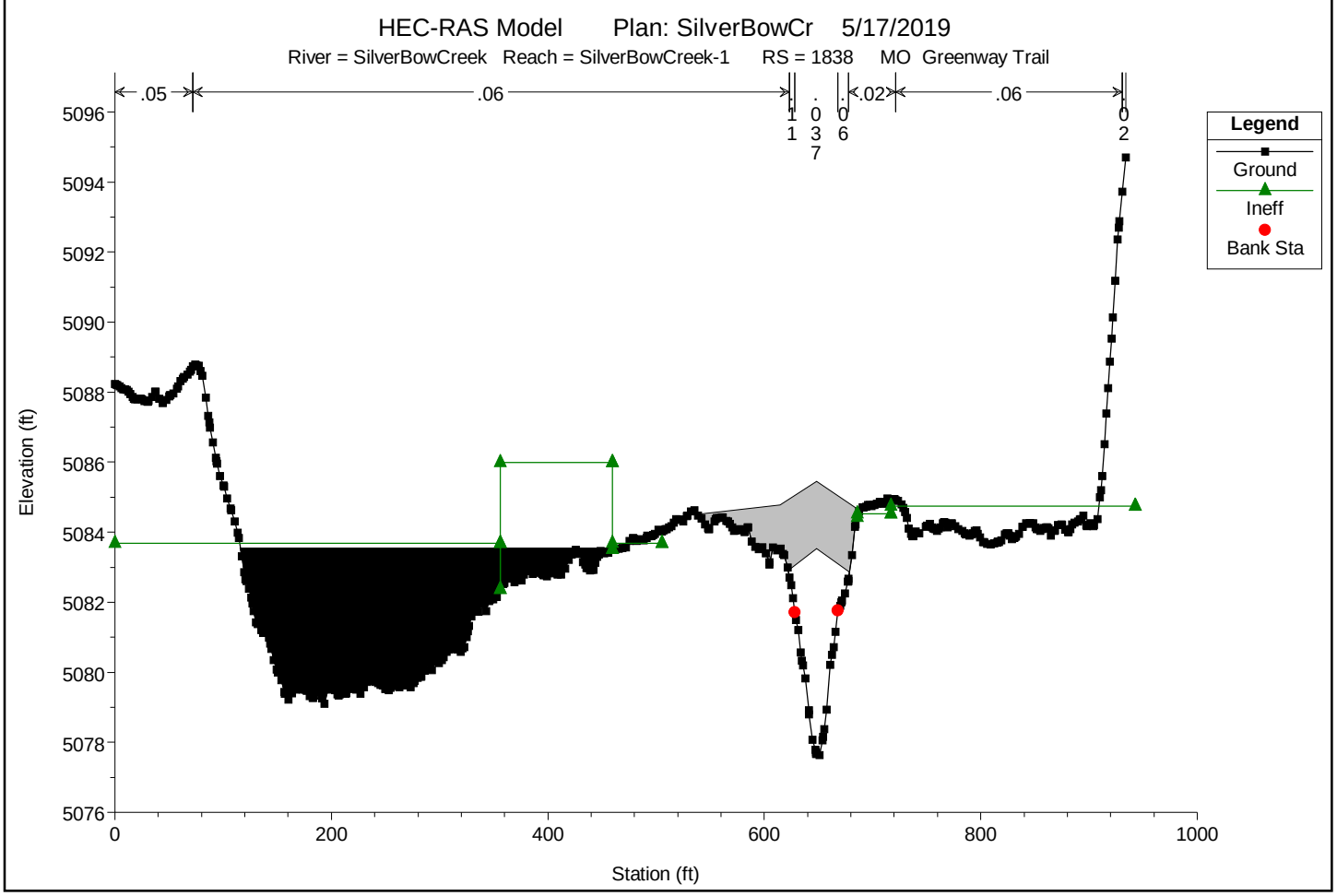

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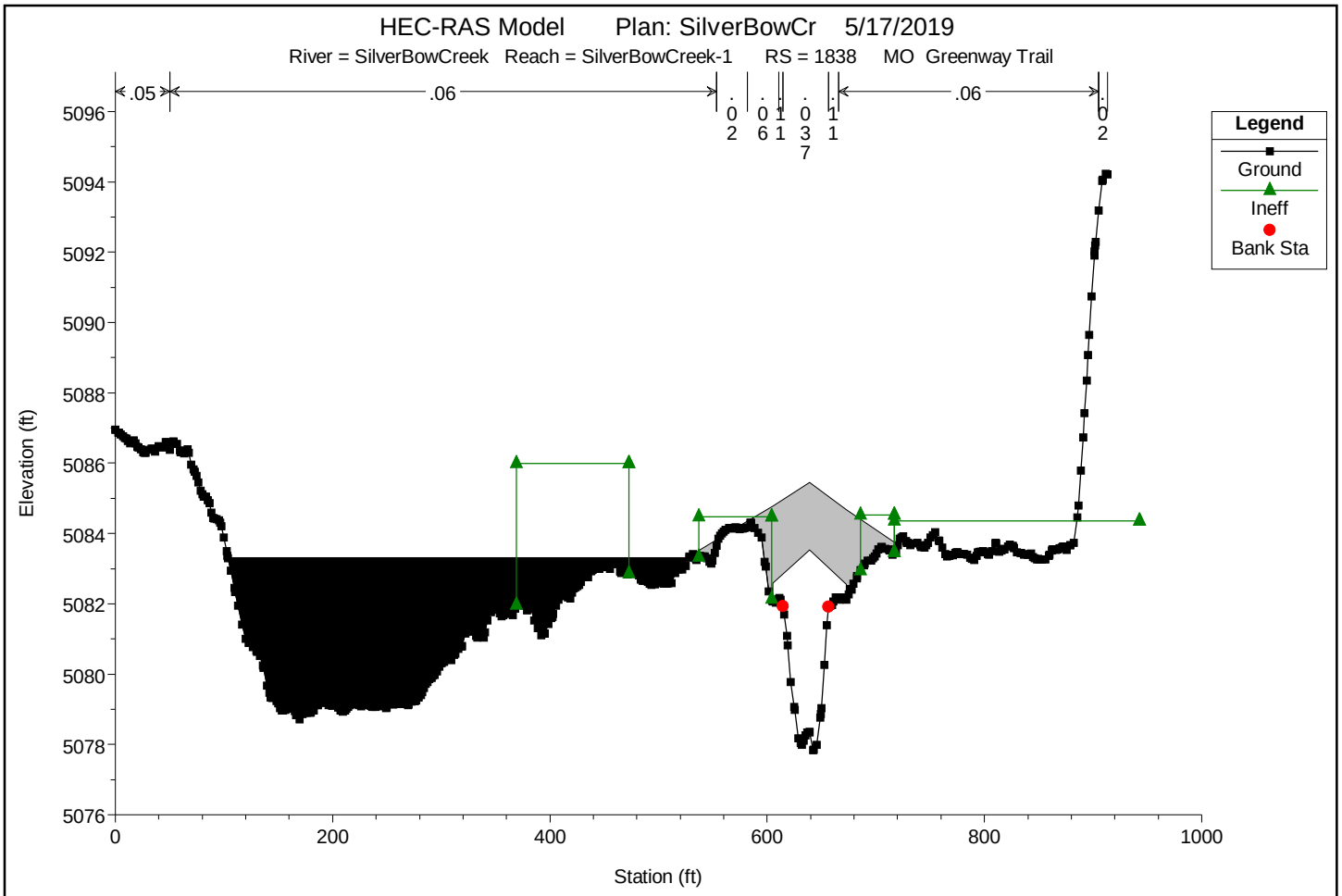

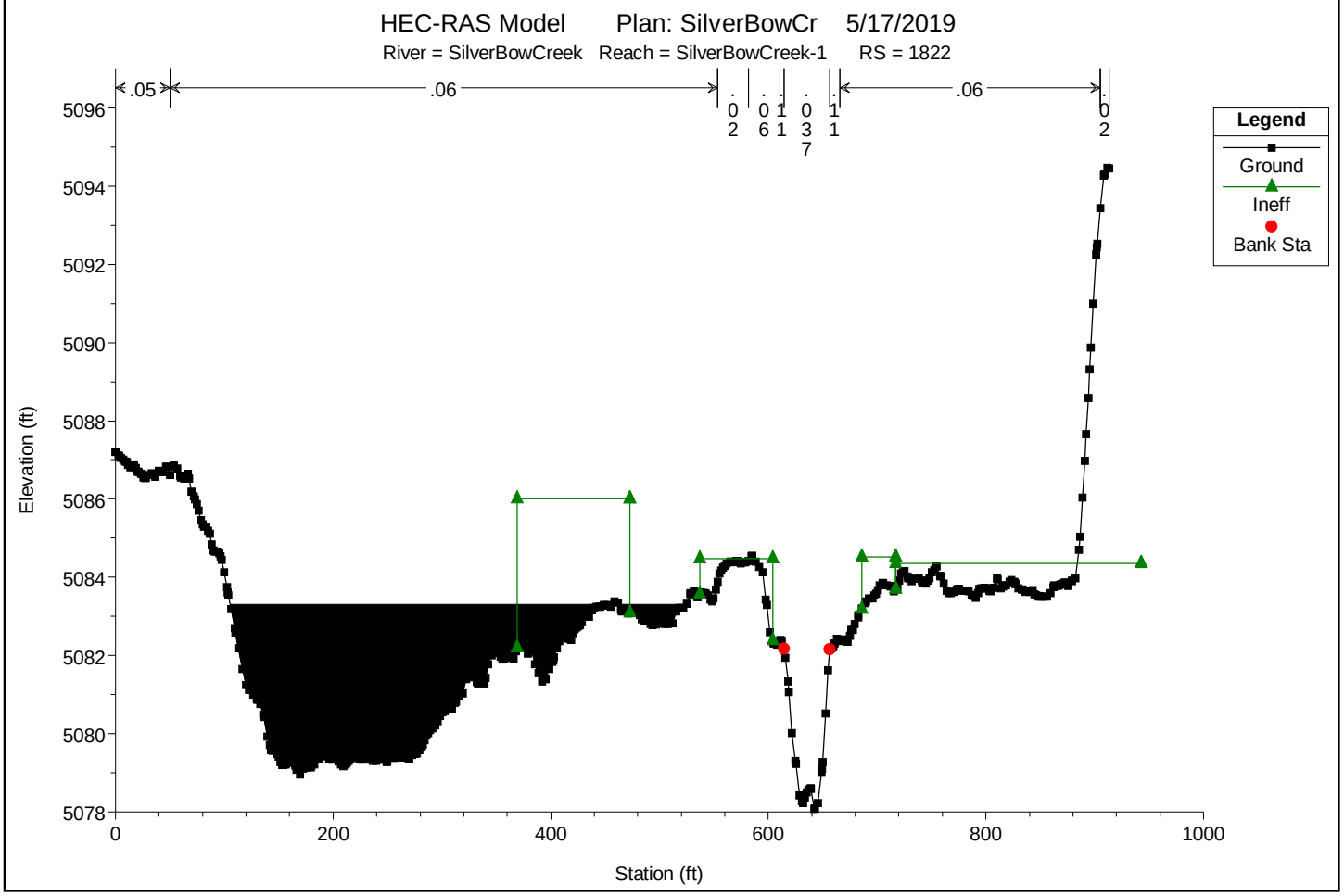

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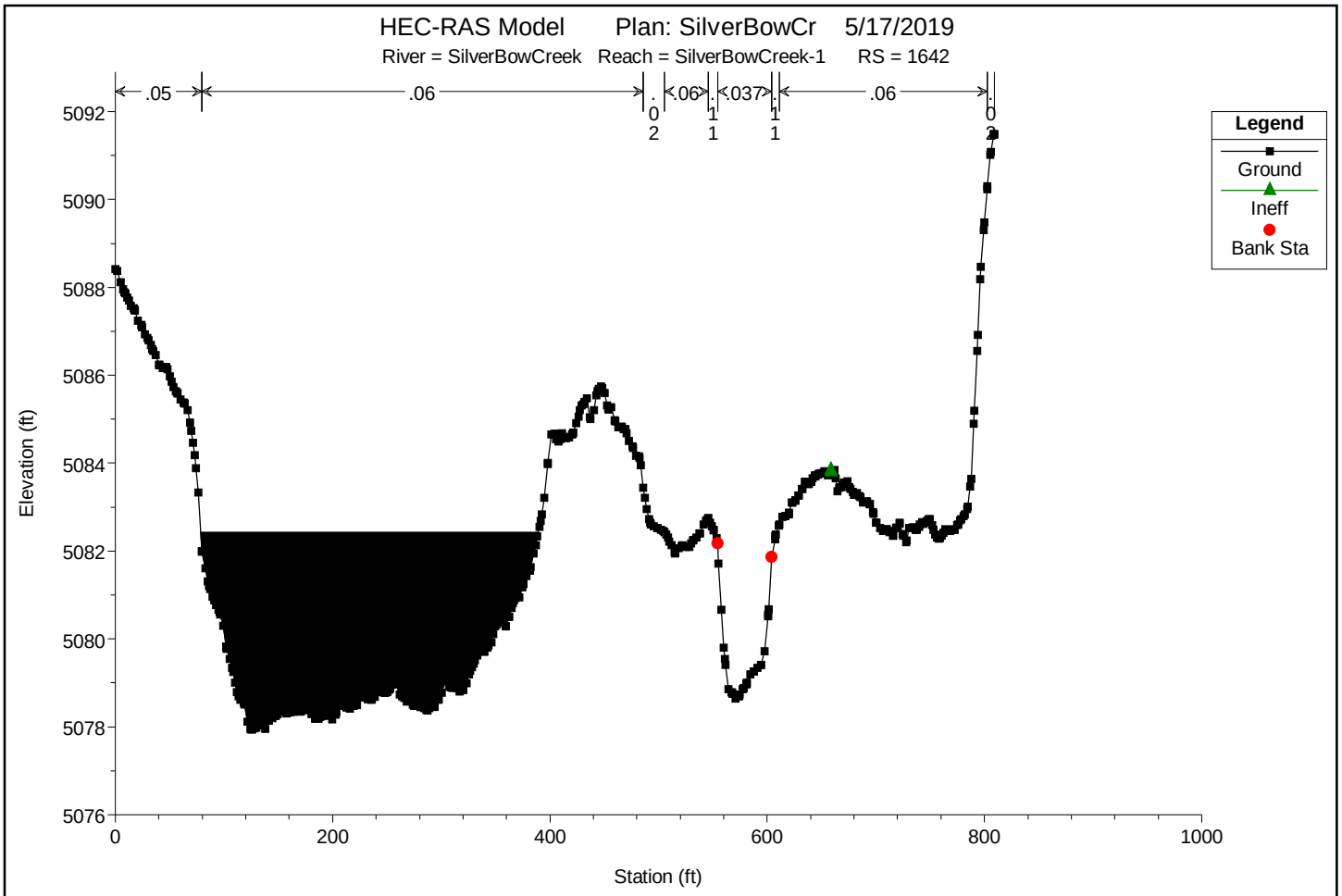

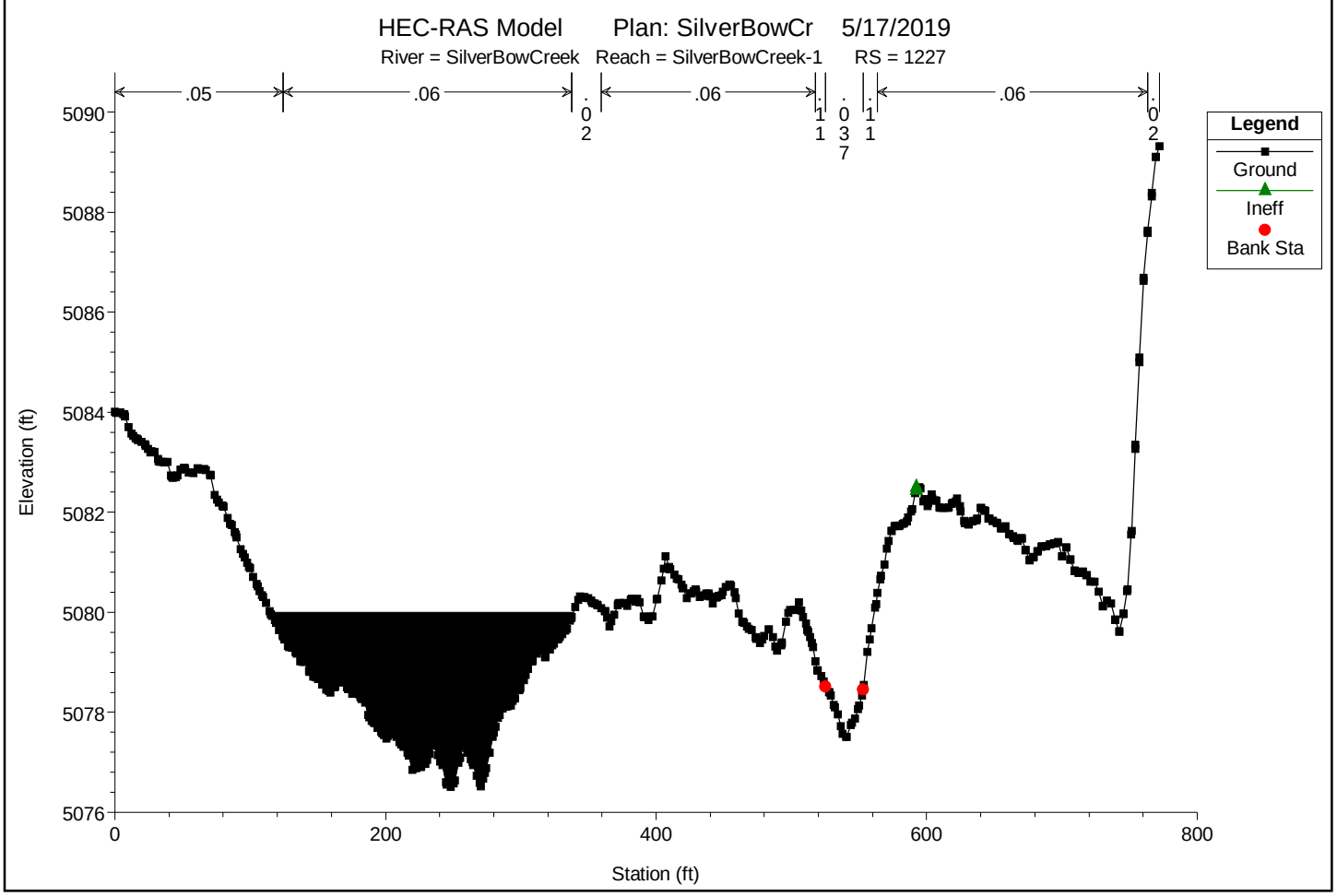

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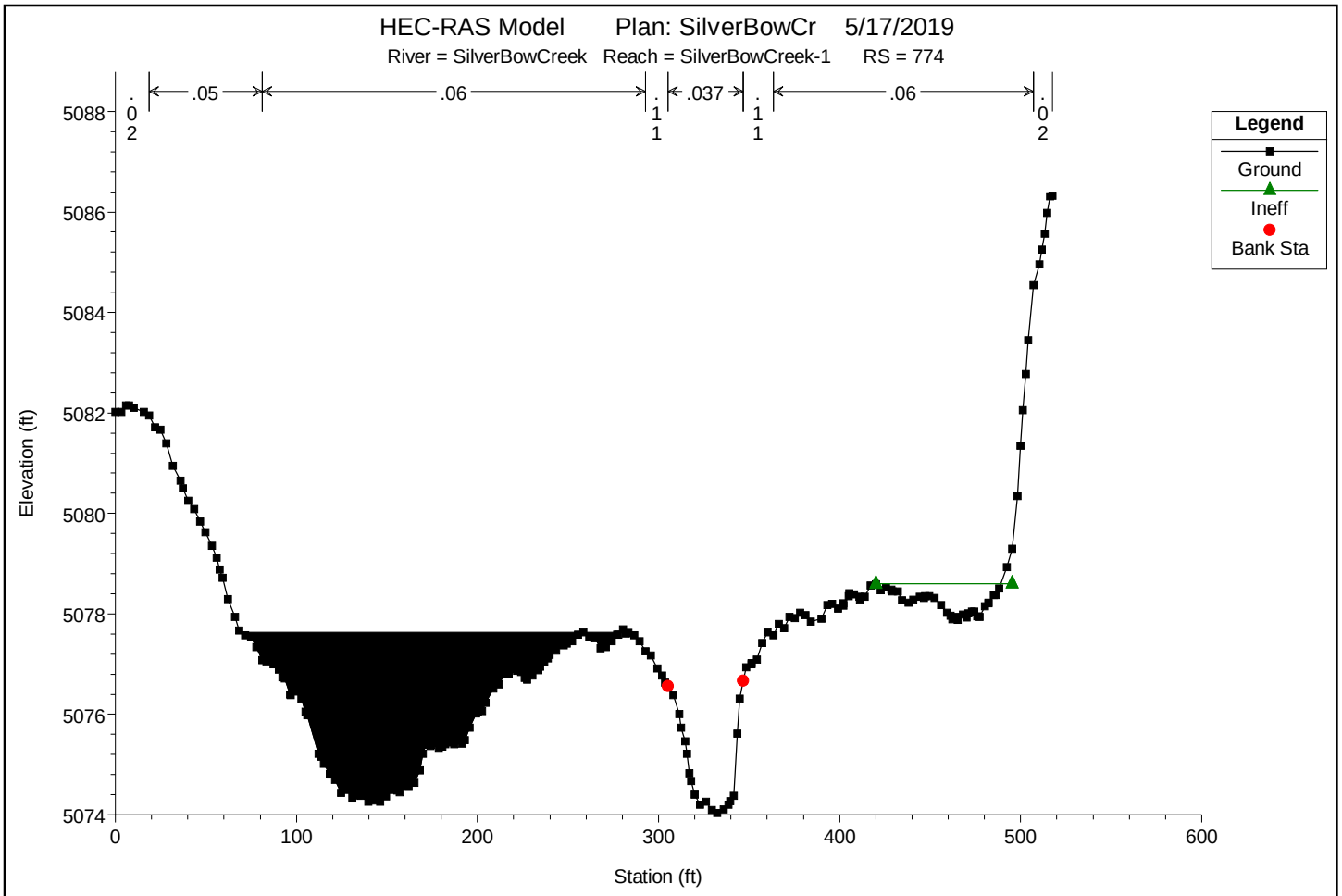

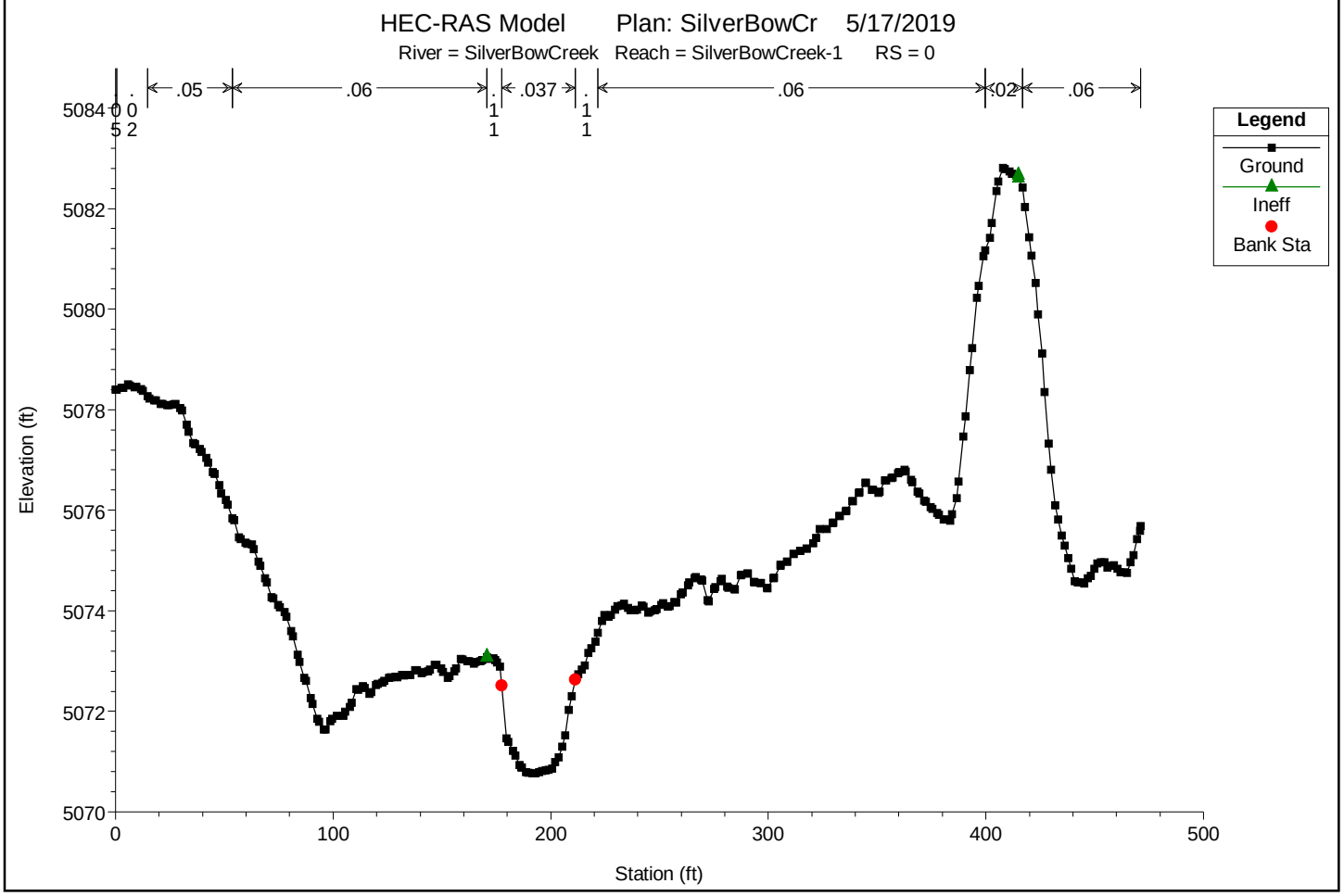

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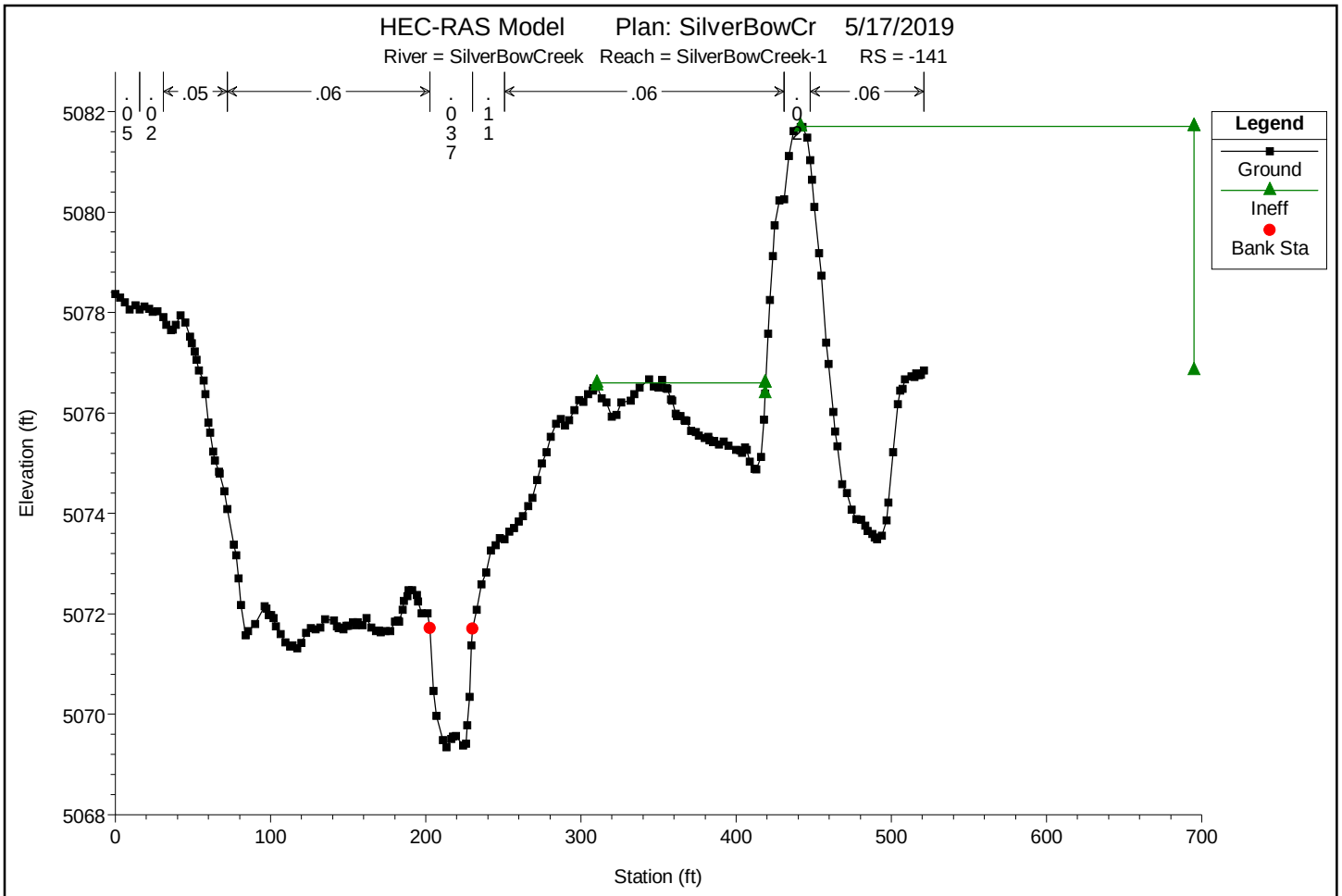

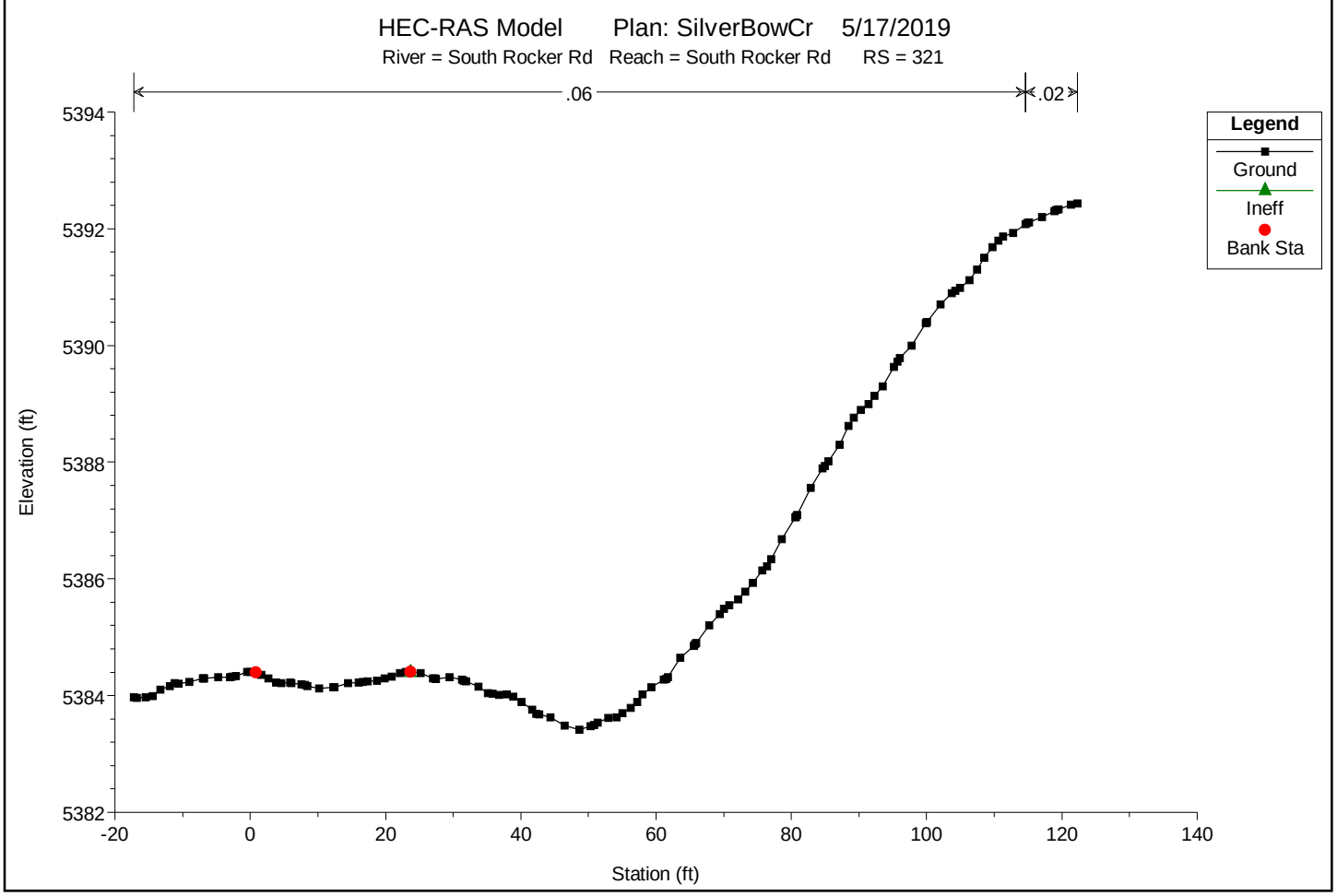

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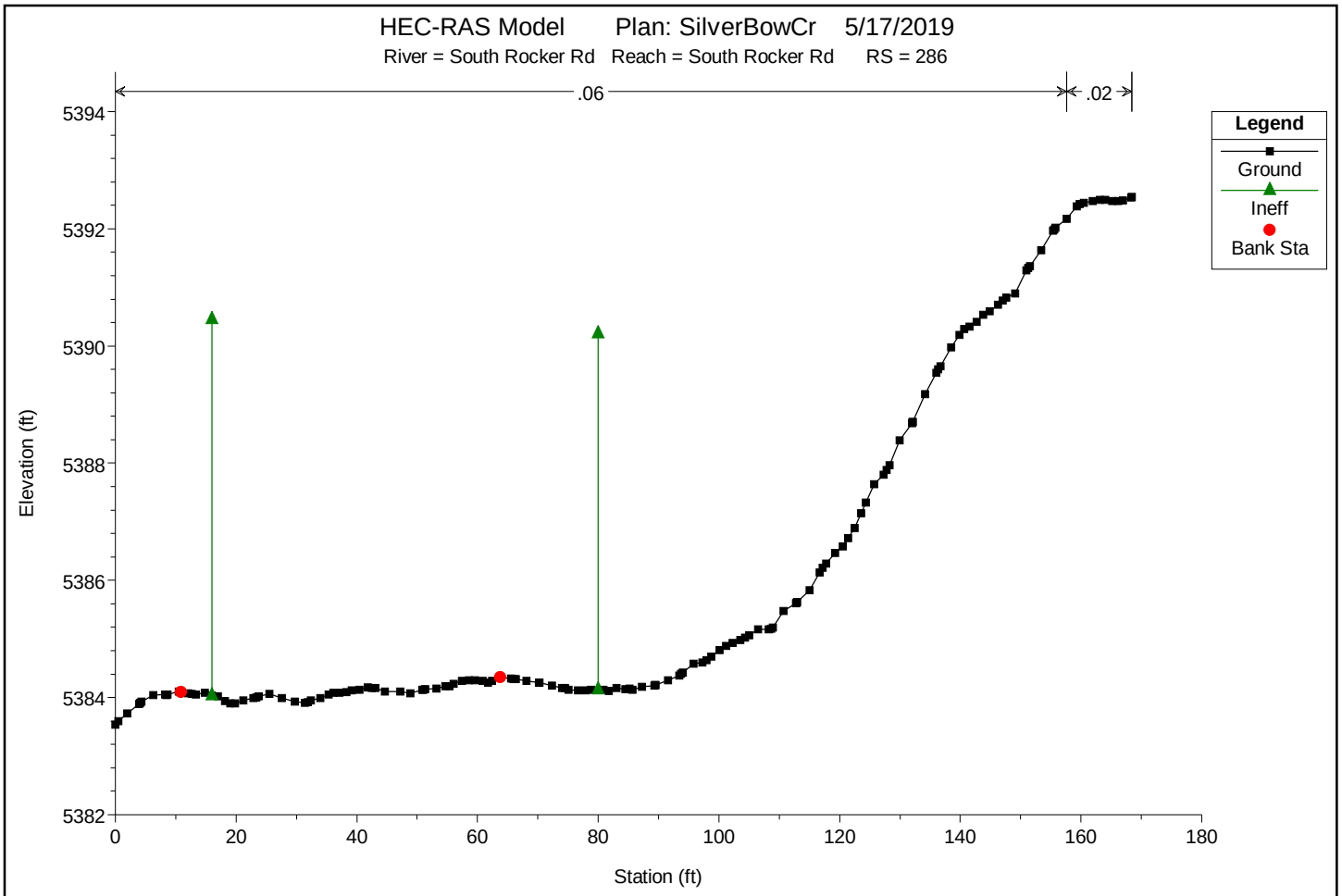

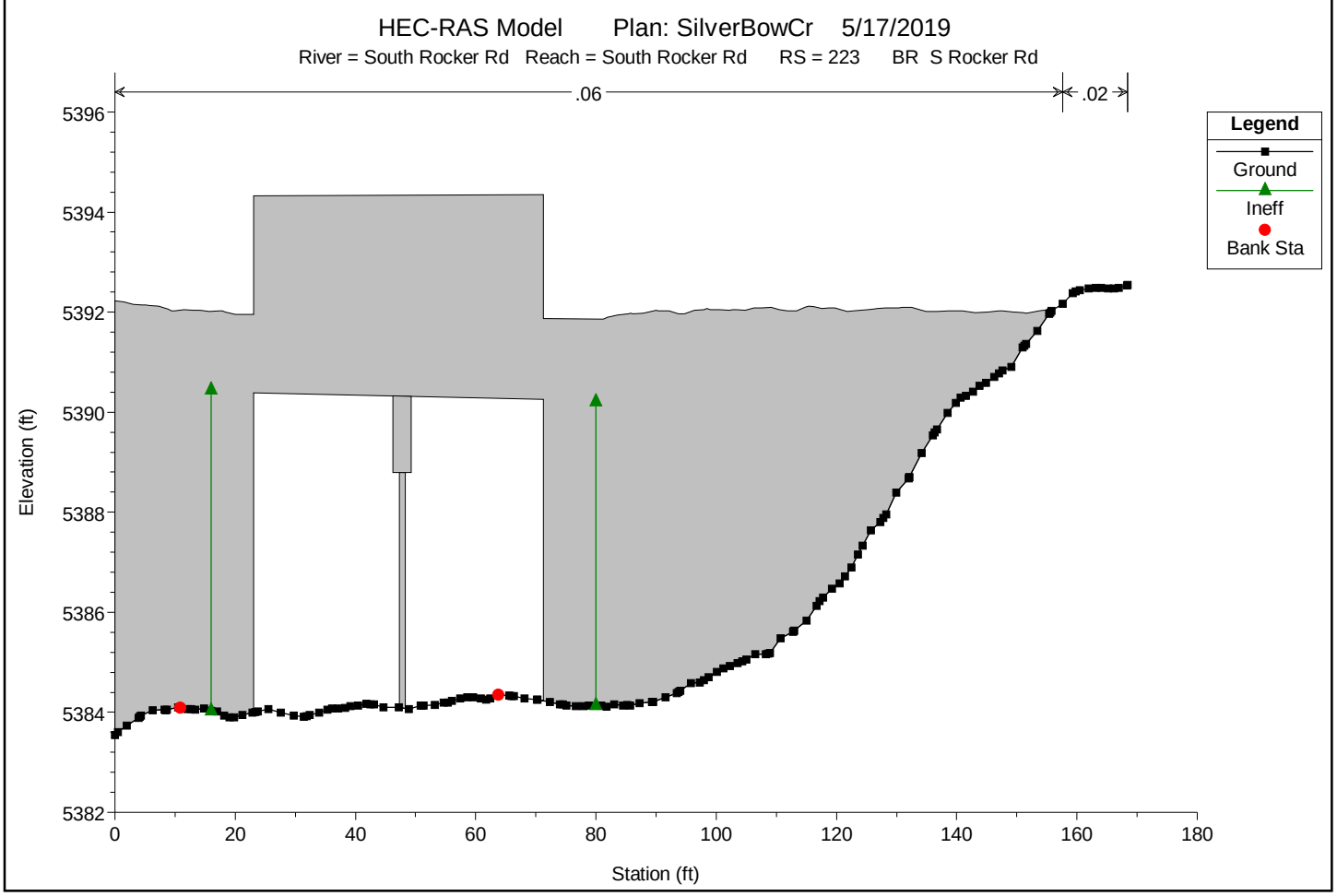

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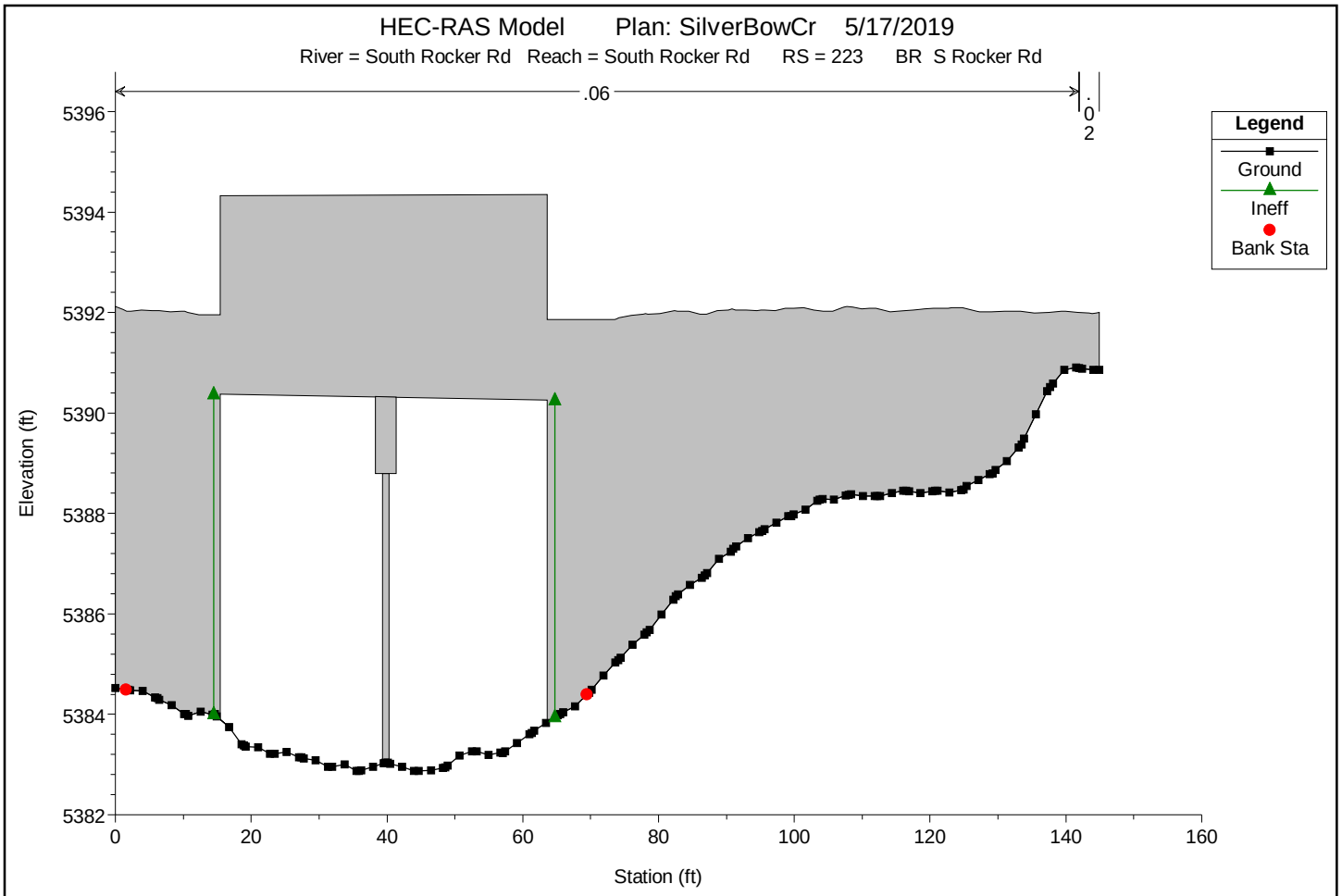

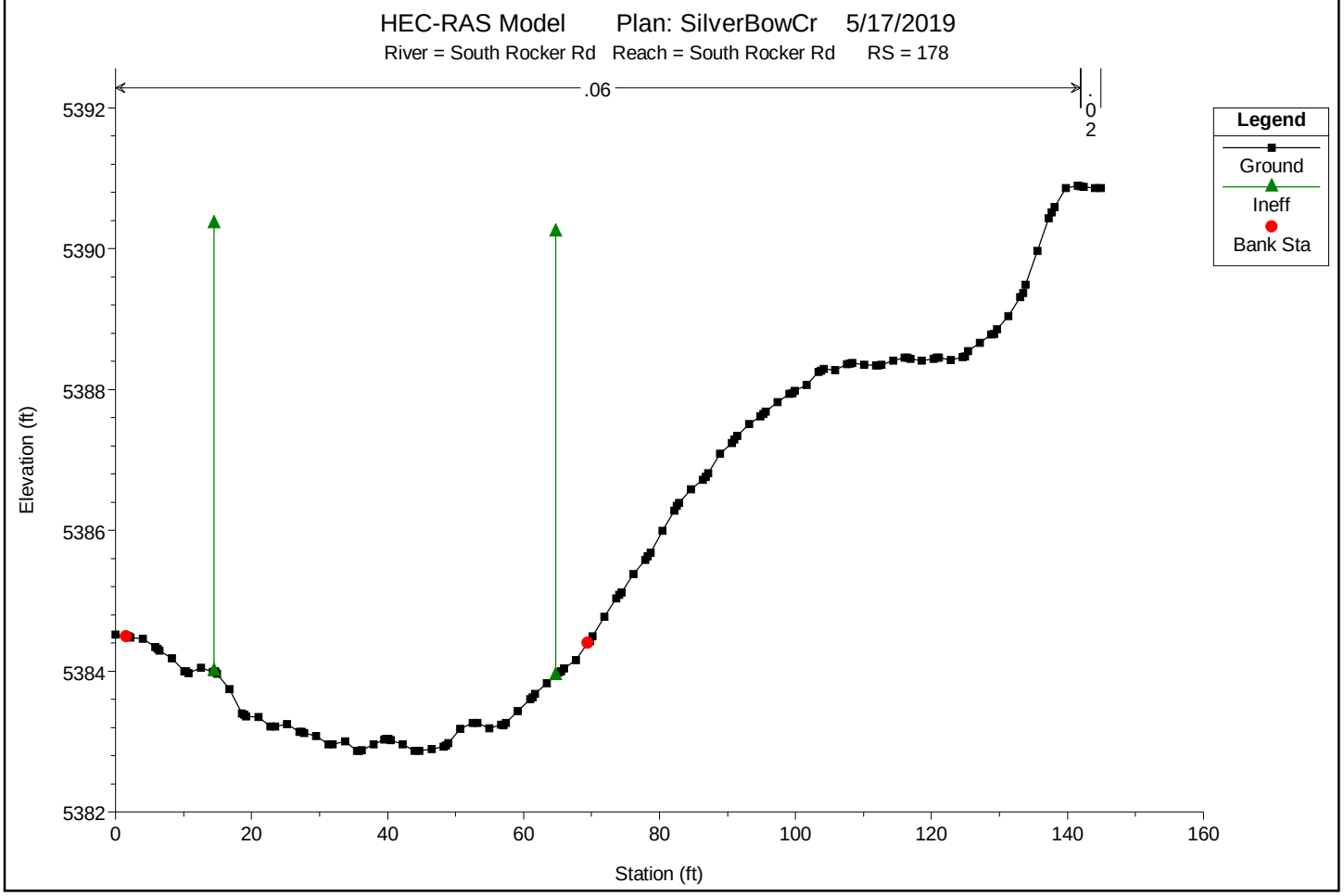

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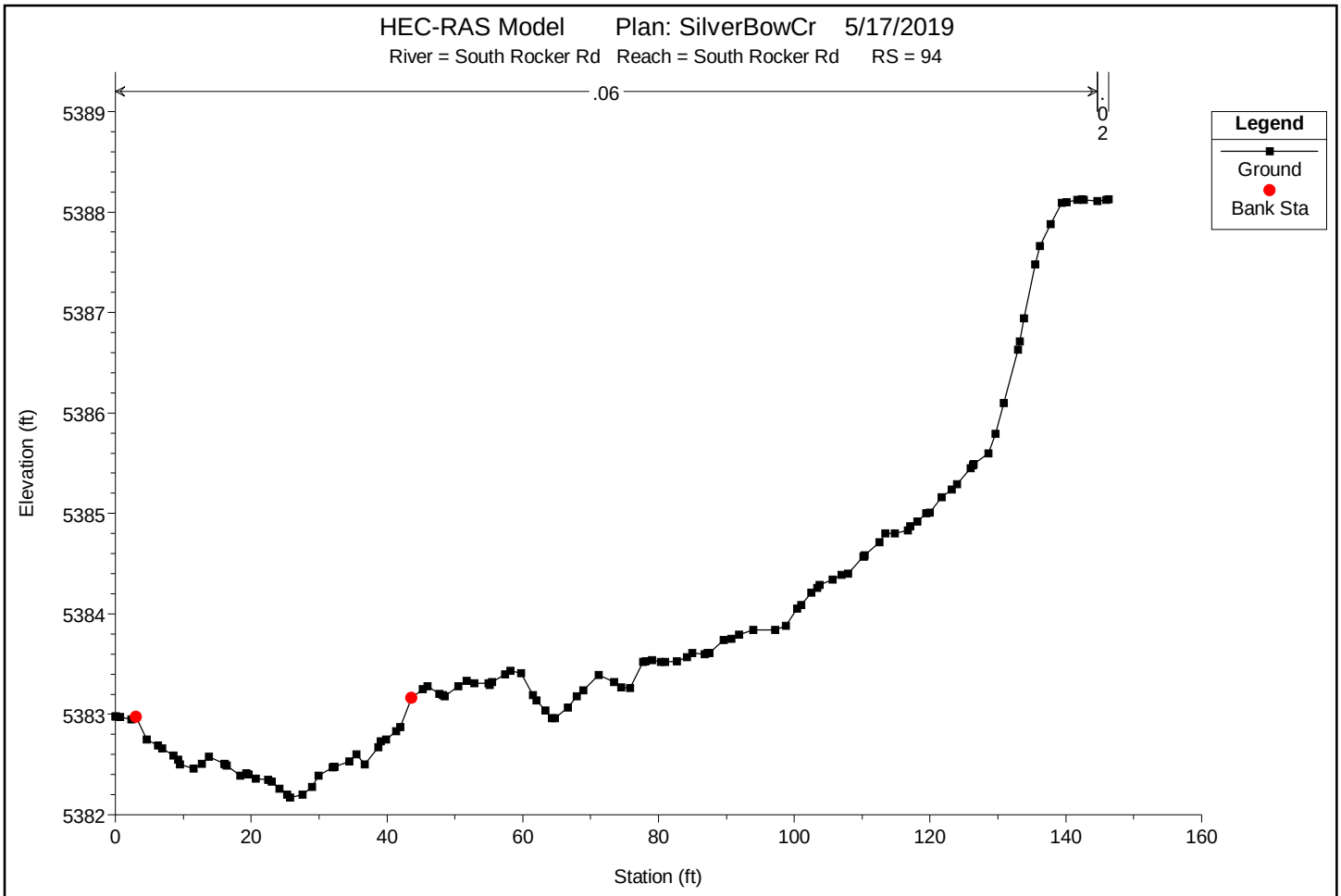

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Appendix F cHECk-RAS Reports

cHECk-RAS Report

HEC-RAS Project:	*silverbowcreek.prj*
Plan File:	*silverbowcreek.p07*
Geometry File:	*silverbowcreek.g07*
Flow File:	*silverbowcreek.f06*
Report Date:	*5/9/2019*

Message ID	Message	Cross sections affected	Comments
MP SW 01DD	The name of the stream is ($streamname$). The flow regime is subcritical or mixed flow. The downstream starting water-surface elevation, SWSEL, is computed from different methods.		
MP TW 01	The Top Width Act is the same for $profilename1$ flood and $profilename2$ flood. The velocity head for $profilename1$ flood is greater than 0.5 ft. The top width of the active flow area appears to be too narrow. The location of the ineffective flow stations should be investigated.	36486(Bridge-UP)	Modeled correctly, top width controlled by bridge, not ineffective flow.
MS IF 01S2L	This is Section 2 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 2. The Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	1838(MultiOpen); 33270(MultiOpen); 70494(MultiOpen); 72118(MultiOpen); 79073(MultiOpen); 83514(MultiOpen)	Multiple block ineffectives are used, correctly.
MS IF 01S2R	This is Section 2 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 2. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 the Applications Guide (HEC, 2010).	1838(MultiOpen); 33270(MultiOpen); 70494(MultiOpen); 72118(MultiOpen); 79073(MultiOpen); 83514(MultiOpen)	Multiple block ineffectives are used, correctly to account for ineffective flow outside of railgrade.
MS IF 01S2R	This is Section 2 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 2. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 the Applications Guide (HEC, 2010).	1838(MultiOpen); 33270(MultiOpen); 70494(MultiOpen); 72118(MultiOpen); 79073(MultiOpen); 83514(MultiOpen)	Multiple block ineffectives are used, correctly.

MS IF 01S3L	This is Section 3 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be equal to $LMnTpRdU$. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	1838(MultiOpen); 33270(MultiOpen); 70494(MultiOpen); 72118(MultiOpen); 79073(MultiOpen); 83514(MultiOpen)	Ineffective flows are used correctly.
MS IF 01S3L	This is Section 3 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be equal to $LMnTpRdU$. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	1838(MultiOpen); 33270(MultiOpen); 70494(MultiOpen); 72118(MultiOpen); 79073(MultiOpen); 83514(MultiOpen)	Multiple block ineffectives are used, correctly to account for ineffective flow outside of railgrade.
MS IF 01S3L	This is Section 3 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be equal to $LMnTpRdU$. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	1838(MultiOpen); 33270(MultiOpen); 70494(MultiOpen); 72118(MultiOpen); 79073(MultiOpen); 83514(MultiOpen)	Multiple block ineffectives are used, correctly.
MS IF 01S3R	This is Section 3 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be equal to $RMnTpRdU$. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	1838(MultiOpen); 33270(MultiOpen); 70494(MultiOpen); 72118(MultiOpen); 79073(MultiOpen); 83514(MultiOpen)	Multiple block ineffectives are used, correctly to account for ineffective flow outside of railgrade.
MS IF 01S3R	This is Section 3 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be equal to $RMnTpRdU$. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	1838(MultiOpen); 33270(MultiOpen); 70494(MultiOpen); 72118(MultiOpen); 79073(MultiOpen); 83514(MultiOpen)	Multiple block ineffectives are used, correctly.

NT RC 01L	All of the left overbank Manning’s "n" values are less than 0.030. The "n" values for the overbank areas are usually larger than 0.030 (Chow, 1959, page 113). The "n" value(s) should be re-evaluated. Follow the procedure outlined to compute the overbank "n" value(s) for a natural floodplain (FHWA, 1984). Or follow the procedure outlined to compute the "n" values for urban development (USGS, 1977). Please submit supporting information on the evaluation of the "n" values.	104; 2491; 2638; 2674(Culvert-DN); 2674(Culvert-UP); 2720; 2847; 3121; 3746; 819; 1342; 1903; 2052; 118; 0; 774; 1227; 1642; 1822; 1838(MultiOpen-DN); 4758; 6136; 6481; 6792; 6940; 6992(InlineWeir-DN); 6992(InlineWeir-UP); 7020; 7076; 7120; 7591; 8102; 10519; 10959; 11313; 11374; 11434; 11560; 11602; 11944; 12184; 12644; 12841; 13199; 13431; 13910; 14439; 15165; 15510; 15835; 16187; 16922; 17675; 19162; 23461(Bridge-UP); 23474; 23587; 24336; 24690; 24801; 24829(Bridge-DN); 24829(Bridge-UP); 24843; 24922; 25514; 26025; 26148; 26193(Culvert-DN); 26193(Culvert-UP); 26221; 26308; 26851; 27530; 27651; 27685(Culvert-DN); 27685(Culvert-UP); 27719; 27739(Bridge-DN); 27739(Bridge-UP); 27769; 27801(Bridge-DN); 27801(Bridge-UP); 27832; 28038; 28498(Bridge-UP); 28552; 28922; 28959(Bridge-DN); 29087; 30230; 31077; 31886; 32457; 33083; -141; 34097; 35079; 36170; 36352; 36457; 36486(Bridge-DN); 36486(Bridge-UP); 36516; 36683; 37394; 56199; 56370; 56456; 56489(Bridge-DN); 56489(Bridge-UP); 56512; 56569; 57380; 58246; 58866; 59417; 60154; 60549; 60588; 60622(Bridge-DN); 60763(Bridge-UP); 60793; 60822(Bridge-DN); 61402; 62008; 62761; 63427; 64068; 64653; 65189; 65329; 65436; 65478(Bridge-DN); 65478(Bridge-UP); 65508; 65628; 65781; 65968; 66103(Bridge-DN); 66103(Bridge-UP); 66267; 66531; 68086; 68902; 69751; 70474; 70494(MultiOpen-DN); 70596; 70932; 71186; 71231(Bridge-DN); 71231(Bridge-UP); 71266; 71345; 71572; 71972; 72094; 72118(MultiOpen-DN); 72118(MultiOpen-UP); 72139; 72228; 72420; 72779; 73754; 74873; 75786; 76465; 76500(Bridge-DN); 76605(Bridge-UP); 76701; 76850; 77426; 77953; 78257; 78445; 78491(Culvert-DN); 78491(Culvert-UP); 78562; 78630; 78764; 78974; 79055; 79073(MultiOpen-DN); 79073(MultiOpen-UP); 79091; 79154; 79558; 79829; 80566; 81281; 81670; 82283; 82965; 83417; 83495; 83514(MultiOpen-DN); 83514(MultiOpen-UP); 83543; 83638; 84280; 84962; 78396; 85615; 85696; 85733(Culvert-DN); 85733(Culvert-UP); 85782; 85873; 86027; 86550; 87244; 87789; 88355; 88513; 88739(Bridge-DN); 88739(Bridge-UP); 88899; 88995; 89182; 89287; 89421; 89510; 89563(Bridge-DN); 89707; 89951; 90215; 85584	Not all overbank values are less than 0.03 only roads (0.02) and standing water (0.028)

NT RC 01R	All of the right overbank "n" values are less than 0.030. Manning’s "n" values for the overbank areas are usually larger than 0.030 (Chow, 1959, page 113). The "n" value(s) should be re-evaluated. Follow the procedure on pages 17 and 54 of (FHWA, 1984) to compute the overbank "n" value for the natural floodplain. Or follow the procedure in (USGS, 1977) to compute the "n" value for urban development. Please submit supporting information on the evaluation of "n" value.	2491; 2638; 2674(Culvert-DN); 2720; 2847; 3121; 3746; 819; 1342; 1903; 2052; 118; 0; 774; 1227; 1642; 1822; 1838(MultiOpen-DN); 1838(MultiOpen-UP); 1854; 1996; 2258; 2653; 2789; 2846(Bridge-DN); 2952; 3058; 3304; 3917; 4758; 5190; 6136; 6481; 7076; 7120; 7591; 8102; 8947; 9165; 9280; 9304(Bridge-DN); 9304(Bridge-UP); 9337; 9446; 10138; 10519; 10959; 11313; 11374; 11434; 11560; 11602; 11944; 12184; 12644; 12841; 13199; 13431; 13910; 14439; 15165; 15510; 15835; 17675; 18357; 19162; 19518; 20061; 20639; 21420; 21807; 22054; 22579; 23328; 23474; 23587; 24336; 24690; 24801; 24829(Bridge-UP); 24843; 24922; 25514; 26025; 26148; 26193(Culvert-DN); 26193(Culvert-UP); 26221; 27685(Culvert-UP); 27719; 27739(Bridge-DN); 27739(Bridge-UP); 27769; 27801(Bridge-DN); 28038; 28375; 28439; 28498(Bridge-DN); 28498(Bridge-UP); 28552; 28606; 28804; 29087; 30230; 31077; 31886; 32457; 33083; -141; 36486(Bridge-UP); 36516; 36683; 37394; 38085; 38324; 38823; 39482; 40331; 40841; 41000; 41051(Culvert-DN); 44198; 44896; 45586; 46642; 47845; 48882; 49807; 50997; 51449; 54351; 55171; 55902; 56152; 56199; 56370; 56456; 56489(Bridge-DN); 58866; 59417; 60763(Bridge-UP); 60793; 60822(Bridge-DN); 61402; 62008; 62761; 63427; 64068; 64653; 65189; 65329; 65436; 65478(Bridge-DN); 65478(Bridge-UP); 65508; 65628; 65781; 65968; 66103(Bridge-DN); 66103(Bridge-UP); 66267; 66531; 67248; 68086; 68902; 70345; 70474; 70494(MultiOpen-DN); 70494(MultiOpen-UP); 70521; 70596; 70932; 71186; 71231(Bridge-DN); 71231(Bridge-UP); 71266; 71345; 71972; 72094; 72118(MultiOpen-DN); 74873; 76500(Bridge-UP); 76534; 76557; 76605(Bridge-DN); 76605(Bridge-UP); 76701; 76850; 77426; 77953; 78257; 78764; 78974; 79055; 79073(MultiOpen-DN); 79073(MultiOpen-UP); 79091; 79154; 79558; 80566; 81281; 81670; 82283; 83495; 83514(MultiOpen-DN); 83514(MultiOpen-UP); 83543; 83638; 84280; 88355; 88739(Bridge-UP); 88899; 89707; 89951; 90215; 94	Not all overbank values are less than 0.03 only roads (0.02) and standing water (0.028)

NT RC 03C	All of the channel "n" values are equal to or less than 0.025. The "n" value of the channel is usually greater than 0.025. The "n" values or the Channel Bank stations should be re-evaluated. Select the Channel Bank stations to include bank slopes and low flow channel to represent a confined cross section. Channel Bank stations must not be placed at the banks of the low flow channel, at the bottom of the channel, or above the 1%-annual-chance water-surface elevation. Let HEC-RAS compute the composite "n" values by using the Horizontal Variation in "n" Values option within the channel (HEC, 2010, HEC-RAS Reference Manual, page 2-6). Or follow the procedure on pages 9 and 52 of (FHWA, 1984) to compute the total channel "n" value. Please submit supporting information on the evaluation of "n" value.	2674(Culvert-DN); 24829(Bridge-DN); 24829(Bridge-UP)	Channel n value = 0.042
NT RC 03C	All of the channel "n" values are equal to or less than 0.025. The "n" value of the channel is usually greater than 0.025. The "n" values or the Channel Bank stations should be re-evaluated. Select the Channel Bank stations to include bank slopes and low flow channel to represent a confined cross section. Channel Bank stations must not be placed at the banks of the low flow channel, at the bottom of the channel, or above the 1%-annual-chance water-surface elevation. Let HEC-RAS compute the composite "n" values by using the Horizontal Variation in "n" Values option within the channel (HEC, 2010, HEC-RAS Reference Manual, page 2-6). Or follow the procedure on pages 9 and 52 of (FHWA, 1984) to compute the total channel "n" value. Please submit supporting information on the evaluation of "n" value.	2674(Culvert-DN); 24829(Bridge-DN); 24829(Bridge-UP)	Channel n value = 0.06
NT RC 05	The left overbank n-value of $nlob$ and the right overbank n-value of $nrob$ are less than or equal to the channel n-value of nch. Follow the procedure in (FHWA, 1984) to compute the n-value for the natural floodplain and the channel. Or follow the procedure in (USGS, 1977) to compute the n-value for urban development. Please submit supporting information on the evaluation of n-values.	2491; 2638; 2674(Culvert-DN); 2720; 2847; 3121; 3746; 819; 1342; 1903; 2052; 118; 24829(Bridge-UP); 27739(Bridge-UP); 27769; 27801(Bridge-DN); 56152; 56199; 60793; 89287	0.02 corresponds to roads on the outside of the banks

NT RC 05	The left overbank n-value of $nlob$ and the right overbank n-value of $nrob$ are less than or equal to the channel n-value of nch. Follow the procedure in (FHWA, 1984) to compute the n-value for the natural floodplain and the channel. Or follow the procedure in (USGS, 1977) to compute the n-value for urban development. Please submit supporting information on the evaluation of n-values.	2491; 2638; 2674(Culvert-DN); 2720; 2847; 3121; 3746; 819; 1342; 1903; 2052; 118; 24829(Bridge-UP); 27739(Bridge-UP); 27769; 27801(Bridge-DN); 56152; 56199; 60793; 89287	0.02 corresponds to roads on the outside of the banks, 0.06 is grass lined channel
NT RC 05	The left overbank n-value of $nlob$ and the right overbank n-value of $nrob$ are less than or equal to the channel n-value of nch. Follow the procedure in (FHWA, 1984) to compute the n-value for the natural floodplain and the channel. Or follow the procedure in (USGS, 1977) to compute the n-value for urban development. Please submit supporting information on the evaluation of n-values.	2491; 2638; 2674(Culvert-DN); 2720; 2847; 3121; 3746; 819; 1342; 1903; 2052; 118; 24829(Bridge-UP); 27739(Bridge-UP); 27769; 27801(Bridge-DN); 56152; 56199; 60793; 89287	Channel n value =0.042
NT RC 05	The left overbank n-value of $nlob$ and the right overbank n-value of $nrob$ are less than or equal to the channel n-value of nch. Follow the procedure in (FHWA, 1984) to compute the n-value for the natural floodplain and the channel. Or follow the procedure in (USGS, 1977) to compute the n-value for urban development. Please submit supporting information on the evaluation of n-values.	2491; 2638; 2674(Culvert-DN); 2720; 2847; 3121; 3746; 819; 1342; 1903; 2052; 118; 24829(Bridge-UP); 27739(Bridge-UP); 27769; 27801(Bridge-DN); 56152; 56199; 60793; 89287	Channel n value high due to vegetation in and around channel
NT RS 02BDC	This is the Downstream Bridge Section (BRD). The channel n value of $chldn$ for the downstream internal bridge opening section is equal to or larger than the channel n value of $chl2$ at Section 2. Usually, the channel "n" value of the bridge opening section represents the area below the bridge deck and is less than the channel "n" value of Section 2. The "n" value for Section 2 represents the natural valley channel section roughness for the reach between Section 3 and Section 4. Please change the "n" value of the internal bridge opening section or provide supporting information for the use of the higher "n" value.	2846(Bridge-DN); 9304(Bridge-DN); 19346(Bridge-DN); 23461(Bridge-DN); 27739(Bridge-DN); 27801(Bridge-DN); 28498(Bridge-DN); 36486(Bridge-DN); 38567(Bridge-DN); 38669(Bridge-DN); 56489(Bridge-DN); 60622(Bridge-DN); 65478(Bridge-DN); 66103(Bridge-DN); 71231(Bridge-DN); 76500(Bridge-DN); 76605(Bridge-DN); 88739(Bridge-DN); 89563(Bridge-DN)	Channel n value is consistent through bridge

NT RS 02BUC	This is the Upstream Bridge Section (BRU). The channel n value of $chlup$ for the upstream internal bridge opening section is equal to or larger than the channel n value of $chl3$ at Section 3. Usually, the channel "n" value of the bridge opening section represents the area below the bridge deck and is less than the channel "n" value of Section 3. The "n" value for Section 3 represents the natural valley channel section roughness for the reach between Section 3 and Section 4. Please change the "n" value of the internal bridge opening section or provide supporting information for the use of a higher "n" value.	2846(Bridge-UP); 9304(Bridge-UP); 10314(Bridge-UP); 19346(Bridge-UP); 27739(Bridge-UP); 27801(Bridge-UP); 28498(Bridge-UP); 36486(Bridge-UP); 38567(Bridge-UP); 56489(Bridge-UP); 60822(Bridge-UP); 65478(Bridge-UP); 66103(Bridge-UP); 71231(Bridge-UP); 76500(Bridge-UP); 76605(Bridge-UP); 88739(Bridge-UP)	Channel n value is consistent through bridge
NT TL 01S2	This is Section2 of a hydraulic structure. The contraction and expansion loss coefficients are cc and ce. They should be equal to 0.3 and 0.5, respectively, for typical structure sections according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	9280; 36457; 38637; 60588; 70474; 72094; 88513; 89510	Higher coefficients used to better represent hydraulics
NT TL 01S3	This is Section3 of a hydraulic structure. The contraction and expansion loss coefficients are cc and ce. They should be equal to 0.3 and 0.5, respectively, for typical structure sections according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	2896; 9337; 10391; 76701	Higher coefficients used to better represent hydraulics
NT TL 01S4	This is Section 4 of a hydraulic structure. The contraction and expansion loss coefficients are cc and ce. They should be equal to 0.3 and 0.5, respectively according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010)..	79154	Higher coefficients used to better represent hydraulics
NT TL 02	Contraction and expansion loss coefficients are cc and ce, respectively. However, this cross section is not at a hydraulic structure. They should be equal to 0.1 and 0.3 according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	7120; 33208	Higher coefficients used to better represent hydraulics
ST DT 01B	This is ($strucname$). 'Upstream Dist' of $distup$ in "Bridge Width Table" is less than the height of the bridge opening of $height$. This indicates that Section 3 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 3 should be relocated or provide a statement that it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 4, 3 and 2 and 'Upstream Dist' should be adjusted.	23461(Bridge-UP); 56220(Bridge-UP)	Located between a series of bridges, no true natrual valley is present. comment ignored.

ST DT 01B	This is ($strucname$). 'Upstream Dist' of $distup$ in "Bridge Width Table" is less than the height of the bridge opening of $height$. This indicates that Section 3 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 3 should be relocated or provide a statement that it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 4, 3 and 2 and 'Upstream Dist' should be adjusted.	23461(Bridge-UP); 56220(Bridge-UP)	Stream makes sharp angle to go under bridge, XS represents natural valley, comment ignored.
ST DT 01C	This is ($strucname$). 'Distance to Upstrm XS' of $distup$ in 'Culvert Data Editor' window is less than the height of the culvert opening of $height$. This indicates that Section 3 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 3 should be relocated or provide a statement that it represents the natural valley cross section. A HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 4, 3 and 2 and 'Distance to Upstrm XS' should be adjusted.	26193(Culvert-UP)	XS represents natural valley, comment ignored
ST DT 02B	This is ($strucname$). 'Downstream Dist' of $distdn$ in 'Bridge Width Table' is less than the height of the bridge opening of $height$. This indicates that Section 2 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 2 should be relocated or provide a statement that it represents the natural valley cross section. A HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 3 and 2 should be adjusted.	27739(Bridge-DN); 56183(Bridge-DN); 89563(Bridge-DN)	Located between a series of bridges, no true natrual valley is present, comment ignored.
ST DT 02B	This is ($strucname$). 'Downstream Dist' of $distdn$ in 'Bridge Width Table' is less than the height of the bridge opening of $height$. This indicates that Section 2 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 2 should be relocated or provide a statement that it represents the natural valley cross section. A HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 3 and 2 should be adjusted.	27739(Bridge-DN); 56183(Bridge-DN); 89563(Bridge-DN)	Placed between Interstate bridge and flume. Flow is incised and XS represents natural valley XS

ST DT 02B	This is ($strucname$). 'Downstream Dist' of $distdn$ in 'Bridge Width Table' is less than the height of the bridge opening of $height$. This indicates that Section 2 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 2 should be relocated or provide a statement that it represents the natural valley cross section. A HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 3 and 2 should be adjusted.	27739(Bridge-DN); 56183(Bridge-DN); 89563(Bridge-DN)	XS placed between multiple bridges.
ST DT 02C	This is ($strucname$). The culvert downstream distance, $distdn$ is equal to Length_Chnl at Section 3 minus (DistanceUp + CulvertLength). The culvert downstream distance of $distdn$ is less than the height of the culvert opening of $height$. This indicates that Section 2 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 2 should be relocated or provide a statement that it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 3 & 2 should be adjusted.	2674(Culvert-DN); 308(Culvert-DN); 78491(Culvert-DN)	XS placed at foot of embankment.
ST DT 03	This is ($Structure$) section. The Contraction Length is longer than the Expansion Length. Section 4 channel distance of $Length_Chnl4$ is longer than Section 2 channel distance of $Length_Chnl2$. Section 4 and Section 1 should be relocated. The HEC-RAS geometry file may need to be recreated using a GIS program.	308(Culvert-UP); 23461(Bridge-UP); 27685(Culvert-UP); 27739(Bridge-UP); 27801(Bridge-UP); 36486(Bridge-UP); 38669(Bridge-UP); 56183(Bridge-UP); 56220(Bridge-UP); 60622(Bridge-UP); 60763(Bridge-UP); 60822(Bridge-UP); 65478(Bridge-UP); 66103(Bridge-UP); 76605(Bridge-UP); 78491(Culvert-UP); 85733(Culvert-UP); 89563(Bridge-UP)	Flow is incised and XS represents natural valley XS for studied flows.
ST DT 03	This is ($Structure$) section. The Contraction Length is longer than the Expansion Length. Section 4 channel distance of $Length_Chnl4$ is longer than Section 2 channel distance of $Length_Chnl2$. Section 4 and Section 1 should be relocated. The HEC-RAS geometry file may need to be recreated using a GIS program.	308(Culvert-UP); 23461(Bridge-UP); 27685(Culvert-UP); 27739(Bridge-UP); 27801(Bridge-UP); 36486(Bridge-UP); 38669(Bridge-UP); 56183(Bridge-UP); 56220(Bridge-UP); 60622(Bridge-UP); 60763(Bridge-UP); 60822(Bridge-UP); 65478(Bridge-UP); 66103(Bridge-UP); 76605(Bridge-UP); 78491(Culvert-UP); 85733(Culvert-UP); 89563(Bridge-UP)	XS placed at foot of embankment.
ST DT 03	This is ($Structure$) section. The Contraction Length is longer than the Expansion Length. Section 4 channel distance of $Length_Chnl4$ is longer than Section 2 channel distance of $Length_Chnl2$. Section 4 and Section 1 should be relocated. The HEC-RAS geometry file may need to be recreated using a GIS program.	308(Culvert-UP); 23461(Bridge-UP); 27685(Culvert-UP); 27739(Bridge-UP); 27801(Bridge-UP); 36486(Bridge-UP); 38669(Bridge-UP); 56183(Bridge-UP); 56220(Bridge-UP); 60622(Bridge-UP); 60763(Bridge-UP); 60822(Bridge-UP); 65478(Bridge-UP); 66103(Bridge-UP); 76605(Bridge-UP); 78491(Culvert-UP); 85733(Culvert-UP); 89563(Bridge-UP)	XS placed between multiple bridges.

ST DT 03	This is ($Structure$) section. The Contraction Length is longer than the Expansion Length. Section 4 channel distance of $Length_Chnl4$ is longer than Section 2 channel distance of $Length_Chnl2$. Section 4 and Section 1 should be relocated. The HEC-RAS geometry file may need to be recreated using a GIS program.	308(Culvert-UP); 23461(Bridge-UP); 27685(Culvert-UP); 27739(Bridge-UP); 27801(Bridge-UP); 36486(Bridge-UP); 38669(Bridge-UP); 56183(Bridge-UP); 56220(Bridge-UP); 60622(Bridge-UP); 60763(Bridge-UP); 60822(Bridge-UP); 65478(Bridge-UP); 66103(Bridge-UP); 76605(Bridge-UP); 78491(Culvert-UP); 85733(Culvert-UP); 89563(Bridge-UP)	XS placed just outside of 90 degree bend to keep cross section overbanks out of channel.
ST GD 02BD	This is the Downstream Bridge Section. There is only one bridge. However, the low cord line crosses the ground line at more than two locations. The ground and deck/roadway data should be checked.	2846(Bridge); 9304(Bridge); 10314(Bridge); 19346(Bridge); 23461(Bridge); 24829(Bridge); 27739(Bridge); 27801(Bridge); 28498(Bridge); 28959(Bridge); 36486(Bridge); 38567(Bridge); 38669(Bridge); 56127(Bridge); 56183(Bridge); 56220(Bridge); 56489(Bridge); 60622(Bridge); 60763(Bridge); 60822(Bridge); 65478(Bridge); 66103(Bridge); 71231(Bridge); 76500(Bridge); 76605(Bridge); 88739(Bridge); 89563(Bridge); 223(Bridge)	Ground and Roadway Data checked no issues found
ST GD 02BU	This is the Upstream Bridge Section. There is only one bridge. However, the low cord line crosses the ground line at more than two locations. The ground and deck/roadway data should be checked.	2846(Bridge); 9304(Bridge); 10314(Bridge); 19346(Bridge); 23461(Bridge); 24829(Bridge); 27739(Bridge); 27801(Bridge); 28498(Bridge); 28959(Bridge); 36486(Bridge); 38567(Bridge); 38669(Bridge); 56127(Bridge); 56183(Bridge); 56220(Bridge); 56489(Bridge); 60622(Bridge); 60763(Bridge); 60822(Bridge); 65478(Bridge); 66103(Bridge); 71231(Bridge); 76500(Bridge); 76605(Bridge); 88739(Bridge); 89563(Bridge); 223(Bridge)	Ground and Roadway Data checked no issues found
ST GD 05S1	This is Section 1. 'Cross Section Lid' option is used for this section. 'Cross Section Lid' data must be removed from this section, unless the structure is modeled as culverts in series.	89421(Bridge)	Cross section Lid is used to model flume and does not affect the studied flows.
ST GD 06	Left and/or right abutment station computed by the cHECk-RAS program is equal to zero. cHECk-RAS cannot evaluate this structure.	223(Bridge)	Structure is modeled correctly, comment ignored.
ST IF 01S2L	This is Section 2 of a hydraulic structure. The highest flood frequency that has low or pressure flow is $profilename$. However, the Left Ineffective Flow station was not considered at Section 2. The ineffective flow station and elevation should be inserted. The left ineffective flow elevation should be equal to wsel2 of $wsel$. The placement of the left ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	56183(Bridge); 56220(Bridge); 60822(Bridge); 76605(Bridge); 88739(Bridge); 89563(Bridge); 223(Bridge)	Flow is not constricted by geometry at this location.

ST IF 01S2R	This is Section 2 of a hydraulic structure. The highest flood frequency that has low or pressure flow is $profilename$. However, the Right Ineffective Flow Station was not considered at Section 2. The ineffective flow station and elevation should be inserted. The right ineffective flow elevation should be equal to wsel2 of $wsel$. The placement of the right ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	56183(Bridge); 56220(Bridge); 60822(Bridge); 89563(Bridge); 223(Bridge)	Flow is not constricted by geometry at this location.
ST IF 01S3L	This is Section 3. The highest flood frequency that has low or pressure flow is $profilename$. However, the Left Ineffective Flow station was not considered at Section 3. The ineffective flow station and elevation should be inserted. The left ineffective flow elevation should be equal to lmntprdu of $lmntprdu$. The placement of the left ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	56127(Bridge); 56183(Bridge); 60763(Bridge); 76605(Bridge); 88739(Bridge); 89563(Bridge)	Flow is not constricted by geometry at this location.
ST IF 01S3R	This is Section 3 of a hydraulic structure. The highest flood frequency that has low or pressure flow is $profilename$. However, the Right Ineffective Flow station was not considered at Section 3. The ineffective flow station and elevation should be inserted. The right ineffective flow elevation should be equal to rmntprdu of $rmntprdu$. The placement of the right ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	23461(Bridge); 56127(Bridge); 56183(Bridge); 60763(Bridge); 89563(Bridge)	Flow is not constricted by geometry at this location.
ST IF 01S3R	This is Section 3 of a hydraulic structure. The highest flood frequency that has low or pressure flow is $profilename$. However, the Right Ineffective Flow station was not considered at Section 3. The ineffective flow station and elevation should be inserted. The right ineffective flow elevation should be equal to rmntprdu of $rmntprdu$. The placement of the right ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	23461(Bridge); 56127(Bridge); 56183(Bridge); 60763(Bridge); 89563(Bridge)	Flow is not constricted by geometry at this location.v

ST IF 02S2L	This is Section 2. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, left ineffective flow station was not considered at Section 2. The ineffective flow station and elevation should be inserted. The left ineffective flow elevation should be less than the wsel2 of $wsel$ of the $profilename$ profile. The placement of the left ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	38482(Culvert)	Weir flow occurs at this location
ST IF 03S2L	This is Section 2. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the left ineffective flow elevation of $ineffelr$ at the left ineffective flow station $ineffstal$ is equal to or higher than the WSEL of $wsel2$. The ineffective flow elevation should be lower than the WSEL at Section 2.	1822(MultiOpen); 6940(InlineWeir); 76465(Bridge); 83495(MultiOpen)	Ineffective flow set for bridge embankment at multiple opening location.
ST IF 03S2R	This is Section 2. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the right ineffective flow elevation of $ineffell$ at the right ineffective flow station $ineffstar$ is equal to or higher than the WSEL of $wsel2$. The ineffective flow elevation should be lower than the WSEL at Section 2.	6940(InlineWeir)	Ineffective flow set for bridge embankment at multiple opening location.
ST IF 03S3L	This is Section 3. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the left ineffective flow elevation of $ineffelr$ at the left ineffective flow station $ineffstal$ is equal to or higher than the WSEL of $wsel3$. The computed upstream LMnTpRd is $lmntprdu$. The ineffective flow elevation should be equal to or lower than the computed LMnTpRdU. It should also be lower than the WSEL at Section 3.	1854(MultiOpen); 7020(InlineWeir); 56512(Bridge); 76534(Bridge); 83543(MultiOpen)	Ineffective flow set for bridge embankment at multiple opening location.
ST IF 03S3L	This is Section 3. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the left ineffective flow elevation of $ineffelr$ at the left ineffective flow station $ineffstal$ is equal to or higher than the WSEL of $wsel3$. The computed upstream LMnTpRd is $lmntprdu$. The ineffective flow elevation should be equal to or lower than the computed LMnTpRdU. It should also be lower than the WSEL at Section 3.	1854(MultiOpen); 7020(InlineWeir); 56512(Bridge); 76534(Bridge); 83543(MultiOpen)	Ineffective flow set for floodplain topography at multiple opening location.

ST IF 03S3R	This is Section 3. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the right ineffective flow elevation of $ineffell$ at the right ineffective flow station $ineffstar$ is equal to or higher than the WSEL of $wsel3$. The computed upstream RMnTpRd is $rmntprdu$. The ineffective flow elevation should be equal to or lower than the computed RMnTpRdU. It should also be lower than the WSEL at Section 3.	7020(InlineWeir)	Ineffective flow set for bridge embankment at multiple opening location.
ST IF 04S2R	This is Section 2. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the right ineffective flow elevation of $ineffell$ at the right ineffective flow station $ineffstar$ is equal to or higher than the WSEL of $wsel2$. The upstream RMnTpRu is $rmntprdu$. The ineffective flow elevation should be lower than the WSEL at Section 2.	1822(MultiOpen); 56456(Bridge); 76465(Bridge); 83495(MultiOpen)	Weir flow does not occur on the right side.
ST IF 04S3R	This is Section 3. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the right ineffective flow elevation of $ineffell$ at the right ineffective flow station $ineffstar$ is equal to or higher than the WSEL of $wsel3$. The computed upstream RMnTpRd is $rmntprdu$. The ineffective flow elevation should be equal to the computed RMnTpRdU.	1854(MultiOpen); 56512(Bridge); 76534(Bridge); 83543(MultiOpen)	Ineffective boundaries are set correctly.
ST IF 04S3R	This is Section 3. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the right ineffective flow elevation of $ineffell$ at the right ineffective flow station $ineffstar$ is equal to or higher than the WSEL of $wsel3$. The computed upstream RMnTpRd is $rmntprdu$. The ineffective flow elevation should be equal to the computed RMnTpRdU.	1854(MultiOpen); 56512(Bridge); 76534(Bridge); 83543(MultiOpen)	Weir flow does not occur on the right side.
ST IF 05S2L	This is Section 2 of a hydraulic structure. The left ineffective flow station is within the opening area of the structure. The left ineffective flow station of $ineffstal$ is greater than the downstream left abutment station of $abutstal$ at ($strucname$). The Left ineffective flow station should be adjusted.	6940(InlineWeir); 65968(Bridge); 178(Bridge)	Ineffective flow boundaries are set correctly.

ST IF 05S2L	This is Section 2 of a hydraulic structure. The left ineffective flow station is within the opening area of the structure. The left ineffective flow station of $ineffstal$ is greater than the downstream left abutment station of $abutstal$ at ($strucname$). The Left ineffective flow station should be adjusted.	6940(InlineWeir); 65968(Bridge); 178(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction.
ST IF 05S2R	This is Section 2 of a hydraulic structure. The right ineffective flow station is within the opening area of the structure. The right ineffective flow station of $ineffstar$ is less than the upstream right abutment station of $abutstar$ at ($strucname$). The Right ineffective flow station should be adjusted.	6940(InlineWeir); 28439(Bridge); 65968(Bridge); 88513(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction.
ST IF 05S3L	This is Section 3 of a hydraulic structure. The left ineffective flow station is within the opening area of the structure. The left ineffective flow station of $ineffstal$ is greater than the upstream left abutment station of $abutstal$ at ($strucname$). The Left ineffective flow station should be adjusted.	7020(InlineWeir); 66267(Bridge)	Ineffective flow boundaries are set correctly.
ST IF 05S3L	This is Section 3 of a hydraulic structure. The left ineffective flow station is within the opening area of the structure. The left ineffective flow station of $ineffstal$ is greater than the upstream left abutment station of $abutstal$ at ($strucname$). The Left ineffective flow station should be adjusted.	7020(InlineWeir); 66267(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction.
ST IF 05S3R	This is Section 3 of a hydraulic structure. The right ineffective flow station is within the opening area of the structure. The right ineffective flow station of $ineffstar$ is less than the upstream right abutment station of $abutstar$ at ($strucname$). The Right ineffective flow station should be adjusted.	7020(InlineWeir); 88899(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction.
ST IF 06S3L	This is Section 3. The selected profile is $profilename$. Low or pressure flow occurs at ($strucname$). The Up_Dist of $updist$ at the structure is less than the opening height of $openheight$ of the structure. The cHECk-RAS computed left ineffective flow station of $compineffstal$ is less than the input left ineffective flow station of $ineffstal$. The left ineffective flow station should be adjusted per the help instructions and the HEC-RAS manual.	23474(Bridge)	Ineffective flow boundaries are set correctly, comment ignored.

ST IF 07S1L	This is Section 1. Left Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 3 of the downstream structure.	55902(Bridge); 88355(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction.
ST IF 07S1R	This is Section 1. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 3 of the downstream structure.	55902(Bridge); 88355(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction.
ST IF 07S1R	This is Section 1. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 3 of the downstream structure.	55902(Bridge); 88355(Bridge)	This cross section is not clear of the bridge affects, comment ignored.
ST IF 07S4L	This is Section 4. Left Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 2 of the upstream structure.	60953(Bridge); 76850(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction.
ST IF 07S4R	This is Section 4. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 2 of the upstream structure.	60728(Bridge); 60953(Bridge); 72228(MultiOpen)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction.

ST IF 07S4R	This is Section 4. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 2 of the upstream structure.	60728(Bridge); 60953(Bridge); 72228(MultiOpen)	Intermediate section birdge section.
ST IF 07S4R	This is Section 4. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 2 of the upstream structure.	60728(Bridge); 60953(Bridge); 72228(MultiOpen)	Section 2 of upstream structure.
ST IF 09S2L	This is Section 2. The highest flood frequency that is having low flow or pressure flow is $profilename$. The leftineffective flow elevation, Ineff_El_Left, should be equal to or higher than the WSEL at Section 2. However, the Ineff_El_Left of $ineffell$ at the left ineffective flow station $ineffstal$ is lower than the WSEL of $wsel2$ at Section 2. The Ineff_El_Left should be raised to or above the WSEL at Section 2.	2789(Bridge); 76557(Bridge); 88513(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction.
ST IF 09S2L	This is Section 2. The highest flood frequency that is having low flow or pressure flow is $profilename$. The leftineffective flow elevation, Ineff_El_Left, should be equal to or higher than the WSEL at Section 2. However, the Ineff_El_Left of $ineffell$ at the left ineffective flow station $ineffstal$ is lower than the WSEL of $wsel2$ at Section 2. The Ineff_El_Left should be raised to or above the WSEL at Section 2.	2789(Bridge); 76557(Bridge); 88513(Bridge)	No left ineffective flow at this section.
ST IF 09S3L	This is Section 3. The highest flood frequency that is having low flow or pressure flow is $profilename$. The left ineffective flow elevation, Ineff_El_Left, should be equal to or higher than the WSEL at Section 3. However, the Ineff_El_Left of $ineffell$ at the left ineffective flow station $ineffstal$ is lower than the WSEL of $wsel3$ at Section 3. The computed Left Upstream Minimum Top Road elevation, LMnTpRdU of $lmntprdu$ is higher than the WSEL of $wsel3$ at Section 3. The Ineff_El_Left should be raised to the computed LMnTpRdU.	76701(Bridge); 88899(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction.

ST IF 09S3L	This is Section 3. The highest flood frequency that is having low flow or pressure flow is $profilename$. The left ineffective flow elevation, Ineff_El_Left, should be equal to or higher than the WSEL at Section 3. However, the Ineff_El_Left of $ineffell$ at the left ineffective flow station $ineffstal$ is lower than the WSEL of $wsel3$ at Section 3. The computed Left Upstream Minimum Top Road elevation, LMnTpRdU of $lmntprdu$ is higher than the WSEL of $wsel3$ at Section 3. The Ineff_El_Left should be raised to the computed LMnTpRdU.	76701(Bridge); 88899(Bridge)	No left ineffective flow at this section.
ST IF 10S2L	This is Section 2 of a ($Structure$). More than one set of Left Ineffective Flow Stations were considered. There is only one structure at this location. Multiple Block Ineffective Flow option should not be used unless the area blocked by the ineffective flow stations can be considered non conveyance. cHECk-RAS will only check the ineffective flow elevations adjacent to the structure opening.	56456(Bridge)	Only one left ineffective flow placed.
ST IF 10S2R	This is Section 2 of a ($Structure$). More than one set of Right Ineffective Flow Stations were considered. There is only one structure at this location. Multiple Block Ineffective Flow option should not be used unless the area blocked by the ineffective flow stations can be considered non conveyance. cHECk-RAS will only check the ineffective flow elevations adjacent to the structure opening.	76465(Bridge)	Only one right ineffective flow placed.
ST IF 10S3L	This is Section 3 of a ($Structure$). More than one set of Left Ineffective Flow Stations were considered. There is only one structure at this location. Multiple Block Ineffective Flow option should not be used unless the area blocked by the ineffective flow stations can be considered non conveyance. The cHECk-RAS will only check the ineffective flow elevations adjacent to the structure opening.	88899(Bridge)	No left ineffective flows set at this location.
ST IF 10S3R	This is Section 3 of a ($Structure$). More than one set of Left Ineffective Flow Stations were considered. There is only one structure at this location. Multiple Block Ineffective Flow option should not be used unless the area blocked by the ineffective flow stations can be considered non conveyance. cHECk-RAS will only check the ineffective flow elevations adjacent to the structure opening.	23474(Bridge); 56512(Bridge)	Ineffective flow boundaries are set for floodplain topography, and bridge contraction.

ST IF 10S3R	This is Section 3 of a ($Structure$). More than one set of Left Ineffective Flow Stations were considered. There is only one structure at this location. Multiple Block Ineffective Flow option should not be used unless the area blocked by the ineffective flow stations can be considered non conveyance. cHECk-RAS will only check the ineffective flow elevations adjacent to the structure opening.	23474(Bridge); 56512(Bridge)	No right ineffective flows set at this location.
XS BO 02L	Multiple Block Obstruction. The Flow Code will be MBL. The block obstruction elevation is higher than the left bank elevation. The ground elevation within the block obstruction is lower than the highest discharge WSEL. The block obstruction is not within the block ineffective flow stations. If it is, the ineffective flow elevation is lower than the highest discharge WSEL. This option is suitable to represent individual buildings within the floodway. Compute appropriate "n" values to represent a group of buildings as outlined in (USGS, 1977) or use the Ineffective Flow option.	1227; 1642; 1822; 1854; 1996; 2258; 2653; 36170; 36352; 51449; 52703; 53469; 54351; 55902	Block obstruction used to remove low spots in the topography not conveying flow.
XS CT 03	Maximum number of iterations is $maxnoiter$. It should be the default value of 20.		
XS DC 01	Discharge decreases in the downstream direction for $assignedname$ flood. There are no lateral structures. Documentation of hydrologic analysis is required or provide explanation.	3975; 453; 1838(MultiOpen-UP); 33270(MultiOpen-UP); 35886; 38608; 70494(MultiOpen-UP); 72118(MultiOpen-UP); 78630; 79073(MultiOpen-UP); 83514(MultiOpen-UP); 85873; 321	Flow does not decrease at this location, comment ignored.
XS DC 01	Discharge decreases in the downstream direction for $assignedname$ flood. There are no lateral structures. Documentation of hydrologic analysis is required or provide explanation.	3975; 453; 1838(MultiOpen-UP); 33270(MultiOpen-UP); 35886; 38608; 70494(MultiOpen-UP); 72118(MultiOpen-UP); 78630; 79073(MultiOpen-UP); 83514(MultiOpen-UP); 85873; 321	Flow values correspond to split flow and multiple opening conditions, comment ignored.
XS DC 03	Discharge is different between the upstream side and downstream side of the structure for $assignedname$ flood. They should be the same.	1822; 33208; 70474; 72094; 79055; 83495	Multiple opening structure where in channel flow changes in downstream direction. Q total is consistent.
XS DC 04L	There is no flow on the right overbank at the downstream cross section $presecno$ for the 1%-annual-chance flood. There is no flow on the left overbank at this Section $secno$. Consider placing a cross section in between these sections. The HEC-RAS geometry file may need to be recreated using a GIS program.	3746; 3975; 819; 1342; 1903; 2052	Cross section placed properly, comment ignored.
XS DC 04R	There is no flow on the left overbank at the downstream cross section $presecno$. There is no flow on the right overbank at this Section $secno$ for the 1%-annual-chance flood. Consider placing a cross section in between these sections. The HEC-RAS geometry file may need to be recreated using a GIS program.	3746; 3975; 819; 1342; 1903; 2052	Cross section placed properly, comment ignored.

XS DF 01L	Divided flow. Flow code will be DL. The $assignedname$ flood discharge has a divided flow. The starting and ending stations of the cross section should not extend beyond the watershed boundary of the studied stream. Please review the extent of the cross section. If the cross section extends beyond the watershed boundary then the cross sections need to be trimmed and the HEC-RAS geometry file may need to be recreated using a GIS program. Or use the ineffective flow option, if it has not been considered, to limit the extent of the cross section or to block the divided flow area if it is a local depression.	1642; 1996; 40331; 41084; 47845	Flow divided by high ground, road or railgrade, comment ignored.
XS DF 01R	Divided flow. Flow code will be DR. The $assignedname$ flood discharge has a divided flow. The starting and ending stations of the cross section should not extend beyond the watershed boundary of the studied stream. Please review the extent of the cross section. If the cross section extends beyond the watershed boundary then the cross section needs to be trimmed and the HEC-RAS geometry file may need to be recreated using a GIS program. Or use the ineffective flow option, if it has not been considered, to limit the extent of the cross section or to block the divided flow area if it is a local depression.	26851; 28552; 36516	Flow divided by high ground, road or railgrade, comment ignored.
XS DT 01	Both the right overbank distance of rob and the left overbank distance of lob are longer than the channel distance of chl . Please review the creation of left overbank, channel and right overbank distances. The HEC-RAS geometry file may need to be recreated using a GIS program. Please resolve the differences among the distances.	41164	Flow lengths are correct.
XS DT 02L	The Left overbank distance of lob is greater than the channel distance of chl by more than two times. The Left overbank distance may be in error. Please review the creation of left overbank, channel and right overbank distances. The HEC-RAS geometry file may need to be recreated using a GIS program. Please resolve the differences between the distances.	28606; 79055	Flow lengths are correct.
XS DT 02R	The Right overbank distance of rob is greater than the channel distance of chl by more than two times. The Right overbank distance may be in error. Please review the creation of left overbank, channel and right overbank distances. The HEC-RAS geometry file may need to be recreated using a GIS program. Please resolve the differences between the distances.	33389	Flow lengths are correct.

XS EC 01BDL	Cross section extended vertically. Flow Code willbe ER. The $assignedname$ WSEL of $wsel$ is higher than the starting combined GR and Road station elevation of $grelv$. The Left_Sta_Eff is equal to the starting GR station. Section 2 and/or the Road section should be expanded to cover the $assignedname$ floodplain. The HEC-RAS geometry file may need to be recreated using a GIS program. Or use the lid option at the upstream and downstream internal sections and a lateral weir to determine the amount of overflow down the roadway. Or provide explanation why the cross section should not be expanded.	76500(Bridge-DN)	Flow to the left is ineffective, comment ignored.
XS EC 01L	Cross section extended vertically. Flow Code will be EL. The $assignedname$ WSEL of $wsel$ is higher than the starting GR station elevation of $grelv$. The Left_Sta_Eff is equal to the starting GR station. If there is divided flow then cross section should be trimmed or the ineffective flow station should be used to block the divided flow. If there is no divided flow then the cross section should be expanded to cover the $assignedname$ floodplain.The HEC-RAS geometry file may need to be recreated using a GIS program. Or provide explanation why the cross section should not be expanded.	250; 325; 56; 179; 453; 28981; 35771; 35886; 94; 321	Split flow location, flow is accounted for in neighboring reach.
XS EC 01L	Cross section extended vertically. Flow Code will be EL. The $assignedname$ WSEL of $wsel$ is higher than the starting GR station elevation of $grelv$. The Left_Sta_Eff is equal to the starting GR station. If there is divided flow then cross section should be trimmed or the ineffective flow station should be used to block the divided flow. If there is no divided flow then the cross section should be expanded to cover the $assignedname$ floodplain.The HEC-RAS geometry file may need to be recreated using a GIS program. Or provide explanation why the cross section should not be expanded.	250; 325; 56; 179; 453; 28981; 35771; 35886; 94; 321	XS placed to accurately represent US face of bridge, comment ignored

XS EC 01R	Cross section extended vertically. Flow Code will be ER. The $assignedname$ WSEL of $wsel$ is higher than the ending GR station elevation of $grelv$. The Rght_Sta_Eff is equal to the ending GR station. If there is divided flow then the cross section should be trimmed or the ineffective flow station should be used to block the divided flow. If there is no divided flow then the cross section should be expanded to cover the $assignedname$ floodplain. The HEC-RAS geometry file may need to be recreated using a GIS program. Or provide explanation why the cross section should not be expanded.	325; 28922; 78396; 78630; 85584; 85873	Split flow location, flow is accounted for in neighboring reach.
XS EC 01R	Cross section extended vertically. Flow Code will be ER. The $assignedname$ WSEL of $wsel$ is higher than the ending GR station elevation of $grelv$. The Rght_Sta_Eff is equal to the ending GR station. If there is divided flow then the cross section should be trimmed or the ineffective flow station should be used to block the divided flow. If there is no divided flow then the cross section should be expanded to cover the $assignedname$ floodplain. The HEC-RAS geometry file may need to be recreated using a GIS program. Or provide explanation why the cross section should not be expanded.	325; 28922; 78396; 78630; 85584; 85873	XS placed to accurately represent US face of bridge, comment ignored
XS FS 01	The name of the stream is $streamname$. $frictionslopename$ method was used. The Average Conveyance method should be selected.		
XS GD 01	'Cross Section Lid' option is used for this section. Instead, the bridge or culvert option should be used. Cross Section Lid option may be used to model small obstructions, such as, pipe crossing or if the type of flow through the lid sections and the main stream is in super critical flow, or if there is lateral weir flow between Sections 3 and 2 of a structure.	104; 11374; 89182	Pipeline/Flume, comment ignored
XS GD 01	'Cross Section Lid' option is used for this section. Instead, the bridge or culvert option should be used. Cross Section Lid option may be used to model small obstructions, such as, pipe crossing or if the type of flow through the lid sections and the main stream is in super critical flow, or if there is lateral weir flow between Sections 3 and 2 of a structure.	104; 11374; 89182	Used to illustrate Railroad deck elevation, contraction is minimal and does not approach overtopping. Bridge has little affect and is strictly for illustrative purposes.

XS IF 01L	Flow code will be IL. The area left of the ineffective flow station may be considered effective. The $assignedname$ WSEL of $wsel$ is higher than the ground elevation $grelv$ of the Left Ineffective Flow Station. However, it is equal to or lower than the left ineffective flow elevation of $ineffell$. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area left of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area left of the ineffective flow station is non conveyance.	28375; 36170; 36352; 60549; 71345; 72228; 76390	Area left of ineffective is non conveyance area.
XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The $assignedname$ WSEL of $wsel$ is higher than the ground elevation $grelv$ of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of $ineffelr$. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	2952; 3058; 40331; 60549; 60953; 65329; 71972	Area left of ineffective is non conveyance area.
XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The $assignedname$ WSEL of $wsel$ is higher than the ground elevation $grelv$ of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of $ineffelr$. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	2952; 3058; 40331; 60549; 60953; 65329; 71972	Area right of ineffective is non conveyance area.

XS IF 02L	Flow code will be MIL. Multiple (block) Ineffective Stations are selected for the left overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please explain why the multiple blocks ineffective flow option was used. Consider using the normal ineffective flow option.	2720; 1822; 1854; 2653; 12841; 15510; 17675; 26148; 26221; 26308; 31077; 36683; 41978; 44198; 44896; 45586; 46642; 48882; 52168; 52703; 53469; 55171; 55902; 56512; 58866; 62761; 70345; 76465; 79055; 79091; 80566; 81281; 81670; 83495; 83543	Multiple ineffective depressions or areas of non conveyance at different elevations.
XS IF 02R	Flow code will be MIR. Multiple (block) Ineffective Stations are selected for the right overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please justify why the Multiple Blocks Ineffective Flow option was used. Consider using the normal Ineffective Flow option.	-141; 1822; 1854; 2258; 2653; 3917; 37394; 41978; 44198; 45586; 46642; 47845; 48882; 52168; 53469; 55902; 56456; 59417; 60154; 62008; 70345; 70474; 70521; 72094; 72139; 72228; 82965; 83495; 83543; 83638; 84280; 88899; 90215	Multiple ineffective depressions or areas of non conveyance at different elevations.
XS IF 02R	Flow code will be MIR. Multiple (block) Ineffective Stations are selected for the right overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please justify why the Multiple Blocks Ineffective Flow option was used. Consider using the normal Ineffective Flow option.	-141; 1822; 1854; 2258; 2653; 3917; 37394; 41978; 44198; 45586; 46642; 47845; 48882; 52168; 53469; 55902; 56456; 59417; 60154; 62008; 70345; 70474; 70521; 72094; 72139; 72228; 82965; 83495; 83543; 83638; 84280; 88899; 90215	Multiple ineffective depressions or areas of non conveyance at different elevations..
XS JT 01	The Junction option is used. For Flood Insurance Studies, this option should be used if the tributary and main stream can have coincident peaks. It is appropriate to use for approximate-studied streams; if the discharges at different time periods are known from the rainfall-runoff model; for loop analysis; and for unsteady flow analysis. The Junction should be removed if the above conditions are not satisfied. Refer to the Help section for information on how to remove a Junction. Sample XS JT 01 HEC-RAS files can be downloaded from http://www.fema.gov/library/viewRecord.do?id=2300 under the Cross Section Check Data Sets section.		
XS JT 02	The name of the junction is $junctionname$. The length from the $riverreach1$ to the $riverreach2$ is equal to zero. Please insert the length across the junction in the Junction Data window in HEC-RAS if the junction can be considered.		

cHECk-RAS Report

HEC-RAS Project:	*silverbowcreek.prj*
Plan File:	*silverbowcreek.p01*
Geometry File:	*silverbowcreek.g07*
Flow File:	*silverbowcreek.f01*
Report Date:	*5/9/2019*

Message ID	Message	Cross sections affected	Comments
BR LW 01	This is a Bridge Section. The selected profile is $profilename$. Type of flow is low and weir flow because, 1. EGEL 3 of $egel3$ is greater than MinTopRd of $minelweirflow$. 2. EGEL 3 of $egel3$ is less than MxLoCdU of $mxlocdu$.	70494(MultiOpen-UP); 83514(MultiOpen-UP)	
BR PF 04	This is a Bridge Section. Input BrSelMthd is Press/Weir. The highest flood frequency profile is $profilename$. Type of flow is sluice gate pressure flow only. However, the highest flood frequency CritWS of $critws$at BR U is less than or equal to the WSEL of $wsel$ at BR U. Energy should be selected as the High Flow Method.	191(Culvert-UP)	There are (4) culverts at this location, (3) of which are under pressure flow.
BR PW 02	This is a Bridge Section. The selected profile is $profilename$. Type of flow is submerged pressure and weir flow because, 1. EGEL 3 of $egel3$ is greater than MinTopRd of $minelweirflow$. 2. EGEL 3 of $egel3$ is equal to or greater than MxLoCdU of $mxlocdu$. 3. WSEL 2 of $wsel2$ is equal to or greater than MxLoCdD of $mxlocdd$.	1838(MultiOpen-UP); 26193(Culvert-UP); 27685(Culvert-UP); 38482(Culvert-UP); 41051(Culvert-UP); 56489(Bridge-UP)	

FW EM 01	The Floodway encroachment method is not selected at this river station. The Encroachment Method should be inserted from the Steady Flow Analysis window under Options.	69; 104; 132; 250; 325; 2052; 2491; 2847; 3121; 3746; 3975; 118; 819; 1342; 1903; 56; 179; 202; 453; -141; 0; 774; 1227; 1642; 1996; 2258; 2653; 2952; 3058; 3304; 3917; 4758; 5190; 5498; 6136; 6481; 6792; 7076; 7120; 7591; 8102; 8947; 9165; 9446; 10138; 10519; 10959; 11313; 11374; 11434; 11560; 11602; 11944; 12184; 12644; 12841; 13199; 13431; 13910; 14439; 15165; 15510; 15835; 16187; 16561; 16922; 17675; 18357; 19162; 19518; 20061; 20639; 20775; 21180; 21420; 21807; 22054; 22579; 23328; 23587; 24336; 24690; 24922; 25514; 26025; 26308; 26851; 27530; 28038; 28375; 28606; 28804; 29087; 30230; 31077; 31886; 32457; 33083; 33389; 34097; 35079; 35670; 35771; 35886; 36170; 36352; 36683; 37394; 38085; 38324; 38823; 39482; 40331; 40841; 41164; 41978; 43145; 44198; 44896; 45586; 46642; 47845; 48882; 49807; 50997; 51449; 51916; 52168; 52703; 53469; 54351; 55171; 55902; 56370; 56569; 57380; 58246; 58866; 59417; 60154; 60549; 60953; 61402; 62008; 62761; 63427; 64068; 64653; 65189; 65329; 65628; 65781; 66531; 67248; 68086; 68902; 69751; 70345; 70596; 70932; 71345; 71572; 71972; 72228; 72420; 72779; 73754; 74873; 75786; 76390; 76850; 77426; 77953; 78257; 78396; 78630; 78764; 78974; 79154; 79558; 79829; 80566; 81281; 81670; 82283; 82965; 83417; 83638; 84280; 84962; 85584; 85615; 85873; 86027; 86550; 87244; 87789; 88355; 88995; 89182; 89287; 89421; 89951; 90215; 94; 321	Floodway encroachment only performed between station 0 to 6,705, 51,638 to 56,561 and 66,069 to 78,269.
FW FW 03L	The left channel bank elevation of $lobelev$ is higher than the 1-percent-annual-chance WSEL of $wsel$. Relocate the left channel bank station at or below the 1-percent-annual-chance WSEL. Do not place the bank stations at the bottom of the channel. Do not place the bank stations at the low flow channel. Use the Horizontal Variation in "n" Values option in HEC-RAS to assign different "n" values to the left bank slope, low flow channel, and the right bank slope. Let HEC-RAS compute the composite "n" value based on the depth of flow.	2052; 2491; 2847; 3121; 3746; 3975; 118; 819; 1342; 1903; 179; 202	Railroad split is a secondary channel between two railgrades, the "n" value is consistent throughout.

FW FW 03L	The left channel bank elevation of $lobelev$ is higher than the 1-percent-annual-chance WSEL of $wsel$. Relocate the left channel bank station at or below the 1-percent-annual-chance WSEL. Do not place the bank stations at the bottom of the channel. Do not place the bank stations at the low flow channel. Use the Horizontal Variation in "n" Values option in HEC-RAS to assign different "n" values to the left bank slope, low flow channel, and the right bank slope. Let HEC-RAS compute the composite "n" value based on the depth of flow.	2052; 2491; 2847; 3121; 3746; 3975; 118; 819; 1342; 1903; 179; 202	Santa Claus Rd is a secondary channel without defined banks, the "n" value is consistent throughout.
FW FW 03R	The right channel bank elevation of $robelev$ is higher than the 1-percent annual chance WSEL of $wsel$. Relocate the right channel bank station at or below the 1-percent annual chance WSEL. Do not place the bank stations at the bottom of the channel. Do not place the bank stations at the low flow channel. Use the Horizontal Variation in "n" Values option in HEC-RAS to assign different "n" values to the left bank slope, low flow channel, and the right bank slope. Let HEC-RAS compute the composite "n" value based on the depth of flow.	2052; 2491; 2847; 3121; 3746; 3975; 118; 819; 1342; 1903; 202	Railroad split is a secondary channel between two railgrades, the "n" value is consistent throughout.
FW ST 01S2	This is Section 2 of a hydraulic structure. The Encroachment Method was not specified at this River Station. For Flood Insurance Studies, Encroachment Methods 4 and 1 should be used.	160; 2638; 276; 1822; 2789; 6940; 9280; 10272; 19287; 23406; 24801; 26148; 27651; 27769; 28439; 28922; 33208; 36457; 38457; 38527; 38637; 41000; 56082; 56152; 56456; 60588; 60728; 65436; 65968; 70474; 71186; 72094; 76465; 76557; 78445; 79055; 83495; 85696; 88513; 89510; 178	Method 4 or 1 were used at all cross sections floodway study reaches.
FW ST 01S3	This is Section 3 of a hydraulic structure. The Encroachment Method was not specified at this River Station. For Flood Insurance Studies, Encroachment Methods 4 and 1 should be used.	229; 2720; 359; 1854; 2896; 7020; 9337; 10391; 19408; 23474; 24843; 26221; 27719; 27832; 28552; 28981; 33325; 36516; 38608; 38702; 41084; 56199; 56263; 56512; 60672; 60793; 60856; 65508; 66267; 70521; 71266; 72139; 76534; 76701; 78562; 79091; 83543; 85782; 88899; 89707; 286	Method 4 or 1 were used at all cross sections floodway study reaches.
FW ST 03BDR	This is ($strucname$) Downstream Internal Section. The right encroachment station is within the structure opening area. The right station effective of $ineffstar$ for the 1-percent-annual-chance profile is greater than the right abutment station of $abutstar$. The 1-percent-annual-chance floodplain is outside the structure opening. The right encroachment station of $encstar$ is less than the right abutment station of $abutstar$. Enc_Sta_R should be relocated outside of the structure opening area.	1838(MultiOpen-DN)	Bridge embnakment does not contain flow, comment ignored.

FW ST 03BUL	This is ($strucname$) Upstream Internal Section. The left encroachment station is within the structure opening area. The left station effective of $ineffstal$ for the 1-percent-annual-chance profile is less than the left abutment station of $abutstal$. The 1-percent-annual-chance floodplain is outside the structure opening. The left encroachment station of $encstal$ is greater than the left abutment station of $abutstal$. Enc_Sta_L should be relocated outside of the structure opening area.	66103(Bridge-UP)	Interstate 15 Bridge, bridge opening does not affect flow, comment ignored.
FW ST 03S2R	This is Section 2 of a hydraulic structure. The right encroachment station is within the structure opening area. The right station effective of $ineffstar$ for the 1%-annual-chance profile is greater than the right most abutment station of $abutstar$. The 1%-annual-chance floodplain is outside the structure opening. The right encroachment station of $encstar$ is less than the right most abutment station of $abutstar$. Enc_Sta_R should be relocated oustide of the structure opening area.	1822	Bridge embnakment does not contain flow, comment ignored.
FW ST 03S3R	This is Section 3 of a hydraulic structure. The right encroachment station is within the structure opening area. The right station effective of $ineffstar$ for the 1%-annual-chance profile is greater than the right most abutment station of$abutstar$. The 1%-annual-chance floodplain is outside the structure opening. The right encroachment station of $encstar$ is less than the right most abutment station of $abutstar$. Enc_Sta_R should be relocated outside of the structure opening area.	1854(MultiOpen-UP)	Bridge embnakment does not contain flow, comment ignored.
MP SW 01DD	The name of the stream is ($streamname$). The flow regime is subcritical or mixed flow. The downstream starting water-surface elevation, SWSEL, is computed from different methods.		
MS IF 01S2L	This is Section 2 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 2. The Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	1838(MultiOpen); 33270(MultiOpen); 70494(MultiOpen); 72118(MultiOpen); 79073(MultiOpen); 83514(MultiOpen)	Multiple block ineffectives are used correctly. Comment ignored

MS IF 01S2R	This is Section 2 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 2. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 the Applications Guide (HEC, 2010).	1838(MultiOpen); 33270(MultiOpen); 70494(MultiOpen); 72118(MultiOpen); 79073(MultiOpen); 83514(MultiOpen)	Multiple block ineffectives are used correctly. Comment ignored
MS IF 01S3L	This is Section 3 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be equal to $LMnTpRdU$. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	1838(MultiOpen); 33270(MultiOpen); 70494(MultiOpen); 72118(MultiOpen); 79073(MultiOpen); 83514(MultiOpen)	Multiple block ineffectives are used correctly. Comment ignored
MS IF 01S3R	This is Section 3 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be equal to $RMnTpRdU$. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	1838(MultiOpen); 33270(MultiOpen); 70494(MultiOpen); 72118(MultiOpen); 79073(MultiOpen); 83514(MultiOpen)	Multiple block ineffectives are used correctly. Comment ignored

NT RC 01L	All of the left overbank Manning’s "n" values are less than 0.030. The "n" values for the overbank areas are usually larger than 0.030 (Chow, 1959, page 113). The "n" value(s) should be re-evaluated. Follow the procedure outlined to compute the overbank "n" value(s) for a natural floodplain (FHWA, 1984). Or follow the procedure outlined to compute the "n" values for urban development (USGS, 1977). Please submit supporting information on the evaluation of the "n" values.	104; 2491; 2638; 2674(Culvert-DN); 2674(Culvert-UP); 2720; 2847; 3121; 3746; 819; 1342; 1903; 2052; 118; 0; 774; 1227; 1642; 1822; 1838(MultiOpen-DN); 4758; 6136; 6481; 6792; 6940; 6992(InlineWeir-DN); 6992(InlineWeir-UP); 7020; 7076; 7120; 7591; 8102; 10519; 10959; 11313; 11374; 11434; 11560; 11602; 11944; 12184; 12644; 12841; 13199; 13431; 13910; 14439; 15165; 15510; 15835; 16187; 16922; 17675; 19162; 23461(Bridge-UP); 23474; 23587; 24336; 24690; 24801; 24829(Bridge-DN); 24829(Bridge-UP); 24843; 24922; 25514; 26025; 26148; 26193(Culvert-DN); 26193(Culvert-UP); 26221; 26308; 26851; 27530; 27651; 27685(Culvert-DN); 27685(Culvert-UP); 27719; 27739(Bridge-DN); 27739(Bridge-UP); 27769; 27801(Bridge-DN); 27801(Bridge-UP); 27832; 28038; 28498(Bridge-UP); 28552; 28922; 28959(Bridge-DN); 29087; 30230; 31077; 31886; 32457; 33083; -141; 34097; 35079; 36170; 36352; 36457; 36486(Bridge-DN); 36486(Bridge-UP); 36516; 36683; 37394; 56199; 56370; 56456; 56489(Bridge-DN); 56489(Bridge-UP); 56512; 56569; 57380; 58246; 58866; 59417; 60154; 60549; 60588; 60622(Bridge-DN); 60763(Bridge-UP); 60793; 60822(Bridge-DN); 61402; 62008; 62761; 63427; 64068; 64653; 65189; 65329; 65436; 65478(Bridge-DN); 65478(Bridge-UP); 65508; 65628; 65781; 65968; 66103(Bridge-DN); 66103(Bridge-UP); 66267; 66531; 68086; 68902; 69751; 70474; 70494(MultiOpen-DN); 70596; 70932; 71186; 71231(Bridge-DN); 71231(Bridge-UP); 71266; 71345; 71572; 71972; 72094; 72118(MultiOpen-DN); 72118(MultiOpen-UP); 72139; 72228; 72420; 72779; 73754; 74873; 75786; 76465; 76500(Bridge-DN); 76605(Bridge-UP); 76701; 76850; 77426; 77953; 78257; 78445; 78491(Culvert-DN); 78491(Culvert-UP); 78562; 78630; 78764; 78974; 79055; 79073(MultiOpen-DN); 79073(MultiOpen-UP); 79091; 79154; 79558; 79829; 80566; 81281; 81670; 82283; 82965; 83417; 83495; 83514(MultiOpen-DN); 83514(MultiOpen-UP); 83543; 83638; 84280; 84962; 78396; 85615; 85696; 85733(Culvert-DN); 85733(Culvert-UP); 85782; 85873; 86027; 86550; 87244; 87789; 88355; 88513; 88739(Bridge-DN); 88739(Bridge-UP); 88899; 88995; 89182; 89287; 89421; 89510; 89563(Bridge-DN); 89707; 89951; 90215; 85584	Not all overbank values are less than 0.030 only roads (0.02) and standing water (0.028). Comment ignored.

NT RC 01R	All of the right overbank "n" values are less than 0.030. Manning’s "n" values for the overbank areas are usually larger than 0.030 (Chow, 1959, page 113). The "n" value(s) should be re-evaluated. Follow the procedure on pages 17 and 54 of (FHWA, 1984) to compute the overbank "n" value for the natural floodplain. Or follow the procedure in (USGS, 1977) to compute the "n" value for urban development. Please submit supporting information on the evaluation of "n" value.	2491; 2638; 2674(Culvert-DN); 2720; 2847; 3121; 3746; 819; 1342; 1903; 2052; 118; 0; 774; 1227; 1642; 1822; 1838(MultiOpen-DN); 1838(MultiOpen-UP); 1854; 1996; 2258; 2653; 2789; 2846(Bridge-DN); 2952; 3058; 3304; 3917; 4758; 5190; 6136; 6481; 7076; 7120; 7591; 8102; 8947; 9165; 9280; 9304(Bridge-DN); 9304(Bridge-UP); 9337; 9446; 10138; 10519; 10959; 11313; 11374; 11434; 11560; 11602; 11944; 12184; 12644; 12841; 13199; 13431; 13910; 14439; 15165; 15510; 15835; 17675; 18357; 19162; 19518; 20061; 20639; 21420; 21807; 22054; 22579; 23328; 23474; 23587; 24336; 24690; 24801; 24829(Bridge-UP); 24843; 24922; 25514; 26025; 26148; 26193(Culvert-DN); 26193(Culvert-UP); 26221; 27685(Culvert-UP); 27719; 27739(Bridge-DN); 27739(Bridge-UP); 27769; 27801(Bridge-DN); 28038; 28375; 28439; 28498(Bridge-DN); 28498(Bridge-UP); 28552; 28606; 28804; 29087; 30230; 31077; 31886; 32457; 33083; -141; 36486(Bridge-UP); 36516; 36683; 37394; 38085; 38324; 38823; 39482; 40331; 40841; 41000; 41051(Culvert-DN); 44198; 44896; 45586; 46642; 47845; 48882; 49807; 50997; 51449; 54351; 55171; 55902; 56152; 56199; 56370; 56456; 56489(Bridge-DN); 58866; 59417; 60763(Bridge-UP); 60793; 60822(Bridge-DN); 61402; 62008; 62761; 63427; 64068; 64653; 65189; 65329; 65436; 65478(Bridge-DN); 65478(Bridge-UP); 65508; 65628; 65781; 65968; 66103(Bridge-DN); 66103(Bridge-UP); 66267; 66531; 67248; 68086; 68902; 70345; 70474; 70494(MultiOpen-DN); 70494(MultiOpen-UP); 70521; 70596; 70932; 71186; 71231(Bridge-DN); 71231(Bridge-UP); 71266; 71345; 71972; 72094; 72118(MultiOpen-DN); 74873; 76500(Bridge-UP); 76534; 76557; 76605(Bridge-DN); 76605(Bridge-UP); 76701; 76850; 77426; 77953; 78257; 78764; 78974; 79055; 79073(MultiOpen-DN); 79073(MultiOpen-UP); 79091; 79154; 79558; 80566; 81281; 81670; 82283; 83495; 83514(MultiOpen-DN); 83514(MultiOpen-UP); 83543; 83638; 84280; 88355; 88739(Bridge-UP); 88899; 89707; 89951; 90215; 94	Not all overbank values are less than 0.030 only roads (0.02) and standing water (0.028). Comment ignored.

NT RC 03C	All of the channel "n" values are equal to or less than 0.025. The "n" value of the channel is usually greater than 0.025. The "n" values or the Channel Bank stations should be re-evaluated. Select the Channel Bank stations to include bank slopes and low flow channel to represent a confined cross section. Channel Bank stations must not be placed at the banks of the low flow channel, at the bottom of the channel, or above the 1%-annual-chance water-surface elevation. Let HEC-RAS compute the composite "n" values by using the Horizontal Variation in "n" Values option within the channel (HEC, 2010, HEC-RAS Reference Manual, page 2-6). Or follow the procedure on pages 9 and 52 of (FHWA, 1984) to compute the total channel "n" value. Please submit supporting information on the evaluation of "n" value.	2674(Culvert-DN); 24829(Bridge-DN); 24829(Bridge-UP)	Channel n value = 0.042
NT RC 05	The left overbank n-value of $nlob$ and the right overbank n-value of $nrob$ are less than or equal to the channel n-value of nch. Follow the procedure in (FHWA, 1984) to compute the n-value for the natural floodplain and the channel. Or follow the procedure in (USGS, 1977) to compute the n-value for urban development. Please submit supporting information on the evaluation of n-values.	2491; 2638; 2674(Culvert-DN); 2720; 2847; 3121; 3746; 819; 1342; 1903; 2052; 118; 24829(Bridge-UP); 27739(Bridge-UP); 27769; 27801(Bridge-DN); 56152; 56199; 60793; 89287	0.02 corresponds to roads on the outside of the banks, comment ignored
NT RS 02BDC	This is the Downstream Bridge Section (BRD). The channel n value of $chldn$ for the downstream internal bridge opening section is equal to or larger than the channel n value of $chl2$ at Section 2. Usually, the channel "n" value of the bridge opening section represents the area below the bridge deck and is less than the channel "n" value of Section 2. The "n" value for Section 2 represents the natural valley channel section roughness for the reach between Section 3 and Section 4. Please change the "n" value of the internal bridge opening section or provide supporting information for the use of the higher "n" value.	2846(Bridge-DN); 9304(Bridge-DN); 19346(Bridge-DN); 23461(Bridge-DN); 27739(Bridge-DN); 27801(Bridge-DN); 28498(Bridge-DN); 36486(Bridge-DN); 38567(Bridge-DN); 38669(Bridge-DN); 56489(Bridge-DN); 60622(Bridge-DN); 65478(Bridge-DN); 66103(Bridge-DN); 71231(Bridge-DN); 76500(Bridge-DN); 76605(Bridge-DN); 88739(Bridge-DN); 89563(Bridge-DN)	Channel n value is consistent through bridge, comment ignored

NT RS 02BUC	This is the Upstream Bridge Section (BRU). The channel n value of $chlup$ for the upstream internal bridge opening section is equal to or larger than the channel n value of $chl3$ at Section 3. Usually, the channel "n" value of the bridge opening section represents the area below the bridge deck and is less than the channel "n" value of Section 3. The "n" value for Section 3 represents the natural valley channel section roughness for the reach between Section 3 and Section 4. Please change the "n" value of the internal bridge opening section or provide supporting information for the use of a higher "n" value.	2846(Bridge-UP); 9304(Bridge-UP); 10314(Bridge-UP); 19346(Bridge-UP); 27739(Bridge-UP); 27801(Bridge-UP); 28498(Bridge-UP); 36486(Bridge-UP); 38567(Bridge-UP); 56489(Bridge-UP); 60822(Bridge-UP); 65478(Bridge-UP); 66103(Bridge-UP); 71231(Bridge-UP); 76500(Bridge-UP); 76605(Bridge-UP); 88739(Bridge-UP)	Channel n value is consistent through bridge, comment ignored
NT TL 01S2	This is Section2 of a hydraulic structure. The contraction and expansion loss coefficients are cc and ce. They should be equal to 0.3 and 0.5, respectively, for typical structure sections according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	9280; 36457; 38637; 60588; 70474; 72094; 88513; 89510	Higher coefficients used to better represent hydraulics, comment ignored
NT TL 01S3	This is Section3 of a hydraulic structure. The contraction and expansion loss coefficients are cc and ce. They should be equal to 0.3 and 0.5, respectively, for typical structure sections according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	2896; 9337; 10391; 76701	Higher coefficients used to better represent hydraulics, comment ignored
NT TL 01S4	This is Section 4 of a hydraulic structure. The contraction and expansion loss coefficients are cc and ce. They should be equal to 0.3 and 0.5, respectively according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010)..	79154	Higher coefficients used to better represent hydraulics, comment ignored
NT TL 02	Contraction and expansion loss coefficients are cc and ce, respectively. However, this cross section is not at a hydraulic structure. They should be equal to 0.1 and 0.3 according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	7120; 33208	Higher coefficients used to better represent hydraulics, comment ignored
ST DT 01B	This is ($strucname$). 'Upstream Dist' of $distup$ in "Bridge Width Table" is less than the height of the bridge opening of $height$. This indicates that Section 3 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 3 should be relocated or provide a statement that it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 4, 3 and 2 and 'Upstream Dist' should be adjusted.	23461(Bridge-UP); 56220(Bridge-UP)	SilverBowCreekSilverBow Creek-256220Bridge-UPSTRUCTURE CHECKST DT 01BThis is (Bridge-UP). Upstream Dist of 5.28 in "Bridge Width Table" is less than the height of the bridge opening of 11.66. This indicates that Section 3 may not be placed at the

ST DT 01B	This is ($strucname$). 'Upstream Dist' of $distup$ in "Bridge Width Table" is less than the height of the bridge opening of $height$. This indicates that Section 3 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 3 should be relocated or provide a statement that it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 4, 3 and 2 and 'Upstream Dist' should be adjusted.	23461(Bridge-UP); 56220(Bridge-UP)	Channel takes severe right angle US&DS of bridge, XS were placed upstream as far as possible w/out being placed in channel, comment ignored.
ST DT 01C	This is ($strucname$). 'Distance to Upstrm XS' of $distup$ in 'Culvert Data Editor' window is less than the height of the culvert opening of $height$. This indicates that Section 3 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 3 should be relocated or provide a statement that it represents the natural valley cross section. A HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 4, 3 and 2 and 'Distance to Upstrm XS' should be adjusted.	26193(Culvert-UP)	XS placed at foot of embankment, comment ignored.
ST DT 02B	This is ($strucname$). 'Downstream Dist' of $distdn$ in 'Bridge Width Table' is less than the height of the bridge opening of $height$. This indicates that Section 2 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 2 should be relocated or provide a statement that it represents the natural valley cross section. A HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 3 and 2 should be adjusted.	27739(Bridge-DN); 56183(Bridge-DN); 89563(Bridge-DN)	Placed between multiple bridges, comment ignored.
ST DT 02C	This is ($strucname$). The culvert downstream distance, $distdn$ is equal to Length_Chnl at Section 3 minus (DistanceUp + CulvertLength). The culvert downstream distance of $distdn$ is less than the height of the culvert opening of $height$. This indicates that Section 2 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 2 should be relocated or provide a statement that it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 3 & 2 should be adjusted.	2674(Culvert-DN); 308(Culvert-DN); 78491(Culvert-DN)	XS placed at foot of embankment, comment ignored

ST DT 02C	This is ($strucname$). The culvert downstream distance, $distdn$ is equal to Length_Chnl at Section 3 minus (DistanceUp + CulvertLength). The culvert downstream distance of $distdn$ is less than the height of the culvert opening of $height$. This indicates that Section 2 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 2 should be relocated or provide a statement that it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 3 & 2 should be adjusted.	2674(Culvert-DN); 308(Culvert-DN); 78491(Culvert-DN)	XS placed at foot of embankment, comment ignored.
ST DT 03	This is ($Structure$) section. The Contraction Length is longer than the Expansion Length. Section 4 channel distance of $Length_Chnl4$ is longer than Section 2 channel distance of $Length_Chnl2$. Section 4 and Section 1 should be relocated. The HEC-RAS geometry file may need to be recreated using a GIS program.	308(Culvert-UP); 23461(Bridge-UP); 27685(Culvert-UP); 27739(Bridge-UP); 27801(Bridge-UP); 36486(Bridge-UP); 38669(Bridge-UP); 56183(Bridge-UP); 56220(Bridge-UP); 60622(Bridge-UP); 60763(Bridge-UP); 60822(Bridge-UP); 65478(Bridge-UP); 66103(Bridge-UP); 76605(Bridge-UP); 78491(Culvert-UP); 85733(Culvert-UP); 89563(Bridge-UP)	Additional cross sections capture Contr/Exp. comment ignored.
ST DT 03	This is ($Structure$) section. The Contraction Length is longer than the Expansion Length. Section 4 channel distance of $Length_Chnl4$ is longer than Section 2 channel distance of $Length_Chnl2$. Section 4 and Section 1 should be relocated. The HEC-RAS geometry file may need to be recreated using a GIS program.	308(Culvert-UP); 23461(Bridge-UP); 27685(Culvert-UP); 27739(Bridge-UP); 27801(Bridge-UP); 36486(Bridge-UP); 38669(Bridge-UP); 56183(Bridge-UP); 56220(Bridge-UP); 60622(Bridge-UP); 60763(Bridge-UP); 60822(Bridge-UP); 65478(Bridge-UP); 66103(Bridge-UP); 76605(Bridge-UP); 78491(Culvert-UP); 85733(Culvert-UP); 89563(Bridge-UP)	Multiple bridge location, cross sections placed accordingly, comment ignored.
ST DT 03	This is ($Structure$) section. The Contraction Length is longer than the Expansion Length. Section 4 channel distance of $Length_Chnl4$ is longer than Section 2 channel distance of $Length_Chnl2$. Section 4 and Section 1 should be relocated. The HEC-RAS geometry file may need to be recreated using a GIS program.	308(Culvert-UP); 23461(Bridge-UP); 27685(Culvert-UP); 27739(Bridge-UP); 27801(Bridge-UP); 36486(Bridge-UP); 38669(Bridge-UP); 56183(Bridge-UP); 56220(Bridge-UP); 60622(Bridge-UP); 60763(Bridge-UP); 60822(Bridge-UP); 65478(Bridge-UP); 66103(Bridge-UP); 76605(Bridge-UP); 78491(Culvert-UP); 85733(Culvert-UP); 89563(Bridge-UP)	XS placed just outside of 90 degree bend to keep cross section overbanks out of channel, comment ignored.
ST GD 02BD	This is the Downstream Bridge Section. There is only one bridge. However, the low cord line crosses the ground line at more than two locations. The ground and deck/roadway data should be checked.	2846(Bridge); 9304(Bridge); 10314(Bridge); 19346(Bridge); 23461(Bridge); 24829(Bridge); 27739(Bridge); 27801(Bridge); 28498(Bridge); 28959(Bridge); 36486(Bridge); 38567(Bridge); 38669(Bridge); 56127(Bridge); 56183(Bridge); 56220(Bridge); 56489(Bridge); 60622(Bridge); 60763(Bridge); 60822(Bridge); 65478(Bridge); 66103(Bridge); 71231(Bridge); 76500(Bridge); 76605(Bridge); 88739(Bridge); 89563(Bridge); 223(Bridge)	Ground and Roadway Data checked no issues found, comment ignored

ST GD 02BU	This is the Upstream Bridge Section. There is only one bridge. However, the low cord line crosses the ground line at more than two locations. The ground and deck/roadway data should be checked.	2846(Bridge); 9304(Bridge); 10314(Bridge); 19346(Bridge); 23461(Bridge); 24829(Bridge); 27739(Bridge); 27801(Bridge); 28498(Bridge); 28959(Bridge); 36486(Bridge); 38567(Bridge); 38669(Bridge); 56127(Bridge); 56183(Bridge); 56220(Bridge); 56489(Bridge); 60622(Bridge); 60763(Bridge); 60822(Bridge); 65478(Bridge); 66103(Bridge); 71231(Bridge); 76500(Bridge); 76605(Bridge); 88739(Bridge); 89563(Bridge); 223(Bridge)	Ground and Roadway Data checked no issues found, comment ignored
ST GD 03S2	This is Section 2. The highest flood frequency that has weir flow is $Assigned_Name$. All the ineffective flow elevations at Section 2 are lower than the water-surface elevation at Section 2. The velocity head at Section 2 is more than 0.5 foot and more than the velocity head at Section 1. Section 2 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	38482(Culvert)	Section 2 represents the natural valley cross section, comment ignored
ST GD 05S1	This is Section 1. 'Cross Section Lid' option is used for this section. 'Cross Section Lid' data must be removed from this section, unless the structure is modeled as culverts in series.	89421(Bridge)	Cross Section Lid is used to model a flume and does not affect the studied flow, comment ignored.
ST GD 06	Left and/or right abutment station computed by the cHECk-RAS program is equal to zero. cHECk-RAS cannot evaluate this structure.	223(Bridge)	Modeled correctly, comment ignored.
ST IF 01S2L	This is Section 2 of a hydraulic structure. The highest flood frequency that has low or pressure flow is $profilename$. However, the Left Ineffective Flow station was not considered at Section 2. The ineffective flow station and elevation should be inserted. The left ineffective flow elevation should be equal to wsel2 of $wsel$. The placement of the left ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	56183(Bridge); 56220(Bridge); 60822(Bridge); 76605(Bridge); 88739(Bridge); 89563(Bridge); 223(Bridge)	Flow is not constricted by bridge geometry at this location, comment ignored
ST IF 01S2L	This is Section 2 of a hydraulic structure. The highest flood frequency that has low or pressure flow is $profilename$. However, the Left Ineffective Flow station was not considered at Section 2. The ineffective flow station and elevation should be inserted. The left ineffective flow elevation should be equal to wsel2 of $wsel$. The placement of the left ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	56183(Bridge); 56220(Bridge); 60822(Bridge); 76605(Bridge); 88739(Bridge); 89563(Bridge); 223(Bridge)	Ineffective flow is correctly assigned, comment ignored

ST IF 01S2R	This is Section 2 of a hydraulic structure. The highest flood frequency that has low or pressure flow is $profilename$. However, the Right Ineffective Flow Station was not considered at Section 2. The ineffective flow station and elevation should be inserted. The right ineffective flow elevation should be equal to wsel2 of $wsel$. The placement of the right ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	56183(Bridge); 56220(Bridge); 60822(Bridge); 89563(Bridge); 223(Bridge)	Flow is not constricted by bridge geometry at this location, comment ignored
ST IF 01S2R	This is Section 2 of a hydraulic structure. The highest flood frequency that has low or pressure flow is $profilename$. However, the Right Ineffective Flow Station was not considered at Section 2. The ineffective flow station and elevation should be inserted. The right ineffective flow elevation should be equal to wsel2 of $wsel$. The placement of the right ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	56183(Bridge); 56220(Bridge); 60822(Bridge); 89563(Bridge); 223(Bridge)	Ineffective flow is correctly assigned, comment ignored
ST IF 01S3L	This is Section 3. The highest flood frequency that has low or pressure flow is $profilename$. However, the Left Ineffective Flow station was not considered at Section 3. The ineffective flow station and elevation should be inserted. The left ineffective flow elevation should be equal to lmntprdu of $lmntprdu$. The placement of the left ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	56127(Bridge); 56183(Bridge); 60763(Bridge); 76605(Bridge); 88739(Bridge); 89563(Bridge)	Flow is not constricted by bridge geometry at this location, comment ignored
ST IF 01S3R	This is Section 3 of a hydraulic structure. The highest flood frequency that has low or pressure flow is $profilename$. However, the Right Ineffective Flow station was not considered at Section 3. The ineffective flow station and elevation should be inserted. The right ineffective flow elevation should be equal to rmntprdu of $rmntprdu$. The placement of the right ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	23461(Bridge); 56127(Bridge); 56183(Bridge); 60763(Bridge); 89563(Bridge)	Flow is not constricted by bridge geometry at this location, comment ignored

ST IF 02S2L	This is Section 2. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, left ineffective flow station was not considered at Section 2. The ineffective flow station and elevation should be inserted. The left ineffective flow elevation should be less than the wsel2 of $wsel$ of the $profilename$ profile. The placement of the left ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	38482(Culvert)	Weir flow occurs at this location and is not restricted, comment ignored.
ST IF 03S2L	This is Section 2. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the left ineffective flow elevation of $ineffelr$ at the left ineffective flow station $ineffstal$ is equal to or higher than the WSEL of $wsel2$. The ineffective flow elevation should be lower than the WSEL at Section 2.	1822(MultiOpen); 6940(InlineWeir); 83495(MultiOpen)	Ineffective flow set for bridge embankment at multiple opening location, comment ignored.
ST IF 03S2L	This is Section 2. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the left ineffective flow elevation of $ineffelr$ at the left ineffective flow station $ineffstal$ is equal to or higher than the WSEL of $wsel2$. The ineffective flow elevation should be lower than the WSEL at Section 2.	1822(MultiOpen); 6940(InlineWeir); 83495(MultiOpen)	Weir flow occurs, but flow is not fully expanded, comment ignored.
ST IF 03S2R	This is Section 2. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the right ineffective flow elevation of $ineffell$ at the right ineffective flow station $ineffstar$ is equal to or higher than the WSEL of $wsel2$. The ineffective flow elevation should be lower than the WSEL at Section 2.	6940(InlineWeir)	Flow is not fully expanded at section 2, comment ignored.
ST IF 03S3L	This is Section 3. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the left ineffective flow elevation of $ineffelr$ at the left ineffective flow station $ineffstal$ is equal to or higher than the WSEL of $wsel3$. The computed upstream LMnTpRd is $lmntprdu$. The ineffective flow elevation should be equal to or lower than the computed LMnTpRdU. It should also be lower than the WSEL at Section 3.	7020(InlineWeir); 83543(MultiOpen)	Flow is not fully expanded at section 3, comment ignored.

ST IF 03S3L	This is Section 3. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the left ineffective flow elevation of $ineffelr$ at the left ineffective flow station $ineffstal$ is equal to or higher than the WSEL of $wsel3$. The computed upstream LMnTpRd is $lmntprdu$. The ineffective flow elevation should be equal to or lower than the computed LMnTpRdU. It should also be lower than the WSEL at Section 3.	7020(InlineWeir); 83543(MultiOpen)	Ineffective flow set for bridge embankment at multiple opening location, comment ignored.
ST IF 03S3R	This is Section 3. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the right ineffective flow elevation of $ineffell$ at the right ineffective flow station $ineffstar$ is equal to or higher than the WSEL of $wsel3$. The computed upstream RMnTpRd is $rmntprdu$. The ineffective flow elevation should be equal to or lower than the computed RMnTpRdU. It should also be lower than the WSEL at Section 3.	7020(InlineWeir)	Flow is not fully expanded at section 3, comment ignored.
ST IF 04S2R	This is Section 2. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the right ineffective flow elevation of $ineffell$ at the right ineffective flow station $ineffstar$ is equal to or higher than the WSEL of $wsel2$. The upstream RMnTpRu is $rmntprdu$. The ineffective flow elevation should be lower than the WSEL at Section 2.	1822(MultiOpen); 56456(Bridge); 83495(MultiOpen)	Ineffective flows set correctly to account for topography and bridge contraction, comment ignored
ST IF 04S3R	This is Section 3. The selected profile is $profilename$. Weir flow occurs at ($strucname$). However, the right ineffective flow elevation of $ineffell$ at the right ineffective flow station $ineffstar$ is equal to or higher than the WSEL of $wsel3$. The computed upstream RMnTpRd is $rmntprdu$. The ineffective flow elevation should be equal to the computed RMnTpRdU.	1854(MultiOpen); 83543(MultiOpen)	Ineffective flows set correctly to account for topography and bridge contraction, comment ignored
ST IF 05S2L	This is Section 2 of a hydraulic structure. The left ineffective flow station is within the opening area of the structure. The left ineffective flow station of $ineffstal$ is greater than the downstream left abutment station of $abutstal$ at ($strucname$). The Left ineffective flow station should be adjusted.	6940(InlineWeir); 65968(Bridge); 178(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction, comment ignored

ST IF 05S2L	This is Section 2 of a hydraulic structure. The left ineffective flow station is within the opening area of the structure. The left ineffective flow station of $ineffstal$ is greater than the downstream left abutment station of $abutstal$ at ($strucname$). The Left ineffective flow station should be adjusted.	6940(InlineWeir); 65968(Bridge); 178(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction, comment ignored.
ST IF 05S2R	This is Section 2 of a hydraulic structure. The right ineffective flow station is within the opening area of the structure. The right ineffective flow station of $ineffstar$ is less than the upstream right abutment station of $abutstar$ at ($strucname$). The Right ineffective flow station should be adjusted.	6940(InlineWeir); 28439(Bridge); 65968(Bridge); 88513(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction, comment ignored
ST IF 05S3L	This is Section 3 of a hydraulic structure. The left ineffective flow station is within the opening area of the structure. The left ineffective flow station of $ineffstal$ is greater than the upstream left abutment station of $abutstal$ at ($strucname$). The Left ineffective flow station should be adjusted.	7020(InlineWeir); 66267(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction, comment ignored
ST IF 05S3R	This is Section 3 of a hydraulic structure. The right ineffective flow station is within the opening area of the structure. The right ineffective flow station of $ineffstar$ is less than the upstream right abutment station of $abutstar$ at ($strucname$). The Right ineffective flow station should be adjusted.	7020(InlineWeir); 88899(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction, comment ignored
ST IF 06S3L	This is Section 3. The selected profile is $profilename$. Low or pressure flow occurs at ($strucname$). The Up_Dist of $updist$ at the structure is less than the opening height of $openheight$ of the structure. The cHECk-RAS computed left ineffective flow station of $compineffstal$ is less than the input left ineffective flow station of $ineffstal$. The left ineffective flow station should be adjusted per the help instructions and the HEC-RAS manual.	23474(Bridge)	Cross section placement result of sharp turn in stream, comment ignored.
ST IF 07S1L	This is Section 1. Left Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 3 of the downstream structure.	55902(Bridge); 88355(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction, comment ignored.

ST IF 07S1R	This is Section 1. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 3 of the downstream structure.	55902(Bridge); 88355(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction, comment ignored.
ST IF 07S4L	This is Section 4. Left Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 2 of the upstream structure.	60953(Bridge); 76850(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction, comment ignored.
ST IF 07S4R	This is Section 4. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 2 of the upstream structure.	60728(Bridge); 60953(Bridge); 72228(MultiOpen)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction, comment ignored.
ST IF 07S4R	This is Section 4. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 2 of the upstream structure.	60728(Bridge); 60953(Bridge); 72228(MultiOpen)	Intermediate bridge section, comment ignored.
ST IF 07S4R	This is Section 4. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 2 of the upstream structure.	60728(Bridge); 60953(Bridge); 72228(MultiOpen)	Section 2 of upstream structure, comment ignored.

ST IF 09S2L	This is Section 2. The highest flood frequency that is having low flow or pressure flow is $profilename$. The leftineffective flow elevation, Ineff_El_Left, should be equal to or higher than the WSEL at Section 2. However, the Ineff_El_Left of $ineffell$ at the left ineffective flow station $ineffstal$ is lower than the WSEL of $wsel2$ at Section 2. The Ineff_El_Left should be raised to or above the WSEL at Section 2.	2789(Bridge); 76557(Bridge); 88513(Bridge)	Ineffective flow boundaries are set for floodplain topography, not bridge contraction, comment ignored.
ST IF 09S2L	This is Section 2. The highest flood frequency that is having low flow or pressure flow is $profilename$. The leftineffective flow elevation, Ineff_El_Left, should be equal to or higher than the WSEL at Section 2. However, the Ineff_El_Left of $ineffell$ at the left ineffective flow station $ineffstal$ is lower than the WSEL of $wsel2$ at Section 2. The Ineff_El_Left should be raised to or above the WSEL at Section 2.	2789(Bridge); 76557(Bridge); 88513(Bridge)	Section 2 of upstream structure, comment ignored.
ST IF 09S3L	This is Section 3. The highest flood frequency that is having low flow or pressure flow is $profilename$. The left ineffective flow elevation, Ineff_El_Left, should be equal to or higher than the WSEL at Section 3. However, the Ineff_El_Left of $ineffell$ at the left ineffective flow station $ineffstal$ is lower than the WSEL of $wsel3$ at Section 3. The computed Left Upstream Minimum Top Road elevation, LMnTpRdU of $lmntprdu$ is higher than the WSEL of $wsel3$ at Section 3. The Ineff_El_Left should be raised to the computed LMnTpRdU.	76701(Bridge); 88899(Bridge)	No left inneffective flow at this section, comment ignored.
ST IF 10S2L	This is Section 2 of a ($Structure$). More than one set of Left Ineffective Flow Stations were considered. There is only one structure at this location. Multiple Block Ineffective Flow option should not be used unless the area blocked by the ineffective flow stations can be considered non conveyance. cHECk-RAS will only check the ineffective flow elevations adjacent to the structure opening.	56456(Bridge)	Ineffective flows account for more than bridge contraction, comment ignored.
ST IF 10S2R	This is Section 2 of a ($Structure$). More than one set of Right Ineffective Flow Stations were considered. There is only one structure at this location. Multiple Block Ineffective Flow option should not be used unless the area blocked by the ineffective flow stations can be considered non conveyance. cHECk-RAS will only check the ineffective flow elevations adjacent to the structure opening.	76465(Bridge)	Ineffective flows account for more than bridge contraction, comment ignored.

ST IF 10S3L	This is Section 3 of a ($Structure$). More than one set of Left Ineffective Flow Stations were considered. There is only one structure at this location. Multiple Block Ineffective Flow option should not be used unless the area blocked by the ineffective flow stations can be considered non conveyance. The cHECk-RAS will only check the ineffective flow elevations adjacent to the structure opening.	88899(Bridge)	Ineffective flows account for more than bridge contraction, comment ignored.
ST IF 10S3R	This is Section 3 of a ($Structure$). More than one set of Left Ineffective Flow Stations were considered. There is only one structure at this location. Multiple Block Ineffective Flow option should not be used unless the area blocked by the ineffective flow stations can be considered non conveyance. cHECk-RAS will only check the ineffective flow elevations adjacent to the structure opening.	23474(Bridge); 56512(Bridge)	Ineffective flows account for more than bridge contraction, comment ignored.
ST IF 10S3R	This is Section 3 of a ($Structure$). More than one set of Left Ineffective Flow Stations were considered. There is only one structure at this location. Multiple Block Ineffective Flow option should not be used unless the area blocked by the ineffective flow stations can be considered non conveyance. cHECk-RAS will only check the ineffective flow elevations adjacent to the structure opening.	23474(Bridge); 56512(Bridge)	Only one set of Left ineffective flows are set, comment ignored.
XS BO 02L	Multiple Block Obstruction. The Flow Code will be MBL. The block obstruction elevation is higher than the left bank elevation. The ground elevation within the block obstruction is lower than the highest discharge WSEL. The block obstruction is not within the block ineffective flow stations. If it is, the ineffective flow elevation is lower than the highest discharge WSEL. This option is suitable to represent individual buildings within the floodway. Compute appropriate "n" values to represent a group of buildings as outlined in (USGS, 1977) or use the Ineffective Flow option.	1227; 1642; 1822; 1854; 1996; 2258; 2653; 36170; 36352; 51449; 52703; 53469; 54351; 55902	Block obstruction used to remove low spots in the topography not conveying flow, comment ignored
XS CD 01	Critical Depth occurs at $assignedname$ flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	2720; 179; 774; 1642; 1996; 2258; 2789; 3917; 11602; 11944; 12841; 15165; 15510; 17675; 21180; 21420; 21807; 23587; 36516; 38457; 51449; 89951	Ineffective flows placed to account for topography that prevents active flow, ie roads, railgrades and high spots, comment ignored
XS CT 03	Maximum number of iterations is $maxnoiter$. It should be the default value of 20.		

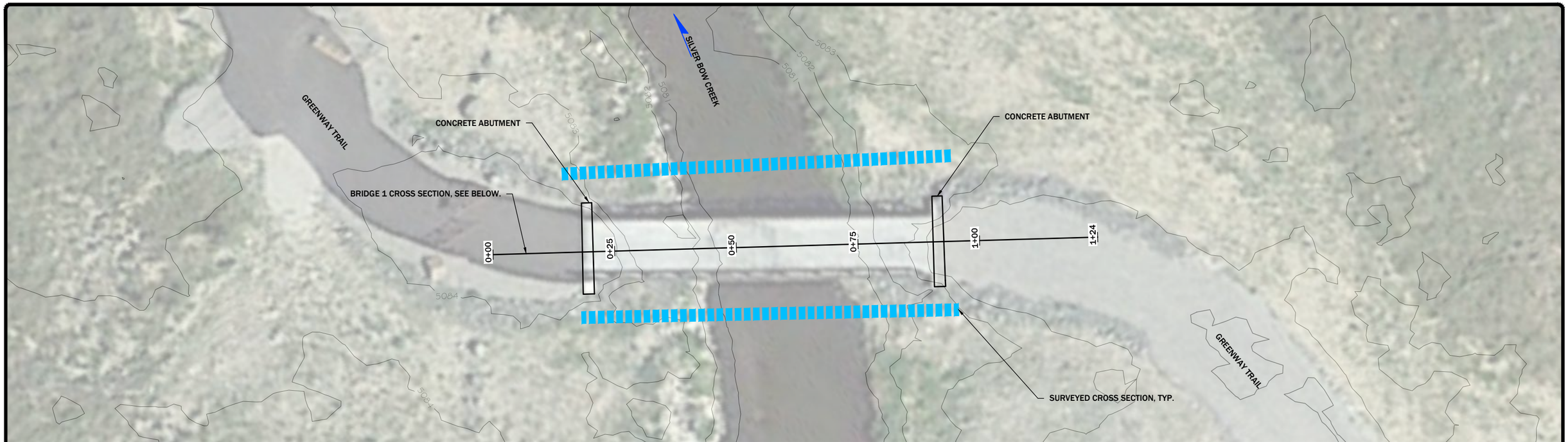
XS DC 01	Discharge decreases in the downstream direction for $assignedname$ flood. There are no lateral structures. Documentation of hydrologic analysis is required or provide explanation.	3975; 453; 1838(MultiOpen-UP); 33270(MultiOpen-UP); 35886; 38608; 78630; 79073(MultiOpen-UP); 83514(MultiOpen-UP); 85873; 321	Multiple opening structure where in channel flow changes in downstream direction, Q total is consistent, comment ignored.
XS DC 01	Discharge decreases in the downstream direction for $assignedname$ flood. There are no lateral structures. Documentation of hydrologic analysis is required or provide explanation.	3975; 453; 1838(MultiOpen-UP); 33270(MultiOpen-UP); 35886; 38608; 78630; 79073(MultiOpen-UP); 83514(MultiOpen-UP); 85873; 321	Split flow location, flow returns to system downstream, comment ignored.
XS DC 03	Discharge is different between the upstream side and downstream side of the structure for $assignedname$ flood. They should be the same.	1822; 33208; 79055; 83495	Multiple opening structure where in channel flow changes in downstream direction, Q total is consistent, comment ignored.
XS DC 04L	There is no flow on the right overbank at the downstream cross section $presecno$ for the 1%-annual-chance flood. There is no flow on the left overbank at this Section $secno$. Consider placing a cross section in between these sections. The HEC-RAS geometry file may need to be recreated using a GIS program.	3746; 3975; 819; 1342; 1903; 2052	Flow does not leave the "channel" under studied flows. This is an overflow channel between railgrades, comment ignored.
XS DC 04R	There is no flow on the left overbank at the downstream cross section $presecno$. There is no flow on the right overbank at this Section $secno$ for the 1%-annual-chance flood. Consider placing a cross section in between these sections. The HEC-RAS geometry file may need to be recreated using a GIS program.	3746; 3975; 819; 1342; 1903; 2052	Flow does not leave the "channel" under studied flows. This is an overflow channel between railgrades, comment ignored.
XS DF 01L	Divided flow. Flow code will be DL. The $assignedname$ flood discharge has a divided flow. The starting and ending stations of the cross section should not extend beyond the watershed boundary of the studied stream. Please review the extent of the cross section. If the cross section extends beyond the watershed boundary then the cross sections need to be trimmed and the HEC-RAS geometry file may need to be recreated using a GIS program. Or use the ineffective flow option, if it has not been considered, to limit the extent of the cross section or to block the divided flow area if it is a local depression.	1642; 1996; 38457; 51449; 56569; 62008	Flow divided by high ground, road or railgrade, comment ignored.
XS DT 01	Both the right overbank distance of rob and the left overbank distance of lob are longer than the channel distance of chl . Please review the creation of left overbank, channel and right overbank distances. The HEC-RAS geometry file may need to be recreated using a GIS program. Please resolve the differences among the distances.	41164	Flow lengths are correct, comment ignored.

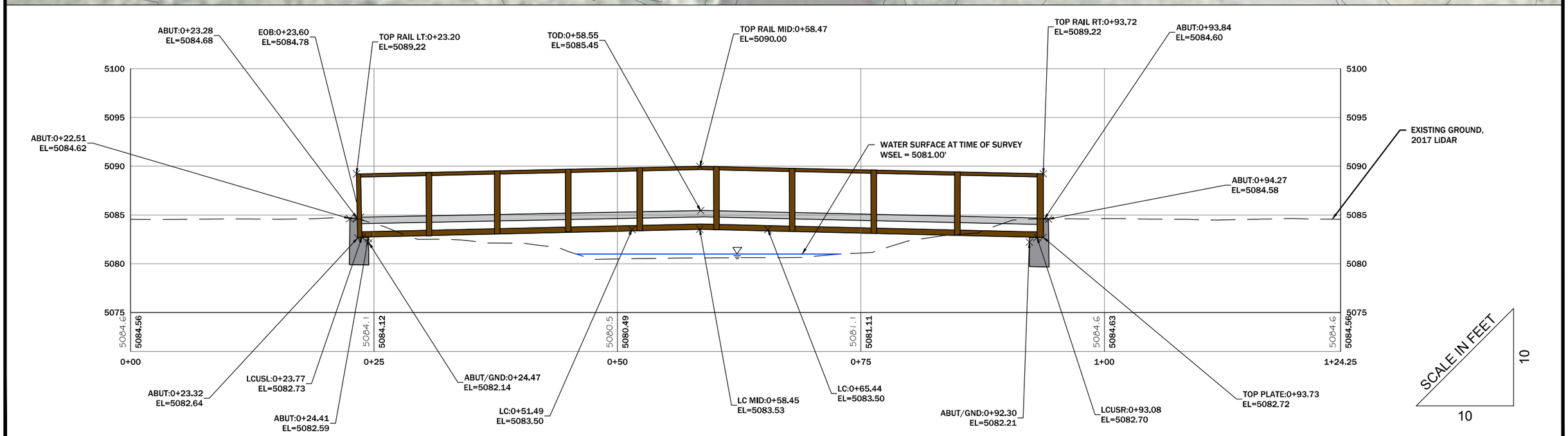
XS DT 02L	The Left overbank distance of lob is greater than the channel distance of chl by more than two times. The Left overbank distance may be in error. Please review the creation of left overbank, channel and right overbank distances. The HEC-RAS geometry file may need to be recreated using a GIS program. Please resolve the differences between the distances.	28606; 79055	Flow lengths are correct, comment ignored.
XS DT 02R	The Right overbank distance of rob is greater than the channel distance of chl by more than two times. The Right overbank distance may be in error. Please review the creation of left overbank, channel and right overbank distances. The HEC-RAS geometry file may need to be recreated using a GIS program. Please resolve the differences between the distances.	33389	Flow lengths are correct, comment ignored.
XS EC 01L	Cross section extended vertically. Flow Code will be EL. The $assignedname$ WSEL of $wsel$ is higher than the starting GR station elevation of $grelv$. The Left_Sta_Eff is equal to the starting GR station. If there is divided flow then cross section should be trimmed or the ineffective flow station should be used to block the divided flow. If there is no divided flow then the cross section should be expanded to cover the $assignedname$ floodplain.The HEC-RAS geometry file may need to be recreated using a GIS program. Or provide explanation why the cross section should not be expanded.	250; 325; 56; 453; 35771; 35886; 94; 321	Flow is ineffective at extended area, comment ignored.
XS EC 01L	Cross section extended vertically. Flow Code will be EL. The $assignedname$ WSEL of $wsel$ is higher than the starting GR station elevation of $grelv$. The Left_Sta_Eff is equal to the starting GR station. If there is divided flow then cross section should be trimmed or the ineffective flow station should be used to block the divided flow. If there is no divided flow then the cross section should be expanded to cover the $assignedname$ floodplain.The HEC-RAS geometry file may need to be recreated using a GIS program. Or provide explanation why the cross section should not be expanded.	250; 325; 56; 453; 35771; 35886; 94; 321	Split flow location flow is accountd for in neighboring reach, comment ignored.

XS EC 01R	Cross section extended vertically. Flow Code will be ER. The $assignedname$ WSEL of $wsel$ is higher than the ending GR station elevation of $grelv$. The Rght_Sta_Eff is equal to the ending GR station. If there is divided flow then the cross section should be trimmed or the ineffective flow station should be used to block the divided flow. If there is no divided flow then the cross section should be expanded to cover the $assignedname$ floodplain. The HEC-RAS geometry file may need to be recreated using a GIS program. Or provide explanation why the cross section should not be expanded.	78396; 78630; 85584; 85873	Split flow location flow is accountd for in neighboring reach, comment ignored.
XS FS 01	The name of the stream is $streamname$. $frictionslopename$ method was used. The Average Conveyance method should be selected.		
XS GD 01	'Cross Section Lid' option is used for this section. Instead, the bridge or culvert option should be used. Cross Section Lid option may be used to model small obstructions, such as, pipe crossing or if the type of flow through the lid sections and the main stream is in super critical flow, or if there is lateral weir flow between Sections 3 and 2 of a structure.	104; 11374; 89182	Flume or pipeline location, comment ignored.
XS GD 01	'Cross Section Lid' option is used for this section. Instead, the bridge or culvert option should be used. Cross Section Lid option may be used to model small obstructions, such as, pipe crossing or if the type of flow through the lid sections and the main stream is in super critical flow, or if there is lateral weir flow between Sections 3 and 2 of a structure.	104; 11374; 89182	Used to illustrate Railroad deck elevation, contraction is minimal and does not approach overtopping, comment ignored.
XS IF 01L	Flow code will be IL. The area left of the ineffective flow station may be considered effective. The $assignedname$ WSEL of $wsel$ is higher than the ground elevation $grelv$ of the Left Ineffective Flow Station. However, it is equal to or lower than the left ineffective flow elevation of $ineffell$. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area left of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area left of the ineffective flow station is non conveyance.	28375; 36170; 36352; 60549; 71345; 72228; 85873	Area left of ineffective is non conveyance area, comment ignored.

XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The $assignedname$ WSEL of $wsel$ is higher than the ground elevation $grelv$ of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of $ineffelr$. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	2258; 2952; 3058; 60549; 60953; 65329; 71972	Area right of ineffective is non conveyance area, comment ignored.
XS IF 02L	Flow code will be MIL. Multiple (block) Ineffective Stations are selected for the left overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please explain why the multiple blocks ineffective flow option was used. Consider using the normal ineffective flow option.	2720; 1822; 1854; 2653; 12841; 15510; 17675; 26148; 26221; 26308; 31077; 36683; 41978; 44198; 44896; 45586; 46642; 48882; 52168; 52703; 53469; 55171; 55902; 56512; 58866; 62761; 70345; 76465; 79055; 79091; 80566; 81281; 81670; 83495; 83543	Multiple ineffective depressions or areas of non conveyance at different elevations, comment ignored
XS IF 02R	Flow code will be MIR. Multiple (block) Ineffective Stations are selected for the right overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please justify why the Multiple Blocks Ineffective Flow option was used. Consider using the normal Ineffective Flow option.	-141; 1822; 1854; 2258; 2653; 3917; 37394; 41978; 44198; 45586; 46642; 47845; 48882; 52168; 53469; 55902; 56456; 59417; 60154; 62008; 70345; 70474; 70521; 72094; 72139; 72228; 82965; 83495; 83543; 83638; 84280; 88899; 90215	Multiple ineffective depressions or areas of non conveyance at different elevations, comment ignored
XS JT 01	The Junction option is used. For Flood Insurance Studies, this option should be used if the tributary and main stream can have coincident peaks. It is appropriate to use for approximate-studied streams; if the discharges at different time periods are known from the rainfall-runoff model; for loop analysis; and for unsteady flow analysis. The Junction should be removed if the above conditions are not satisfied. Refer to the Help section for information on how to remove a Junction. Sample XS JT 01 HEC-RAS files can be downloaded from http://www.fema.gov/library/viewRecord.do?id=2300 under the Cross Section Check Data Sets section.		
XS JT 02	The name of the junction is $junctionname$. The length from the $riverreach1$ to the $riverreach2$ is equal to zero. Please insert the length across the junction in the Junction Data window in HEC-RAS if the junction can be considered.		

Appendix G Bridge Sketches





NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL, CONCRETE, AND WOOD
3. BRIDGE WIDTH = 11.9'.
4. SPAN 1 = WEST ABUTMENT TO EAST ABUTMENT= 67.85'.
5. RIVER MILE = 0.35

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 10 20

FIGURE 6

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 1
PLAN AND PROFILE

DATE: 10-31-18

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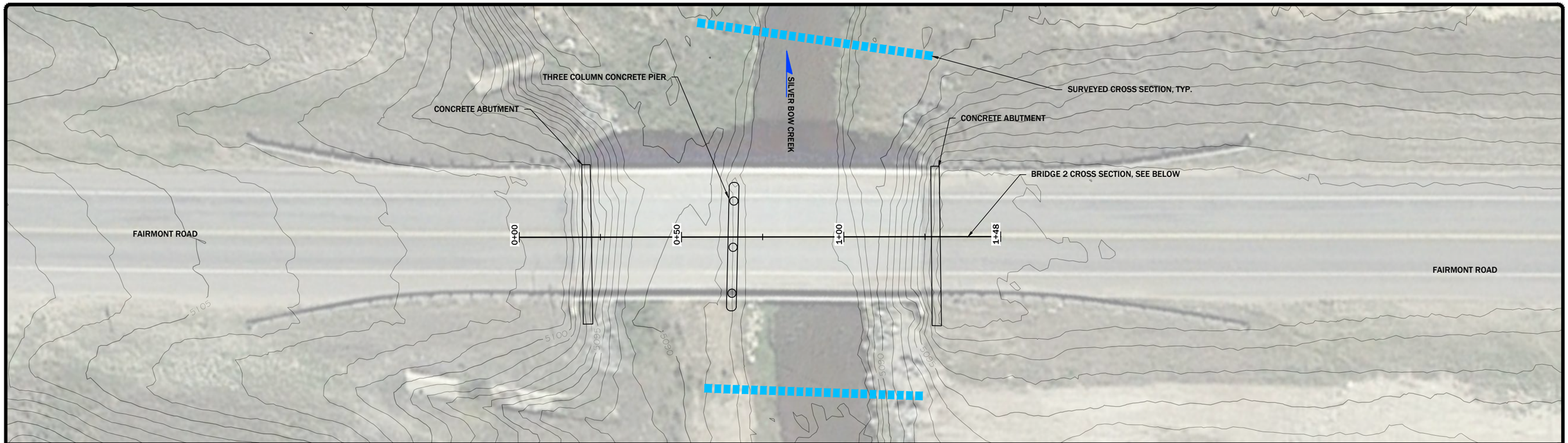

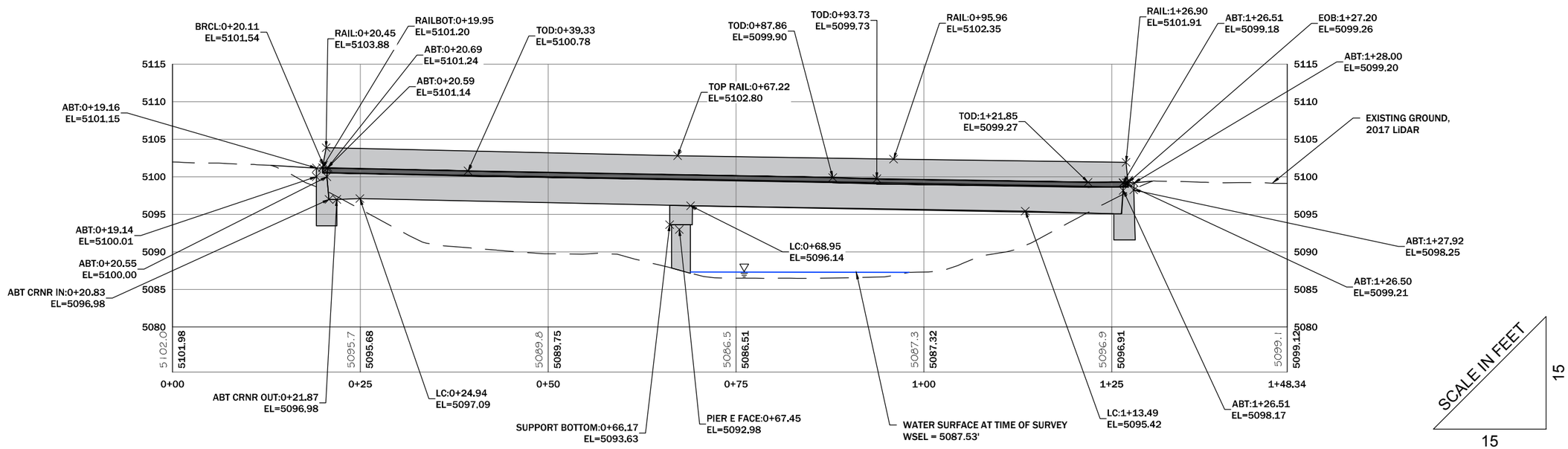

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: CONCRETE
3. BRIDGE WIDTH = 37.5'.
4. SPAN 1 = WEST ABUTMENT TO PIER 1 = 45.8'.
5. SPAN 2 = PIER 1 TO EAST ABUTMENT = 57.6'.
6. RIVER MILE = 0.55

N

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 7

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 2
PLAN AND PROFILE

DATE: 10-31-18

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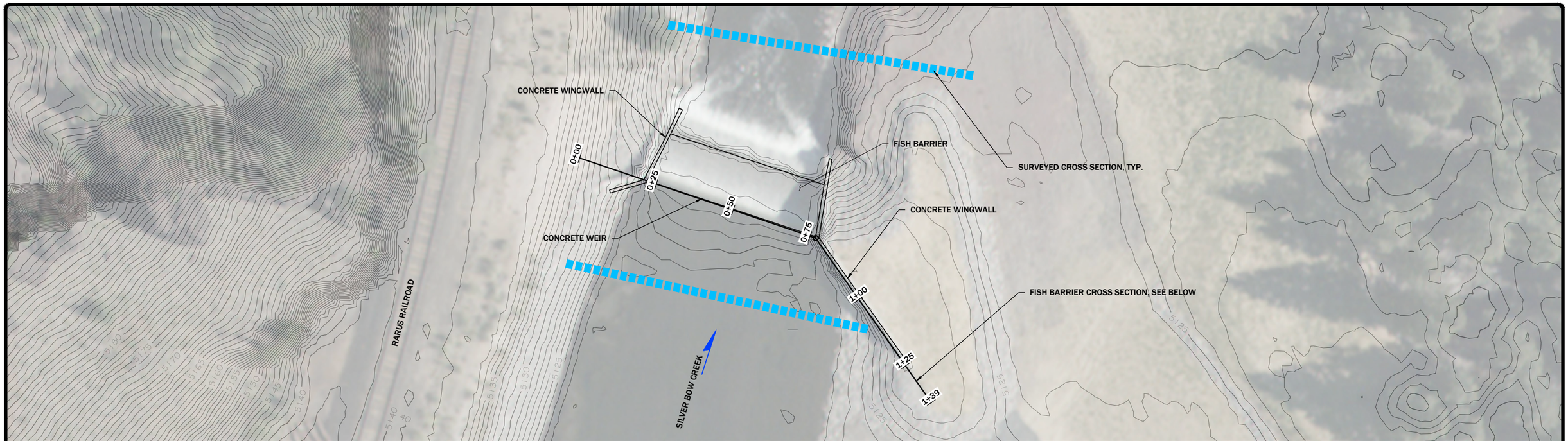

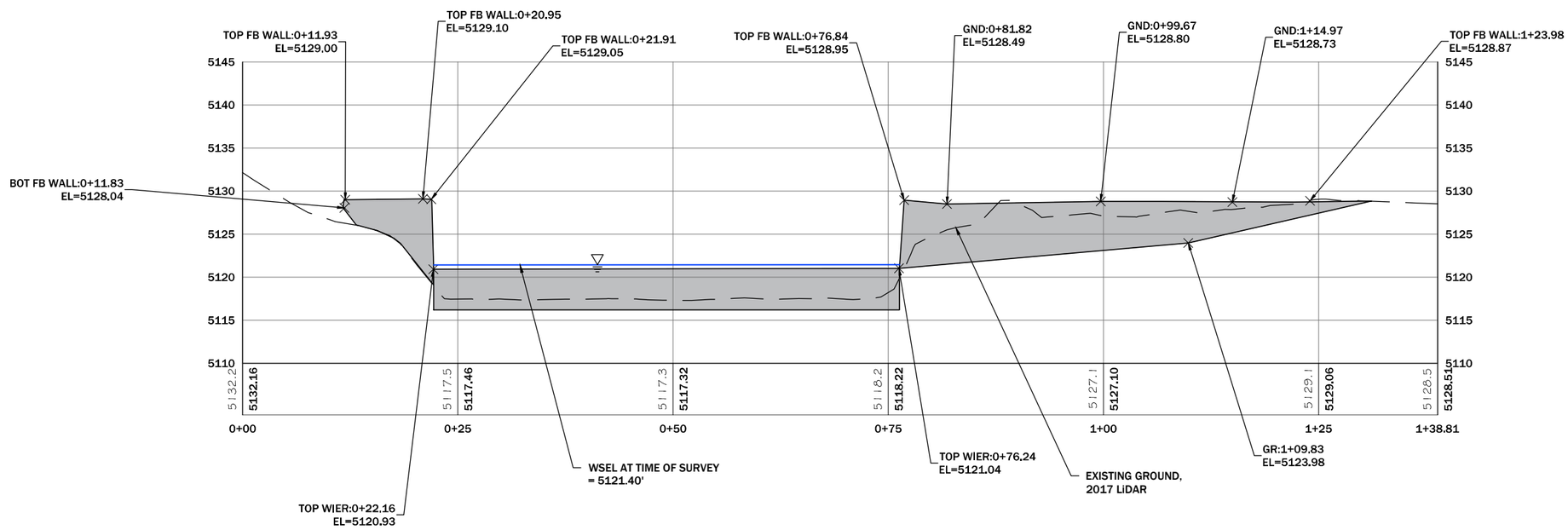

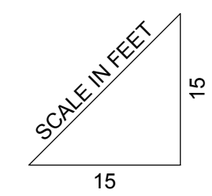

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BARRIER.
2. STRUCTURE MATERIAL TYPE: CONCRETE
3. BRIDGE WIDTH = 24.25'.
4. SPAN 1 = WEST WALL TO EAST WALL = 55.0'.
5. RIVER MILE = 1.33.

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 8

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
FISH BARRIER
(BRIDGE 3)
PLAN AND PROFILE

DATE: 10-31-18

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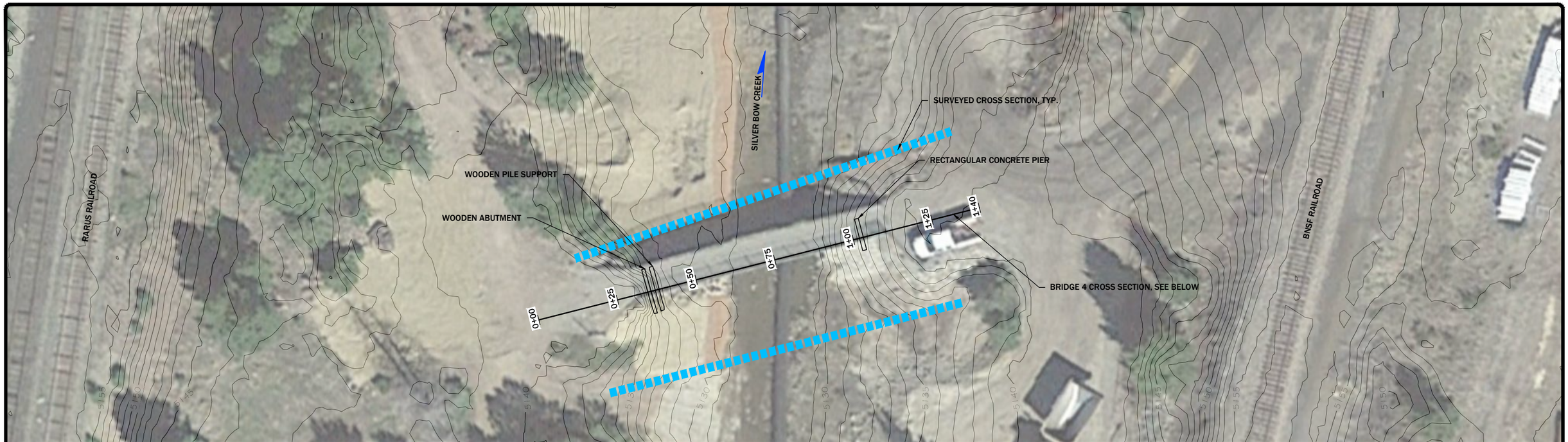
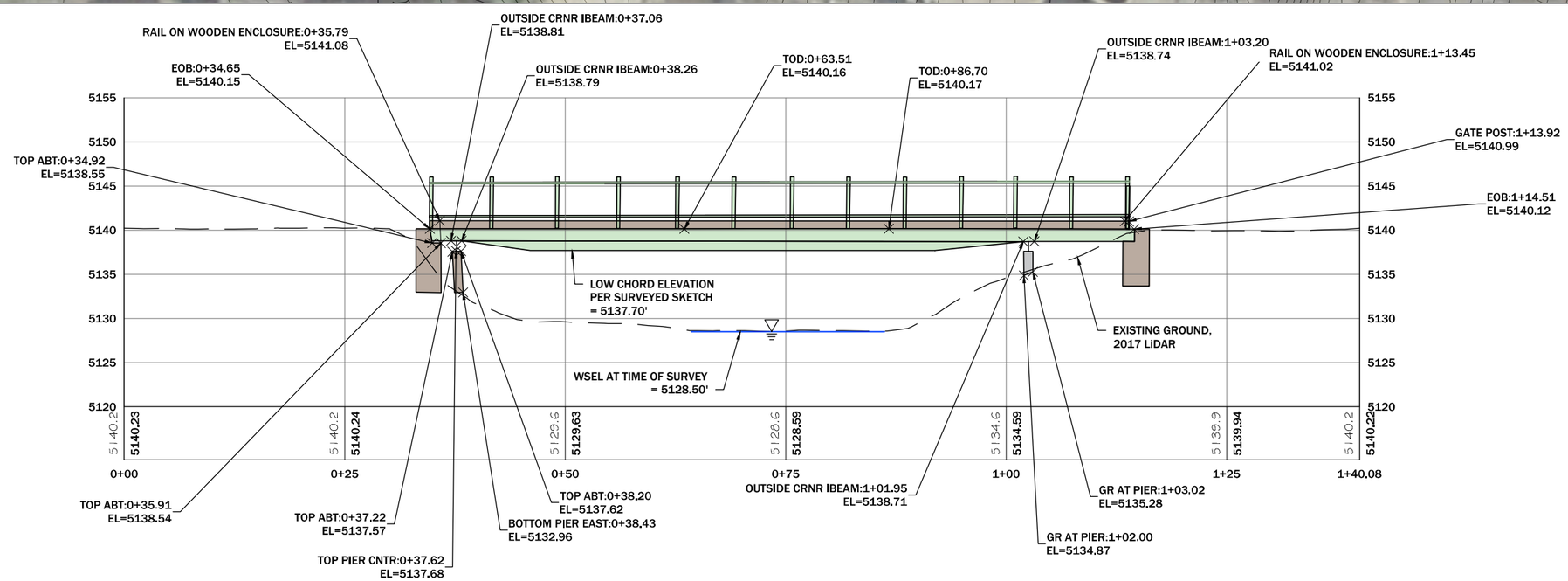




NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL AND WOOD
3. BRIDGE WIDTH = 8.7'.
4. SPAN 1 = WEST ABUTMENT TO PIER 1 = 1.30'.
5. SPAN 2 = PIER 1 TO PIER 2 = 64.91'.
6. SPAN 3 = PIER 2 TO EAST ABUTMENT = 12.0'.
7. RIVER MILE = 1.77

N

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

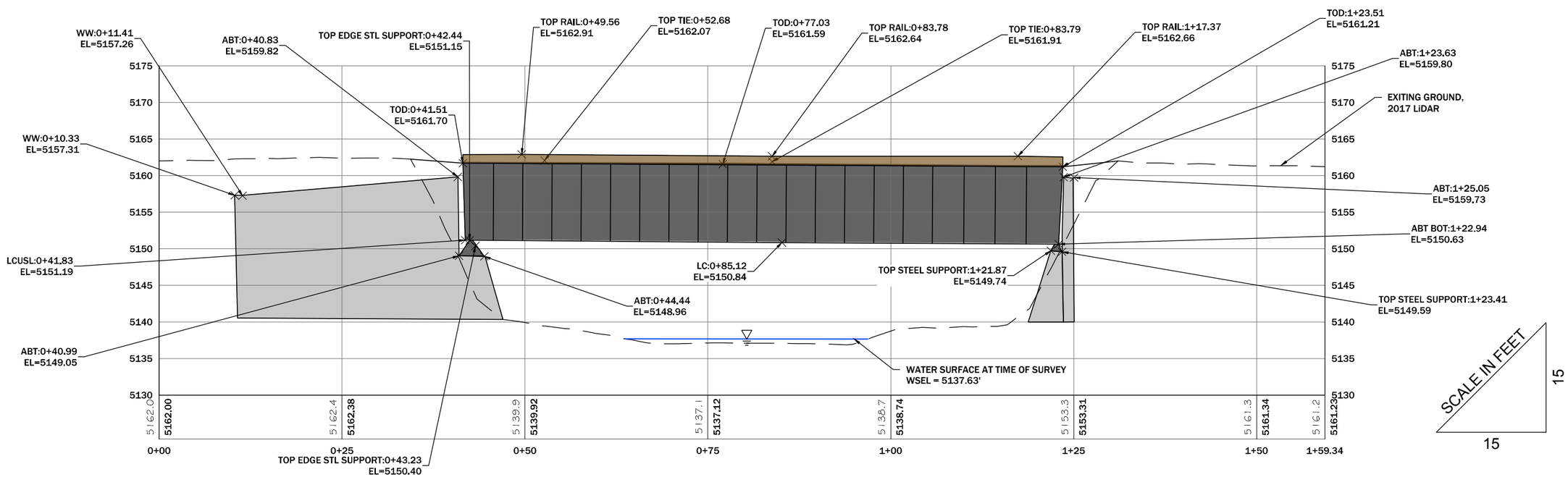
FIGURE 9

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 4
PLAN AND PROFILE

DATE: 10-31-18

11/19/2018 2:47:41 PM H:\DEQ\SSTOU NEW\2018\FEMA_PMR\SURVEY\DRAWINGS\CAD\BRIDGES\SSTOU-BRG-FIG-004-18.DWG



NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL AND WOOD
3. BRIDGE WIDTH = 14.9'.
4. SPAN 1 = SOUTH ABUTMENT TO NORTH ABUTMENT = 77.36'.
5. RIVER MILE = 1.96

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 10 20

FIGURE 10

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 5
PLAN AND PROFILE

DATE: 10-31-18

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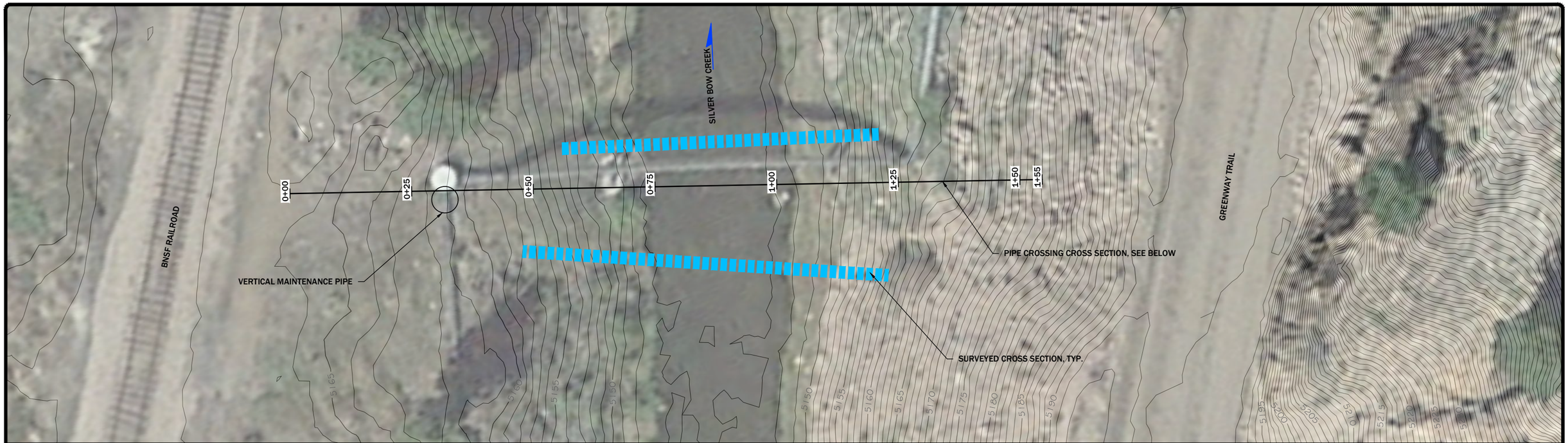

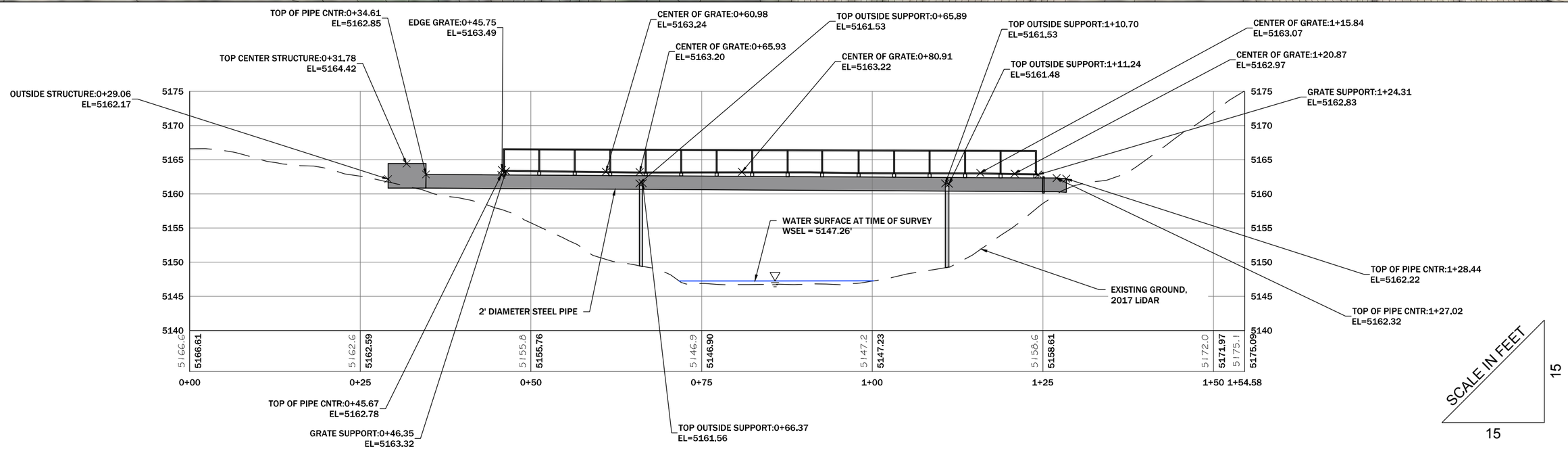

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL
3. BRIDGE WIDTH = 2.0'.
4. SPAN 1 = WEST ABUTMENT TO PIER 1 = 31.55'.
5. SPAN 2 = PIER 1 TO PIER 2 = 44.84'.
6. SPAN 3 = PIER 2 TO EAST ABUTMENT = 16.55'.
7. RIVER MILE = 2.16

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 10 20

FIGURE 11

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
PIPELINE CROSSING
(BRIDGE 6)
PLAN AND PROFILE

DATE: 10-31-18

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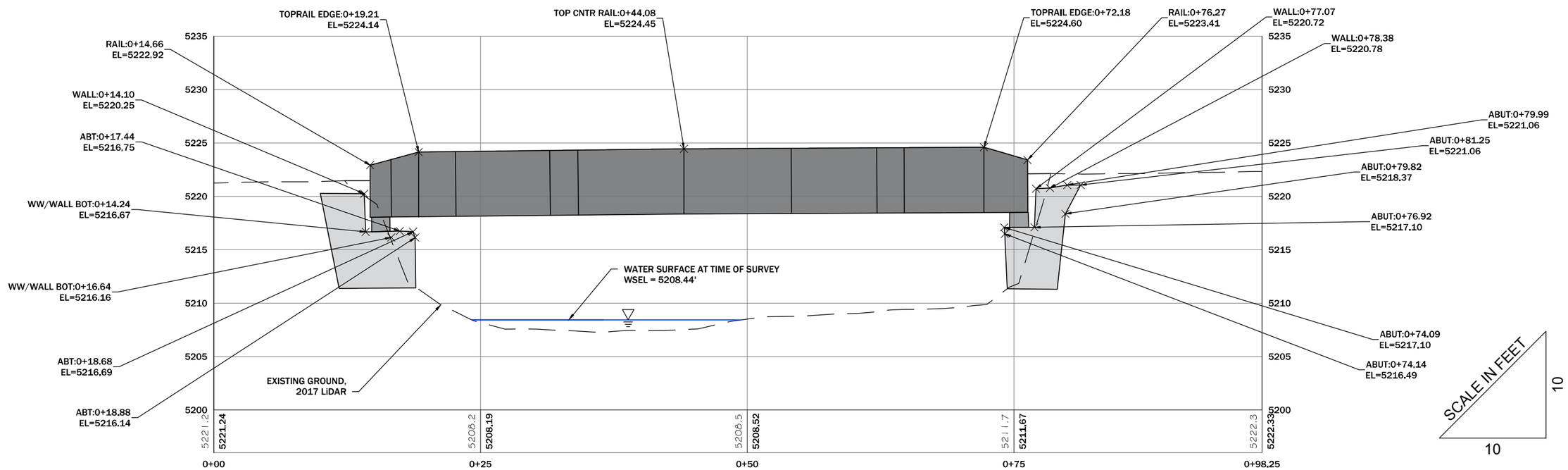


NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL AND CONCRETE
3. BRIDGE WIDTH = 14.4'.
4. SPAN 1 =SOUTH ABUTMENT TO NORTH ABUTMENT = 56.6'.
5. RIVER MILE = 3.65

N

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

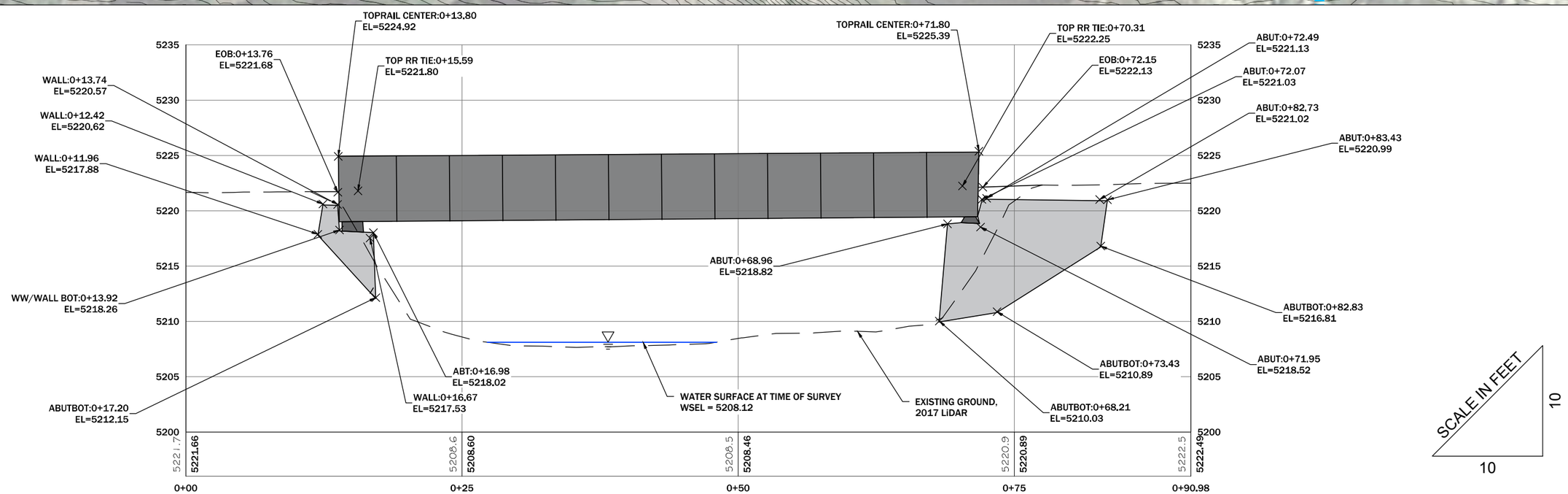
SCALE IN FEET
0 15 30

FIGURE 12

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 7A
PLAN AND PROFILE

DATE: 10-31-18



NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. LOW CHORD STATIONS AND ELEVATIONS ARE PROJECTED UP FROM THE INSIDE EDGE OF ABUMENTS FOR CONSERVATIVE MODELING PURPOSES
3. STRUCTURE MATERIAL TYPE: STEEL AND CONCRETE
4. BRIDGE WIDTH = 16.2'.
5. SPAN 1 = NORTH ABUTMENT TO SOUTH ABUTMENT = 52.0'.
6. RIVER MILE = 3.66

N

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 13

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 7B
PLAN AND PROFILE

DATE: 10-31-18

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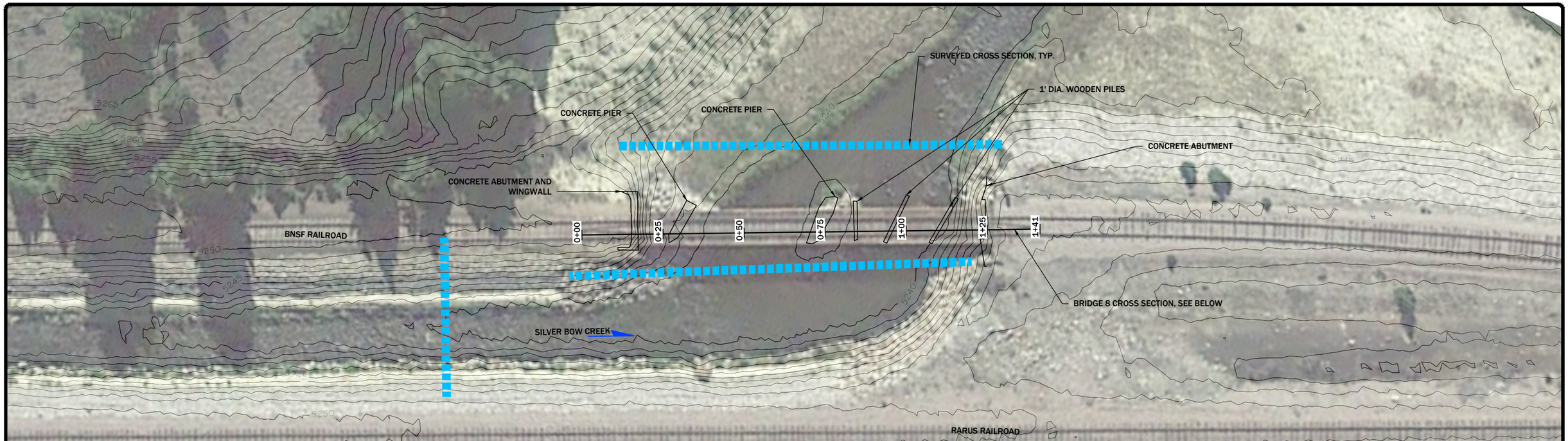
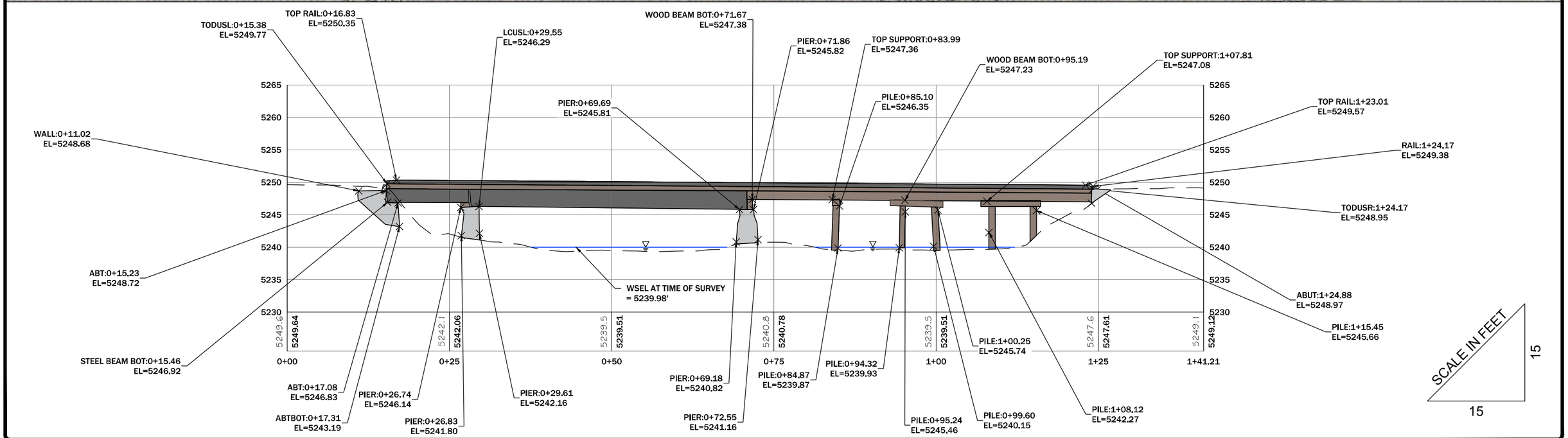




NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL, CONCRETE, AND WOOD.
3. BRIDGE WIDTH = 11.0'
4. SPAN 1 = NORTH ABUTMENT TO PIER 1 = 11.46'
5. SPAN 2 = PIER 1 TO PIER 2 = 42.33'
6. SPAN 3 = PIER 2 TO PIER 3 = 13.62'
7. SPAN 4 = PIER 3 TO PIER 4 = 10.33'
8. SPAN 5 = PIER 4 TO PIER 5 = 13.8'
9. SPAN 6 = PIER 5 TO SOUTH ABUTMENT = 15.31'
10. RIVER MILE = 4.44

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

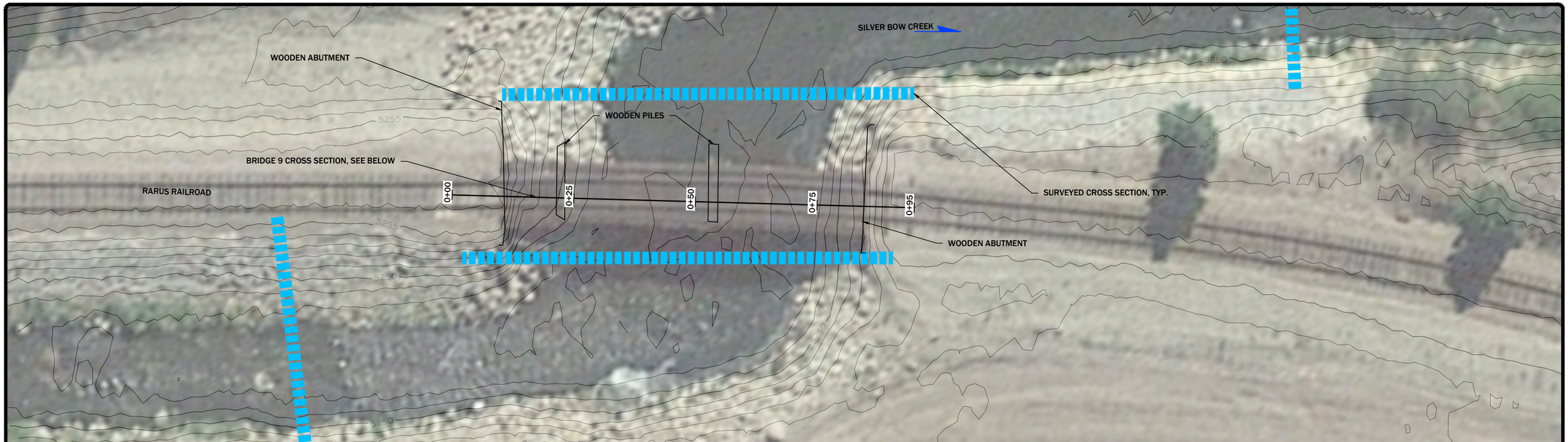
SCALE IN FEET
0 15 30

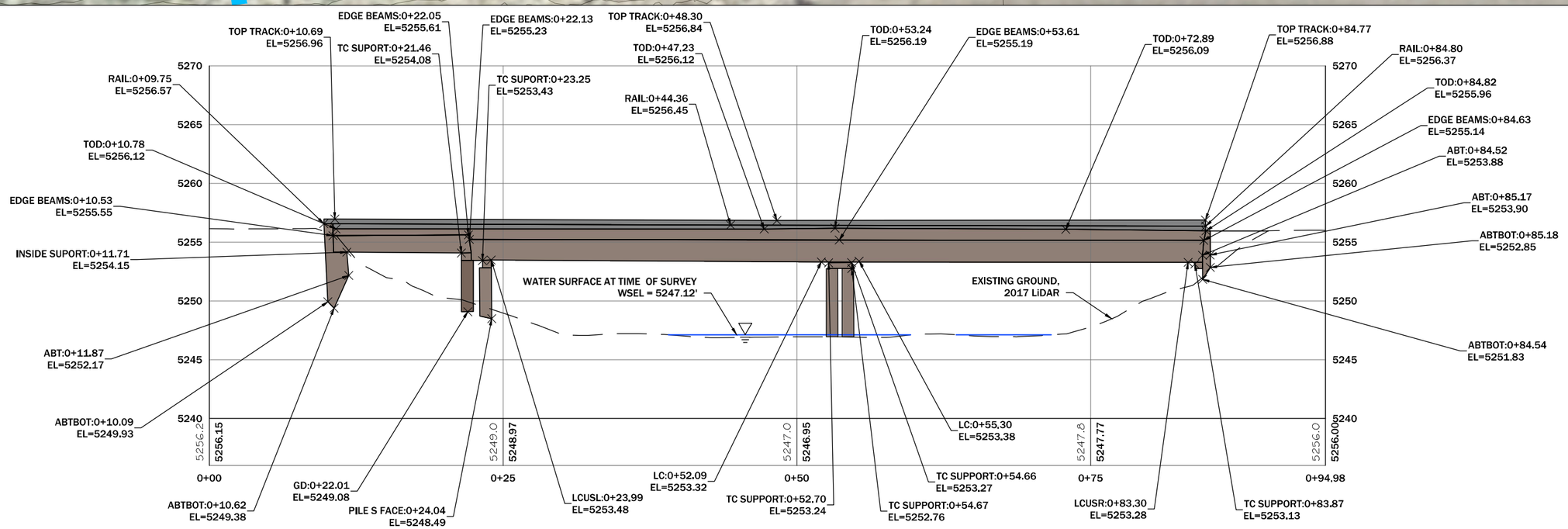
FIGURE 14

SILVER BOW CREEK
BRIDGE 8
PLAN AND PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

DATE: 10-31-18





NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: WOOD AND STEEL
3. BRIDGE WIDTH = 12.5'.
4. SPAN 1 = WEST ABUTMENT TO PIER 1 = 10.25'.
5. SPAN 2 = PIER 1 TO PIER 2 = 1.53'
6. SPAN 2 = PIER 2 TO PIER 3 = 29.21'.
7. SPAN 3 = PIER 3 TO PIER 4 = 1.97'.
8. SPAN 4 = PIER 4 to EAST ABUTMENT = 28.63'.
9. RIVER MILE = 4.71

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

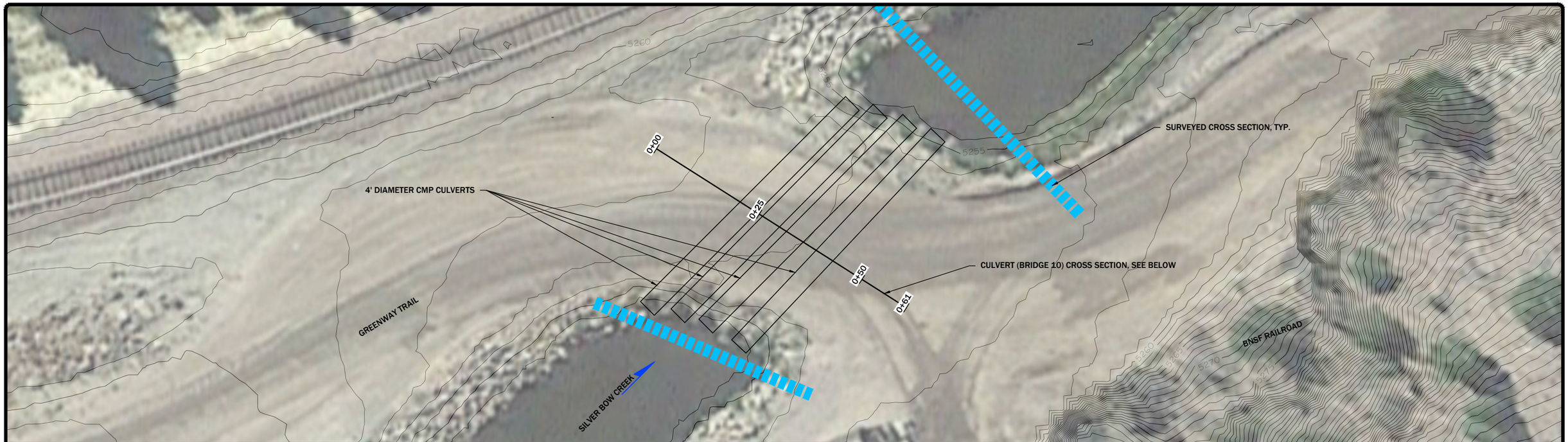
SCALE IN FEET
0 10 20

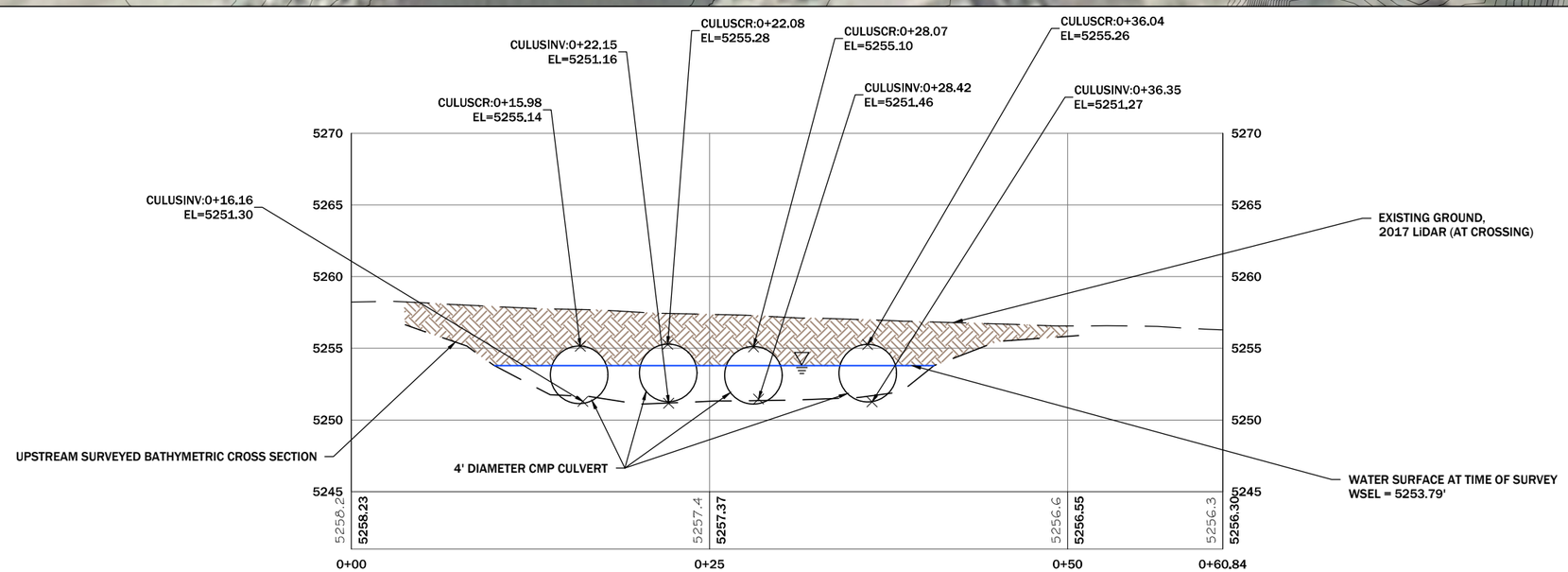
FIGURE 15

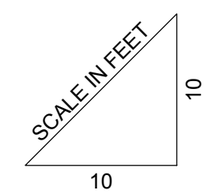
SILVER BOW CREEK
BRIDGE 9
PLAN AND PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

DATE: 10-31-18







NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF CULVERT
2. CLUVERT LENGTH = 59.0' (ALL CULVERTS).
3. CULVERT DIAMETER = 4.0' (ALL CULVERTS).
4. RIVER MILE = 4.96.

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

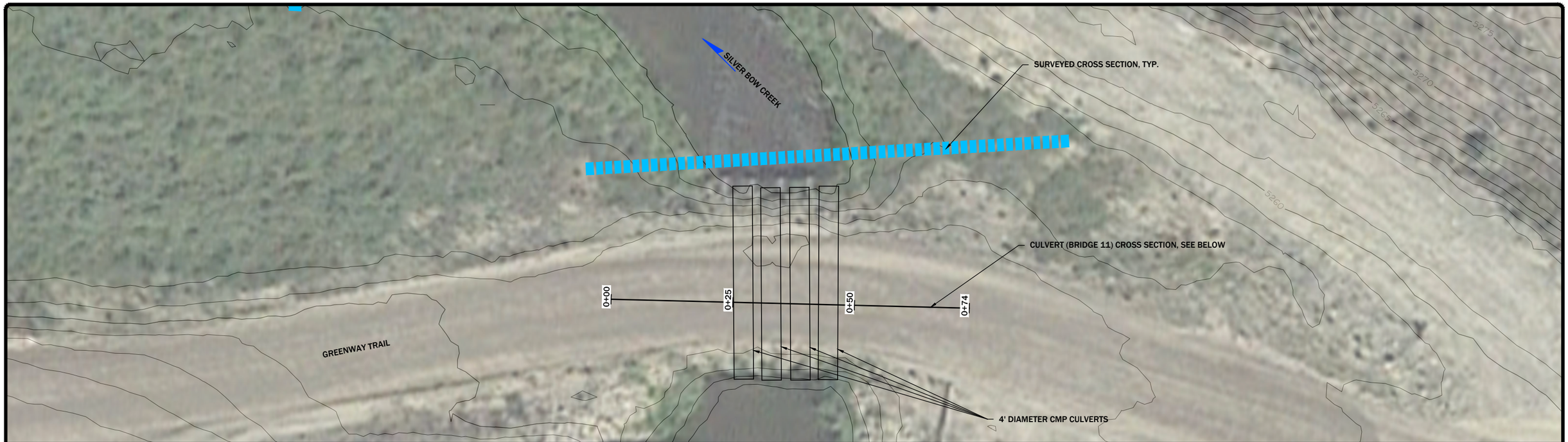
SCALE IN FEET
0 10 20

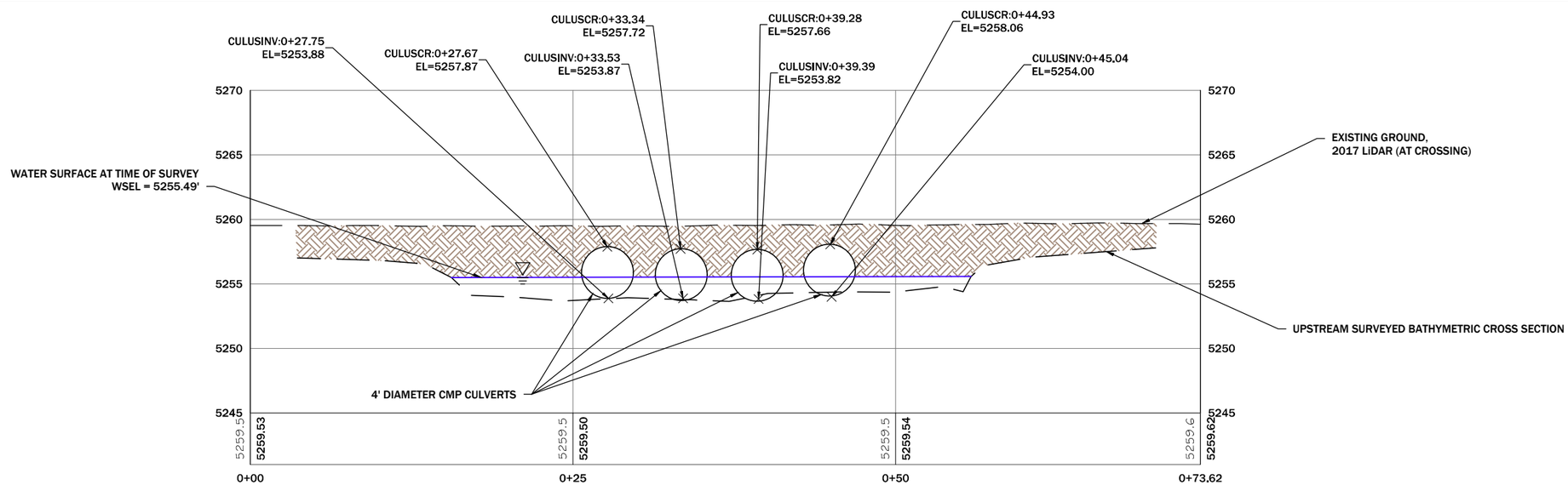
FIGURE 16

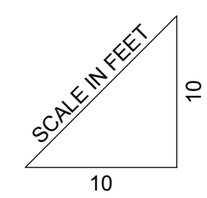
SILVER BOW CREEK
BRIDGE 10 (CULVERT)
PLAN AND PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

DATE: 10-31-18







NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF CULVERT
2. CULVERT LENGTH = 39.5' (ALL CULVERTS).
3. CULVERT DIAMETER = 4.0' (ALL CULVERTS).
4. RIVER MILE = 5.24.

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 10 20

FIGURE 17

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 11 (CULVERT)
PLAN AND PROFILE

DATE: 10-31-18

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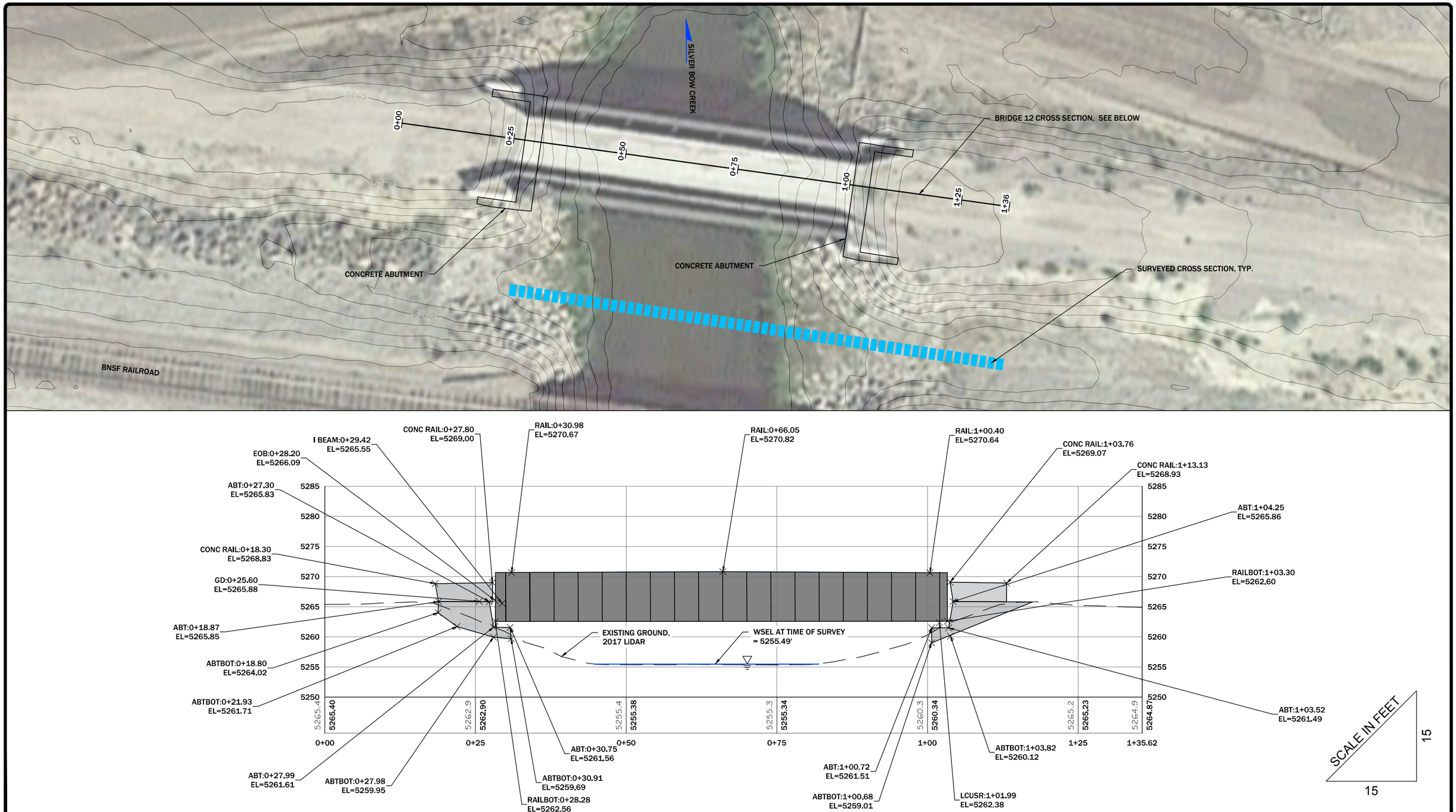


NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL AND CONCRETE
3. BRIDGE WIDTH = 21.0'.
4. SPAN 1 = WEST ABUTMENT TO EAST ABUTMENT= 69.97'.
5. RIVER MILE = 5.26

N

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

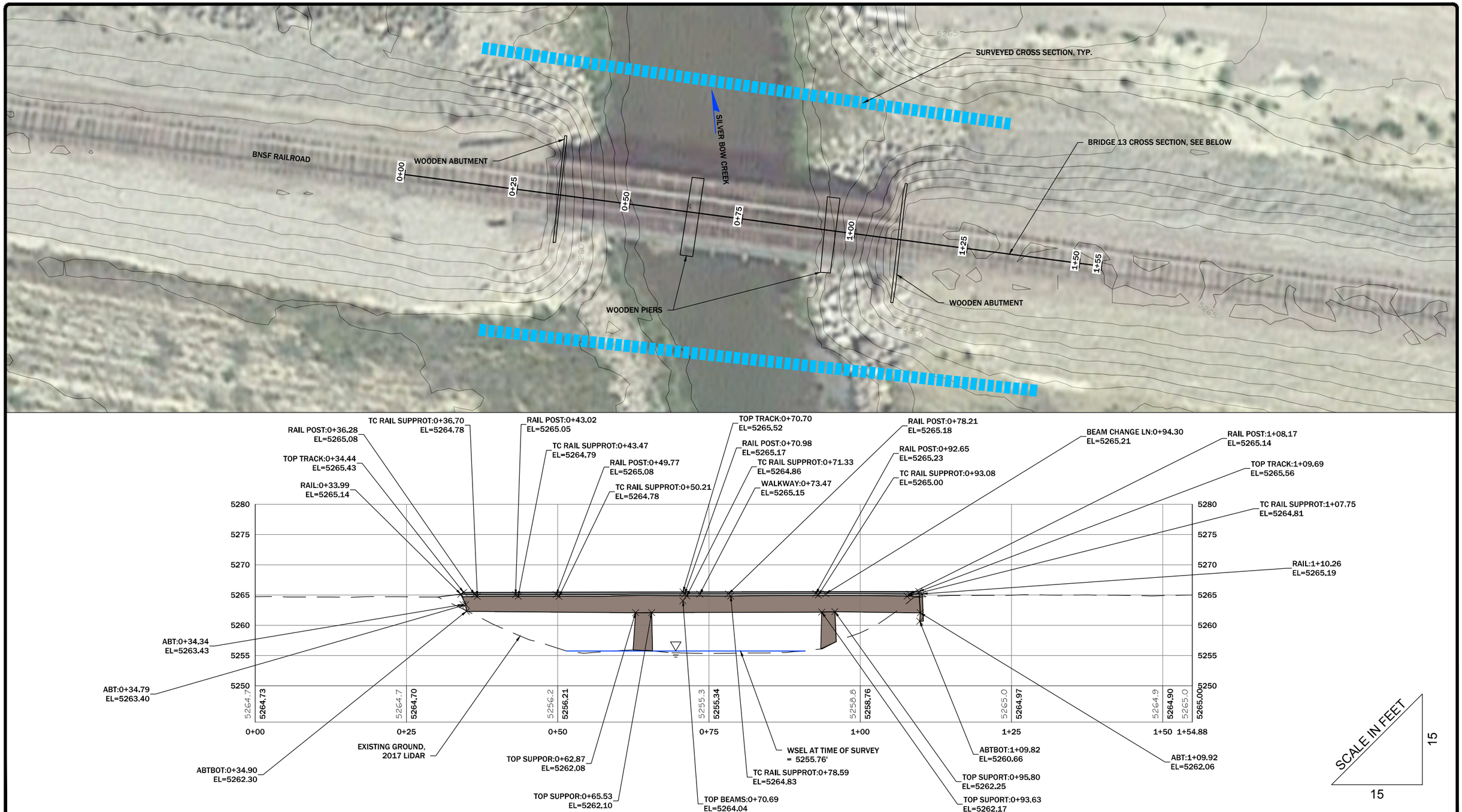
SCALE IN FEET
0 10 20

FIGURE 18

SILVER BOW CREEK
BRIDGE 12
PLAN AND PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

DATE: 10-31-18



NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL AND WOOD
3. BRIDGE WIDTH = 14.6'.
4. SPAN 1 = WEST ABUTMENT TO PIER 1 = 29.30'.
5. SPAN 2 = PIER 1 TO PIER 2 = 30.51'.
6. SPAN 3 = PIER 2 TO EAST ABUTMENT = 15.21'.
7. RIVER MILE = 5.27.

N

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

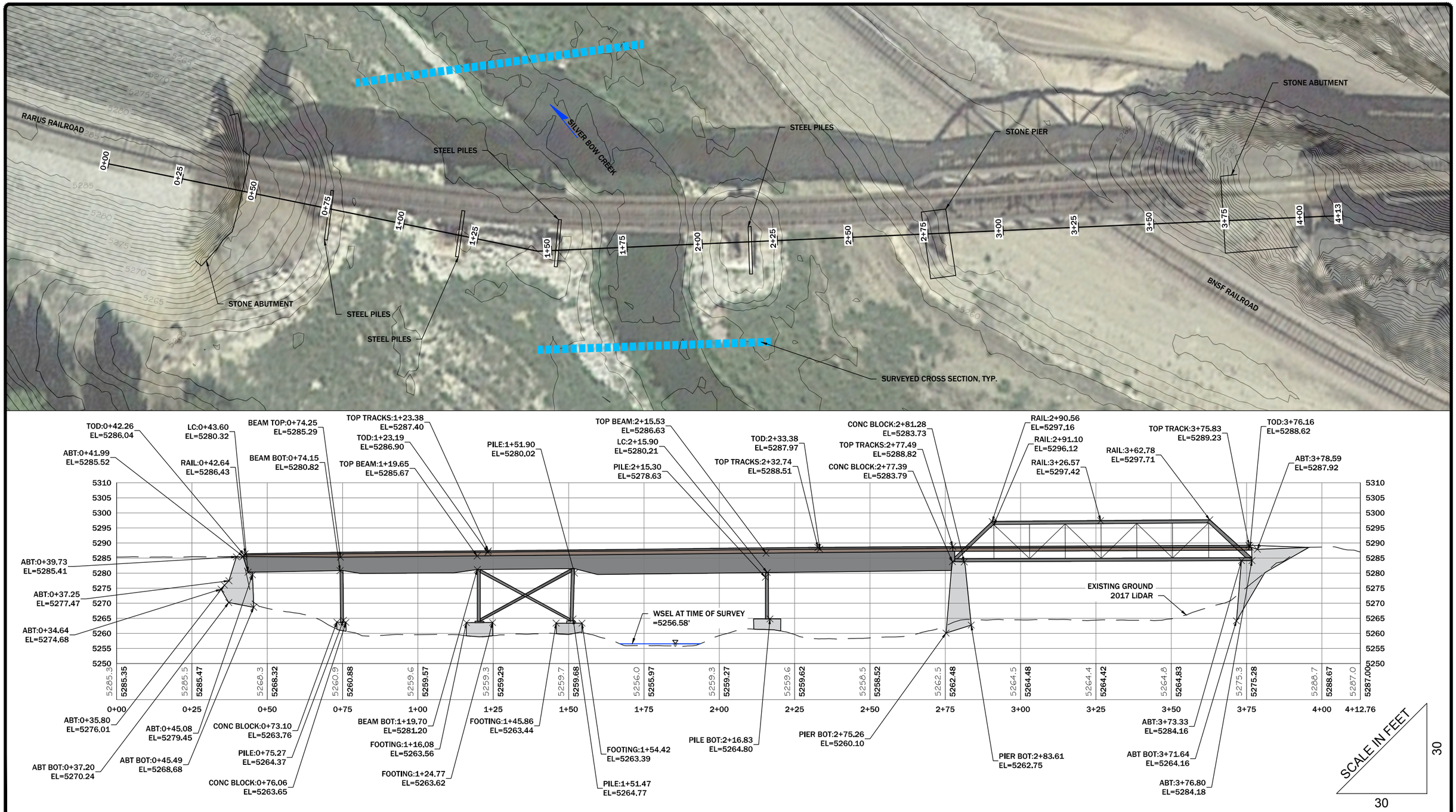
SCALE IN FEET
0 10 20

FIGURE 19

SILVER BOW CREEK
BRIDGE 13
PLAN AND PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

DATE: 10-31-18



NOTES:

1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL, CONCRETE, STONE AND WOOD
3. BRIDGE WIDTH = 11.0'
4. SPAN 1 = WEST ABUTMENT TO PIER 1 = 29.50'
5. SPAN 2 = PIER 1 TO PIER 2 = 60.70'
6. SPAN 3 = PIER 2 TO PIER 3 = 80.65'
7. SPAN 4 = PIER 3 TO PIER 4 = 63.43'
8. SPAN 5 = PIER 4 TO EAST ABUTMENT = 94.00'
9. RIVER MILE = 5.41

N

DISPLAYED AS:	
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 20

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK BRIDGE 14 PLAN AND PROFILE

DATE: 10-31-18

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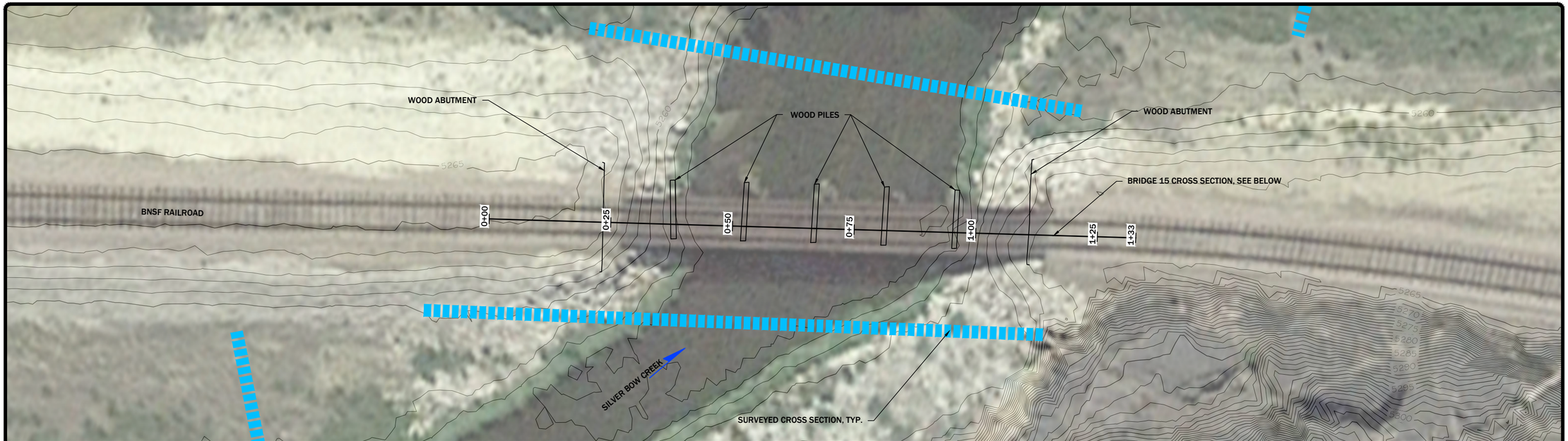
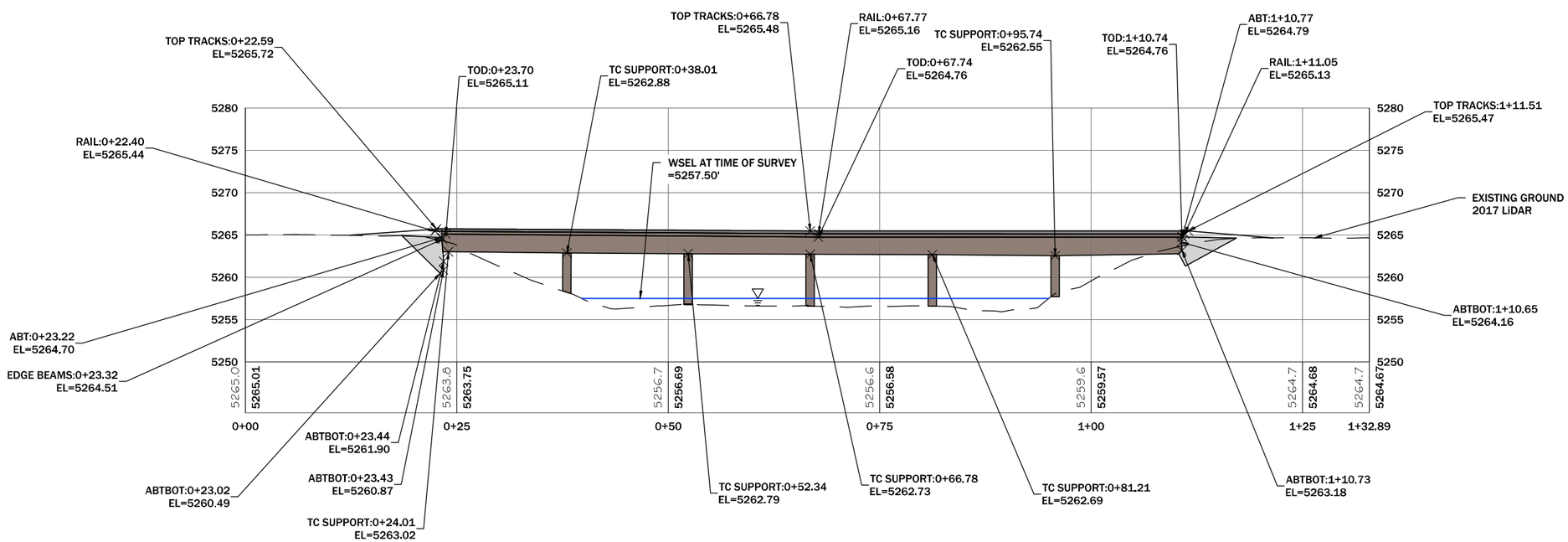




NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: WOOD AND CONCRETE
3. BRIDGE WIDTH = 10.0'
4. SPAN 1 = EAST ABUTMENT TO PIER 1 = 12.00'
5. SPAN 2 = PIER 1 TO PIER 2 = 14.33'
6. SPAN 3 = PIER 2 TO PIER 3 = 18.44'
7. SPAN 4 = PIER 3 TO PIER 4 = 14.43'
8. SPAN 5 = PIER 4 TO PIER 5 = 14.53'
9. SPAN 6 = PIER 5 TO WEST ABUTMENT = 14.64'
10. RIVER MILE = 5.49

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

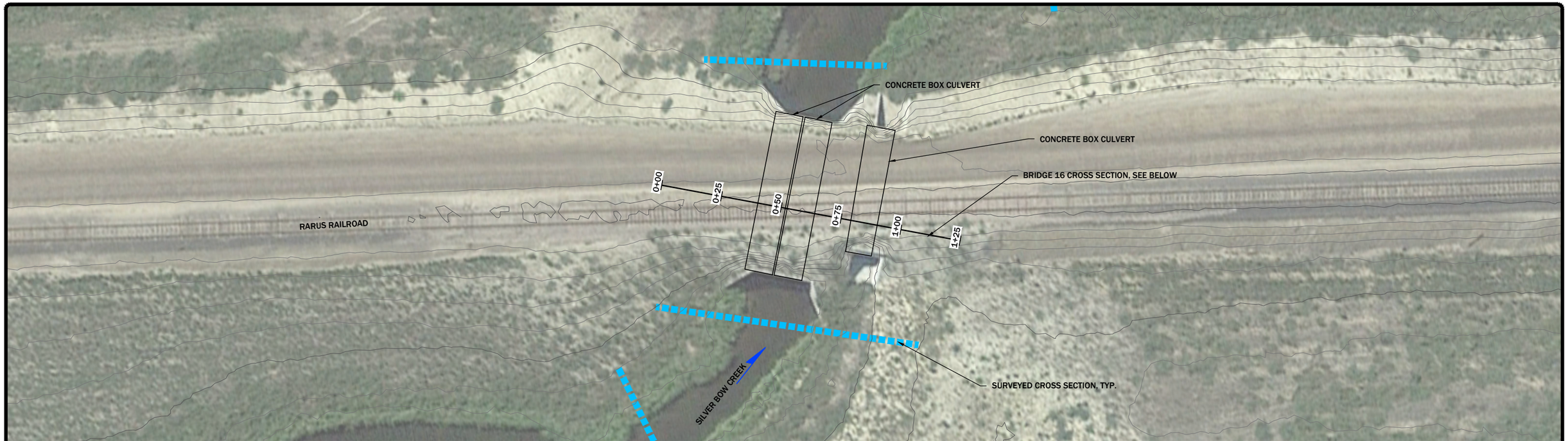
SCALE IN FEET
0 10 20

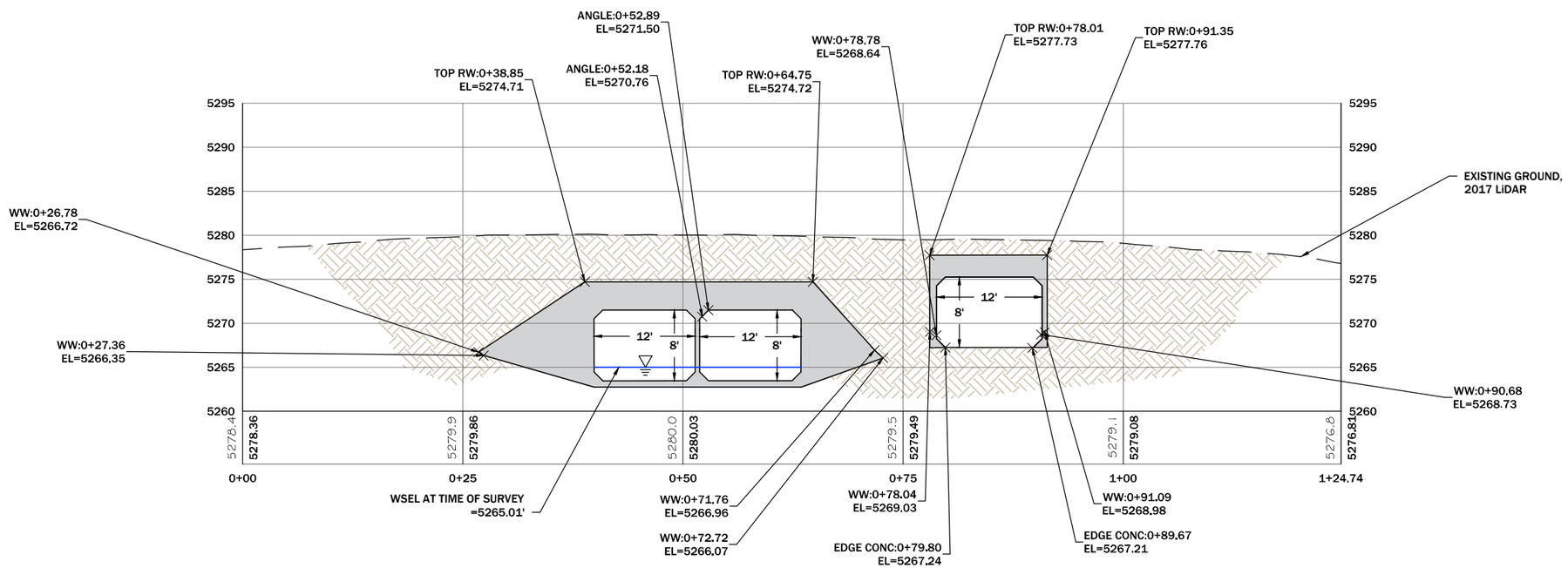
FIGURE 21

SILVER BOW CREEK
BRIDGE 15
PLAN AND PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

DATE: 10-31-18





NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF CULVERT
2. CULVERT SPAN = 12' (ALL CULVERTS)
3. CULVERT RISE = 8' (ALL CULVERTS)
4. CULVERT 1 AND 2 LENGTH = 66.20'
5. CULVERT 3 LENGTH = 48.60'
6. RIVER MILE = 6.31

N

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 20 40

FIGURE 22

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 16
PLAN AND PROFILE

DATE: 10-31-18

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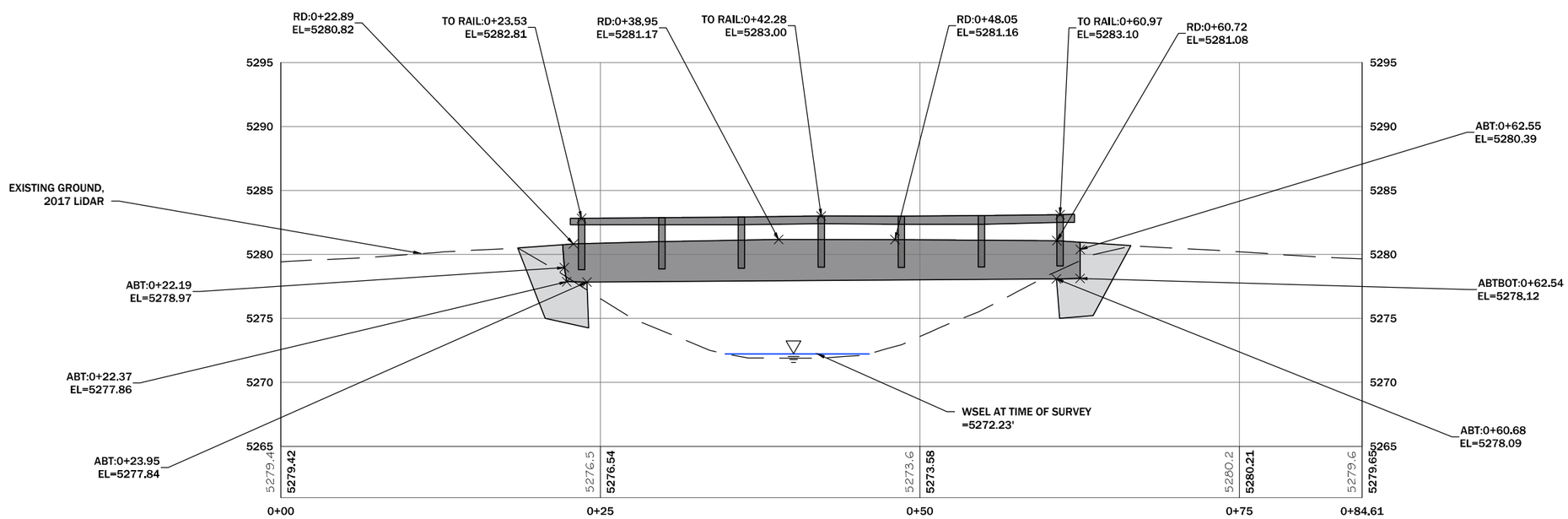
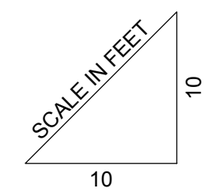




NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL AND CONCRETE
3. BRIDGE WIDTH = 14.5'
4. SPAN 1 = SOUTH ABUTMENT TO NORTH ABUTMENT= 36.7'
5. RIVER MILE = 6.92

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

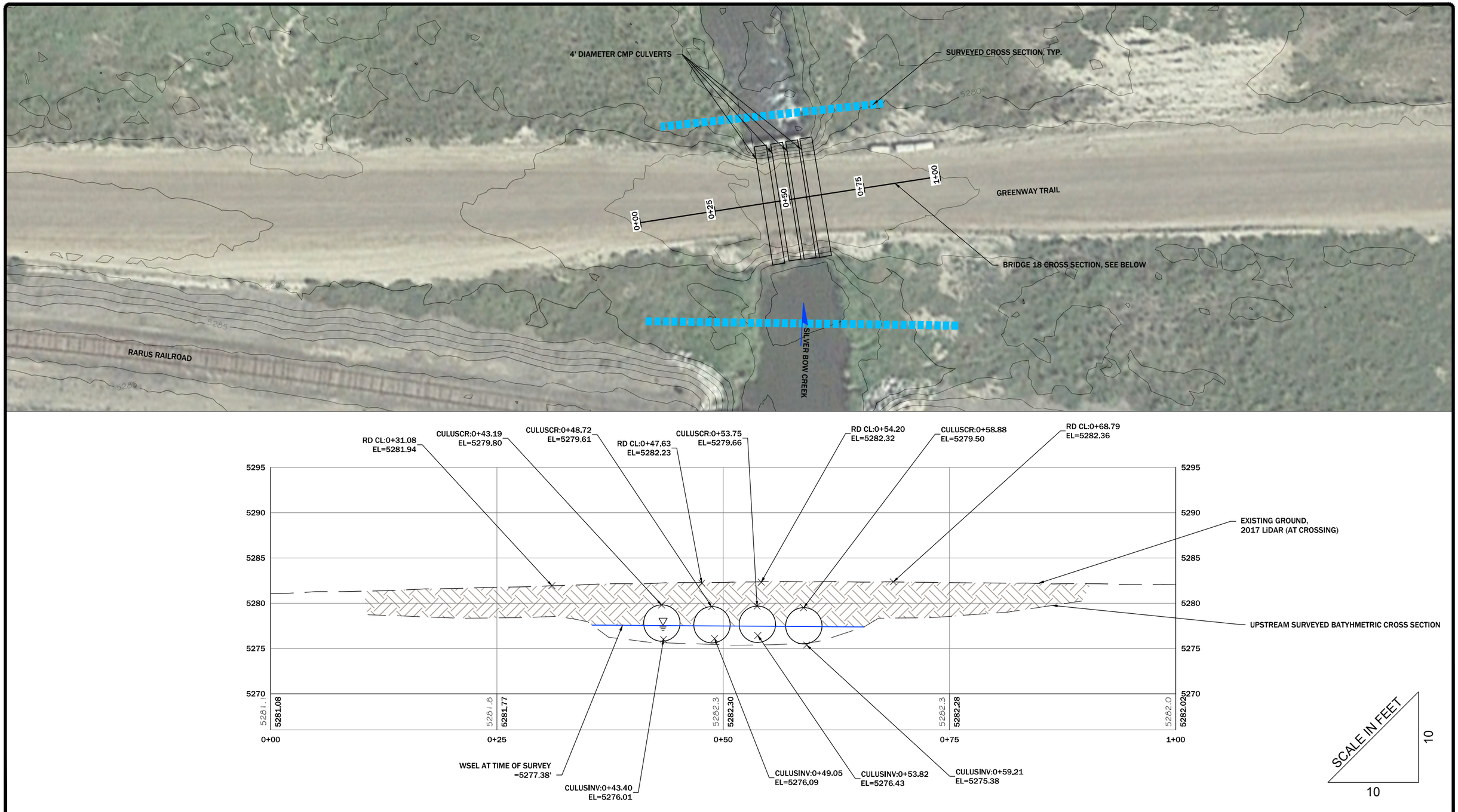
SCALE IN FEET
0 15 30

FIGURE 23

SILVER BOW CREEK
BRIDGE 17
PLAN AND PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

DATE: 10-31-18



NOTES:

1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF CULVERT
2. CLUVERT LENGTH = 39.7' (ALL CULVERTS).
3. CULVERT DIAMETER = 4.0' (ALL CULVERTS).
4. RIVER MILE = 7.29.

N

DISPLAYED AS:	
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 24

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 18 (CULVERT)
PLAN AND PROFILE

DATE: 10-31-18

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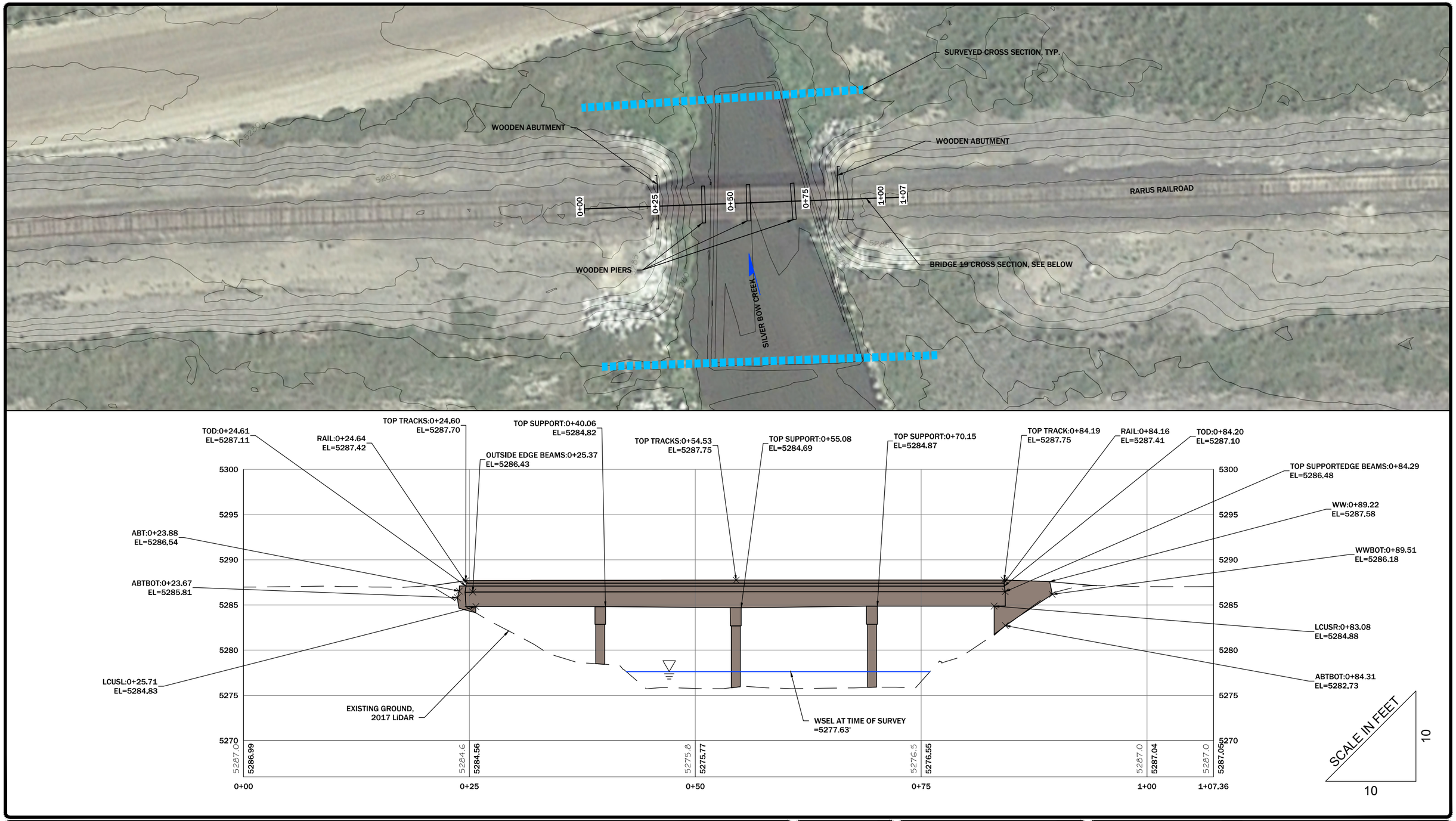


NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: WOOD
3. BRIDGE WIDTH = 10.0'
4. SPAN 1 = WEST ABUTMENT TO PIER 1 = 13.75'
5. SPAN 2 = PIER 1 TO PIER 2 = 15.02'
6. SPAN 3 = PIER 2 TO PIER 3 = 15.07'
7. SPAN 4 = PIER 3 TO EAST ABUTMENT = 13.53'
8. RIVER MILE = 7.30

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

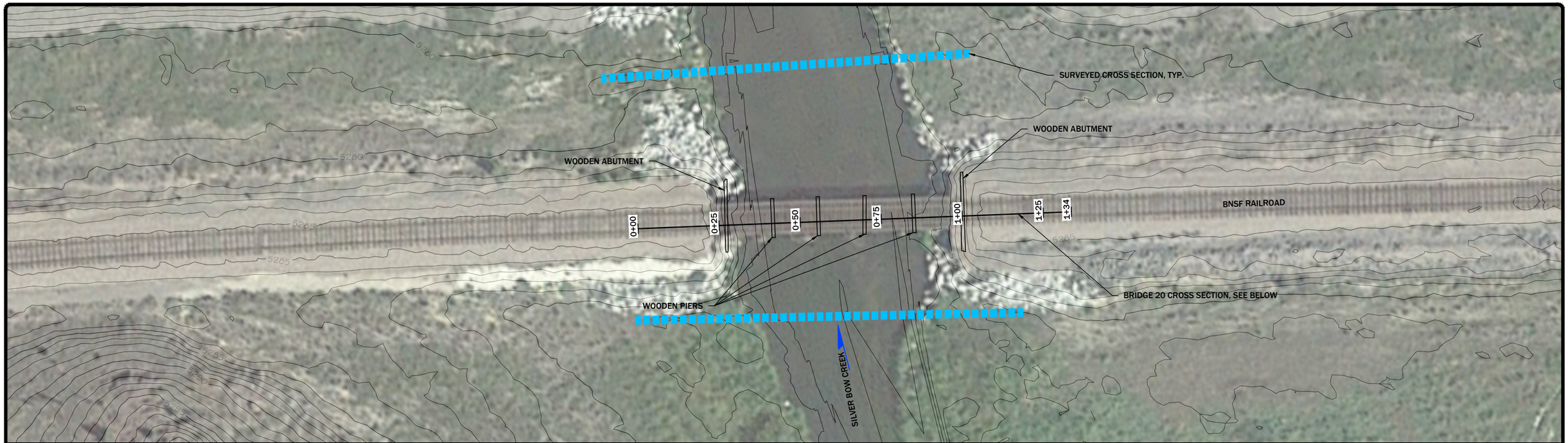
SCALE IN FEET
0 15 30

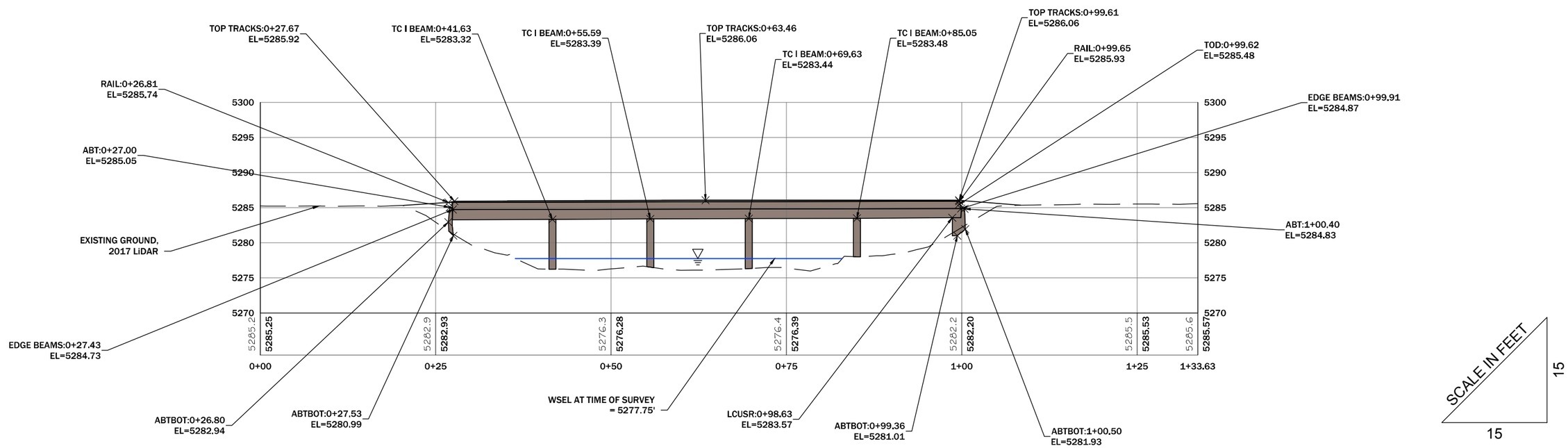
FIGURE 25

SILVER BOW CREEK
BRIDGE 19
PLAN AND PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

DATE: 10-31-18





NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: WOOD
3. BRIDGE WIDTH = 10.0'
4. SPAN 1 = WEST ABUTMENT TO PIER 1 = 14.10'
5. SPAN 2 = PIER 1 TO PIER 2 = 13.96'
6. SPAN 3 = PIER 2 TO PIER 3 = 14.04'
7. SPAN 4 = PIER 3 TO PIER 4 = 15.42'
8. SPAN 5 = PIER 4 TO EAST ABUTMENT = 13.58'
9. RIVER MILE = 7.34

N

DISPLAYED AS:	
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 26

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 20
PLAN AND PROFILE

DATE: 10-31-18

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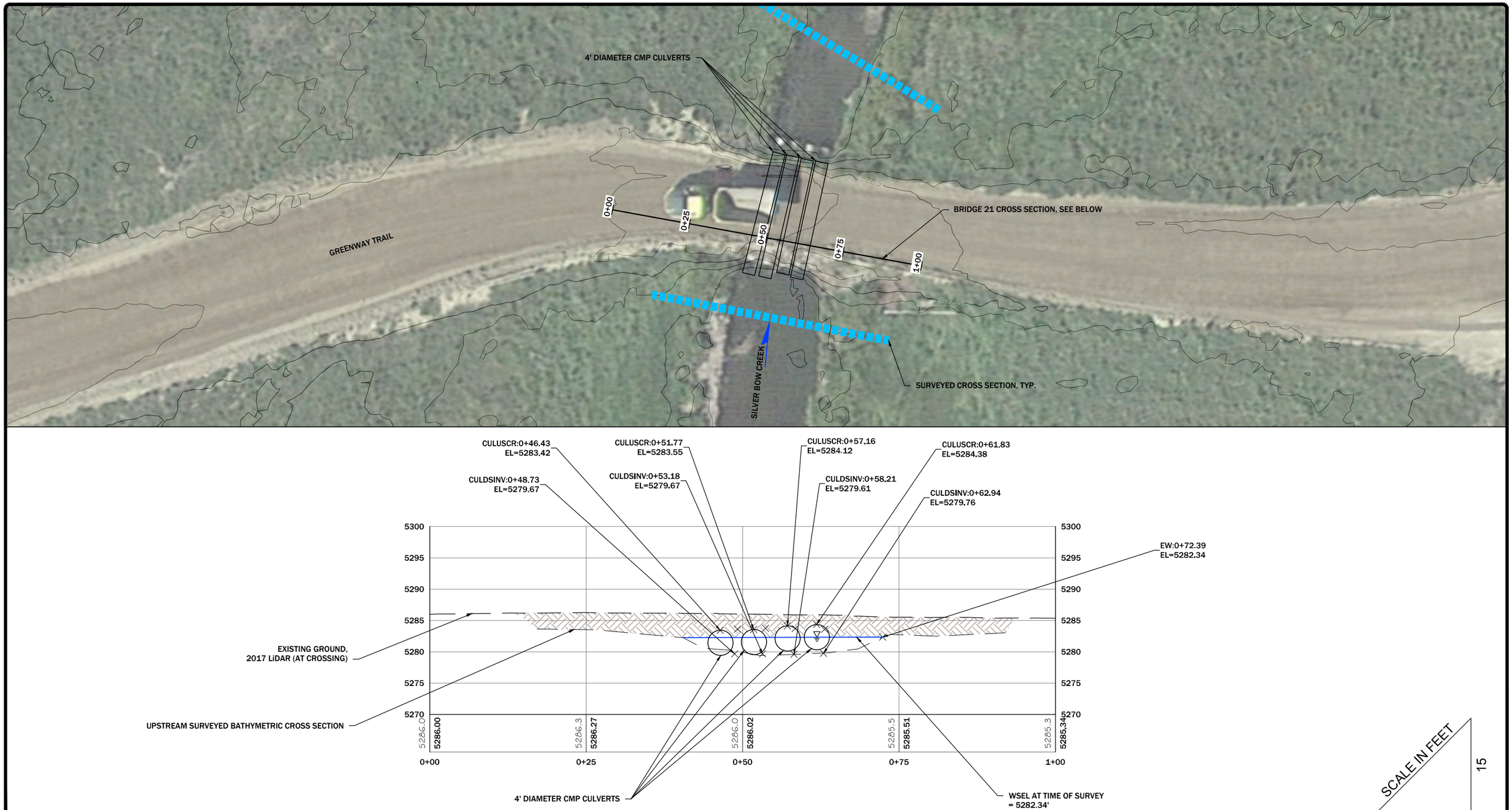

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF CULVERT
2. CULVERT 1 AND 2 LENGTH = 40.0'
3. CULVERT 3 LENGTH = 37.3'
4. CULVERT 4 LENGTH = 38.0'
5. CULVERT DIAMETER = 4.0' (ALL CULVERTS).
6. RIVER MILE = 7.78.

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 27

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 21
PLAN AND PROFILE

DATE: 10-31-18

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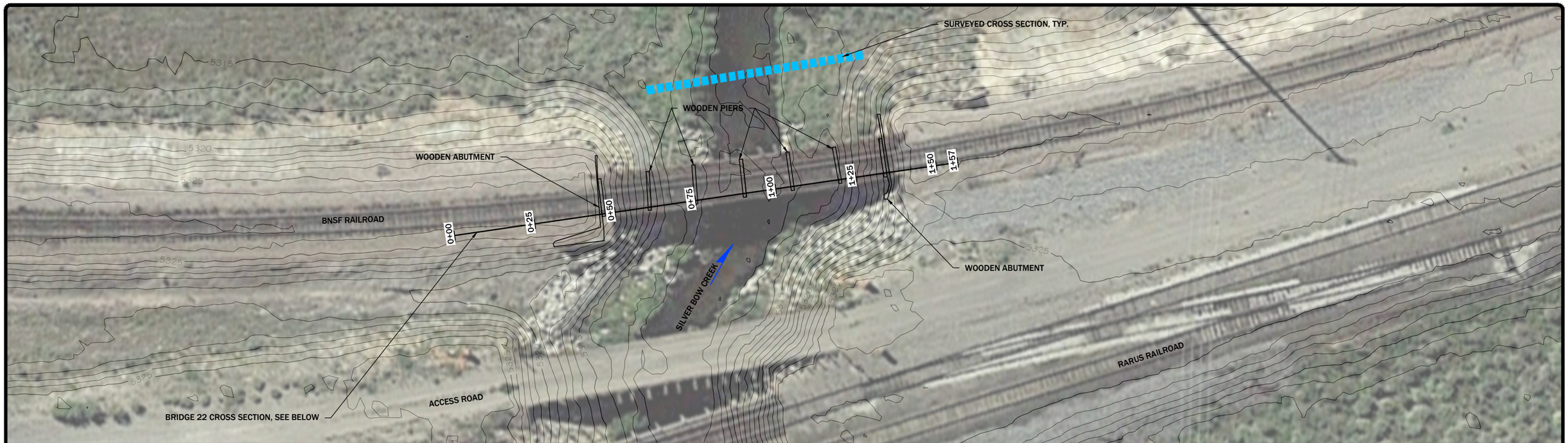

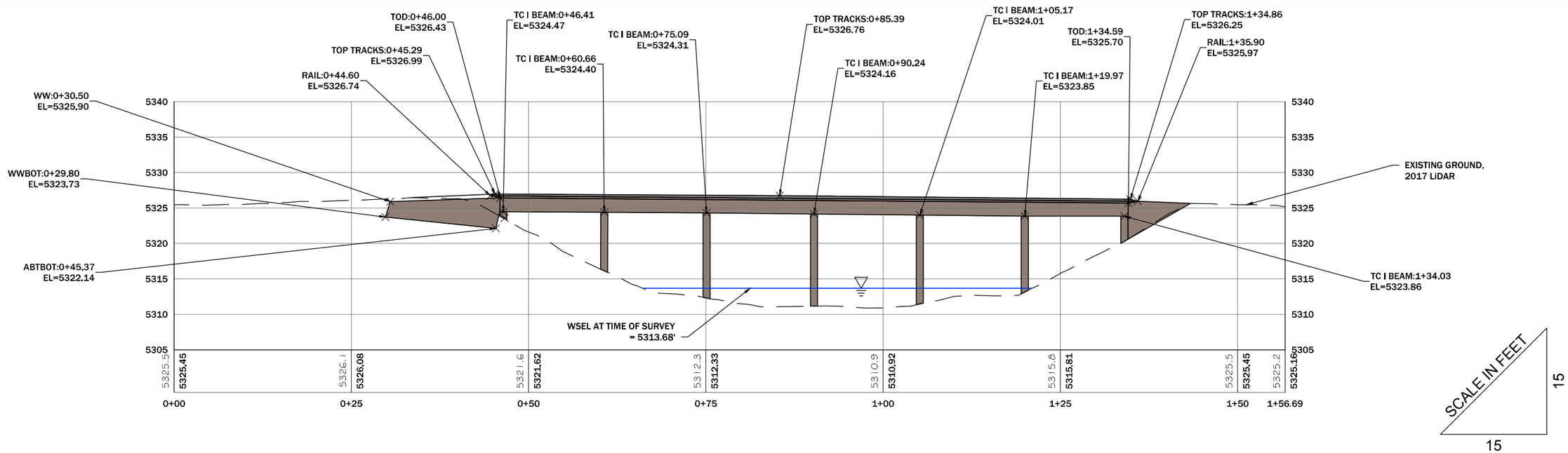

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: WOOD AND STEEL
3. BRIDGE WIDTH = 13.0'
4. SPAN 1 = EAST ABUTMENT TO PIER 1 = 13.75'
5. SPAN 2 = PIER 1 TO PIER 2 = 14.43'
6. SPAN 3 = PIER 2 TO PIER 3 = 15.15'
7. SPAN 4 = PIER 3 TO PIER 4 = 14.93'
8. SPAN 5 = PIER 4 TO PIER 5 = 14.80'
9. SPAN 6 = PIER 5 TO WEST ABUTMENT = 13.56'
10. RIVER MILE = 10.63

N

DISPLAYED AS:	
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 28

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 22
PLAN AND PROFILE

DATE: 10-31-18

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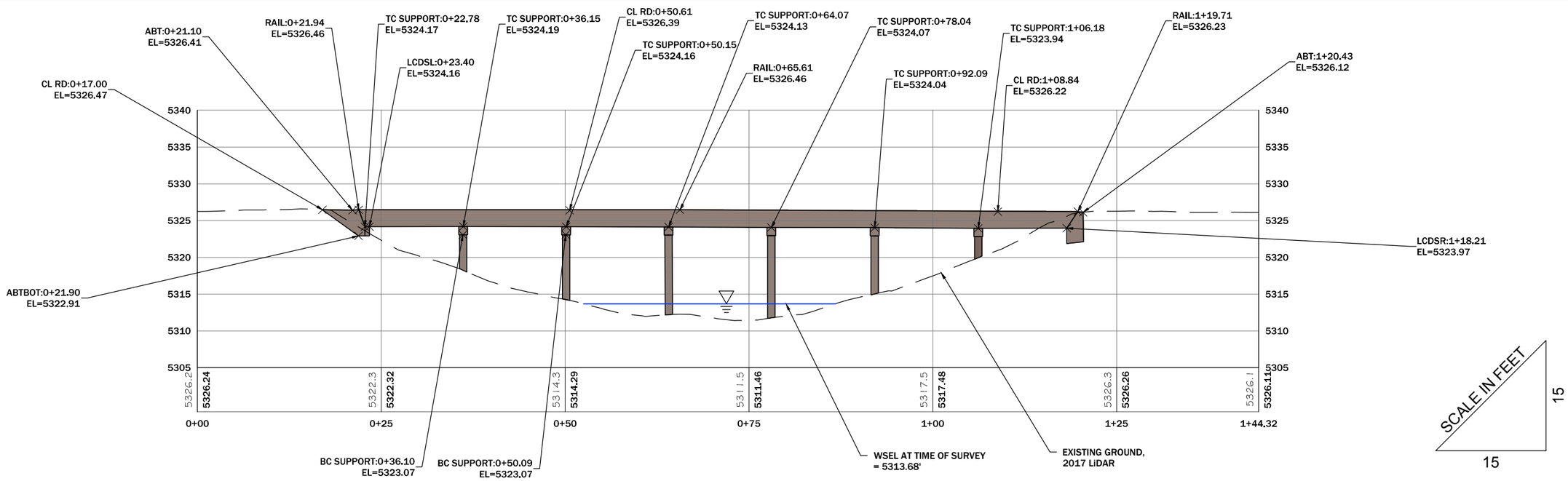

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: WOOD
3. BRIDGE WIDTH = 14.3'
4. SPAN 1 = EAST ABUTMENT TO PIER 1 = 12.75'
5. SPAN 2 = PIER 1 TO PIER 2 = 13.94'
6. SPAN 3 = PIER 2 TO PIER 3 = 13.98'
7. SPAN 4 = PIER 3 TO PIER 4 = 13.97'
8. SPAN 5 = PIER 4 TO PIER 5 = 14.05'
9. SPAN 6 = PIER 5 TO PIER 6 = 14.09'
10. SPAN 7 = PIER 6 TO WEST ABUTMENT = 12.03'
11. RIVER MILE = 10.65

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 29

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 23
PLAN AND PROFILE

DATE: 10-31-18

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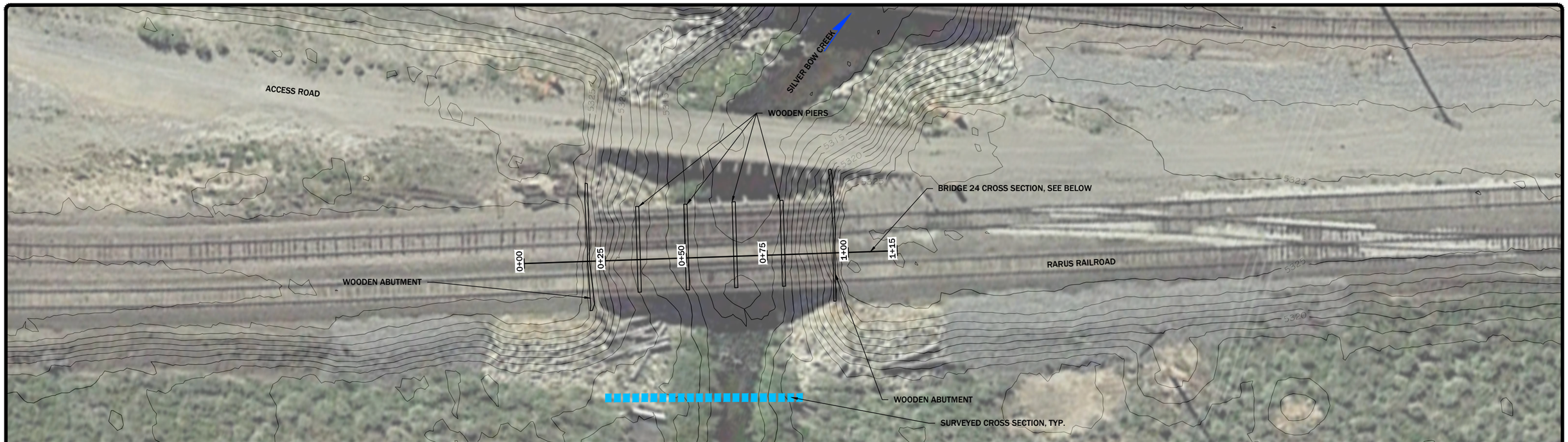

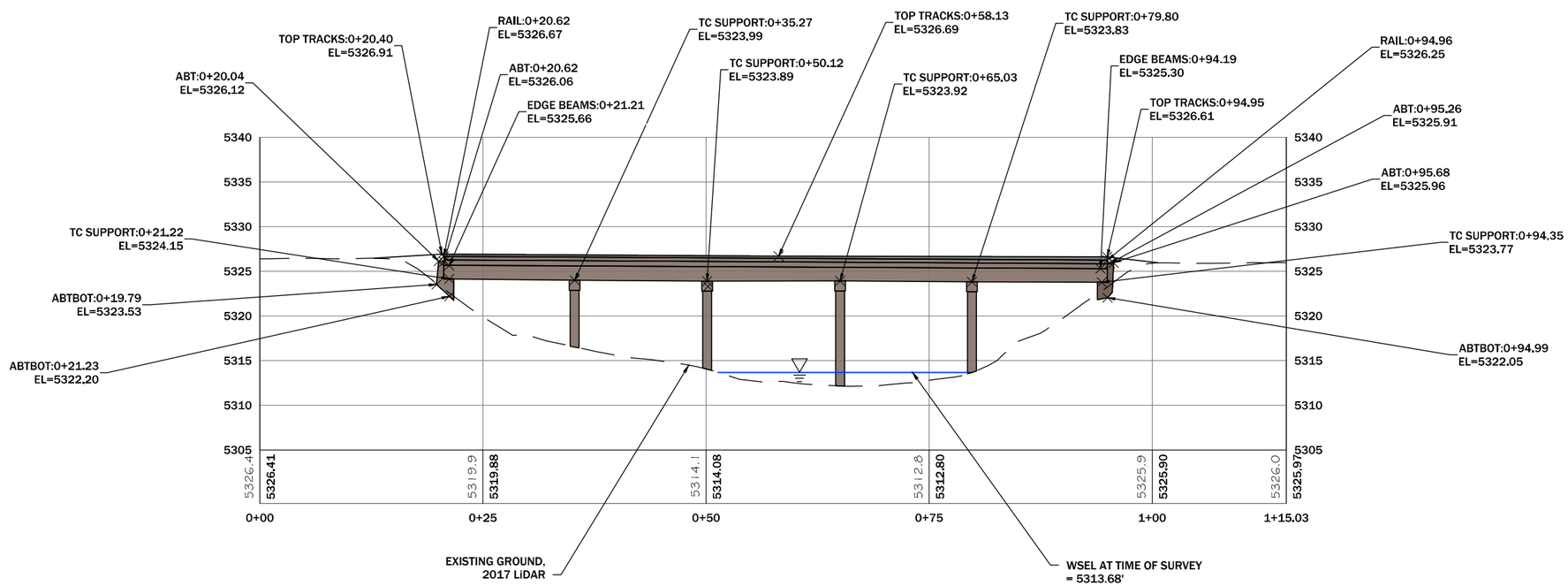

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: WOOD AND STEEL
3. BRIDGE WIDTH = 21.5'
4. SPAN 1 = EAST ABUTMENT TO PIER 1 = 13.55'
5. SPAN 2 = PIER 1 TO PIER 2 = 14.85'
6. SPAN 3 = PIER 2 TO PIER 3 = 14.91'
7. SPAN 4 = PIER 3 TO PIER 4 = 14.77'
8. SPAN 6 = PIER 4 TO WEST ABUTMENT = 14.05'
9. RIVER MILE = 10.66

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 30

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 24
PLAN AND PROFILE

DATE: 10-31-18

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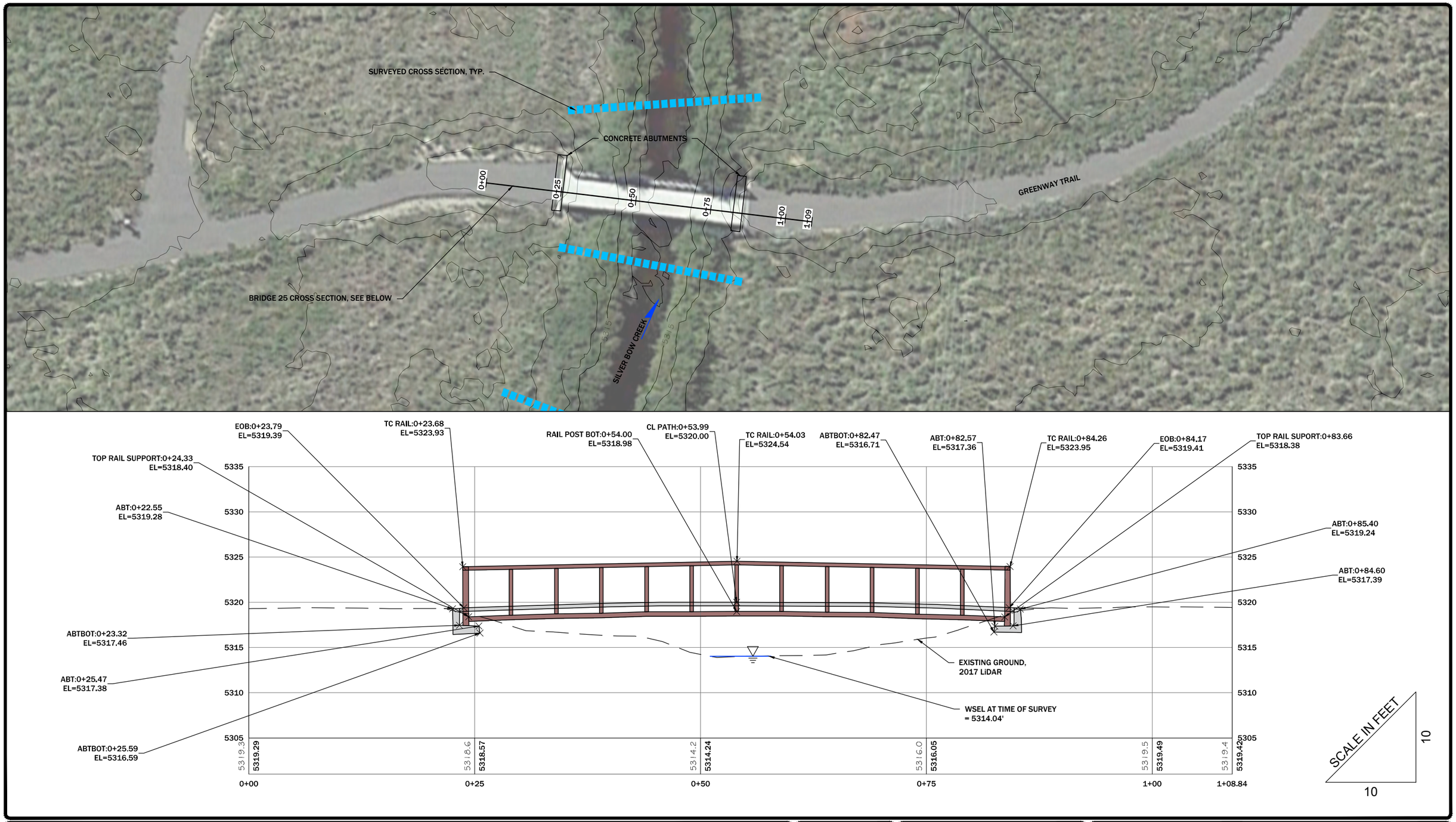

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL AND CONCRETE
3. BRIDGE WIDTH = 13.2'
4. SPAN 1 = EAST ABUTMENT TO WEST ABUTMENT= 56.9'
5. RIVER MILE = 10.70

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 31

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 25
PLAN AND PROFILE

DATE: 10-31-18

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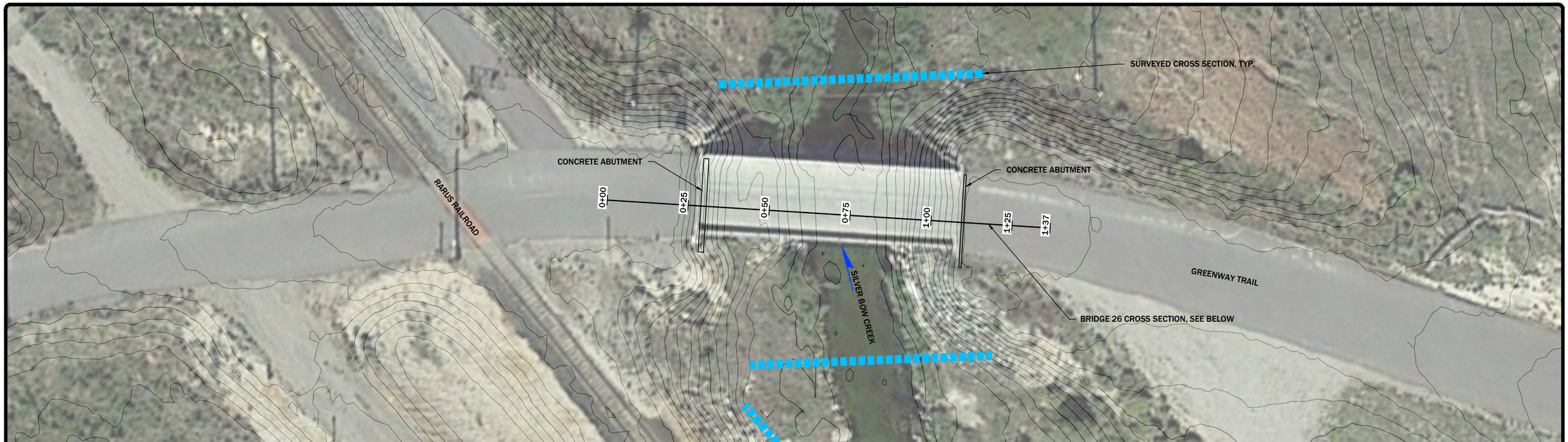
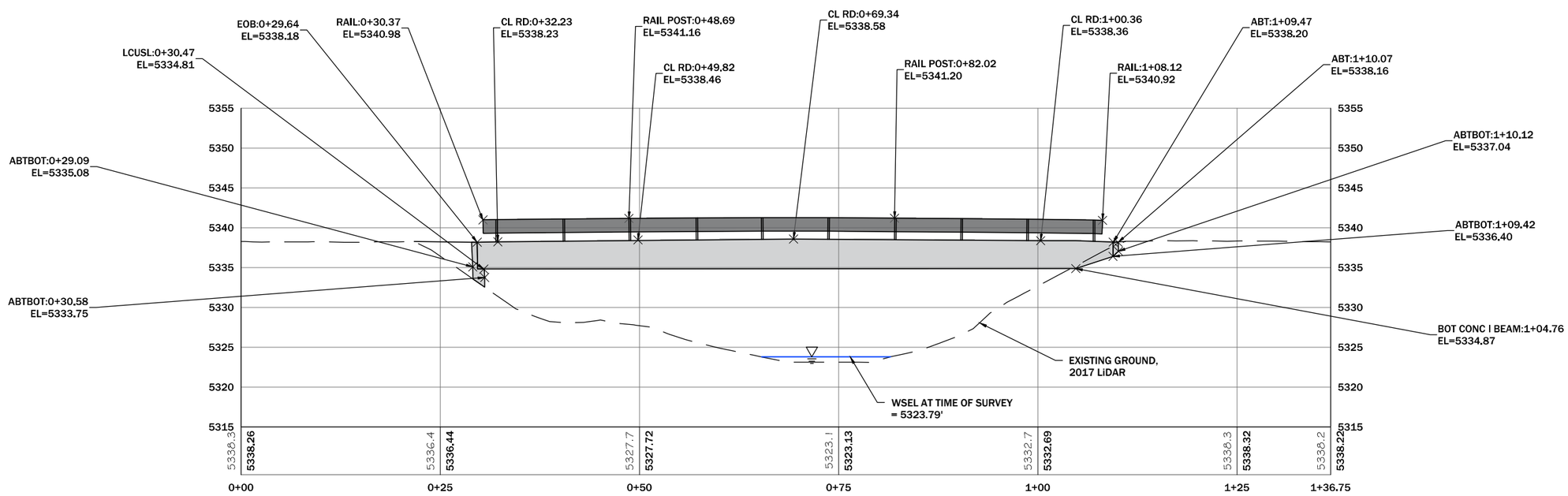
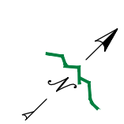




NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL AND CONCRETE
3. BRIDGE WIDTH = 24.0'
4. SPAN 1 = WEST ABUTMENT TO EAST ABUTMENT= 74.3'
5. RIVER MILE = 11.49



	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 32

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 26
PLAN AND PROFILE

DATE: 10-31-18

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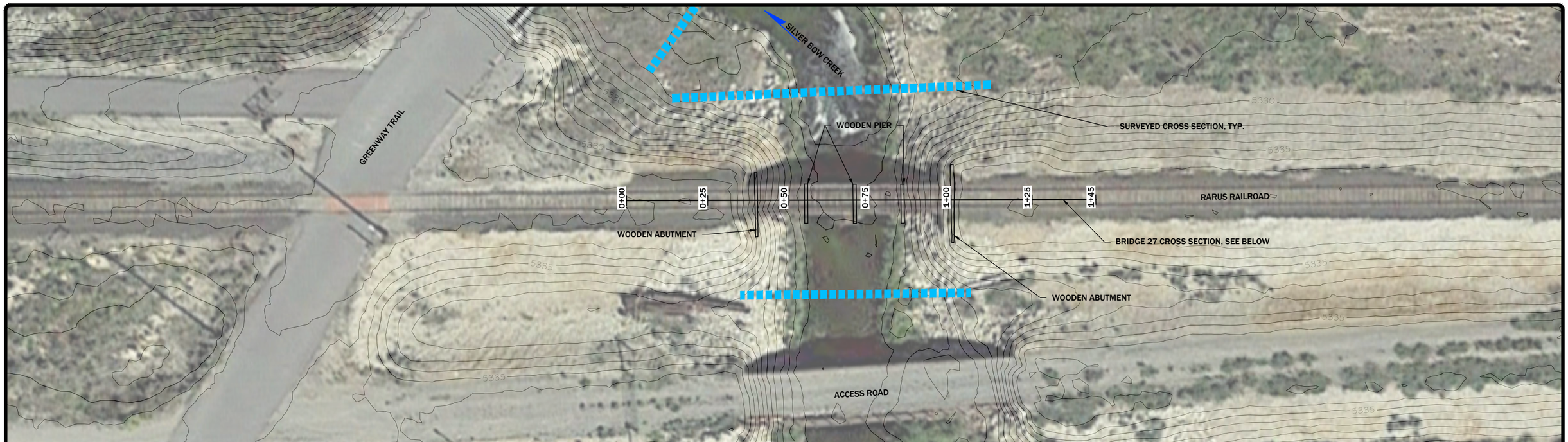
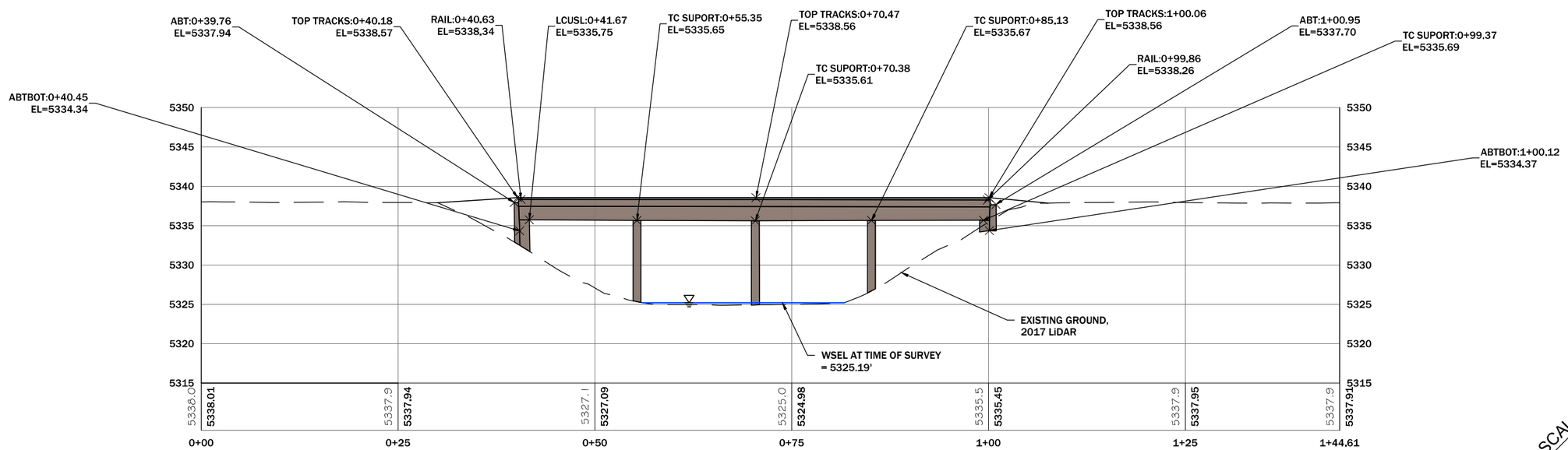




NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: WOOD
3. BRIDGE WIDTH = 9.2'
4. SPAN 1 = WEST ABUTMENT TO PIER 1 = 13.68'
5. SPAN 2 = PIER 1 TO PIER 2 = 15.03'
6. SPAN 3 = PIER 2 TO PIER 3 = 14.75'
7. SPAN 4 = PIER 3 TO EAST ABUTMENT = 13.74'
8. RIVER MILE = 11.52

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

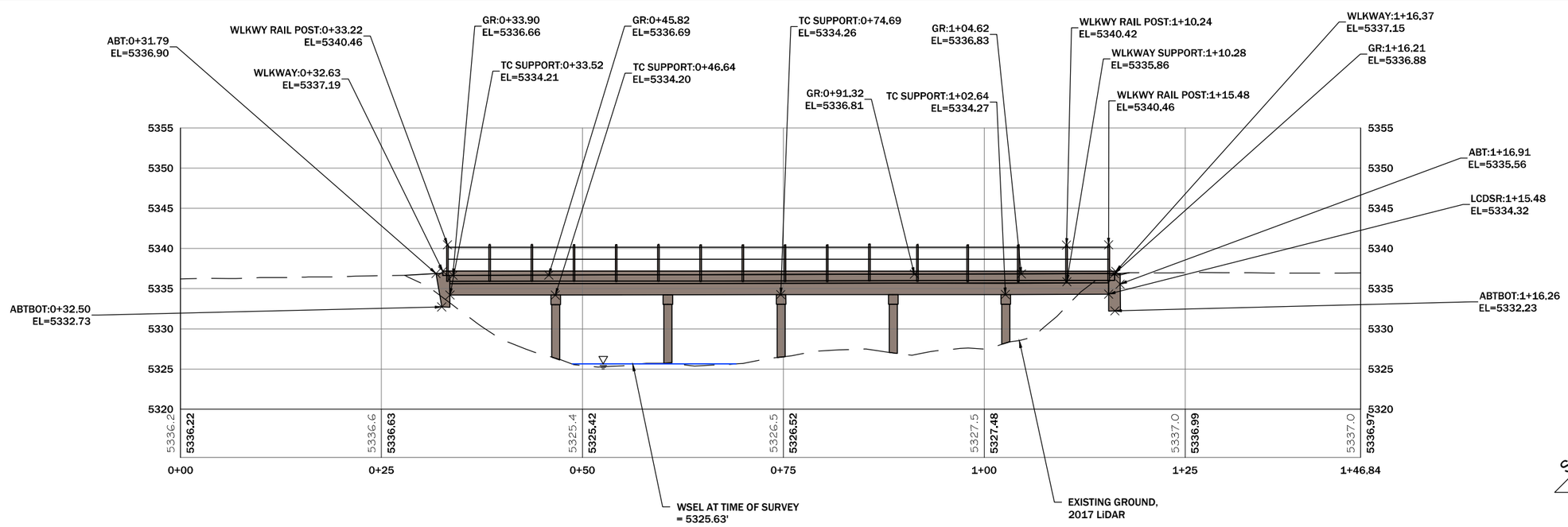
SCALE IN FEET
0 15 30

FIGURE 33

SILVER BOW CREEK
BRIDGE 27
PLAN AND PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

DATE: 10-31-18



NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: WOOD
3. BRIDGE WIDTH = 16.5'
4. SPAN 1 = EAST ABUTMENT TO PIER 1 = 13.12'
5. SPAN 2 = PIER 1 TO PIER 2 = 13.97'
6. SPAN 3 = PIER 2 TO PIER 3 = 14.08'
7. SPAN 4 = PIER 3 TO PIER 4 = 13.99'
8. SPAN 5 = PIER 4 TO PIER 5 = 13.96'
9. SPAN 6 = PIER 5 TO WEST ABUTMENT = 12.84'
10. RIVER MILE = 11.53

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 34

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 28
PLAN AND PROFILE

DATE: 10-31-18

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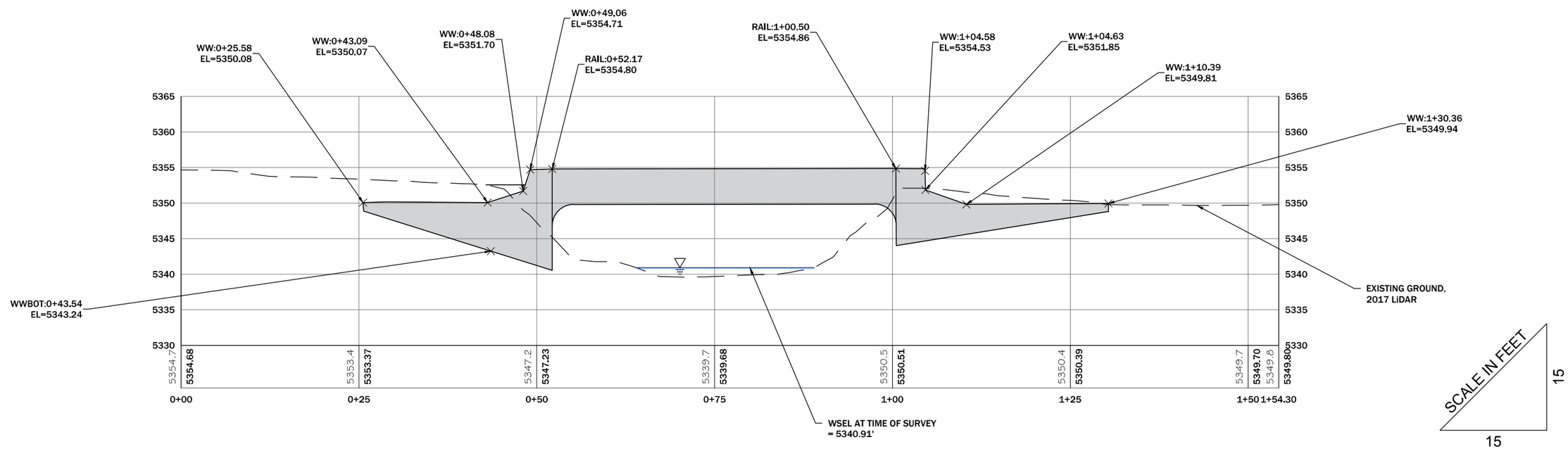

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL: CONCRETE
3. BRIDGE WIDTH: 18.5'
4. SPAN 1 = SOUTH ABUTMENT TO NORTH ABUTMENT = 46.8'
5. RIVER MILE: 12.40

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 35

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 29
PLAN AND PROFILE

DATE: 10-31-18

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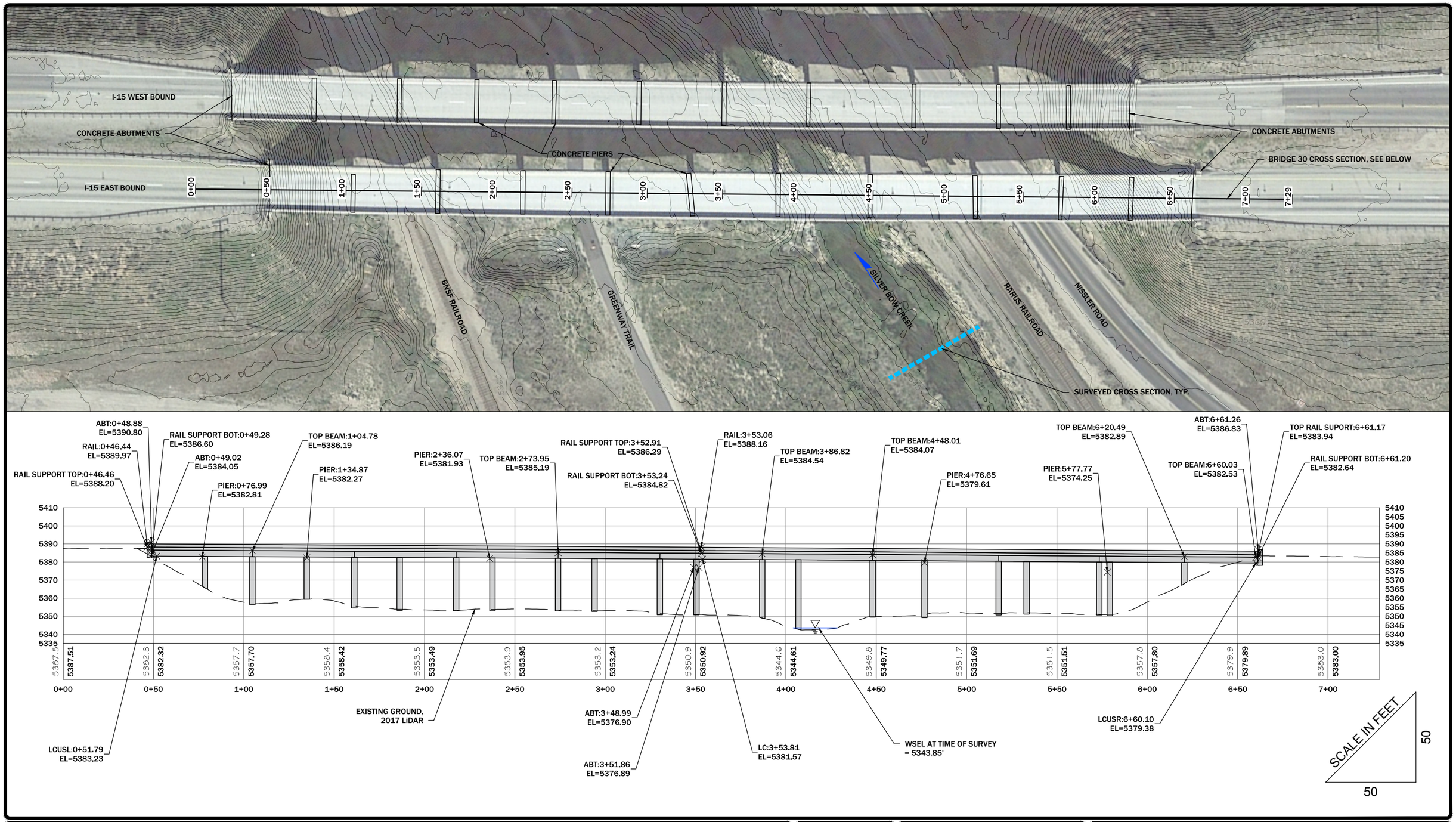

NOTES:

1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL: CONCRETE AND STEEL
3. BRIDGE WIDTH: 89.6'
4. SPAN 1 = SOUTH ABUTMENT TO PIER 1 = 26.69'
5. SPAN 2 = PIER 1 TO PIER 2 = 26.28'
6. SPAN 3 = PIER 2 TO PIER 3 = 30.18'
7. SPAN 4 = PIER 3 TO PIER 4 = 26.23'
8. SPAN 5 = PIER 4 TO PIER 5 = 25.05'
9. SPAN 6 = PIER 5 TO PIER 6 = 31.24'
10. SPAN 7 = PIER 6 TO PIER 7 = 20.12'
11. SPAN 8 = PIER 7 TO PIER 8 = 36.36'
12. SPAN 9 = PIER 8 TO PIER 9 = 20.10'
13. SPAN 10 = PIER 9 TO PIER 10 = 36.22'
14. SPAN 11 = PIER 10 TO PIER 11 = 20.25'
15. SPAN 12 = PIER 11 TO PIER 12 = 36.35'
16. SPAN 13 = PIER 12 TO PIER 13 = 20.03'
17. SPAN 14 = PIER 13 TO PIER 14 = 41.09'
18. SPAN 15 = PIER 14 TO PIER 15 = 28.65'
19. SPAN 16 = PIER 15 TO PIER 16 = 41.09'
20. SPAN 17 = PIER 16 TO PIER 17 = 15.51'
21. SPAN 18 = PIER 17 TO PIER 18 = 40.25'
22. SPAN 19 = PIER 18 TO PIER 19 = 5.87'
23. SPAN 20 = PIER 19 TO PIER 20 = 41.22'
24. SPAN 21 = PIER 20 TO NORTH ABUTMENT = 39.63'
25. RIVER MILE: 12.53

N

DISPLAYED AS:	
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 30 60

FIGURE 36

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 30
PLAN AND PROFILE

DATE: 10-31-18

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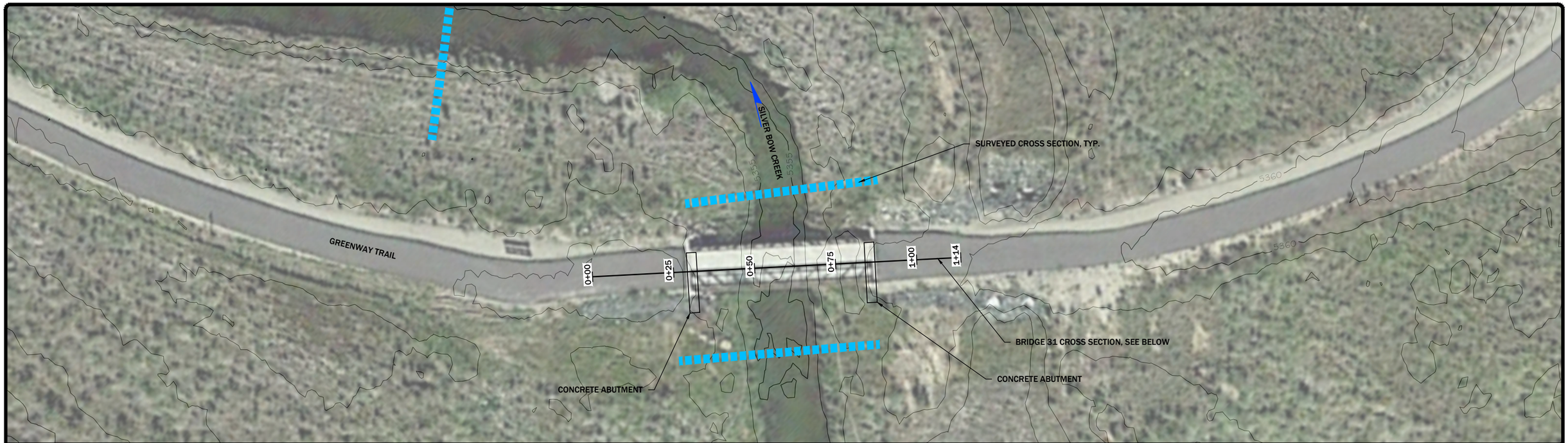

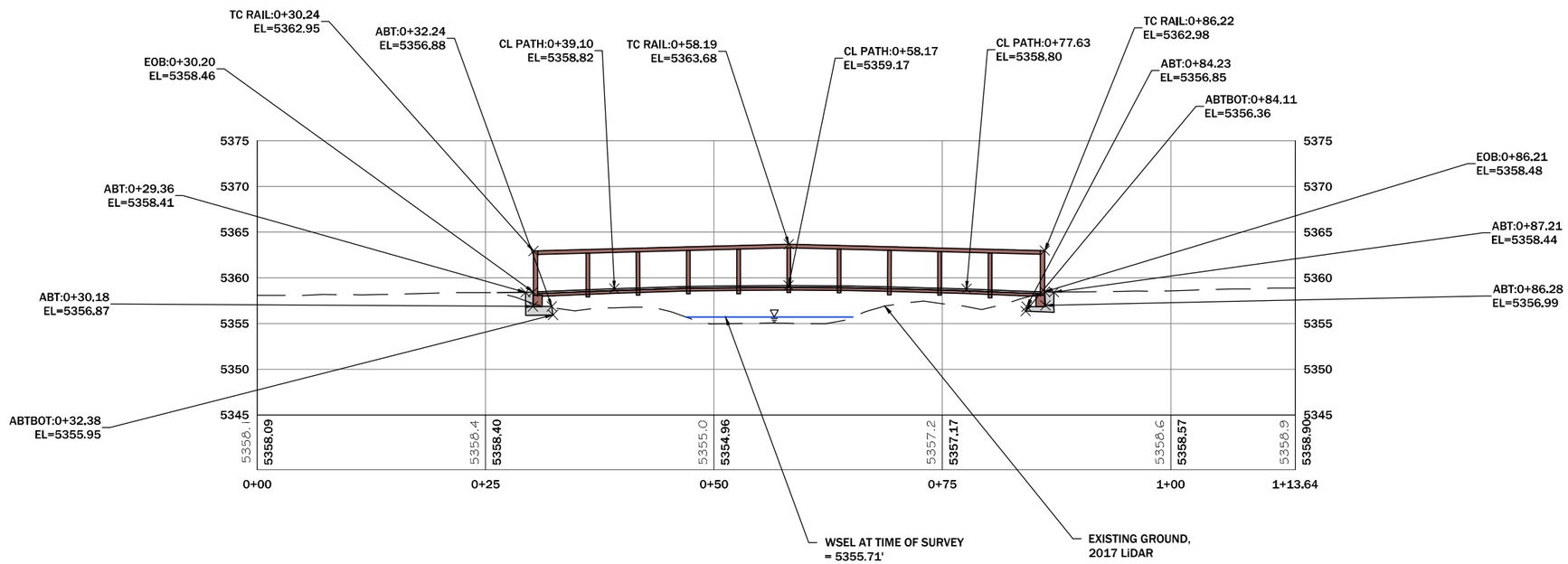

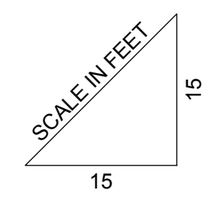

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL and CONCRETE
3. BRIDGE WIDTH = 13.0'
4. SPAN 1 = WEST ABUTMENT TO EAST ABUTMENT= 51.7'
5. RIVER MILE = 13.35

DISPLAYED AS:	
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 37

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 31
PLAN AND PROFILE

DATE: 10-31-18

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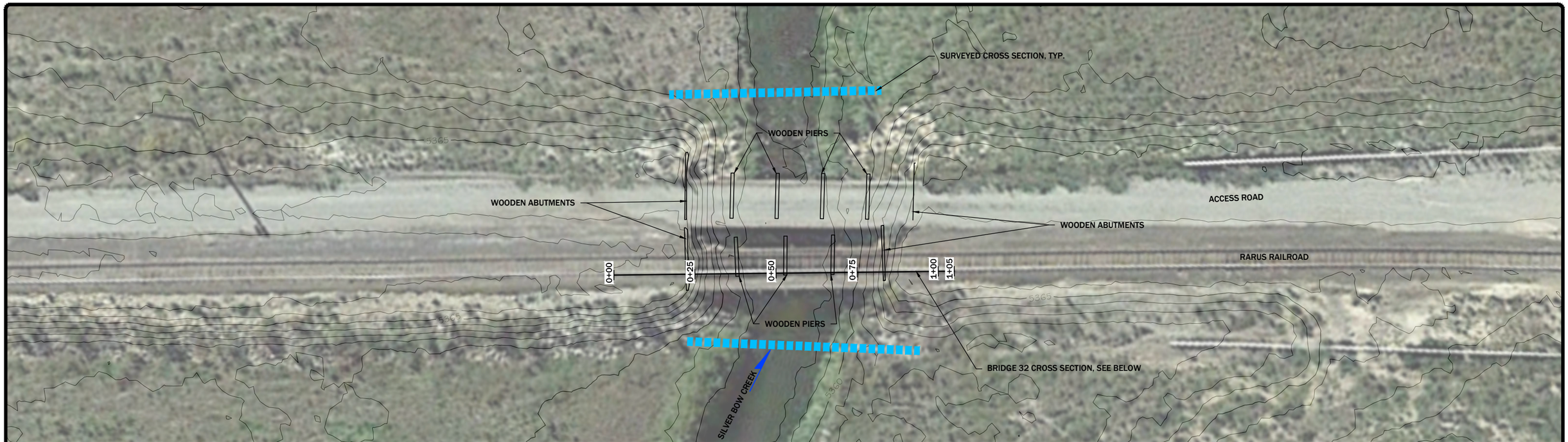

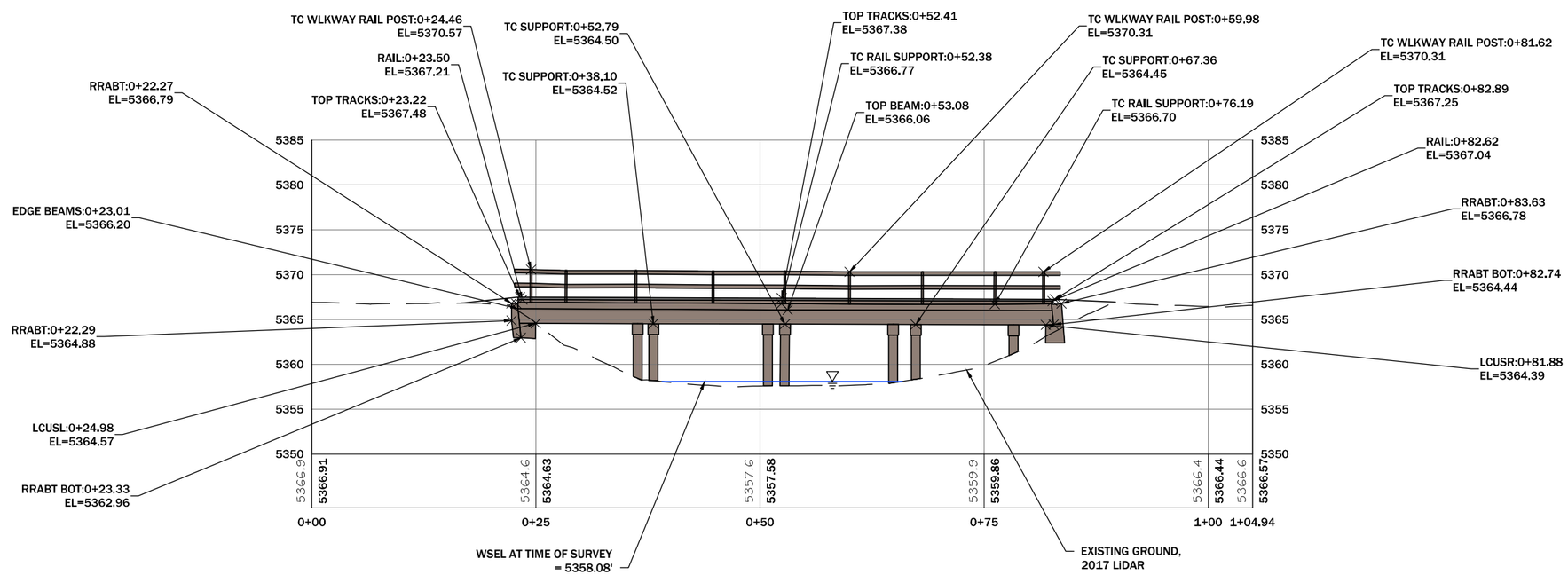

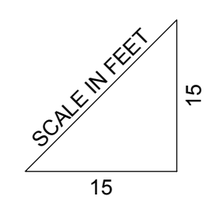

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: WOOD
3. BRIDGE WIDTH = 35.2'
4. SPAN 1 = EAST ABUTMENT TO PIER 1 = 11.36'
5. SPAN 2 = PIER 1 TO PIER 2 = 1.76'
6. SPAN 3 = PIER 2 TO PIER 3 = 12.78'
7. SPAN 4 = PIER 3 TO PIER 4 = 1.91'
8. SPAN 5 = PIER 4 TO PIER 5 = 12.06'
9. SPAN 6 = PIER 5 TO PIER 6 = 2.51'
10. SPAN 7 = PIER 6 TO PIER 7 = 10.91'
11. SPAN 8 = PIER 7 TO WEST ABUTMENT = 3.61'
12. RIVER MILE = 13.49

N

DISPLAYED AS:	
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 38

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 32
PLAN AND PROFILE

DATE: 10-31-18

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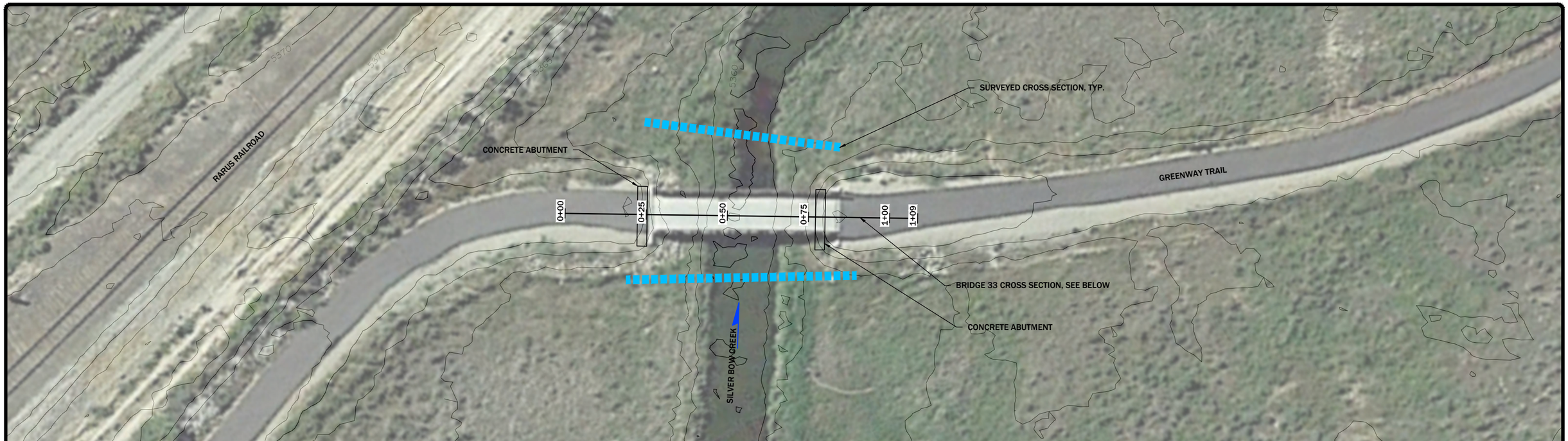

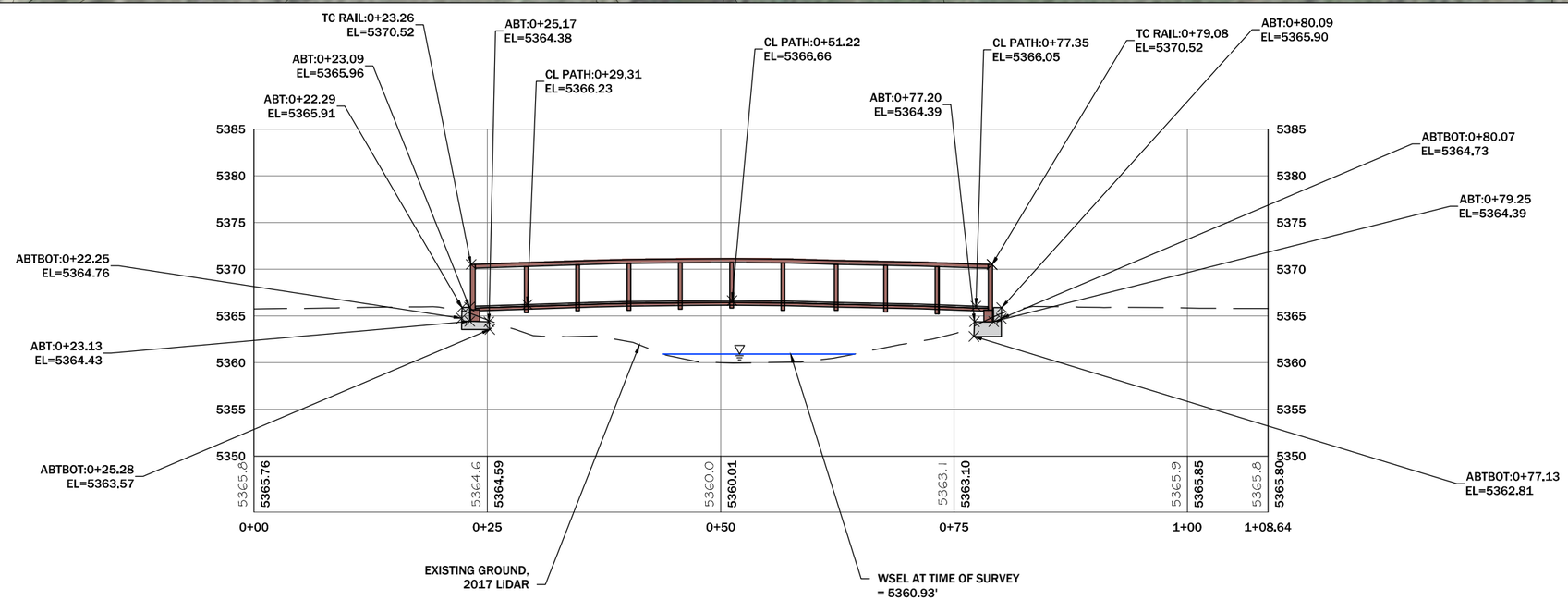

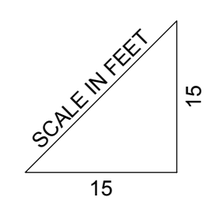

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL AND CONCRETE
3. BRIDGE WIDTH = 12.0'
4. SPAN 1 = WEST ABUTMENT TO EAST ABUTMENT= 51.85'
5. RIVER MILE = 13.66

N

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 39

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 33
PLAN AND PROFILE

DATE: 10-31-18

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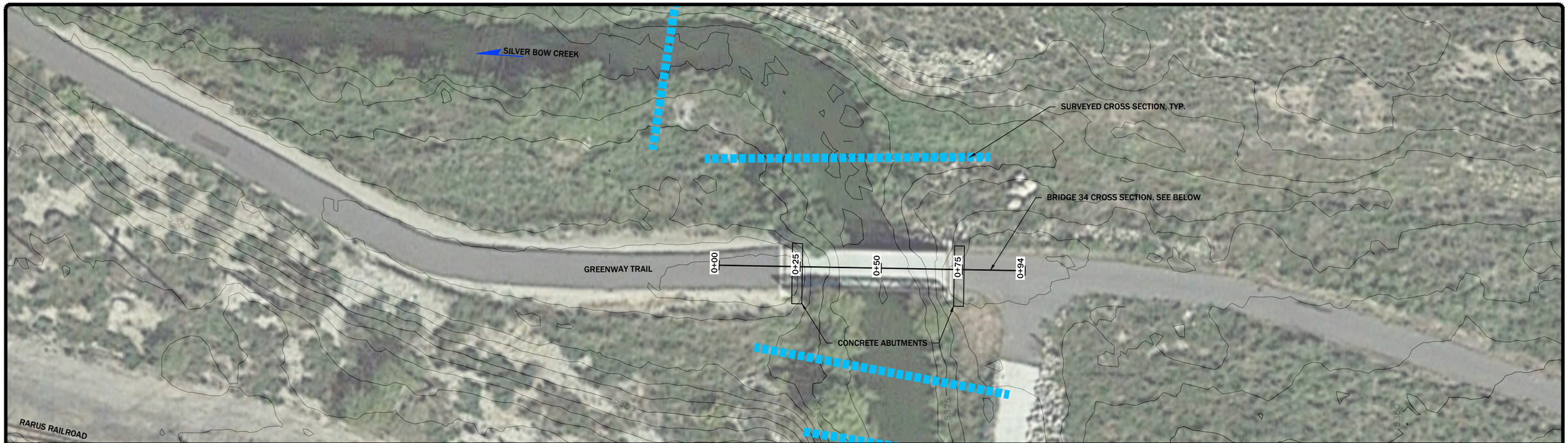

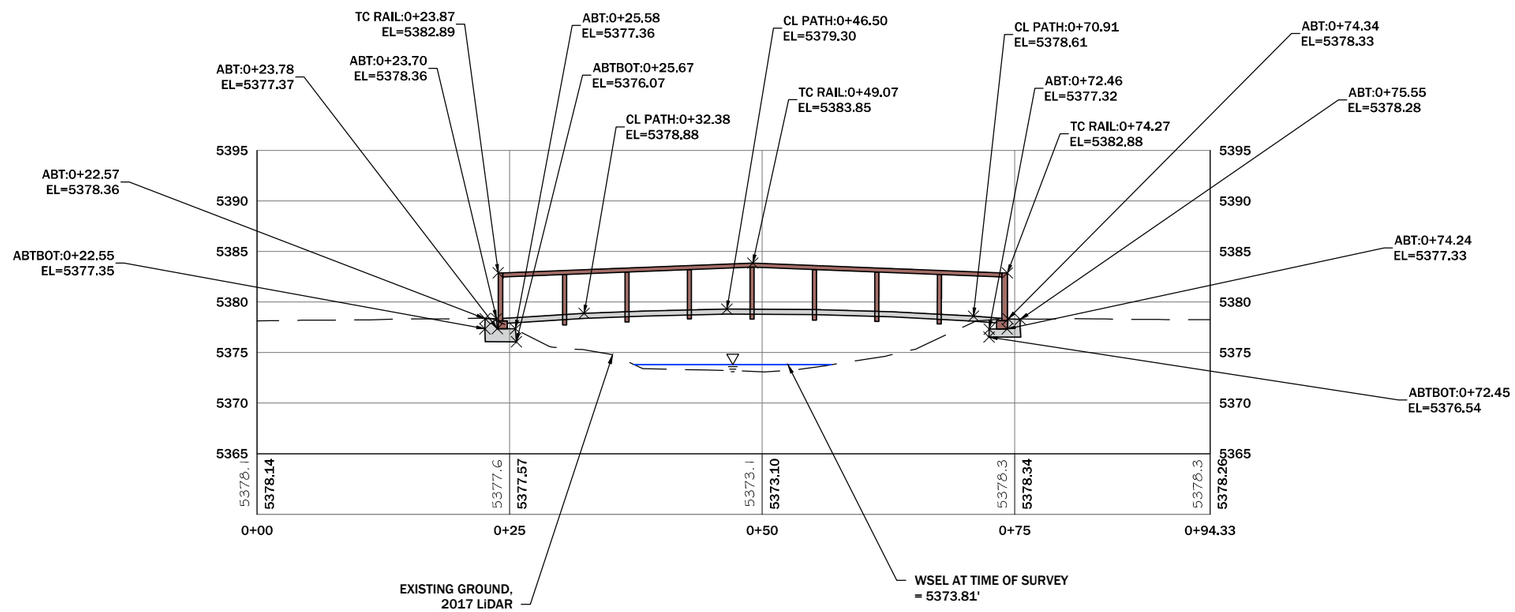

SCALE IN FEET
15
15

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL AND CONCRETE
3. BRIDGE WIDTH = 13.0'
4. SPAN 1 = WEST ABUTMENT TO EAST ABUTMENT= 46.77'
5. RIVER MILE = 14.50

N

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 40

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 34
PLAN AND PROFILE

DATE: 10-31-18

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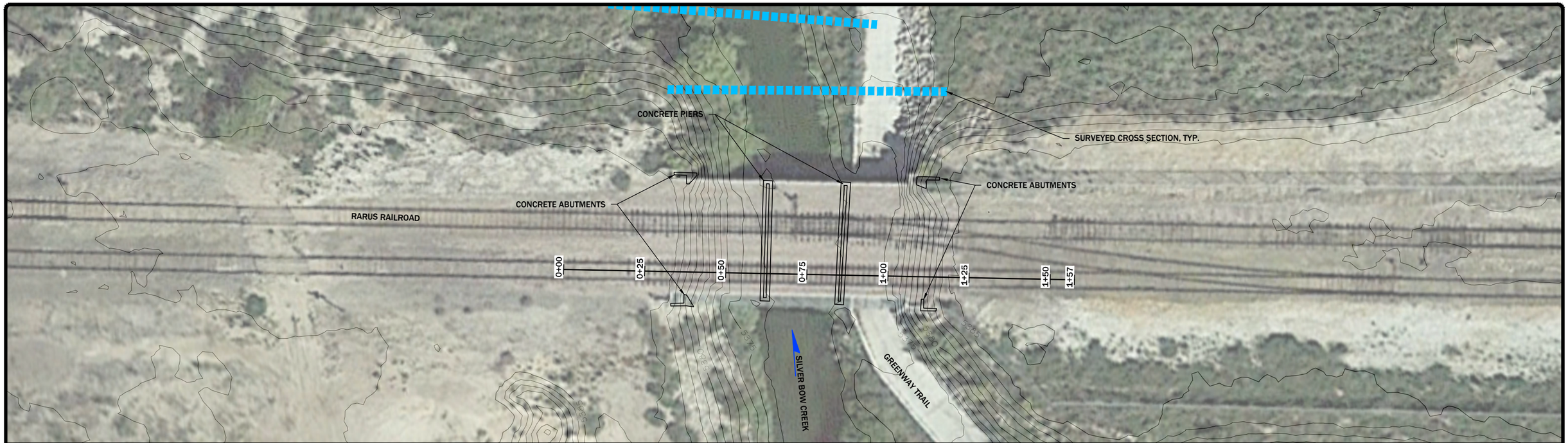

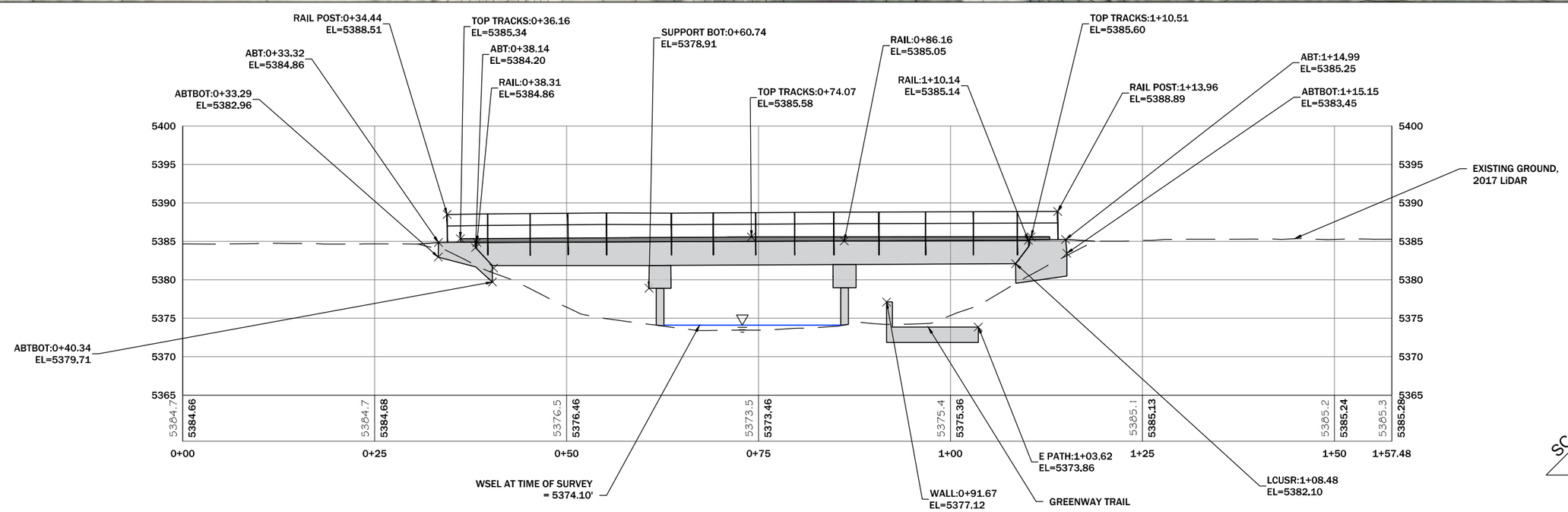

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: CONCRETE AND STEEL
3. BRIDGE WIDTH = 35.0'
4. SPAN 1 = WEST ABUTMENT TO PIER = 21.83'
5. SPAN 2 = PIER 1 TO PIER 2 = 24.02'
6. SPAN 3 = PIER 2 TO EAST ABUTMENT = 22.29'
7. RIVER MILE = 14.52

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 41

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 35
PLAN AND PROFILE

DATE: 10-31-18

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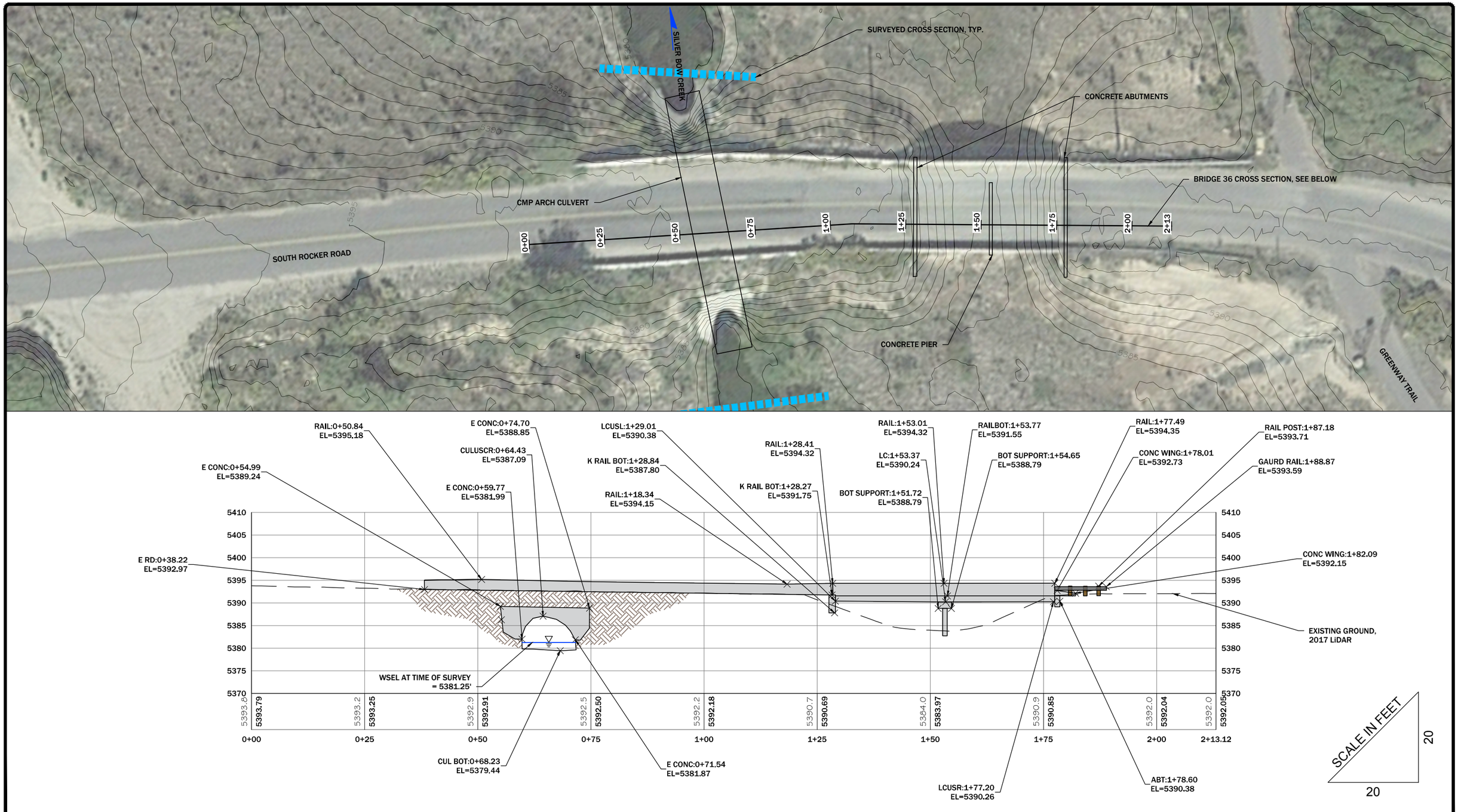

CULVERT NOTES:

1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF CULVERT.
2. CLUVERT SPAN = 11.8'
3. CULVERT RISE = 7.6'
4. CULVERT LENGTH = 86.7'
5. RIVER MILE = 14.86

BRIDGE NOTES:

1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL: CONCRETE
3. BRIDGE WIDTH: 33.0'
4. SPAN 1 = WEST ABUTMENT TO PIER 1 = 24.36'
5. SPAN 2 = PIER 1 TO EAST ABUTMENT = 23.83'
6. RIVER MILE = 14.86

N

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 42

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 36
PLAN AND PROFILE

DATE: 10-31-18

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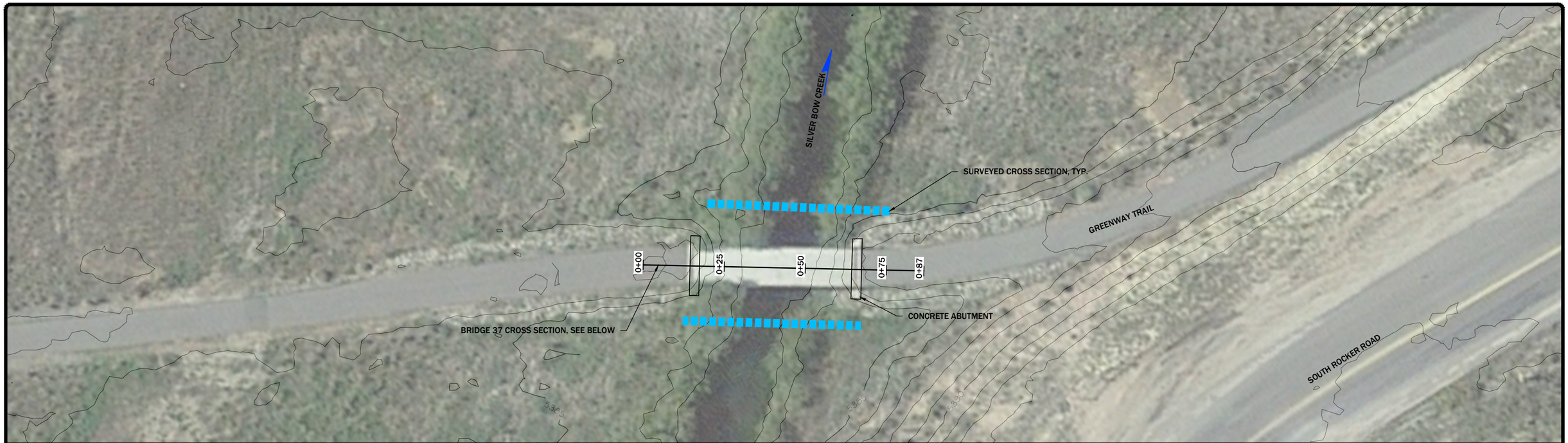

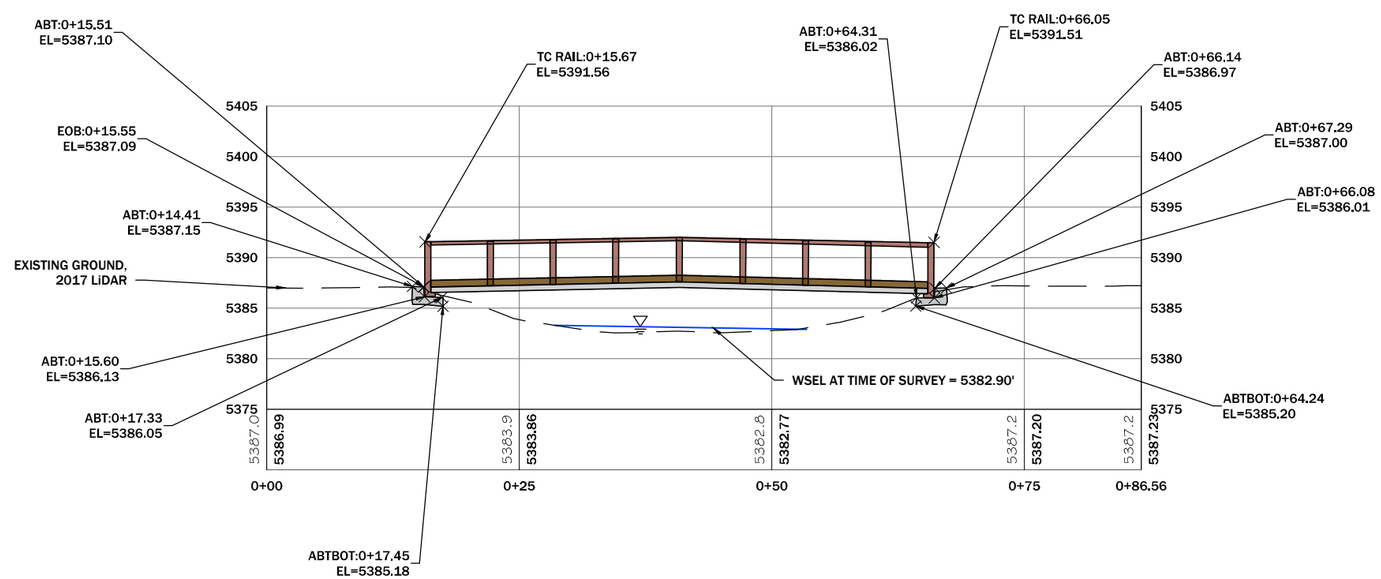

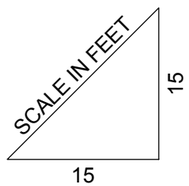

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL, CONCRETE, AND WOOD
3. BRIDGE WIDTH = 12.0'.
4. SPAN 1 = WEST ABUTMENT TO EAST ABUTMENT= 46.9'.
5. RIVER MILE = 14.98

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 43

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 37
PLAN AND PROFILE

DATE: 10-31-18

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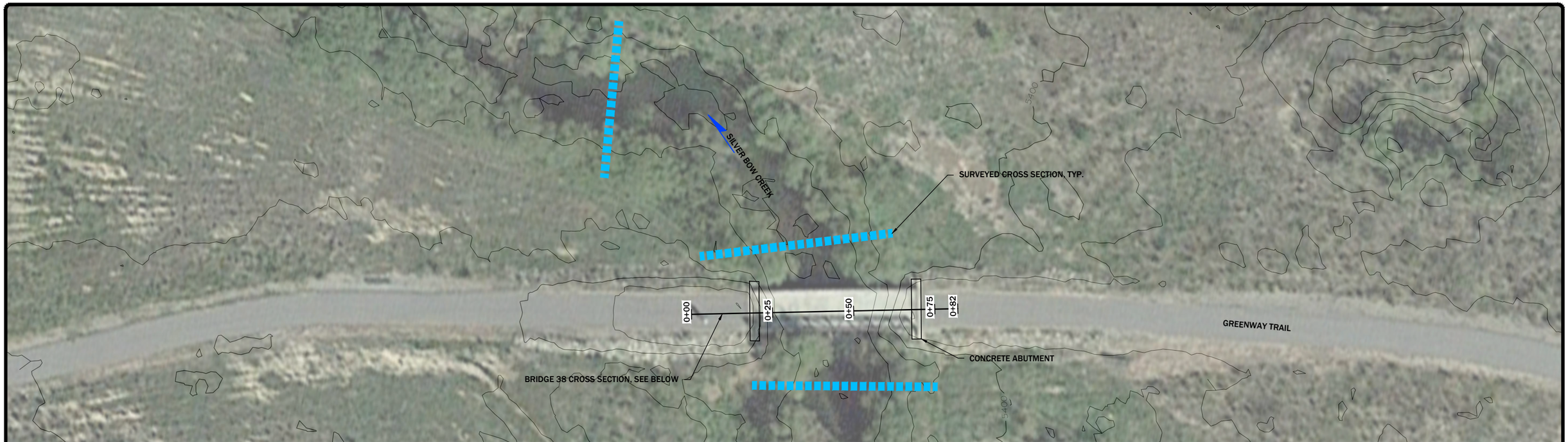

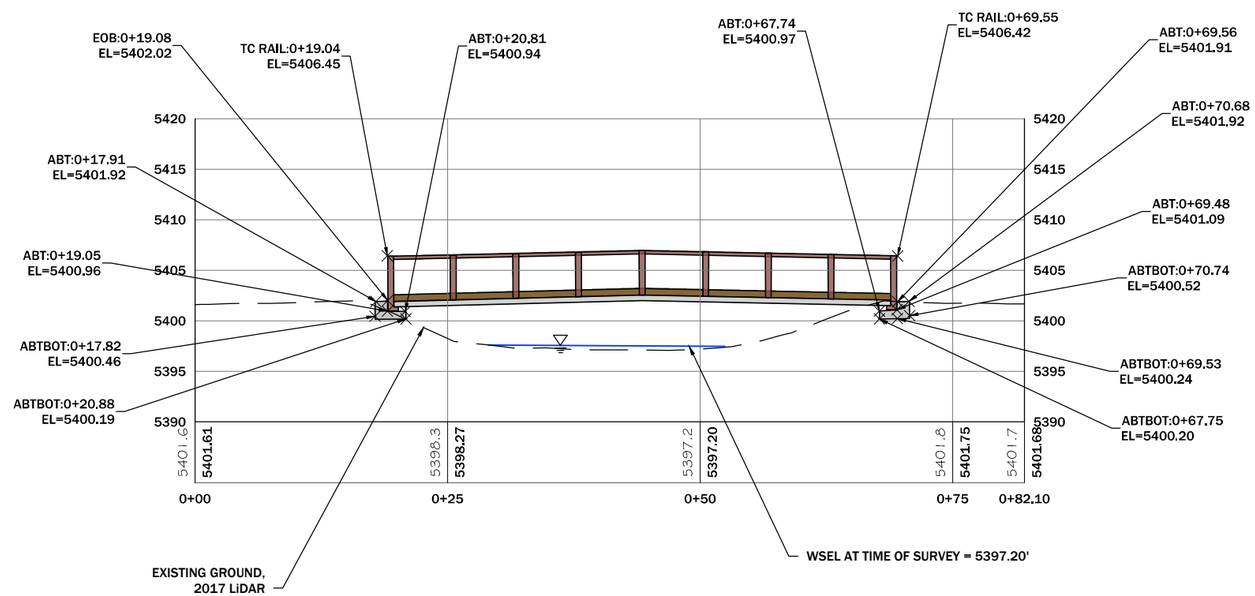

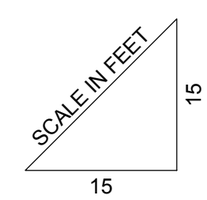

NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL, CONCRETE, AND WOOD
3. BRIDGE WIDTH = 12.0'.
4. SPAN 1 = WEST ABUTMENT TO EAST ABUTMENT= 46.9'.
5. RIVER MILE = 15.82

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 44

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 38
PLAN AND PROFILE

DATE: 10-31-18

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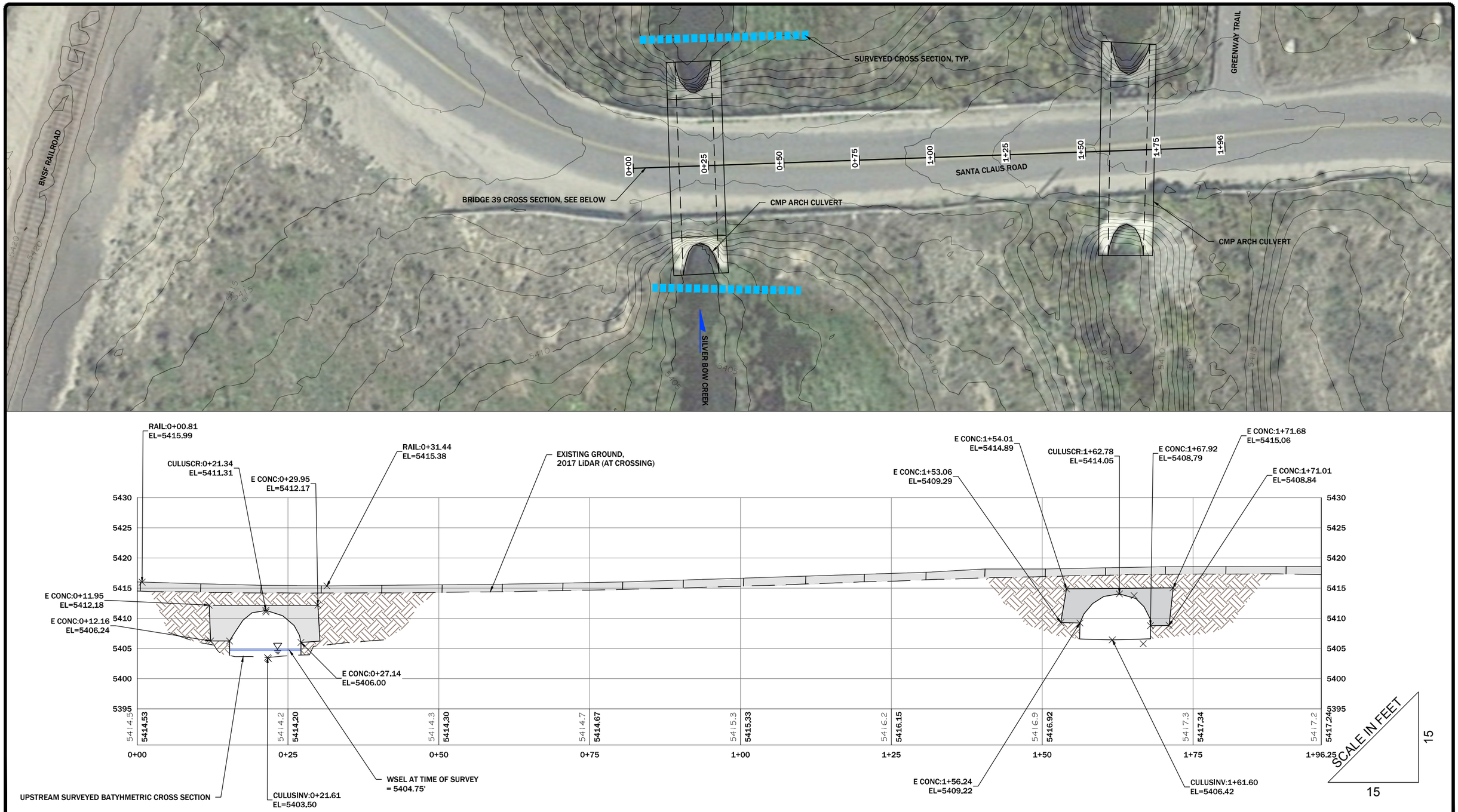


NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF CULVERT.
2. CULVERT SPAN = 11.8' (ALL CULVERTS).
3. CULVERT RISE = 7.6' (ALL CULVERTS).
4. CULVERT LENGTH = 49.9'
5. RIVER MILE = 16.24

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 15 30

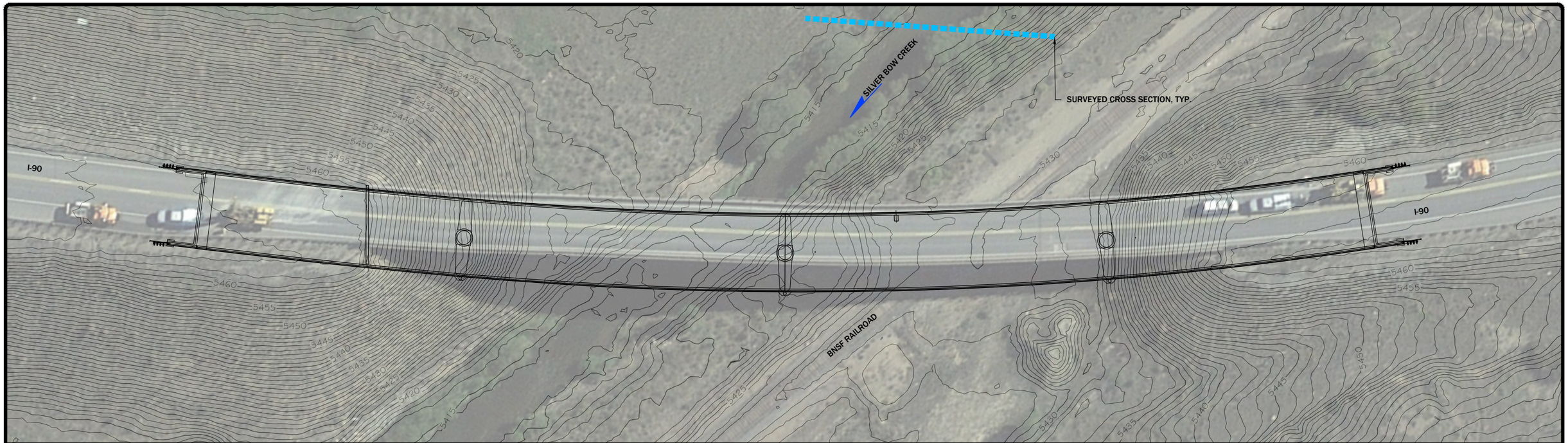
FIGURE 45

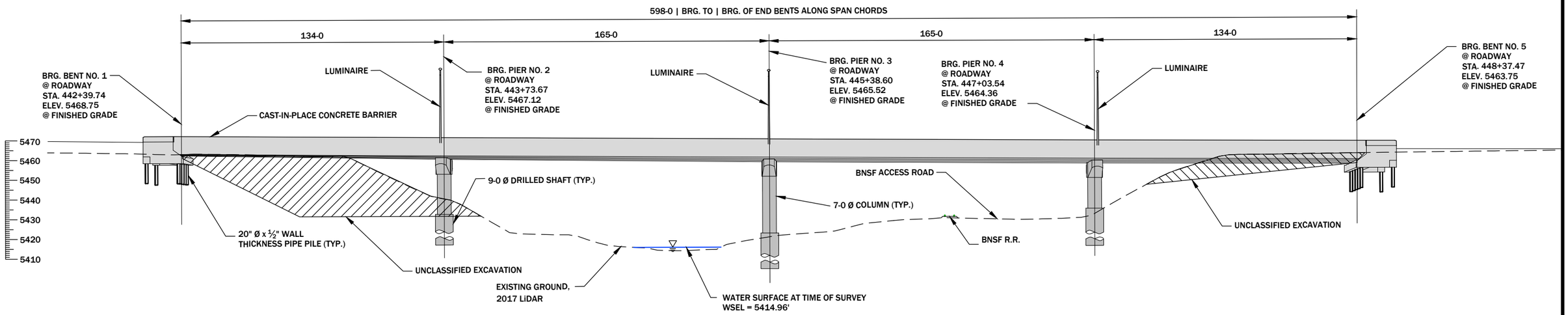
PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 39
PLAN AND PROFILE

DATE: 10-31-18

11/19/2018 3:43:10 PM H:\DEQ\SSTOU NEW\2018\FEMA_PMR\SURVEY\DRAWINGS\CAD\BRIDGES\SSTOU-BRG-FIG-039-18.DWG





NOTES:
1. PROPOSED BRIDGE DESIGN PER MDT
2. PROFILE VIEW IS LOOKING UPSTREAM
3. STRUCTURE MATERIAL TYPE: CONCRETE
4. BRIDGE WIDTH = 40.0'
5. BRIDGE SPANS PER PROFILE
6. RIVER MILE = 16.80

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 25 50

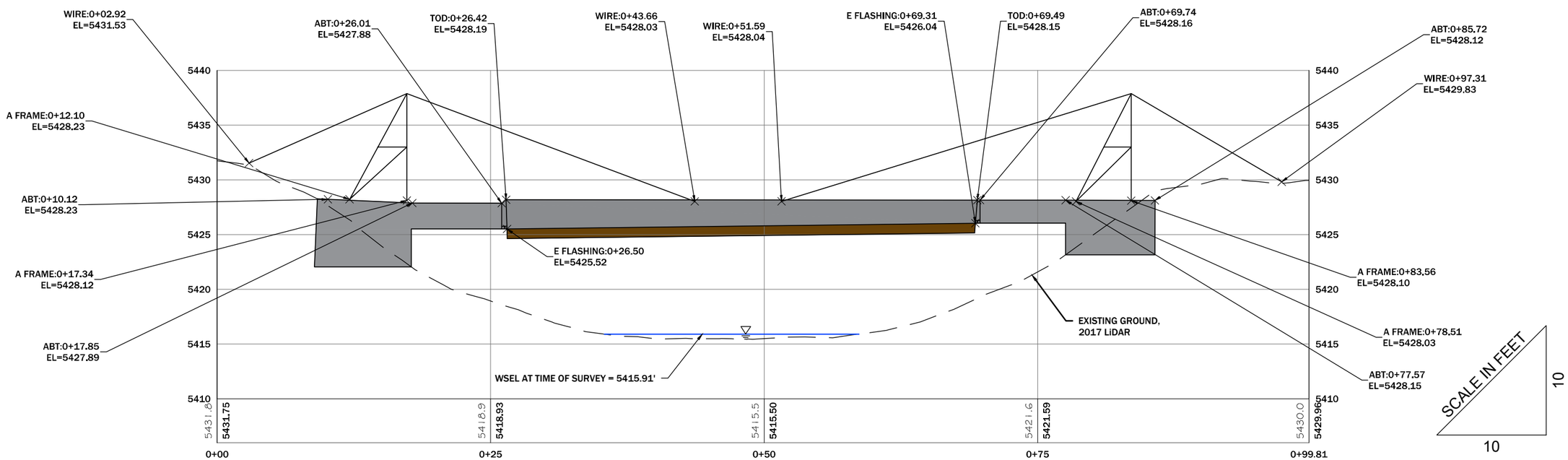
FIGURE 46

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRDIGE 40
PLAN AND PROFILE

DATE: 10-31-18

11/19/2018 3:45:11 PM H:\DEQ\SSTOU NEW\2018\FEMA_PMR\SURVEY\DRAWINGS\CAD\BRIDGES\SSTOU-BRG-FIG-040&043-18.DWG



NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL, CONCRETE, AND WOOD
3. BRIDGE WIDTH = 5.2'.
4. SPAN 1 = WEST ABUTMENT TO EAST ABUTMENT= 59.82'.
5. RIVER MILE = 16.9

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 15 30

FIGURE 47

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 41
PLAN AND PROFILE

DATE: 10-31-18

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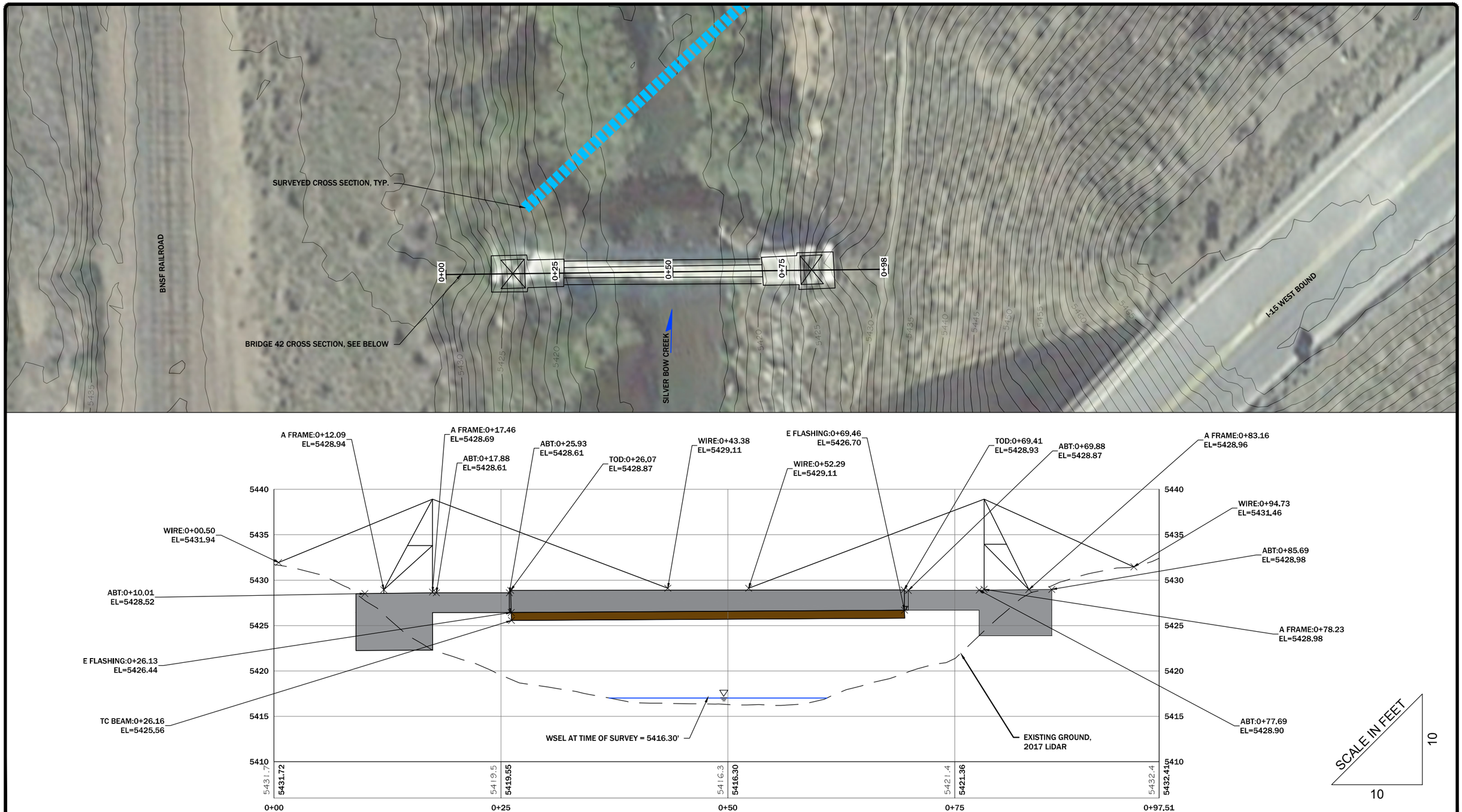


NOTES:
1. PROFILE VIEW REPRESENTS UPSTREAM FACE OF BRIDGE.
2. STRUCTURE MATERIAL TYPE: STEEL, CONCRETE, AND WOOD
3. BRIDGE WIDTH = 5.4'.
4. SPAN 1 = WEST ABUTMENT TO EAST ABUTMENT= 60.31'.
5. RIVER MILE = 16.94

	DISPLAYED AS:
COORD SYS/ZONE:	MONTANA STATE PLANE
DATUM:	NAD 83, NAVD 88
UNITS:	INT. FEET
SOURCE:	PIONEER/GOOGLE

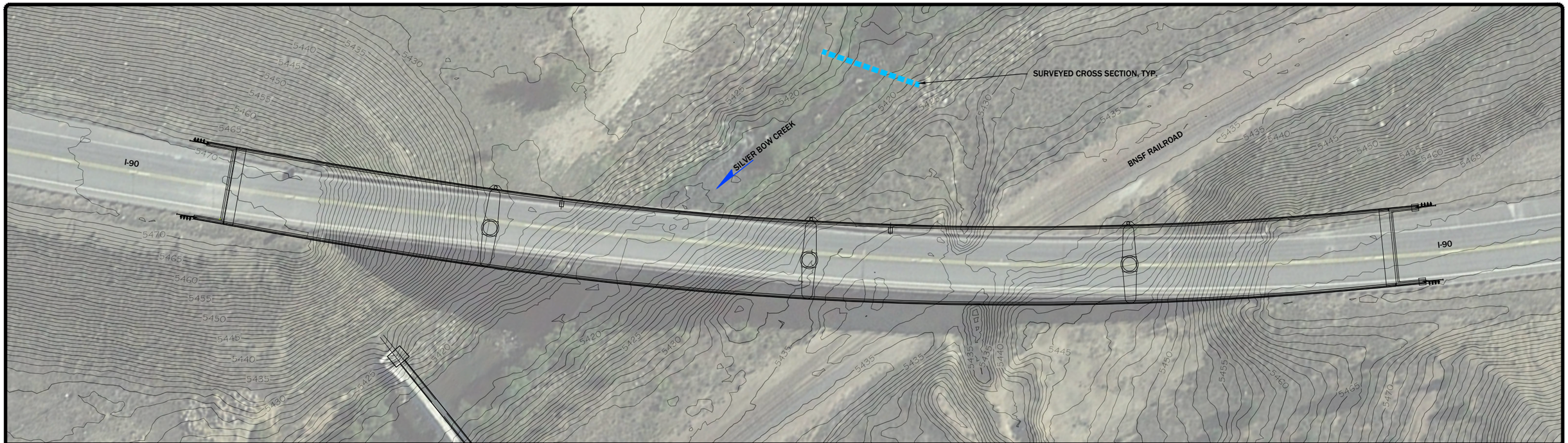
SCALE IN FEET
0 10 20

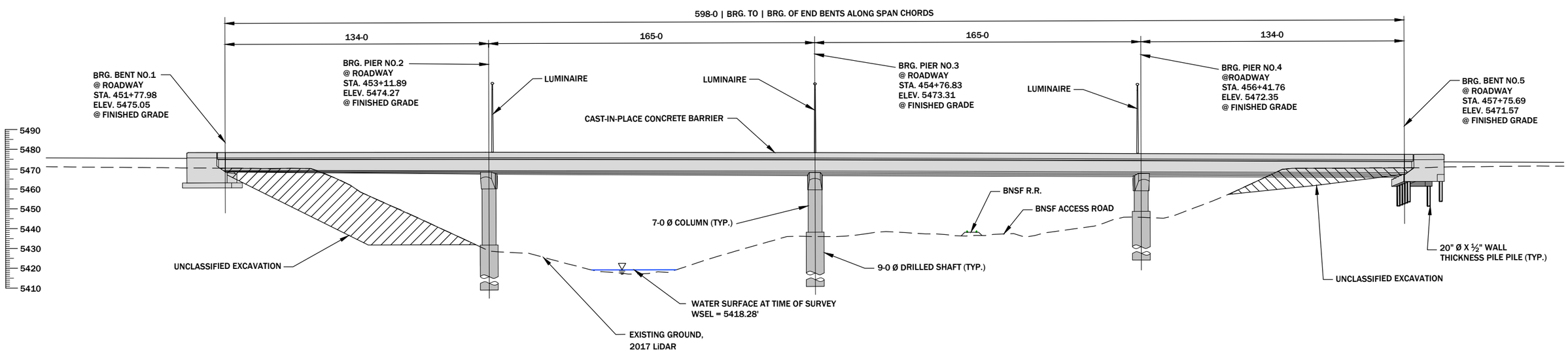
FIGURE 48

SILVER BOW CREEK
BRIDGE 42
PLAN AND PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

DATE: 10-31-18





NOTES:
1. PROPOSED BRIDGE DESIGN PER MDT
2. PROFILE VIEW IS LOOKING UPSTREAM
3. STRUCTURE MATERIAL TYPE: CONCRETE
4. BRIDGE WIDTH = 40.0'
5. BRIDGE SPANS PER PROFILE
6. RIVER MILE = 16.97

N

DISPLAYED AS:
COORD SYS/ZONE: MONTANA STATE PLANE
DATUM: NAD 83, NAVD 88
UNITS: INT. FEET
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 25 50

FIGURE 49

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, SUITE C
HELENA, MT 59601
(406) 457-8252

SILVER BOW CREEK
BRIDGE 43
PLAN AND PROFILE

DATE: 10-31-18

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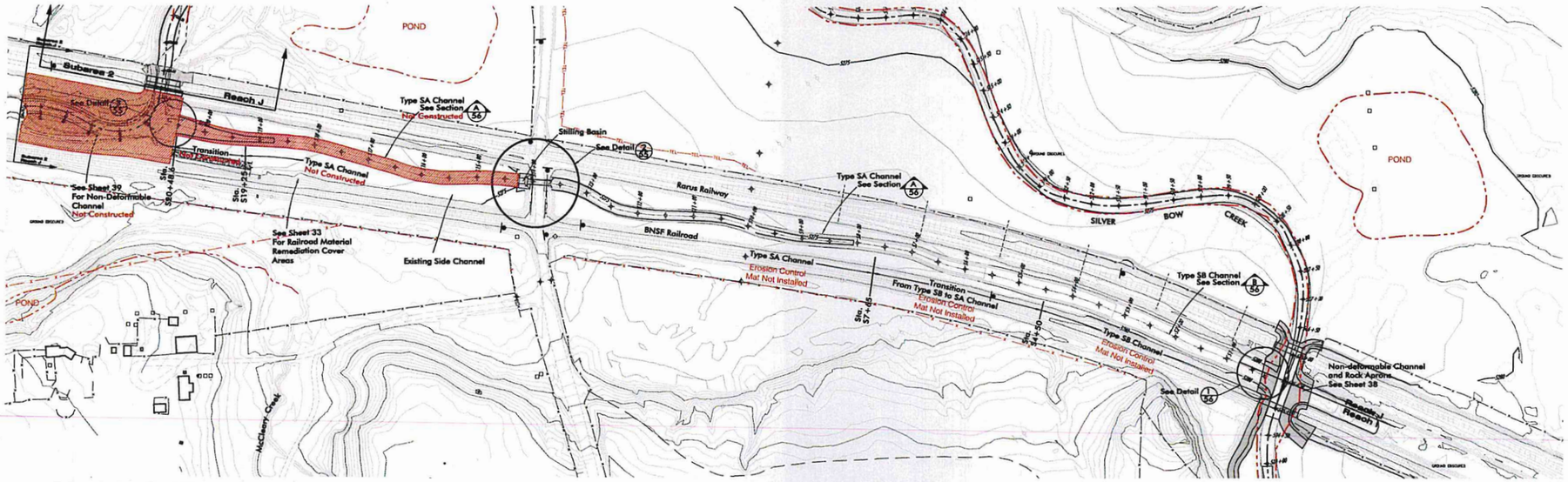
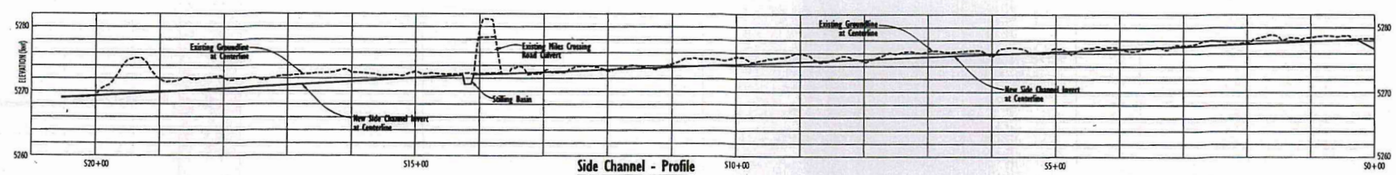
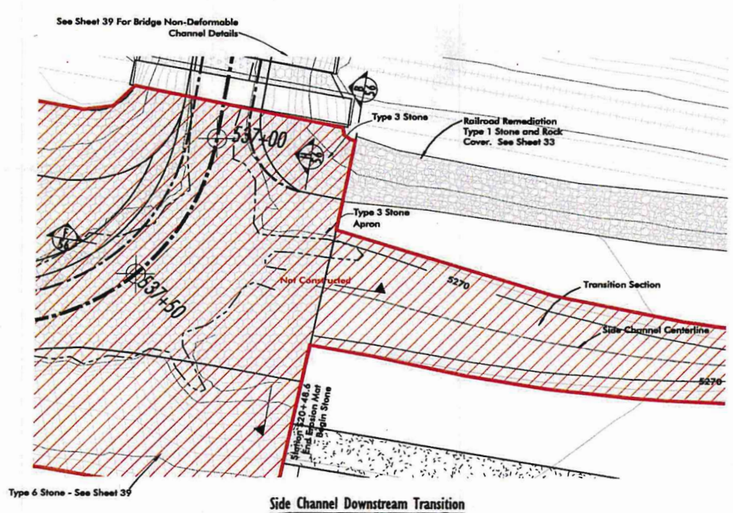
Miles Crossing Culvert at Railroad Split



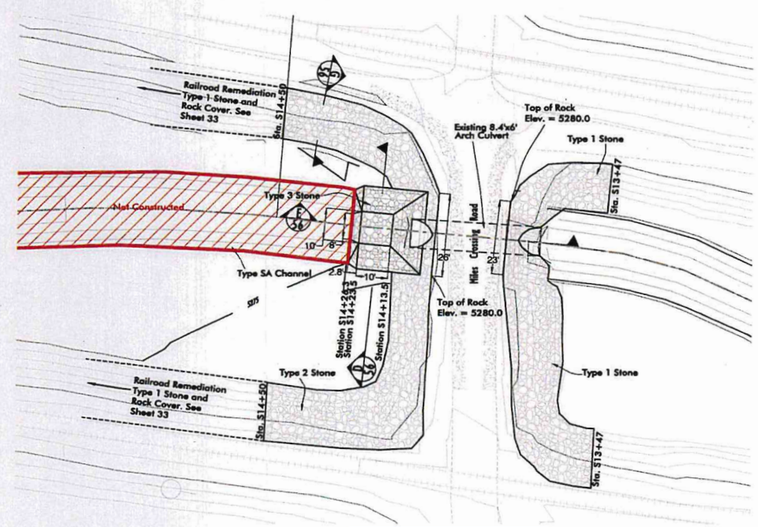
Side Channel - Plan
Scale: 1"=100'



Side Channel - Profile
Scale: Horizontal 1"=100'
Vertical 1" = 10'



Side Channel Downstream Transition to Silver Bow Creek - Detail (3/55)
Scale: 1"=20'



Miles Crossing Culvert Rock Protection and Stilling Basin - Detail (2/55)
Scale: 1"=20'

NOTES

1. Side channel centerline o
Maxim Technologies.

Station	Side Channel Invert Elevation	
S0+29	5278.2	
S1+85	5277.6	
S3+35	5276.9	
S4+45	5276.5	
S4+50	5276.5	
S6+50	5275.6	
S7+00	5275.4	
S7+65	5275.2	
S8+50	5274.8	
S9+50	5274.4	
S10+00	5274.2	
S13+66	5272.7	INLET
S14+09	5272.6	OUTLET
S14+13.5	5271.1	STILLING BASIN
S14+23.5	5271.1	
S14+26.3	5272.5	
S14+30.8	5272.5	
S18+23.5	5270.3	
S18+73.5	5270	
S19+23.5	5269.7	
S19+25	5269.7	
S19+73.5	5269.4	
S20+23.5	5269.2	
S20+48.6	5269	

AS

REV	DATE

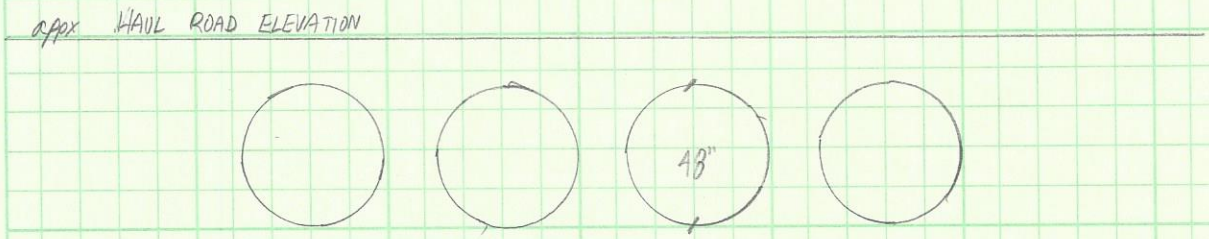
Date: December 2009
Project # 7581495
File: M:\autores2\dogreat\reaches I-J\stuff\side c

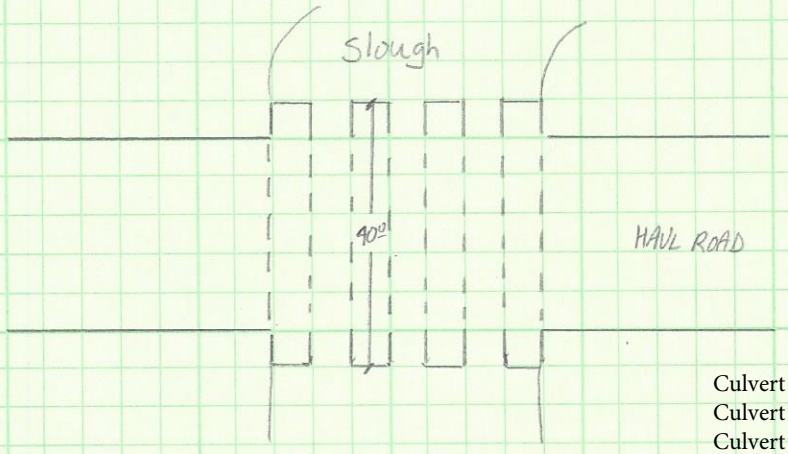
TETRA TEC

SHEET 55

Unnamed road crossing on Miles Crossing Split Reach

C-4 Profile



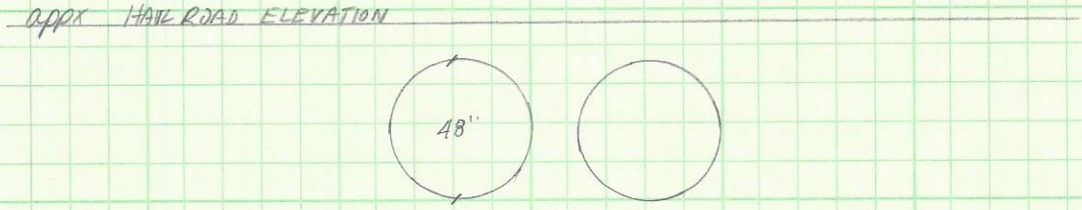


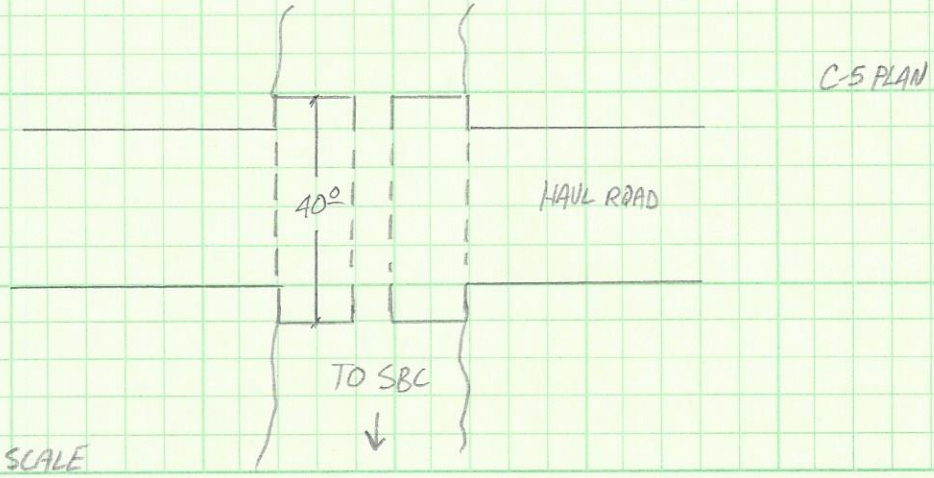
	US Invert (ft)	DS Invert (ft)
Culvert 1:	5268.86	5269.10
Culvert 2:	5268.92	5268.74
Culvert 3:	5269.00	5269.02
Culvert 4:	5269.09	5268.70

Per Brown and Associates Survey

☆ pipes are CMP type

C-5 Profile





• NOT TO SCALE