Sparks Arroyo Drainage Study
Socorro, Texas

Prepared for:

City of Socorro, TX

Prepared by:

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DEC Project No. 4935-01

Sparks Arroyo Drainage Study
City of Socorro, TX

Executive Summary

Dannenbaum Engineering Corporation (DEC) was contracted by the City of Socorro, Texas (City) to develop flood mitigation solutions along the Sparks Arroyo between Downstream of I-10 and a property known as the Onion Field. The objective of this study is to identify the existing flooding problem and evaluate flood reduction solutions through hydrologic and hydraulic modeling. The residences near Onion Field experience flooding during frequent storm events, and the flooding is severe during extreme events. The Sparks Arroyo channel currently overtops the banks during extreme storm events. The extreme event flows also overtop Stockyard Drive. In addition, the channel receives high amounts of silt deposits from upstream, which further decrease the channel capacity and require regular dredging. Channel bank erosion is also a serious concern along the channel. The channel intersection with Thunder Road does not have any culvert crossing in existing condition. Storm water runoff flows over Thunder Road during all storm events to reach Onion Field causing flooding and silting of the road. This results in roadblocks, obstruction to traffic movement, and damage to the road. The floodwater from Onion Field flows into the Mesa Spur Drain and potentially across the drain.

The City desires to utilize the Onion Field area as a flood control basin in combination with channel improvements to alleviate flooding along the channel. An additional flood control basin is proposed in this study near Stockyard Drive to reach the desired flood mitigation benefits.

The study proposes improvements along Sparks Arroyo that will provide a 100-year event level of flood protection to the residents and structures along Sparks Arroyo. The flood reduction will be achieved by providing channel improvements, flood control basins, and additional drainage structures. The channel improvements include channel widening and deepening to provide additional conveyance capacity. Drop structures were provided along the channel to reduce velocities, accommodate steep terrain, and to drain the basins. A new culvert crossing is also proposed underneath Thunder Road. One of the flood control basins is a detention basin near Stockyard Drive (Stockyard Basin) which will reduce the peak flows downstream of Stockyard Drive and into the Mesa Spur Drain. The other basin is a detention/retention basin in Onion Field (Onion Field Basin), which further reduces the peak flows into Mesa Spur Drain. The USACE Feasibility Study determined that only about 30 cfs should be allowed at each outfall location into Mesa Spur Drain in order to prevent overflow from the drain. The proposed Onion Field Basin will discharge only 29.1 cfs into the Mesa Spur Drain, which is significantly less than the existing overflow and also less than the flow recommended by the USACE Feasibility Study. It has to be noted that the current study proposes an outfall pipe into Mesa Spur Drain from the proposed Onion Filed Basin, whereas in existing conditions, there are no pipes discharging into the drain. **Therefore, the City should coordinate with the El Paso County Water Improvement District #1 before construction of any outfalls into Mesa Spur Drain.**

Sparks Arroyo Drainage Study
City of Socorro, TX

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1.0 INTRODUCTION

Dannenbaum Engineering Corporation (DEC) was contracted by the City of Socorro (City) to evaluate flood reduction alternatives along Sparks Arroyo, south of Interstate Highway – 10, within the City limits. The current study documents the existing flood conditions along the channel and presents a design solution to address the 100-year flooding problems. The design solution includes a combination of channel improvements and detention/retention basins. A cost estimate is also presented for the design solution.

1.1 Location and Description

A project vicinity map is shown in **Exhibit 1**. The project limits along Sparks Arroyo extend from just south of Interstate Highway (IH) -10 on the upstream end to downstream of Mesa Spur Drain at Horizon Boulevard. The channel generally drains south and discharges into the Mesa Spur Drain area, which serves as an alluvial fan. Between IH-10 and Stockyard Drive, the existing channel shape is defined by silt bottom and silt banks. The silt banks have been created by removing silt deposited at the channel bottom during storm events and depositing along the banks over a long time. The silt banks are generally above the natural ground. Downstream (south) of Stockyard Drive, the channel is natural and unmaintained. The side slopes are overgrown with grass and shrubs, whereas the channel bottom is silted. Near Reid Road, the channel flowline is very steep. There is also significant bank erosion observed in this area. The flowline in this area drops more than 35 feet over a short distance of 300 feet. Sparks Arroyo crosses Stockyard Drive with 3-5'x4' RCBs, whereas at Thunder Road, there are no cross drainage structures. The storm water flows over Thunder Road and spreads out into Onion Field.

1.2 Problem Statement and Study Purpose

The residences near Onion Field experience flooding during frequent storm events, and the flooding is severe during extreme events. The flows from Sparks Arroyo do not have a defined outfall. Therefore, flows from the channel just flood the Onion Field and surrounding properties even during frequent storm events. The Sparks Arroyo channel currently overtops the banks during extreme storm events for most of this length near Stockyard Drive and downstream. The extreme event flows also overtop Stockyard Drive. In addition, the channel receives high amounts of silt deposits from upstream, which further decrease the channel capacity and require regular dredging. Channel bank erosion is also a serious concern along the channel, especially downstream of Stockyard Drive. The channel intersection with Thunder Road does not have any culvert crossing in existing condition. Storm water runoff flows over Thunder Road during all storm events to reach Onion Field causing flooding and silting of the road. This results in roadblocks, obstruction to traffic movement, and damage to the road. The floodwater from Onion Field flows into Mesa Spur Drain and potentially across the drain.

The City desires to utilize the Onion Field area as a detention/retention basin in combination with channel improvements to alleviate flooding along the channel. An additional detention basin is proposed in this study near Stockyard Drive to reach the desired flood benefits.

The purpose of the study is to evaluate the existing problems along Spark Arroyo within the City of Socorro and to propose solutions to reduce the flooding problem. The goal of the study is to propose a solution that will contain the 100-year flows within the channel and eliminate the 100-year flooding by proposing a combination of channel improvements and detention/retention basins. A new drainage crossing is also proposed under Thunder Road and additional culverts are proposed under Stockyard Drive.

1.3 References

The current study references the following documents:

1. Review Plan – Feasibility Study - Sparks Arroyo Colonia, El Paso County, Texas, dated March 2014, prepared by the United States Army Corps of Engineers (USACE).
2. Sparks Arroyo Drainage Improvements Design Plans, dated June 2016, prepared by CSA Design Group, Inc.
3. Comprehensive Master Plan – City of Socorro, Texas, dated June 2014, prepared by Sites Southwest, LLC.
4. El Paso County Stormwater Master Plan, dated August 2010, prepared by URS Corporation.
5. Multi-Hazard Mitigation Action Plan – El Paso County, Texas, dated 2015, prepared by Rio Grande Council of Governments.

1.4 Design Criteria

The design guidelines utilized in this study were generally based on the City of El Paso's Drainage Design Manual, dated May 2013. The following general design criteria were used:

1. The improved channel should contain the 100-year flow without the banks being overtopped.
2. The proposed drainage crossings should be able to pass the 100-year flows without being overtopped.
3. Proposed water surface elevations should be at or below existing conditions.
4. Discharge into Mesa Spur Drain should be limited to 30 cfs.
5. At least 0.50 ft of freeboard should be maintained in the flood control basins.

1.5 Datum

All elevations presented in this report are referenced to the North American Vertical Datum (NAVD) of 1988 unless noted otherwise.

1.6 Flood Hazard Areas

The FEMA effective FIRM and the preliminary FIRM are shown in **Exhibit 2** and **Exhibit 3**, respectively. The effective FIRM No. 4802120237B, dated September 4, 1991, shows Sparks Arroyo Channel to be defined as Zone AE through the project limits. Zone AE represents the 100-year floodplain with defined water surface elevations. The Onion Field area is defined as Zone A, which represents 100-year floodplain with an approximate flood depth.

Preliminary FIRMs were developed for the area in October 2014. These FIRMs are not yet effective. The Sparks Arroyo is shown on Preliminary FIRMs 48141C0542F and 48141C0561F, which show Zone A along the channel. Zone A represents approximate floodplain, which does not have defined flood elevations or depths.

1.7 Previous Studies

Sparks Arroyo has been a subject of previous local and federal studies. The USACE conducted a reconnaissance study for selected channels in El Paso County (County) in November of 2002. In 2003, congressional authority was received by the USACE to conduct a Feasibility Study in collaboration with the County and the City of El Paso. The Feasibility Study recommends flood and sediment reduction along

Sparks Arroyo primarily by providing regional detention and sediment control basin in the upstream reaches of the watershed. The project cost was determined to be $30 million. The County prepared a Stormwater Master Plan in August 2010 in collaboration with El Paso Water Utilities Public Service Board and Texas Water Development Board. The study adopted the regional basin from the Feasibility Study with some updates and recommended additional detention basins along the channel with channel improvement alternatives. The cost of these improvements ranged from $ 1.9 million to $22.6 million.

The City of Socorro released a Comprehensive Master Plan in June 2014, which identifies solving the flooding problems along Sparks Arroyo as the highest priority infrastructure project. The City master plan recommends implementation of the County master plan for Sparks Arroyo.

1.8 Data Collection

The following data were collected in support of this study:

1. Topographic survey: Topographic survey was acquired for the project and is referred to as Project Survey. Project Survey covers the entire project limits including Onion Field and is referenced to NAVD 1988 datum.
2. USGS Contours: Contours from USGS were acquired for the study to delineate drainage areas. The USGS contours are 20-foot contours.
3. TXDOT DEM: A DEM of the area, prepared by TxDOT for their transportation projects was acquired and utilized for overbank areas, where Project Survey is not available.
4. 2017 ESRI Aerial Photographs: Latest aerial photographs from ESRI were used in this study.
5. Horizon City Zoning Map: A zoning map for Horizon City, dated August 2013, and prepared by Huitt Zollars, Inc. was used.

2.0 Hydrologic and Hydraulic Methodology

Hydrologic and hydraulic modeling was performed to determine flows and flood elevations along Sparks Arroyo. The USACE's HEC-HMS hydrologic model was used to generate flows along the channel, and the USACE's HEC-RAS hydraulic model was used to develop flood profiles. The flow and flood profiles were developed for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storm events. The modeling was performed in accordance with the methodology documented in the City of El Paso's Drainage Design Manual.

2.1 Drainage Areas

The total drainage area for Sparks Arroyo Watershed from the upstream end to Onion Field is approximately 4,530 acres as shown in **Exhibit 4**. Sparks Arroyo Watershed was sub-divided into several drainage areas for this study. The drainage areas were delineated using the USGS DEMs and 20-foot contours. Approximately 2,200 acres of the total area in the most upstream portions of the watershed have been retained by residential and commercial developments. Therefore, only the remaining 2,330 acres of area contributes flows to the Sparks Arroyo main channel. The drainage areas are presented in **Table 1**.

2.2 Hydrologic Methodology

The NRCS Runoff Hydrograph Method was used to estimate runoff. The methodology uses the NRCS Curve Number Method for calculating runoff losses and the NRCS Unit Hydrograph Method to estimate hydrographs and peak runoff. The land use in the watershed was determined from the City of Horizon Zoning Map, City of Socorro Comprehensive Master Plan, field visit, and aerial photographs. The land use within the watershed is comprised primarily of residential and undeveloped areas. The watershed in general is partially developed. The land use map is shown in **Exhibit 5**. Appropriate Curve Numbers were assigned to each land use type and a weighted average Curve Number was determined for drainage areas.

Time of concentration, Tc, was computed using a combination of the three methods provided in the City of El Paso's Drainage Design Manual, which are Upland Method for sheet flows, Kirpich Method and Upland Method for concentrated flows. The flow path lengths and slopes were determined based on the USGS Contours and TxDOT DEM. Lag time was calculated using the NRCS Equation. The 24-hour rainfall depths were determined from the City of El Paso's Drainage Design Manual for Eastside Region, which were distributed using NRCS Type II-75 distribution, as it is more applicable to the study area.

The peak flows and runoff hydrographs were calculated using HEC-HMS software. Within the HEC-HMS model, the drainage areas were connected with routing reaches representing the channel, which were modeled using the Modified Puls Method.

In the proposed conditions, the detention/retention basins used for flood reduction were modeled as reservoirs with outfall structures within the HEC-HMS model.

The drainage areas and peak flows are presented in **Table 1**. The hydrologic parameter calculations, routing reach data, and peak flows are presented in **Appendix A**, and the HEC-HMS model outputs are presented in **Appendix B**.

Table 1. Hydrologic Calculations Summary

Drainage Area ID	Drainage Area	Curve Number	Lag Time	24 hr. Rainfall Depth (El Paso Drainage Design Manual)			Peak Runoff (HEC-HMS)		
				10-YR	50-YR	100-YR	10-YR	50-YR	100-YR
	(sq. mi)	(---)	(hr.)	(in)	(in)	(in)	(cfs)	(cfs)	(cfs)
DA-1a	2.70	79.5	1.69	2.29	3.59	4.30	386	942	1,286
DA-2	0.06	85.2	0.36	2.29	3.59	4.30	39	82	108
DA-3	0.61	83.2	0.80	2.29	3.59	4.30	210	471	628
DA-4	0.18	82.3	0.60	2.29	3.59	4.30	75	170	229
DA-5	0.01	70.1	0.14	2.29	3.59	4.30	4	12	18
DA-6	0.09	83	0.36	2.29	3.59	4.30	53	116	155

2.3 Hydraulic Methodology

A HEC-RAS model was developed for the channel to generate flood profiles. The model cross sections were developed based on Project Survey for information within the banks and TxDOT DEMs in the overbank areas where survey is not available. Drainage structures crossing the channel were also included within the model. The Peak flows obtained from the HEC-HMS model were used in HEC-RAS to determine the water surface profiles for 2, 5, 10, 25, 50 and 100-year frequency storm events. The HEC-RAS model outputs are presented in **Appendix C**.

3.0 Existing Conditions Analysis

The purpose of the Existing Conditions analysis was to evaluate the existing flooding problems along the Sparks Arroyo channel. The peak flows and water surface elevations at key locations along Sparks Arroyo are presented in **Table 2**. The HEC-HMS and HEC-RAS model outputs are presented in **Appendix B** and **Appendix C**, respectively. The existing condition floodplain maps are presented in **Exhibit 6**.

Existing condition floodplain maps show that the flow from Sparks Arroyo flows over Thunder Road and spreads into Onion Field and surrounding residences at the downstream end. The channel does not have a defined outfall. The residences near Onion Field experience flooding even during frequent storm events, and the flooding is severe during extreme events. The floodwater from Onion Field overflows into Mesa Spur Drain. During the 100-year storm event, approximately 1,564 cfs overflows from onion field into Mesa Spur Drain. Mesa Spur Drain has only about 200 cfs of capacity, therefore, it is likely that the 100-year flows surcharge the drain and continue across the drain. There is no evidence of flow overtopping Horizon Boulevard. The channel intersection with Thunder Road does not have any culvert crossing in existing condition. Flows along Spark Arroyo overtop Thunder Road during all storm events to reach Onion Field causing flooding and silting of the road. This results in frequent roadblocks, obstruction to traffic movement, and damage to the road.

The existing conditions results show that the main channel of Sparks Arroyo has less than 10-year capacity. The flows overtop the banks during the 10-year storm event. During the extreme events, the flows are out of banks for most of the channel between Stockyard Drive and Onion Field. Stockyard Drive is overtopped during the 25-year storm event. In addition to the above, the channel receives high amounts of silt deposits from upstream, which further decrease the channel capacity and require regular dredging.

Table 2. Summary of Existing Flows and Water Surface Elevations at Key Locations

Location	Existing Drainage Structure	Peak Flow, cfs			WSEL, ft		
		10-yr	50-yr	100-yr	10-yr	50-yr	100-yr
IH-10	4 – 10'x7' RCBs	386	942	1,286	3,744.97	3,746.00	3,746.51
Stockyard Dr. Crossing	3- 5'x4' RCBs	464	1,118	1,525	3,715.89	3,717.96	3,718.31
Thunder Rd. Crossing	No existing drainage structure	467	1,125	1,523	3,656.19	3,656.45	3,656.54
Outfall to Mesa Spur Drain	No outfall – overflow from Onion Field	484	1,169	1,564	3,653.31	3,653.55	3,653.66

4.0 Proposed Project

The current study proposes a design solution to eliminate flooding of residences near Onion Field and along the main channel. The design solution presented in the current study will contain the 100-year flows within the channel and within proposed detention/retention facilities. The proposed 100-year floodplain is presented in **Exhibit 7** and the proposed project is presented in **Exhibit 8**. The proposed project includes the following components along Sparks Arroyo:

1. Detention/retention basin in Onion Field (Onion Field Basin)
2. Detention basin along Stockyard Drive (Stockyard Basin)
3. Channel improvements between IH-10 and Thunder Road

In the proposed conditions, there is no change in contributing drainage area, land use pattern and peak flows generated by the drainage areas. Any change is peak flows is due to storage in basins and channel improvements.

Onion Field Basin

The Onion Field Basin is proposed to be constructed within the Onion Field area. The basin will provide 282.0 acre-feet of volume and will discharge into Mesa Spur Drain. The bottom of the basin is at 3,640.00 feet and the top of the basin is at 3,655.00 feet. The lowest outlet into Mesa Spur Drain is at an elevation of 3,643.00 feet. Therefore, below the elevation of 3,643.00 feet, the basin will function as a retention basin with no outlet. The basin will empty from infiltration and evaporation only. The USACE Feasibility Study determined that only about 30 cfs of flows should be allowed at each outfall location into Mesa Spur Drain for the 100-year storm event in order to prevent overflow from the drain. The current study restricts the total proposed outflow into Mesa Spur drain to 29 cfs during the 100-year storm event. The outfall into the drain comprises of a 24" RCP with a 21" diameter effective opening. The 21" inch diameter effective opening may be achieved by providing a restrictor place at the upstream end of the 24"pipe. There is no overflow into Mesa Spur Drain from Onion Field Basin. The 100-year water surface is contained within the basin at 3,654.30 feet allowing a freeboard of 0.80 feet. A 0.50 ft deep and 100 ft wide emergency spillway is recommended at 3,654.50 feet to allow overflow in case the outflow pipe is clogged. A minimum 15-foot maintenance berm is recommended around the basin resulting in a total basin footprint of 26.0 acres. The basin and outlet structure details are presented in **Table 3**.

The current study proposes an outfall pipe into Mesa Spur Drain from Onion Field Basin, whereas in existing conditions, there are no outfall pipes. **Therefore, the City should coordinate with the El Paso County Water Improvement District #1 (EPCWID#1) before construction of any outfalls into Mesa Spur Drain.**

Stockyard Basin

The Stockyard Basin is located along Stockyard Drive. The basin is proposed as an inline basin along Sparks Arroyo. The basin has a bottom elevation of 3,700.00 feet, top elevation of 3,719.50 feet, and a total volume of 216.3 acre-feet. The basin will outflow through the existing 3 – 5'x4' RCB culverts underneath Stockyard Drive, which are at the elevation of 3,713.85 feet. During the analysis it was determined that this basin will not function efficiently as a retention basin. Therefore, in order to empty the basin and to control the outflow downstream, a 24" RCP is recommended at the basin bottom. The 100-year water surface elevation will be contained within the basin at an elevation of 3,718.60 feet allowing a freeboard

of 0.90 feet. The total outflow from Stockyard Basin into the channel downstream of Stockyard Drive is limited to 478 cfs. A 0.5 ft deep and 100 ft wide emergency spillway is recommended at an elevation of 3,719.00 feet to allow overflow (estimated capacity = 95 cfs) in case the outflow structures are clogged. A minimum 15-foot maintenance berm is recommended around the basin resulting in a total basin footprint of 13.3 acres. The details of the basin outlet structures are presented in **Table 3**.

Table 3. Summary of Proposed Detention/Retention Basins

Basin Parameters	Stockyard Basin	Onion Field Basin
Bottom Elevation, ft	3,700.00	3,640.00
Top of Berm Elevation, ft	3,719.50	3,655.00
100-year Inflow, cfs	1,291	890
100-year Outflow, cfs	433	29
100-year WSEL, ft	3,718.60	3,654.30
Total Basin Volume, ac-ft	216.3	282.0
Basin Outfall Structures	3 - 5'x4' RCBs at 3,713.85 ft (Existing)	24" RCP with 21" Diameter Effective Opening at 3,643.00 ft
	24" RCP at 3,700.00 ft	

Sparks Arroyo Channel Improvements

The current study proposes improvements along Sparks Arroyo between IH-10 and Thunder Road. Between IH-10 and Stockyard Drive, the proposed channel will have a bottom width of 8.0 feet, average depth of 6.5 feet, and 2H:1V side slope. Between Stockyard Drive and Reid Road, the proposed channel will have a bottom width of 8.0 feet, average depth of 7 feet, and 2H:1V side slope. Between Reid Road and Thunder Road, the proposed channel will have a bottom width of 8.0 feet, average depth of 15.5 ft and 2H:1V side slope. In order to reduce channel slopes and to accommodate outfall from Stockyard Basin, drop structures are recommended immediately downstream of Stockyard Drive. This is because the existing channel elevation is at approximately at 3,713.00 feet, which is higher than the Stockyard Basin bottom at 3,700 feet. The existing 3 – 5'x4' RCB culverts underneath Stockyard Drive will be maintained in proposed conditions and additional culverts are recommended below the existing culverts to drain Stockyard Basin as discussed above. Drop structures are also recommended along the channel near Reid Road in order to accommodate the natural drop in the terrain. Gabion lining is recommended for the improved channel to control velocities and provide long-term stability. New culverts are recommended underneath Thunder Road. At Thunder Road, a sanitary sewer line runs along the road approximately 5.0 feet below ground. The proposed crossing at Thunder Road consists of 4 – 7'X4' RCBs, which will cross underneath the sanitary sewer line. A 15-foot maintenance berm is recommended on either side of the channel. The ultimate right-of-way width required for the channel improvements upstream of Stockyard Drive is 80 feet, whereas the ultimate right-of-way width required for channel improvements downstream of Stockyard Drive varies between 80 feet and 180 feet. The channel improvement details are summarized in **Table 4** and the Thunder Road crossing options are presented in **Table 5**.

Table 4. Sparks Arroyo Proposed Channel Improvements

Channel Parameter	IH-10 to Stockyard Drive	Stockyard Drive to Reid Road	Reid Road to Thunder Road
Bottom Width, ft	8.0	8.0	8.0
Average Depth, ft	6.5	7.0	15.5
Side Slope	2H:1V	2H:1V	2H:1V

Table 5. Summary of Proposed Thunder Road Crossing

Crossing Details	
Crossing Size	4 - 7'x4' RCBs
Upstream Invert	3,641.00
Downstream Invert	3,640.00

The proposed configuration of improved channels, detention/retention basins and drainage structures provides a unique and optimized solution to control ultimate peak discharge into Mesa Spur Drain, to contain the 100-year flow within the channel banks, and to reduce the overall flooding potential up to and including the 100-year storm event. The flows and water surface elevations at key locations along Sparks Arroyo are presented in **Table 6** below.

Table 6. Summary of Proposed Flows and Water Surface Elevations at Key Locations

Location	Proposed Drainage Structure	Peak Flow, cfs			WSEL, ft		
		10-yr	50-yr	100-yr	10-yr	50-yr	100-yr
I-10	4 – 10'x7' RCBs (Same as Existing)	386	942	1,286	3,745.98	3,747.15	3,747.70
Stockyard Dr. Crossing	Existing 3- 5'x4' RCBs in Place Proposed 18" RCP	210	471	628	3,713.88	3,716.54	3,718.86
Thunder Rd. Crossing	4 – 7'x4' RCBs	226	498	665	3,644.38	3,650.25	3,655.32
Outfall to Mesa Spur Drain	24" RCP with 21" Diameter Effective Opening	0	18	29	3,644.30	3,649.70	3,654.30

The proposed improvements do not cause any adverse flood impacts along Sparks Arroyo up to and including the 100-year storm event. The project will also not cause any adverse flow impacts to Mesa Spur Drain.

5.0 Cost-Benefit Analysis

The cost of construction of the proposed project and the benefits are presented in detail below. The benefits of the proposed project include the following:

1. Removal of frequently flooded residences near Onion Field out of the 100-year floodplain.
2. Improvement of traffic movement along Thunder Road and removal of the roadway out of the 100-year floodplain.
3. Removal of Stockyard Drive out of the 100-year floodplain.
4. Containing the 100-year flows within the channel banks.
5. Channel stability and velocity reduction by utilizing gabion lining and milder slopes.
6. Significant reduction of flows into Mesa Spur Drain.

The proposed project will provide long-term flood benefits and improved mobility to the area. The project will remove several residences from floodplain and improve the quality of life of the residents. The improvements will also provide channel stability and prevent erosion of roadways.

Project Cost Estimation

The major project costs include costs associated with excavation of basins, channel excavation, gabion lining, culvert crossings, and acquisition of right-of-way. Currently, the City has limited right-of-way along the channel. The existing City right-of-way varies between 70 feet and 400 feet. The total existing right-of-way along the channel is 11.22 acres. Additional right-of-way area of approximately 0.93 acres is needed to accommodate the channel improvements and the two basins. The cost summary is presented in **Table 7**.

Table 7. Proposed Project Cost Summary

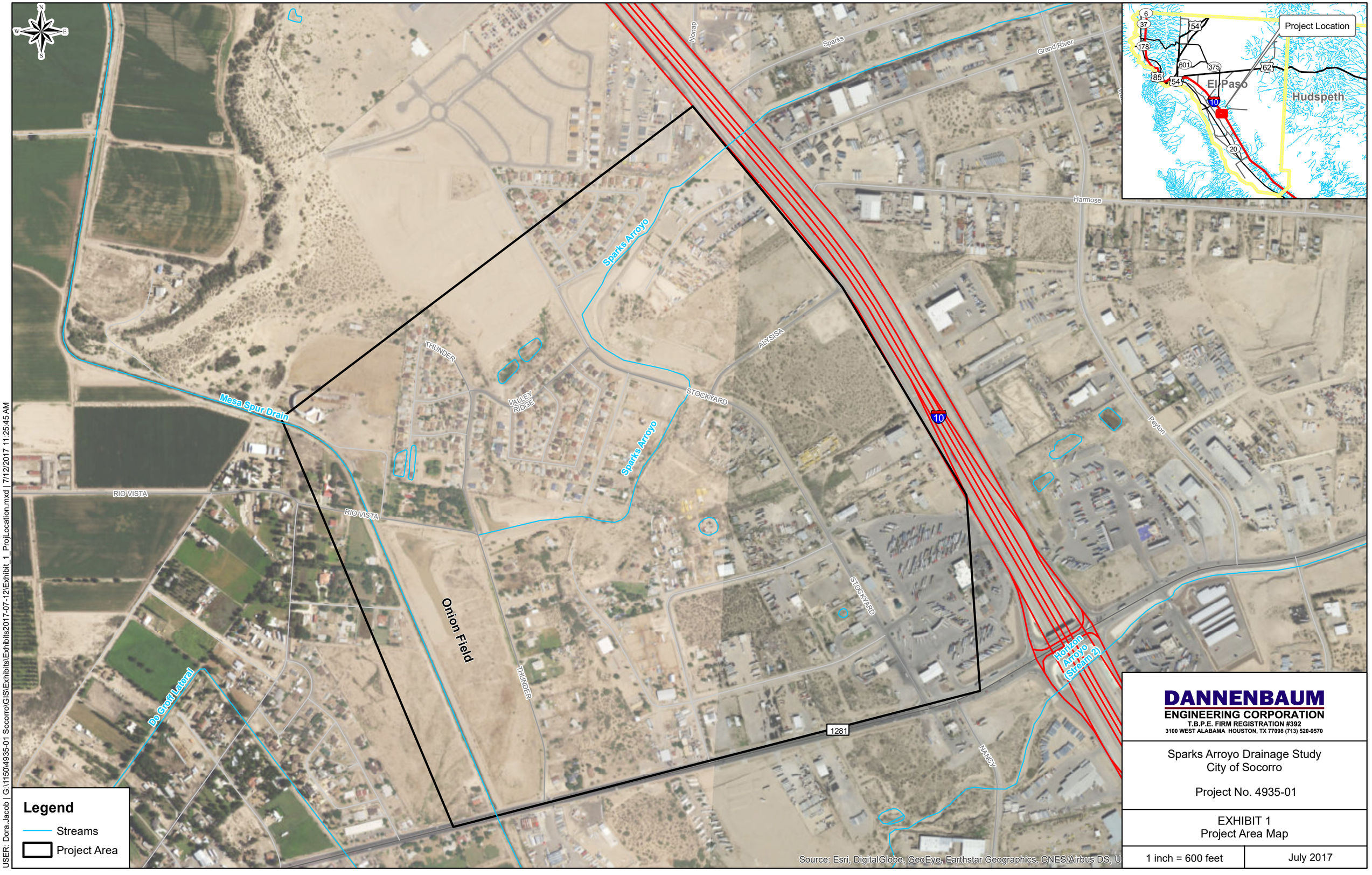
Cost Item	Cost
Onion Field Basin	$ 3,183,584.00
Culverts at Thunder	$543,220.50
Outfall Structures to Mesa Spur Drain	$51,300.00
Stockyard Basin & Outfall Structures	$ 4,072,343.00
Channel Improvements	$ 2,786,609.00
Total Cost	$ 10,637,056.50

6.0 Conclusions

Dannenbaum Engineering Corporation (DEC) was contracted by the City of Socorro to develop flood reduction solutions along Sparks Arroyo between downstream of I-10 and the Onion Field. The objective of this study is to identify probable solutions to the existing flooding problem and evaluate flood reduction benefits through hydrologic and hydraulic modeling of the project area. The flood reduction benefits will be achieved by providing channel improvements, flood control basins, and additional drainage structures. The study used HEC-HMS and HEC-RAS models with available information and latest survey data to establish the existing conditions. The proposed solution was also modeled to evaluate the benefits. The project will provide a 100-year level of flood protection to the residents and structures along Sparks Arroyo.

The channel improvements include channel widening and deepening to provide additional conveyance capacity. Drop structures are provided along the channel to reduce velocities, accommodate steep terrain, and to drain the basins. A new culvert crossing is also proposed underneath Thunder Road. One of the flood control basins is a detention basin near Stockyard Drive (Stockyard Basin) which will reduce the peak flows downstream of Stockyard Drive and into Mesa Spur Drain. The other basin is a detention/retention basin in Onion Field (Onion Field Basin), which further reduces the peak flows into Mesa Spur Drain. The proposed Onion Field Basin will discharge only 29 cfs into Mesa Spur Drain during the 100-year storm event, which is significantly less than the existing overflow, and also less than the maximum recommended flow of 30 cfs as per the USACE Feasibility Study. The current study proposes an outfall pipe into Mesa Spur Drain from Onion Field Basin, whereas in existing conditions, there are no outfall pipes into the drain. **Therefore, City should coordinate with the El Paso County Water Improvement District #1 (EPCWID#1) before construction of any outfalls into Mesa Spur Drain.**

EXHIBITS



Legend

- Streams
- Project Area

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, U

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Sparks Arroyo Drainage Study
City of Socorro

Project No. 4935-01

EXHIBIT 1
Project Area Map

1 inch = 600 feet	July 2017

USER: Dora.Jacob | G:\1150\4935-01 Socorro\GIS\Exhibits\Exhibits\2017-07-12\Exhibit_1_ProjLocation.mxd | 7/12/2017 11:25:45 AM

Project Area

ZONE X

ZONE AO
(DEPTH 1')

ZONE A

ZONE AE

ZONE X

ZONE AO
(DEPTH 1')
(VELOCITY 7 FPS)

ZONE A

ZONE AE

ZONE X

ZONE X

ZONE AE

ZONE X

ZONE X

ZONE AE

ZONE X

ZONE X

JOINS PANEL 0236

LIMIT OF DETAILED STUDY

RM 2

RM 3

RM 4

Stream 1

Stream 2

Onion Field

ALYSISA

VALLEY RIDGE

STOCKYARD

NANCY

PEYTON

ROAD

THUNDER

ACCESS

FRONTAGE

BUFORD

RIO VISTA

VISA

1281

10

80

3799

3772

3767

3757

3749

3745

3735

3729

3723

3721

3719

3712

3706

3700

3690

3680

3671

3662

3788

3795

3802

3810

3818

3825

3835

3780

3773

3766

3758

3751

3745

3738

3730

3722

3715

3709

3703

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY, TEXAS
UNINCORPORATED AREAS

PANEL 237 OF 375
(SEE MAP INDEX FOR PANELS NOT PRINTED)

PANEL LOCATION

COMMUNITY-PANEL NUMBER
480212 0237 B

EFFECTIVE DATE:
SEPTEMBER 4, 1991

Federal Emergency Management Agency

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Sparks Arroyo Drainage Study
City of Socorro

Project No. 4935-01

EXHIBIT 2
Effective FIRM

1 inch = 600 feet | July 2017

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Legend

- Stream
- Base Flood Elevation
- Project Area

Preliminary Flood Hazard Areas

- A
- AE
- AE, FLOODWAY
- AH
- AO
- 0.2 PCT ANNUAL CHANCE FLOOD HAZARD,
- X PROTECTED BY LEVEE,
- X,

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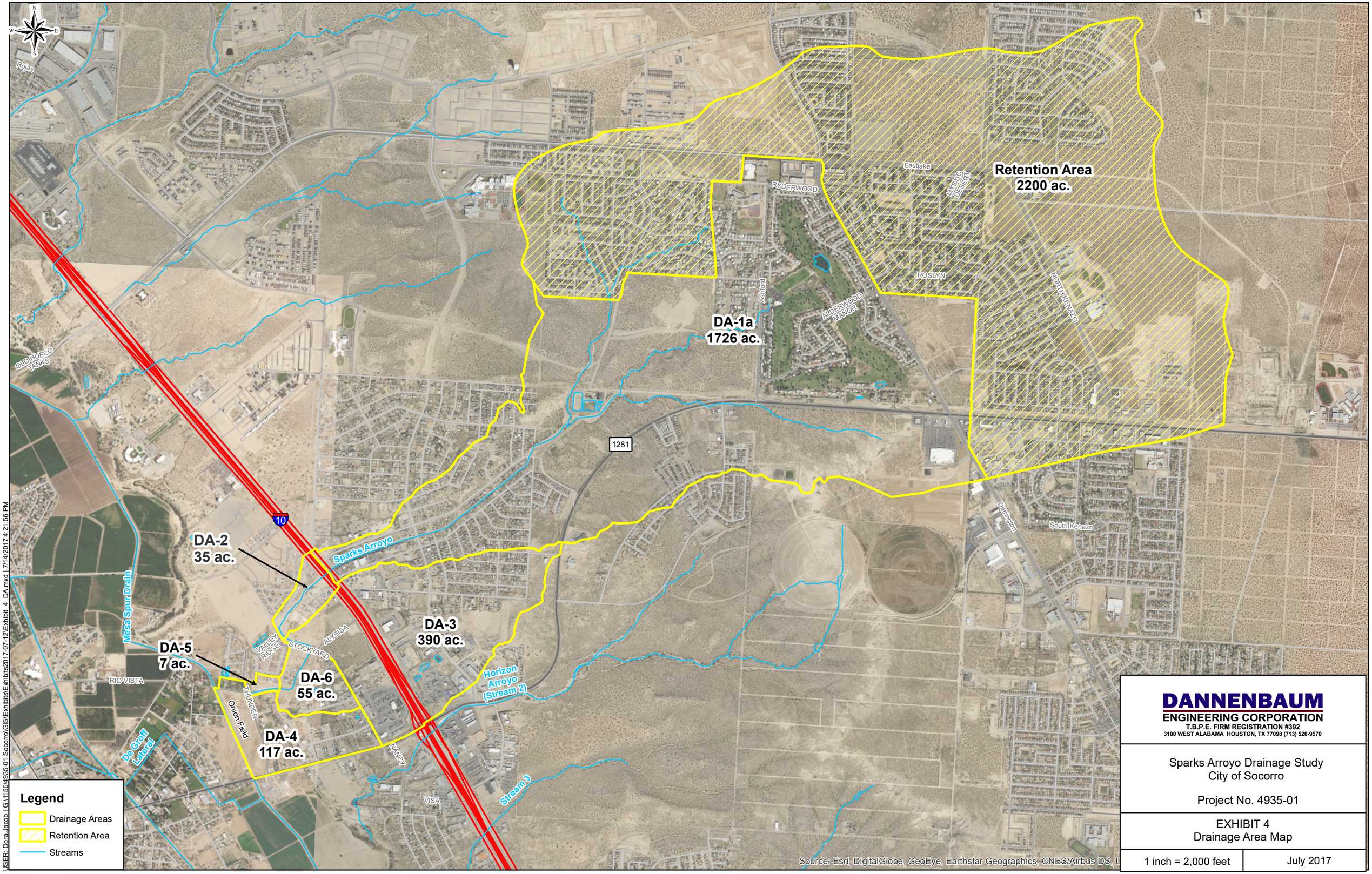
City of Socorro

Project No. 4935-01

EXHIBIT 3
Preliminary FIRM

1 inch = 600 feet	July 2017



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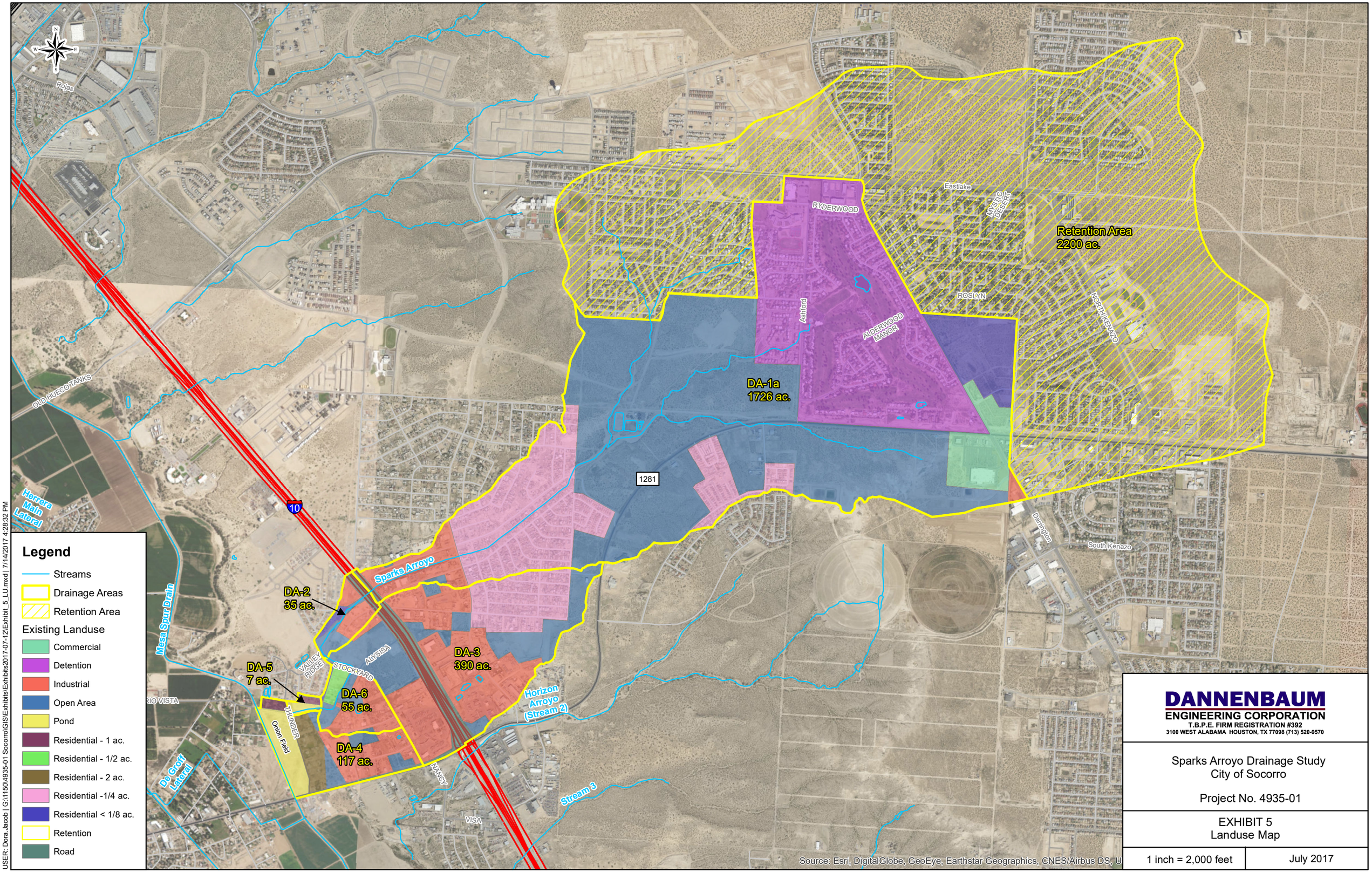
City of Socorro

Project No. 4935-01

EXHIBIT 4
Drainage Area Map

1 inch = 2,000 feet	July 2017



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Sparks Arroyo Drainage Study
City of Socorro

Project No. 4935-01

EXHIBIT 5
Landuse Map

1 inch = 2,000 feet	July 2017

N

1 inch = 600 feet

DA-1a

Sparks Arroyo

DA-2

E2

ALYSISA

DA-3

E1

VALLEY RIDGE

E3

DA-5

DA-6

RIO VISTA

STOCKYARD

10

THUNDER

DA-4

Horizon Arroyo (Stream 2)

Mesa Spur Drain

De Groff Lateral

1281

Legend

- Streams
- Drainage Area
- Floodplain Extents-2YR

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmap
Community

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City of Socorro
Drainage Impact Study

EXHIBIT 6A
Existing 2-YR Floodplain

1 inch = 600 feet	February, 2017

USER: ashish.waghray | G:\115\04935-01 Socorro\GIS\Exhibits\Exhibit_6A_Ex2YR.mxd | 2/6/2017 4:27:40 PM

N

1 inch = 600 feet

DA-1a

Sparks Arroyo

DA-2

E2

ALYSISA

DA-3

E1

VALLEY RIDGE

E3

DA-5

DA-6

RIO VISTA

STOCKYARD

10

THUNDER

DA-4

Horizon Arroyo (Stream 2)

Mesa Spur Drain

De Groff Lateral

1281

Legend

- Streams
- Drainage Area
- Floodplain Extents-5YR

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmap
Community

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City of Socorro
Drainage Impact Study

EXHIBIT 6B
Existing 5-YR Floodplain

1 inch = 600 feet	February, 2017

N

1 inch = 600 feet

DA-1a

Sparks Arroyo

DA-2

E2

ALYSISA

DA-3

E1

VALLEY RIDGE

E3

DA-5

DA-6

RIO VISTA

STOCKYARD

10

THUNDER

DA-4

Horizon Arroyo (Stream 2)

Mesa Spur Drain

1281

De Groff Lateral

Legend

- Streams
- Drainage Area
- Floodplain Extents-10YR

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmap
Community

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Drainage Impact Study

EXHIBIT 6C
Existing 10-YR Floodplain

1 inch = 600 feet	February, 2017

USER: ashish.waghray | G:\11504935-01 Socorro\GIS\Exhibits\Exhibit_6C_Ex10YR.mxd | 2/6/2017 5:06:42 PM

N

1 inch = 600 feet

DA-1a

Sparks Arroyo

DA-2

E2

ALYSISA

DA-3

E1

VALLEY RIDGE

E3

DA-5

DA-6

RIO VISTA

STOCKYARD

I-10

THUNDER

DA-4

Horizon Arroyo (Stream 2)

Mesa Spur Drain

De Groff Lateral

1281

Legend

- Streams
- Drainage Area
- Floodplain Extents-25YR

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmap
Community

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City of Socorro
Drainage Impact Study

EXHIBIT 6D
Existing 25-YR Floodplain

1 inch = 600 feet	February, 2017

N

1 inch = 600 feet

DA-1a

Sparks Arroyo

DA-2

E2

ALYSISA

DA-3

E1

VALLEY RIDGE

E3

DA-5

DA-6

RIO VISTA

STOCKYARD

10

THUNDER

DA-4

Horizon Arroyo (Stream 2)

Mesa Spur Drain

1281

De Groff Lateral

Legend

- Streams
- Drainage Area
- Floodplain Extents-50YR

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmap
Community

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Project No. 4935-01

City of Socorro
Drainage Impact Study

EXHIBIT 6E
Existing 50-YR Floodplain

1 inch = 600 feet	February, 2017

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N

1 inch = 600 feet

DA-1a

Sparks Arroyo

DA-2

E2

ALYSISA

E1

VALLEY RIDGE

E3

DA-3

DA-5

DA-6

RIO VISTA

STOCKYARD

THUNDER

DA-4

Horizon Arroyo (Stream 2)

Mesa Spur Drain

De Groff Lateral

1281

Legend

- Streams
- Drainage Area
- Floodplain Extents-100YR

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmap
Community

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Project No. 4935-01

City of Socorro
Drainage Impact Study

EXHIBIT 6F
Existing 100-YR Floodplain

1 inch = 600 feet	February, 2017

N

1 inch = 600 feet

DA-1a

Sparks Arroyo

DA-2

STOCKYARD DETENTION POND (10.5 ac)

ALYSISA

VALLEY RIDGE

DA-3

DA-5

DA-6

RIO VISTA

STOCKYARD

ONION FIELD DETENTION POND (26 ac)

THUNDER

Horizon Arroyo (Stream 2)

Mesa Spur Drain

DA-4

Decatur Arroyo

1281

10

Legend

- Streams
- Drainage Area
- Floodplain Extents-100YR

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, U

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Sparks Arroyo Drainage Study
City of Socorro

Project No. 4935-01

EXHIBIT 7
Proposed 100-YR Floodplain

1 inch = 600 feet	July 2017

N

1 inch = 600 feet

Proposed Channel Improvements
Bottom Width: 8.0 feet
Average Depth: 6.5 feet

DA-1a

Sparks Arroyo

DA-2

STOCKYARD DETENTION POND (13.3 ac)

Proposed drop structures to accomodate steep terrain

Proposed Crossing
4 - 7' x 4' RCBs

DA-3

DA-6

DA-5

Existing Crossing
Ex. 3 - 5' x 4' RCBs
(To Remain In Place)
Proposed Crossing
Pr. 24" RCP
Note: Proposed RCP to be jack and bored through existing road.

Mesa Spur Drain

Proposed Emergency Overflow Spillway
Width: 100 feet
Side Slope: 8:1
Invert: 3654.5 feet

ONION FIELD DETENTION POND (26 ac)

Proposed Channel Improvements
Bottom Width: 8.0 feet
Average Depth: 7.0 feet

Horizon Arroyo (Stream 2)

Proposed Outflow from Onion Field to Mesa Spur Drain
24" RCP With 21" Effectve Opening

Proposed Channel Improvements
Bottom Width: 8.0 feet
Average Depth: 15.5 feet

DA-4

De Cora Lateral

Legend

- Channel Improvements
- Streams
- Drainage Area
- Floodplain Extents-100YR

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, U

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Sparks Arroyo Drainage Study
City of Socorro

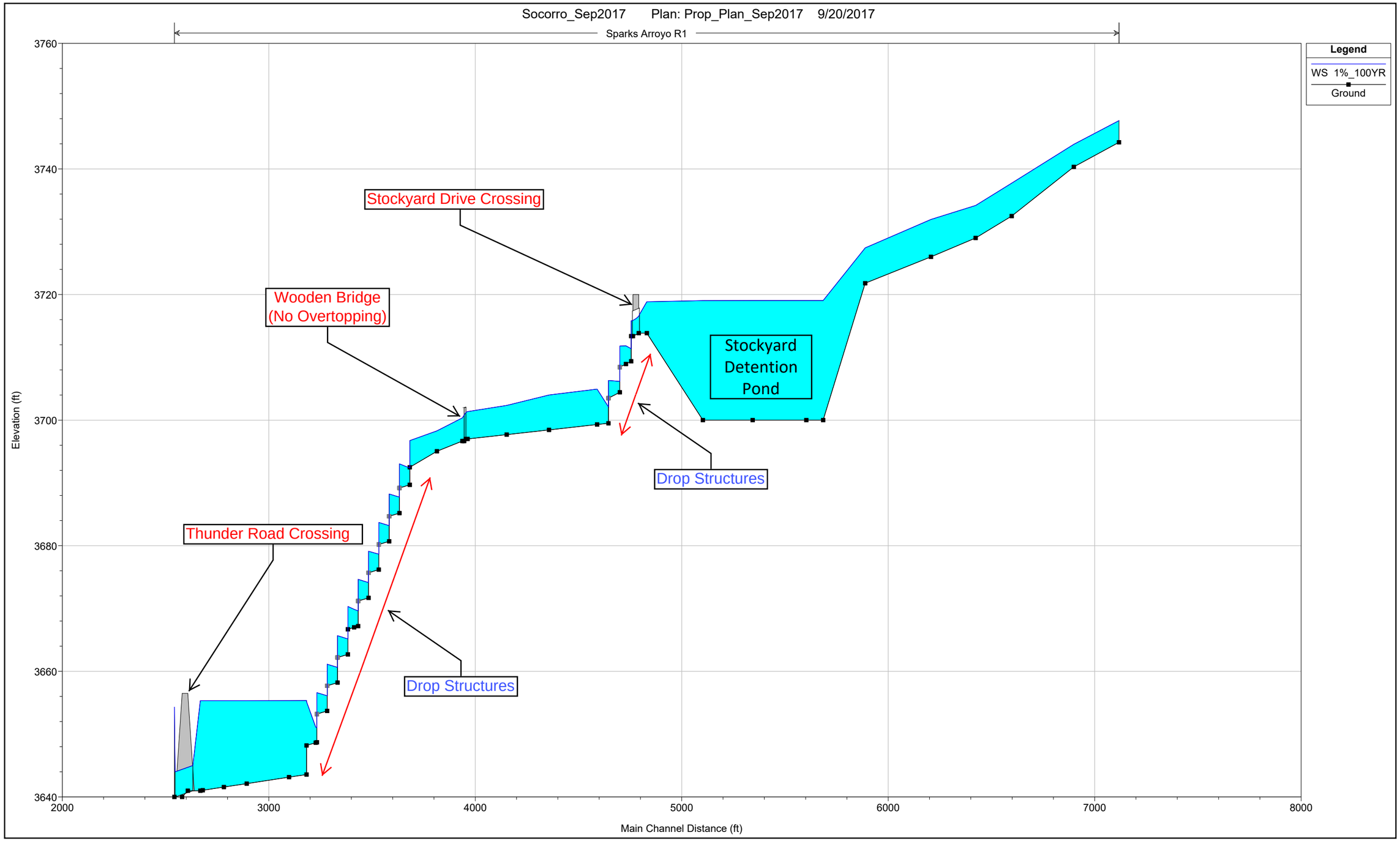
Project No. 4935-01

EXHIBIT 8
Proposed Plan

1 inch = 600 feet	September 2017

USER: ashish.waghray | G:\1150\4935-01 Socorro\GIS\Exhibits\2017_09_19\Exhibit_8_SchematicProposedPlan.mxd | 9/20/2017 5:40:19 AM

Exhibit 9. Proposed Profile (100-year) showing the Drop Structures



APPENDICES

APPENDIX-A

H&H CALCULATIONS

Land Use Computations

Sparks Arroyo Drainage Study

Table ID: A.1
Description: Land Use Computations
Project Name: Drainage Study - Sparks Arroyo
Location: El Paso County, Texas
Drainage Condition: Existing
Date: 2017-07-14

Drainage Area ID	Drainage Area (ac.)	Sub-Areas (ac.)												Curve Number, CN
		Open Areas	Development w/ Detention	Development w/ Retention	Residential Districts					Commercial	Industrial	Onion Field Area	Pavement	
					Avg Lot Size < 1/8 ac.	Avg Lot Size = 1/4 ac.	Avg Lot Size = 1/2 ac.	Avg Lot Size = 1 ac.	Avg Lot Size = 2 ac.					
Runoff Coefficient		**79**	**79**	**79**	**85**	**75**	**70**	**68**	**65**	**92**	**88**	**98**	**89**	**(---)**
Imperviousness %		**0**	**0**	**0**	**65**	**38**	**25**	**20**	**12**	**85**	**72**	**100**	**90**	
DA-1a	1726	768.65	507.69	1.24	76.40	252.33	0.00	0.00	0.00	63.93	52.44	0.00	3.25	79.5
DA-2	35	10.05	0.00	0.00	4.11	0.00	0.00	0.00	0.00	0.00	15.78	0.00	5.30	85.2
DA-3	390	108.17	0.00	0.00	0.14	72.96	0.16	0.00	0.00	0.00	171.87	0.00	36.74	83.2
DA-4	117	16.84	0.00	0.00	0.04	0.00	0.00	3.52	22.18	0.00	40.75	29.80	4.33	82.3
DA-5	7	0.21	0.00	0.00	0.70	0.00	0.00	1.90	0.04	0.00	0.00	4.32	0.00	70.1
DA-6	55	14.18	0.00	0.00	1.01	0.00	7.43	0.14	0.00	0.00	32.16	0.01	0.00	83.0

Lag Time Calculations

Sparks Arroyo Drainage Impact Study

Table ID:	A.2
Description:	Lag Time Calculations
Project Name:	Drainage Impact Study - Sparks Arroyo
Location:	El Paso County, Texas
Drainage Condition:	Existing
Date:	2017-04-24

Drainage Area ID	Drainage Area	Curve Number	Hydraulic Length of Watershed, L	Watershed Slope, Y	Maximum Retention, S	Lag Time
	(sq.mi.)	(---)	(ft.)	(%)	(in.)	(Hr.)
DA-1a	2.70	79.5	18639	3.920	2.59	1.69
DA-2	0.06	85.2	2202	1.956	1.73	0.36
DA-3	0.61	83.2	8039	3.618	2.03	0.80
DA-4	0.18	82.3	3753	2.000	2.15	0.60
DA-5	0.01	70.1	968	8.445	4.27	0.14
DA-6	0.09	83.0	2017	2.006	2.05	0.36

SCS Runoff Hydrograph Peak Flows

Sparks Arroyo Drainage Impact Study

Table ID: A.3

Description: SCS Runoff Hydrograph Peak Flows

Project Name: Drainage Impact Study - Sparks Arroyo

Location: El Paso County, Texas

Drainage Condition: Existing

Date: 2017-04-24

Drainage Area ID	Drainage Area	Curve Number	Lag Time	Peak Runoff (HEC-HMS)		
				10-YR	50-YR	100-YR
	(sq.mi.)	(---)	(hr.)	(cfs)	(cfs)	(cfs)
DA-1a	2.70	79.46	1.69	386	942	1286
DA-2	0.06	85.23	0.36	39	82	108
DA-3	0.61	83.16	0.80	210	471	628
DA-4	0.18	82.30	0.60	75	170	229
DA-5	0.01	70.06	0.14	4	12	18
DA-6	0.09	82.96	0.36	53	116	155

APPENDIX-B

HEC-HMS OUTPUT

EXISTING CONDITION

Existing Condition: 2-year

Global Summary Results for Run "OptionA_Ex_2yr"

Project: Socorro Simulation Run: OptionA_Ex_2yr

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 19Jul2017, 18:20:27

Basin Model: Existing_optionA
Meteorologic Model: 2-YR
Control Specifications: Control 1

Show Elements: All Elements | Volume Units: (•) IN ( ) AC-FT | Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
101-DA-1a	2.697	71.2	01Jan2000, 07:50	0.15
J1	2.697	71.2	01Jan2000, 07:50	0.15
R1	2.697	71.0	01Jan2000, 07:55	0.15
102-DA-2	0.055	10.4	01Jan2000, 06:15	0.30
J2	2.752	71.5	01Jan2000, 07:55	0.15
R2	2.752	71.3	01Jan2000, 08:00	0.15
103-DA-3	0.609	47.6	01Jan2000, 06:45	0.24
J3	3.361	88.5	01Jan2000, 07:45	0.17
R3	3.361	88.3	01Jan2000, 07:50	0.17
106-DA-6	0.086	12.2	01Jan2000, 06:15	0.23
J4	3.447	89.1	01Jan2000, 07:45	0.17
R4	3.447	89.1	01Jan2000, 07:50	0.17
105-DA-5	0.011	0.1	01Jan2000, 06:05	0.03
J5	3.458	89.1	01Jan2000, 07:50	0.17
104-DA-4	0.184	15.8	01Jan2000, 06:30	0.22
Ex-OnionField	3.642	86.0	01Jan2000, 08:10	0.13
Onion Field	0.000	0.0	01Jan2000, 00:00	n/a

Existing Condition: 5-year

Global Summary Results for Run "OptionA_Ex_5yr"

Project: Socorro Simulation Run: OptionA_Ex_5yr

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 19Jul2017, 18:24:42

Basin Model: Existing_optionA
Meteorologic Model: 5-YR
Control Specifications: Control 1

Show Elements: All Elements | Volume Units: (•) IN ( ) AC-FT | Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
101-DA-1a	2.697	227.6	01Jan2000, 07:45	0.44
J1	2.697	227.6	01Jan2000, 07:45	0.44
R1	2.697	227.0	01Jan2000, 07:50	0.43
102-DA-2	0.055	25.3	01Jan2000, 06:15	0.68
J2	2.752	228.3	01Jan2000, 07:50	0.44
R2	2.752	228.2	01Jan2000, 07:50	0.44
103-DA-3	0.609	129.5	01Jan2000, 06:40	0.59
J3	3.361	276.6	01Jan2000, 07:30	0.47
R3	3.361	276.5	01Jan2000, 07:35	0.47
106-DA-6	0.086	33.1	01Jan2000, 06:15	0.58
J4	3.447	279.2	01Jan2000, 07:30	0.47
R4	3.447	279.3	01Jan2000, 07:35	0.47
105-DA-5	0.011	1.8	01Jan2000, 06:05	0.18
J5	3.458	279.3	01Jan2000, 07:35	0.47
104-DA-4	0.184	45.4	01Jan2000, 06:30	0.55
Ex-OnionField	3.642	291.0	01Jan2000, 07:35	0.42
Onion Field	0.000	0.0	01Jan2000, 00:00	n/a

Existing Condition: 10-year

Global Summary Results for Run "OptionA_Ex_10yr"

Project: Socorro Simulation Run: OptionA_Ex_10yr

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 19Jul2017, 18:21:00

Basin Model: Existing_optionA
Meteorologic Model: 10-YR
Control Specifications: Control 1

Show Elements: All Elements | Volume Units: (•) IN ( ) AC-FT | Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
101-DA-1a	2.697	386.3	01Jan2000, 07:45	0.71
J1	2.697	386.3	01Jan2000, 07:45	0.71
R1	2.697	386.0	01Jan2000, 07:45	0.71
102-DA-2	0.055	39.0	01Jan2000, 06:15	1.02
J2	2.752	388.1	01Jan2000, 07:45	0.72
R2	2.752	387.5	01Jan2000, 07:45	0.72
103-DA-3	0.609	209.7	01Jan2000, 06:40	0.91
J3	3.361	464.2	01Jan2000, 07:30	0.75
R3	3.361	463.2	01Jan2000, 07:35	0.75
106-DA-6	0.086	53.1	01Jan2000, 06:15	0.90
J4	3.447	466.9	01Jan2000, 07:35	0.75
R4	3.447	467.4	01Jan2000, 07:35	0.75
105-DA-5	0.011	4.1	01Jan2000, 06:05	0.36
J5	3.458	467.6	01Jan2000, 07:35	0.75
104-DA-4	0.184	74.5	01Jan2000, 06:30	0.86
Ex-OnionField	3.642	484.4	01Jan2000, 07:30	0.71
Onion Field	0.000	0.0	01Jan2000, 00:00	n/a

Existing Condition: 25-year

Global Summary Results for Run "OptionA_Ex_25yr"

Project: Socorro Simulation Run: OptionA_Ex_25yr

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 19Jul2017, 18:21:35

Basin Model: Existing_optionA
Meteorologic Model: 25-YR
Control Specifications: Control 1

Show Elements: All Elements | Volume Units: (•) IN ( ) AC-FT | Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
101-DA-1a	2.697	663.7	01Jan2000, 07:40	1.18
J1	2.697	663.7	01Jan2000, 07:40	1.18
R1	2.697	662.8	01Jan2000, 07:45	1.18
102-DA-2	0.055	60.7	01Jan2000, 06:15	1.58
J2	2.752	665.8	01Jan2000, 07:45	1.19
R2	2.752	666.2	01Jan2000, 07:45	1.19
103-DA-3	0.609	342.1	01Jan2000, 06:40	1.43
J3	3.361	794.3	01Jan2000, 07:25	1.23
R3	3.361	791.5	01Jan2000, 07:30	1.23
106-DA-6	0.086	85.3	01Jan2000, 06:15	1.42
J4	3.447	798.2	01Jan2000, 07:30	1.24
R4	3.447	798.8	01Jan2000, 07:30	1.24
105-DA-5	0.011	8.1	01Jan2000, 06:05	0.71
J5	3.458	799.1	01Jan2000, 07:30	1.24
104-DA-4	0.184	122.5	01Jan2000, 06:30	1.37
Ex-OnionField	3.642	825.1	01Jan2000, 07:30	1.20
Onion Field	0.000	0.0	01Jan2000, 00:00	n/a

Existing Condition: 50-year

Global Summary Results for Run "OptionA_Ex_50yr"

Project: Socorro Simulation Run: OptionA_Ex_50yr

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 19Jul2017, 18:22:05

Basin Model: Existing_optionA
Meteorologic Model: 50-YR
Control Specifications: Control 1

Show Elements: All Elements | Volume Units: (•) IN ( ) AC-FT | Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
101-DA-1a	2.697	942.2	01Jan2000, 07:40	1.65
J1	2.697	942.2	01Jan2000, 07:40	1.65
R1	2.697	940.2	01Jan2000, 07:45	1.65
102-DA-2	0.055	81.9	01Jan2000, 06:10	2.10
J2	2.752	944.1	01Jan2000, 07:40	1.65
R2	2.752	942.8	01Jan2000, 07:45	1.65
103-DA-3	0.609	470.6	01Jan2000, 06:40	1.94
J3	3.361	1117.6	01Jan2000, 07:25	1.71
R3	3.361	1115.2	01Jan2000, 07:30	1.70
106-DA-6	0.086	116.4	01Jan2000, 06:10	1.93
J4	3.447	1124.9	01Jan2000, 07:25	1.71
R4	3.447	1124.5	01Jan2000, 07:25	1.71
105-DA-5	0.011	12.3	01Jan2000, 06:05	1.07
J5	3.458	1124.9	01Jan2000, 07:25	1.71
104-DA-4	0.184	170.1	01Jan2000, 06:25	1.87
Ex-OnionField	3.642	1168.8	01Jan2000, 07:25	1.67
Onion Field	0.000	0.0	01Jan2000, 00:00	n/a

Existing Condition: 100-year

Global Summary Results for Run "OptionA_Ex_100yr"

Project: Socorro Simulation Run: OptionA_Ex_100yr

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 19Jul2017, 18:22:30

Basin Model: Existing_optionA
Meteorologic Model: 100-YR
Control Specifications: Control 1

Show Elements: All Elements Volume Units: (•) IN ( ) AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
101-DA-1a	2.697	1286.4	01Jan2000, 07:40	2.22
J1	2.697	1286.4	01Jan2000, 07:40	2.22
R1	2.697	1285.0	01Jan2000, 07:40	2.22
102-DA-2	0.055	107.6	01Jan2000, 06:10	2.74
J2	2.752	1290.5	01Jan2000, 07:40	2.23
R2	2.752	1291.4	01Jan2000, 07:40	2.23
103-DA-3	0.609	627.6	01Jan2000, 06:40	2.55
J3	3.361	1524.8	01Jan2000, 07:30	2.29
R3	3.361	1513.1	01Jan2000, 07:35	2.28
106-DA-6	0.086	155.3	01Jan2000, 06:10	2.54
J4	3.447	1522.5	01Jan2000, 07:35	2.29
R4	3.447	1525.6	01Jan2000, 07:35	2.29
105-DA-5	0.011	17.5	01Jan2000, 06:05	1.54
J5	3.458	1526.1	01Jan2000, 07:35	2.29
104-DA-4	0.184	228.8	01Jan2000, 06:25	2.47
Ex-OnionField	3.642	1564.0	01Jan2000, 07:35	2.25
Onion Field	0.000	0.0	01Jan2000, 00:00	n/a

PROPOSED CONDITION

Proposed Condition: 2-year

Global Summary Results for Run "Proposed_HSM_4_002"

Project: Socorro Simulation Run: Proposed_HSM_4_002

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 20Sep2017, 01:59:15

Basin Model: Proposed_HSM_4
Meteorologic Model: 2-YR
Control Specifications: Control 1

Show Elements: All Elements | Volume Units: (•) IN ( ) AC-FT | Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
101-DA-1a	2.697	71.2	01Jan2000, 07:50	0.15
J1	2.697	71.2	01Jan2000, 07:50	0.15
R1	2.697	71.0	01Jan2000, 07:55	0.15
102-DA-2	0.055	10.4	01Jan2000, 06:15	0.30
J2	2.752	71.5	01Jan2000, 07:55	0.15
Stockyard Basin	2.752	7.5	01Jan2000, 13:10	0.06
103-DA-3	0.609	47.6	01Jan2000, 06:45	0.24
J3	3.361	47.6	01Jan2000, 06:45	0.09
R3	3.361	47.2	01Jan2000, 06:50	0.09
106-DA-6	0.086	12.2	01Jan2000, 06:15	0.23
J4	3.447	51.2	01Jan2000, 06:45	0.10
R4	3.447	51.0	01Jan2000, 06:50	0.10
105-DA-5	0.011	0.1	01Jan2000, 06:05	0.03
J5	3.458	51.1	01Jan2000, 06:50	0.09
104-DA-4	0.184	15.8	01Jan2000, 06:30	0.22
Prop-OnionField	3.642	0.0	01Jan2000, 00:00	0.00
Mesa	3.642	0.0	01Jan2000, 00:00	0.00

Proposed Condition: 5-year

Global Summary Results for Run "Proposed_HSM_4_005"

Project: Socorro Simulation Run: Proposed_HSM_4_005

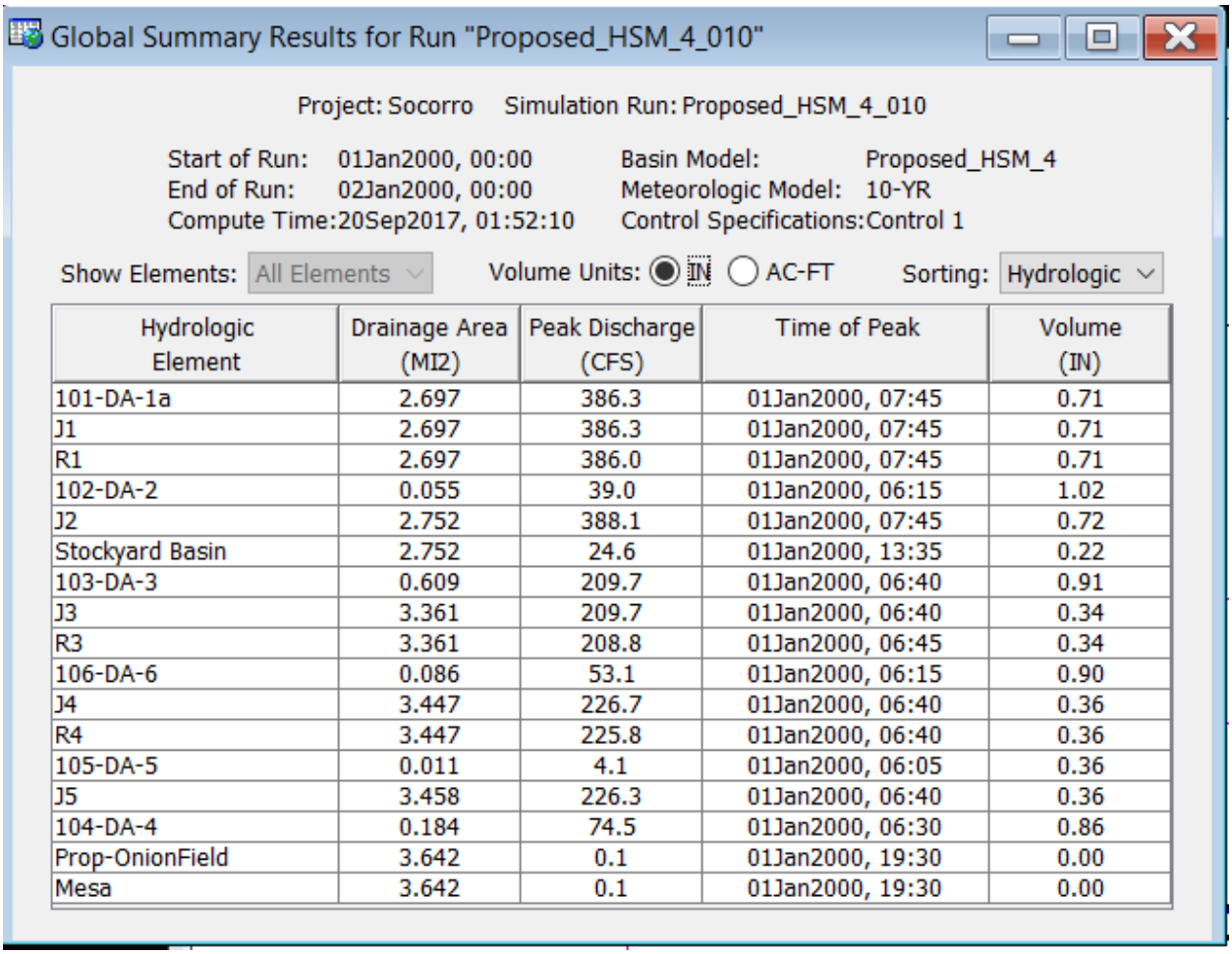
Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 20Sep2017, 01:54:30

Basin Model: Proposed_HSM_4
Meteorologic Model: 5-YR
Control Specifications: Control 1

Show Elements: All Elements | Volume Units: (•) IN ( ) AC-FT | Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Dischar... (CFS)	Time of Peak	Volume (IN)
101-DA-1a	2.697	227.6	01Jan2000, 07:45	0.44
J1	2.697	227.6	01Jan2000, 07:45	0.44
R1	2.697	227.0	01Jan2000, 07:50	0.43
102-DA-2	0.055	25.3	01Jan2000, 06:15	0.68
J2	2.752	228.3	01Jan2000, 07:50	0.44
Stockyard Basin	2.752	18.3	01Jan2000, 12:50	0.16
103-DA-3	0.609	129.5	01Jan2000, 06:40	0.59
J3	3.361	129.5	01Jan2000, 06:40	0.24
R3	3.361	128.8	01Jan2000, 06:45	0.24
106-DA-6	0.086	33.1	01Jan2000, 06:15	0.58
J4	3.447	139.3	01Jan2000, 06:45	0.24
R4	3.447	139.3	01Jan2000, 06:45	0.24
105-DA-5	0.011	1.8	01Jan2000, 06:05	0.18
J5	3.458	139.6	01Jan2000, 06:45	0.24
104-DA-4	0.184	45.4	01Jan2000, 06:30	0.55
Prop-OnionField	3.642	0.0	01Jan2000, 00:00	0.00
Mesa	3.642	0.0	01Jan2000, 00:00	0.00

Proposed Condition: 10-year



Global Summary Results for Run "Proposed_HSM_4_010"

Project: Socorro Simulation Run: Proposed_HSM_4_010

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 20Sep2017, 01:52:10

Basin Model: Proposed_HSM_4
Meteorologic Model: 10-YR
Control Specifications: Control 1

Show Elements: All Elements Volume Units: (•) IN ( ) AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
101-DA-1a	2.697	386.3	01Jan2000, 07:45	0.71
J1	2.697	386.3	01Jan2000, 07:45	0.71
R1	2.697	386.0	01Jan2000, 07:45	0.71
102-DA-2	0.055	39.0	01Jan2000, 06:15	1.02
J2	2.752	388.1	01Jan2000, 07:45	0.72
Stockyard Basin	2.752	24.6	01Jan2000, 13:35	0.22
103-DA-3	0.609	209.7	01Jan2000, 06:40	0.91
J3	3.361	209.7	01Jan2000, 06:40	0.34
R3	3.361	208.8	01Jan2000, 06:45	0.34
106-DA-6	0.086	53.1	01Jan2000, 06:15	0.90
J4	3.447	226.7	01Jan2000, 06:40	0.36
R4	3.447	225.8	01Jan2000, 06:40	0.36
105-DA-5	0.011	4.1	01Jan2000, 06:05	0.36
J5	3.458	226.3	01Jan2000, 06:40	0.36
104-DA-4	0.184	74.5	01Jan2000, 06:30	0.86
Prop-OnionField	3.642	0.1	01Jan2000, 19:30	0.00
Mesa	3.642	0.1	01Jan2000, 19:30	0.00

Proposed Condition: 25-year

Global Summary Results for Run "Proposed_HSM_4_025"

Project: Socorro Simulation Run: Proposed_HSM_4_025

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 20Sep2017, 01:50:14

Basin Model: Proposed_HSM_4
Meteorologic Model: 25-YR
Control Specifications: Control 1

Show Elements: All Elements | Volume Units: (•) IN ( ) AC-FT | Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
101-DA-1a	2.697	663.7	01Jan2000, 07:40	1.18
J1	2.697	663.7	01Jan2000, 07:40	1.18
R1	2.697	662.8	01Jan2000, 07:45	1.18
102-DA-2	0.055	60.7	01Jan2000, 06:15	1.58
J2	2.752	665.8	01Jan2000, 07:45	1.19
Stockyard Basin	2.752	32.8	01Jan2000, 13:55	0.29
103-DA-3	0.609	342.1	01Jan2000, 06:40	1.43
J3	3.361	342.1	01Jan2000, 06:40	0.50
R3	3.361	337.3	01Jan2000, 06:45	0.50
106-DA-6	0.086	85.3	01Jan2000, 06:15	1.42
J4	3.447	363.0	01Jan2000, 06:40	0.52
R4	3.447	362.7	01Jan2000, 06:45	0.52
105-DA-5	0.011	8.1	01Jan2000, 06:05	0.71
J5	3.458	363.6	01Jan2000, 06:45	0.52
104-DA-4	0.184	122.5	01Jan2000, 06:30	1.37
Prop-OnionField	3.642	4.1	02Jan2000, 00:00	0.00
Mesa	3.642	4.1	02Jan2000, 00:00	0.00

Proposed Condition: 50-year

Global Summary Results for Run "Proposed_HSM_4_050"

Project: Socorro Simulation Run: Proposed_HSM_4_050

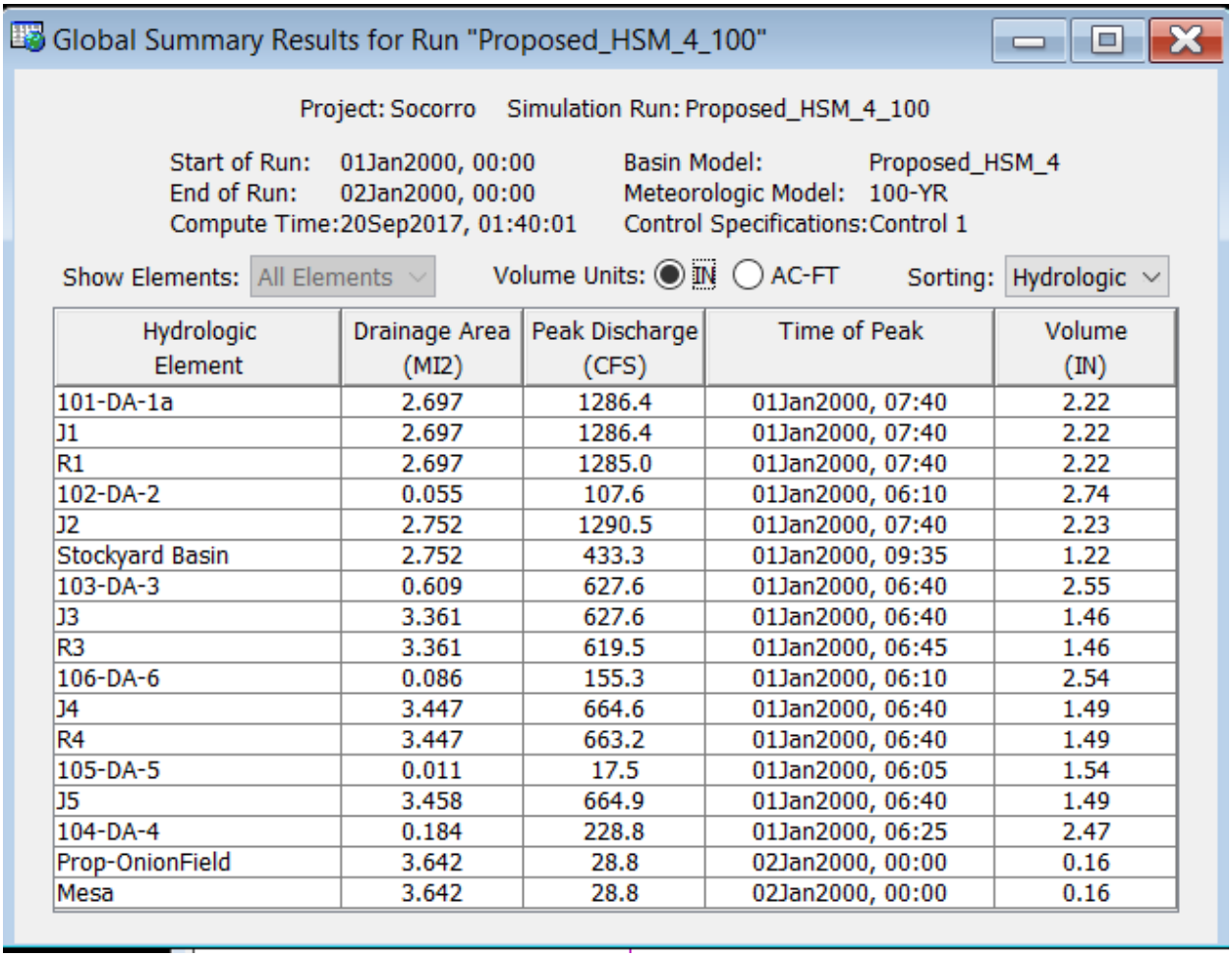
Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 20Sep2017, 01:47:47

Basin Model: Proposed_HSM_4
Meteorologic Model: 50-YR
Control Specifications: Control 1

Show Elements: All Elements | Volume Units: (•) IN ( ) AC-FT | Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
101-DA-1a	2.697	942.2	01Jan2000, 07:40	1.65
J1	2.697	942.2	01Jan2000, 07:40	1.65
R1	2.697	940.2	01Jan2000, 07:45	1.65
102-DA-2	0.055	81.9	01Jan2000, 06:10	2.10
J2	2.752	944.1	01Jan2000, 07:40	1.65
Stockyard Basin	2.752	174.5	01Jan2000, 10:30	0.67
103-DA-3	0.609	470.6	01Jan2000, 06:40	1.94
J3	3.361	470.6	01Jan2000, 06:40	0.90
R3	3.361	463.2	01Jan2000, 06:45	0.90
106-DA-6	0.086	116.4	01Jan2000, 06:10	1.93
J4	3.447	497.2	01Jan2000, 06:40	0.92
R4	3.447	496.8	01Jan2000, 06:45	0.92
105-DA-5	0.011	12.3	01Jan2000, 06:05	1.07
J5	3.458	498.0	01Jan2000, 06:45	0.92
104-DA-4	0.184	170.1	01Jan2000, 06:25	1.87
Prop-OnionField	3.642	18.3	02Jan2000, 00:00	0.08
Mesa	3.642	18.3	02Jan2000, 00:00	0.08

Proposed Condition: 100-year



Global Summary Results for Run "Proposed_HSM_4_100"

Project: Socorro Simulation Run: Proposed_HSM_4_100

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 20Sep2017, 01:40:01

Basin Model: Proposed_HSM_4
Meteorologic Model: 100-YR
Control Specifications: Control 1

Show Elements: All Elements Volume Units: (•) IN ( ) AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
101-DA-1a	2.697	1286.4	01Jan2000, 07:40	2.22
J1	2.697	1286.4	01Jan2000, 07:40	2.22
R1	2.697	1285.0	01Jan2000, 07:40	2.22
102-DA-2	0.055	107.6	01Jan2000, 06:10	2.74
J2	2.752	1290.5	01Jan2000, 07:40	2.23
Stockyard Basin	2.752	433.3	01Jan2000, 09:35	1.22
103-DA-3	0.609	627.6	01Jan2000, 06:40	2.55
J3	3.361	627.6	01Jan2000, 06:40	1.46
R3	3.361	619.5	01Jan2000, 06:45	1.46
106-DA-6	0.086	155.3	01Jan2000, 06:10	2.54
J4	3.447	664.6	01Jan2000, 06:40	1.49
R4	3.447	663.2	01Jan2000, 06:40	1.49
105-DA-5	0.011	17.5	01Jan2000, 06:05	1.54
J5	3.458	664.9	01Jan2000, 06:40	1.49
104-DA-4	0.184	228.8	01Jan2000, 06:25	2.47
Prop-OnionField	3.642	28.8	02Jan2000, 00:00	0.16
Mesa	3.642	28.8	02Jan2000, 00:00	0.16

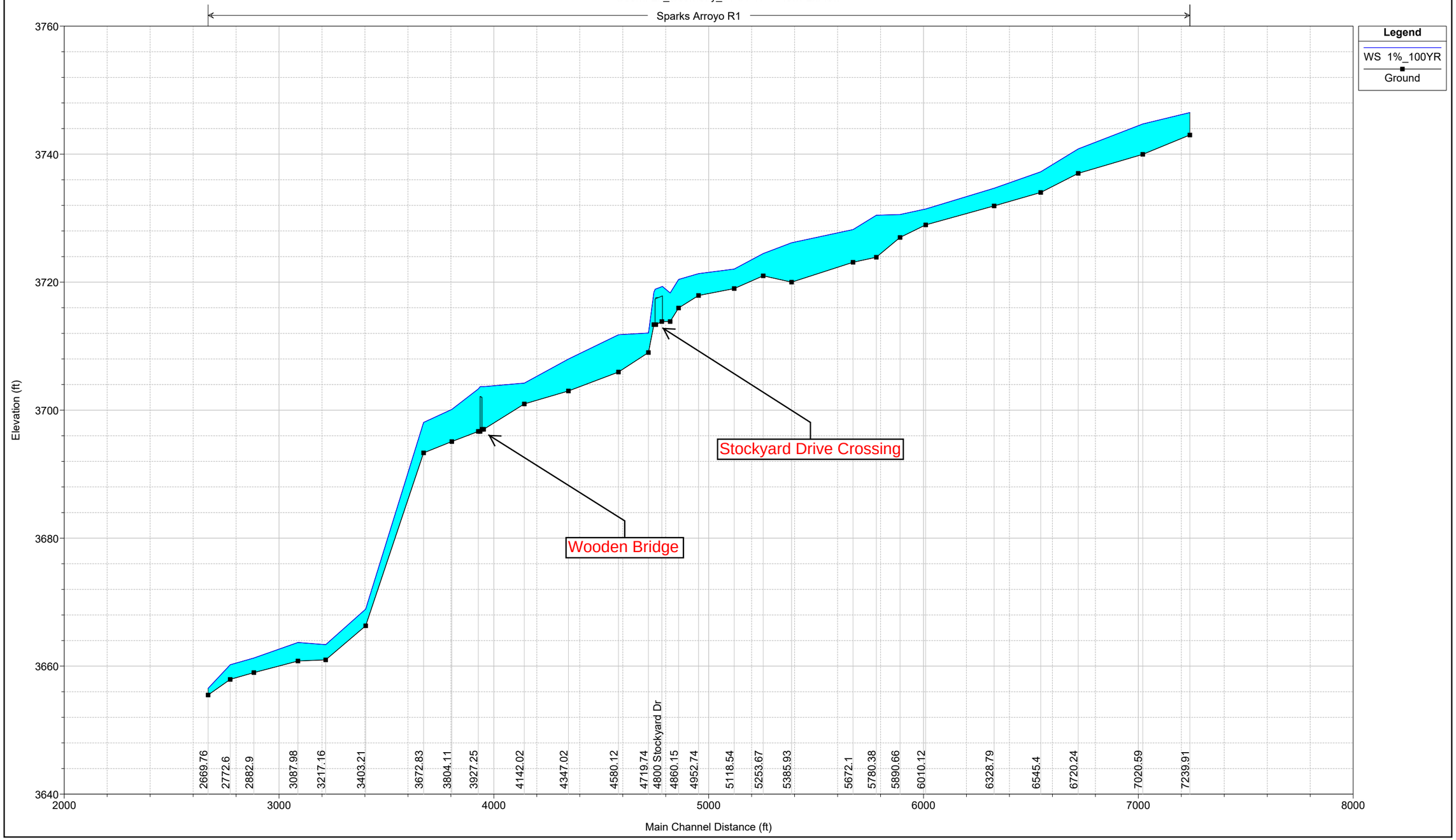
APPENDIX-C

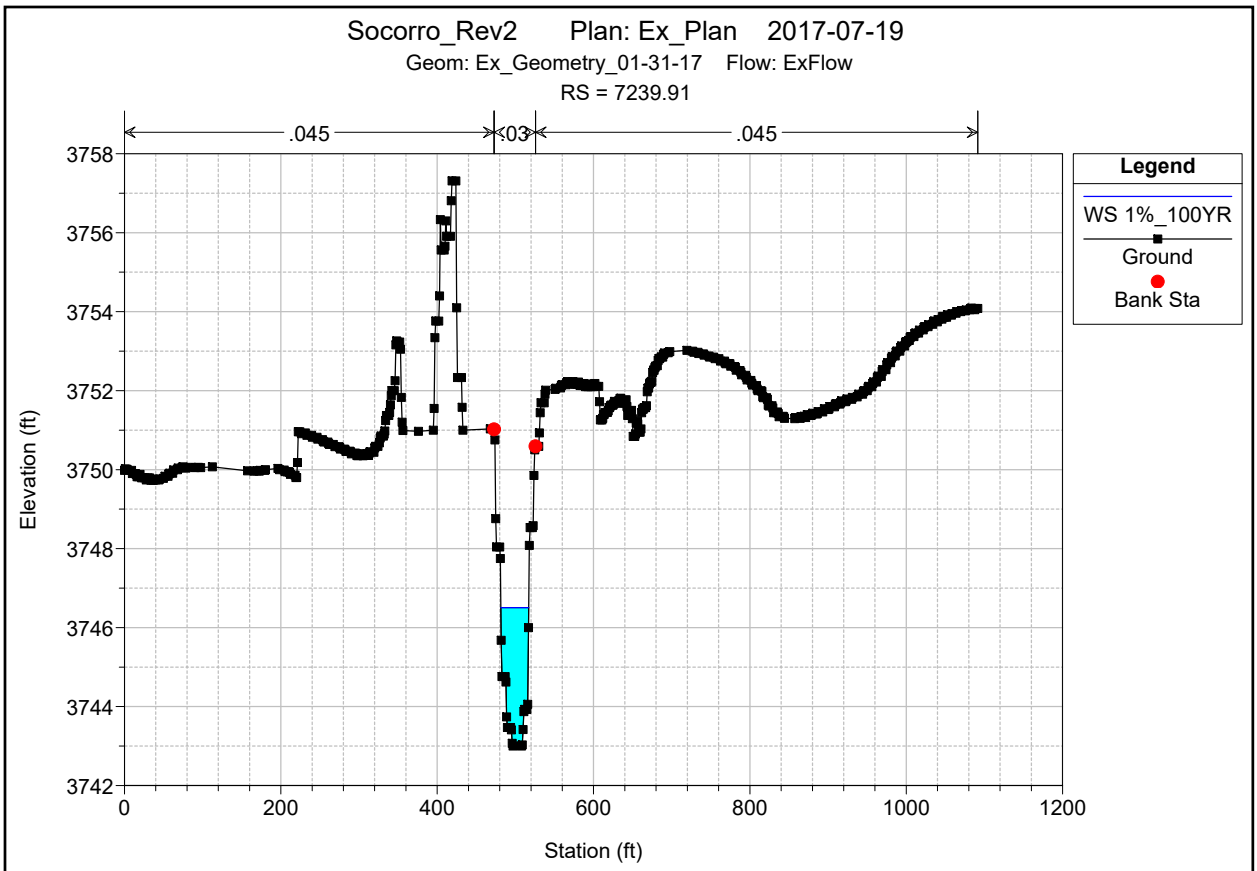
HEC-RAS OUTPUT

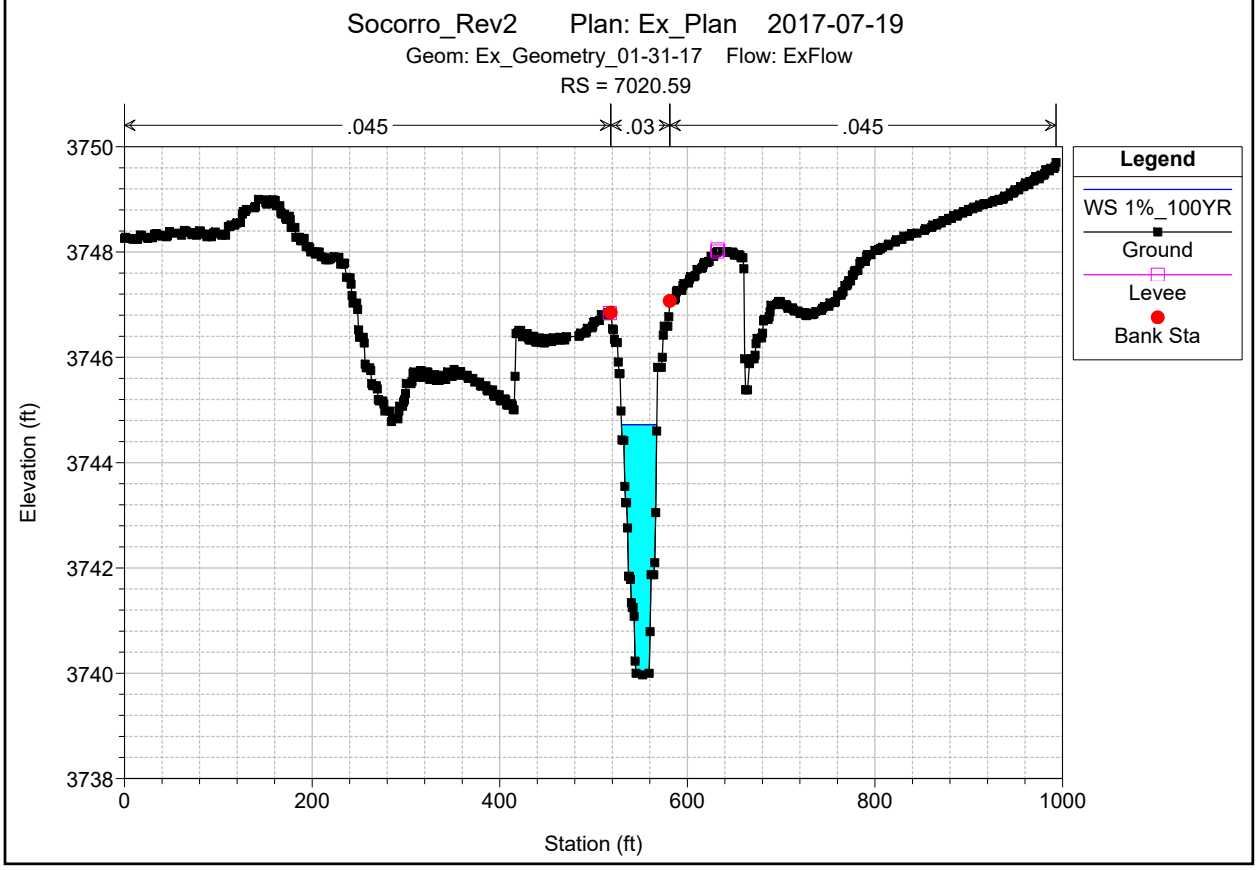
EXISTING CONDITION

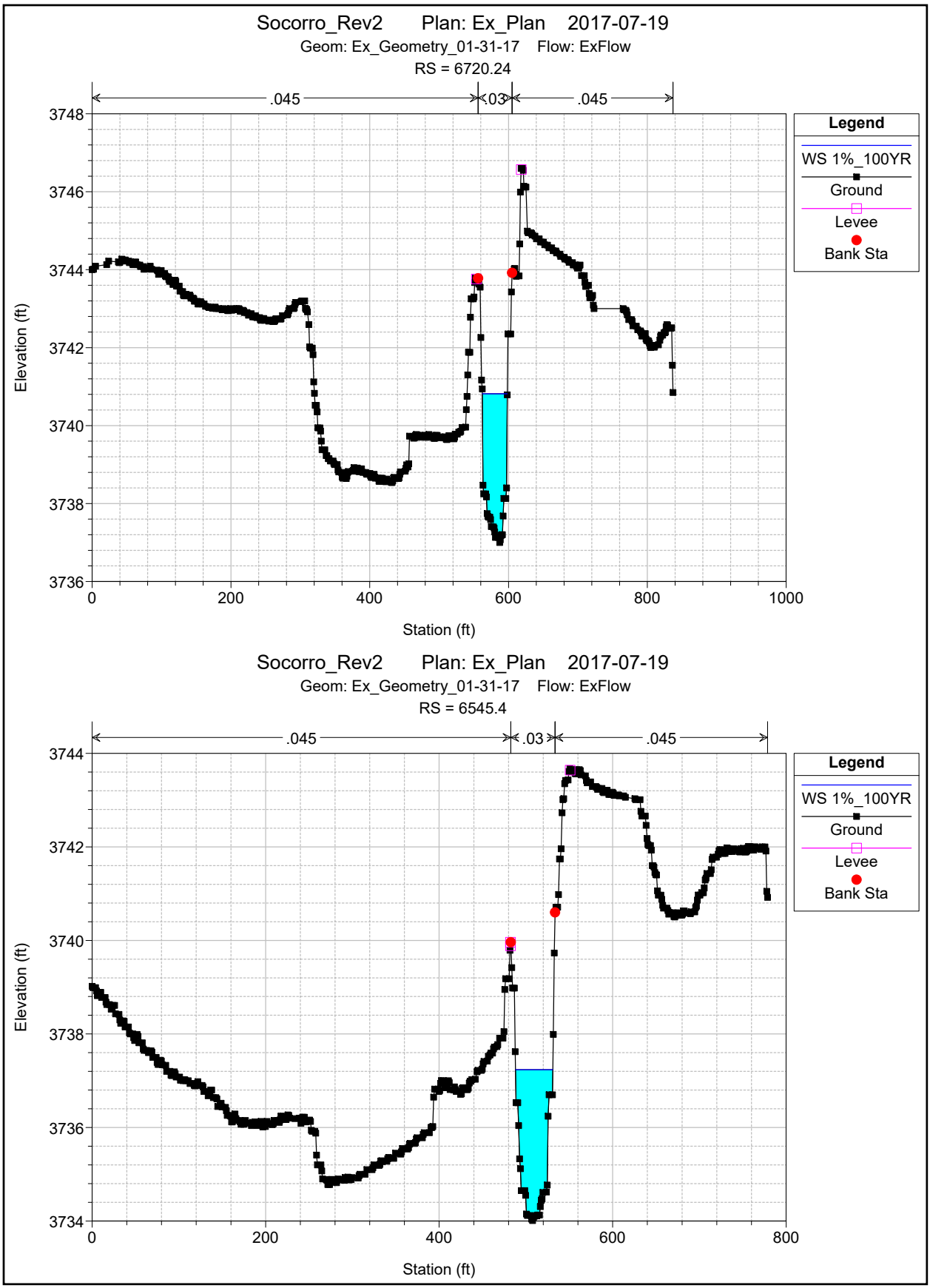
Socorro_Rev2 Plan: Ex_Plan 2017-07-19

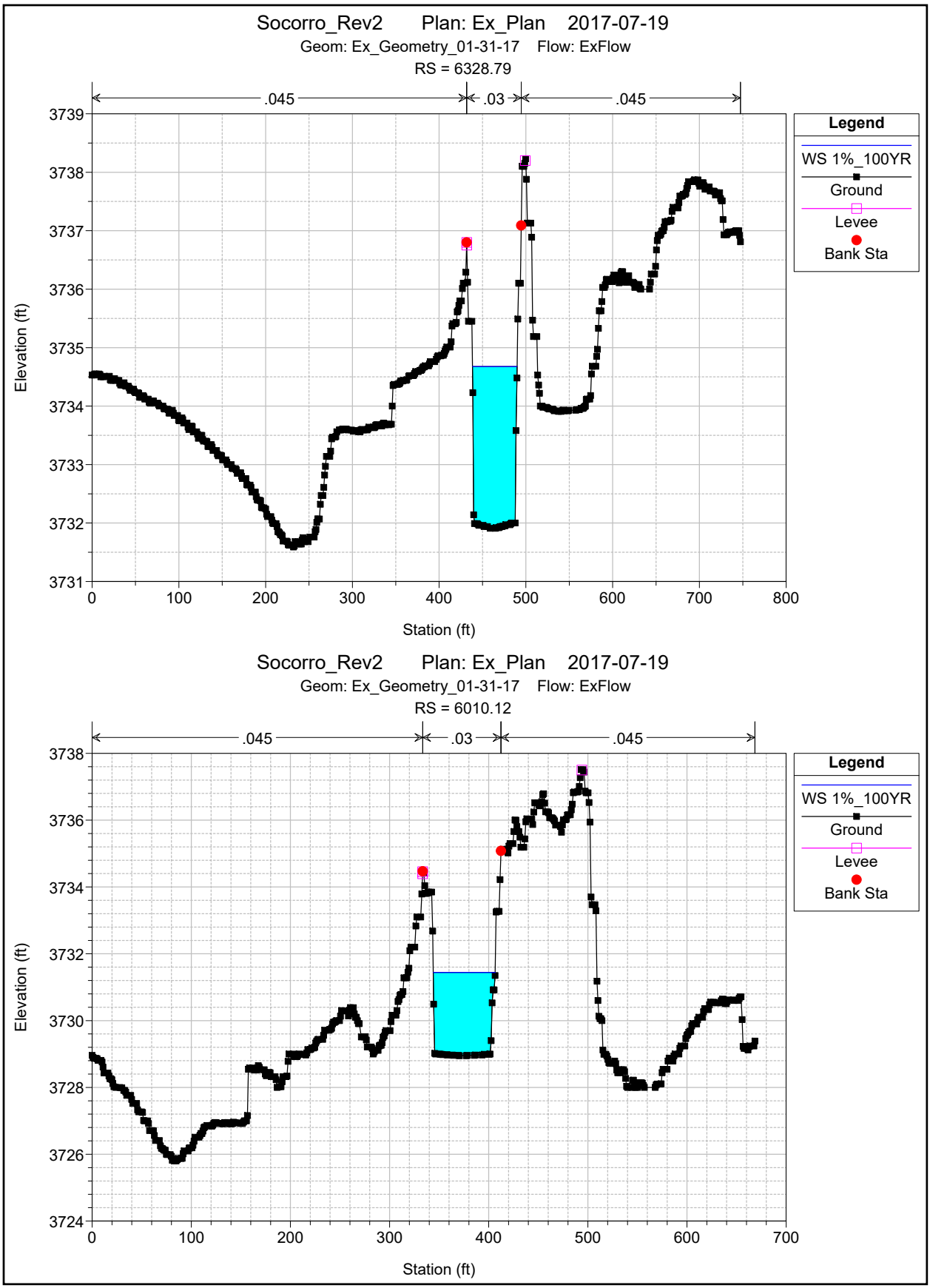
Geom: Ex_Geometry_01-31-17 Flow: ExFlow

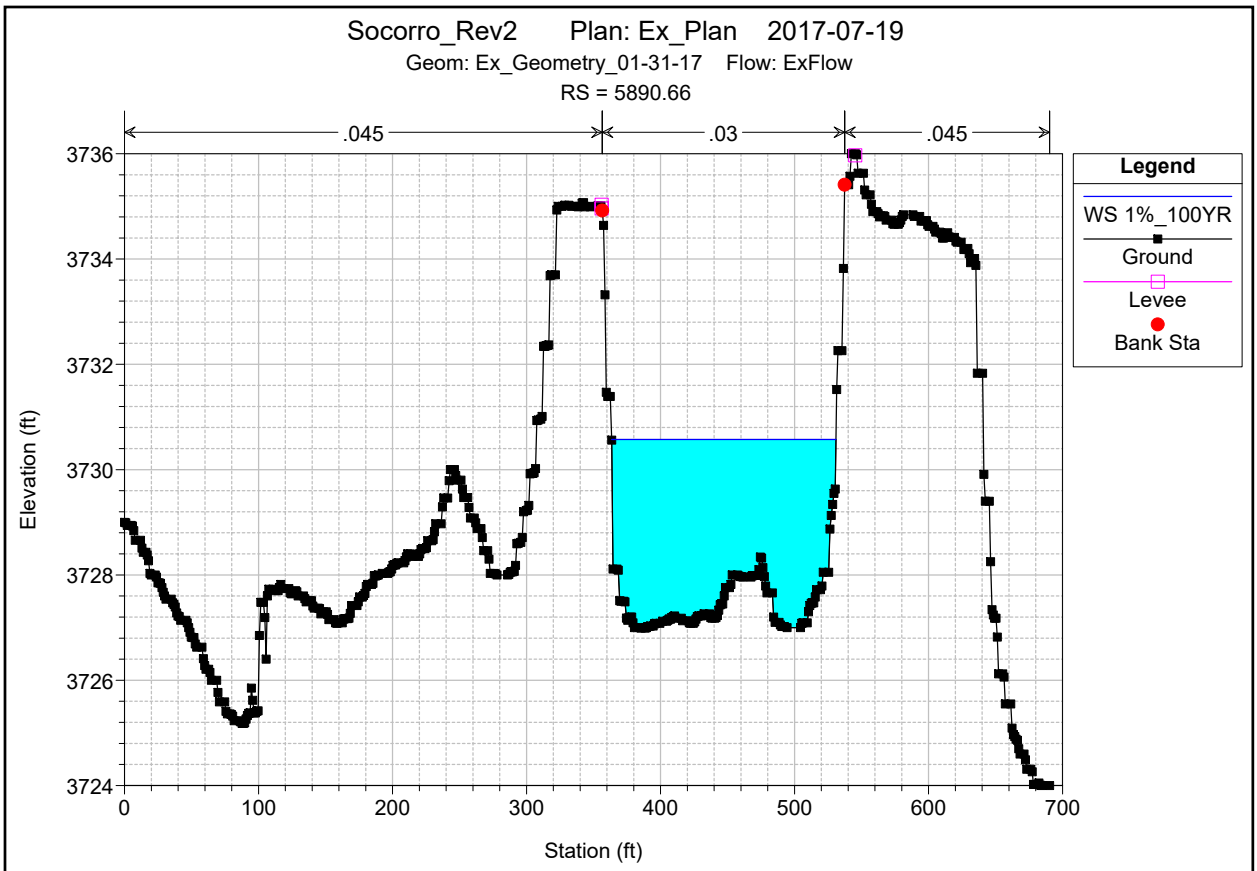


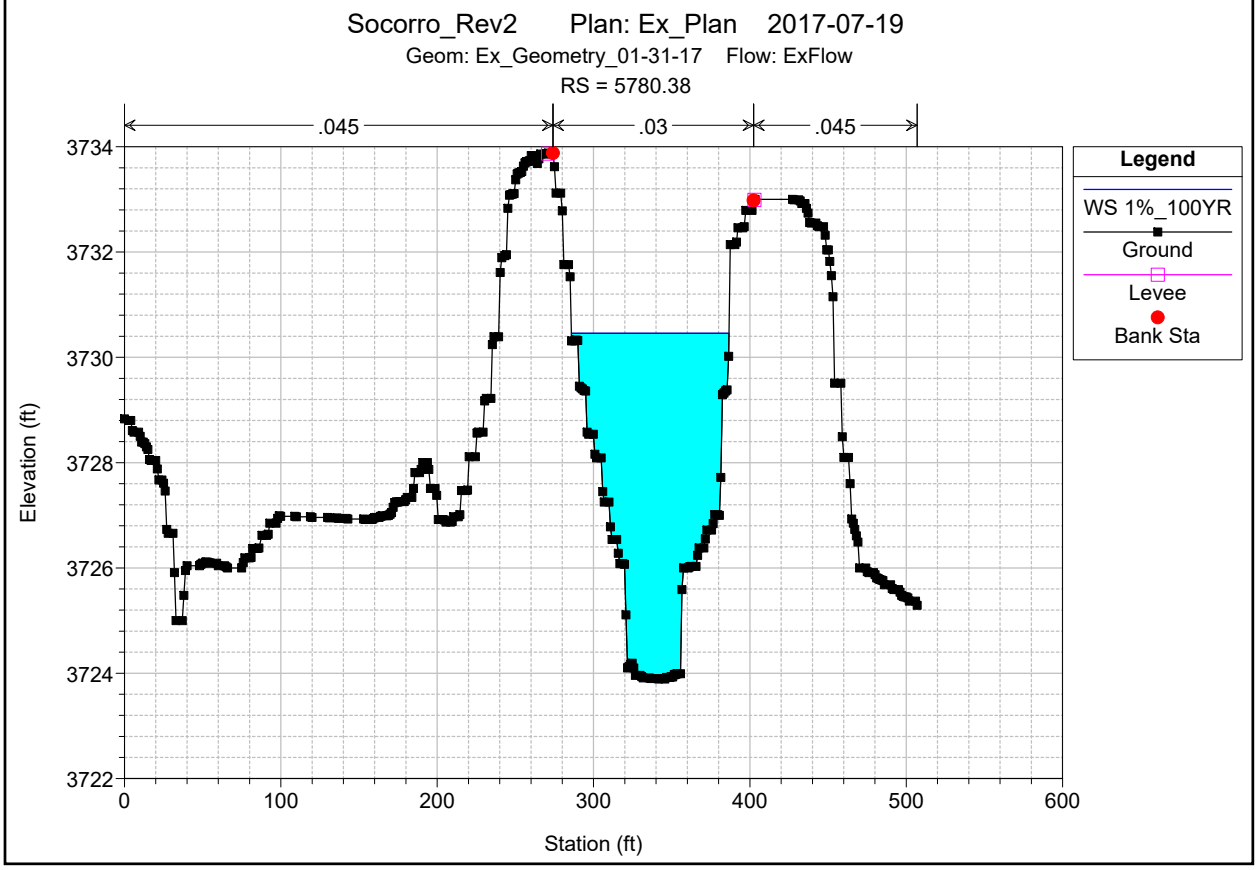

Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 7239.91
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3758
3756
3754
3752
3750
3748
3746
3744
3742
0
200
400
600
800
1000
1200

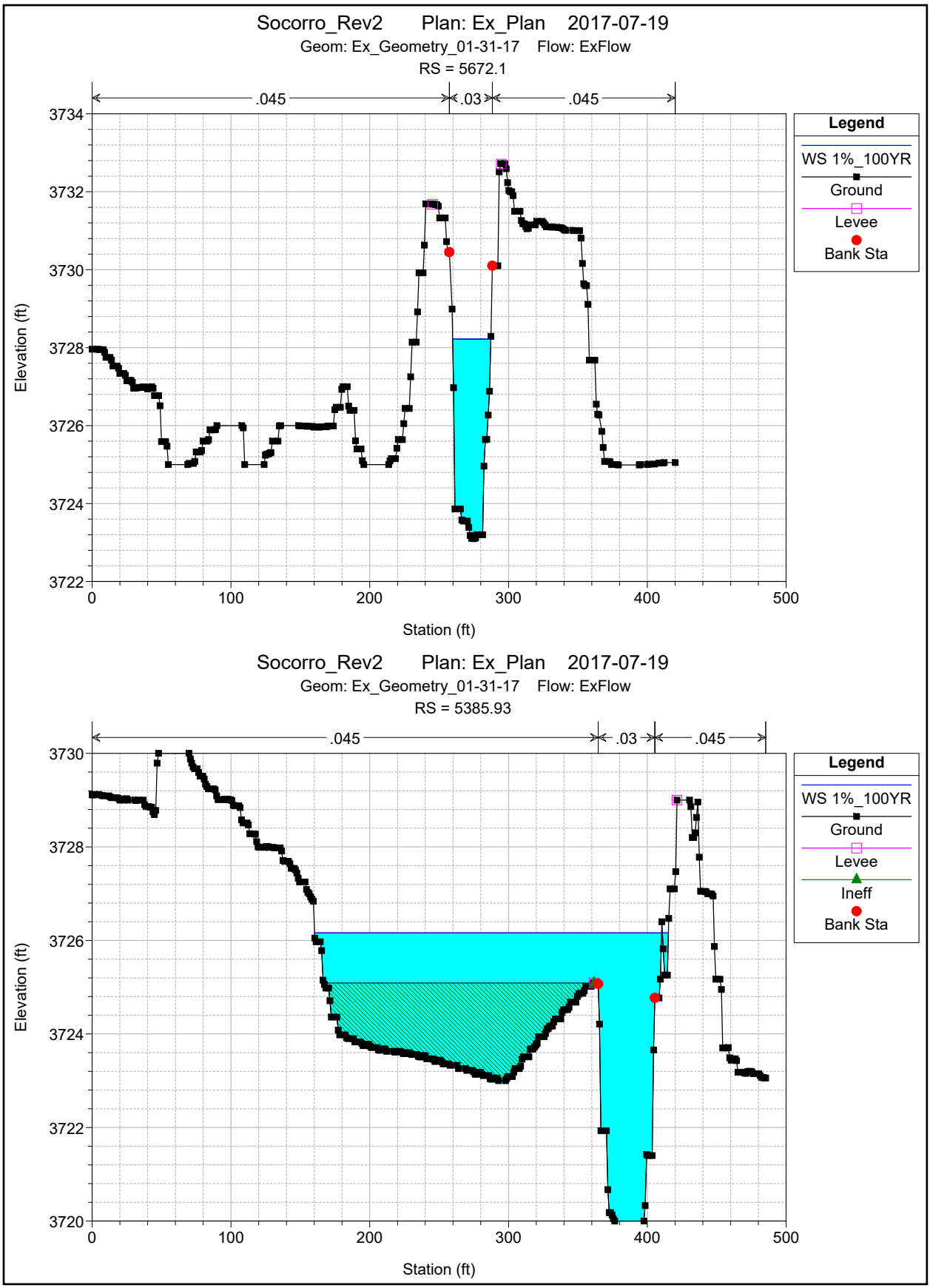

Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 7020.59
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
3750
3748
3746
3744
3742
3740
3738
0
200
400
600
800
1000

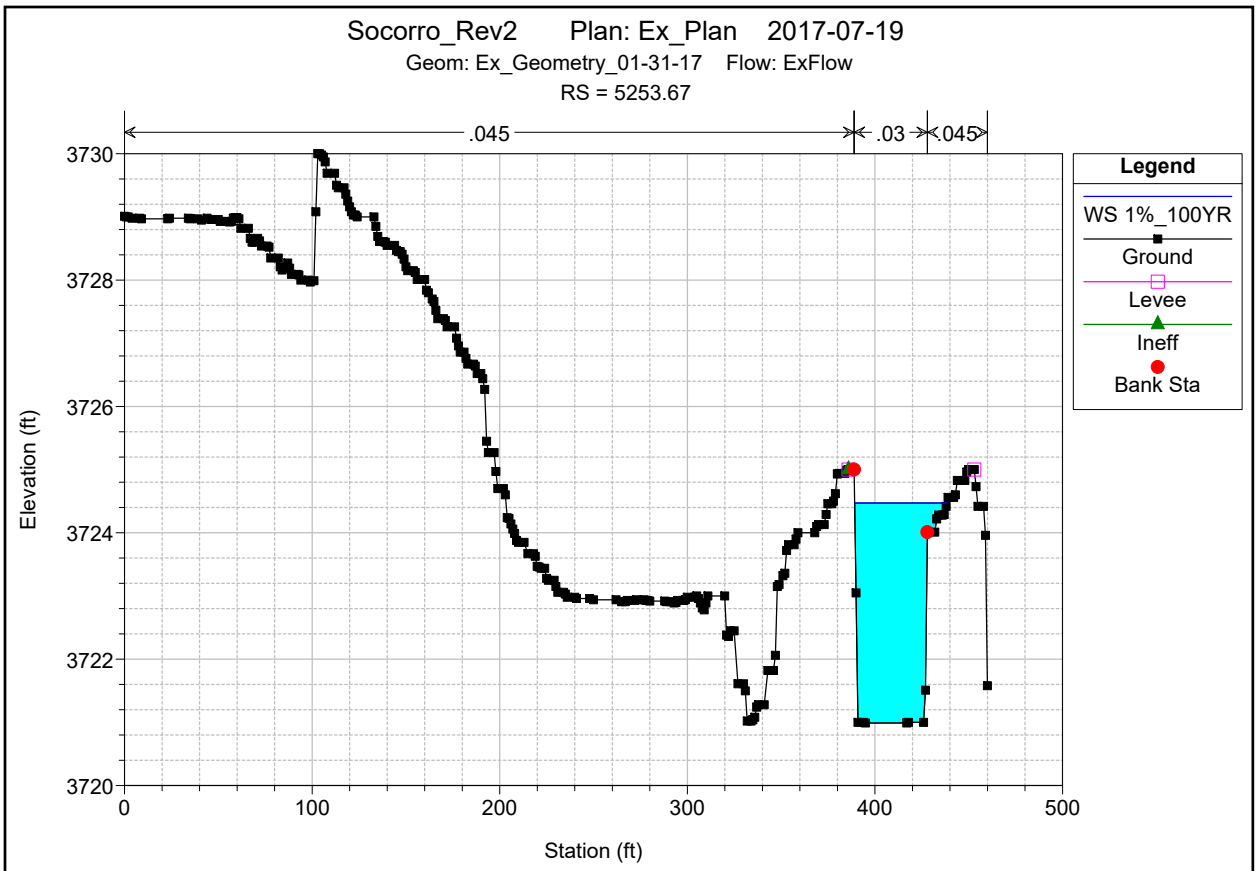

Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 6720.24
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
3748
3746
3744
3742
3740
3738
3736
0
200
400
600
800
1000
Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 6545.4
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
3744
3742
3740
3738
3736
3734
0
200
400
600
800

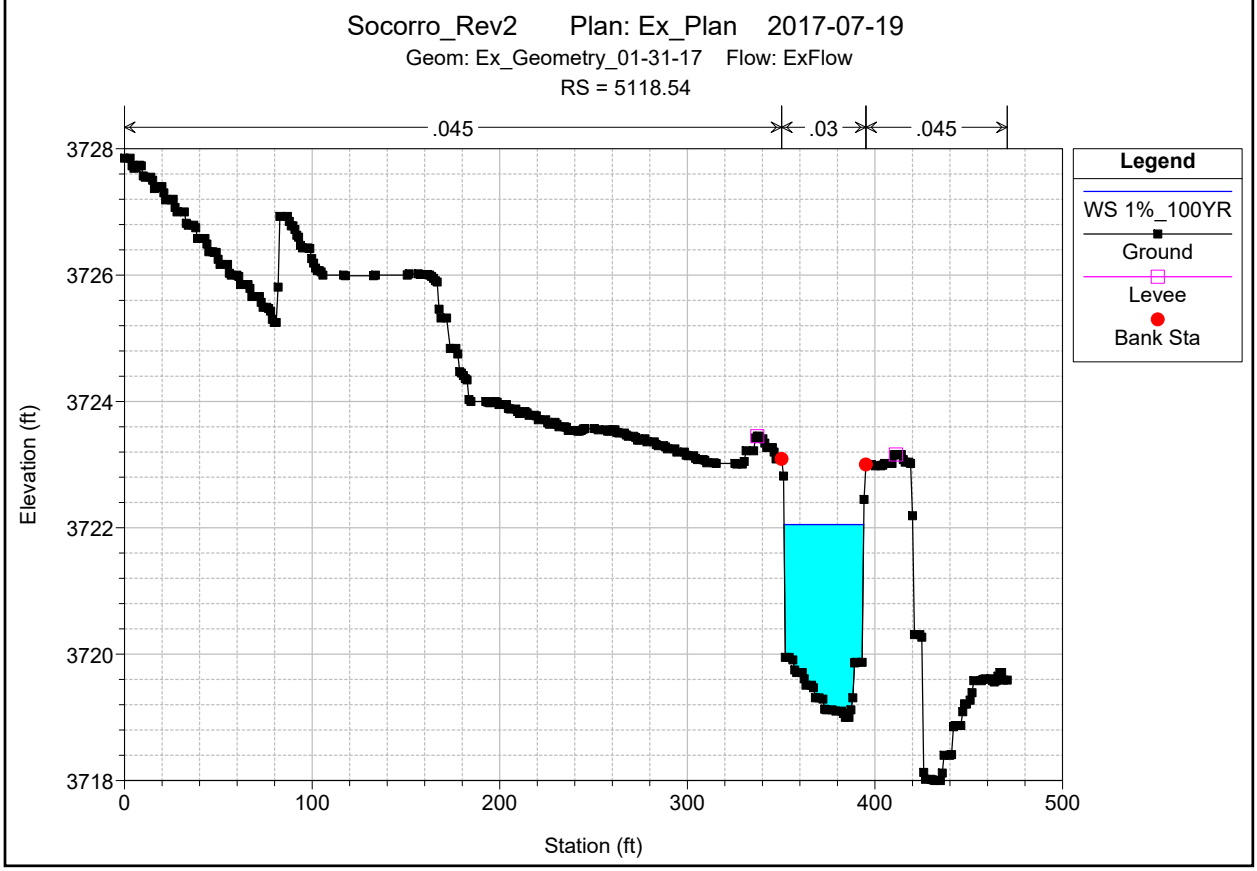

Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 6328.79
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
3739
3738
3737
3736
3735
3734
3733
3732
3731
0
100
200
300
400
500
600
700
800
Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 6010.12
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
3738
3736
3734
3732
3730
3728
3726
3724
0
100
200
300
400
500
600
700

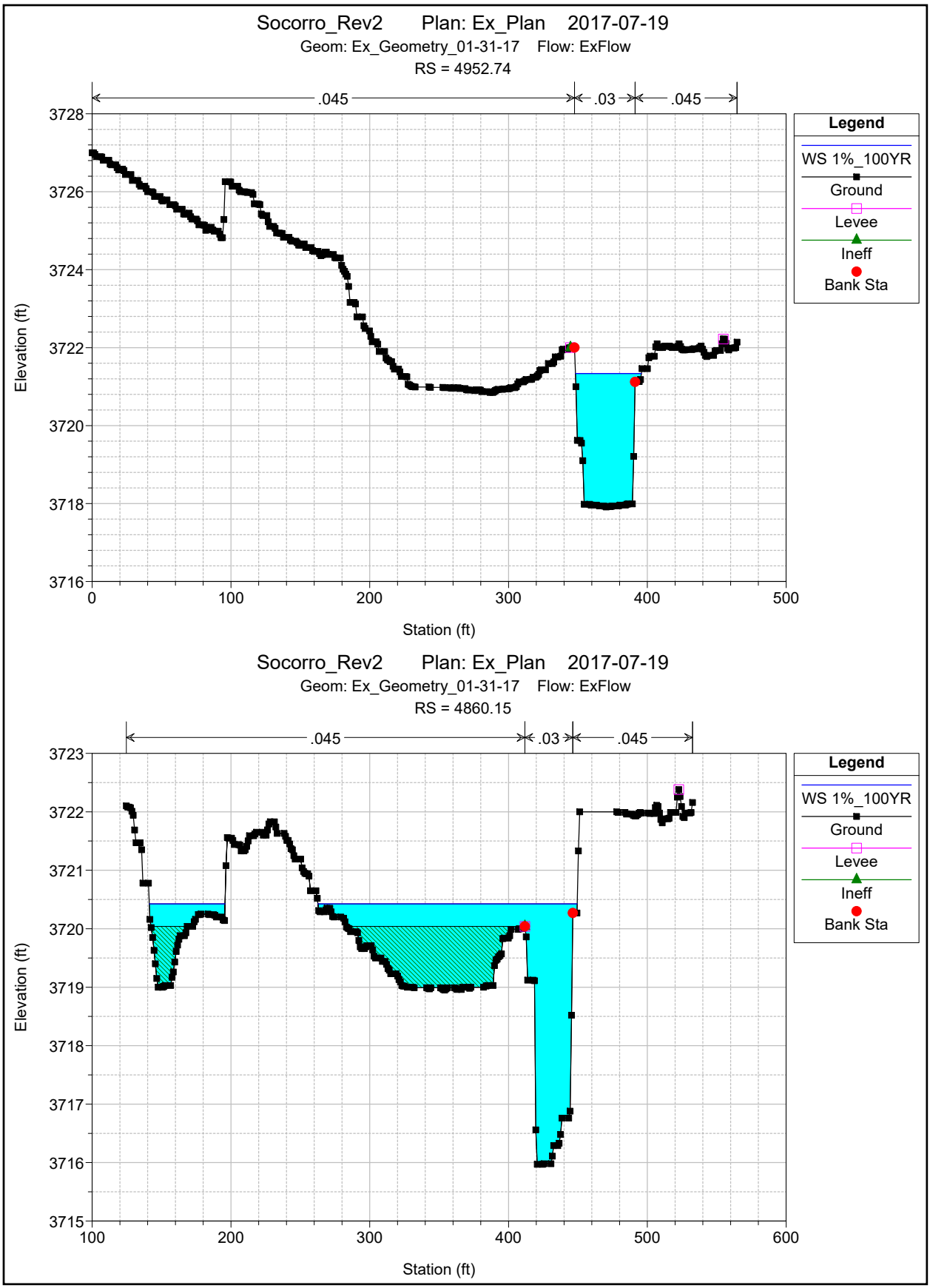

Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 5890.66
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
3736
3734
3732
3730
3728
3726
3724
0
100
200
300
400
500
600
700


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 5780.38
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
3734
3732
3730
3728
3726
3724
3722
0
100
200
300
400
500
600


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 5672.1
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
3734
3732
3730
3728
3726
3724
3722
0
100
200
300
400
500
Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 5385.93
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3730
3728
3726
3724
3722
3720
0
100
200
300
400
500


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 5253.67
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3730
3728
3726
3724
3722
3720
0
100
200
300
400
500


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 5118.54
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
3728
3726
3724
3722
3720
3718
0
100
200
300
400
500


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 4952.74
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3728
3726
3724
3722
3720
3718
3716
0
100
200
300
400
500
Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 4860.15
.045
.03
.045
Legend
WS 1%_100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3723
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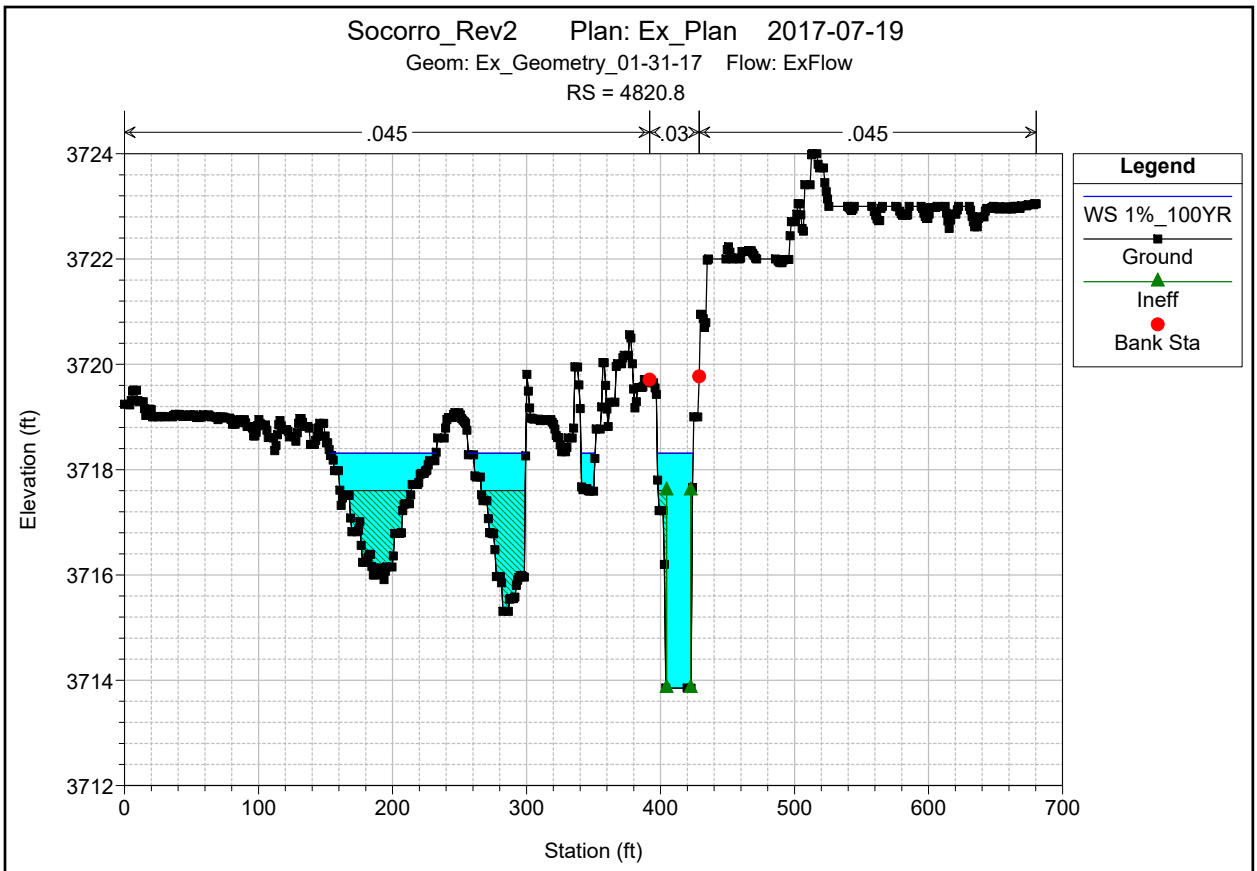
Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 4820.8
.045
.03
.045
Legend
WS 1%_100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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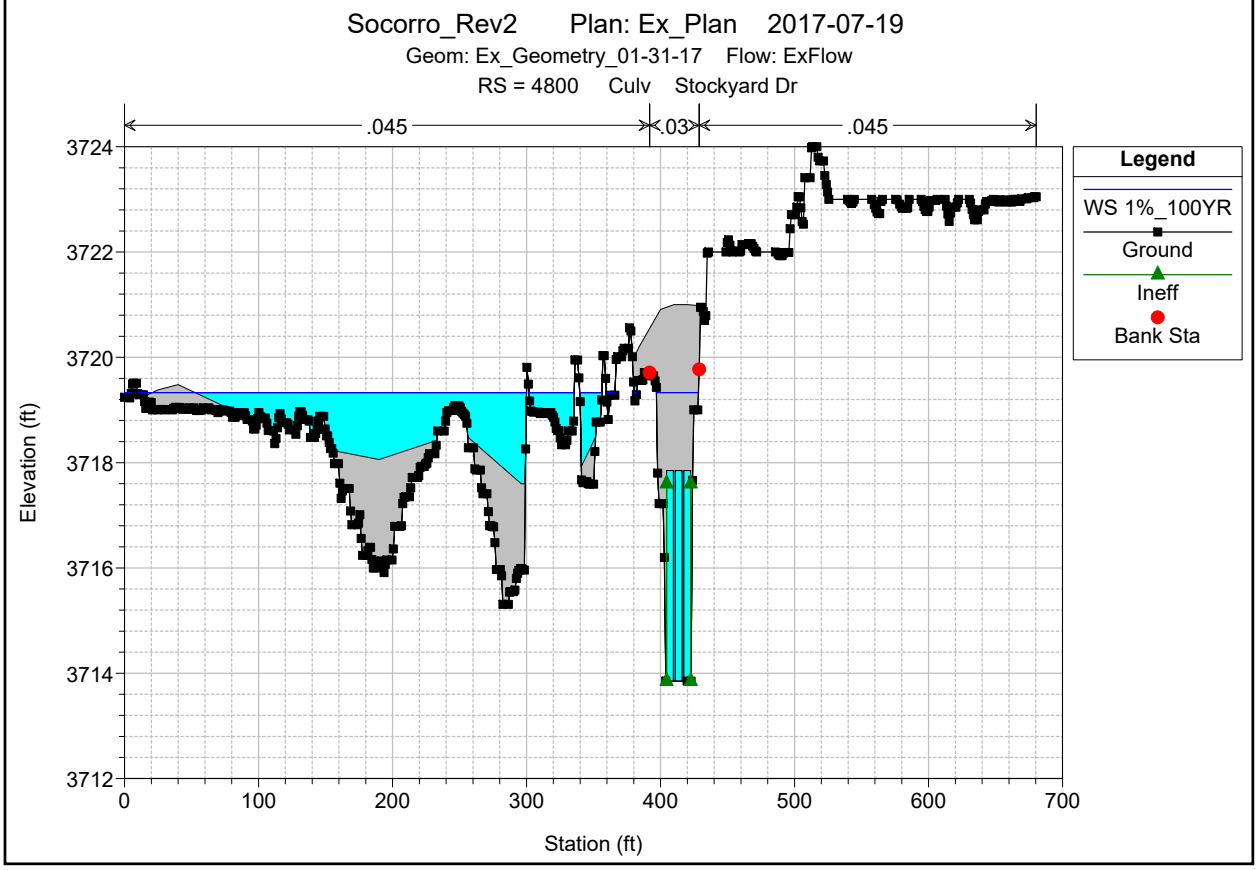
Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 4800 Culv Stockyard Dr
.045
.03
.045
Legend
WS 1%_100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3724
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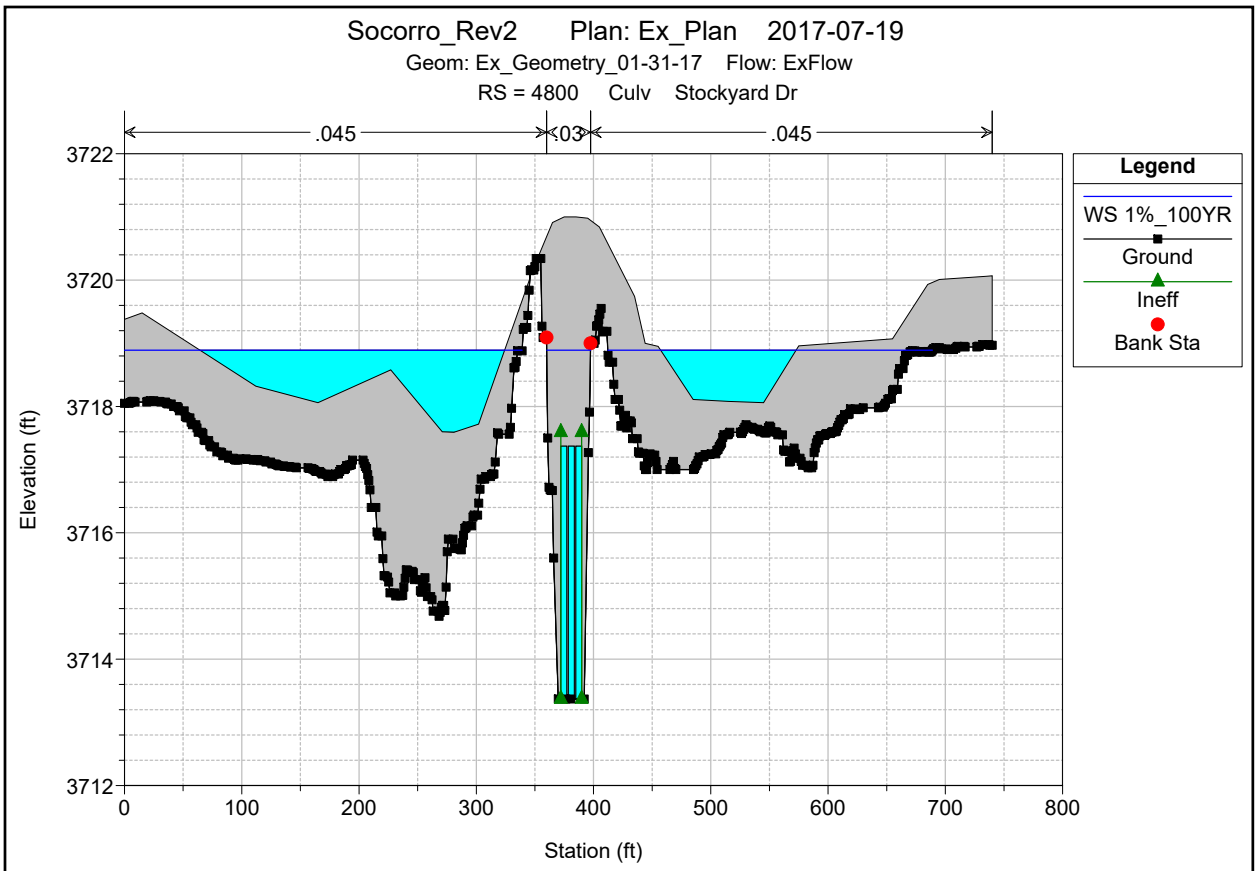
Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 4800 Culv Stockyard Dr
.045
.03
.045
Legend
WS 1%_100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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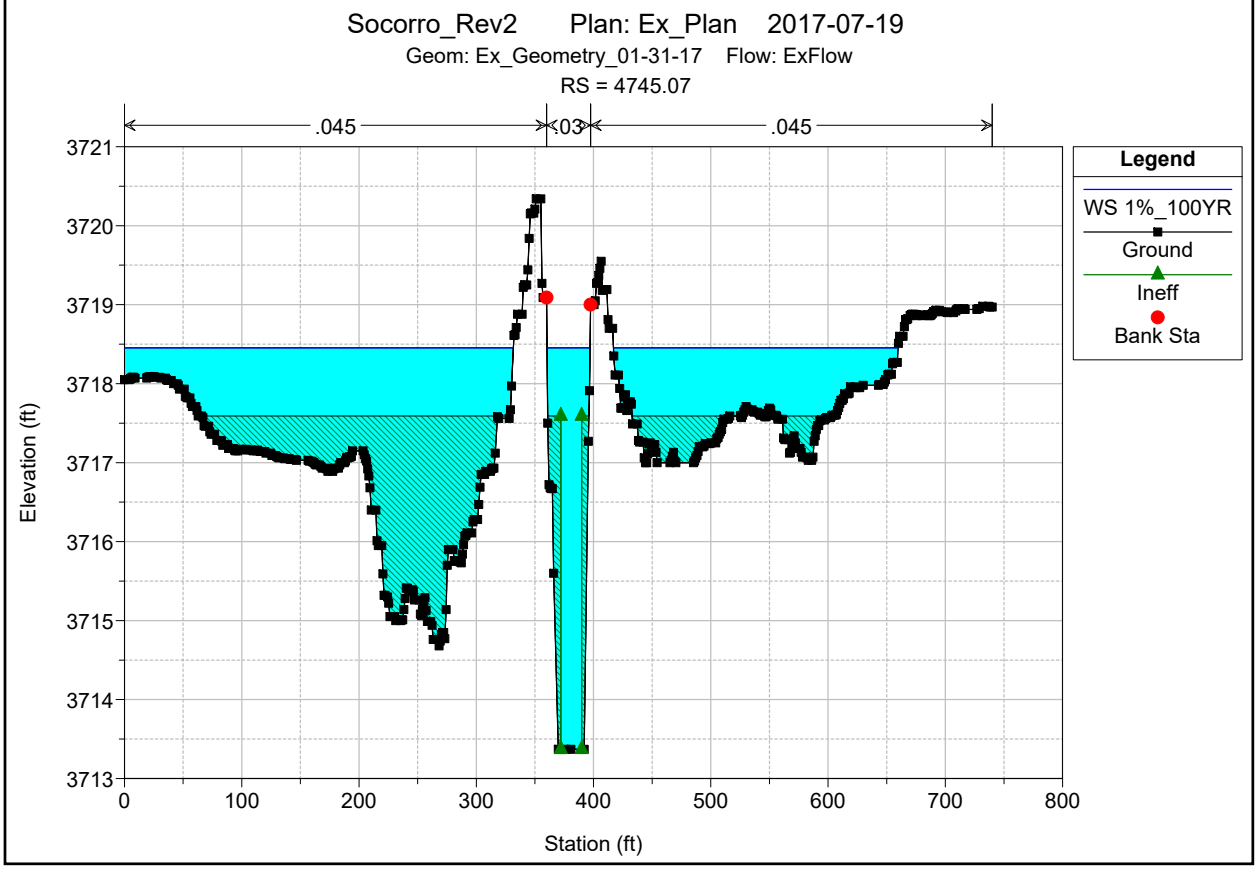
Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 4745.07
.045
.03
.045
Legend
WS 1%_100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3721
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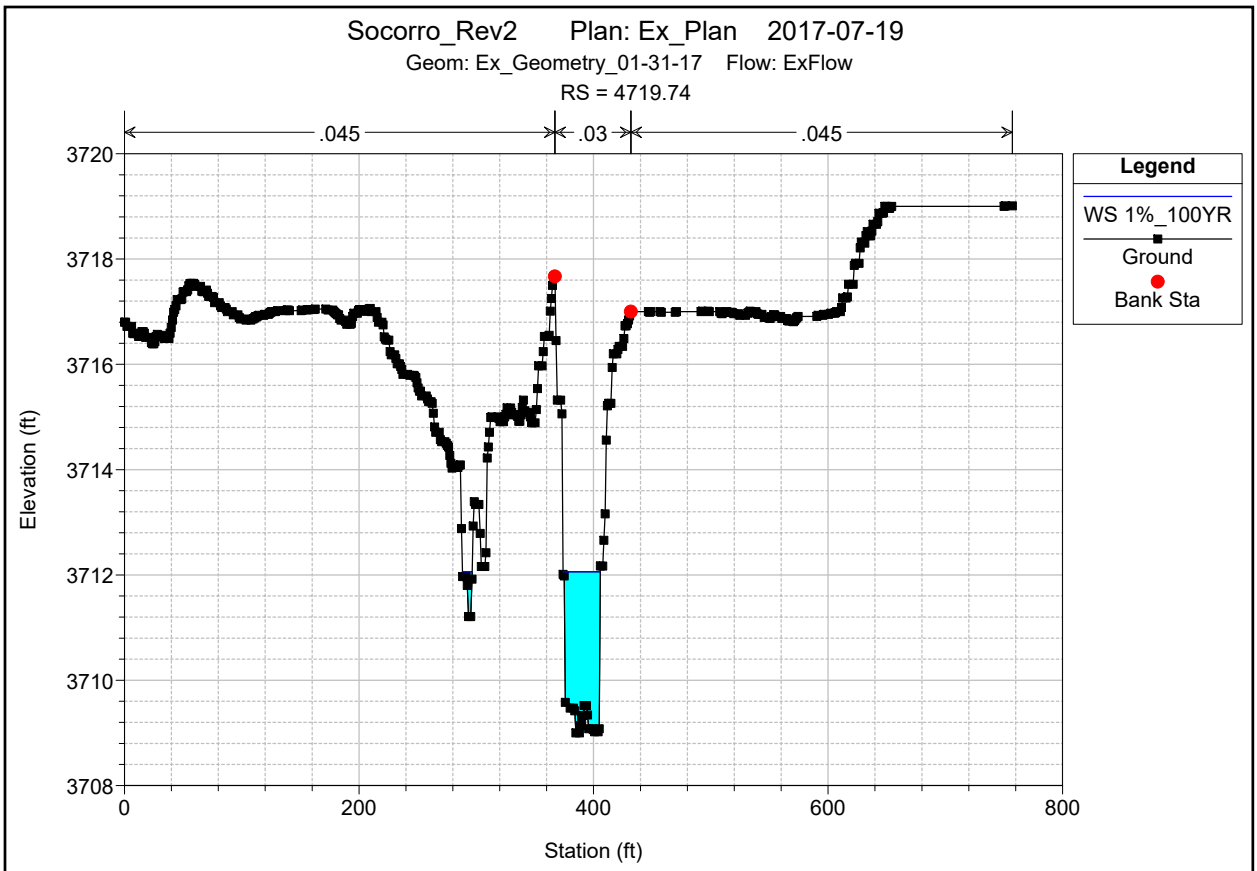
Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 4719.74
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3720
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600
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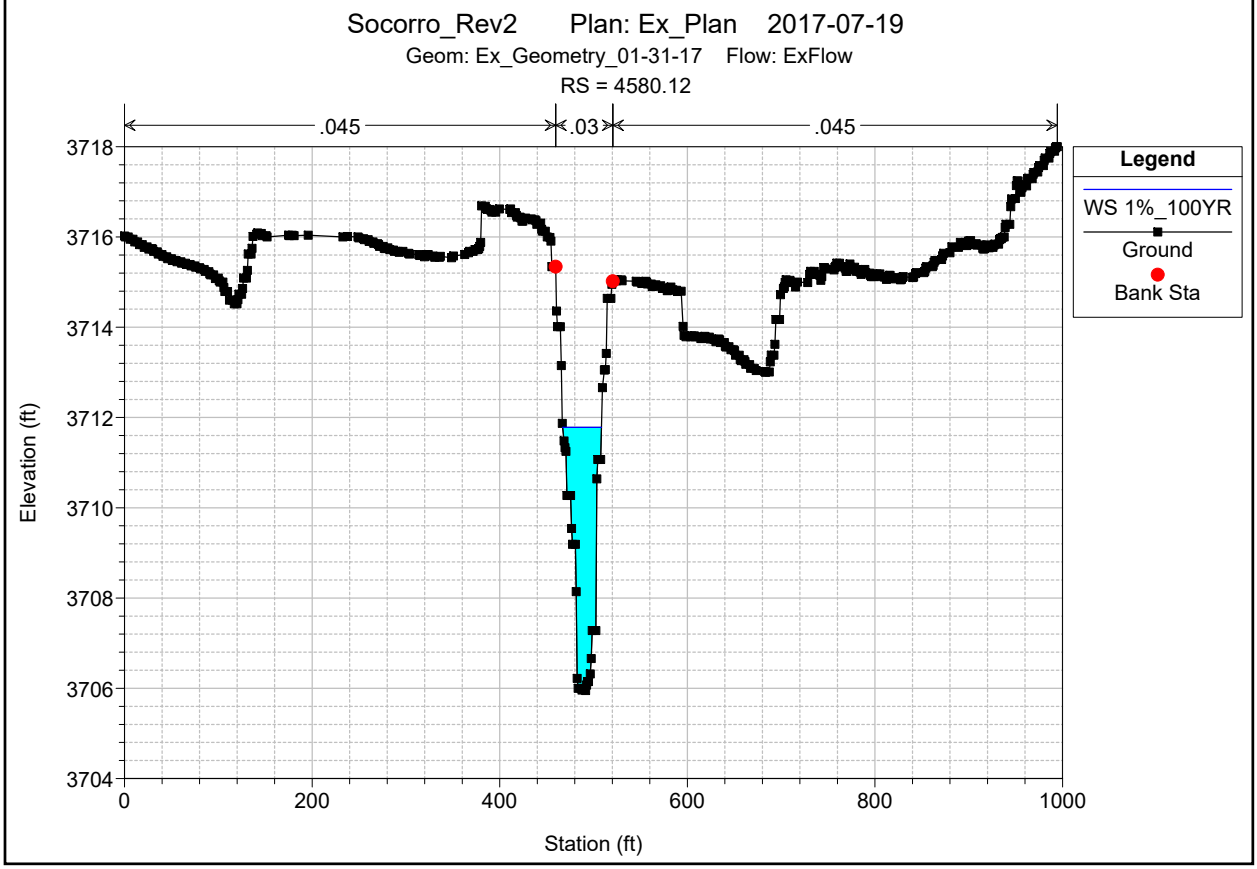
Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 4580.12
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3718
3716
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3712
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3708
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3704
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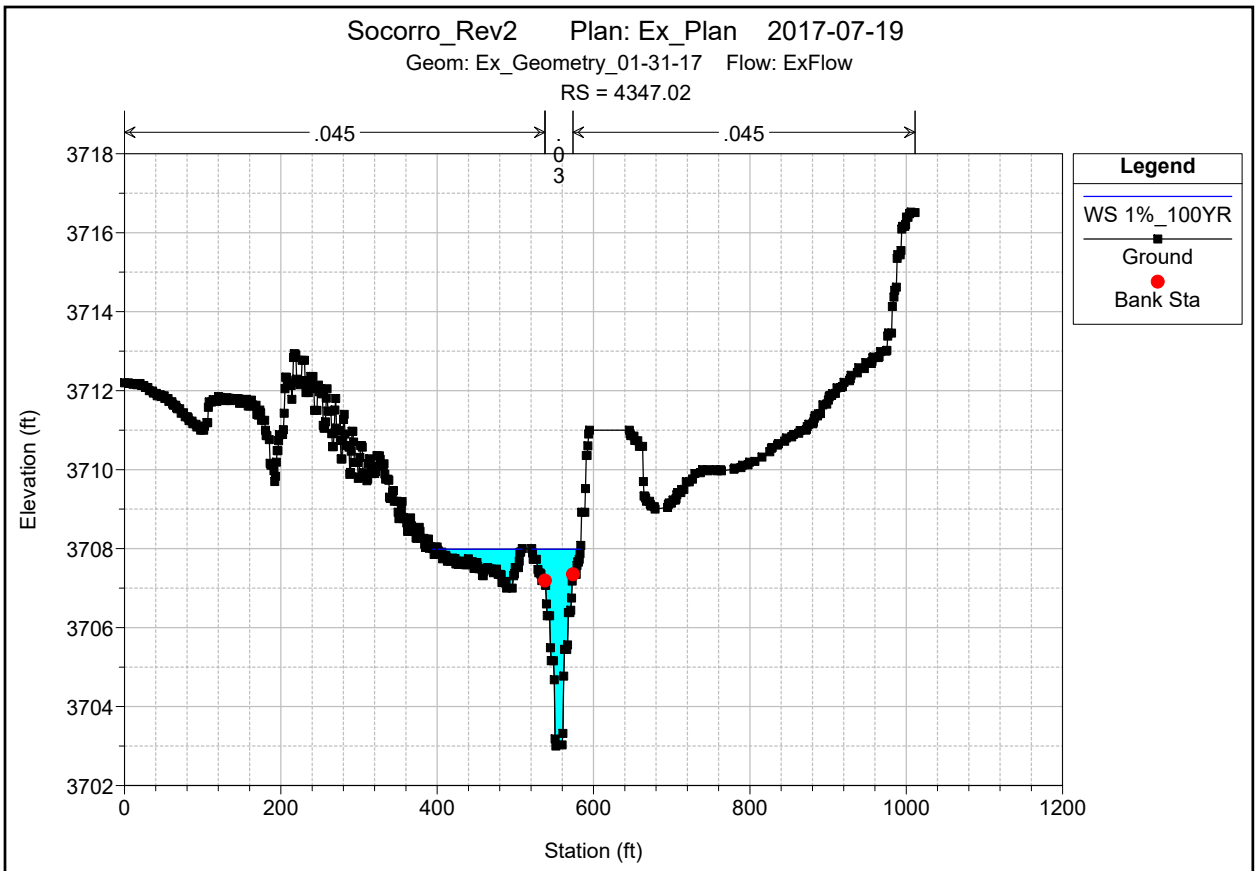
600
800
1000


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 4347.02
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3718
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3712
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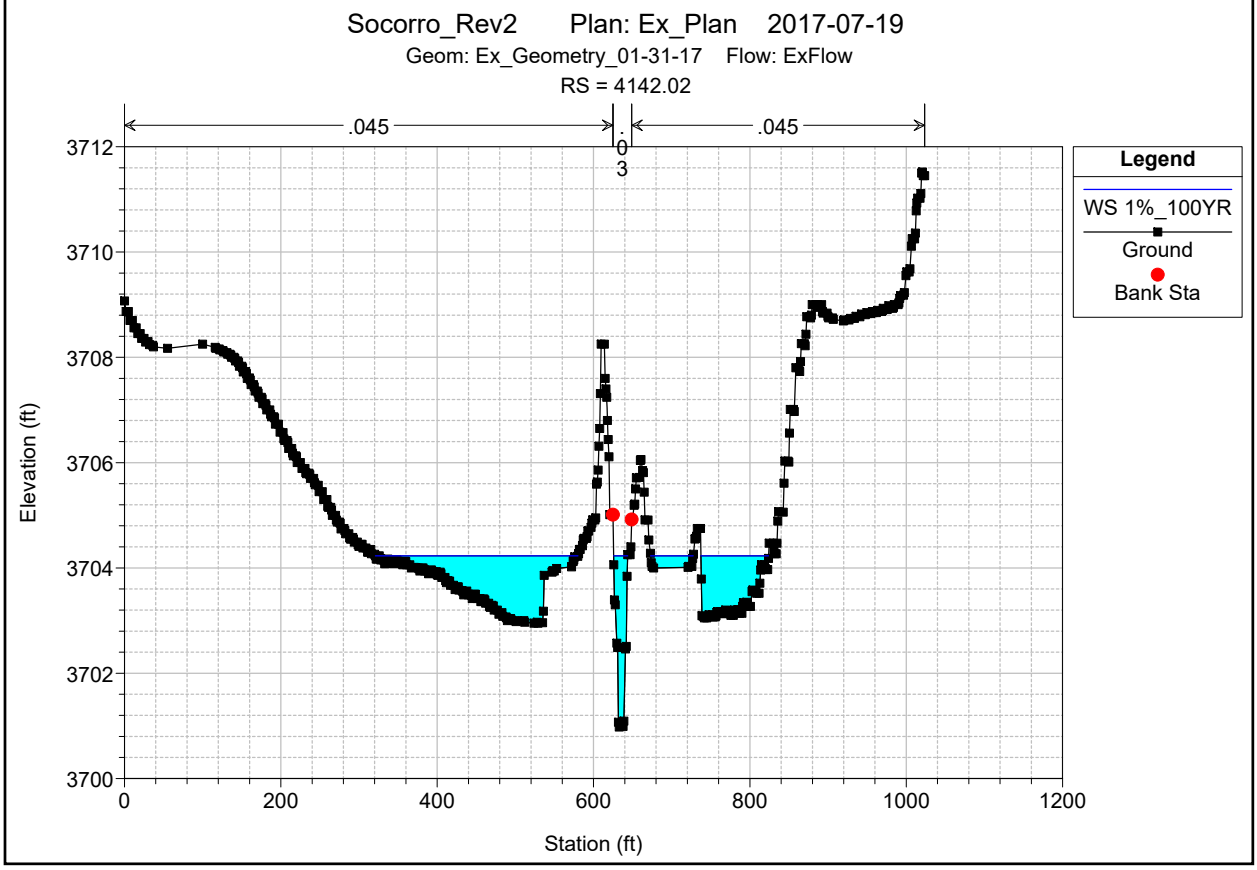
1000
1200


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 4142.02
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3712
3710
3708
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3704
3702
3700
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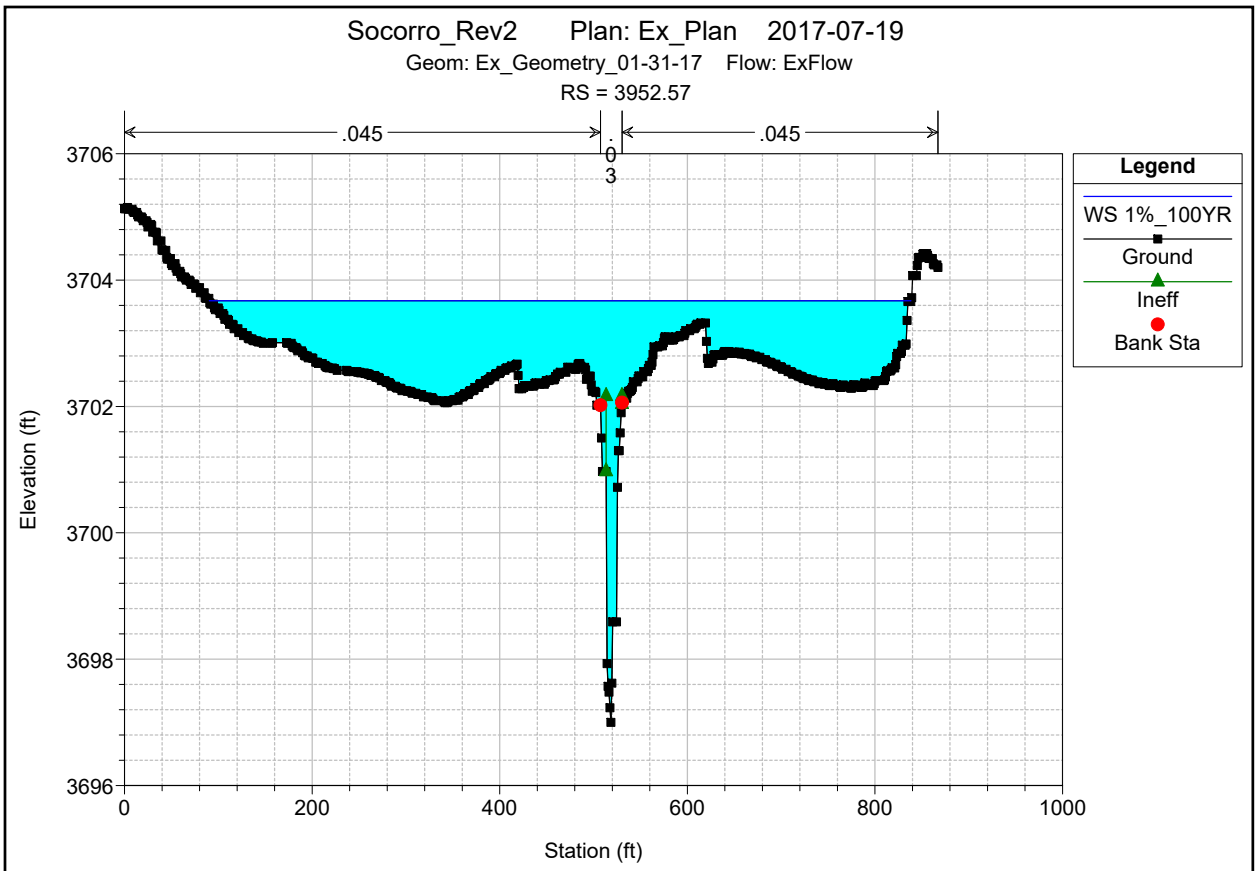
1000
1200


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 3952.57
.045
.03
.045
Legend
WS 1%_100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3706
3704
3702
3700
3698
3696
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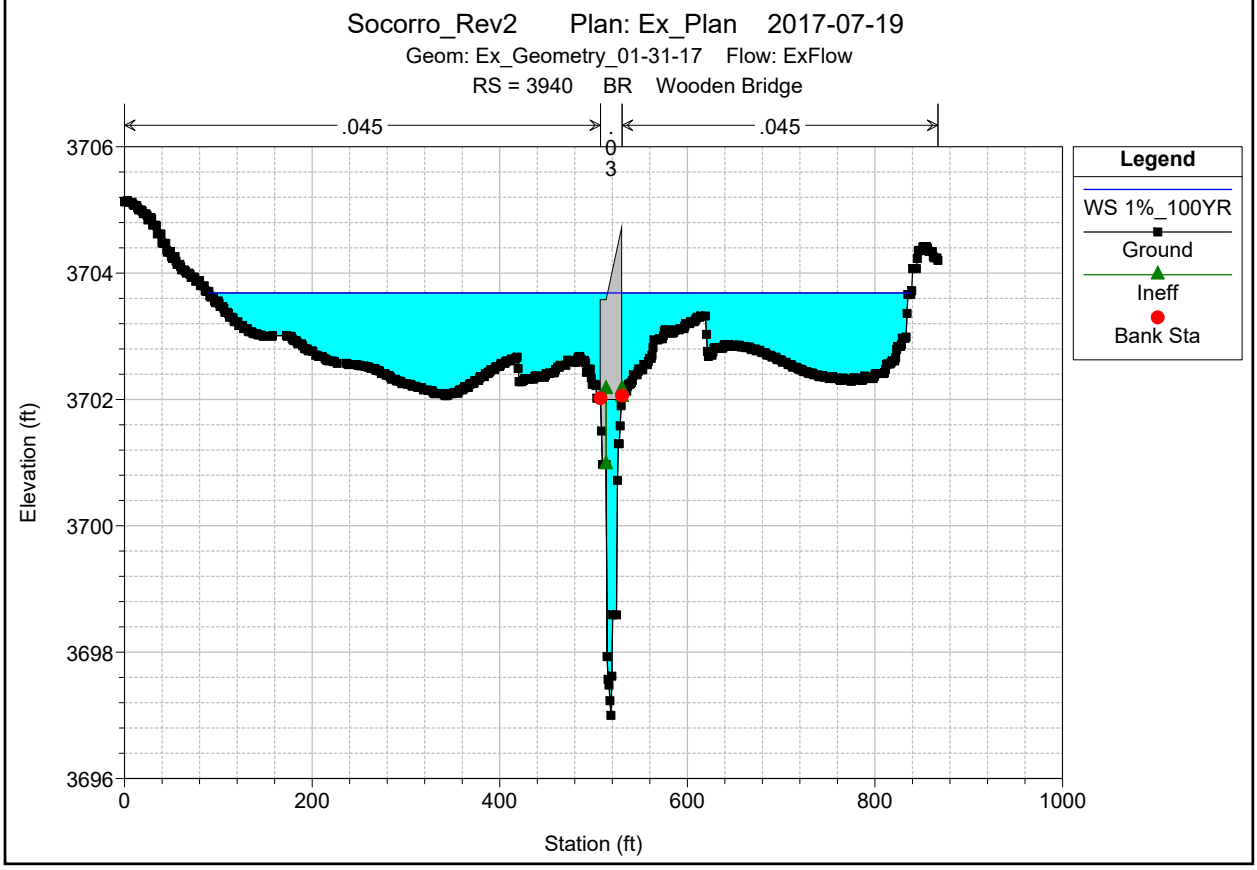
400
600
800
1000


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 3940 BR Wooden Bridge
.045
.03
.045
Legend
WS 1%_100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3706
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3702
3700
3698
3696
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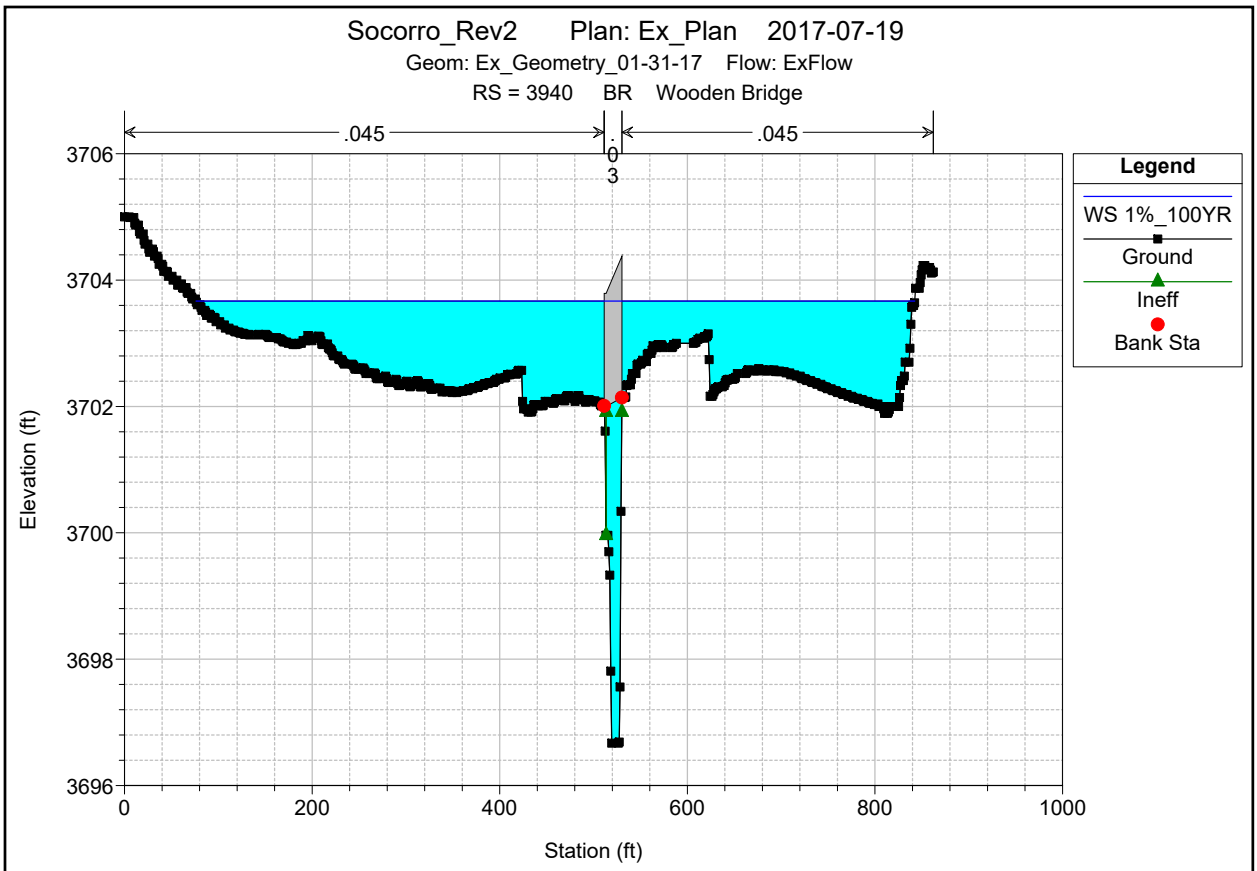
800
1000


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 3940 BR Wooden Bridge
.045
.045
.03
Legend
WS 1%_100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3706
3704
3702
3700
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3696
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600
800
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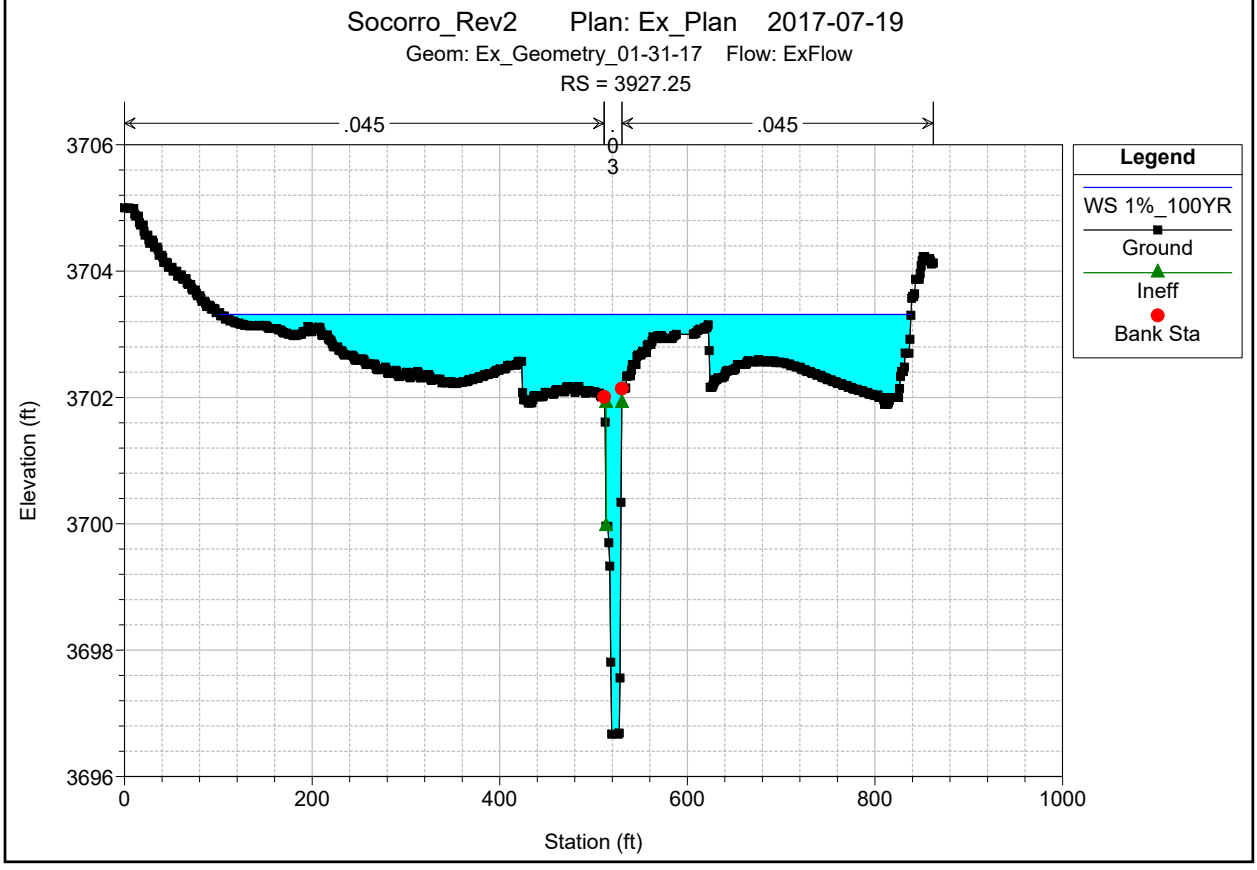
Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 3927.25
.045
.045
.03
Legend
WS 1%_100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3706
3704
3702
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3698
3696
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800
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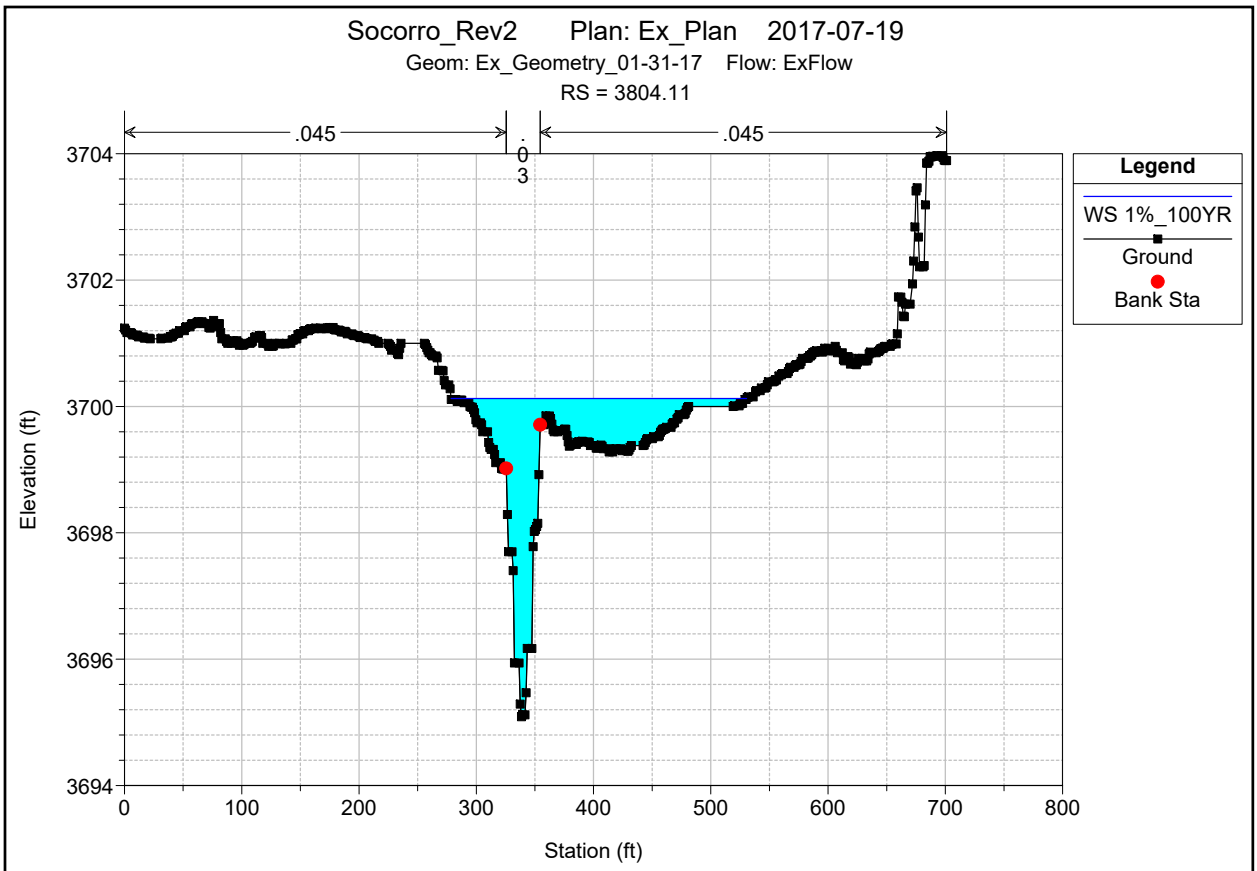
Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 3804.11
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3704
3702
3700
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3696
3694
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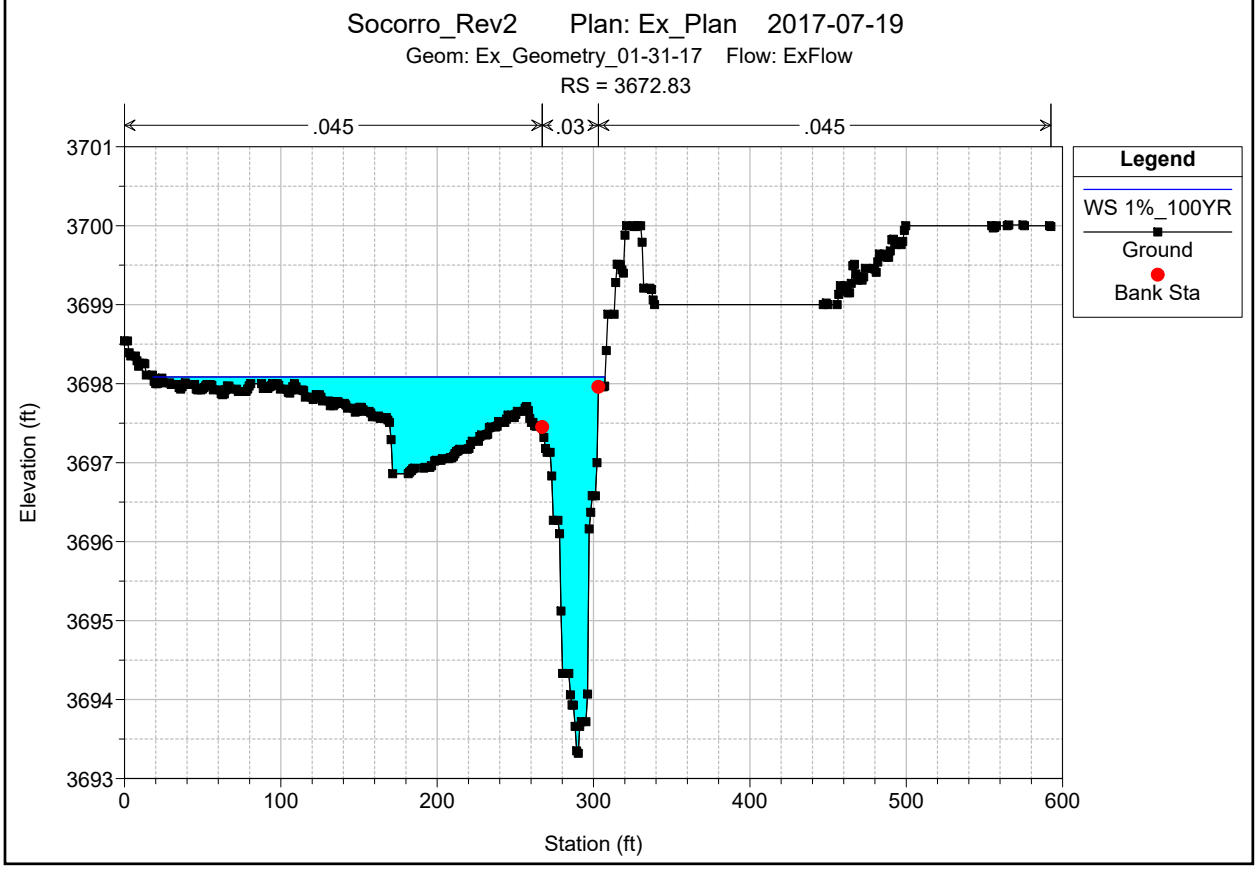
500
600
700
800


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 3672.83
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3701
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3699
3698
3697
3696
3695
3694
3693
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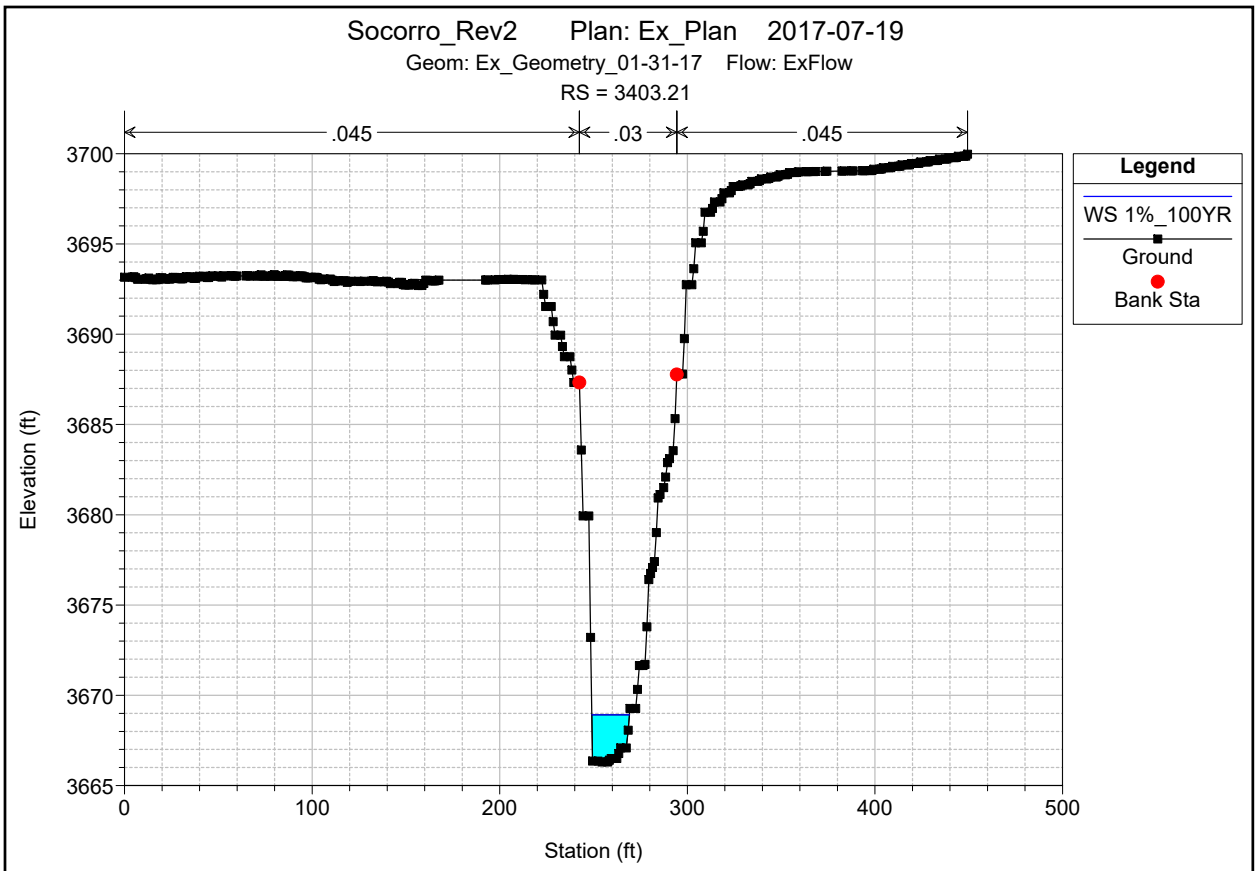
500
600


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 3403.21
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3700
3695
3690
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3665
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200
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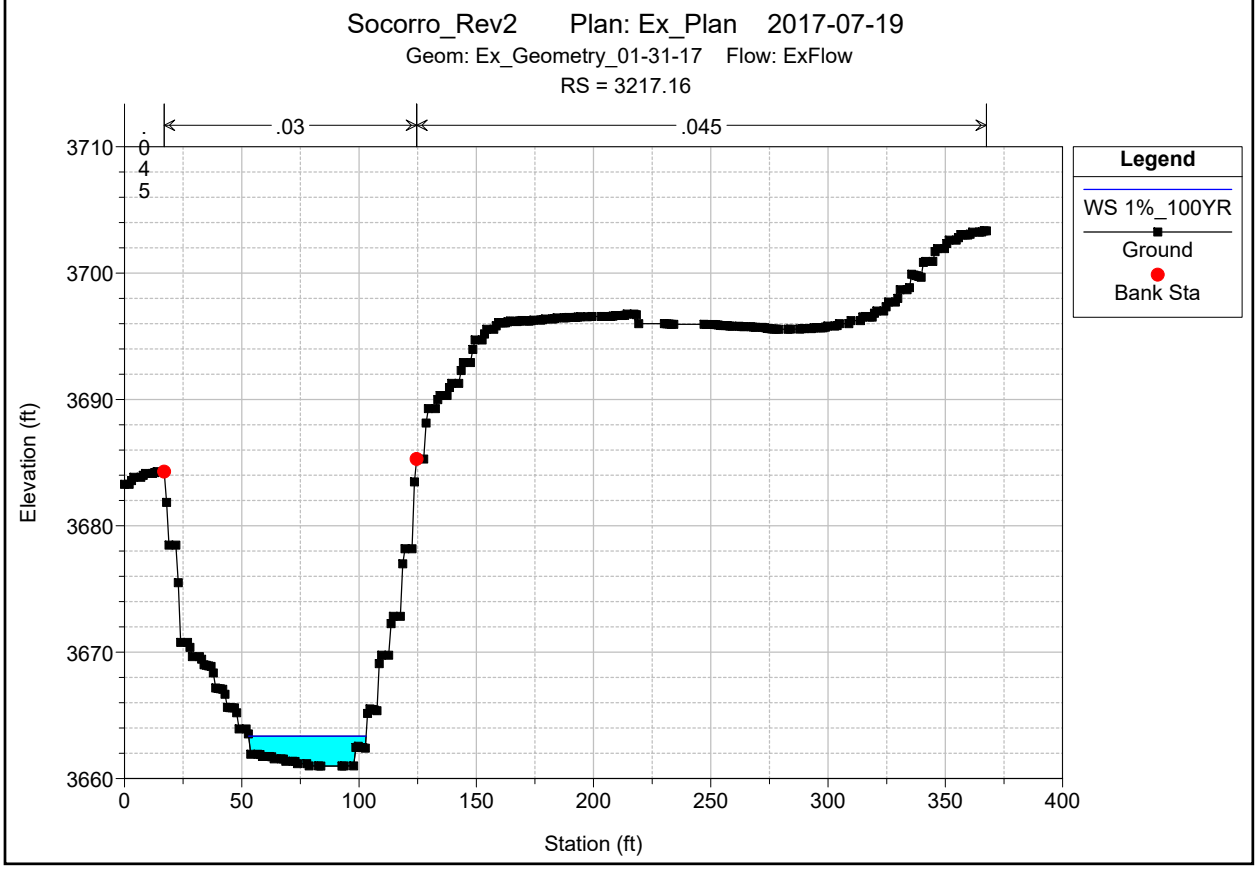
400
500


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 3217.16
.03
.045
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3710
3700
3690
3680
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3660
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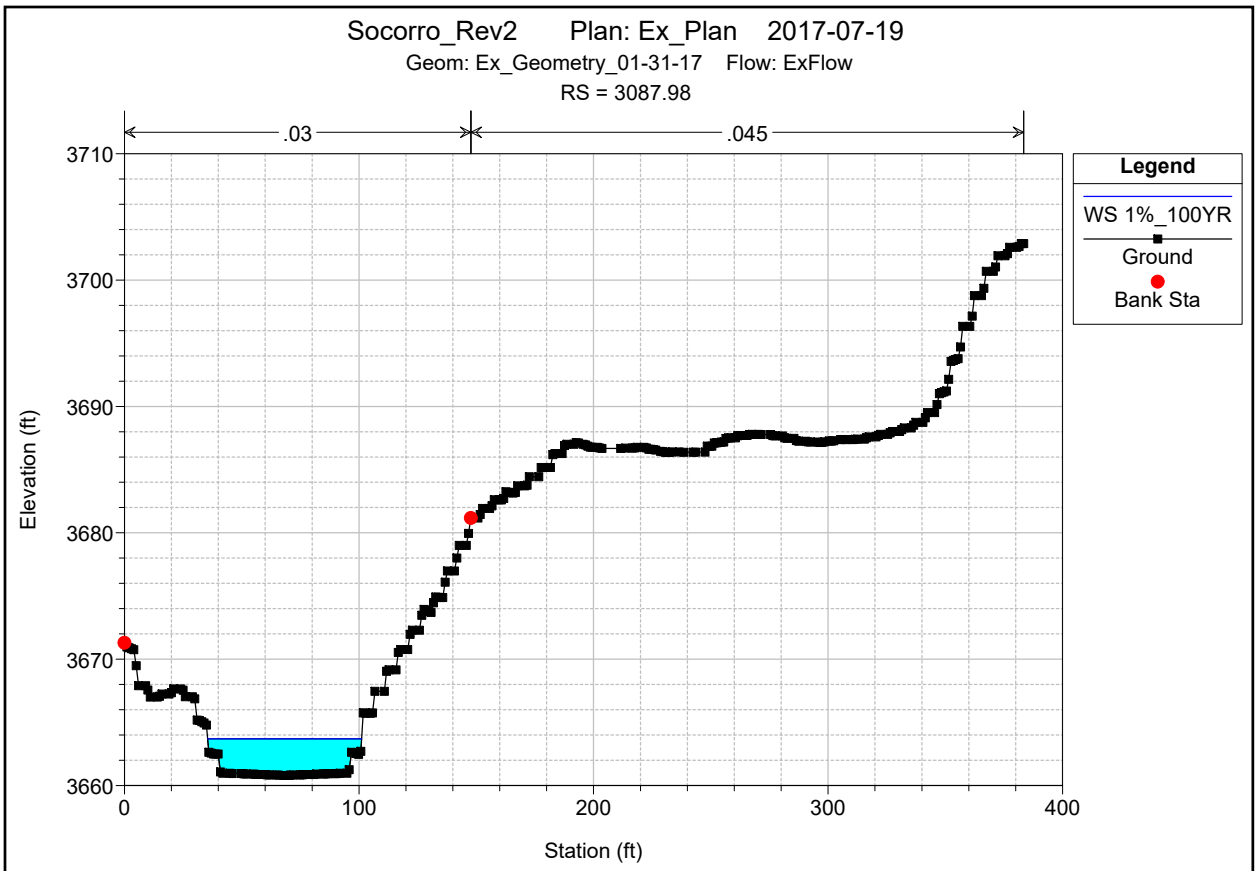
300
350
400


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 3087.98
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3710
3700
3690
3680
3670
3660
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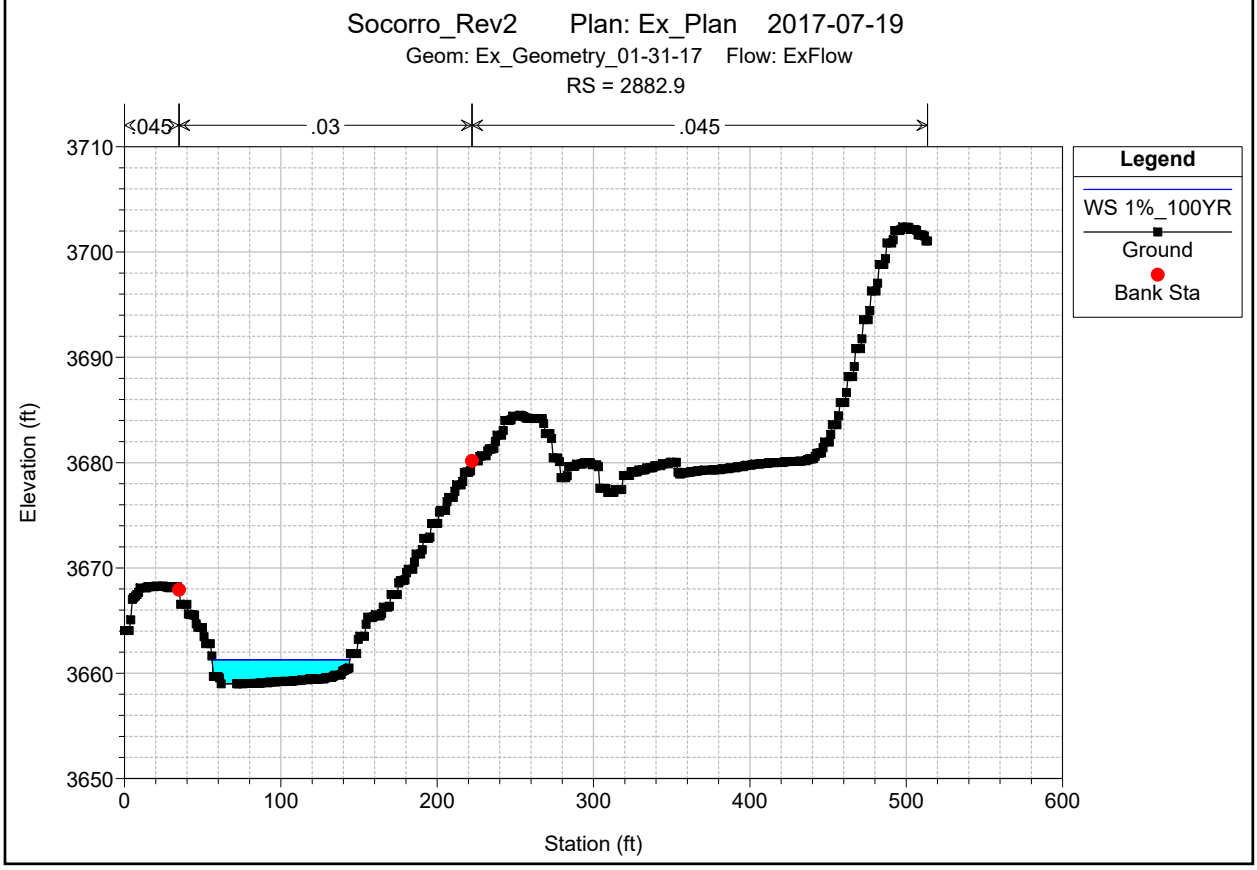
200
300
400


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 2882.9
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3710
3700
3690
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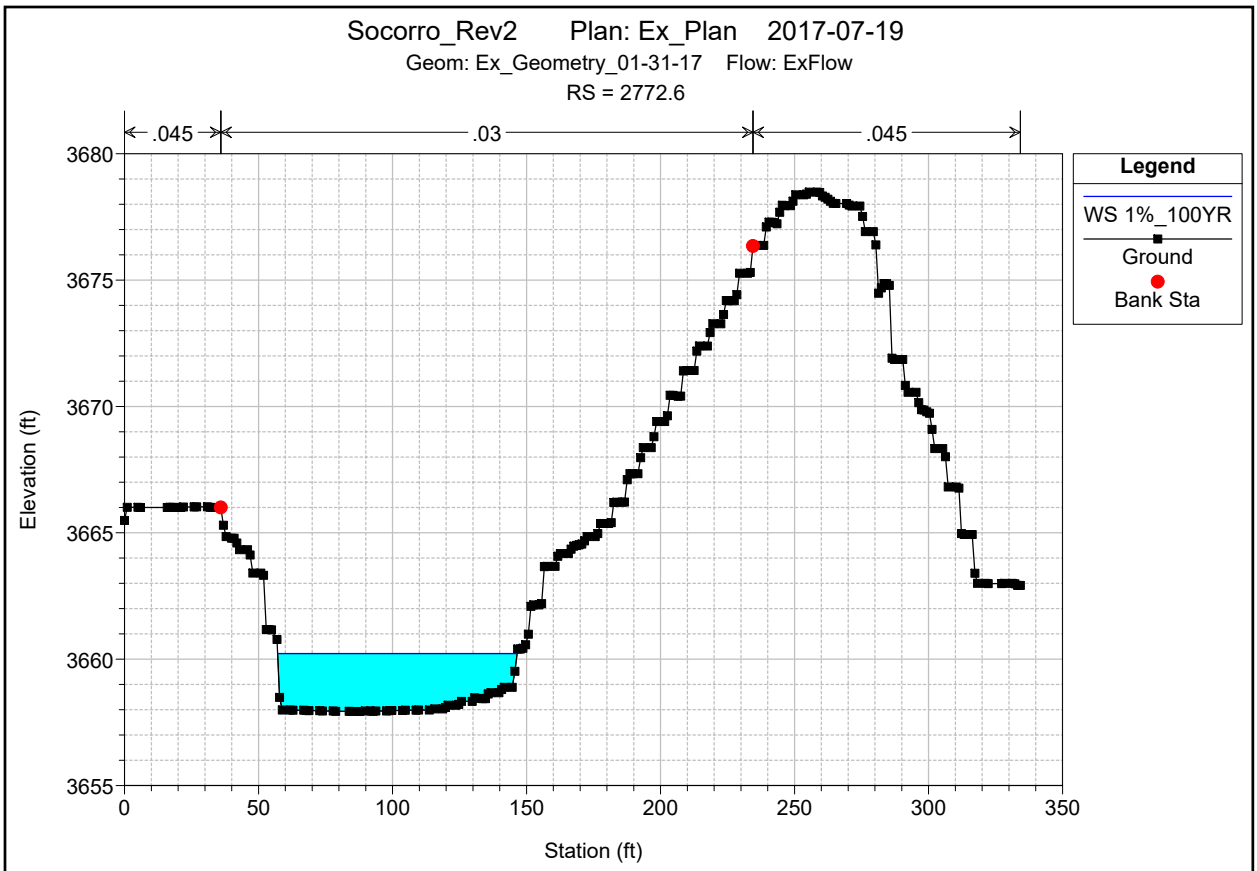
400
500
600


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 2772.6
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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3675
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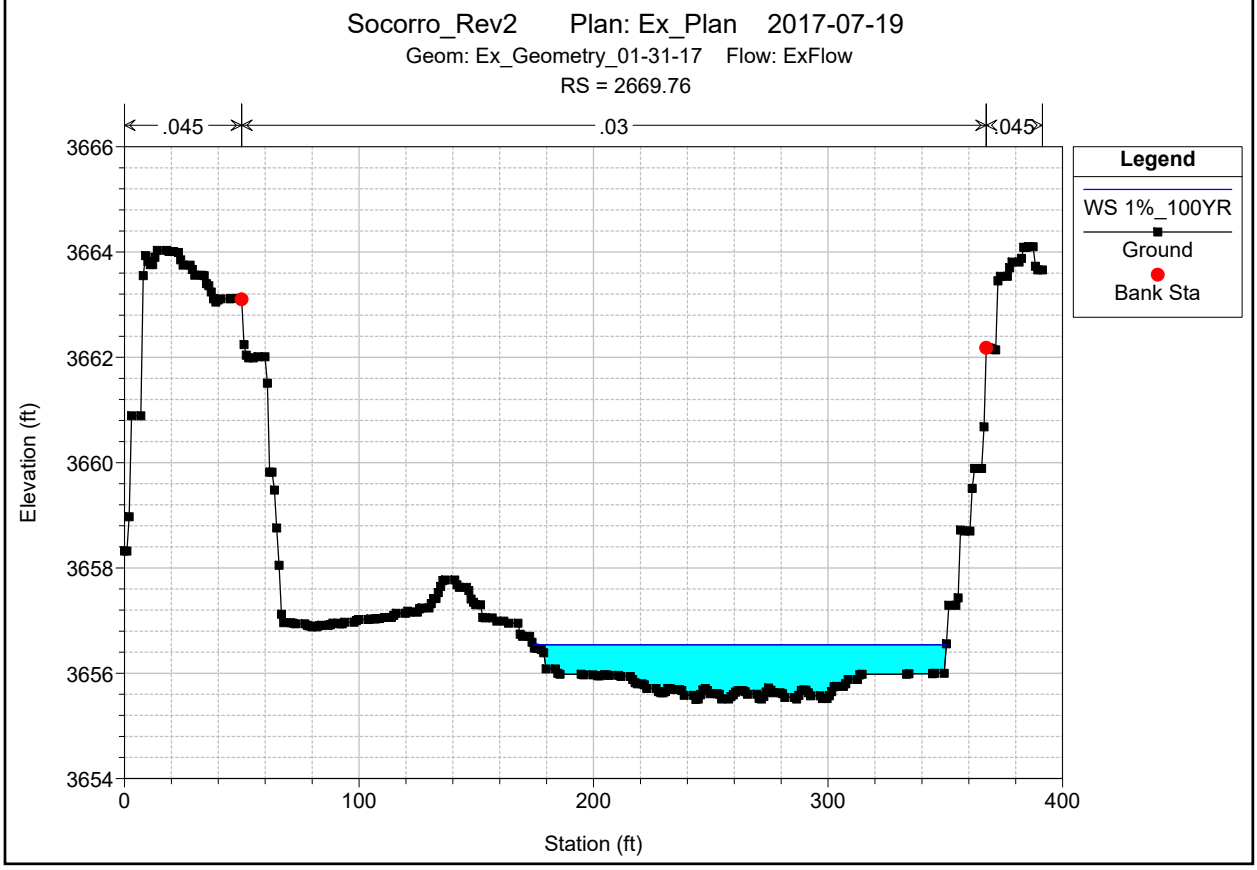
300
350


Socorro_Rev2 Plan: Ex_Plan 2017-07-19
Geom: Ex_Geometry_01-31-17 Flow: ExFlow
RS = 2669.76
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3666
3664
3662
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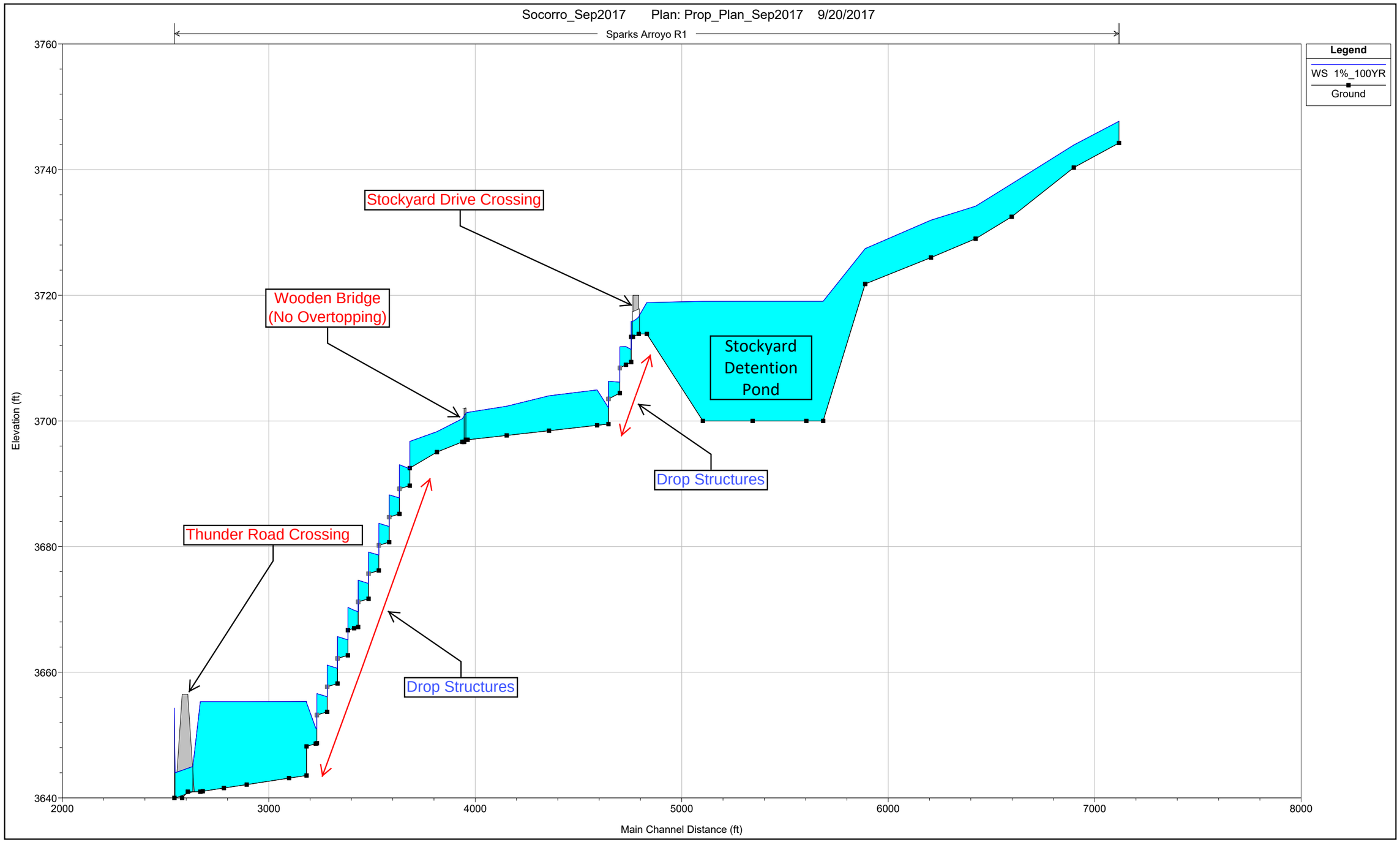
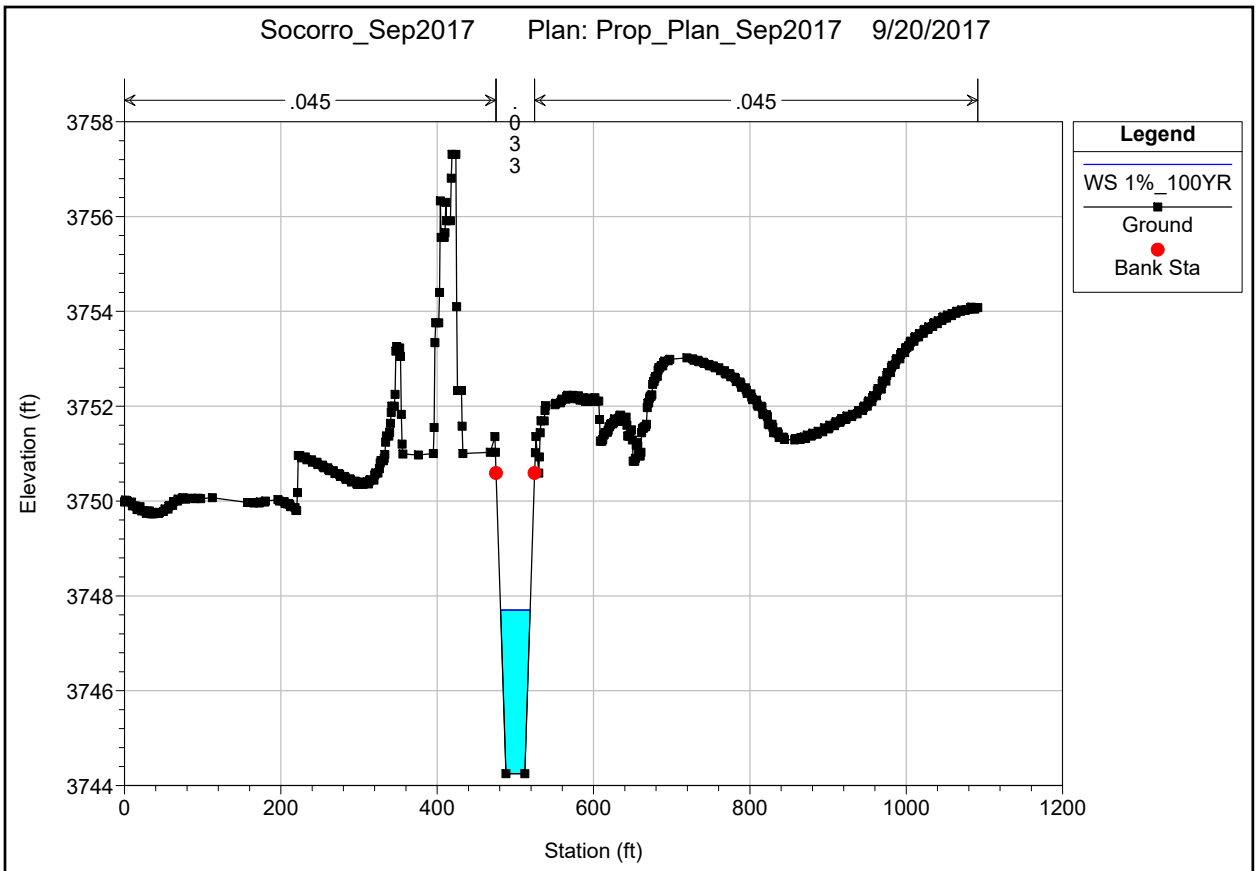
3658
3656
3654
0
100
200
300
400

PROPOSED CONDITION

Proposed Profile (100-year) showing the Drop Structures




Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
.033
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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3748
3746
3744
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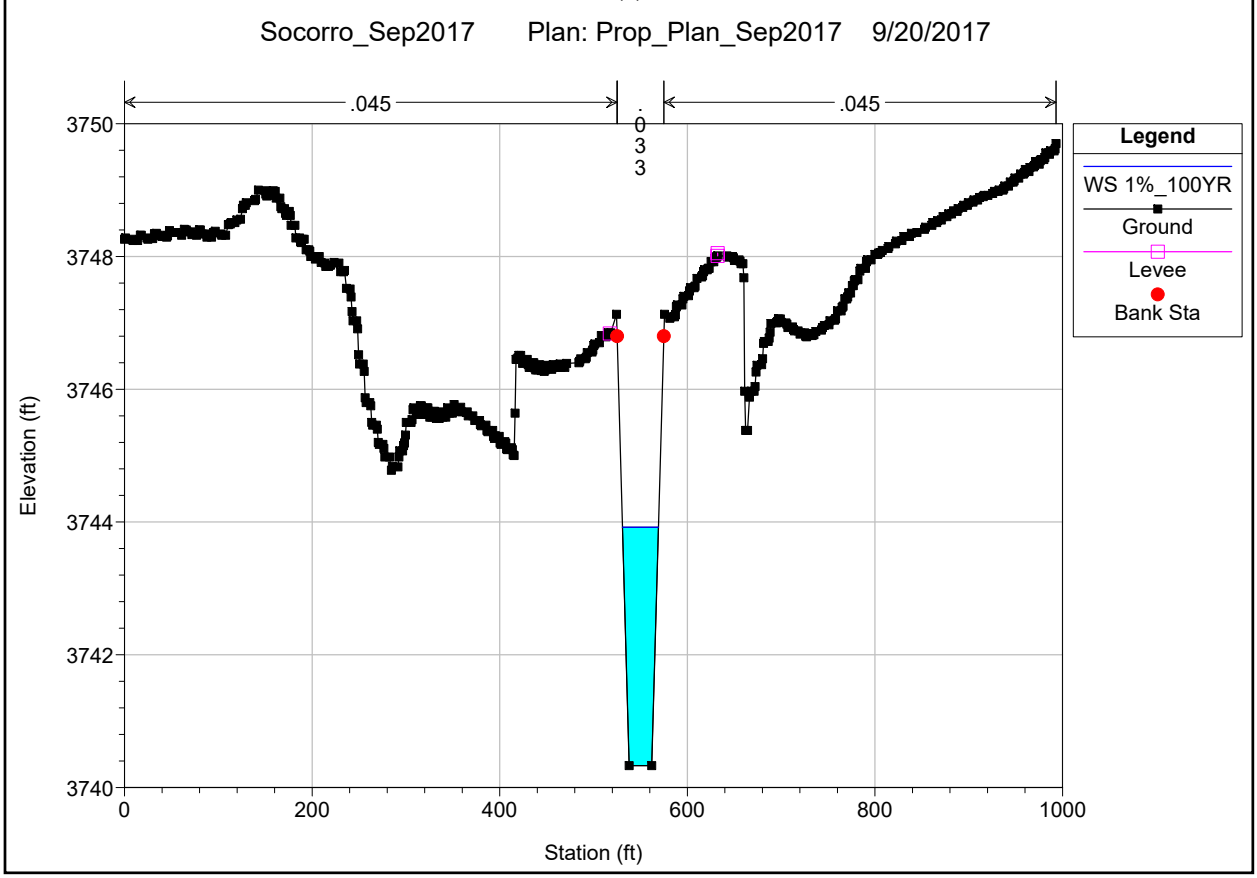
200
400
600
800
1000
1200


Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
.033
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
3750
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3746
3744
3742
3740
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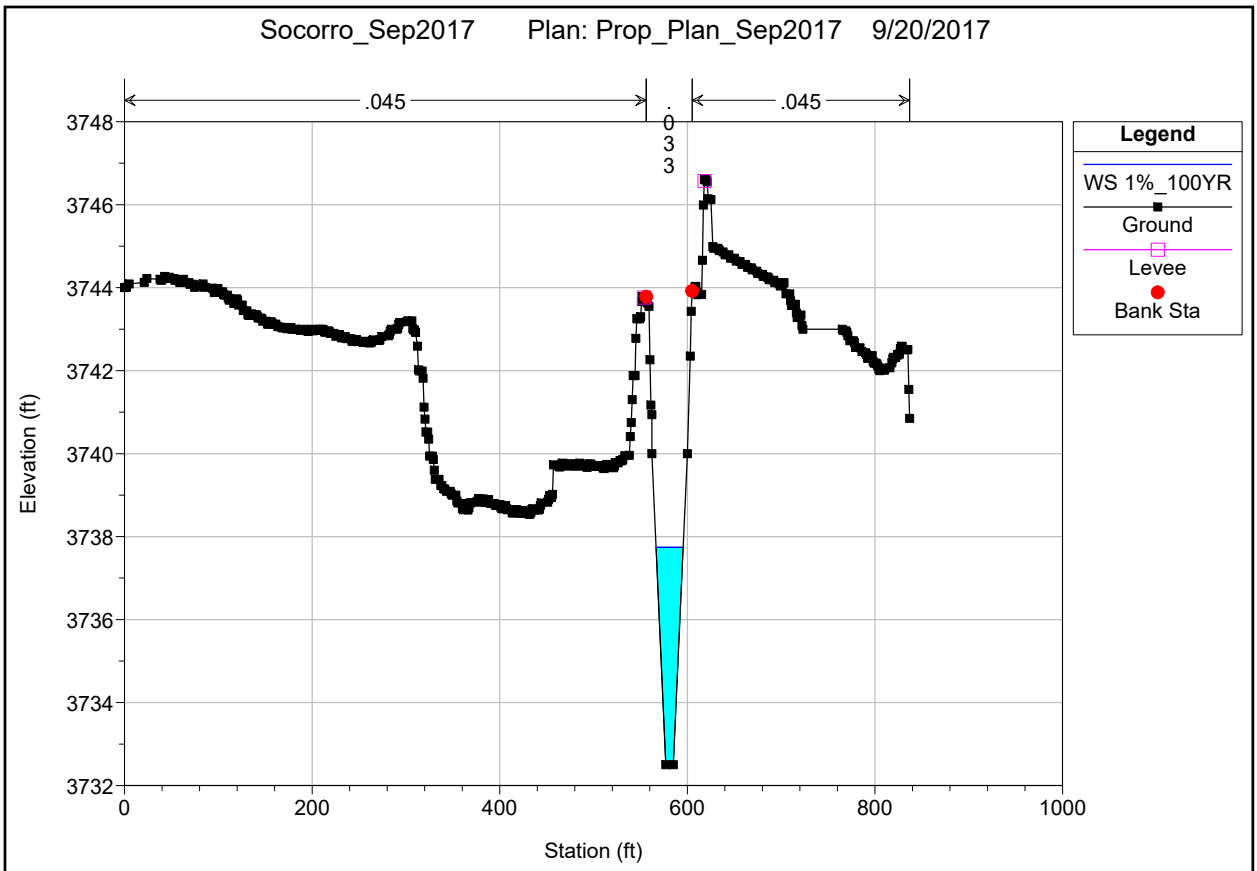
200
400
600
800
1000


Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
.033
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
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3744
3742
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3732
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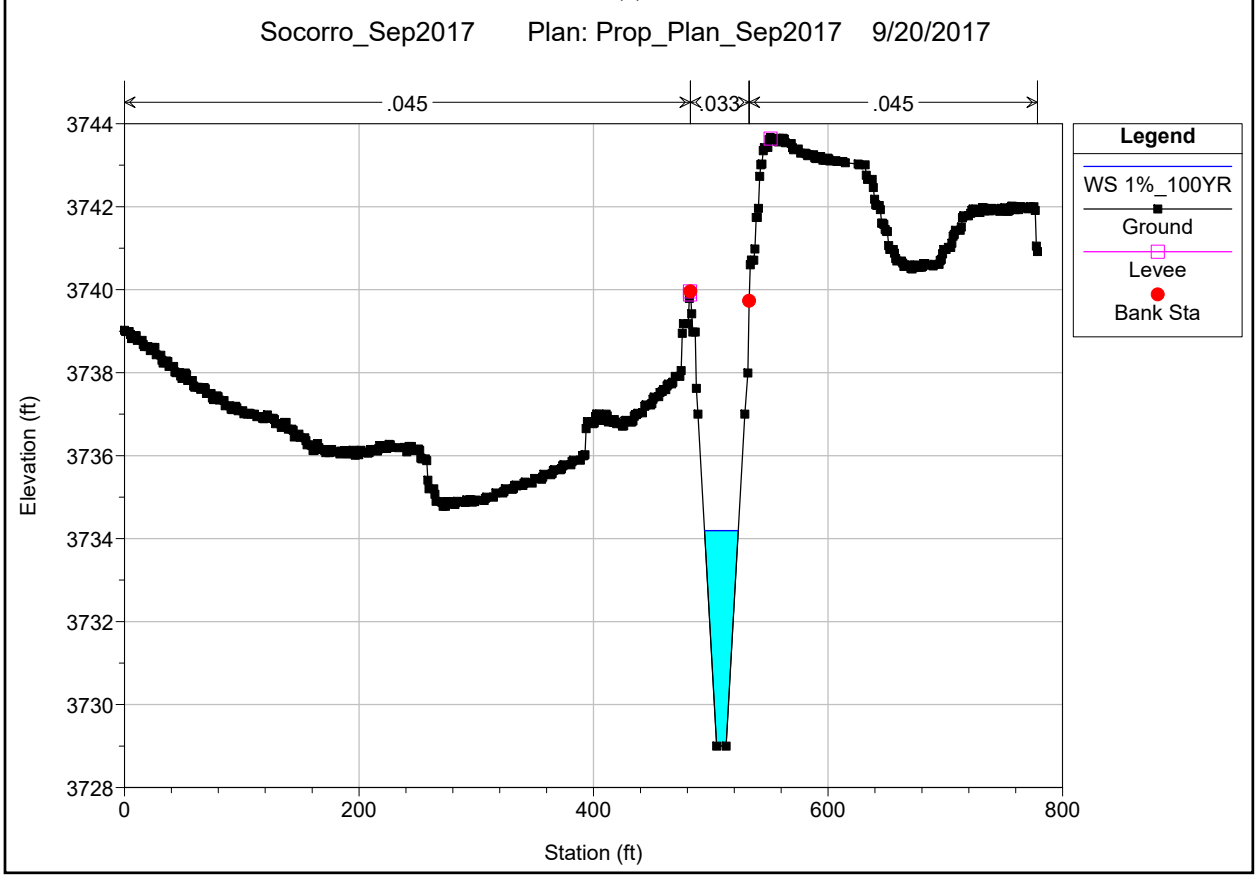
400
600
800
1000


Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
.033
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
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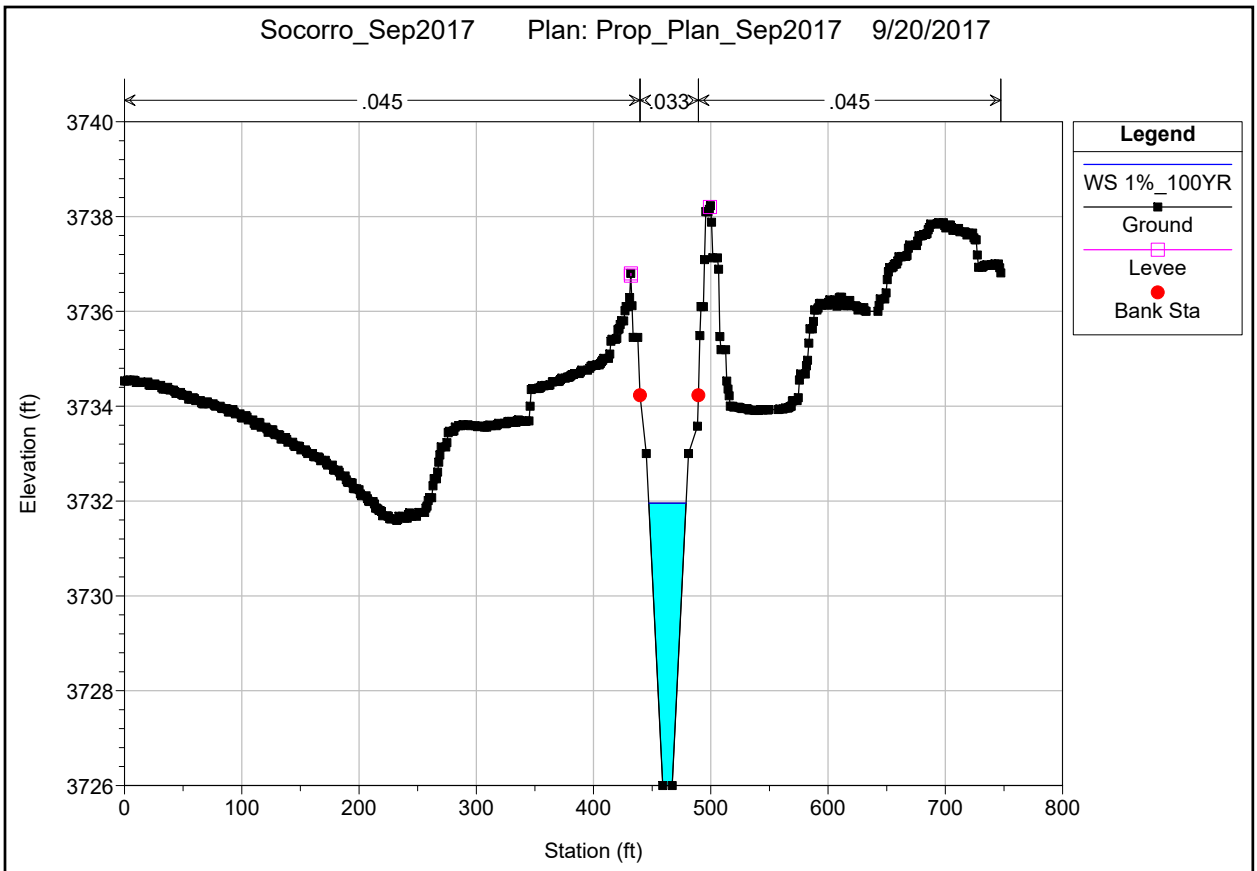
600
800


Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
.033
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
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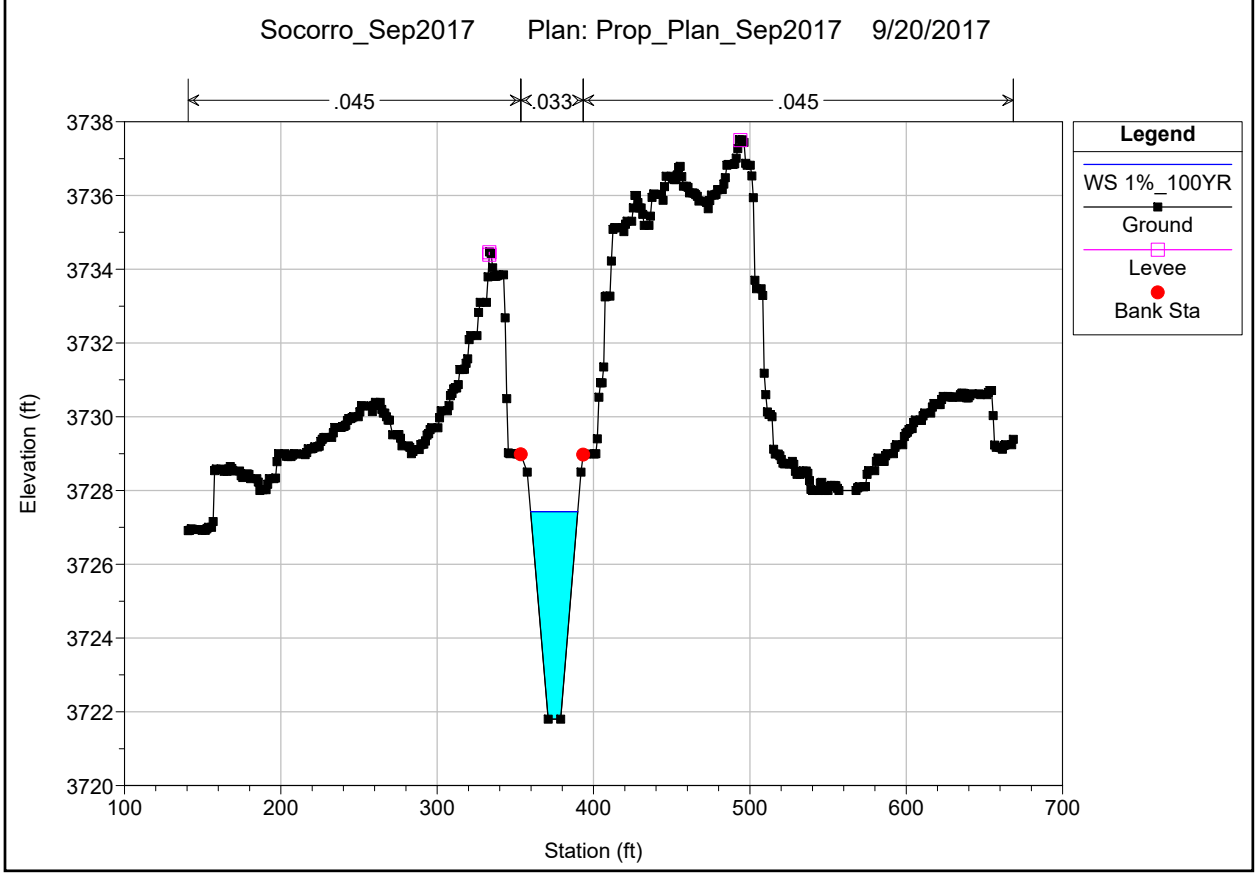
500
600
700
800


Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
.033
.045
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
3738
3736
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3732
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3726
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3720
100
200
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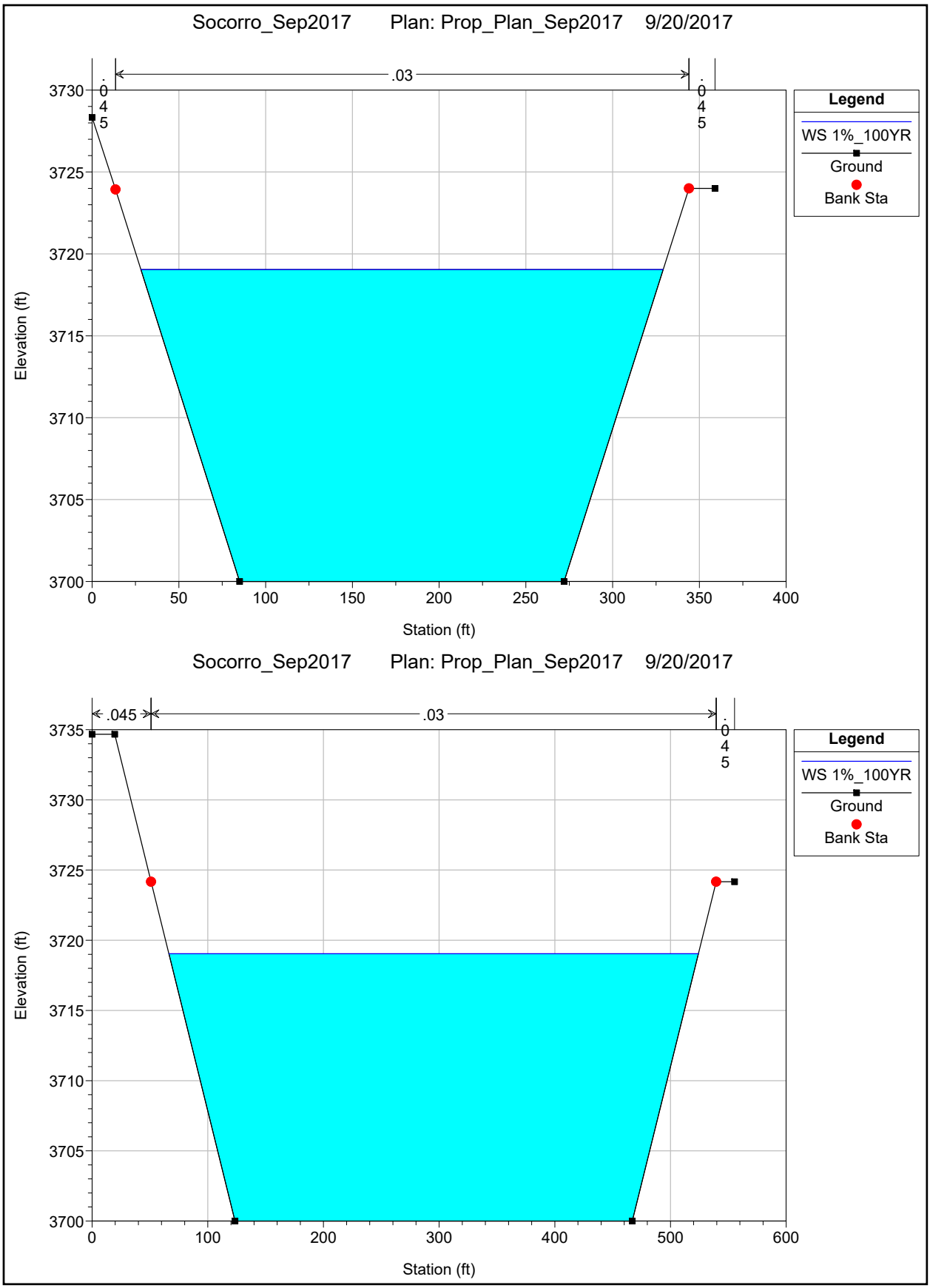
400
500
600
700


Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.03
.045
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3730
3725
3720
3715
3710
3705
3700
0
50
100
150
200
250
300
350
400
Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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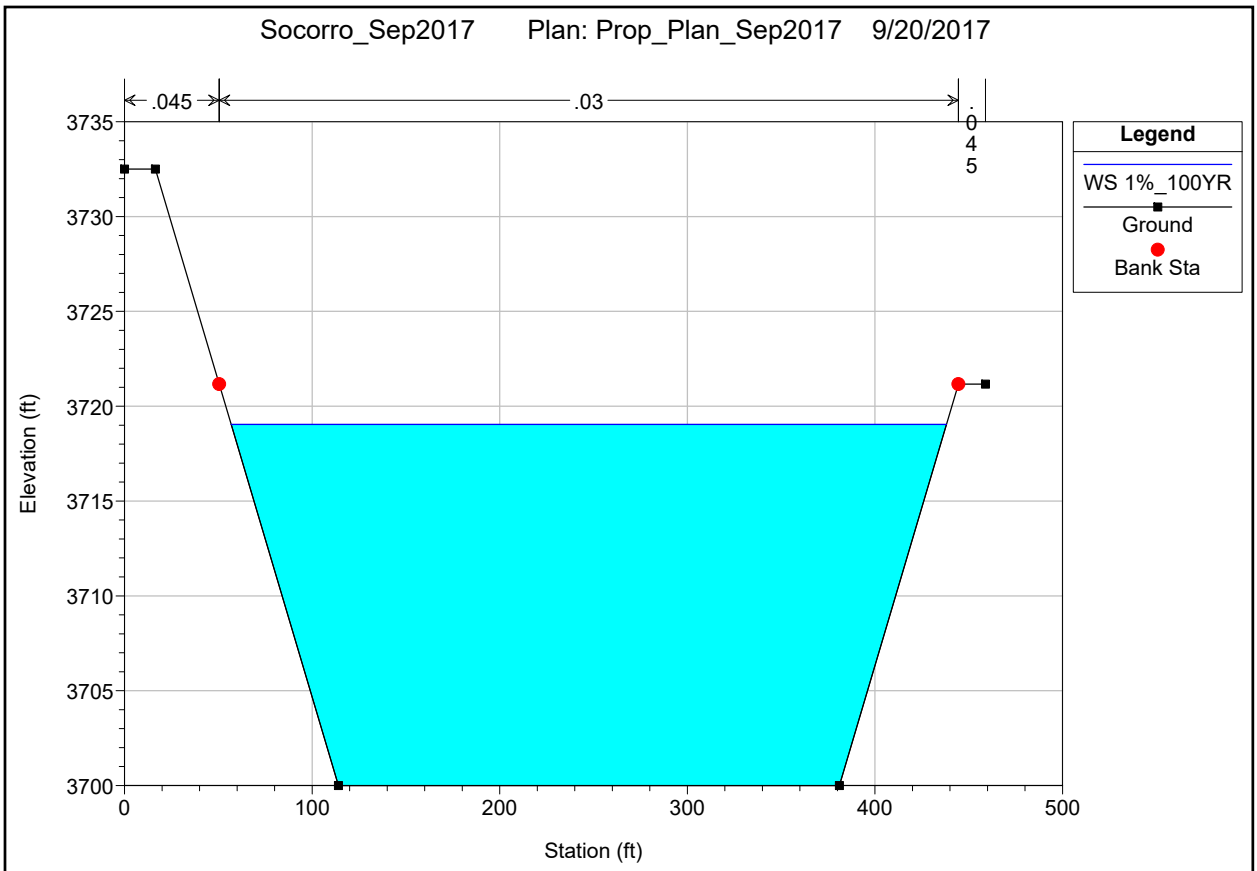
600


Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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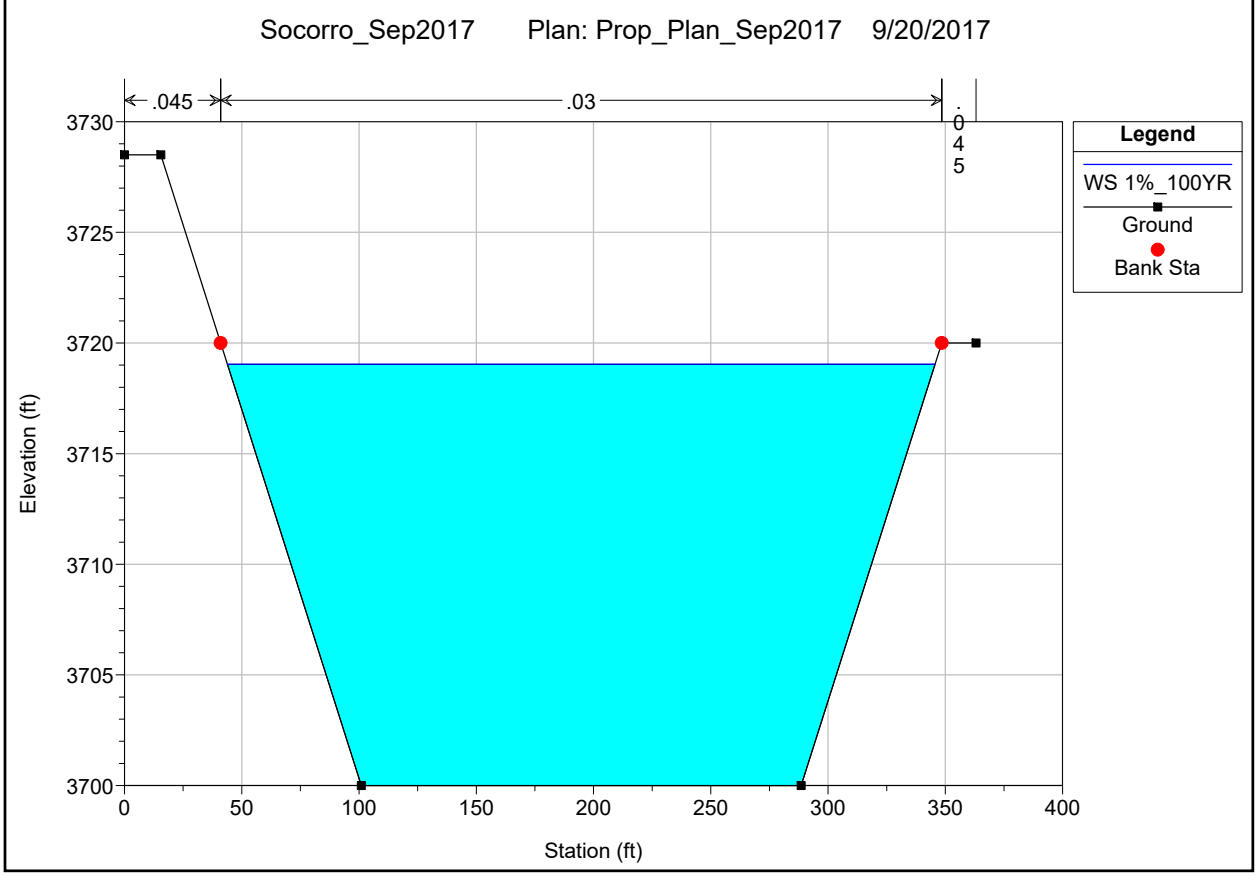
400
500


Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
.03
.045
Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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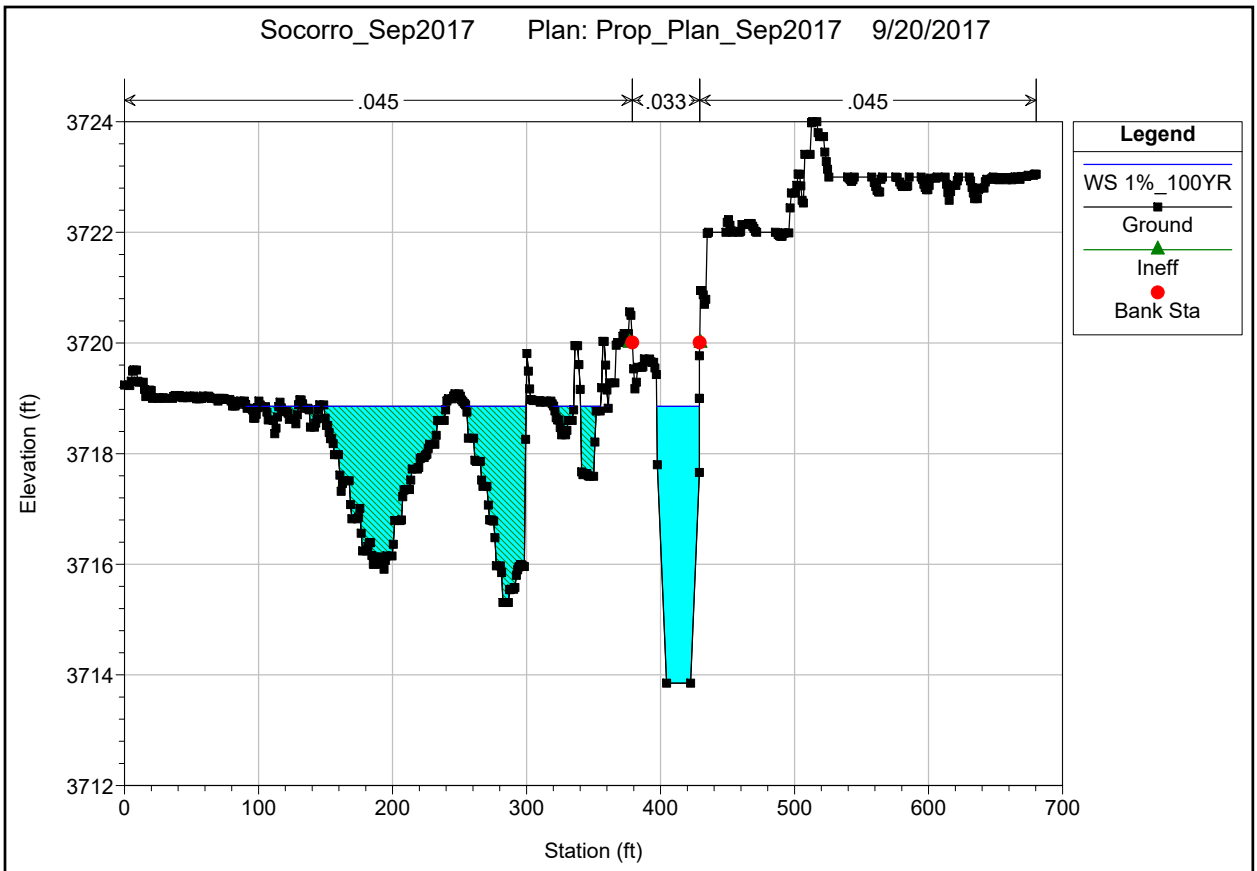
350
400


Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
.033
.045
Legend
WS 1%_100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3724
3722
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3718
3716
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3712
0
100
200
300
400
500
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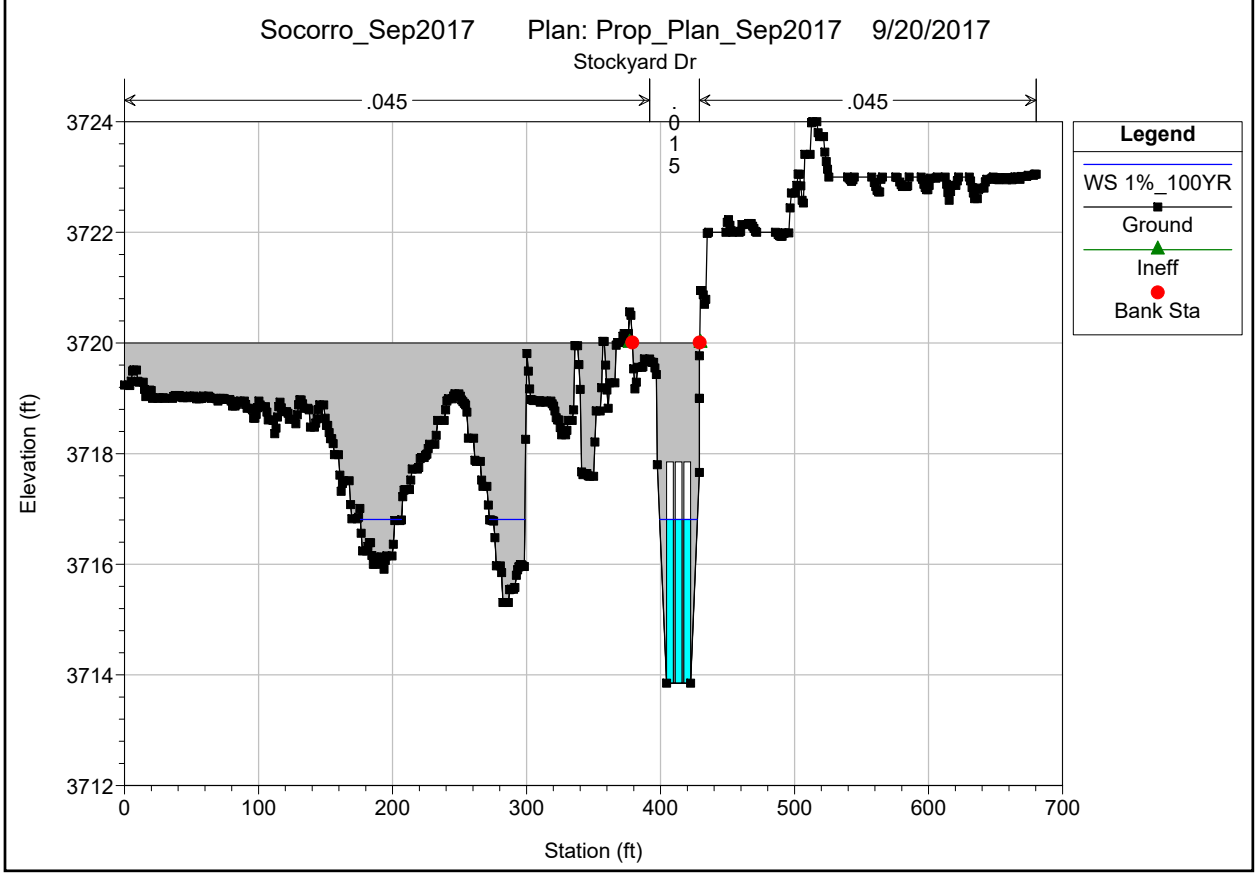
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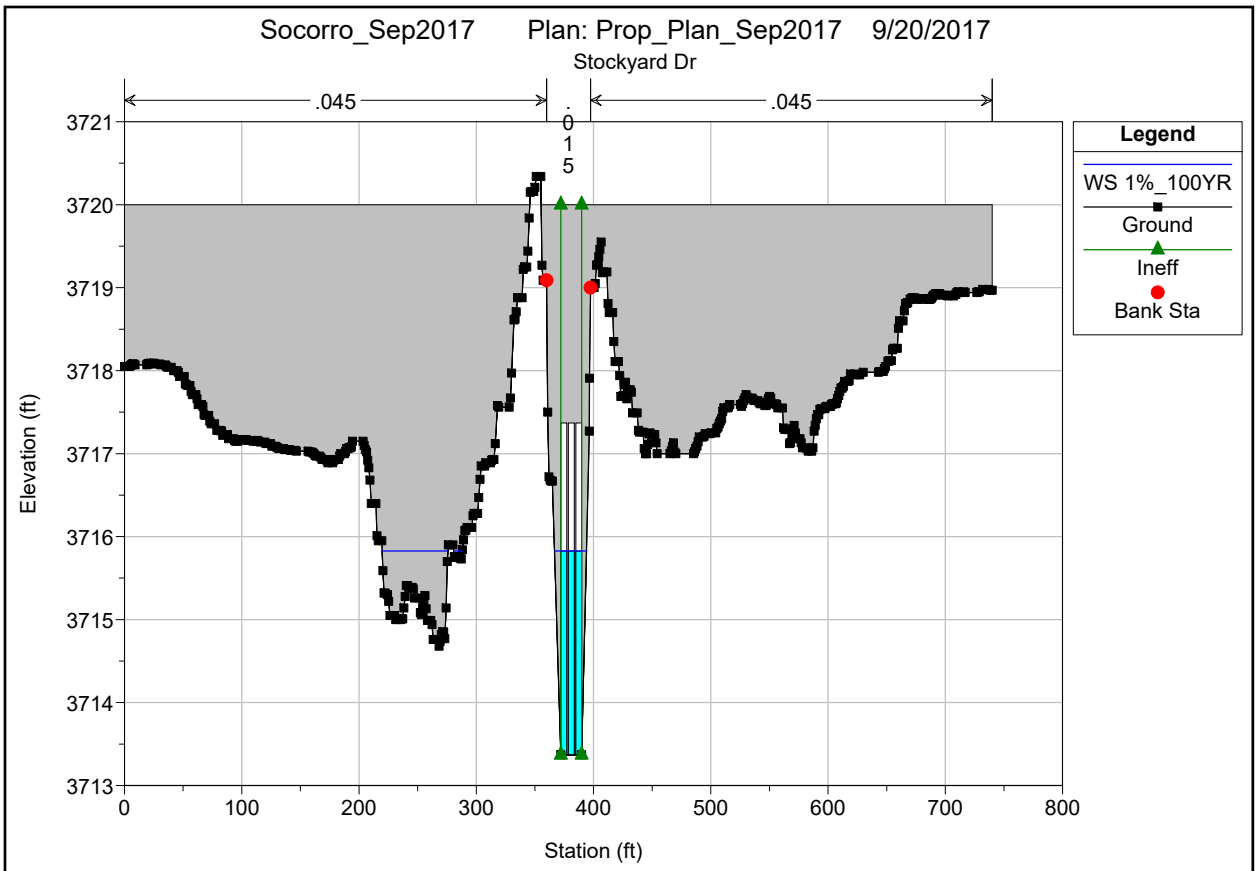
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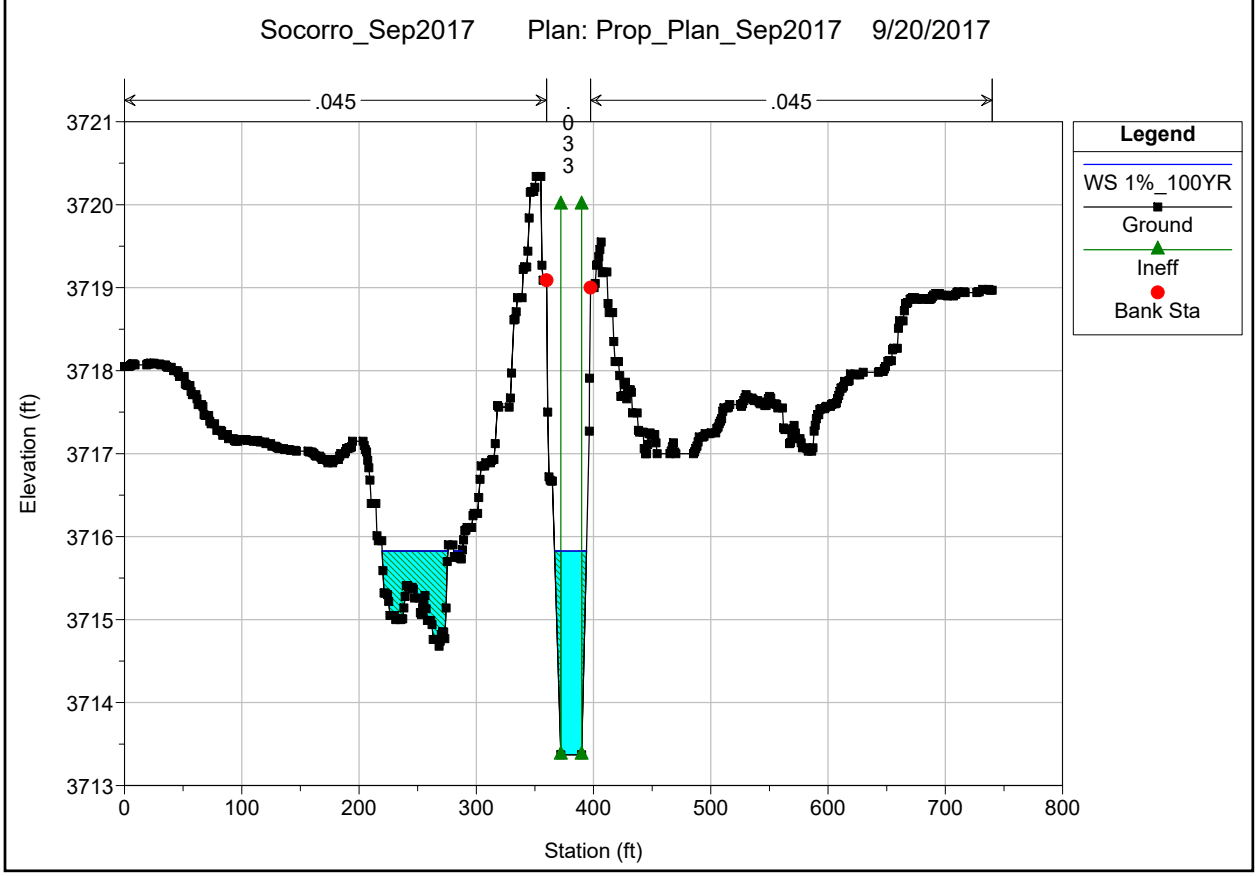
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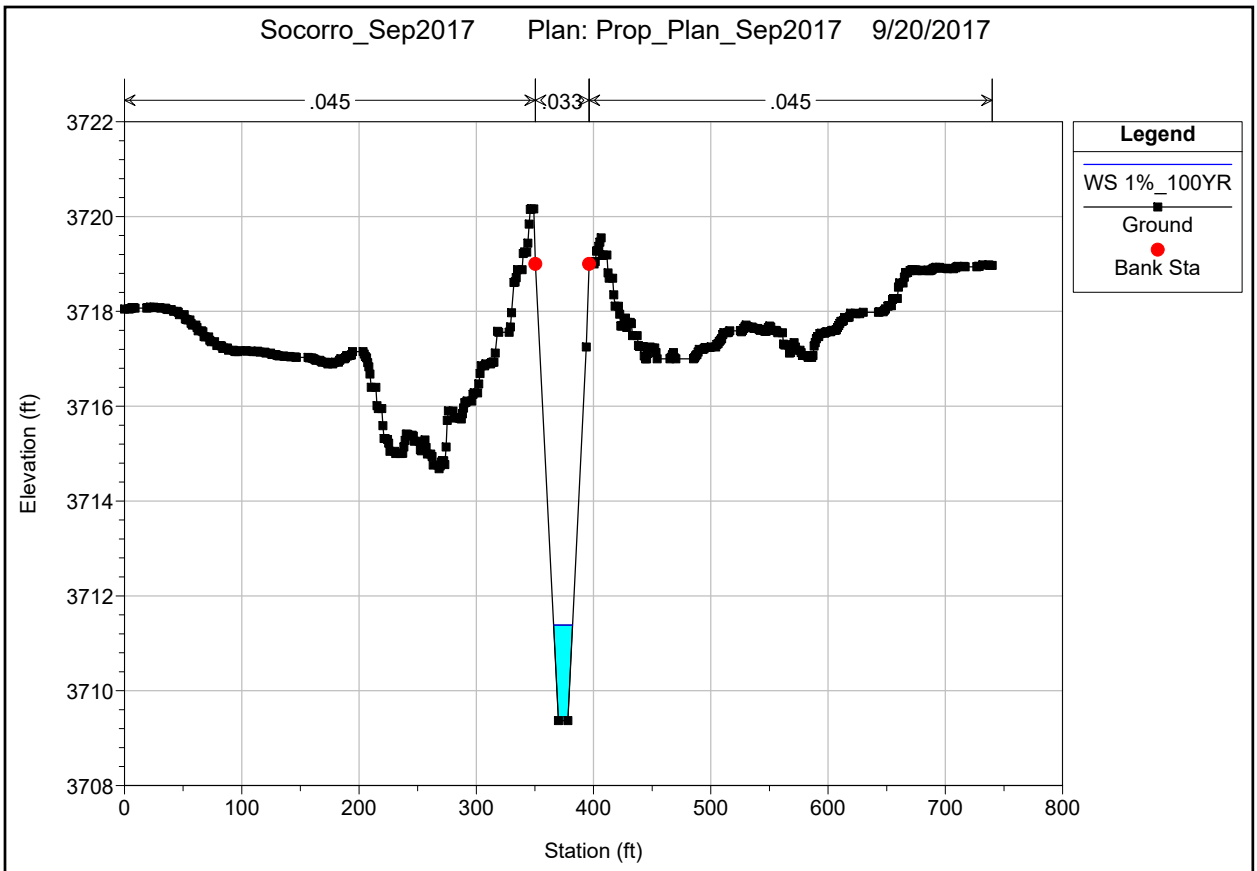
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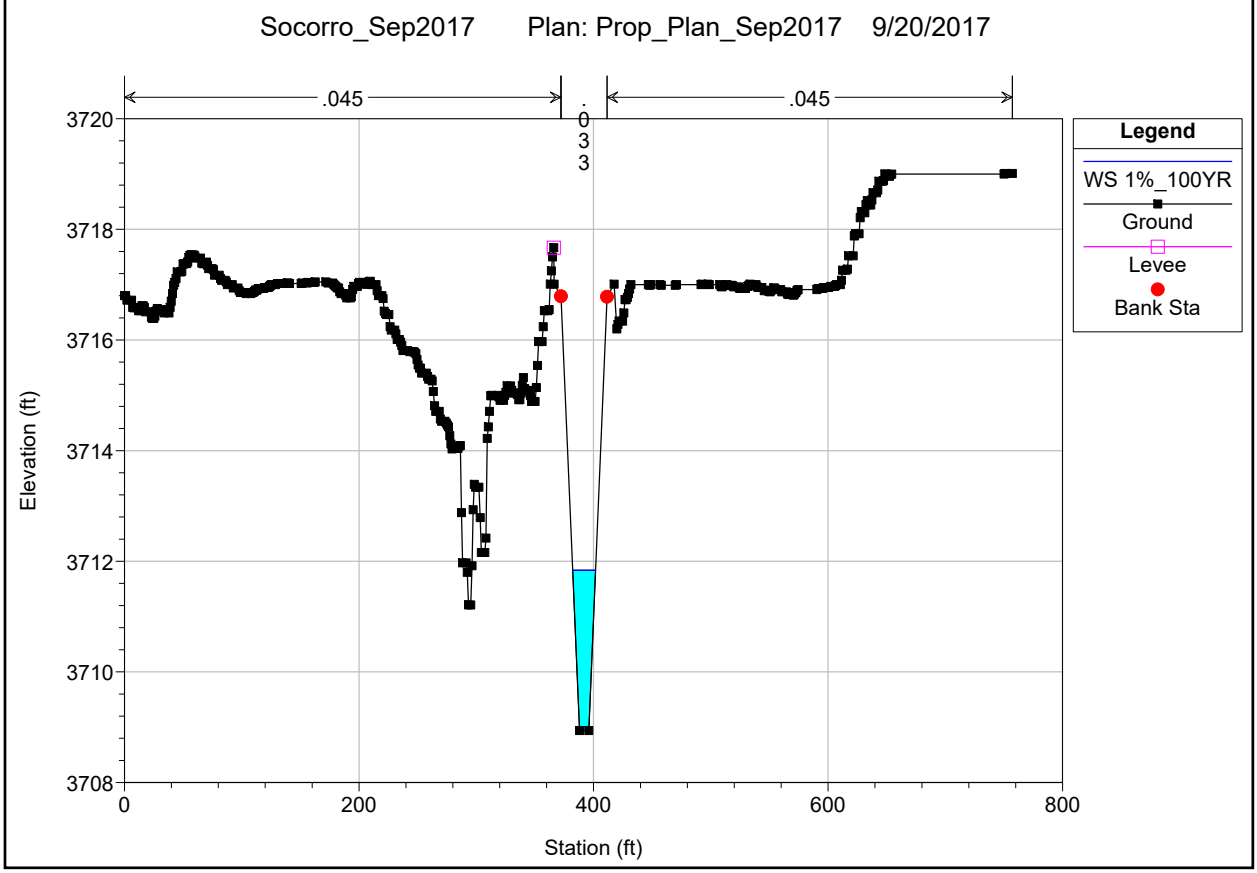
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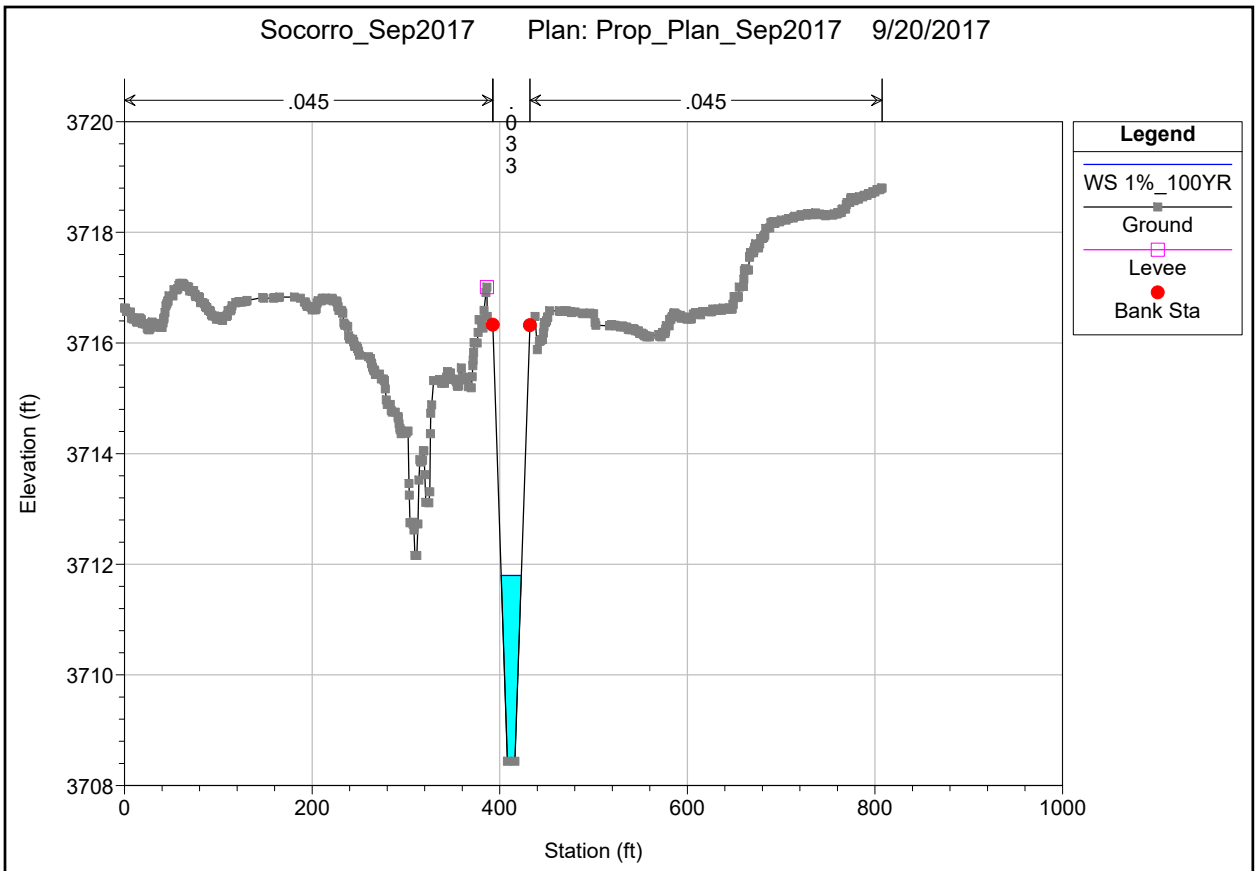
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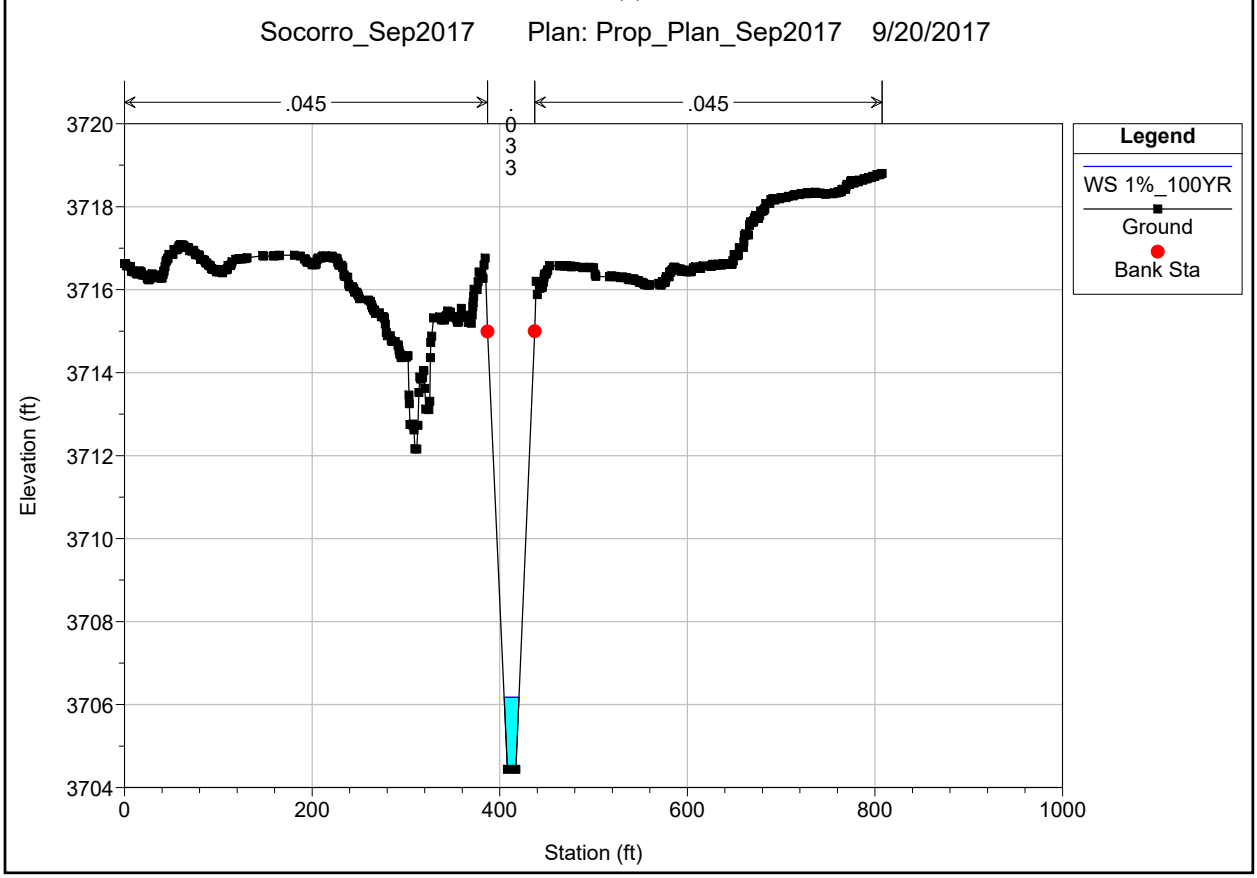
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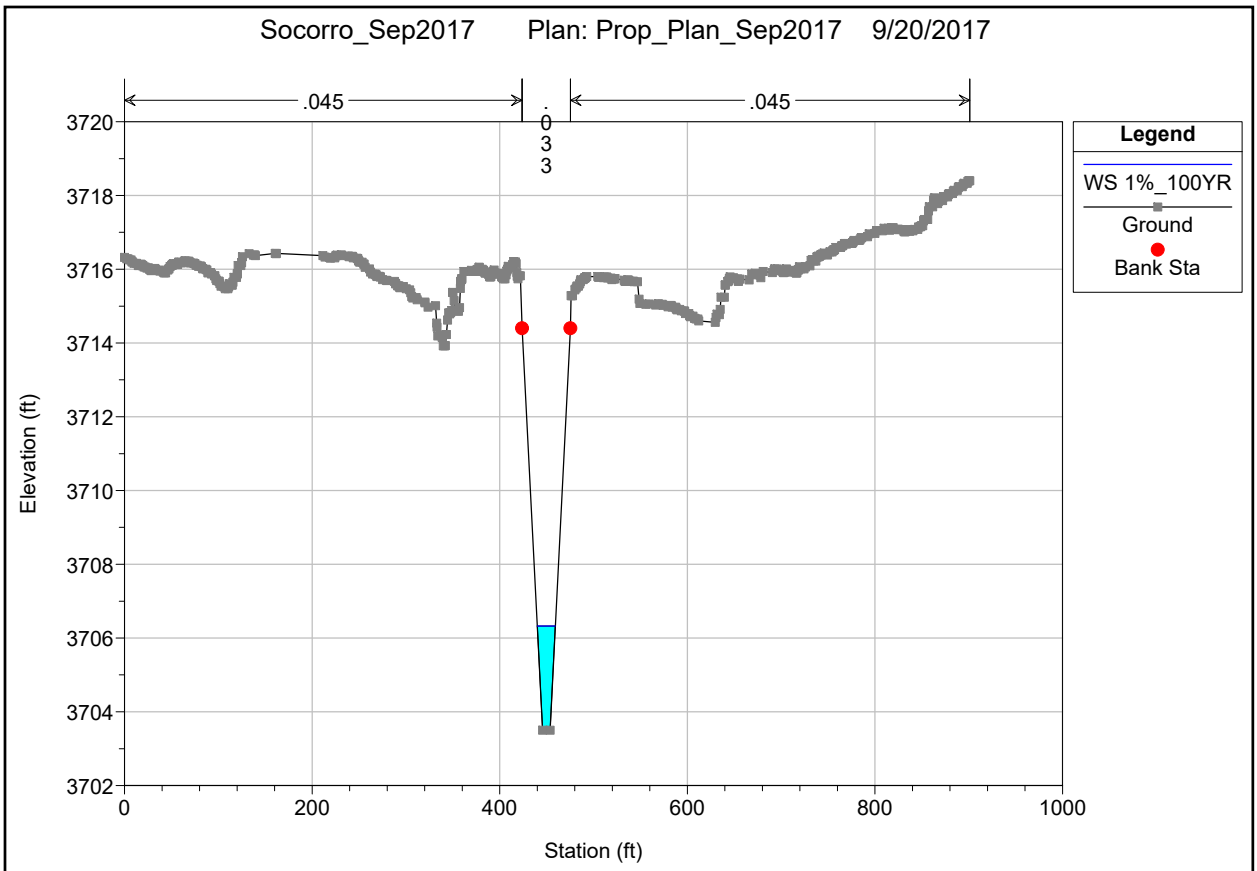
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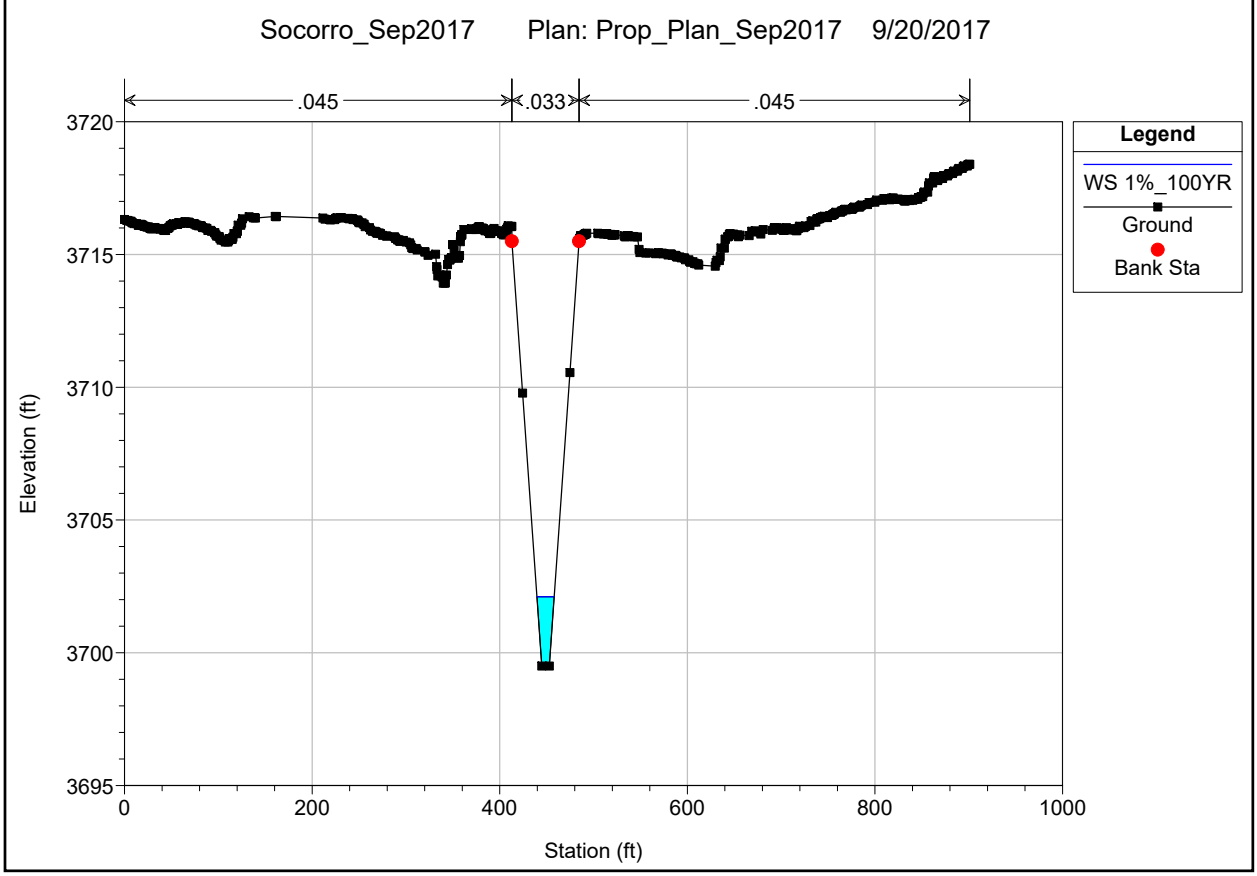
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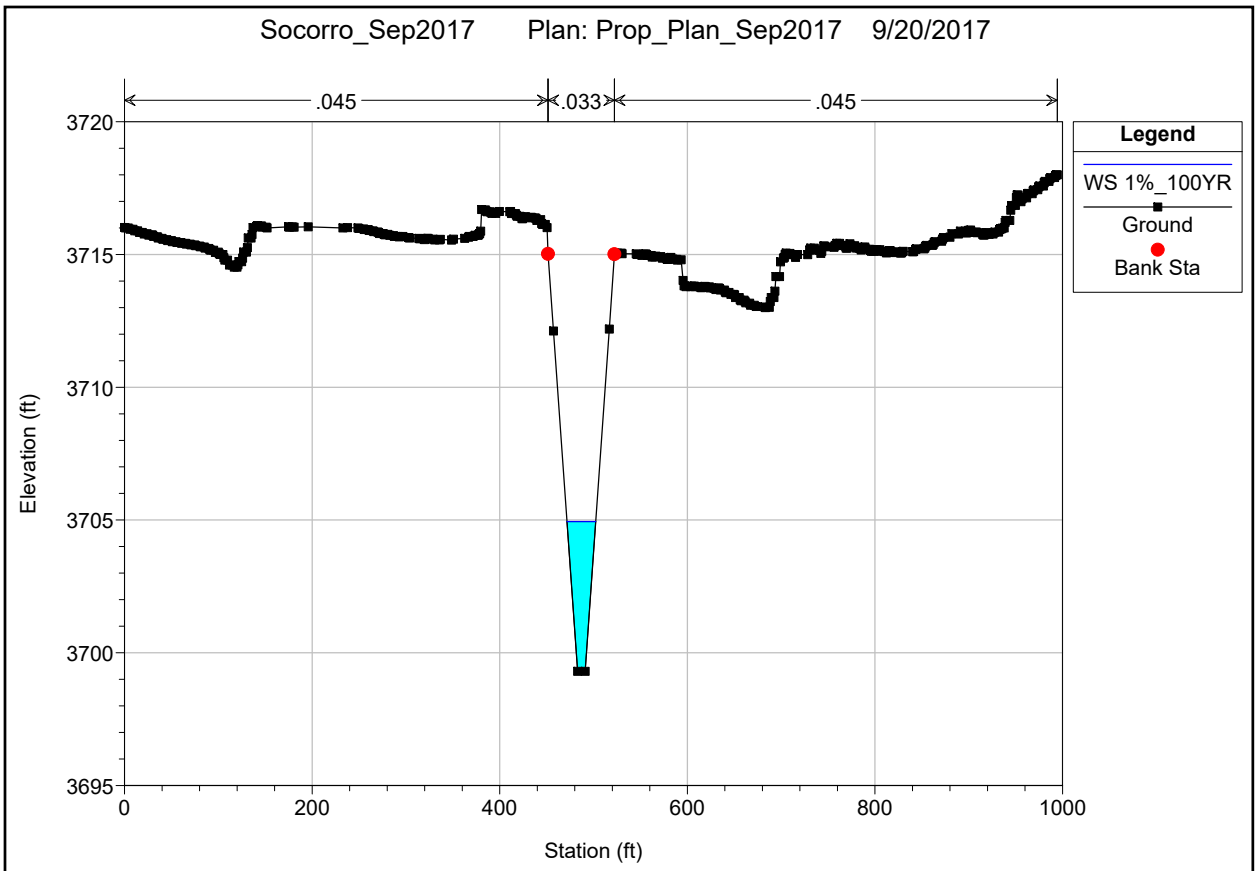
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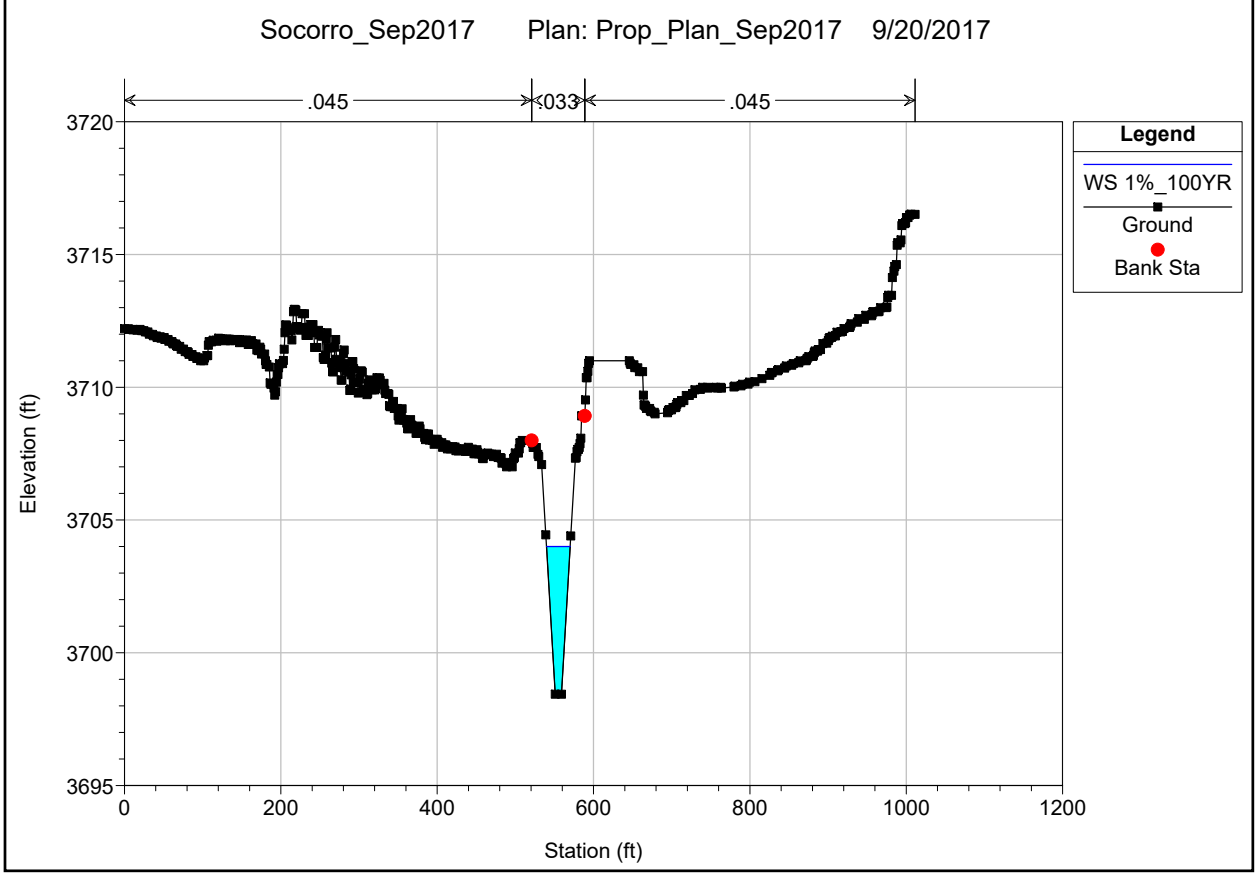
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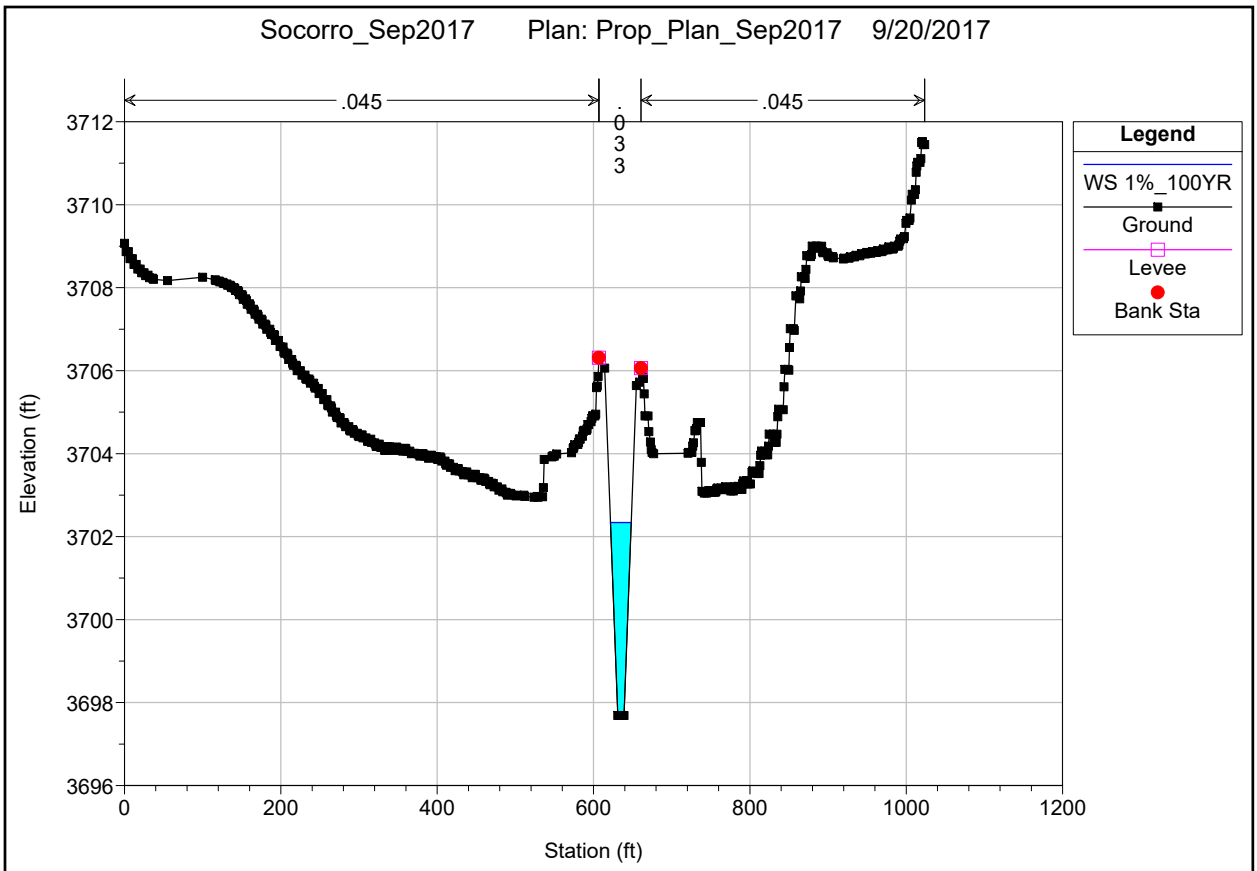
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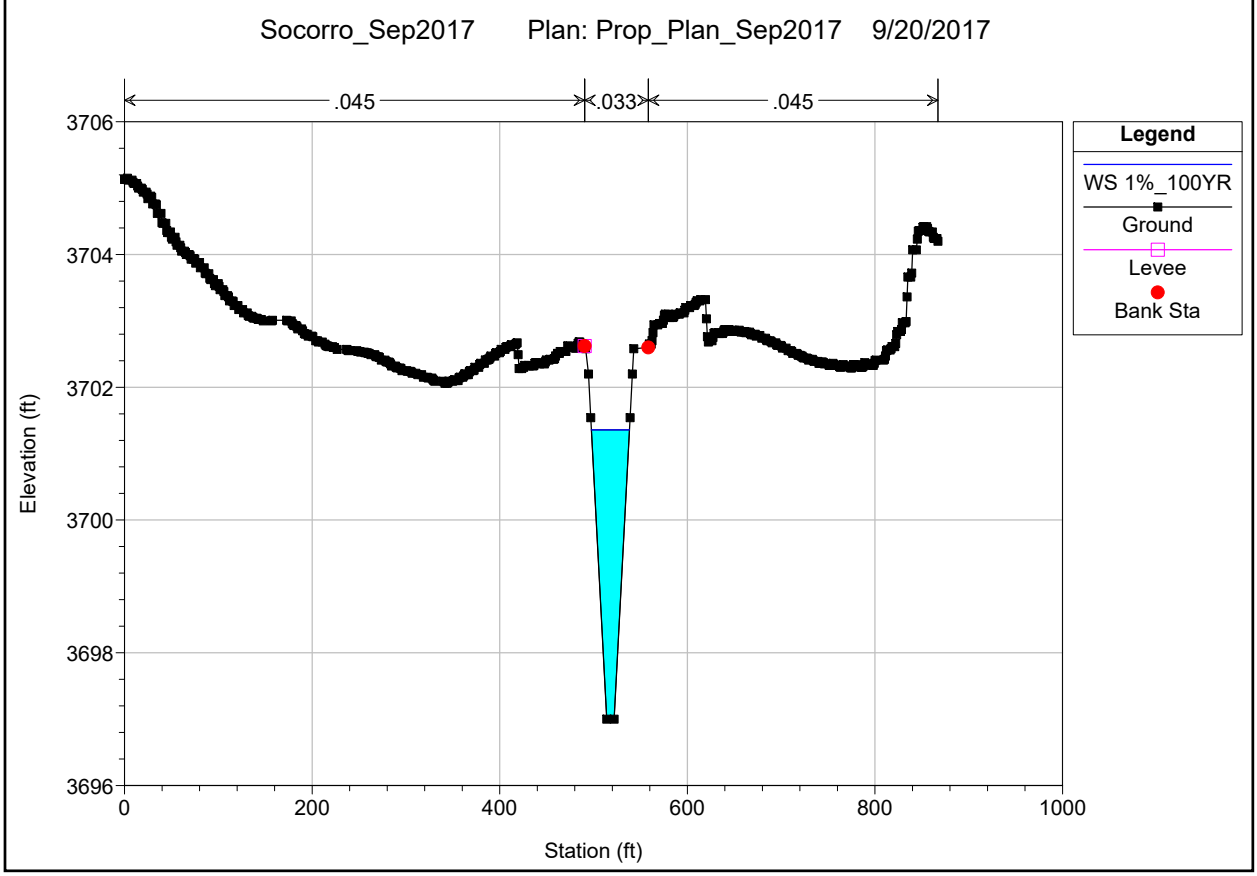
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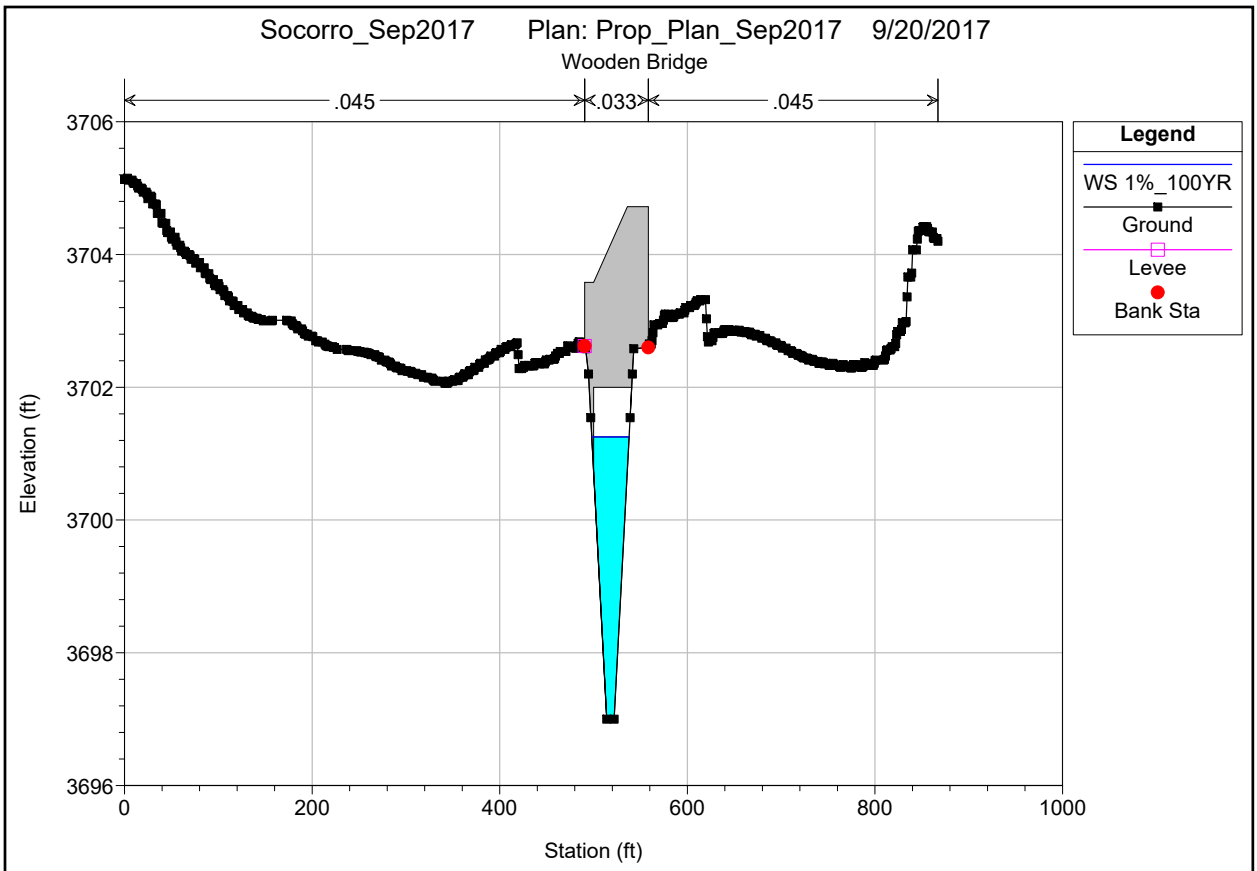
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Wooden Bridge
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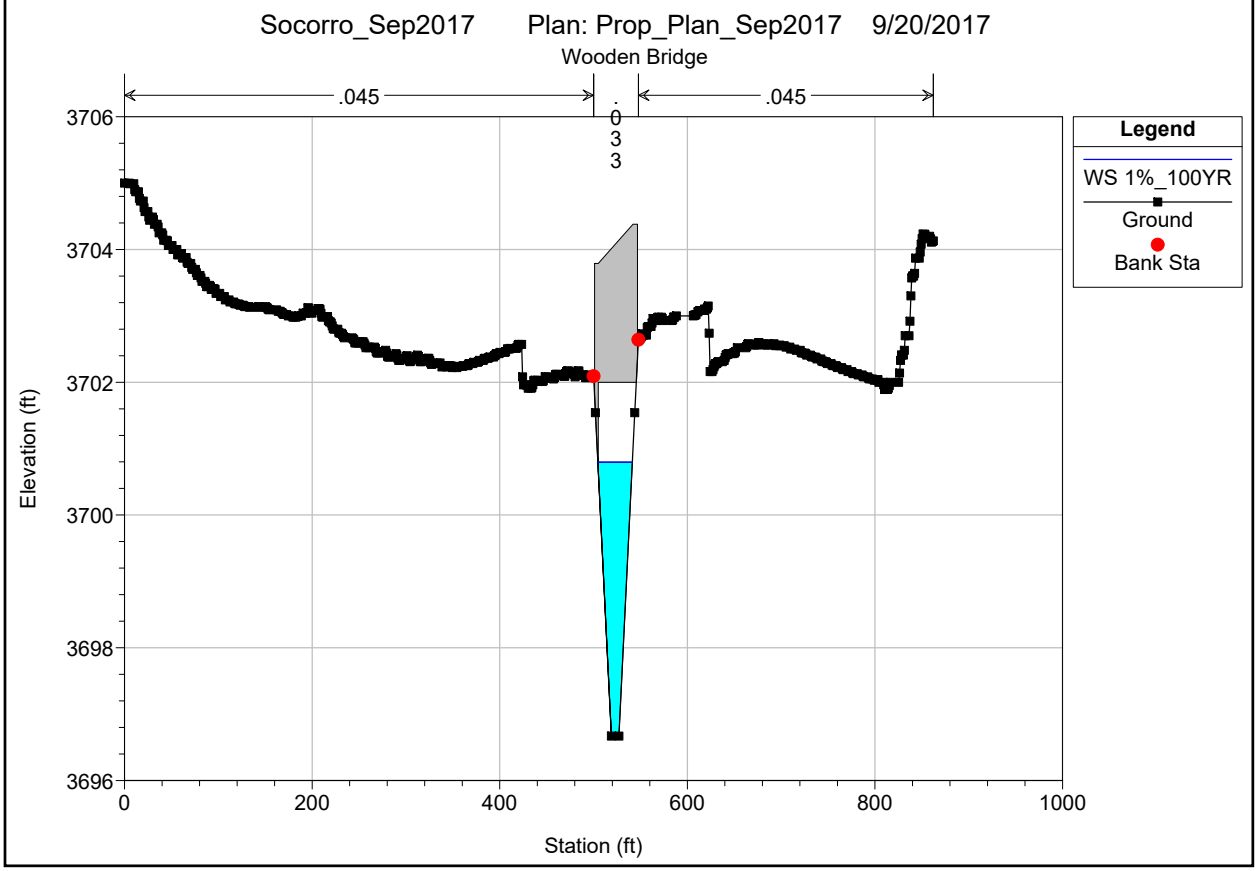
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Wooden Bridge
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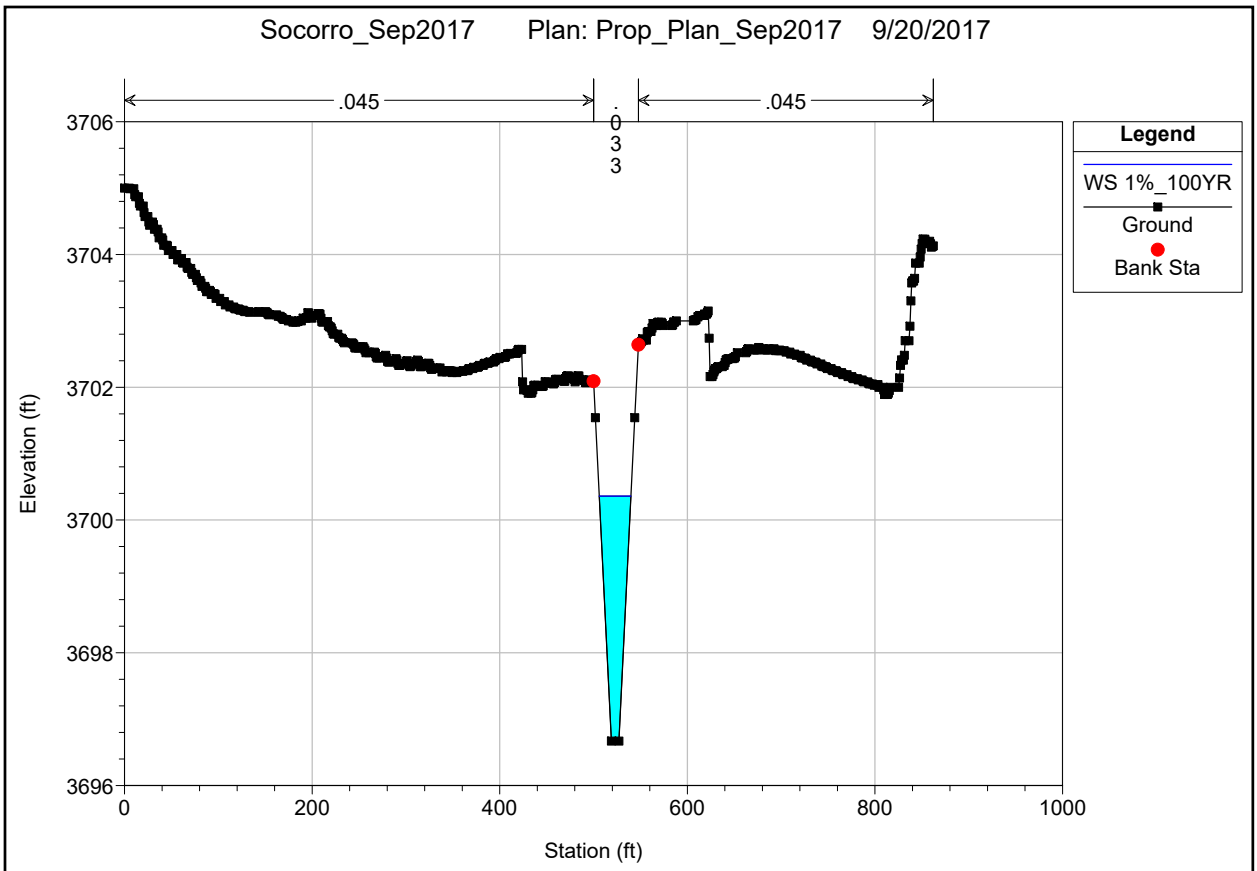
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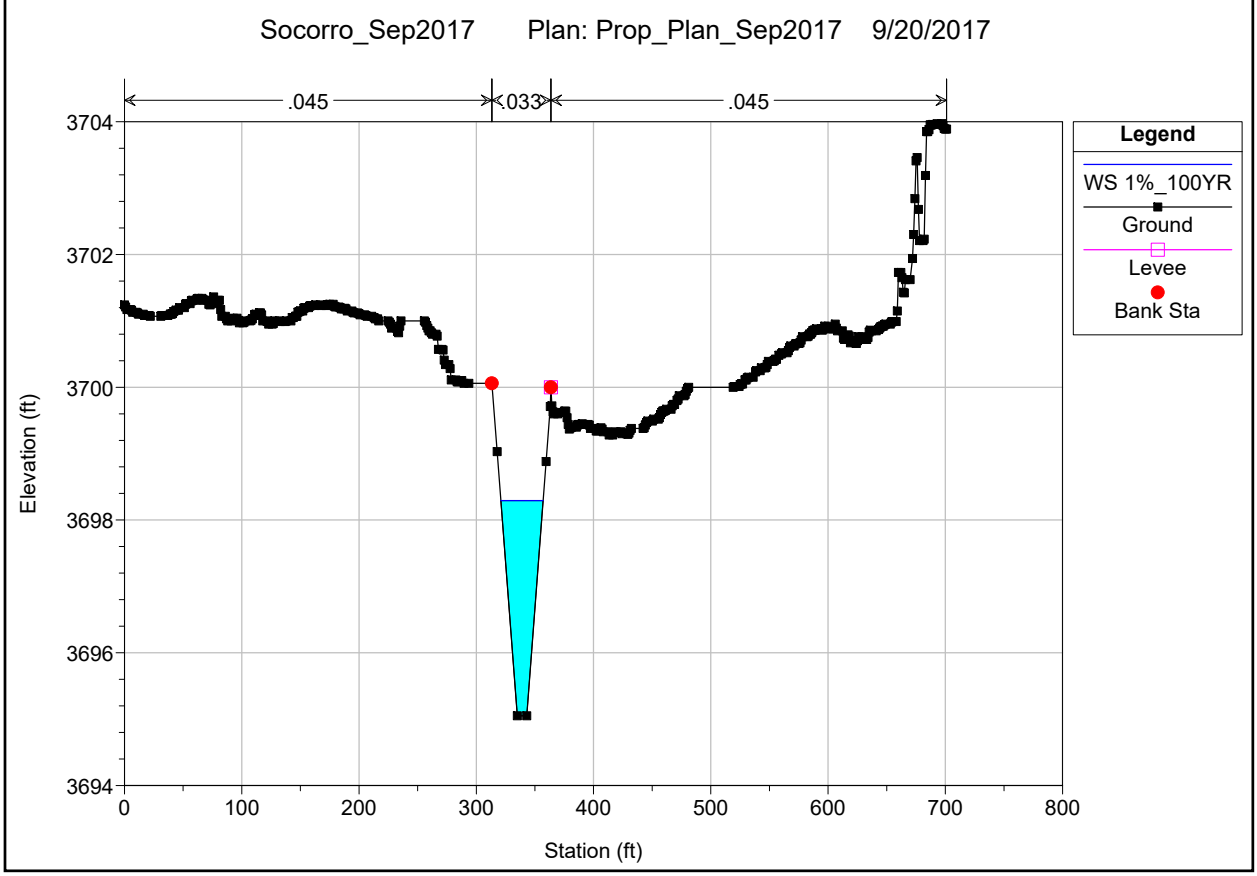
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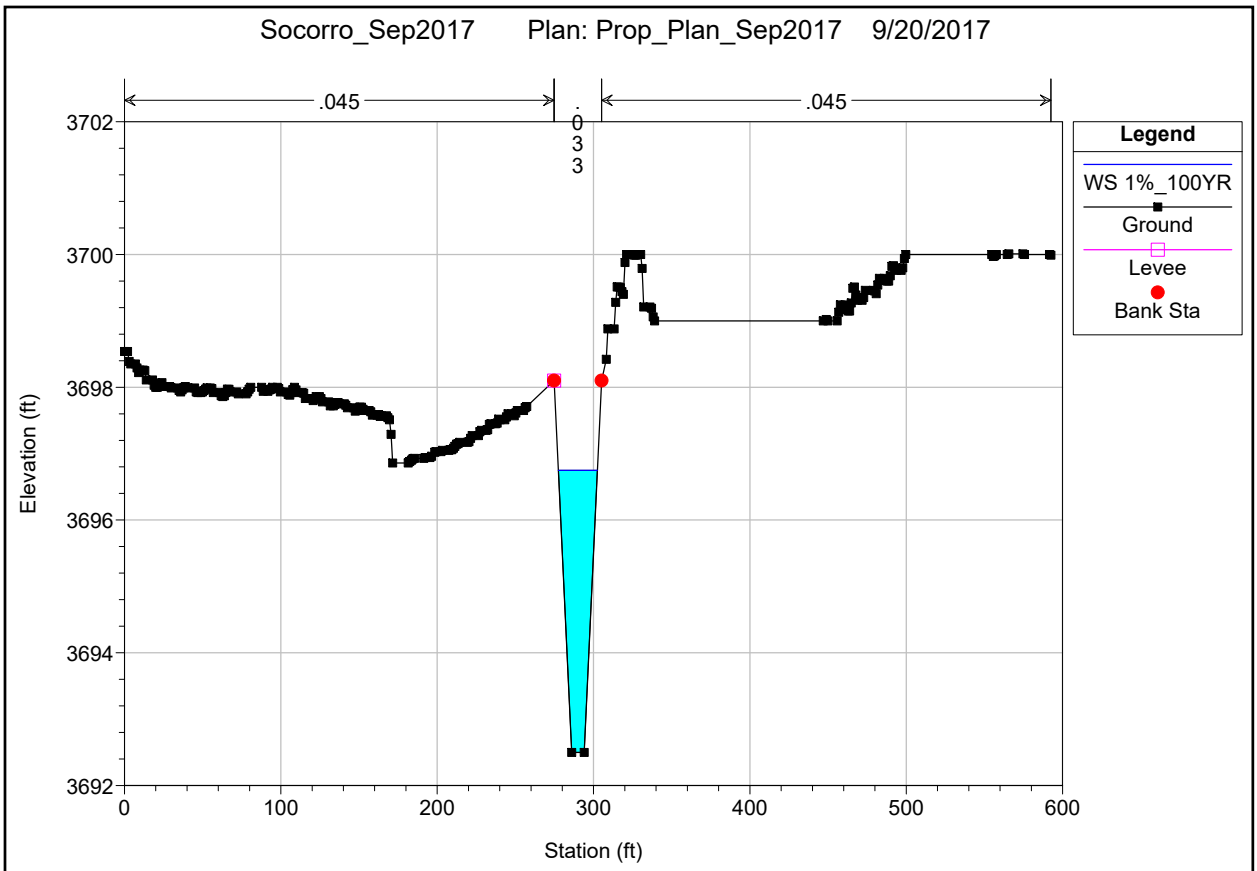
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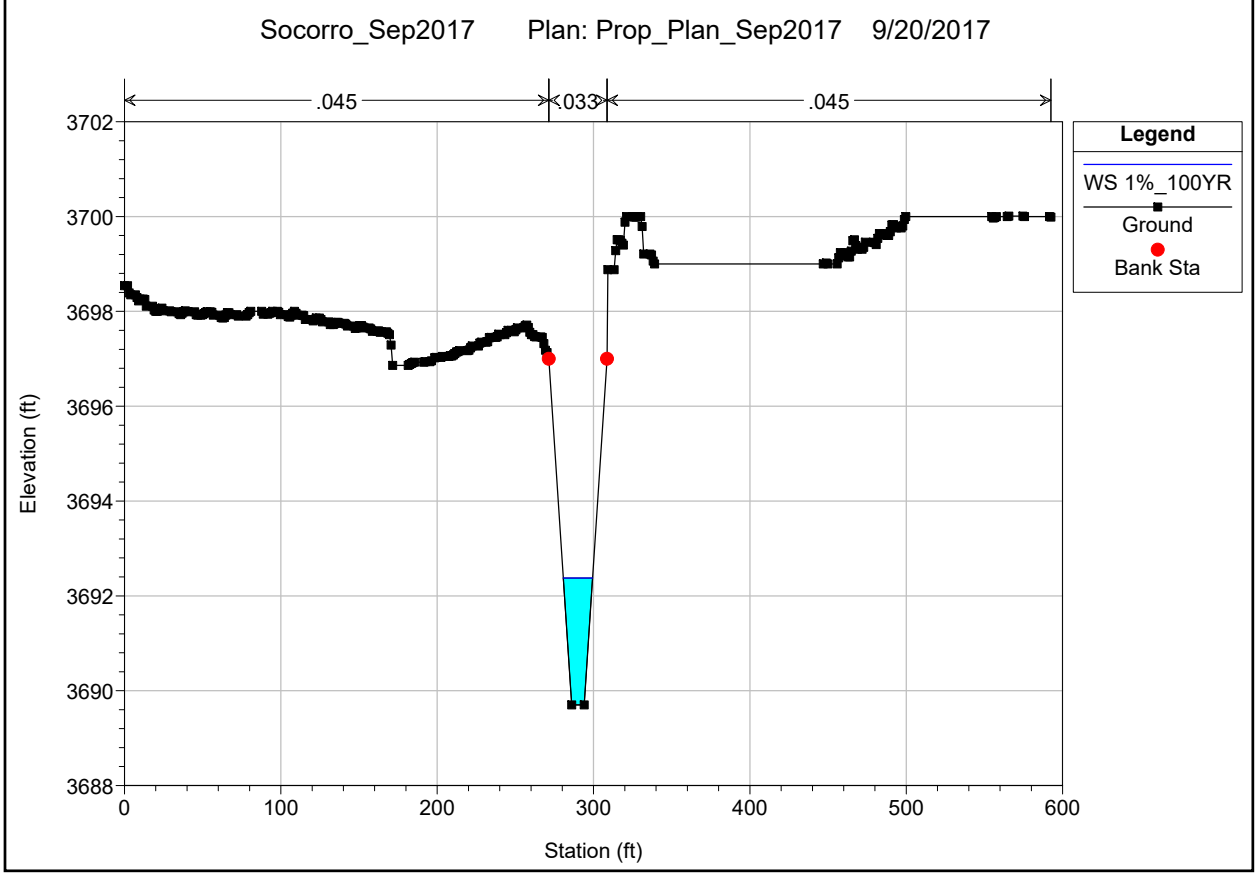
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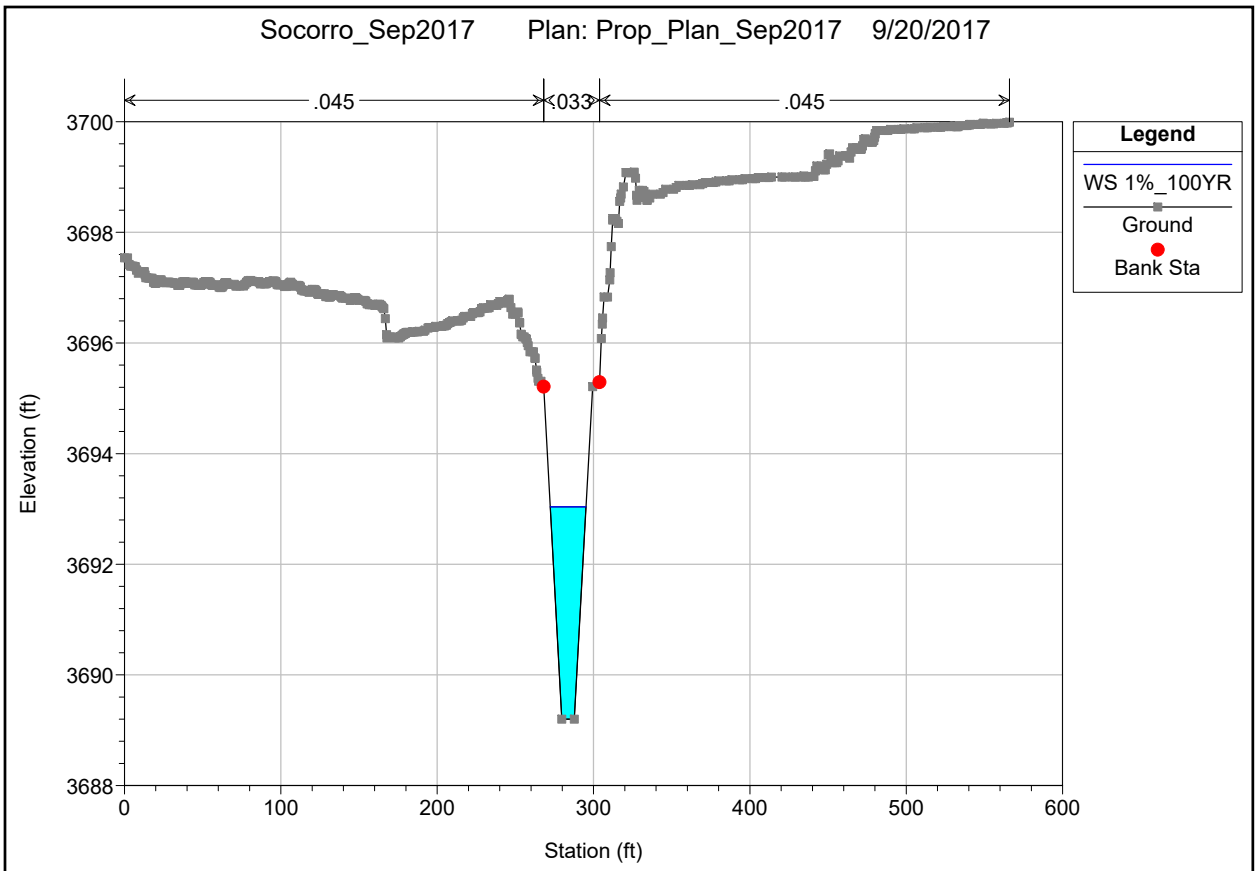
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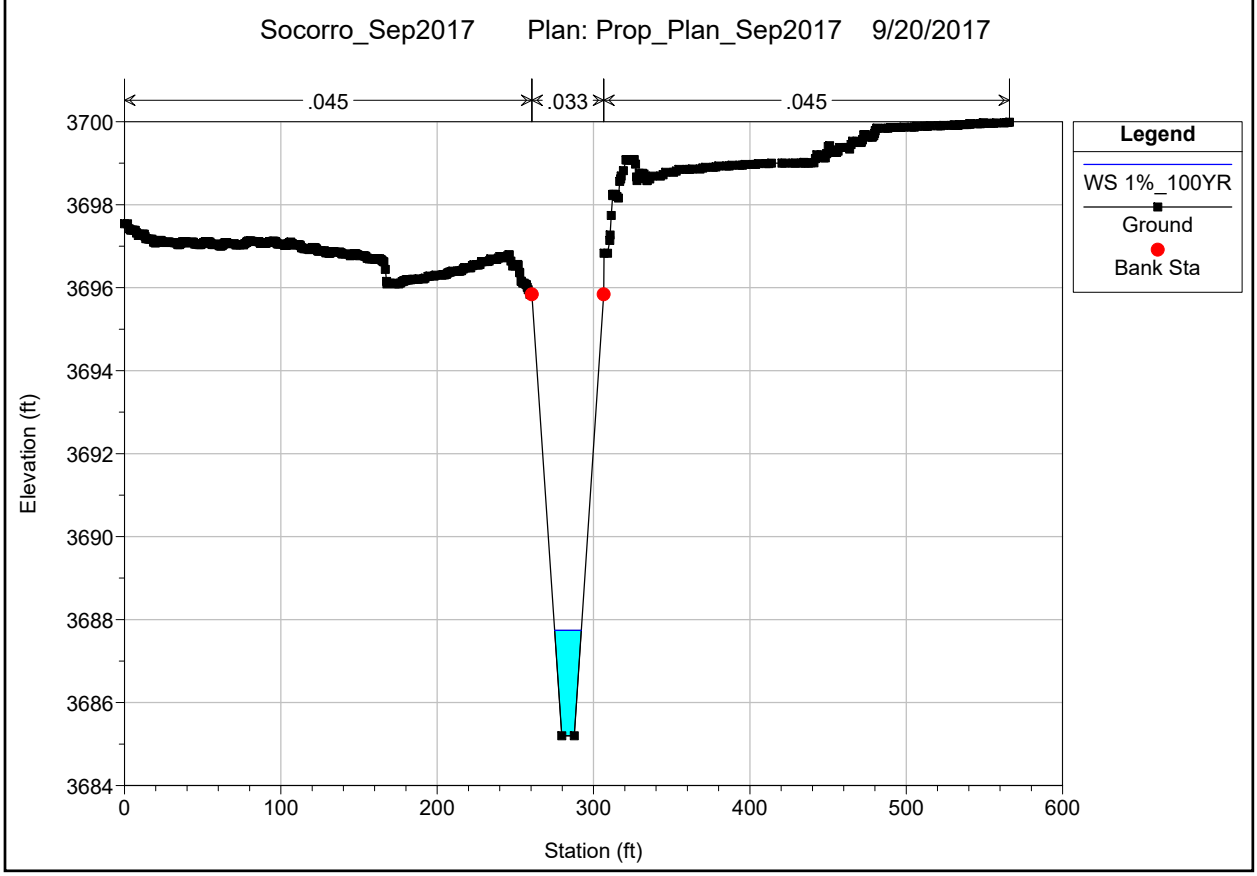
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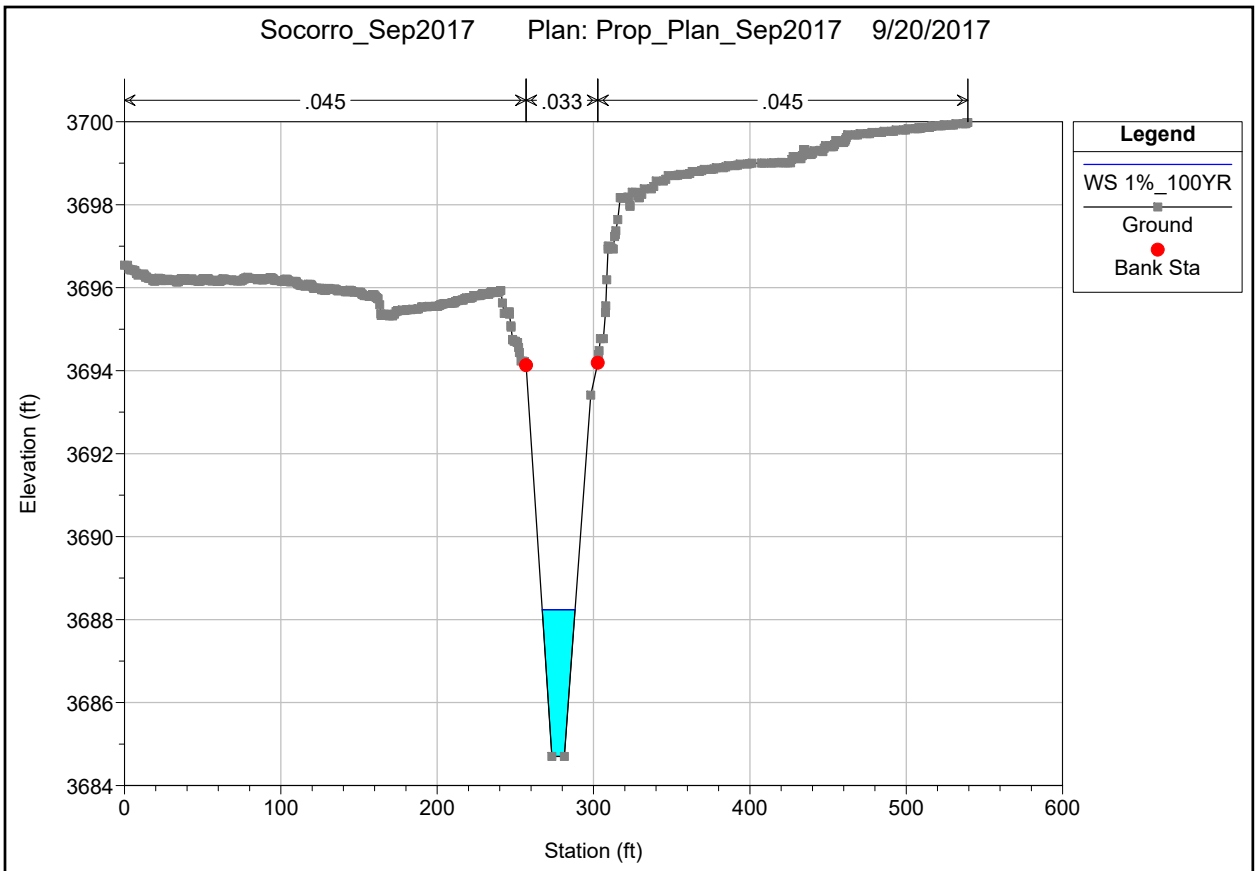
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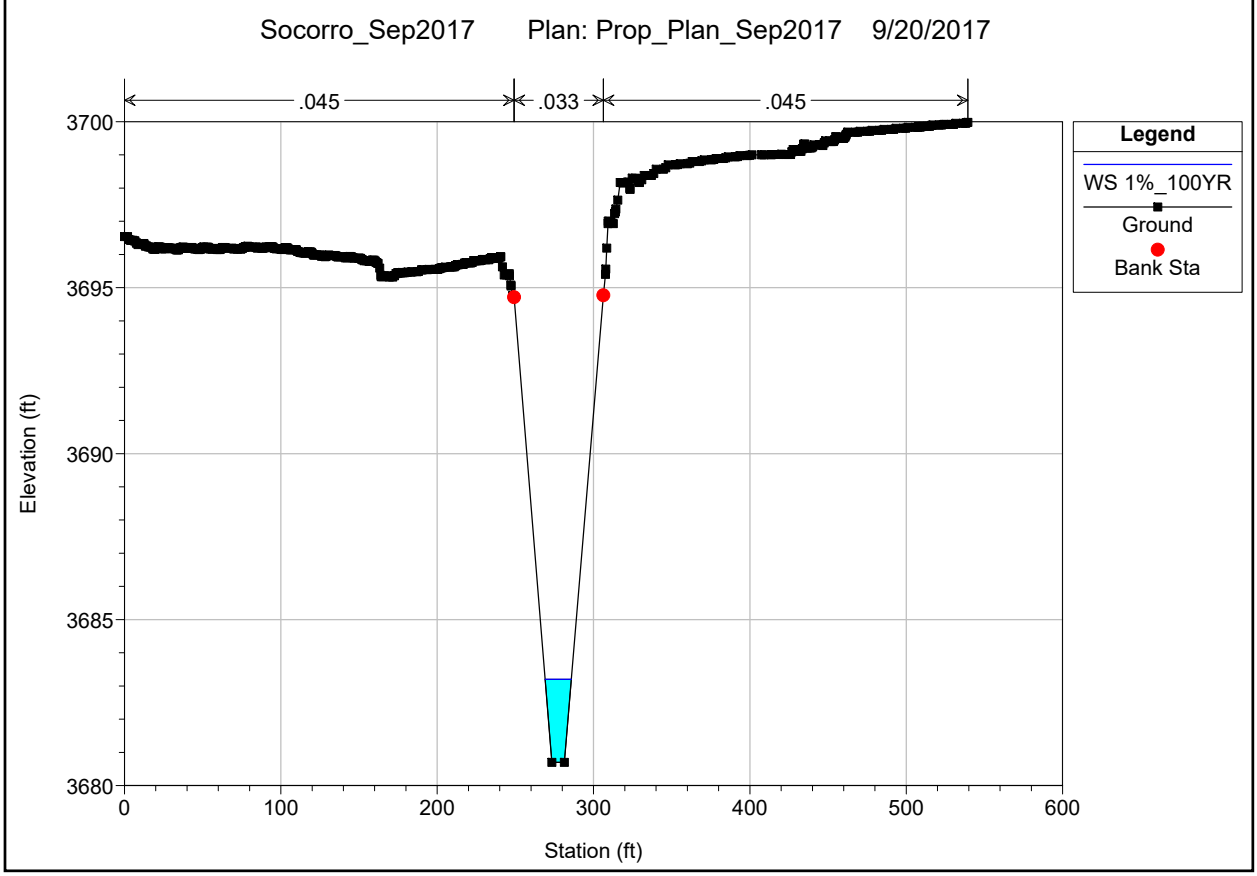
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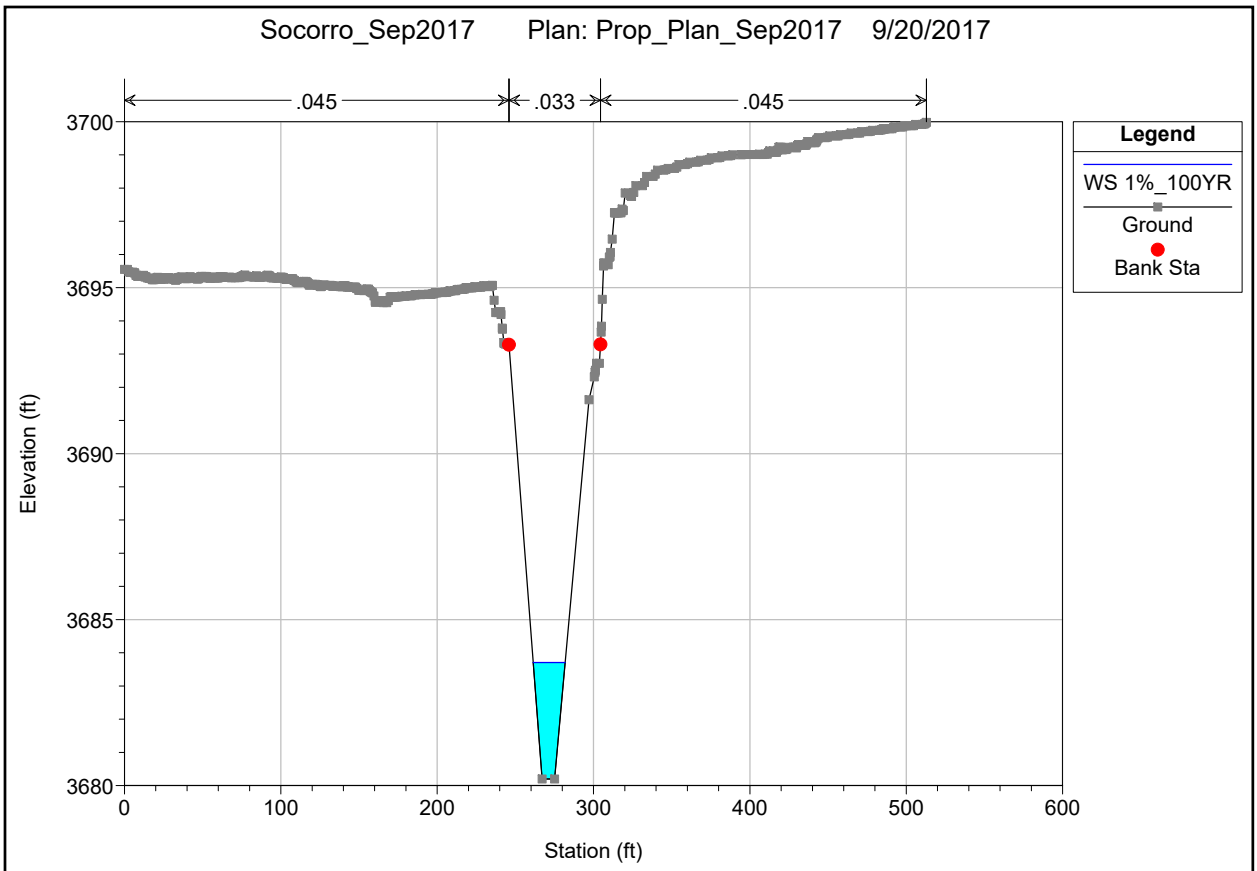
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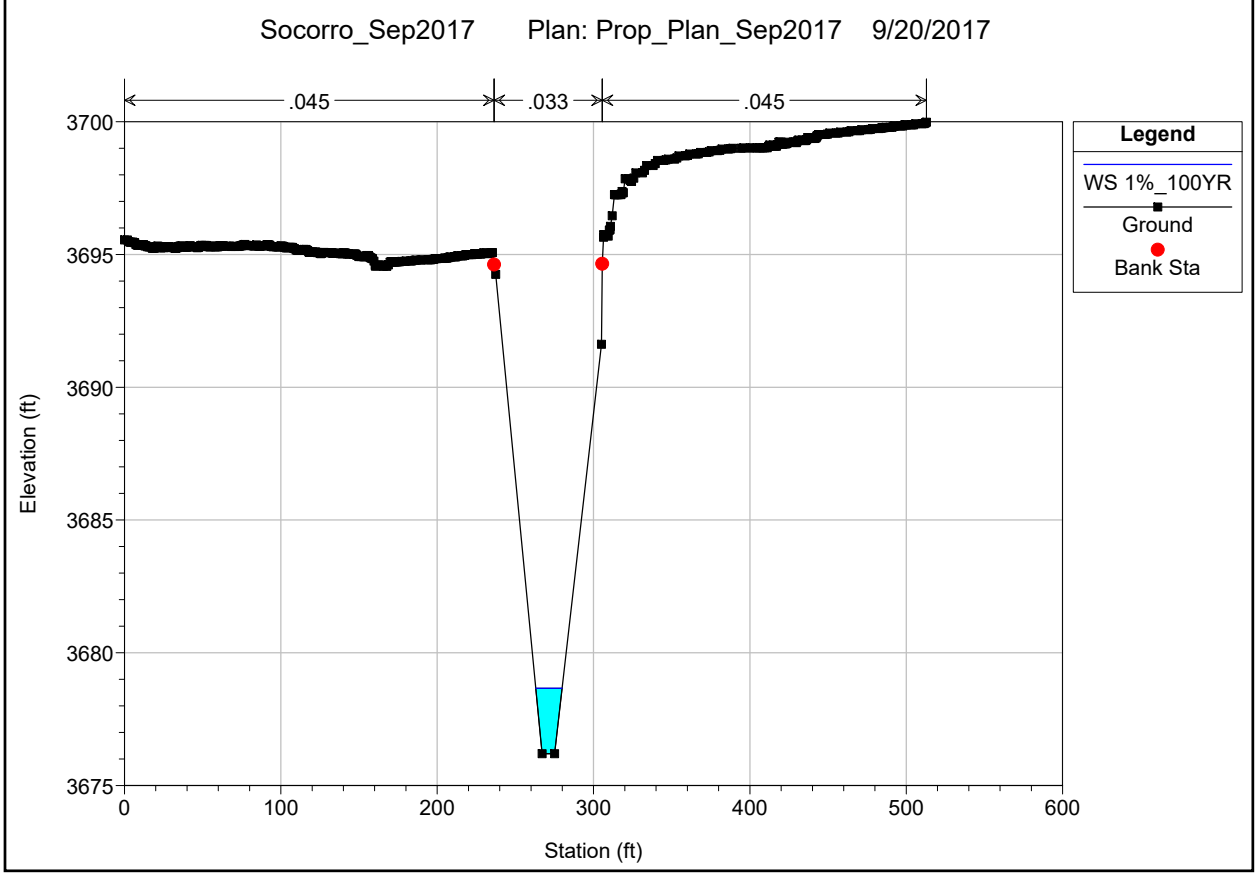
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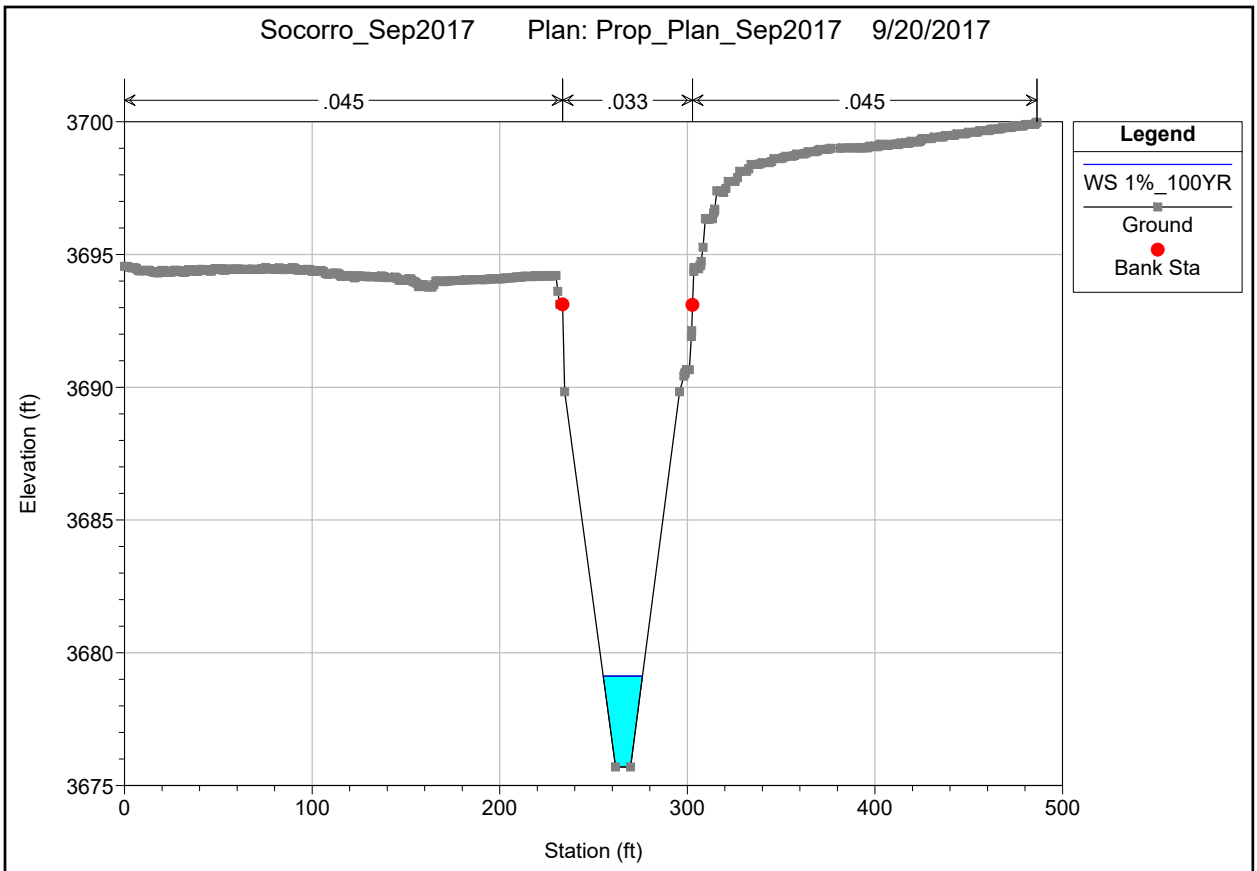
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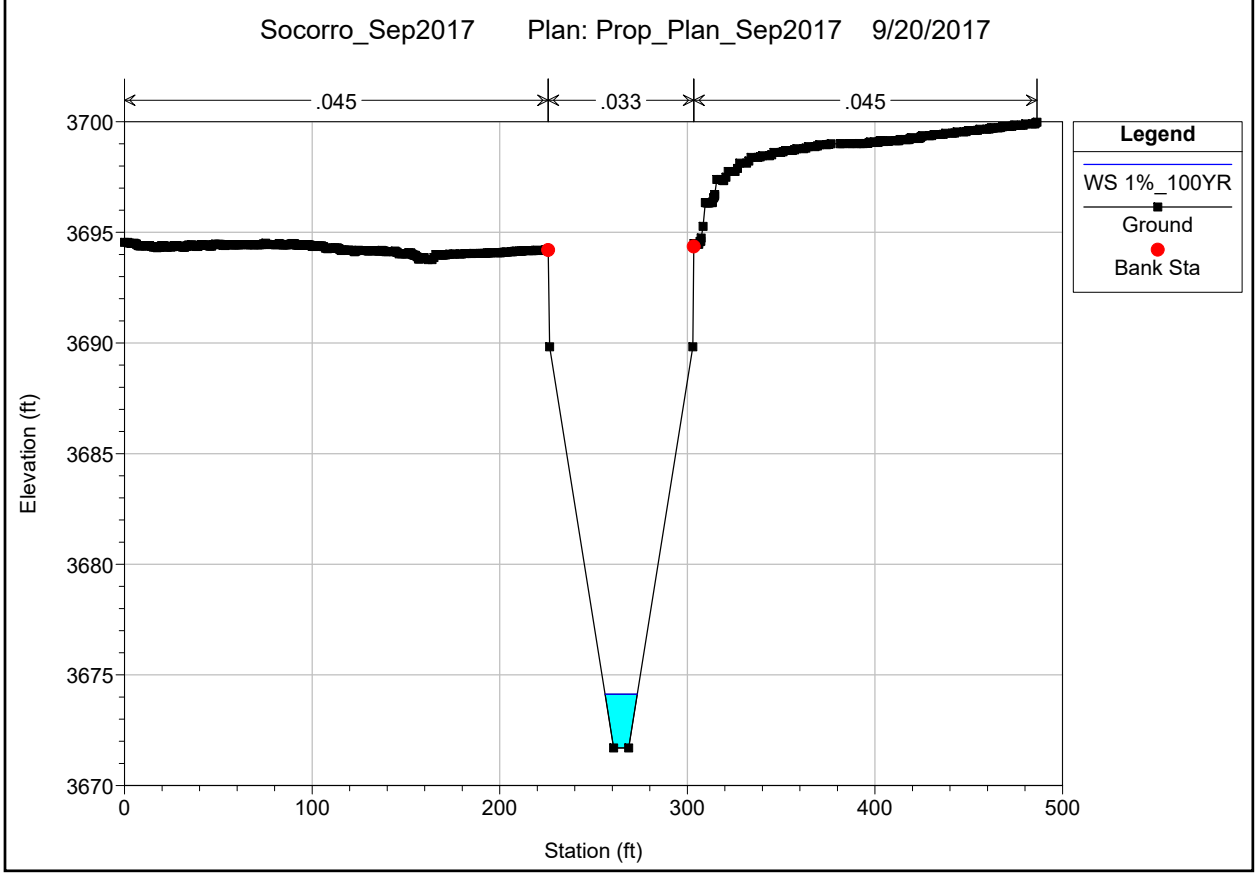
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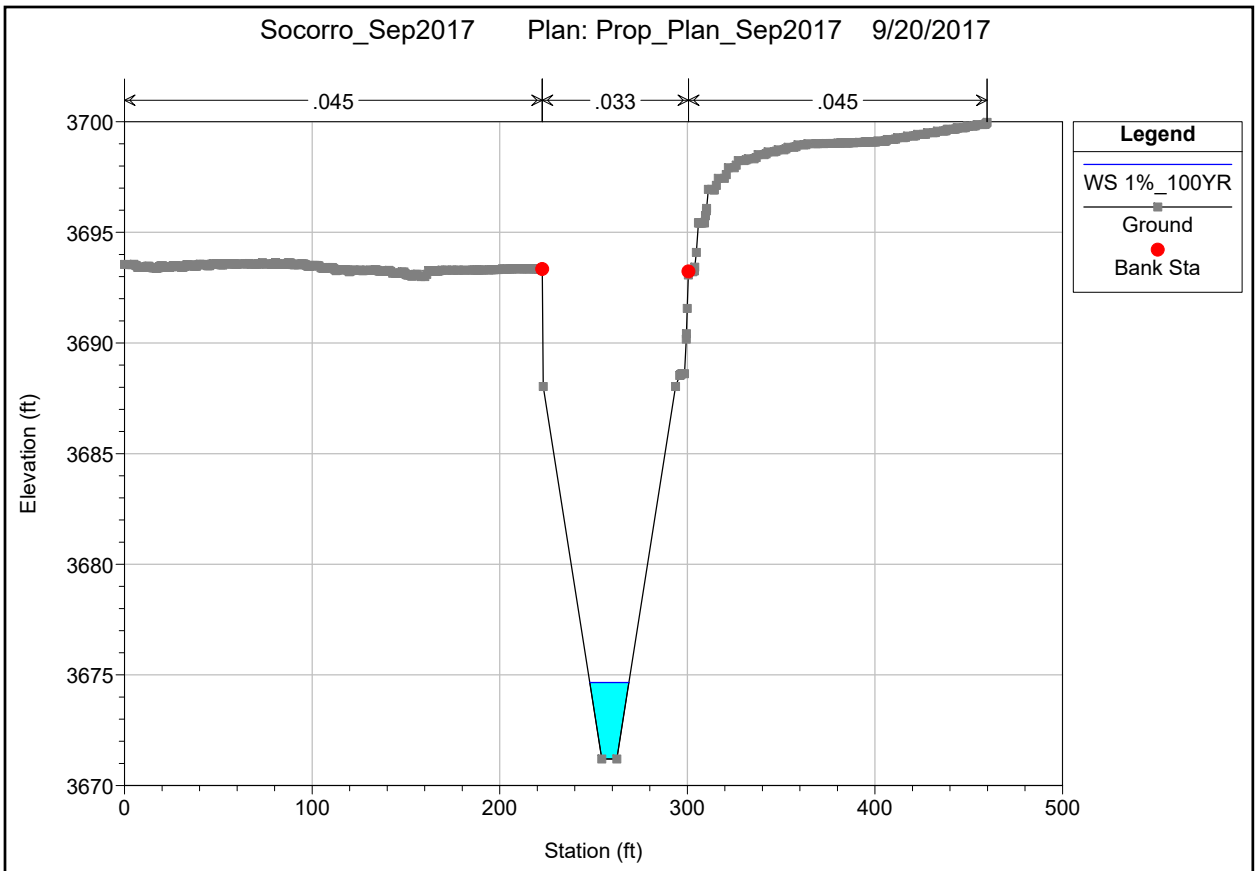
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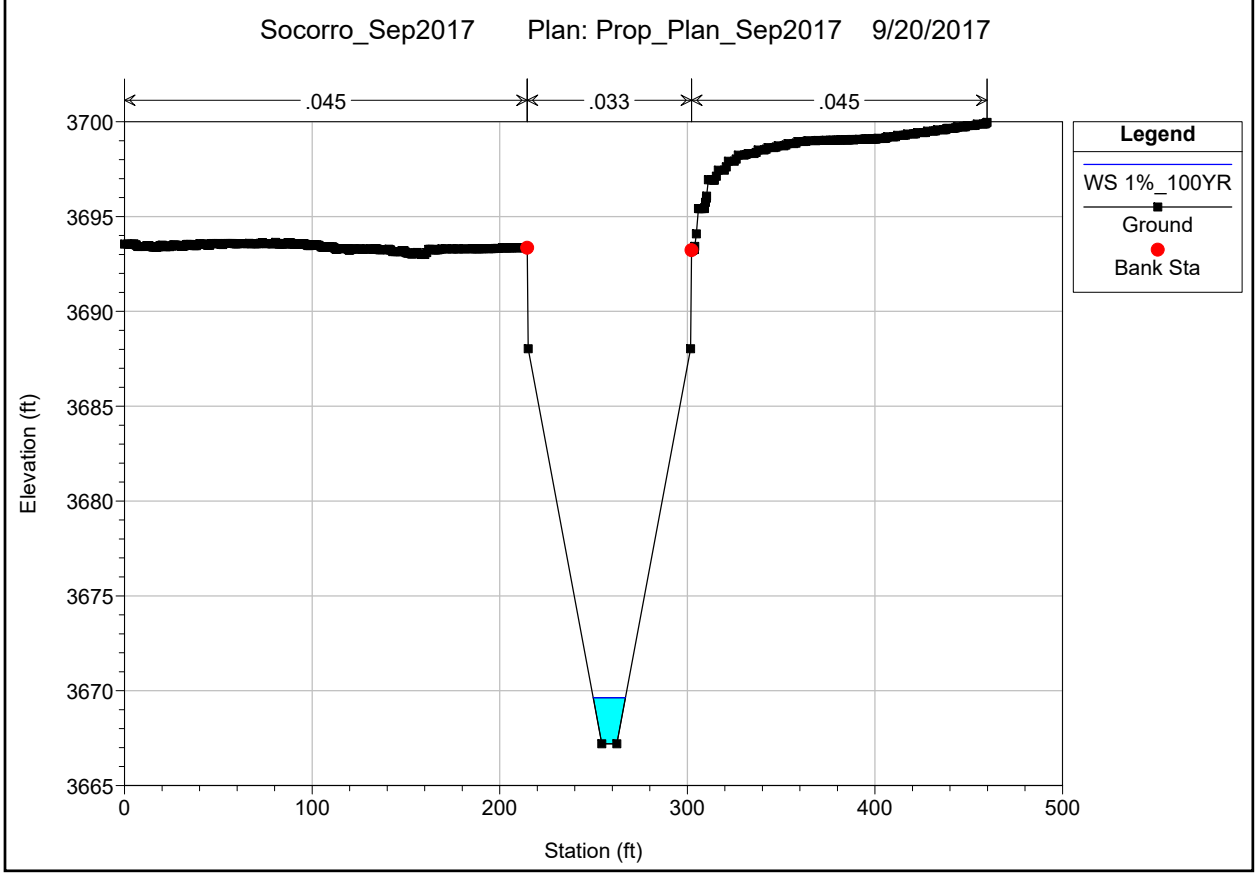
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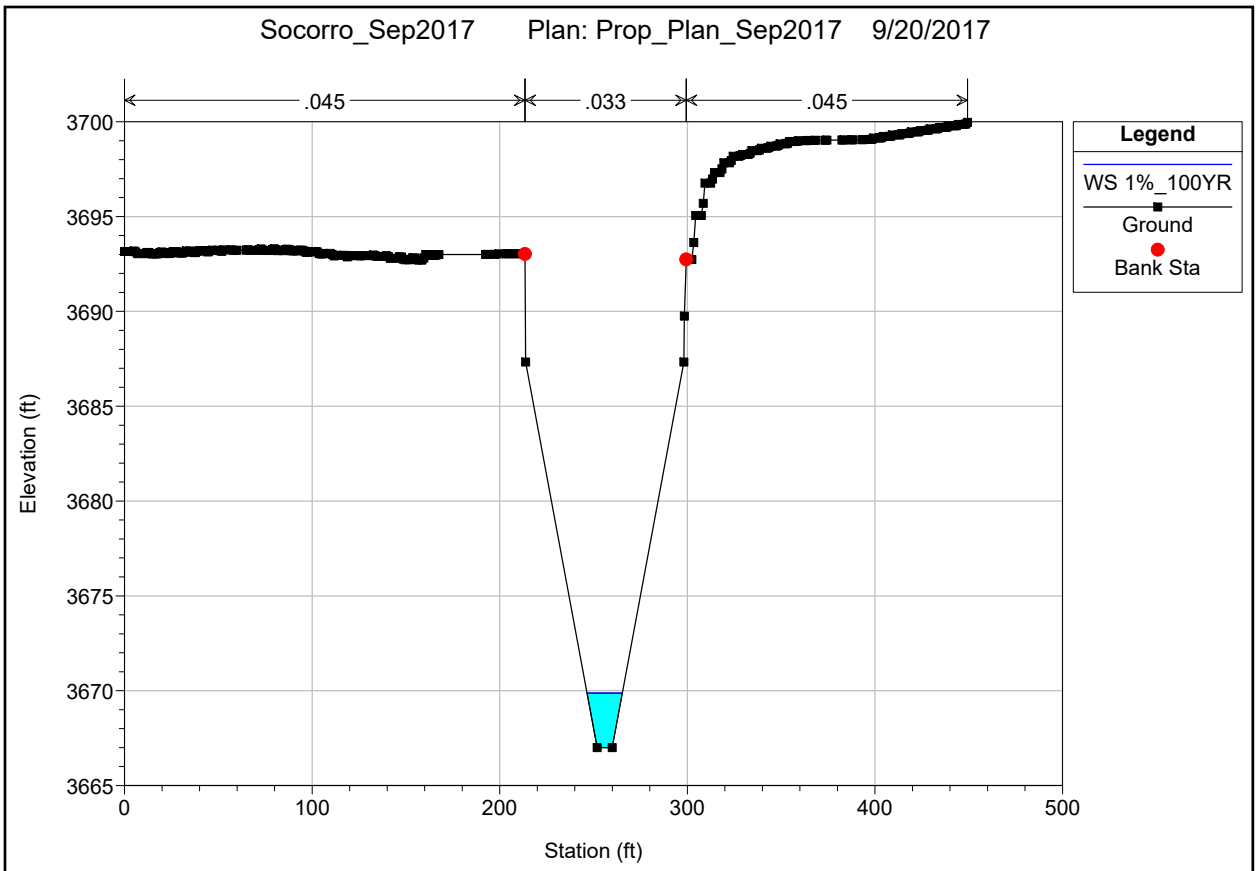
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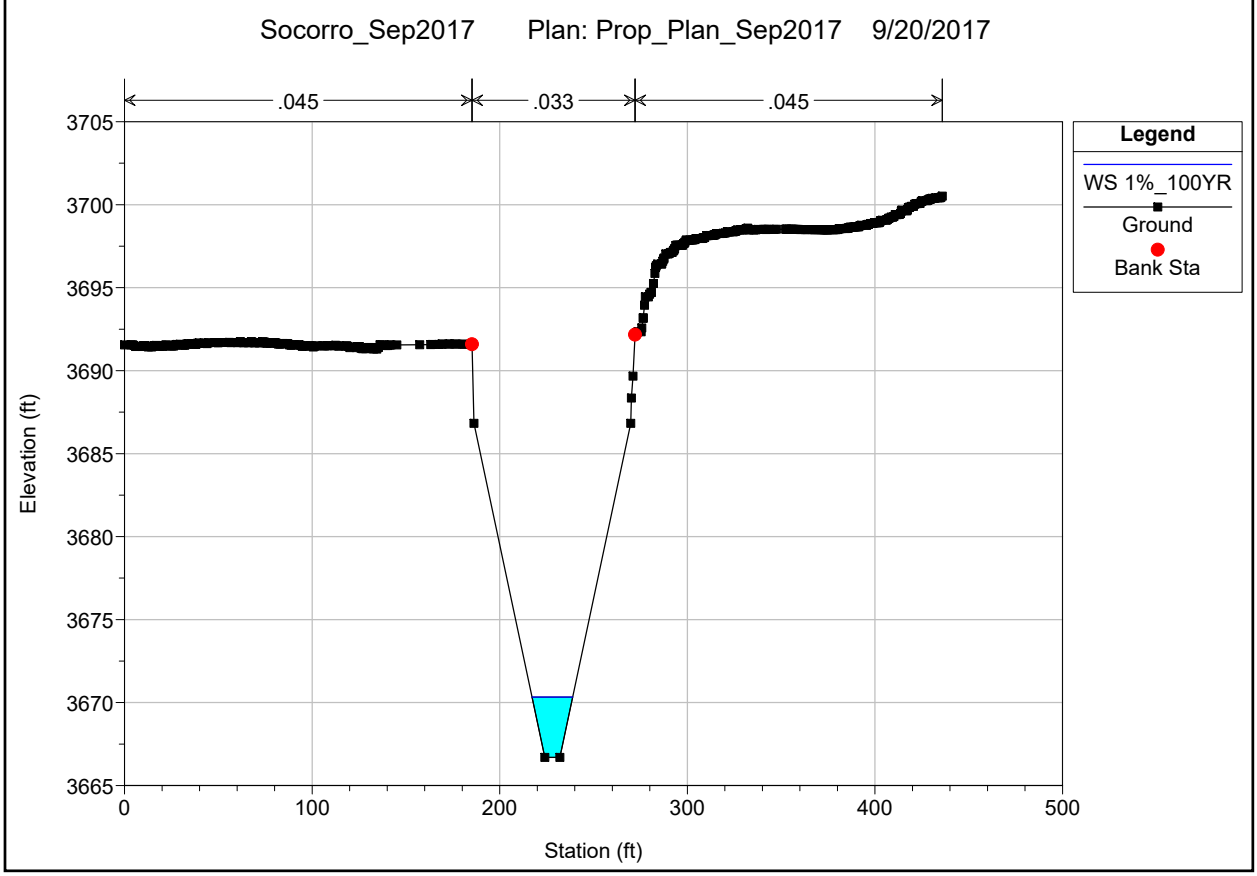
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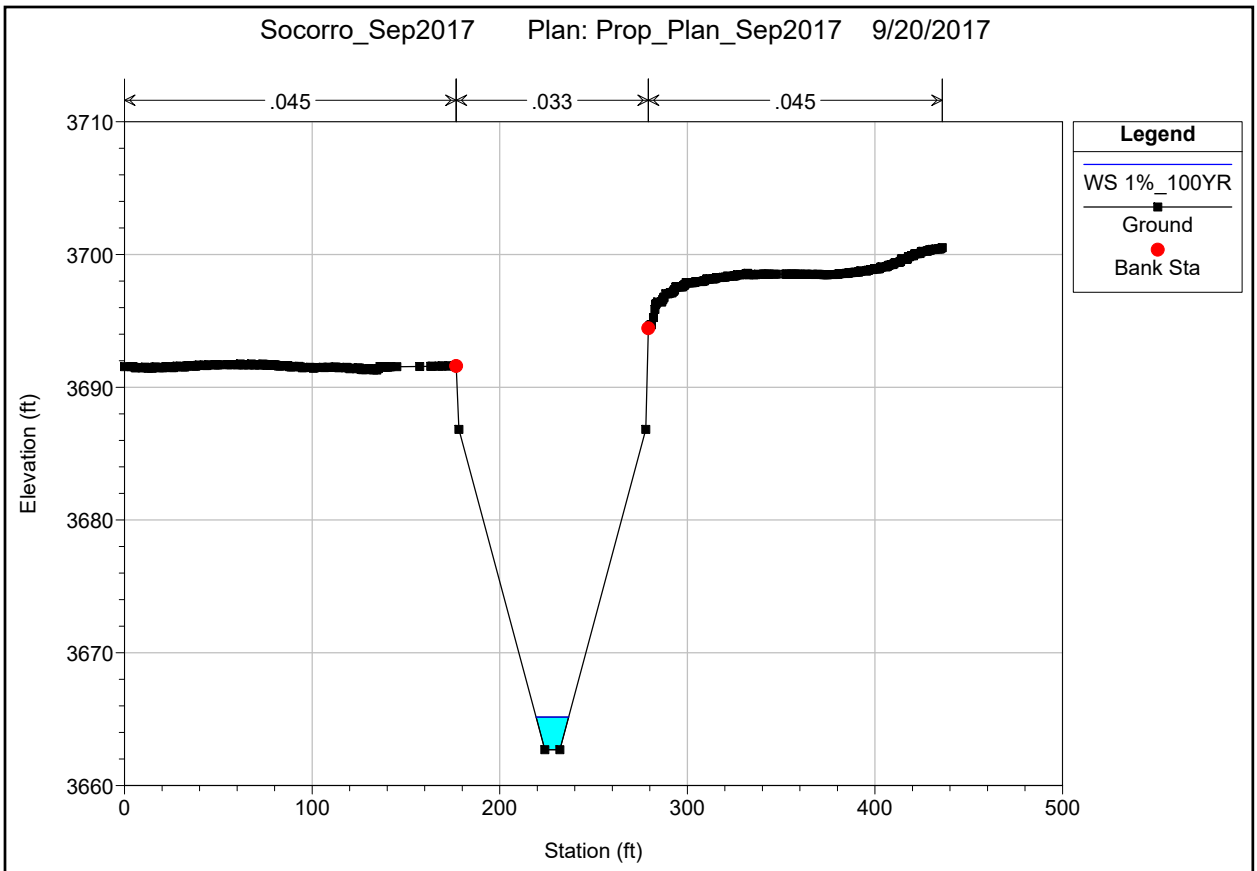
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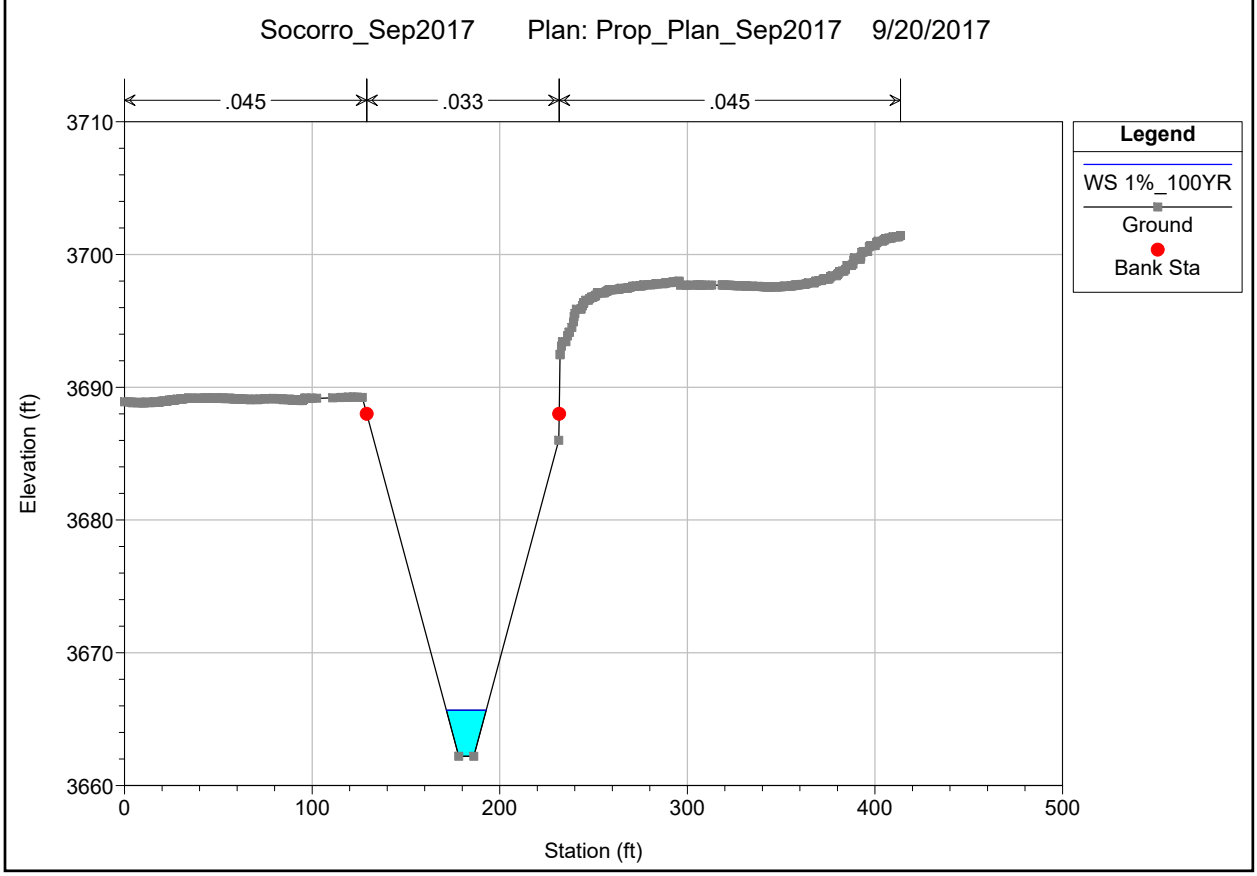
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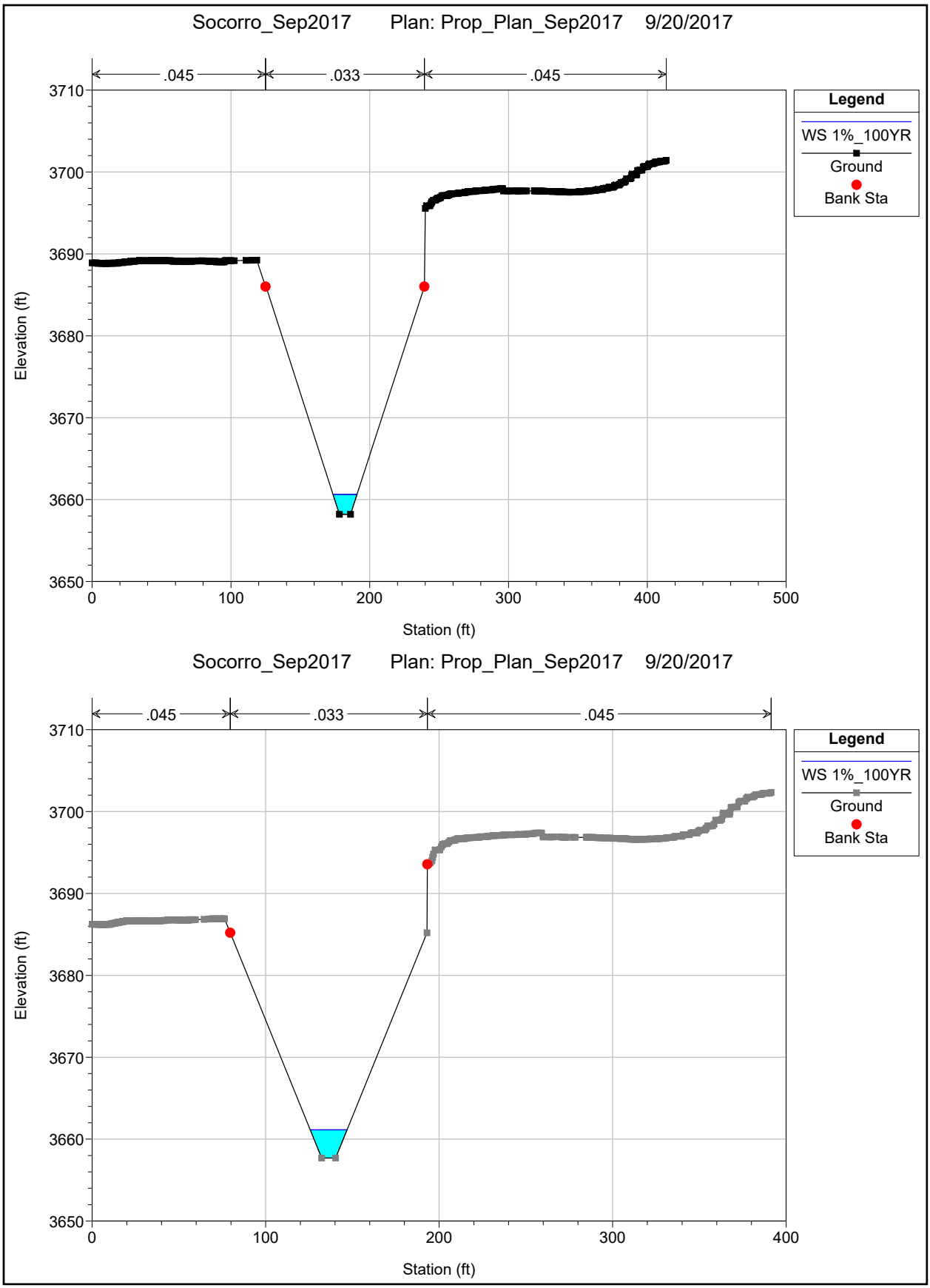
Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
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Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
3710
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Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
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Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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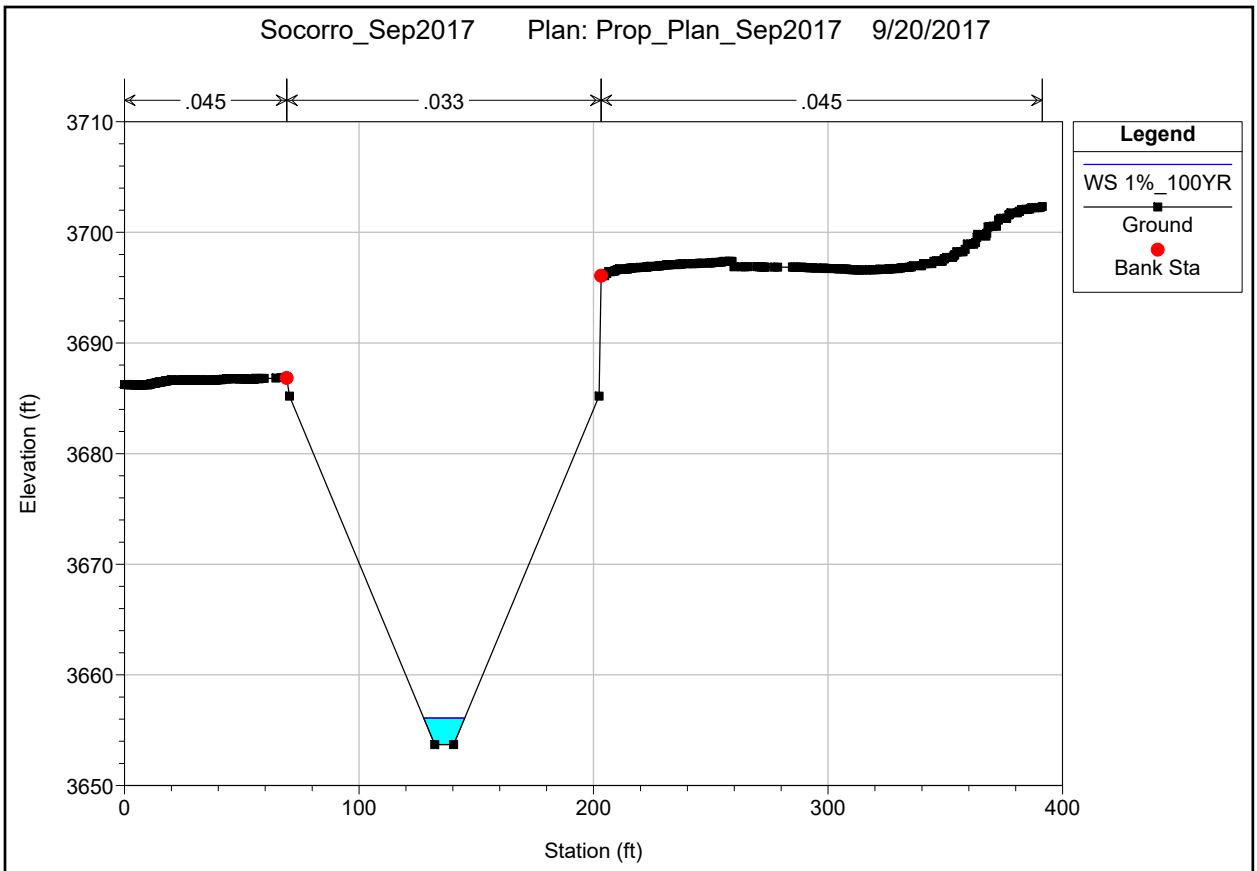
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Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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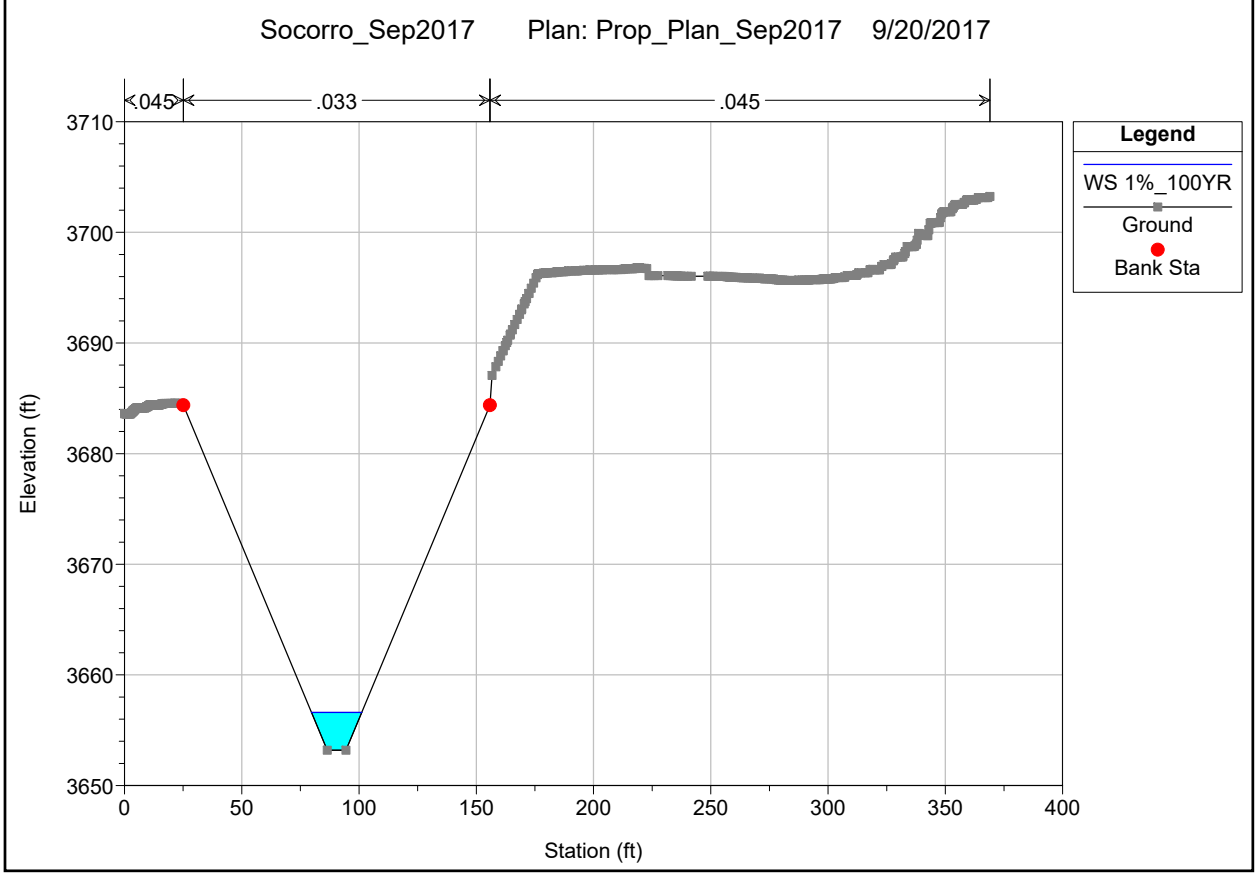
Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
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Legend
WS 1%_100YR
Ground
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Elevation (ft)
Station (ft)
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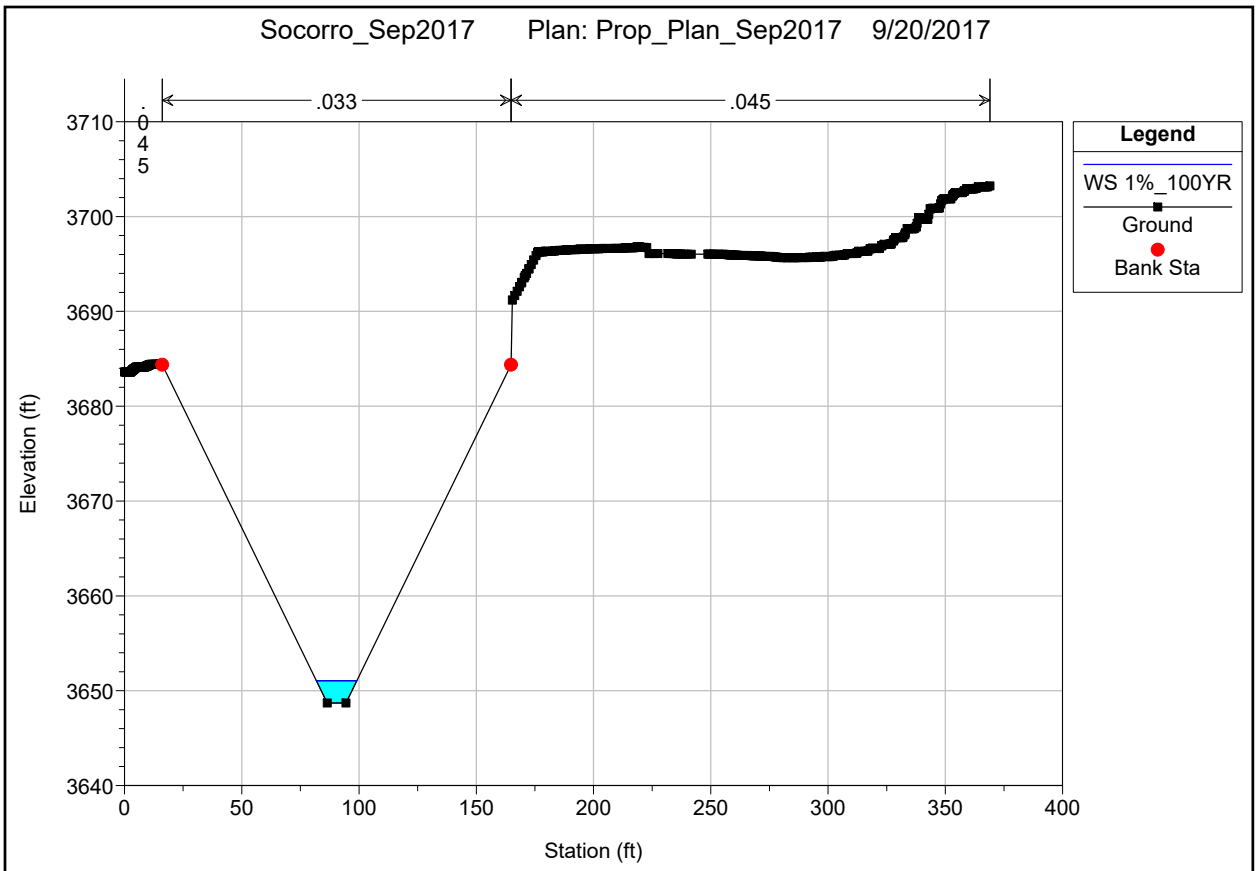
Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
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Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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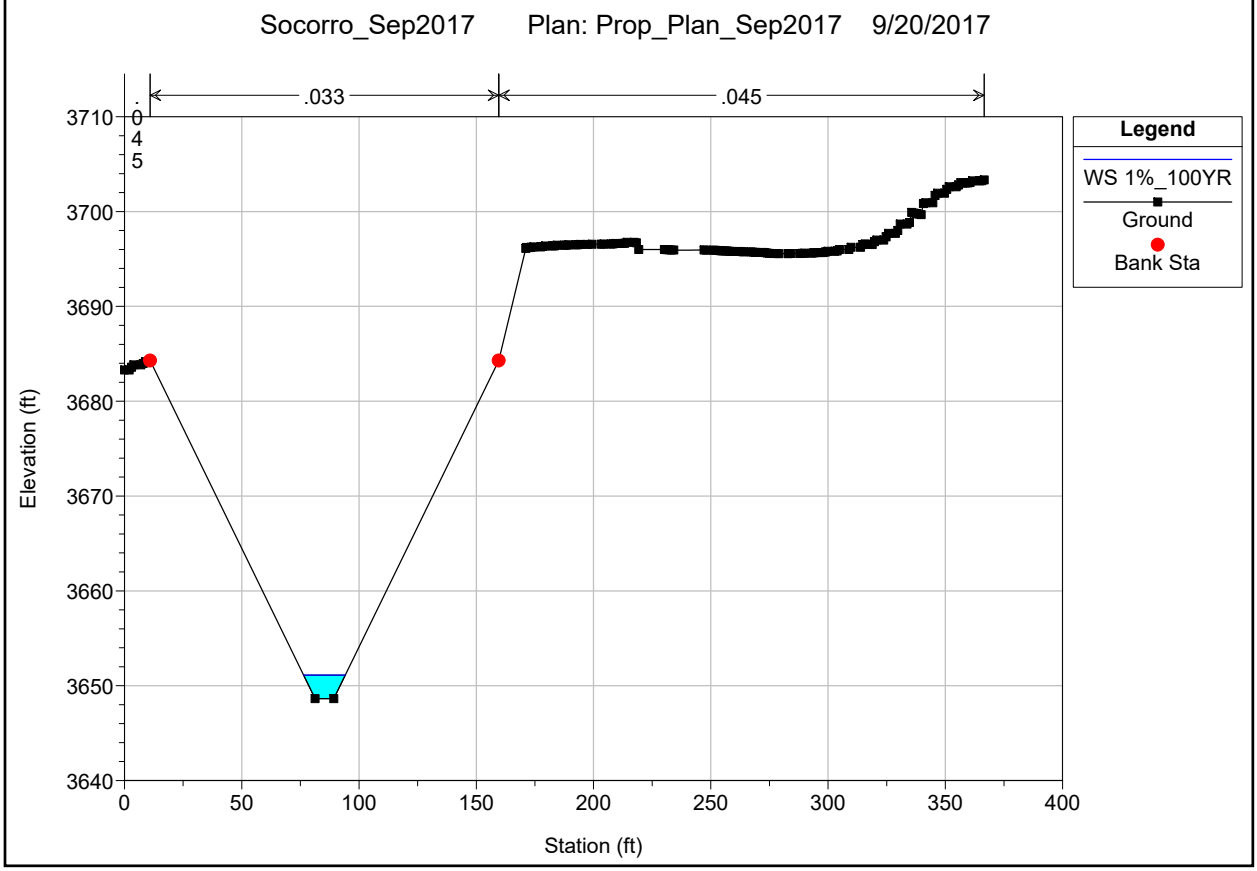
Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
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Legend
WS 1%_100YR
Ground
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Elevation (ft)
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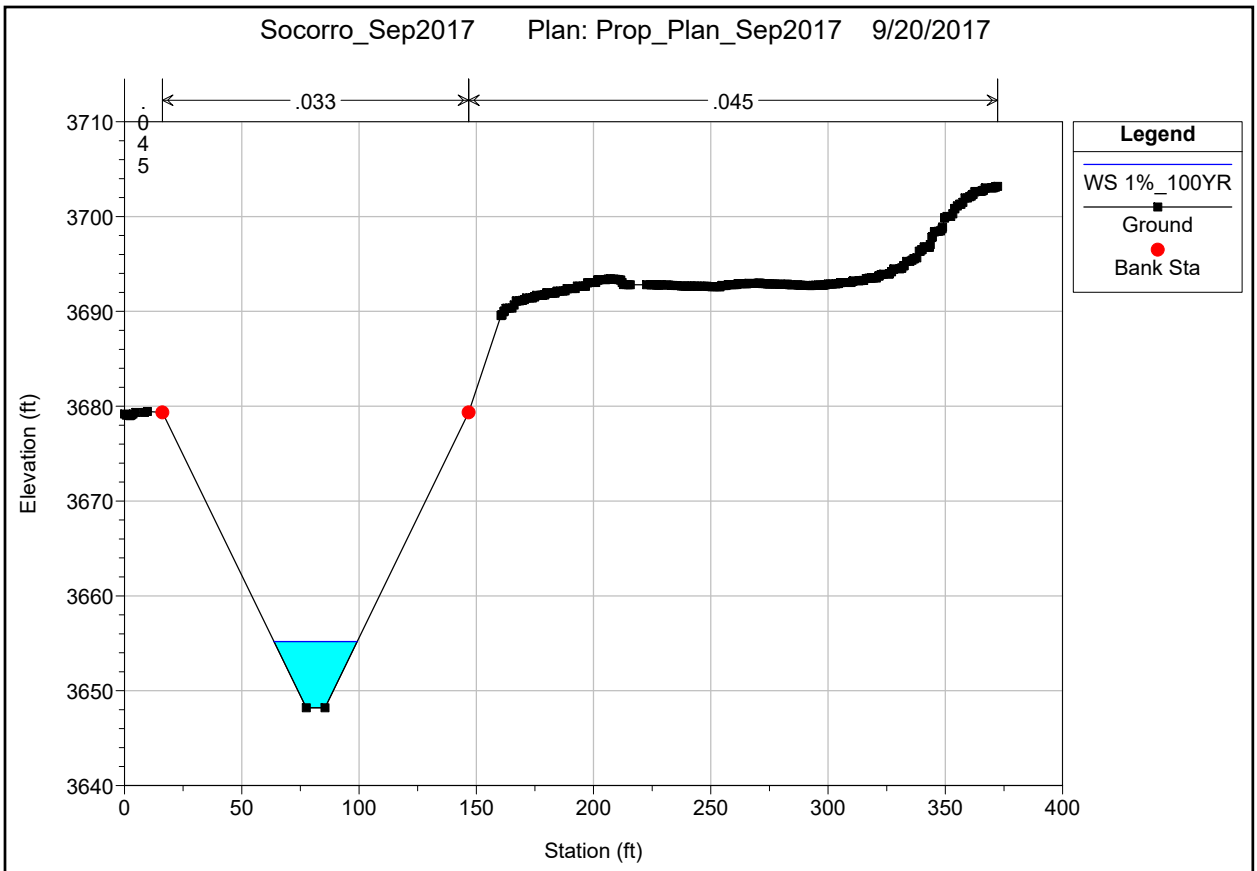
Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
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WS 1%_100YR
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Elevation (ft)
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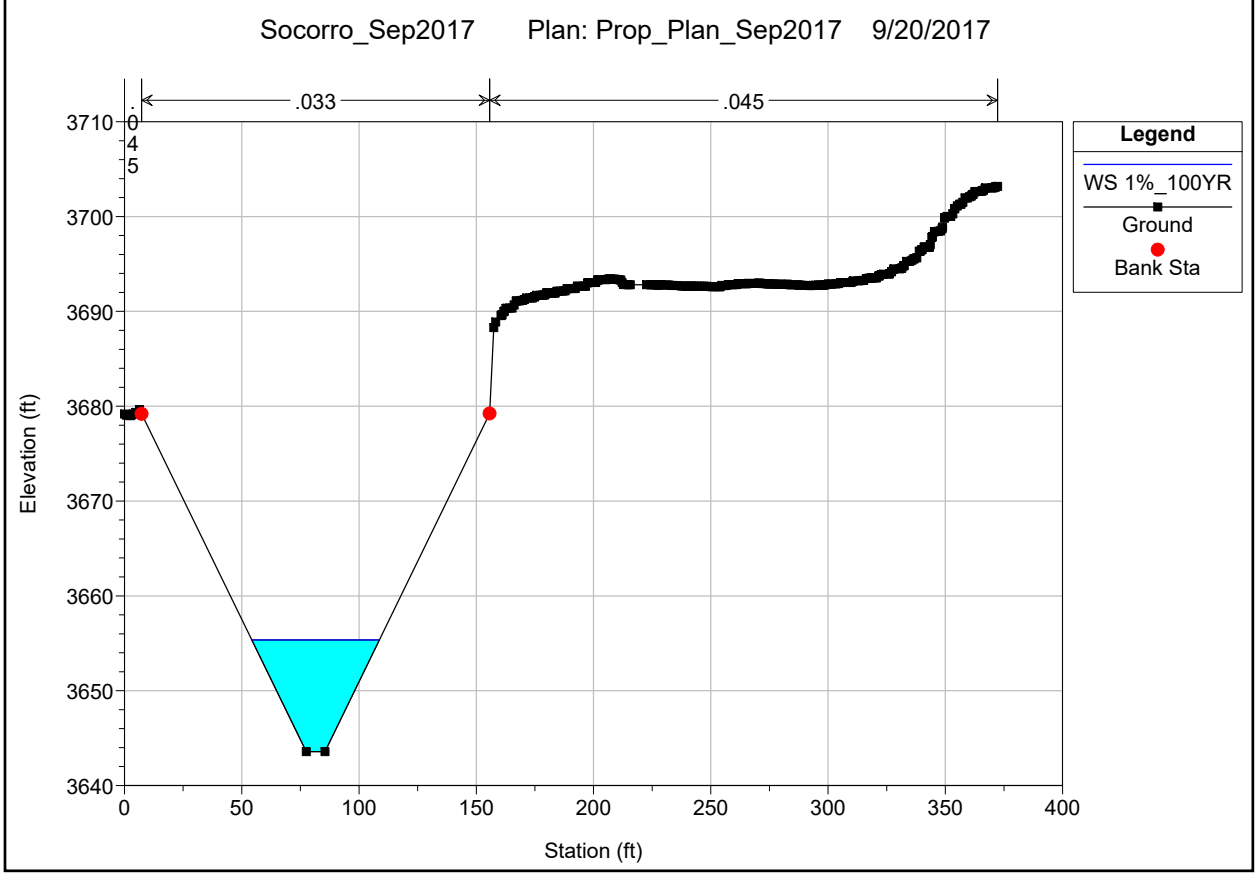
Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.033
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Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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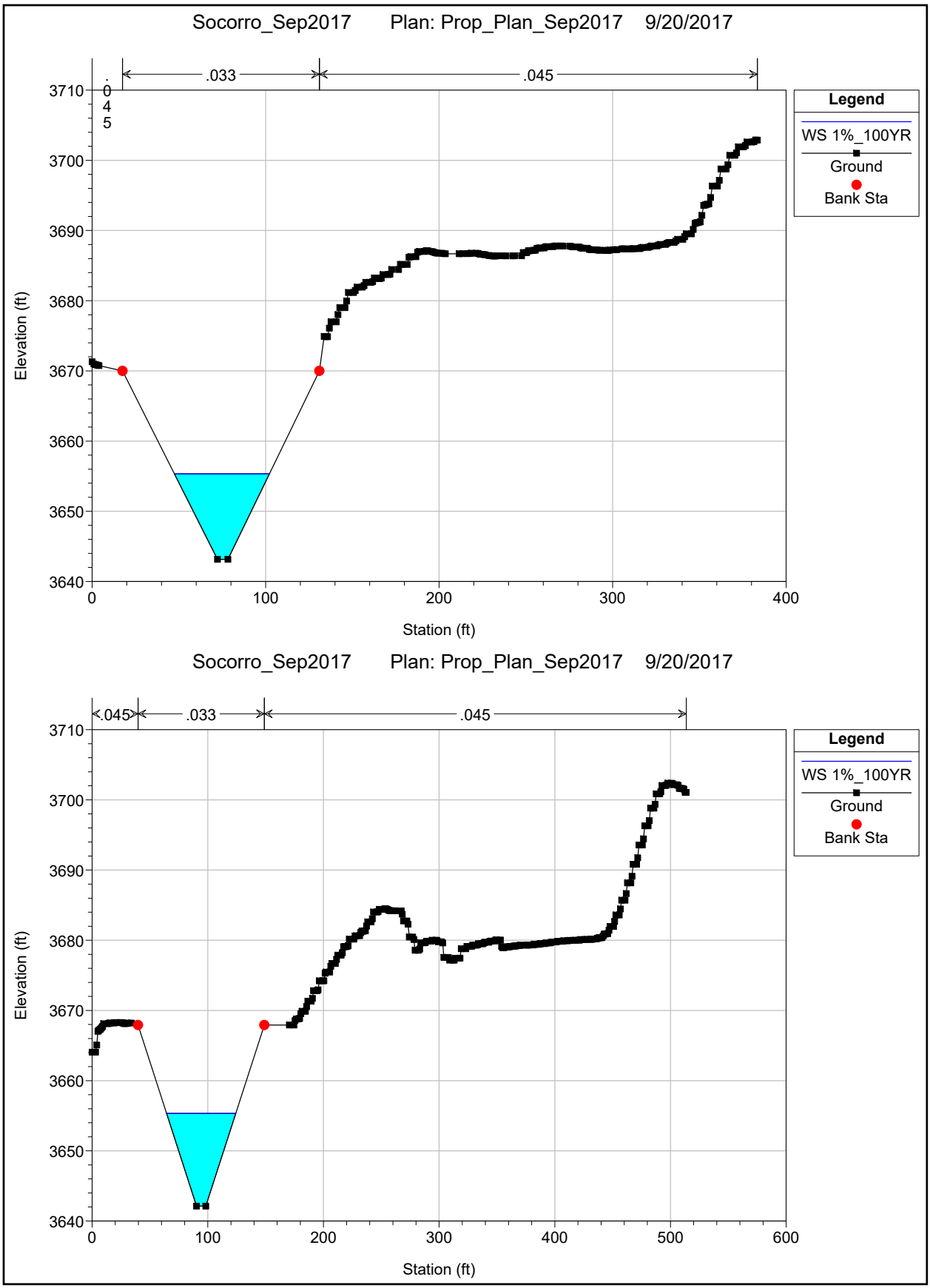
Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
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Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
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Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
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Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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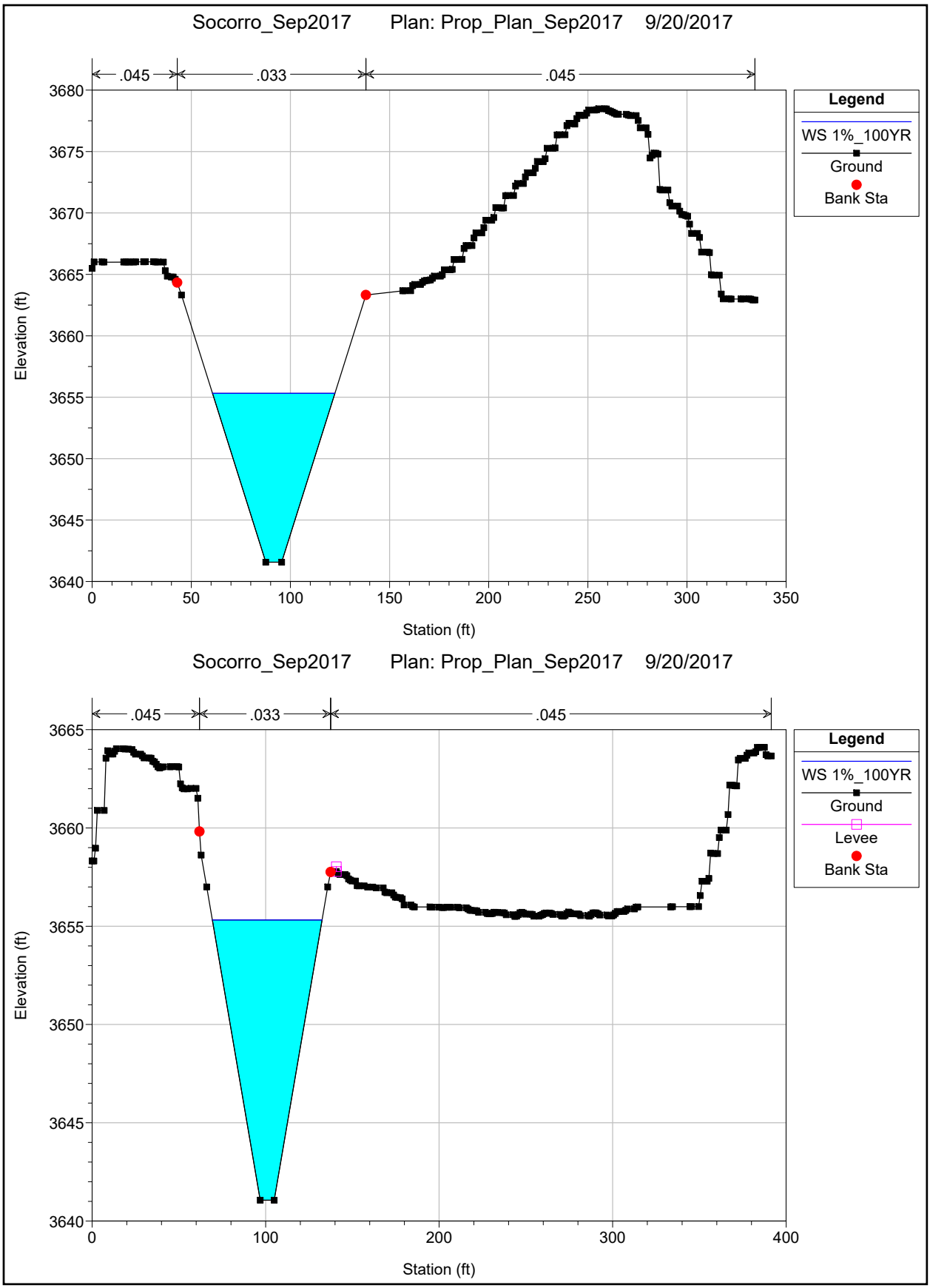
Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
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Legend
WS 1%_100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
.045
.033
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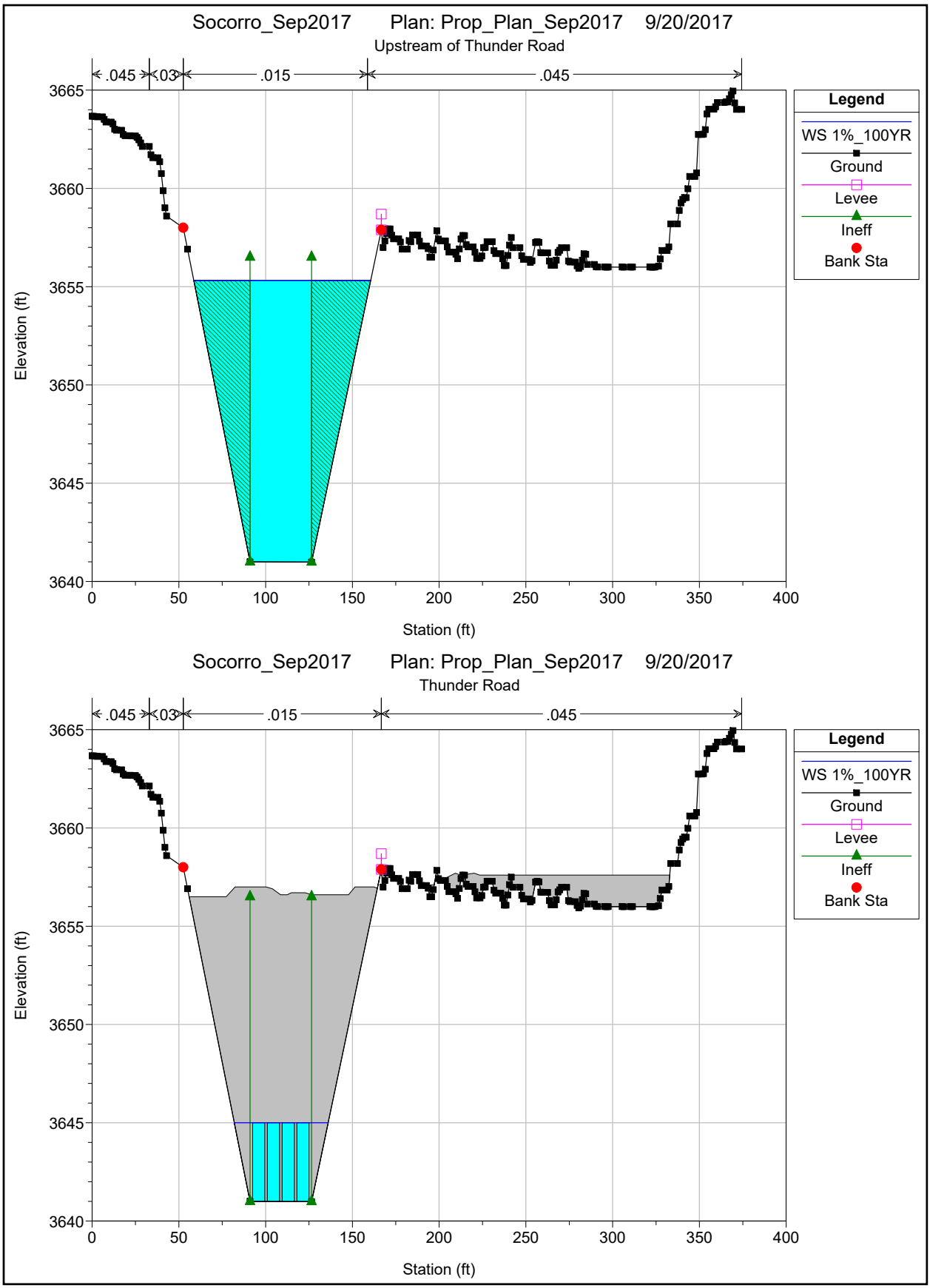
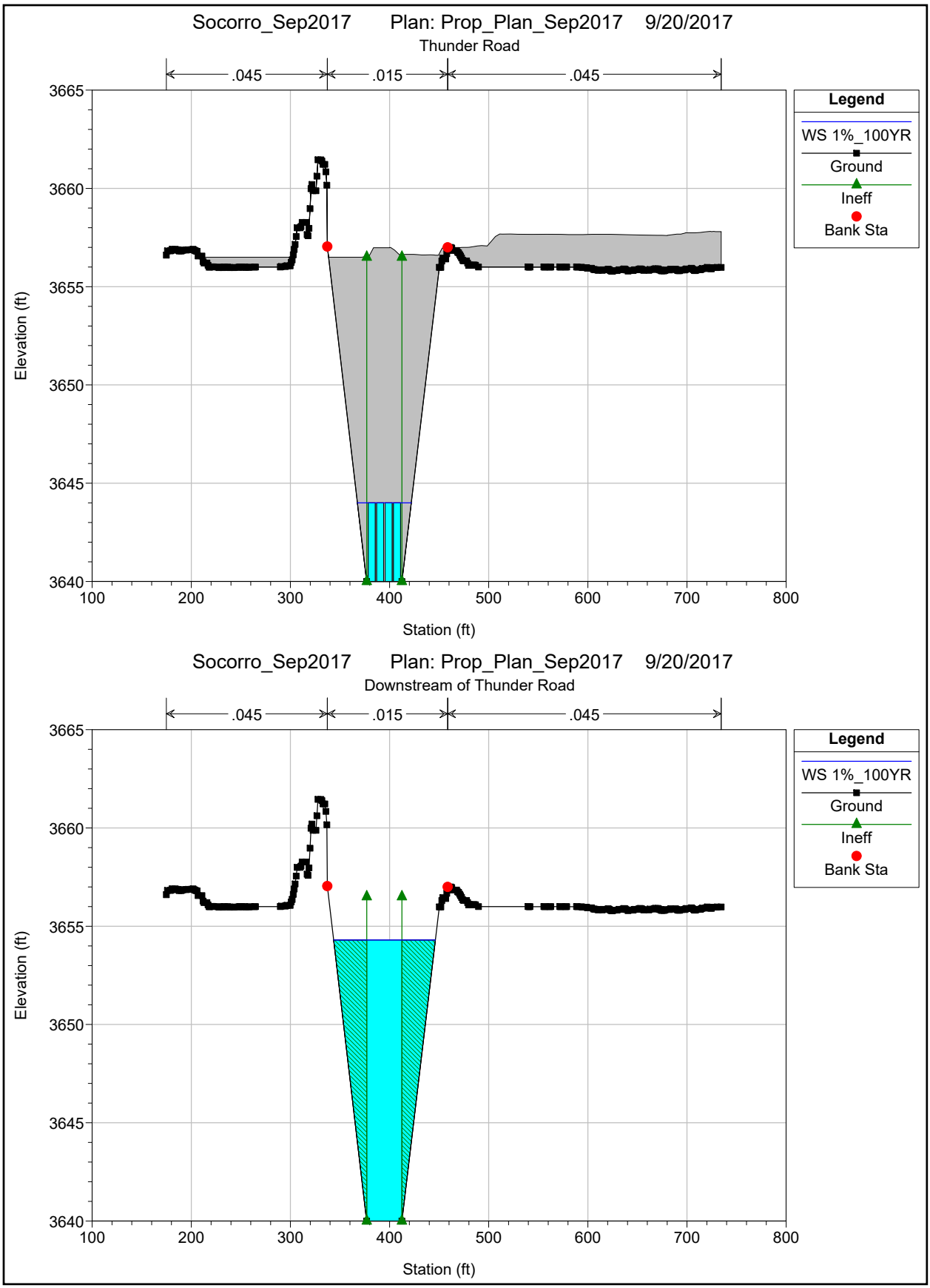
Legend
WS 1%_100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
Upstream of Thunder Road
.045
.03
.015
.045
Legend
WS 1%_100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
Thunder Road
.045
.03
.015
.045
Legend
WS 1%_100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
Thunder Road
.045
.015
.045
Legend
WS 1%_100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3665
3660
3655
3650
3645
3640
100
200
300
400
500
600
700
800
Socorro_Sep2017 Plan: Prop_Plan_Sep2017 9/20/2017
Downstream of Thunder Road
.045
.015
.045
Legend
WS 1%_100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)